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ABSTRACTS

Drone Assisted Stream Habitat (DASH) Protocol: Increasing the Accuracy & Efficiency of Data Collection for Large Spatial Scales

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Effective ecosystem management relies on accurate and timely evaluations of environmental status and trends, often equating to, time intensive survey efforts. Rapid advances in technology are constantly improving sampling methods, robust statistical inference, and thus cost and time efficiency. A recent major improvement in broad-scale habitat and wildlife monitoring has been advances in remote sensing technologies. The Columbia River Basin is a major target for habitat restoration toward the de-listing of endangered Chinook salmon and steelhead. Multi-scale habitat characteristics are critical to understanding what defines quality habitat and where to focus restoration efforts. We developed the Drone Assisted Stream Habitat (DASH) protocol to collect data at the channel unit and habitat reach (~200 m) scale in an efficient manner, which is then paired with imagery collected via drone. Thanks to the time and efficiency of drone surveys, this approach can be applied to larger scales (restoration project, tributary) with reduced on-the-ground sampling. Furthermore, we are developing tools that automate the post-processing of data and imagery, with hopes to substantially reduce the cost efficiency and ease post-processing. The approach allows for the pairing of fish (e.g., snorkel) and habitat data at multiple spatial scales. These data can then be used to populate fish-habitat models, such as quantile regression forest (QRF) capacity models at multiple spatial scales. In the Upper Salmon Subbasin, Idaho, we have applied DASH and QRF to define quality juvenile Chinook salmon and steelhead habitat, identify current capacity limitations, and will soon use DASH to monitor the effectiveness of restoration actions. Taken together, the DASH and QRF approach provides a promising & efficient tool to prioritize, direct, and monitor habitat restoration.

Genomic insight into salmon parasites

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Ceratonova shasta is a microscopic parasite that infects native salmonids. Its seasonal abundance in the Klamath River is closely monitored to inform fisheries management and mitigate disease events. C. shasta belongs to the group of parasites Myxozoa, which threaten wild and cultured fishes worldwide. At Oregon State University, we utilize lab cultures of C. shasta to understand the genomic underpinnings of myxozoan infection and disease. In this talk I will discuss the initial steps of myxozoan infection: host-sensing and venom delivery. Myxozoans are distant relatives of free-living cnidarians like jellyfish and anemones and likewise deploy nematocyst stinging cells to attach to fish. We identified inherited fish-sensing genes but an overall reduction and simplification relative to free-living cnidarians. Once C. shasta is attached to host fish, it increases transcription of venom-like proteins and continues to produce these compounds throughout the infection. These findings are consistent with transcriptomic datasets of the distantly-related myxozoan parasite Tetracapsuloides bryosalmonae, suggesting reductions in host-sensing genes and venom delivery in C. shasta may be

representative of many myxozoans. Further, I will discuss applications of our findings in predicting myxozoan disease outbreaks and inhibiting infection.

The role of hatchery production for Chinook salmon in the Elwha River: past, present and questions for the future

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Elwha River Chinook salmon were legendary for their large body size, but construction of Elwha (1912) and Glines Canyon (1927) dams severely restricted their distribution and reduced the quality of the remaining 8 km of habitat in the lower river. While the dams were in place, a hatchery program initiated in 1930 by the Washington Department of Fisheries helped preserve the unique genetic lineage of Elwha Chinook salmon, with relatively few releases of non-Elwha juveniles. Still, important components of life history diversity, notably spring-run and large bodied adults, were lost over time. During dam removal, hatchery production helped ensure population persistence despite large-scale sediment disturbance and increased the abundance of potential recolonizers. However, the long term management goal is to transition towards entirely self-sustaining natural production without the need for hatchery supplementation. We sampled Chinook salmon spawned at the hatchery and senescent carcasses of fish spawning naturally in the river to track hatchery mark rates and compare traits of hatchery-origin and natural-origin salmon. From 2009 to 2020, hatchery mark rates averaged 95.4 %. Run reconstructions combining abundance, hatchery mark and age structure information indicate that fish spawning naturally in the river 2004 – 2016 failed to replace themselves in all cohorts (average spawner to spawner productivity = 0.15). There was some indication of lower hatchery mark rates at more upstream locations, likely linked to the hatchery releases occurring in the lower river near its mouth. At present, some level of hatchery production appears necessary to maintain the persistence of the endemic Elwha population. However, after nearly 100 years of domestication selection, transitioning towards self-sustaining natural reproduction may require 1) a significant reduction in the number or proportion of hatchery-origin fish spawning naturally and 2) time for natural selection to shape traits advantageous in the river environment.

Hunting tiny vampires: modeling the occurrence of a salmonid ectoparasite in Willamette Valley Reservoirs

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The freshwater copepod Salmincola californiensis is an ectoparasite affecting salmonids in the genus Oncorhynchus. Chinook Salmon reared in reservoirs of the upper Willamette River Basin have been reported to experience higher rates of infection by S. californiensis than would be experienced by their counterparts reared in streams. These high levels of infection can lead to decreased fish fitness and survival, especially when simultaneous stressors are present, which may ultimately hinder the recovery of these ESA-listed salmon. Currently, the relationship between reservoir conditions and infection rates is poorly understood. Here, we aim to inform these associations by modeling the occupancy and abundance of the free-living, infective stage (copepodid) of S. californiensis in relation to environmental factors (e.g., temperature, water clarity, reservoir plankton profiles, and season).

We sampled S. californiensis in three reservoirs from the upper Willamette River Basin. Information gained from our modeling effort will be useful for guiding management decisions made by biologists and reservoir operators regarding salmon populations in reservoirs.

State of Oregon Fish Passage Design Rules --- Revision Update ---

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The Oregon Department of Fish and Wildlife (ODFW) Administers the state's fish passage policy and administrative rules. ODFW is in the process of revising these rules, in particular the state's fish passage design criteria. This presentation will provide an update on the rule revision process and will highlight some of the important fish passage design changes being considered by the state.

Revealing wildlife interactions with large wood in rivers

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In-stream large wood affects river channel shape, sediment deposits, hydraulics, and available habitat for aquatic species. Yet, little is known about how wildlife interact with large wood structure in streams. Previous research has shown that small mammals and birds could use woody debris in river channels for foraging and refuge, but this still leaves much to be answered. Here, we document both wildlife and their behaviors associated to in-stream large wood to gain a better understanding of the role of large wood in riparian ecology. Thirteen camera traps were placed at artificial and naturally occurring in-stream large wood structures for 12 months capturing videos of wildlife interacting with the structures. Over 35 species were detected including small mammals, birds, meso-carnivores, large carnivores, and semi-aquatic mammals. Videos have provided information on the diel and seasonal activity of common species. This study will provide foundational information for future studies focusing on restoration ecology and the use of large wood in streams.

Wildfire smoke cools Klamath Basin stream temperatures, especially in large waterbodies during August

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Smoke generated by wildfires acts like a cloud, reducing the amount solar radiation striking the land and water, and reducing temperatures. This smoke-induced cooling has the potential to benefit cold-water adapted species, particularly because wildfires are more likely to occur during the warmest and driest years and seasons. This presentation will highlight results from two statistical research projects: the 2018 publication “Wildfire Smoke Cools Summer River and Stream Water Temperatures” (https://doi.org/10.1029/2018WR022964) and the 2020 report “Influence of Snowpack, Streamflow, Air Temperature, and Wildfire Smoke on Klamath Basin Stream Temperatures, 1995-2017” (http://dx.doi.org/10.13140/RG.2.2.22934.47681). Since the early 1990s, Native American Tribes,

federal and state agencies, non-governmental organizations, and universities have collaboratively monitored water temperatures in rivers and streams in the Klamath River Basin of Northern California and Southern Oregon using continuous probes, providing a long-term dataset to evaluate the effects of smoke. We constructed linear mixed effects models to predict stream temperatures using river flow, air temperature, snowpack, and remote-sensed estimates of wildfire smoke from satellites. The 2018 publication analyzed 12 sites at a daily time scale while the 2020 report analyzed 87 sites at a monthly time scale. The cooling effect of smoke is greater in mainstem rivers than in small tributaries, because tributaries are already shaded by streamside trees so additional shading from smoke has less effect. Smoke reduces daily maximum temperatures more strongly than daily average temperatures. In recent decades, smoke has limited increases in August water temperatures, but has not affected trends in annual maximum water temperatures because in most years fires do not start until after the year's hottest water temperatures have already occurred. The greatest cooling occurs during strong "inversions" when calm conditions allow smoke to continuously accumulate in canyon bottoms for many consecutive days.

Economic Value of Surface Water in Eastern Oregon's Harney Basin

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Surface water in the Harney Basin is used for a variety of social, economic, and ecological benefits. While some surface water uses compete with one another, others are complementary or jointly produce multiple beneficial outcomes. The objective of this study is to utilize existing natural and social science data to quantify the economic benefits and regional economic contributions of activities that are directly or indirectly related to the allocation and use of surface water in the Harney Basin. The focus of these activities are recreational fishing, migratory birding, and wet meadow pasture production. The estimated annual economic benefits of recreational fishing and migratory birding in the Harney Basin total over $3 million with over $4 million in regional economic contributions. The estimated annual economic benefit of wet meadow pasture production in the Harney Basin is over $17 million with over $22 million in regional economic contributions. Given the complex interactions between surface water management on public and private land and the various goods and services that are derived from adequate water resources, identifying, and quantifying economic outcomes can be used to assist decision making in the basin. This is particularly important when considering investment in conservation and working landscapes in anticipation of future disturbance and climate change.

Reduction of Larval Lamprey Entrainment in Bachelor-Hatton Canal, Ahtanum Creek Yakama Nation Fisheries Pacific Lamprey Project (YNF PLP)

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The Yakama Nation Pacific Lamprey Project partnered with Natural Solutions, A Dam Site Better, LLC (Helena, MT) to install their patented Flow Velocity Enhancement System (FVES) at Bachelor-Hatton Canal (Ahtanum Creek, Ahtanum, WA, 58 cfs maximum flow) during spring 2021 to steer larval/juvenile lampreys and parr Coho Salmon away from problematic areas. The FVES system

consists of a venturi pump that creates a strong direction flow by amplifying and directing the flow from an attached submersible pump. Two venturi pumps were installed at the canal; 1) one located immediately upstream of the headgate along the stream edge to steer larval lampreys away from the headgate and 2) one located within the canal upstream of the fish screens to encourage larval lampreys to use the bypass route. Larval and juvenile Pacific Lamprey (Entosphenus tridentatus), larval Western Brook Lamprey (Lampetra richardsoni), and Coho Salmon (Oncorhynchus kisutch) were PIT tagged and released in two locations; 1) upstream of the headgate (51 m upstream of the venturi pump), and 2) within the canal immediately downstream of the headgate (6 m upstream of the venturi pump). Tagged lampreys were released in pairs during a three-day period when the pumps were "ON", followed by a four-day period when the pumps were "OFF" for three weeks (April-May 2021); only one week of paired release was conducted for Coho Salmon. The number, length composition, and release times were kept similar for each paired release. Several challenges during the study included strong interference between the pump and PIT tag arrays (noise levels as high as 60% at the inlet of the bypass array) and highly variable flow between releases (within the canal and in the stream). The preliminary results from this study will be shared.

Those who do not learn from history are doomed to repeat it - The story of Columbia River Sturgeon

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The history of white sturgeon in the Columbia River provides an object lesson in success and failure in fishery management. Overfishing during the late effectively collapsed the once-robust white sturgeon population and recovery required almost 100 years. Sturgeon did not begin to recover until after 1950 when maximum size limits were placed on sturgeon to protect the large adult spawners. By the late 1970s, a tremendous sturgeon fishery had been restored in the lower Columbia River and estuary. However, the lower Columbia River population reversed course and by 2000 began to decline. Sturgeon fisheries have now collapsed to token levels. Sturgeon populations and fisheries in impounded areas upstream from Bonneville Dam never recovered to comparable levels and many fragmented subpopulations are functionally extinct. What have we learned, what don't we know and where do we go from here?

A Tribal Approach to Riparian Forest Management

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In the mid 1800's, the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians were dispossessed of their 1.6 million-acre Ancestral Territory on the South-Central Oregon Coast, which they had called home since time immemorial. The Tribes were moved onto reservations, and federal recognition of the Tribes was eventually terminated altogether. Following restoration of federal recognition of the Confederated Tribes in 1984, the Tribes have sought the return of a small portion of their Ancestral Territory. This goal was achieved in 2018 when the President signed the Western Oregon Tribal Fairness Act into law, transferring 14,742 acres of BLM-managed lands into trust for the benefit of the Tribes. These Tribes are currently developing a Forest Management Plan (FMP) which will guide Tribal management of these forestlands. A significant component of the FMP will be a Tribal

Riparian Management Approach, which will provide forest management direction adjacent to streams on the Tribal Forest. This Tribal approach will differ from common approaches to riparian management, in that it will be outcome based and will not rely on fixed-width no-touch stream buffers. The Tribal approach will place an emphasis on active management to restore aquatic and riparian habitats, using site-specific management prescriptions that are responsive to localized, on-the-ground conditions. Development of site-specific prescriptions will be heavily reliant on models such as NetMap.

A Natural History Context for Timber Harvest-Related Landslides in Western Oregon

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Landslides and debris flows in mountain environments in the Pacific Northwest naturally supply the majority of sediment and a substantial amount of wood to stream channels and are formative factors for the distribution of channel and habitat types across a watershed. Forestry activities can increase the rates of landslide occurrences and alter the supply and storage of sediment and wood to fish-bearing streams. The occurrence and effects of landslides can be evaluated within a natural history context based on distributions of watershed processes that represent disturbance regimes. The naturally skewed landslide rate distribution is estimated based on basin sediment studies and landslide characteristics in the Oregon Coast Range. Timber harvest shifts this distribution, characterized by a falling left tail that reduces the occurrence of very low rates, including zeros, across the 70% of the distribution that is less than the mean. There is a corresponding rising of the right tail of the distribution, characterized by higher rates. These rate modifications result in a shift in debris-flow deposit ages along alluvial valley floors into younger age classes, environments characterized by sediment and wood deposits and disturbed riparian zones with deciduous vegetation. They also result in a 30% shift in the distribution of basin sediment supply and storage in alluvial channels, leading to a lower proportion of sediment-limited conditions and a higher proportion of larger stores of coarse sediment. Effects of altered landslide rate distributions on in-stream wood is dependent on the types and extents of stream and upslope vegetative buffers in managed forests. Shifts in the distributions of thermal insolation and in-stream wood along tributaries in agricultural lands aid in interpreting the ecological consequences of modifying natural disturbance regimes across the Oregon Coast Range.

Spatial variability in vulnerability of growth of redband trout in the northern Great Basin

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Climate vulnerability of fishes to drought and temperature can be evaluated in multiple ways, including shifts in distribution, behavior, or physiology. Growth offers one approach to evaluate response of species that are sensitive to changes in climate exposure – namely temperature and body size (a surrogate for drought). To consider climate variability and growth potential, we studied redband trout populations across the broad extent of the northwest hydrographic Great Basin of southeast Oregon, USA. Based on extensive fish surveys and discharge models, we found the maximum weight of trout decreased with baseflow discharge. We applied a bioenergetics model to 1)

evaluate spatial variability in growth potential across a broad spectrum of contemporary climate exposures and body sizes and 2) account for thermally adapted respiration and consumption parameters to influence growth potential across these exposures. Our results suggest the growth potential of redband trout varied across the region with some sites favorable to growth and other not conducive. High elevation stream sites tended to have a lower annual growth potential compared to lower elevation sites. In addition, larger individuals had reduced growth relative to smaller individuals. Patterns of growth differed for cold or warm water adapted fish. Cold water adapted fish showed bimodal growth, with peaks in spring and autumn, whereas warm water adapted fish showed peaks in summer. Our results offer insight into the spatial variability in redband trout respond to changes in climate exposure. In addition, patterns in growth potential we simulated could have population level impacts such as changes in adult size, fecundity and recruitment.

Environmental DNA experiments help to refine the distribution of Pacific Lamprey in the Deschutes River basin

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If the concentration of environmental DNA (eDNA) in rivers is not correlated with variables that are biologically meaningful (e.g., mass, distance, density) then inferences drawn from eDNA surveys will have limited applications (e.g., presence absence). We used live-cage experiments to test the hypothesis that distance from eDNA source negatively affects the concentration of Pacific Lamprey eDNA in samples collected from rivers. We found strong evidence that high concentrations of eDNA (Cq < 35.50) tend to be found (>95% of the time) relatively close to eDNA sources (0.00 to 40 meters) and the effect was consistent across a range of deployed masses and environments. Inference from the experiments allowed us to design eDNA surveys with high probabilities of detecting Pacific Lamprey across three different watersheds in the Deschutes River basin: Shitike Creek, Deschutes River, and Trout Creek. Surveys provided little evidence for occurrence of Pacific Lamprey in lower Trout Creek, which supports direct surveys implemented by ODFW. We saw strong evidence for wide distribution and seasonal fluctuation of Pacific Lamprey in Shitike Creek downstream of Headworks Dam during Fall 2020 and Spring 2021 with the concentration of eDNA increasing significantly from Fall to Spring. There was some evidence for a patchy or transitory distribution of Pacific Lamprey in the Deschutes River. Results highlighted substantial differences in eDNA concentrations between Fall and Spring and support eDNA as a rapid and cost-effective way to survey large and remote areas (~50 river km) over short time periods (< 7 days).

Fish and Forestry in an Age of Disturbance

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Since the mid-20th century, attempts to reconcile fish conservation with timber production in forested landscapes have experienced an erratic evolution. Advances in scientific knowledge have catalyzed tensions between the potentially conflicting goals of increasing the yield of forest products and conserving aquatic and riparian habitat, especially for species that are imperiled. Periods of relative status quo in forest practice regulations have been interrupted by new science findings, often

technologically driven, that drive new laws aimed at increasing protections for fish and wildlife while maintaining sustainable supplies of forest commodities. I review the history of fish and forestry management issues from the pre-1960s to 2020 and argue that abrupt collisions between scientific advancements and management policies occur periodically, which lead to attempts to achieve both conservation and fiber production objectives. Historical patterns also suggest that the inevitable acquisition of new knowledge will pose continuing challenges to managing the coexistence of fish and fiber, and will require robust future policies that anticipate changes, adopt novel approaches, and learn from past mistakes.

Wildfire and post-fire management effects on water quantity, water quality, and aquatic ecology

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Concerns about the complex and interconnected effects from wildfires on water quantity, water quality, and aquatic ecosystem health has increased in recent decades as wildfire activity, including length of wildfire season, area burned, and fire severity, has increased rapidly in many areas of the world, including the Western US. Due to the broad range of post-fire threats, land managers often apply various techniques to promote regeneration and maintain forest and aquatic ecosystem functions. However, there remains substantial uncertainty about the efficacy of most post-fire management approaches at mitigating effects on aquatic ecosystems. Moreover, the magnitude and longevity of effects from wildfires also remains uncertain. Here, we present results from several empirical and modeling studies, which provide insights into the range of effects of wildfire and post-fire management on streamflow, erosion and suspended sediment, nutrients, primary productivity, and aquatic ecology. Our results also provide insights into the efficacy of different post-fire management approaches at facilitating recovery, while also illuminating the substantial knowledge gaps that remain in this area.

Patterns in distribution and abundance of larval lampreys in the mainstem Columbia River

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The Columbia River and its tributaries historically hosted large numbers of Pacific Lamprey (Entosphenus tridentatus), as well as paired species Western River Lamprey (Lampetra ayresii) and Western Brook Lamprey (L. richardsoni). Starting in the 1930s, mainstem Columbia and Snake River dams were built, curtailing and obstructing migration pathways for lampreys. Additionally, the resulting reservoirs have changed the hydraulics of the river and variation in water releases at hydroelectric facilities cause large diurnal fluctuations in water levels. Cumulatively, these alterations have caused large-scale changes in distribution and abundance of lampreys and likely have impacted larval lamprey habitats. From 2010 to 2018, we used a deepwater electrofisher to examine patterns in occupancy and distribution of larval lampreys in the mainstem Columbia River. Thirteen tributary river mouths were sampled multiple times across seasons and years. Additionally, sampling was conducted throughout the mainstem from downstream of Bonneville Dam (RKM 202) to upstream of the confluence of the Yakima River (RKM 547). Mainstem locations were delineated into shallow water

and pool habitats to distinguish sites where larvae would be more vulnerable to fluctuating reservoir levels. Detection rates were highest at tributary mouths that enter the Columbia River downstream of the Dalles Dam, including tributaries that outlet into Bonneville pool and those downstream of Bonneville Dam. Patterns in distribution and abundance varied among lamprey genera and were not constant spatially or seasonally. Although larval lampreys were found in pool, shallow water, and river mouth habitats, densities were highest in river mouths and shallow water habitats, which are likely areas where water level fluctuations may result in dewatering. Lampreys in the Columbia River Basin are ecologically and culturally important and through our analyses we aim to improve our understanding of patterns in distribution at multiple scales to inform hydro system operations for conservation.

Adding satellite imagery to our stream habitat analysis toolbox: Deep Learning analysis automates the extraction of river attributes from high-resolution multiband imagery

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Large-scale salmon habitat rearing capacity is often estimated from stream attributes derived with morphological analyses from relatively coarse elevation datasets (e.g. National Elevation Dataset, 10m horizontal resolution). While these attributes (e.g. channel form, confinement, gradient, etc.) are very informative about the general description of habitat that may occur at a stream reach, they do not provide the level of information we need to describe how the habitat may change seasonally or annually with changing instream flows. Flow varying habitat estimates are typically 2-D hydraulic model derived from high-resolution (≤ 1 m) channel bathymetry and topography of the surrounding floodplain. These hydraulic models determine which areas would be inundated as water volume changes. However, an alternative approach is to use high-resolution satellite or aerial imagery to ask which habitats have been inundated at various flow volumes in the past. In the Middle Fork John Day River we are using Worldview-2 and Worldview-3 satellite imagery (~1 m resolution) and neural network image classification models to classify all wetted habitat within the river floodplain at each image time and date. For each image, water area is extracted from the floodplain associated with each 200 m reach of the stream to construct a relationship of water area and flow at USGS flow monitoring stations. With this relationship, we can estimate flow thresholds needed to inundate the floodplain habitat in each reach. In addition to providing direct estimates of flow-based habitat at critical periods in salmon phenology, we can use these measurements to calibrate and validate hydraulic modeling efforts in the same reaches.

One fish, two fish, how many fish? Sample size estimation for measuring and weighing juvenile hatchery salmon

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Obtaining precise estimates of fish size from sub-samples of groups of juvenile hatchery reared salmon while balancing personnel time is important as money and time are limited. Our goal was to determine the number of samples needed to obtain precise estimates while optimizing personnel time. Our dataset contained over 1000 length and weight sampling events from 1999–2021 of

hatchery juvenile Chinook and Steelhead Salmon in Northeast Oregon. For each species of salmon sampled, we calculated the median number of samples (fish) needed to detect a defined difference in mean length (e.g., 5 or 10 mm) or weight (e.g., 5 or 10 grams) between rearing groups (e.g., raceway, acclimation pond, or stock). We determined that it takes approximately 67 and 104 samples to be able to detect a difference in length of 5 mm and 4 mm, respectively. However, 184 samples are needed to detect a difference of 3 mm in length between rearing groups. Similar results followed for weight as approximately 40 and 89 samples are needed to detect a difference in weight of 3 and 2 grams, respectively. To detect a 1 gram difference between rearing groups, 352 samples were needed. While more samples may seem logical to obtain a more precise estimate of a single group, the additional samples multiplied by several rearing groups (e.g., raceways) sampled in a single day or location can result in significantly more personnel hours spent sampling fish with minimal gains in measurement precision. We suggest that sampling 100 fish/group will likely be sufficient in most instances to determine at least 4 mm length and 2 gram weight differences. For many managers and researchers, these data show that at some point the extra time required to measure and weigh more fish is not worth the slight gain in precision.

A satellite-based mobile warning system to reduce interactions with an endangered species

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Earth observing satellites are a major research tool for spatially explicit ecosystem nowcasting and forecasting. However, there are practical challenges when integrating satellite data into usable real-time products for stakeholders. The need of forecast immediacy and accuracy means that forecast systems must account for missing data and data latency while delivering a timely, accurate and actionable product to stakeholders. This is especially true for species that have legal protection. Acipenser oxyrinchus oxyrinchus (Atlantic Sturgeon) were listed under the United States Endangered Species Act in 2012, which triggered immediate management action to foster population recovery and increase conservation measures. Building upon an existing research occurrence model, we developed an Atlantic Sturgeon forecast system in the Delaware Bay, U.S.A. To overcome missing satellite data due to clouds and produce a three-day forecast of ocean conditions, we implemented Data Interpolating Empirical Orthogonal Functions (DINEOF) on daily observed satellite data. We applied the Atlantic Sturgeon research model to the DINEOF output and found that it correctly predicted Atlantic Sturgeon telemetry occurrences over 90% of the time within a three-day forecast. A similar framework has been utilized to forecast harmful algal blooms, but to our knowledge, this is the first time a species distribution model has been applied to DINEOF gap-filled data to produce a forecast product for fishes. To implement this product into an applied management setting, we worked with state and federal organizations to develop real-time and forecasted risk maps in the Delaware River Estuary for both state level managers and commercial fishers. An automated system creates and distributes these risk maps to subscribers' mobile devices, highlighting areas that should be avoided to reduce interactions. Additionally, an interactive web interface allows users to plot historic, current, future, and climatological risk maps as well as the underlying model output of Atlantic Sturgeon occurrence. The mobile system and web tool provide both stakeholders and managers real-time access to estimated occurrences of Atlantic Sturgeon, enabling conservation planning and informing

fisher behavior to reduce interactions with this endangered species while minimizing impacts to fisheries and other projects.

Using acoustic telemetry to quantify adult migration behavior of John Day River summer steelhead throughout the Columbia River basin

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The general concept of adult migration for anadromous fish can often be described as a linear process, in which fish enter freshwater and migrate upstream to their basin of origin. However, once we start looking at the fine scale movement patterns of these fish, we begin to see that adult migration can be far removed from a linear process. As variation occurs across the altered landscape of the Columbia River basin, so too does the migration behavior for anadromous fish. High summer temperatures, changes in flow, inundated tributaries, and other limiting factors can all contribute towards a highly variable migratory process. The migration patterns of A-run summer steelhead (Oncorhynchus mykiss) in the Columbia River were examined during the 2020 migratory year. 200 wild A-run summer steelhead were equipped with gastrically implanted acoustic tags and PIT tags at the Bonneville Dam Adult Fish Facility between July and September of 2020. Acoustic receivers were deployed between Bonneville and Priest Rapids Dams at the major thermal refuge areas in the Columbia River, and also at the John Day River confluence. Comparisons between John Day River spawners and other population groups of A-run summer steelhead throughout the Columbia River basin were determined using a combination of last known detections, and genetic samples collected at Bonneville Dam. Migration rates and travel distances will be calculated to compare population groups. We will then begin to address the McNary "overshoot" and "fallback" phenomenon of John Day spawning steelhead by analyzing the effects of migration delay, temperature, stream flow of the John Day River, discharge at John Day dam, and surface velocities at the John Day River confluence.

Response of a Rainbow Trout Population to Wildfire in Omak Creek, Washington

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Increased tree stand density relative to historic conditions may reduce summer baseflows in streams due to evapotranspiration, which can influence the habitat available to native salmonids. In the Omak Creek watershed of northeast Washington stand exams indicate a significant increase of both stems per acre and basal area from 1958 to 2004. To quantify the impact of increased tree stand density on native salmonid productivity, a control-treatment paired watershed study was implemented in two adjacent headwater streams of the Omak Creek basin, Stapaloop and Swimptkin creeks, beginning in 2014. During the study period, a wildfire burned a majority of the Stapaloop Creek watershed while the adjacent Swimptkin Creek watershed remained unburned. The fire provided a unique opportunity and shifted the purpose of the study to focus on the effect of wildfire on salmonid productivity. We examined the impact of fire on flow conditions with a comparative analysis of discrete flow measurements in the two headwater streams and with a time series decomposition of flows in Omak Creek. An ANOVA test followed with Tukey's HSD to determine how mean densities of fish species

differed significantly among sampling years. In Stapaloop Creek, there was a 35.7% increase in baseflow post fire when compared to Swimptkin Creek. Densities of native Rainbow Trout also increased in Stapaloop Creek following the wildfire and was variable among size classes. In contrast, Rainbow Trout densities in Swimptkin Creek remained relatively stable.

Adult Pacific Lamprey Passage at Road Crossings: Guidelines for Evaluating and Providing Passage

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As part of its ongoing efforts to conserve and restore Pacific Lamprey populations, the Lamprey Technical Workgroup (LTW) recently developed guidelines for evaluating potential barriers to passage of migratory adults at road crossings and providing passage. The goals of the guidelines are to raise awareness of adult Pacific Lamprey passage requirements—which are very different from that of salmon—and to help biologists and engineers identify and prioritize barriers to the species and provide unimpaired passage at road crossings. Drawing from various case studies, this presentation will summarize the following elements of the LTW guidelines: (1) current understanding of the key factors affecting passage of adult Pacific Lamprey, (2) process for evaluating passage at road crossings, (3) considerations for prioritizing barrier sites for passage remediation, (4) options for improving passage at road crossings, and (5) key data gaps and uncertainties related to adult Pacific Lamprey passage. While focused on passage at road crossings, the information and concepts covered will be applicable to understanding lamprey passage issues at other instream migration obstacles.

Caring for Salmon on our Reservation---A Foundation of Tribal Wellbeing

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Salmon have always been important to us, which my parents and grandparents have emphasized to me since I was a small boy. Thus, our management of the Warm Springs Reservation Forests starts with how to ensure we have healthy stream and riparian ecosystems. As result of these efforts, the Warm Springs River and its tributaries are often cited as the highest quality salmon habitat in the Deschutes System. Reservation management program ranges from protecting high quality riparian conditions to actively managing the entire riparian zone where it has been degraded. This broad-based approach requires coordination among resource specialists and tribal leaders, especially when more active actions may be needed. Having such flexibility for managing our riparian ecosystems is crucial for restoring and maintaining their continued productivity.

A timber executive, a conservationist, and a Governor walk into a bar...

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With passage of the Forest Practice Act in 1971, Oregon became a leader in protecting waterways from the negative impacts of forest management on private lands but has since fallen behind. By 2019, the Act and its implementing regulations were the weakest on the west coast. Although the water protection rules have been incrementally strengthened after a 1994 overhaul, improvements failed to keep pace with changes in public sentiment and scientific understanding. The conservation

community grew increasingly frustrated by repeated administrative and legislative denials to modernize the protection framework. Taking the issue directly to voters seemed the only viable alternative. Thus, the Forest Waters campaign drafted three measures for the November 2020 ballot. As one might imagine, that campaign was met by resistance from private timberland owners, who were poised to bring forward competing ballot measures. Governor Brown stepped in to broker a deal between representatives of the timber industry, small forest landowners, conservation groups, and the fishing industry. This led to legislation reforming aerial pesticide spray practices and initiating a 10-month negotiation among the parties. Negotiations culminated in an agreement, the Private Forest Accord (PFA), addressing issues related to logging and roads. The PFA advances aquatic ecosystem functions through numerous provisions such as wider riparian buffers; buffers on more of the stream network including many small, non-fish-bearing streams; eliminating timber harvest on highly unstable slopes that can deliver sediment to fish-bearing streams; and designing road culverts to improve fish passage. It also enhances compliance and effectiveness monitoring and establishes an adaptive management program and a mitigation fund. If the PFA components are enacted through the Oregon legislature and the Board of Forestry, then the overall package is expected to underpin the State's application for a Habitat Conservation Plan under the ESA, covering salmon, steelhead, bull trout, and cutthroat trout populations and five amphibian species. The agreement was not crafted to attain assurances of meeting the federal Clean Water Act. Because many streams are water-quality limited for sediment or temperature, with more likely to become so, wrangling over protections on Oregon's private forest lands may not be over.

Synergistic Application of Remote Sensing and Machine Learning for Modeling the Upstream Extent of Fish in Western Oregon Streams

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Knowledge of the upstream extent of fish (UEOF) in streams is a critical planning consideration for land managers who are responsible for ensuring activities are in compliance with applicable federal, state, and local laws. Fransen et al. (2006) sought to increase efficiency over conventional field-centric UEOF survey methods by developing a logistic regression modeling approach for assessing UEOF in western Washington that achieved 96% accuracy using four covariates. In the intervening years, LIDAR-derived stream hydrography and terrain data has become increasingly available, thereby improving digital representations of the geomorphic stream network and surrounding terrain. These data, combined with ready access to parallel computing and machine learning modeling tools, provide an opportunity to enhance Fransen et al’s approach and apply it in western Oregon. Here we present a Random Forest modeling approach to predicting probability of fish presence by fitting models with 2 to 83 covariates to 102,000 training datapoints derived from 103 upper limit of occurrence (ULO) observations in western Oregon. The best model contained 15 covariates with the most influential covariates being related to flow potential and the least influential being associated with barriers to fish passage. The prediction model was subsequently applied to 344 watersheds in western Oregon. A ULO detection processor was then applied to the predicted probabilities to estimate the UEOF for every stream. Model accuracy was 94.1% and median ULO error was -139 m suggesting the model and post processer are effective for characterizing UEOF in the study area. While the UEOF maps may be most immediately useful to land managers, the resulting predictions of fish presence probability may provide a tool for prioritizing field surveys by targeting areas where the model is most uncertain.

Future iterations of this approach would likely benefit from higher resolution climate data, and incorporation of a waterfall detector.

Initial assessment of the development of larval lamprey habitats following the Stage 0 Fivemile Bell Restoration Project

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Fivemile Creek is the largest tributary to Tahkenitch Lake on the Central Oregon Coast. These coastal lake systems contain some of the most productive coho salmon (Oncorhynchus kisutch) streams in the Pacific Northwest with adult spawning peak counts often exceeding 250 fish per mile. The Fivemile Bell Project is a decade long restoration effort conducted in 5 phases that began in 2012. Restoration focused on the re-establishment of historic geomorphic processes of an extremely low gradient 100 acre valley floor including stream, floodplain and native plant communities. The stream channel portion of the project was initially focused on determining the appropriate size of the channel to construct. As the project progressed, monitoring of previous phases, which was mostly floodplain and native vegetation restoration, revealed rapid development of complex aquatic and terrestrial habitats on the floodplain. Based on this monitoring and a robust peer review process with other restoration practitioners, subsequent phases have been modified to encourage the development of stage 0 conditions while still meeting the development of our native plant communities. Throughout the project we have been able to adapt our restoration strategy based on the initial results of the implementation in prior years. We have used a mix of channel construction and non-channel construction techniques to provide varied habitat types and allow for multiple trajectories of stream development. Aquatic organism relocation was a significant part of this restoration project which included the relocation of over 84,000 larval lamprey. As part of the effectiveness monitoring of the project an initial survey to determine the presence/absence of larval lamprey is in process with personnel from ODFW, US Fish and Wildlife Service, Siuslaw Watershed Council and US Forest Service. The use of different restoration strategies during the project implementation provides an intriguing look at the development of lamprey habitats.

Forest-Associated Fishes of the Conterminous United States

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Aquatic ecosystems, including freshwater fishes, are closely tied to the terrestrial ecosystems they are embedded within, yet current datasets have been underutilized to determine associations between freshwater fishes and forested areas. Here, we determined the spatial co-occurrence between freshwater fish distributions and forests within 2,129 watersheds of the conterminous United States. We identified 21% of freshwater fishes as associated with forested watersheds, and 2% as strictly present only in highly forested areas (75%–100% forested). The northern coasts and southeast regions showed the highest fish species richness with the largest numbers of forest-associated fishes in highly forested areas. Fish associated with low-forested areas occurred most in the southwest and central plains. Imperiled fishes were relatively evenly distributed among forest cover categories,

which was distinctly different from patterns for all fishes. Determining large-scale patterns of freshwater biodiversity is necessary for conservation planning at regional levels, especially in highly impacted areas.

Pre- and Post-fire Wildfire Effects in Montane Stream Communities in North-central New Mexico

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High-severity wildfires across large-scale watersheds produce complex and dynamic changes in stream environments and aquatic communities. In Valles Caldera National Preserve of north-central New Mexico, high elevation stream ecosystems have been monitored annually since the mid-2000s, providing extensive data on baseline conditions prior to and following two landscape-level wildfires (Las Conchas 2011, Thompson Ridge 2013). During post-fire flash-flood events, we recorded sudden turbidity and conductivity spikes, with elevated concentrations of total ammonia. Post-fire, the fish communities experienced immediate loss of non-native predatory Brown Trout and Rainbow Trout. This allowed a "predator release" response by native non-game fish (Dace, Sucker and Chub species). As the non-native trout populations began to recover by 2012 (12 months post-fire), the native fish subsequently declined by spring 2013 (less than 18 months post-fire). These trends were greatest in the upper watersheds nearest the fire but decreased downstream further from wildfire effects. The effects of wildfire on the macroinvertebrate communities were more complex. Reduced diversity and shifts in functional feeding groups were affected by warmer minimum daily temperatures and turbidity spikes that were variable across the landscape and relatively long-lived (2-7 years post-fire). Native fishes appear adapted to wildfire effects, having evolved within a landscape of fire over millennia, whereas introduced Brown Trout and Rainbow Trout appeared highly susceptible to fire-induced stream chemistry. We discuss the implications of climate change on fire and montane stream management and how land managers are restoring forests, streams, and wetlands to increase ecosystem resistance and resilience to global warming phenomena.

Varying genetic structure of Entosphenus tridentatus and Lampetra species from subbasin to continental scales

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Over the last century, lampreys in the genera Entosphenus and Lampetra have declined dramatically across western North America. Conservation efforts for these taxa are hindered by lack of information on species designations and functional conservation units. To help address these information gaps, we assessed taxonomic relatedness and genetic structure of these lampreys at varying spatial scales. We used mitochondrial sequence data to explore genetic diversity and structure of anadromous E. tridentatus and unidentified species of freshwater Lampetra across the Willamette River basin. We then combined data from the Willamette River basin with publicly available sequences to evaluate taxonomic relationships and spatial structure of lampreys across western North America. Within the Willamette River basin, maximum divergence among 34 Lampetra haplotypes was 1.6%, greater than the maximum observed among 35 E. tridentatus haplotypes (0.5%). Statistical parsimony networks

displayed a clear pattern of spatial structure among Lampetra, with haplotypes segregating at the subbasin level. In contrast, no spatial structure was observed for E. tridentatus across the Willamette River basin. Phylogenetic analysis revealed weak patterns of divergence among E. tridentatus across western North America. In contrast, strong patterns of divergence were observed in Lampetra species, with only one haplotype from the Willamette River basin also observed in Lampetra from other parts of the continent. Analysis was unable to identify Lampetra in the Willamette River basin down to the species level. Results of a Mantel test found significant isolation by distance among Lampetra across western North America, but no pattern of genetic structure for E. tridentatus. These results reflect how movement patterns of anadromous versus freshwater lamprey create varying spatial structure across riverscapes. Therefore, management units for each taxon may occur on different spatial scales, with functional conservation units for Lampetra likely falling at the subbasin level.

Post-fire hyperspectral surveys for benthic algae (periphyton) in Cascade Range rivers used for municipal water supply

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Different types of algae and cyanobacteria have unique hyperspectral signatures that lend themselves to remote sensing measurements of reflectance. This project aims to expand a growing library of hyperspectral signatures to explore the possibility of differentiating green algae, diatoms, and cyanobacteria in rivers used for municipal supply that show signs of eutrophication. Excessive growths of riverine benthic algae (periphyton) can cause high pH, harm aquatic life - particularly young fish - impart taste and odors to drinking water, increase disinfection by-products, and introduce cyanotoxins to water supplies. Periphyton studies in Cascade Range rivers are few despite decades of evidence showing large fluctuations in pH and dissolved oxygen. Manual monitoring of periphyton is complicated by the heterogeneous distribution of algae longitudinally and across the stream channel, particularly in marginally wadable rivers at higher flows. Direct and remote sensing of surface and below-water reflectance with hyperspectral cameras mounted on laboratory microscopes, streamside tripods, drones, planes, and even satellites can provide an alternative method for monitoring periphyton. This study focuses on three of Oregon's rivers - the Clackamas, North Santiam, and McKenzie - impacted by the 2020 Labor Day wildfires. All three rivers had unusually high concentrations of nitrate-nitrogen (>0.25 mg/L) after the fires that contributed to excessive growth of periphyton during the 2021 growing season. In 2022, we plan to further characterize hyperspectral signatures, evaluate spectral variability within periphyton genera, and examine how spectra change over the course of the growing season. Repeat collections of hyperspectral data can inform models and reveal insights into the seasonal occurrence and distribution of periphyton that can be related to streamflow, solar radiation, and other factors. More application-oriented objectives of the study include predicting periphyton sloughing events, explaining year-to-year variations in benthic algal growth, and improving our understanding of periphyton growth dynamics in these rivers.

Lampreys: A lot has changed

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Human perceptions and actions towards Oregon's native lampreys have evolved substantially. In the 1900s, European settlers commonly perceived these species as undesirable and actively attempted to control them. During the late 1900s – early 2000s, these misperceptions evolved into an acceptance of lampreys as native species. Nevertheless, broad efforts at research, monitoring and evaluation (RME), outreach, and conservation/restoration (management) only began in earnest ca. 2010. These changes can be attributed largely to tribal leadership with other entities subsequently joining in efforts. Recent advances in RME, outreach, and management have grown substantially to the point that, in some situations, a gulf exists in the common understanding of lampreys between lamprey-focused biologists and general fisheries biologists. For instance, not every fisheries biologist knows that: (1) At least 10 species of native lampreys exist in Oregon, (2) Translocating adult Pacific Lamprey to create pheromone plumes to bolster recolonization of newly accessible habitats may not be necessary, (3)Different life histories of Pacific Lamprey exist, and (4)Important plans and initiatives (e.g., the Tribal Pacific Lamprey Restoration Plan, the Pacific Lamprey Conservation Initiative, the ODFW Conservation Plan for Lampreys, among others) are coordinating RME, outreach, and management efforts. Although the increase in efforts towards understanding and improving lamprey populations are cause for optimism, their future is not assured. For example, the effects of climate change, growing human populations and land/water use will likely continue to pose significant challenges to lampreys.

Fish Tales in the Upper Elwha: Updates Since Dam Removal

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Removing the two hydroelectric dams on the Elwha River has reconnected more than 70 miles of pristine, spawning habitat in Olympic National Park. During the final stages of the Glines Canyon Dam removal in late summer 2014, biologists from the Lower Elwha Klallam Tribe and Olympic National Park documented the successful upstream passage of the first adult salmon (Chinook) and bull trout in over a century. Since that momentous occasion, monitoring the fish recolonization of the upper watershed has been a primary focus of the ONP Fisheries Team. This presentation will highlight what we have learned thus far when looking at extent, distribution, and relative abundance of various fish species (mainly salmonids) and will also look at the logistical challenges that our crews encounter in the Elwha backcountry. With support and help from the ONP mule packers, trail crew, researchers, and volunteers, we employed a variety of survey methodologies including backpack electrofishing, snorkeling, riverscape, radio-telemetry, and spawner surveys. Using a combination of these methods, we have begun to characterize fish assemblages in the mainstem Elwha and in some of the major tributaries. We have found O. mykiss to be the predominant species throughout the upper river with bull trout being the second most observed species. Steelhead, anadromous bull trout, Pacific lamprey, and most salmon species (with the exception of chum) are migrating into the upper watershed, some species traveling farther than others. In response to dam removal, many fish species have rapidly moved into the upper watershed and are utilizing more of the newly accessible habitat.

Turning up the heat on Oregon's fisheries managers

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Warming temperatures and drought pose serious threats to cold water fishes and ever-growing challenges for fisheries managers. Prolonged or extreme high temperatures can stress salmonids, compelling managers to close or limit fisheries where angling could exacerbate impacts to stocks of concern. Warmer water also favors the spread of pathogens in both natural and hatchery environments and can affect the survivorship of fish at all life stages. Wildfires and drought can further impact hatchery operations. Here, we discuss these real-world challenges, their impacts to fisheries, recent responses taken by Oregon's fisheries managers, and prospects for the road ahead.

Spatiotemporal population dynamics of common dolphinfish (Coryphaena hippurus) in the Western Central Atlantic

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Common dolphinfish (Coryphanea hippurus) is a migratory coastal pelagic species that supports commercial and recreational fisheries throughout the East Coast United States, Caribbean Island nations and US territories. Mark-recapture and genetic marker studies suggest that dolphinfish caught in the Western Central Atlantic (WCA) comprise a single population, however, they are currently managed by regional fishery management organizations (RFMOs) as discrete, regional sub-stocks. Stock assessments require a reliable index of abundance to estimate changes in the population over time and are ideally derived from a fishery-independent research survey. Although no such survey exists for dolphinfish, the US pelagic longline (PLL) fishery targets dolphinfish throughout the WCA and keeps detailed logbook information. Furthermore, dolphinfish are thermophilic species with a preferred range of temperatures for spawning between 27-30 ºC and preliminary analyses relating average sea surface temperature (SST) to Southeast United States (SE US) commercial and recreational landings data suggested a strong correlation. Therefore, exploration of SST as a covariate is necessary to fully understand the spatiotemporal dynamics. We fit Vector Autoregressive Spatiotemporal (VAST) models to PLL catch-per-unit-effort (CPUE) data during 1991-2019 to standardize a spatiotemporal index of abundance for the WCA population. We observed seasonal dynamics in dolphinfish abundance with peak densities occurring during spring months; a declining trend in abundance overall; and potentially a northward shift in distribution. Additionally, we fit VAST to PLL data during May and June months, treating SST as a non-linear covariate, to further explore the potential relationship between catch information and SST; results suggested that presence/absence and abundance were greatest within dolphinfish's preferred thermal range. These analyses represent the first phase of a larger project to develop a spatially explicit stock assessment for common dolphinfish in the WCA and management strategy evaluation focused on the SE US.

Observations of fish food supply and rare species dynamics in forested headwater streams west of the cascades

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Forests support fish and riparian systems support a robust community of life adapted to habitats developed by forest streams. Over the last twenty-five years I have investigated headwater streams in the Coast Range, and the Calapooia and Chehalis watersheds. Fish food supply observations develop from collections of macroinvertebrates in the drift and benthos. Taxonomic and density data describe who and how many are there? When, both seasonally and daily? And where is the drift from? Extensive taxonomic efforts allow the dynamics of rare species in managed, disturbed (debris flow), and post-disturbance stream habitats to be examined. The suite of animals inhabiting forested streams is broad and rich and biological responses extend beyond charismatic fauna.

Using SONAR to Monitor Adult Chinook, Steelhead, and Coho Populations in the Elwha River Before, During and After Dam Removal.

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A major goal of the removal of two large dams on the Elwha River in Washington State was to increase populations of salmonids in the watershed. In order to assess the success of this goal, we have been using multi-beam imaging SONAR to monitor adult Chinook, steelhead and coho salmon populations since 2010, 2013 and 2019, respectively. SONAR has proven an effective tool to provide accurate estimates of both abundance and run timing before, during, and after dam removal where traditional methods now have reduced efficacy. We incorporate various sources of uncertainty into our estimates including species apportionment, observer error, subsampling expansion, and data gap filling. The project has expanded over the years to the point where it currently operates two multi-beam imaging SONARs near the mouth of the river from late January through late November. The project also conducts weekly net sampling in the vicinity of the SONAR sites to capture migrating salmon and thus apportion raw fish passage derived from the SONAR to species specific passage. The net sampling can also be used to inform hatchery contributions to the total return. From 2009 to 2020, the Chinook population has ranged from 1,370 to 7,600 fish and is generally trending upwards. From 2013 to 2021, the number of steelhead has ranged from 385 to 2,300 with the number increasing each year for the last five years. The project has only recently expanded to counting coho salmon but has proven to be an effective tool to estimate adult returns of this species which migrates during periods of high and dynamic river flows.

Identifying competencies for entry-level Fisheries Technician and integrating UAV technology in Fisheries curriculum for Nez Perce students.

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The NSF funded project, “Building STEM Identity and Career Interests in Native American Students by Using Unmanned Aerial Vehicle (UAV) and Remote Sensing Technologies” was designed to provide experiences with culturally relevant, technology-based learning for Native American youth, and to understand how these experiences contribute to positive outcomes in STEM identity. The scientific context was accomplished by developing, implementing, and assessing an educational model of science education that will occur within a framework of educational research, and was built around 1)

cutting edge STEM technologies, in this case, unmanned aerial vehicles (UAVs), 2) science communication and leadership skills, and 3) an emphasis on the development of science identity connected to the context of students' social and cultural communities. The DACUM process was used to identify competencies for entry-level Fisheries Technician position in the Nez Perce Tribe Department of Fisheries Resource Management in Idaho and the selection of competencies to be integrated in the middle and high school curriculum. Programming included two five-day summer camps and twelve modules during the school year, facilitated by three collaborative partners, McCall Outdoor Science School (MOSS), Lapwai School, and The Nez Perce Department of Natural Resources. Results show that overall, students' satisfaction with the camp was high. Seventy-five percent of students indicated that they liked science after completing the camp, and over 50% agreed that they wanted a job that included doing science. By the end of their experience, students could articulate ways they saw indigenous knowledge coming forward in the STEM learning activities conducted. They identified various sources of that knowledge, including elders and direct experience with the Land. Students also reflected on the learning environment that supported them and the responsibilities that come with learning.

Spatial patterns of fish returning to the Elwha River following dam removal

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The removal of two large dams on the Elwha River, Washington had a goal of restoring anadromous salmonids. We used environmental DNA (eDNA) and riverscape snorkel surveys to assess the response of fish populations. Using a suite of 11 species-specific eDNA markers, we tracked spatial extent of migratory fish upstream of the dams in mainstem and tributary habitats over four years following dam removal. Across 25 longitudinally arranged sites spanning 56 river kilometers, eDNA detections differed among species in the timing and spatial extent upstream of the dams. Multiscale occupancy modeling showed that distance from the mouth of the river was significant, as downstream sites below and between the dams had higher detection probabilities than sites upstream of the upper dam. More abundant species like Chinook Salmon and Coho Salmon were more likely to be detected higher in the watershed than less abundant species like Pink Salmon and Chum Salmon. We also used complementary riverscape snorkeling surveys, conducted before and after dam removal, to assess changes in density and spatial patterns of adult migratory salmonids. These high-scope summer surveys focused on Chinook, summer steelhead, Bull Trout, and trout (mostly Rainbow Trout but potentially including Cutthroat Trout). Highlights showed that while occurring throughout the river, both Rainbow Trout and Bull Trout were more abundant with higher density reaches shifted farther upstream. Also, Chinook Salmon moved upstream past each dam, with the highest density reaches upstream of the dams after dam removal exceeding the highest densities downstream of the dams before dam removal. Summer steelhead, virtually absent prior to dam removal, were detected in 19/22 survey reaches spanning 50 km. Although still early in the post dam removal era, our results show that fish have started to reoccupy mainstem and tributary areas upstream of the dams in the reconnected Elwha River.

Fishes of the Harney Basin: past, present, future

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The Harney Basin is a large, isolated (endorheic) watershed in southeast Oregon that supports a host of native fishes, including local endemics. In this presentation I highlight results from several recently completed and ongoing studies to evaluate the status of native species, invasions by nonnative fish and prospects for the future of water availability for aquatic ecosystems in the basin. Although the Harney Basin faces many potential challenges from warming climates, biological invasions, and other threats, native fishes are still present and widespread within their known, historical distributions. Anticipating and proactively addressing these future threats will be critical to ensuring the longer-term persistence of this unique assemblage of fishes.

Human dimensions: old myths and new opportunities

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Broad integration of human dimensions into fisheries biology is still in its early phases but offers great promise for improving collective outcomes for fisheries management. Expecting improved management outcomes with improved biological information is challenged by the reality of social influences. As this reality becomes more accepted, challenges arise in finding ways to better integrate human dimensions into fisheries management. In this presentation we review three aspects of integrating human dimensions (HD) into fisheries science and management, including: 1) why HD merits more attention; 2) common myths about HD; and 3) solutions for integrating HD into fisheries management. Related to all of these points is the fact that HD represents a broad spectrum of disciplines, perhaps much broader than fisheries science itself. This alone can be challenging to confront. Oregon AFS and the authors of this presentation have established a new external HD Committee to address these needs. This committee will offer opportunities for identifying and understanding the full network of social and biological processes and feedbacks that influence fisheries and how to address these.

Fire and fish: what's old, what's new?

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Recent major wildfires in western Oregon have prompted much interest and concern about fire and aquatic ecosystems. This topic has an active area of research within the inland west, most notably dating back to the massive wildfires in Yellowstone National Park in 1988. Since then, much has been learned of the responses that streams, fish, and other components of aquatic ecosystems respond to fire. In this presentation we review selected aspects of this work and highlight questions that have been important and remain important today, as well as thoughts on new questions that have emerged as longer-term trajectories of wildfire and associated responses to climate change are coming into focus.

Transitioning from environmental genetics to genomics using mitogenome reference databases

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The use of environmental DNA (eDNA) to detect fish species in freshwater systems is an established science. Implementing eDNA monitoring programs for species in these environments worldwide has the potential to revolutionize how we track trends in freshwater biodiversity—a crucial endeavor during times of unprecedented climatic shifts and anthropogenic landscape alteration. Metabarcoding primers and qPCR assays are used to identify multiple and single species, respectively, and many validated assays now exist in the literature. The barrier to knowing how applicable these assays are in a given system is a lack of comprehensive localized reference sequence data. These data may not be publicly available for local species or assay-specific regions of the mitochondrial genome making it impossible to test the appropriateness of a published assay for a particular application in silico. To build this capacity, we recommend curating comprehensive reference sequence databases of full mitochondrial genomic data on a regional scale. We created the Oregon Biodiversity Genome Project for this purpose. With the data our collective has curated, we are able to create and test metabarcoding and qPCR assays against our local species, given regional genetic variation, and have simultaneous prepared Oregon for the future of environmental genomics. Here, we present our protocols and strategies as a blueprint for developing similar mitochondrial reference databases in other areas.

The Lost Lamprey Project: A Community Science Project to Assess Lamprey Distribution and Raise Awareness

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While extensive effort has been made to document Oregon's lamprey distribution, gaps in presence data exist in several regions. Efforts to locate new streams with Pacific Lamprey (Entosphenus tridentatus and Lampetra spp.) and raise awareness of the cultural importance of Pacific Lamprey and the ecological importance of all lampreys is often hindered by the public's negative perception of lampreys. Environmental community science, in which volunteers work with environmental managers to generate data, provides a unique opportunity to document the spatial extent of lampreys in Oregon while simultaneously shifting the public's perception of lampreys. To this end, we developed the Lost Lamprey Project, which partnered with middle school and high school students to raise awareness of the ecological importance of lampreys and document streams in the Middle Willamette Valley and Tualatin watershed that have lampreys. With an emphasis on Indigenous perspectives and Traditional Ecological Knowledge, we developed curriculum and field experiences that provided opportunities for students to learn about and search for live lampreys in streams. We conducted seven field trips to four streams during which more than 150 students searched for lampreys and collected environmental data. We documented the presence of two species of lamprey in previously undocumented streams. Assessment of the Lost Lamprey Project showed that participating students had a more positive perception of lampreys after participating in the project. The results of this pilot project suggest that community science could be used to document new locations of lampreys, raise awareness of Indigenous perspectives, and dispel public misperceptions

that hinder efforts to recover native lampreys in Oregon. We envision a program similar to Salmon Watch in which students from around the state search streams for lamprey each year. We make several recommendations for how this could be achieved.

Why do stakeholders trust and distrust each other in relation to Oregon marine reserves?

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Trust and distrust are key variables for natural resource management. Typically, trust is considered beneficial while distrust is seen as a major obstacle. People recognize a practical difference between trust and distrust, but social scientific research is inconsistent in its conceptualization and measurement of distrust. I use interviews and questionnaires to explore the relationship between trust and distrust. I also uncover why stakeholders trust and distrust others related to Oregon marine reserves. This talk presents (very) preliminary results from a larger mixed-methods human dimensions dissertation.

All is not what it seems: Larval lamprey isotopes are sensitive to lipids

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Stable isotopes ratios of numerous light elements (e.g., H, C, N) are potentially excellent tools to examine larval lamprey diet. However, larval lamprey δ13C signatures reported in the literature are often unconstrained by potential food sources and are more like the largest predators in the system than first order consumers. Measures of δ2H, although more uncommon, are also variable but suggest high support from algae, while δ15N values conform to expectations developed from gut content work (primarily terrestrial detritus with minimal contributions from algae). Lipids could potentially explain these the stable isotope signatures as lipids shift carbon and hydrogen, but not nitrogen, isotope ratios. Here we demonstrate that larval lampreys, unlike all other reported aquatic animals, have lipids highly enriched in 13C instead of 12C. Critically, larval lamprey δ2H follows expectations, with lipids enriched in 1H and depleted in 2H. The physiological mechanism driving these patterns is not yet known, but the present work suggests lipid extraction or correction of larval lamprey tissue is required to interpret stable isotopes of carbon and hydrogen. Stable isotopes will be a powerful tool to deepen our understanding of lamprey ecology, but care needs to be taken in interpreting published studies and while analyzing stable isotopes in lamprey larvae.

Wildfire in changing boreal stream ecosystems: a friend or foe for fishes?

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Fire is the dominant ecological disturbance in interior Alaska boreal forests and a strong control on landscape characteristics that affect freshwater processes and stream fish habitats. Fire frequency, size, and severity are changing across Alaska as a result of climate and land use change. Evidence from

other ecoregions suggests fire negatively impacts fishes and aquatic habitats through removal of hillslope and riparian vegetation resulting in increased water temperatures and turbidity, and facilitation of further disturbance effects such as flooding and erosion. However, such disturbances also contribute to the creation and maintenance of stream habitats that provide a mosaic of dynamic habitats that support resilient populations. The overall goal of the five-year Boreal Fish and Fire Project is to investigate the effects of fire on boreal stream fish and their habitats though a series of field, lab, and modeling studies focused on elucidating relationships among climate, fire, the physical environment, and biological responses at multiple spatial scales. Our study area encompasses a 20,000 km2 region in interior Alaska that includes four river basins: the Chatanika, Chena, Salcha, and Goodpaster Rivers. These basins are important spawning and rearing habitats for fishes including Chinook Salmon and Arctic Grayling, and nearly one-quarter of this area has burned since the early 1980s. Here we highlight initial results from a suite of integrated, spatially-explicit models to identify where and when aquatic populations may be vulnerable to fire across this broad landscape. For the contemporary landscape, we explore potential interactions among observed fires, stream network topology, geomorphic conditions, and fish habitat suitability with consideration of the ability of riparian forest and valley bottoms to buffer streams from fire effects. Additionally, we will use output from dynamic ecosystem models to forecast vulnerability of boreal stream habitats to changes in flammability and active layer depth under future climate scenarios.

Using eDNA as an early detection, rapid response tool for aquatic invasive species in big water environments

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A critical element in the management of public lands and native aquatic species is the identification and eradication of aquatic invasive species. Early detection of invasive species is the key to population control before species become ubiquitous in colonized environments. Visual surveys and single species eDNA methods are common sampling methods employed in the monitoring of invasive species. However, submerged aquatic plants and animals, as well as broad expanses of water bodies such as large rivers and lakes, compromise the effectiveness of traditional sampling methods. Single species eDNA methods are limited in the number of species that can be tested for, which is a problem when management agencies are interested in multiple invasive species. To meet the need to monitor large water bodies for multiple aquatic plant and animal species, we focused on two research questions: 1) is it possible to screen for both plant and animal DNA in the same sample? 2) How does detection of plant and animal DNA vary over time in large water bodies? To answer these questions, we added primers for 10 plant and 10 animal species of interest to the native species screen that we have developed. Field sampling was conducted at boat launches in navigable river reaches, lakes and reservoirs throughout Oregon, USA, bi-weekly from June to October 2018. We found that invasive and native plant and animal DNA was detectable from the same water sample. Best results were found using 6 replicates of 500-ml samples. Terrestrial emergent riparian plants were not detectable using these methods, however submerged aquatic macrophytes were reliably identified. Variability in sample detections was evident in the data, with the highest number of detections occurring in late August/early September. These results offer a new and simple monitoring technology that can screen for hundreds of plants and animals simultaneously.

Changes to Gulf Sturgeon Recruitment, Mortality, and Behavior following Hurricane Michael in the Apalachicola River, Florida

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Gulf Sturgeon (Acipenser oxyrinchus desotoi) have undergone a significant population decline since the start of the 20th century because of human activity, leading to their listing as threatened in 1991. Increased hurricane activity – driven by climate change – presents an additional threat to vulnerable Gulf sturgeon populations. In October 2018, Hurricane Michael struck the Apalachicola River basin, causing a hypoxic event and a fish kill that included adult sturgeon. Because the storm occurred in year 6 of a long-term study of Gulf Sturgeon in that river, we were able to use a variety of data sources to estimate the effect of the hurricane on mortality, migratory behavior, and recruitment. Based on telemetry data and side-scan sonar, apparent adult mortality may have been 40-60% percent in the aftermath of the Hurricane Michael. There was also a rapid and early outmigration of surviving adults immediately after the storm; subsequent migrations returned to normal. The hurricane did not cause a juvenile year class failure – estimated abundance of age-1 fish (which were young-of-year during the storm) was within the range observed in pre-hurricane years. These findings suggest that hurricanes pose a major threat to Gulf Sturgeon, and that projected increases in hurricane frequency and intensity may threaten species recovery and population stability.

A Tale of Two Rivers: Conservation of Atlantic Sturgeon in the Delaware and Hudson

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The Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus) historically supported large fisheries in the late 19th century which although short lived have been compared to clearcutting in reference to their overall long-term impacts. The largescale loss of spawning individuals coupled with deteriorating water quality, habitat destruction, and bycatch impeded recover in this species which ultimately lead to their being listed under the ESA in 2012. In the center of species' range lies the Delaware and Hudson Rivers which historically supported the largest populations prior to exploitation. As neighboring systems, Atlantic Sturgeon natal to the Delaware and Hudson Rivers are exposed to similar risks in the marine environment where there is extensive mixing. Upon moving into riverine habitats, the composition and levels of risks likely vary significantly between the two systems. Given the extensive overlap in marine habitats, we hypothesize that in-river constraints and or threats between the two systems may alter the conservation prospects and ultimately the recovery trajectory for this species. It is our hope that an improved understanding of the river-specific threats and impediments to recovery can both diminish the regulatory burden that comes with an ESA listing as well as improve recovery prospects for this iconic species.

Oregon Recreational Fishers: Knowledge, attitudes and behaviors related to marine reserves

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In summer 2021, we sent an online survey to a random sample of 48,814 Oregon residents who had purchased 2019 recreational fishing licenses. The purpose of this survey was to investigate the effects of marine reserve implementation on the Oregon recreational fishing population. Since ODFW does not have a marine endorsement, these respondents are representative of all anglers in the state of Oregon. Over half (57.6%) of all recreational fishers in Oregon were aware of the marine reserves, though reserve name recognition and spatial knowledge were low. Only 9.9% of all recreational fishers opposed the reserves. Generalized linear models were used to determine how fisher identity, behavior, and demographics influence marine reserve attitudes. Respondents who were members of a sportfishing club, lived in the Willamette Valley, viewed fishing more as a hobby not central to personal identity, and who were previously aware of the marine reserves were significantly more likely to support the reserves. More avid saltwater fishers and those who fished on the southern Oregon coast were significantly less likely to support the reserves. Approximately 500 recreational fishers out of 7,638 total respondents (7%) indicated a reserve caused them to change their angling behavior. Among recreational fishers who engaged in any effort shift due to marine reserve establishment, most respondents found substitute fishing grounds, indicating they still fished in the ocean either within five miles of where they previously fished (45.7%) or more than five miles from where they used to fish (30.3%). Only 84 respondents (1% of all respondents) indicated they had ceased fishing in saltwater due to the reserves. However, of those that reported they had switched to freshwater, 60% indicated that they fished on average between 1 to 61+ days in saltwater per year over the last five years in Oregon, post marine reserve implementation.

The Impacts of Dam Construction and Removal on the Genetics of Recovering Steelhead (Oncorhynchus mykiss) Populations across the Elwha River Watershed

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Dam construction and longitudinal river habitat fragmentation disrupt important life histories and movement of aquatic species. This is especially true for Oncorhynchus mykiss that exhibits both migratory (steelhead) and non-migratory (resident rainbow) forms. While the negative effects of dams on salmonids have been extensively documented, few studies have had the opportunity to compare population genetic diversity and structure prior to and following dam removal. Here we examine the impacts of the removal of two dams on the Elwha River on the population genetics of O. mykiss. Genetic data were produced from >1200 samples collected prior to dam removal from both life history forms, and post-dam removal from steelhead. We identified three genetic clusters prior to dam removal primarily explained by isolation due to dams and natural barriers. Following dam removal, genetic structure decreased and admixture increased. Despite large O. mykiss population declines after dam construction, we did not detect shifts in population genetic diversity or allele frequencies of loci putatively involved in migratory phenotypic variation. Steelhead descendants from formerly below and above dammed populations recolonized the river rapidly after dam removal, suggesting that dam construction did not significantly reduce genetic diversity underlying O. mykiss life history strategies. These results have significant evolutionary implications for the conservation of migratory adaptive potential in O. mykiss populations above current anthropogenic barriers.

Documented occurrence and status assessment of Coastal Cutthroat Trout in Oregon watersheds

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Coastal Cutthroat Trout (CCT) are a unique and important native salmonid subspecies with an extensive distribution in Western Oregon. They are important ecologically and have historically been an important sport fish. However, our understanding of this subspecies remains limited, including our understanding of their status. Coastal Cutthroat Trout have a complex life history in which they depend on freshwater streams and rivers for spawning and rearing. A portion of the CCT that occupy a given watershed have the capacity to migrate to large rivers or marine environments for feeding forays, dispersal, or to seek refuge. As such, watershed characteristics that support spawning, rearing, movement, and estuary residence are important for the full expression of the life history of CCT. In 2018, Pacific States Marine Fisheries Commission along with state, federal, tribal, municipality, county, and NGO partners concluded a status assessment throughout the geographic range of Coastal Cutthroat Trout, which spans from Northern California to Prince William Sound, Alaska. The outcomes of this assessment in Oregon, including Coastal streams, the Willamette River and its tributaries, Cascade Mountain streams, and the Lower Columbia River and its tributaries will be presented. We will present a publicly available database of documented occurrence that can be used to assess the distribution of CCT and information about barriers to migration within the occupied habitat of CCT. We will also present data on the perception of the incidence of hybridization between CCT and RBT/STH and habitat quality at the scale of the fifth-level hydrologic unit by agency professionals. Finally, we will discuss data gaps and next steps for the continued assessment, data needs, and conservation of CCT in Oregon and throughout their geographic range.

The genetics of a novel population of Umpqua Chub in the North Umpqua River

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The Umpqua Chub, a small minnow found only in the Umpqua River Basin, was thought to be locally extinct from the North Umpqua River for nearly a century. However, in May of 2019, Penaluna and Ellenburg (2019) captured 34 Umpqua Chub in minnow traps on the North Umpqua River. Have Umpqua Chub persisted in this area over the 93 year-period when they were unobserved in surveys, or is this population the result of a recent recolonization or introduction? We investigate the origin of the North Umpqua population with genotypes from 10 microsatellite loci, using recently collected tissues from across the Umpqua Basin. We characterize the relationships among populations using Structure and pairwise FST values and interpret these results in reference to the origin of the North Umpqua population. Additionally, we describe genetic diversity across Umpqua Chub populations, and compare our results to those generated by O'Malley et al. (2013) to describe how genetic diversity has shifted over the 15 years between studies.

Stream road crossings in the Pacific Northwest – what's missing and how to find it

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Road networks are a constant presence of human infrastructure in Pacific Northwest ecosystems. Maintaining and inventorying stream-road crossings is a management priority due to how impactful road networks are on stream systems. Roads influence streams in a variety of ways, including changing stream flows, increasing fine sediment loads, altering stream nutrient concentrations, and decreasing stream habitat connectivity for aquatic organisms like native fishes. Currently there are a variety of agency datasets inventorying stream-road crossings in the region. These databases facilitate prioritization of where to spend time and money when maintaining or replacing stream road crossings that are barriers to native fish passage or are in danger of failing to support natural hydrologic and geomorphic processes and road infrastructure. Even with all the crossings included in these established datasets, there are still hundreds if not thousands of stream-road crossings that are not documented. Some crossings we know exist but have not yet been surveyed, while other crossings have not been recorded in any database. Our objective is to create a usable and accessible peer reviewed, publicly available, dataset and an accompanying stream-road crossing assessment survey using a tested feature mapping platform. Recently, the flow permanence survey and dataset FLOwPER was established to provide a quick and accessible field survey utilizing mobile data collection to map flow to an online hosted feature layer. This effort was very successful with nearly 10,000 flow permanence observations collected in three years and we anticipate it will be an accessible platform for establishing a stream-road crossing survey. Our current project will review data collected as part of stream-road crossing surveys for stream habitat and/or road management efforts to ensure that we develop a survey protocol that meets management needs while being transferable across existing stream-road crossing datasets.

Density and Structure: Do they affect how Hatchery Chinook Respond to Stress?

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Previously, we has found that Chinook salmon (Oncorhynchus tshawytscha) reared with structure in their tanks have a lowered stress response as compared to fish reared without structure.In this experiment, we reared fish with and without structure in conjunction with low and high rearing densities. Our goal was to determine if rearing fish with structure at low density resulted in a reduced stress response when confronted with a simulated transport stress. Additionaly, we investigated rearing effects on resting cortisol secretion. We reared brood year 2018 Chinook salmon at low and high (production) densities with and without in-tank structure in triplicate. In fall 2019 when fish were subyearlings, we simulated a transportation event to evaluate the stress response of fish from each treatment. We first collected plasma before the stressor was applied, we then periodically sampled fish over the next 23 hours. To evaluate resting cortisol secretion, we incubated interrenal tissue from unstressed fish in all treatments at ambient water temperature. We found that fish reared at low density with structure in their tanks had the lowest plasma cortisol levels in response to stress while fish reared at high density with structure had similar cortisol levels compared to fish reared at low density without structure. Conversely, fish raised at high density without structure had the highest resting cortisol level and elevation in response to the stressor. Hence, structure in the rearing

environment appears to mitigate the negative effects of elevated density. Resting interrenal cortisol secretion values were not different across treatments, indicating that the stress response observed in this experiment was in fact an acute response and mitigated by the presence of structure in a low density environment. We speculate that the lowered stress response in juvenile Chinook salmon may lead to higher survival rates when released into streams for ocean migration.

Translocated in the wake of the ashes: A Snake River success story for Pacific Lamprey

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Pacific Lamprey is an anadromous fish that has severely declined in the Snake River basin. Translocation of adults to this region from the main stem Columbia River was initiated by the Nez Perce Tribe in 2007 and along with genetic monitoring continue to this day. These actions are aimed at restoring larval abundance along with holistic habitat improvements. We performed parentage and sibship analysis with 260 single nucleotide polymorphism loci to monitor productivity of translocated lamprey over a decade (2007 – 2018). These results provide the first direct evidence that translocations boost larval abundance, increase juvenile production in the interior Columbia River (~3% of total juvenile production in 2017 and 2018), and demonstrate successful migration to the Pacific Ocean. Per capita juvenile production from Snake River adult lamprey translocations out-performed their volitionally-migrating counterparts in the interior Columbia River, demonstrating that translocating adults to suitable habitats can increase overall productivity. These translocations are also restoring Pacific Lamprey to historical areas that had been nearly extirpated which has impactful benefits culturally and ecologically. Further, this project provided an unprecedented volume of data that has redefined key biological attributes including timing of life-stage transformation, larval growth rates, ocean duration, dispersal, and life-span. These data provide an opportunity to monitor ongoing translocation efforts and inform adaptive management to aid species recovery.

Stream habitat and community assemblage response to wildfire in interior Alaska boreal streams

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Wildfire is the primary natural disturbance in boreal forest stream ecosystems and fires are expected to continue to increase in duration and frequency owing to climate change. Wildfire has been shown to have positive (e.g., increased nutrients) and negative (e.g., increased sedimentation) impacts on stream ecosystems. Increased productivity as a result of recent fire may lead to more complex aquatic communities owing to higher food resource availability. As a result, fire may play a key role in determining macroinvertebrate and fish assemblages in boreal streams, but complex interactions make it challenging to quantify these effects. During summer 2019, we investigated community responses to wildfire at 26 spatially-balanced sites on wadeable streams in interior Alaska with varying time since fire disturbance (recent: 0-15 years, historic: 40-70, control: 80+). At each site, we measured physical habitat (e.g., substrate composition, riparian canopy cover, bank stability) and water chemistry, quantified macroinvertebrate and fish assemblage structure, determined fish mass-abundance relationships, and assessed aquatic food webs via stable isotope analysis. Fish community assemblages were relatively simple, with no more than five species detected per site.

Macroinvertebrate and fish diversity and density were higher at recently burned sites relative to control or historic sites. Analysis of habitat characteristics revealed that recently burned sites had more in-channel wood, less fine sediment, lower canopy cover, more soluble reactive phosphorous, and warmer water temperatures relative to control and historic sites. Preliminary stable isotope data reveal that streams that recently experienced wildfire have a wider carbon breadth and longer food chain length than control streams. Knowledge of how aquatic community and food web structure relate to variables associated with fire disturbance may promote a better understanding of how climate change and fire interact to impact boreal stream ecosystems and provide insight into community-wide responses to wildfire.

Expanding the Southeast Aquatic Barrier Prioritization Tool: Assessing Aquatic Fragmentation in the Western United States

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Fragmentation of river habitats by anthropogenic barriers is one of the primary threats to aquatic species in the United States. In an effort to address this issue, SARP has been working with partners including USFWS to identify, prioritize, and remove barriers to aquatic organisms in the Southeastern United States through the Southeast Aquatic Connectivity Program. SARP has developed a comprehensive living inventory of dams and road stream barriers as well as detailed metrics to prioritize these barriers for removal or bypass. The inventory and prioritization is fed to Astute Spruce, who has created a user-friendly interactive tool where partners can readily access this information. The Southeast Aquatic Barrier Prioritization tool provides summaries of barrier densities within user specified areas of interest and allows users to prioritize barriers for removal based on ecological metrics using various filters. The results provided by the tool help identify high priority projects to implement and allow resource managers to access information regarding barrier locations and attributes that were not readily accessible in a one stop shop prior to SARP's work. Using these results, within the Southeast, SARP has been working with partners within and outside of state-based Aquatic Connectivity Teams to incorporate on the ground information and implement high priority barrier removal or remediation projects. With additional funding from the US Fish and Wildlife Service Fish Passage Program, this inventory and tool will be expanded using available data into an additional 12 western states, including Oregon, over the next three years.

Effects of stage 0 restoration on aquatic macroinvertebrate production

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Contemporary stream restoration efforts increasingly prioritize restoring natural stream processes to regain lost ecosystem functions. Stage 0 stream restoration resets disturbed, channelized streams to a theoretical pre-disturbance state ("stage zero"). It is assumed that this valley-scale restoration/disturbance will restore natural abiotic and biotic processes, leading to greater primary and secondary biological productivity, maximizing potential ecosystem services such as the abundance of desirable fish species. As stage 0 restoration projects have been implemented in Oregon and across North America, post-restoration studies have not fully assessed this assumption. In this study, we seasonally sampled aquatic macroinvertebrate communities and fish diets on the South Fork McKenzie River, OR in a reach that underwent stage 0 restoration in 2018, as well as two

upstream, unrestored control reaches. We estimated total annual secondary macroinvertebrate production on the benthos and submerged wood surfaces, and constructed food webs from the dominant taxa found in fish diets. Contrary to expectations, annual production estimates were ~5-times lower on a per-meter-squared basis in the restored reach than in upstream unrestored reaches. However, because there was ~4.5-times greater wetted area available in the restored reach, overall macroinvertebrate production per-unit of valley length was 1.5-times higher than in unrestored reaches. Fish diet assemblages were also more complex in the treatment reach than in the control reaches. Additionally, a greater diversity of macroinvertebrate community assemblages was observed in the restored reach, suggesting that stage 0 restoration may produce a heterogeneous mosaic of fine-scale habitat patches and associated metapopulations. These findings suggest that stage 0 restoration may increase overall macroinvertebrate productivity as well as create a more diverse assembly of prey items with more consistent prey availability and greater overall habitat and foraging opportunities for fishes.

Whiskey Creek Culvert Replacement

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The previous Whiskey Creek culvert was a 60 inch corrugated metal culvert that was undersized causing periodic flooding of OR244. Furthermore, the previous culvert was a velocity barrier to fish passage during high flows and had a foot jump height barrier to juvenile passage during low flows. This culvert was listed as "high priority" on the 2017 ODFW Statewide Fish Passage Priority list for replacement. The project replaced the existing culvert with a much larger stream crossing (concrete box culvert) that provides full, year-round fish passage and meets the fluvial standards of the National Marine Fisheries Service (NMFS) and Unites States Fish and Wildlife Service (USFWS). Whiskey Creek is a tributary of the Grande Ronde River and contains ESA-listed Snake River Basin (SRB) steelhead and is designated critical habitat. Replacing the existing culvert in 2020 improved fish access to 15.61 miles of SRB steelhead habitat above the culvert. The existing culvert is at the confluence of the Grande Ronde River which contains ESA-listed SRB steelhead, Snake River spring/summer run Chinook salmon, Columbia Basin bull trout, and is designated critical habitat for those species. Realignment of the new culvert required the creation of a new upstream channel for approximately 450 feet above the new culvert inlet. The previous stream channel of Whiskey Creek went dry in the summer. This new channel contains water year-round and provides much needed off-channel habitat for fish that inhabit the Upper Grande Ronde River Basin. Project coordination and partnerships included the Confederated Tribes of the Umatilla Indian Reservation, NMFS, USFWS, Department of State Lands, Corps of Engineers, and the Oregon Department of Fish and Wildlife.

Federal Forestry and Salmon in Western Oregon: A Historical Perspective

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Thirty years ago, a series of political, scientific, and policy events put protection of salmon habitat on federal lands in western Oregon on a fundamentally different track, which continues today. Three fish biologists documented the previous condition of many salmon populations. A Congressional Chairman demanded that old-growth policies, then being debated, not forget fish. Two PNW Station scientists

took up that challenge and outlined much more protective and expansive policies for stream and riparian habitat on federal lands. After fierce resistance and challenge, the Forest Service came to see their merit. They were further expanded into the Aquatic Conservation Strategy of the Northwest Forest Plan, which is still in effect and admired. While the ACS showed how a protective policy could be crafted for federal lands, it also showed that these lands, important though they be, form only a small part of the habitat that needs protection and restoration. Private forests and downstream farms, ranches, and towns where we work and live now hold the keys to saving salmon.

Exploring stream connectivity outcomes for stakeholders and Yellowstone cutthroat trout in the Teton River drainage, Idaho

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Two major threats to native fishes worldwide are habitat fragmentation and invasive species. Stream habitat fragmentation divides populations and may lead to local extinction. In some watersheds, fish passage barriers block migratory pathways for native fish species. However, these same barriers may also prevent invasion from non-native fish species that have negative interactions with native species. Throughout the Teton River drainage, barriers block migratory pathways for a native salmonid, Yellowstone cutthroat trout (Oncorhynchus clarkii bouveri). Yellowstone cutthroat trout are also impacted by non-native salmonids, including rainbow trout (Oncorhynchus mykiss), brook trout (Salvelinus fontinalis), and brown trout (Salmo trutta). Increasing migratory life history of Yellowstone cutthroat trout through connectivity restoration could mitigate the impacts of non-native species, but this has not been evaluated. Furthermore, decisions that change stream connectivity or address non-native species have uncertain ecological and social outcomes, and affect not only streams and fish but also irrigation, angling, and other stakeholder interests. Here, we integrate qualitative mental modeling and quantitative individual-based modeling to examine 1) the suite of plausible connectivity scenarios in the Teton River drainage; 2) stakeholder perceptions of the social and ecological outcomes to changing connectivity; and 3) the impacts of stakeholder-identified scenarios on Yellowstone cutthroat trout populations and their interactions with non-native species. The results from this project may will inform management of water resources, in-stream barriers, and trout fisheries in the Teton River drainage, as well as contribute to our understanding of connectivity conservation broadly.

Cultural Beliefs and Outdoor Recreation Habits of Willamette Valley Latin@ Residents

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In Oregon, outdoor recreation activities have continued to grow in popularity, as has the overall Latin@ population of the state. Despite the population increase of this ethnic group, their outdoor recreation habits have continually been examined through an environmental justice lens. This includes accessibility, affordability, and other barriers to participation of certain outdoor activities and visitation of different outdoor settings. Even with this extensive existing data describing the barriers to outdoor recreation for this ethnic group, the influence of cultural beliefs and values in determining preferred outdoor recreation activities and use of outdoor spaces needs more exploration. This cross-sectional qualitative study applied semi-structured interviews to a) describe Latin@s preferred

outdoor recreation activities b) identify key cultural environmental beliefs of various Latin@ subgroups c) determine how these beliefs are formed and d) describe how these beliefs influence preferred outdoor recreation activities. The majority of interviewees shared their held beliefs to respect and take stewardship over nature, especially while recreating outdoors. These beliefs were passed down from older family members, in addition to being motivated by family traditions and commitments related to perceptions of nature and the outdoors. These beliefs were also influenced by friends, who were the primary influence of outdoor recreation behaviors and determining activity types for younger Latin@s (ages 18-37). This is of particular interest in the Willamette Valley of Oregon, where new initiatives for making outdoor recreation activities and spaces more inclusive, diverse, and representative of the current population are being implemented. Focusing on the cultural beliefs and values of this ethnic group will aid non-profit organizations and state & federal agencies that manage public lands and offer outdoor recreation activities and programs, in being more conscious of how culture influences outdoor recreation habits of Latin@ families and individuals.

Riverscape patterns of Chinook Salmon emergence timing and implications for size and growth

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Oregon's rivers exhibit diverse temperature profiles during summer, but these are less understood during non-summer months, including how they shape patterns of temperature-mediated processes such as egg development and fish growth. We predicted patterns of spring Chinook Salmon (Oncorhynchus tshawytscha) emergence timing across four NE Oregon subbasins over 5-9 years using spawning and temperature data. We then related 1) spatial patterns of emergence timing to juvenile salmon size within two subbasins in 2019, and 2) inter-annual variation in emergence dates to annual mean size and growth rates in three subbasins over 5-9 years. Predicted emergence timing exhibited clear longitudinal patterns in each subbasin, but the shape of these patterns differed among subbasins. Emergence occurred progressively later upstream in two subbasins, whereas emergence was earliest at upstream sites in the other two subbasins, presumably attributed to local groundwater inputs. In 2019, the two subbasins with later emergence upstream (~ 6 weeks later upstream compared to the farthest downstream sites) exhibited decreasing juvenile salmon size with distance upstream. In contrast, among years, parr size at consistent tagging locations was not associated with annual emergence estimates, despite nearly a 10 week range in emergence dates. Growth rates were slower in years with earlier emergence, which counteracted the effect of longer growth durations. Years with earlier emergence tended to have higher summer temperatures and lower discharge, suggesting that the conditions that promote early emergence (e.g., warm winters and low snowpack expected with future climate change) may lead to poorer rearing conditions. Collectively, our results suggest that the effects of emergence timing on subsequent growth and size differed between spatial comparisons within years and inter-annual comparisons at consistent locations.

Assessment of Angler Caught Broodstock (ACB) Methods at ODFW Hatcheries

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The Oregon Department of Fish and Wildlife (ODFW) uses several methods to collect wild broodstock to be spawned at hatcheries. These methods include trapping, netting, and angling. Angler Caught Broodstock (ACB) are currently used at seven ODFW hatcheries to produce juvenile steelhead (Oncorhynchus mykiss) for release into coastal Oregon rivers. ACB programs offer a variety of benefits, including stakeholder engagement and an effective collection approach that can be effective even under low water conditions that can impact trap efficiency. Hatcheries using ACB programs operate in accordance with Hatchery Genetic Management Plans (HGMPs) that detail protocols for collecting and spawning broodstock. However, potentially important differences among broodstock collection and holding practices could affect broodstock survivorship-to-spawning and stock performance. A comprehensive survey of these practices has not yet been performed. In our study we surveyed coastal steelhead hatchery programs to gather information about their ACB collection, transport, holding and spawning practices. We related ACB treatment to program success in terms of broodstock survivorship-to-spawning to identify best management practices for ACB programs. Through site visits, analysis of existing data, and hatchery staff surveys, we gathered and compared information to explain the variable success of Oregon's ACB programs.

A Nose For Better Fishing

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Acclimation programs have been an important tool for salmon and steelhead fishery managers to reduce hatchery and wild interactions on the spawning grounds while providing an increase in angling opportunity. As part of South Umpqua River Hatchery Program, the Oregon Department of Fish and Wildlife (ODFW) in conjunction with the Umpqua Fisherman's Association (UFA) and the Cow Creek Band of Umpqua Tribe of Indians (Tribe), has been acclimating and releasing Winter Steelhead into Canyon Creek, a tributary to the South Umpqua. From 1999 until 2017 the acclimation timing and duration remained relatively consistent with smolts being acclimated for three weeks and then released. A workshop was organized by the Tribe at the Oregon Hatchery Research Center in the fall of 2017 to discuss options to improve the return rates of hatchery winter steelhead to anglers as well as to reduce hatchery stray rates in the basin. Using information gathered at the workshop, an acclimation timing investigation began in 2018 to determine which release timing strategies best accomplish our goals. Several groups of juvenile Winter Steelhead were/ will be implanted with coded wire tags and released over five yearsusing different acclimation timings and durations. We will provide a brief history of the program, more details about the study, and present preliminary results.

Capturing and Tracking Adult Pacific Lamprey in an Oregon Coastal Lake System

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This presentation will be an exploration of adult Pacific Lamprey capture and radio tracking techniques in small creeks and lakes in the Eel Creek Basin, on the Oregon Coast. In the past 4 years, we have captured almost 150 adult lamprey using homemade tube traps, hoop nets, and electro-

shocking techniques. After capture, the lamprey were radio tagged and tracked throughout the Eel Creek basin including through Eel Lake which presented specific challenges for tracking.
Data was collected and mapped using a unique GIS mapping system that allows for photos, videos, and other pertinent data to all be presented within the GIS map. We will assess the capture and tracking techniques, highlight a few of our significant findings, and discuss the GIS data presentation method.

Initial research to artificially propagate, release, and assess larval Pacific Lamprey in the Tucannon River, WA

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Restoration of Pacific Lamprey to some areas of the Columbia River Basin may require supplementation of natural populations with artificially propagated individuals. However, broodstock availability is a limiting factor. For this reason, among others, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) developed protocols for artificial propagation of Pacific Lamprey to optimize use of the limited number of broodstock available each year. The ultimate goal is to produce large numbers of larval and juvenile lamprey for both research and restoration. CTUIR began this research in 2012 and, shortly thereafter, built a dedicated Pacific Lamprey and freshwater mussel propagation facility at Walla Walla Community College's Water and Environmental Center in Walla Walla, Washington. Past research at the facility has focused on developing methods for spawning, gamete storage and transfer, broodstock holding, and larval rearing. In May 2021, CTUIR conducted its first release of propagated Pacific Lamprey into the Tucannon River (a tributary of the Snake River in eastern Washington). Larvae were released at 2-4 weeks post-hatching. Two types of release method (staggered and direct release) and two acclimation treatments (Tucannon River and well water) were applied. Genetically-distinct lamprey families were either incubated and reared in river water or well water and then either released in a staggered fashion from artificial "redds" or direct released. Initial survival was estimated for the staggered release method by sampling at 6 h, 24 h, 3 d and 6 d after placement of artificial redds. Survival was high for larvae reared in both river water and well water, with 90% or higher survival at assessments made 6 hours – 6 days after placement in the river. For future assessment of survival of propagated fish, we collected eDNA samples at, above, and below the release site. In addition, electrofishing conducted at index sites established prior to the release event will be used to track population trends and obtain larvae for parentage assignment. This work, and that of collaborators from the Yakama Nation, are the first ever releases of artificially-propagated Pacific Lamprey and the first attempt to assess survival relative to naturally-produced lamprey for any lamprey species.

Responses of linked stream-riparian foodwebs to wildfire in Idaho's Salmon River basin

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Increasing frequency and severity of wildfires is causing concerns about whether or not stream organisms are resilient to wildfire. However, in many cases short-term effects of fire on stream

organisms are minimal or recovery occurs rapidly. In fact, numerous indirect, positive effects may benefit linked stream-riparian communities in the mid-term following high-severity wildfire. A combination of long-term and intensive studies in the Frank Church Wilderness of Idaho have revealed that while linked stream-riparian habitats are often dramatically changed, there are positive pulses of productivity that reverberate between water and land. Organisms in some streams rapidly return to pre-fire conditions, invertebrate diversity appears stable or may even increase, prolonged pulses in invertebrate productivity can benefit predatory invertebrates and endangered fish populations as well as downstream resource availability, and fish have exhibited preference for confluences with burned tributaries. This "fire pulse" extends to riparian organisms through increased insect emergence that can fuel greater abundances of birds, spiders, and bats. Responses vary with the degree of fire severity and other coupled disturbances (e.g. debris flows). In such context, allowing high-severity wildfires to burn may contribute to heterogeneity (in space and time) that helps maintain native biodiversity and the function of stream-riparian ecosystems.

Assessing hybridization risk between native Bull trout (Salvelinus confluentus) and introduced Brook trout (S. fontinalis) using habitat modeling

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Using a spatially-explicit GIS Hybridization Risk Model (HRM) between native ESA-listed Bull Trout and introduced Brook Trout by combining an intrinsic potential model (IPM) of Brook Trout spawning habitat and existing empirical datasets of Bull Trout in Oregon.

The Road to Lamprey Summit V: Leveraging Lamprey Conservation with the Pacific Lamprey Conservation Initiative

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In December 2022 the Pacific Lamprey Conservation Initiative (PLCI) will convene Lamprey Summit V, a vital next step in bringing key signatories and partners together to commit to using science to conserve Pacific Lamprey across its historical range (AK, CA, ID, OR, WA). PLCI's diverse group of more than 176 Native American tribes; federal, state, and local agencies; non-profit organizations and others work collaboratively to conserve and restore lamprey populations and their habitats. Since Lamprey Summit I in 2004, defined by a call to action from the tribes to recognize the decline of Pacific Lamprey, every five years partners have convened to revisit the science and current status of lampreys, and recommit to working collaboratively to preserve this culturally and ecologically important species. As awareness grows, there is a renaissance underway in research and conservation for native lamprey species and at its epicenter is PLCI. Researchers and students are studying lamprey biology, ecology, and cultural importance more than ever before. Engineers, restoration practitioners and funding boards are finally considering lamprey. Important conservation actions are being implemented for lampreys, but so much more can and should be done. 2022 is a big year for lampreys and PLCI! New and existing partners will have the opportunity to sign on to the Pacific Lamprey Conservation Agreement demonstrating commitment to supporting lamprey conservation and PLCI. Partners across the West are invited to contribute to the update of the Pacific Lamprey Assessment.

All of these paths lead to Lamprey Summit V, where partners will strategize to send PLCI into the next five-year chapter of the partnership with a focus on collaborative science and conservation. This presentation will provide an overview of PLCI, its committees and initiatives, and highlight ways new and existing partners can learn more about lampreys and get involved in PLCI.

Going with the Flow: Examining the Role of Hydrologic Variation in the Seasonal Migrations and Disturbance-Driven Movements of Common Snook in the Florida Everglades

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Environmental variation plays a central role in shaping animal movement, with changes in conditions influencing both the timing and patterns of movement for many coastal and riverine fishes. Seasonal shifts in hydrologic conditions, particularly flow and water level, can present predictable cues which trigger behaviors such as spawning migrations. However, rapid and unpredictable changes stemming from abrupt environmental disturbance may also elicit a behavioral response, resulting in large-scale movements and redistribution of fish populations. In this study we share insights from eight years of monitoring (2012 – 2019) using passive acoustic telemetry as part of the Florida Coastal Everglades Long Term Ecological Research program. We investigate how environmental variation at both the seasonal and annual scales influence the migratory patterns of Common Snook, a popular sportfish in coastal/riverine habitats of the tropical/subtropical Atlantic coast. Further, we examine the Snook response to extreme disturbance through movement patterns collected during Hurricane Irma (2017). Our results show how hydrologic patterns influence both migratory timing and the frequency of skipped spawning in Snook, and how similar cues (river stage, daily rate of change) initiate changes in movement patterns during the passage of Irma. By providing mechanistic descriptions of conditions which promote migration and reproduction, combined with an increased understanding of how disturbance influences movement patterns, we can help inform management decisions that seek to conserve ecologically and economically important species under changing conditions.

What does the public think about Oregon's marine reserves? Changes over time in resident knowledge, attitudes, and intentions

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This study examined changes over time in Oregon residents' knowledge, attitudes, and behavioral intentions associated with this state's marine reserves. Baseline data were collected with mail surveys in 2013 from residents of the Oregon coast (n = 596) and in 2016 from residents of the I-5 corridor, which is the state's most populated region (n = 530). Comparative data were then collected with mail surveys in 2021 from both of these populations (n = 1,038) to determine any changes in responses over time. Factual knowledge about these marine reserves was measured with 11 true / false questions, and this knowledge was low with an average of fewer than 50% of these questions answered correctly across both populations and all years. Knowledge did not change over time for coastal residents (2013 vs. 2021), but increased slightly for I-5 corridor residents (2016 vs. 2021). On average, residents of both populations across all years expressed favorable or positive attitudes

toward these marine reserves with this favorability increasing over time, especially among coastal residents. Intentions were measured by asking respondents how they would vote if they were to be given an opportunity to vote for or against having marine reserves in Oregon. More than two-thirds of residents across both populations and all years said they would vote in favor of these reserves. For both populations, residents in 2021 were significantly more likely than residents in 2013 and 2016 to say they would vote in favor of these reserves. Implications of these results for planning, management, and future research will be discussed.

Is it Better to be Lucky or Good? How the BLM and its partners implemented a large-scale stream restoration project one year after the Archie Creek fire.

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On September 8, 2020, the Archie Creek fire started in the North Umpqua watershed. The fire burned over 100,000 acres in 48 hours. The end result was a 300+ year disturbance event that consumed 75% of the Rock Creek watershed. The Roseburg BLM and the Partnership for the Umpqua Rivers (PUR) had already been planning a large stream restoration project in Rock Creek. They were able to change the scope and scale of the project over the winter and implement a large-scale stream restoration project the next summer. This is the largest post-fire stream restoration project in BLM history placing 950 fire-killed trees in over 5 miles of stream and opening 1.2 miles of side-channel habitat. Why isn't this happening in other fire areas? This presentation will not only tell the story of the restoration project, but will focus on administrative hurdles to quickly implementing post-fire watershed restoration.

Longitudinal, lateral, vertical and temporal thermal heterogeneity in a large impounded river: implications for cold-water refuges.

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Dam operations can affect mixing of the water column thereby influencing thermal heterogeneity spatially and temporally. This occurs by restricting or eliminating connectivity in longitudinal, lateral, vertical and temporal dimensions. We examined thermal heterogeneity across space and time and identified potential cold-water refuges for salmonids in a large, impounded river in inland northwestern USA. To describe these patterns, we used thermal infrared (TIR) imagery, in situ thermographs, and high-resolution 3-D hydraulic mapping. We explained the median water temperature and probability of occurrence of cool-water areas using generalized additive models (GAMs) at reach and sub-catchment scales, and we evaluated potential cold-water refuge occurrence in relation to these patterns. We demonstrated that (1) lateral contributions from tributaries dominated thermal heterogeneity; (2) thermal variability at confluences was approximately an order of magnitude greater than of the main stem; (3) potential cold-water refuges were mostly found at confluences; and (4) the probability of occurrence of cool areas and median water temperature were associated with channel geomorphology and distance from dam. These findings highlight the importance of using multiple approaches to describe thermal heterogeneity in large, impounded

rivers and the need to incorporate these types of rivers in our understanding of thermal riverscapes because of their limited representation in the literature.

Using Predation Event Recorders to directly observe predation on Atlantic salmon smolts

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Fewer than two thousand adult Atlantic salmon (Salmo salar) return to Maine waters every spring, and the Gulf of Maine Distinct Population Segment is currently listed under the Endangered Species Act. Atlantic salmon are exposed to a suite of risks through all stages of their complex, anadromous life cycle. The migratory smolt stage is a focus of considerable conservation effort as managers attempt to maximize escapement into the marine environment. More than a decade of acoustic telemetry data in the heavily dammed Penobscot River suggests that predation may be a leading cause of smolt mortality, given losses in dam headponds and the estuary. Traditional methods used to assess fish predation are often speculative, limited in their temporal and spatial resolution, and rarely identify the predator. The recent development of Predation Event Recorders (PERs) to study Pacific salmon predation may offer analogous insight into predation risk of Atlantic salmon during smolt migration. We tethered smolts (n=77) to PERs in the impoundment of Weldon Dam and allowed devices to drift with river flow for 1h deployments. Each PER was equipped with a GPS and waterproof video camera to record the time and location of each predation event while also identifying the predator species. We observed 5 total predation events by chain pickerel (Essox niger, n=4) and smallmouth bass (Micropterus dolomieu, n=1) in addition to 31 non-lethal observations (e.g., aggressive, interested, incidental) from seven different species. Preliminary results suggest that predation risk is highest just after sunrise and in shallow waters. Overall, we show direct evidence of predation on Atlantic salmon smolts and highlight the advantages of using PERs as a complementary method to inform assessments of predation risk.

Great Lakes Sea Lampreys: Communicating the Crisis, Control, and Challenges

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Sea lampreys (Petromyzon marinus) invaded the Great Lakes in the early twentieth century and caused considerable economic and ecological harm, including widespread devastation of fish populations, fisheries, and the livelihoods of people. Subsequently, those people most affected called on elected officials in Canada and the United States to develop a sea lamprey control program, which the Great Lakes Fishery Commission implements under the 1954 Convention on Great Lakes Fisheries. Sea lamprey control is a tremendous success, yet continued public advocacy for and acceptance of the control program is not ensured. Dramatic reductions in Great Lakes sea lamprey populations generate the accompanying risk that public perception could shift from viewing sea lampreys as a contemporary threat to viewing them as a problem of the past that is no longer relevant. Consequently, the Commission engages in communications regarding the negative effects of Great Lakes sea lampreys, the importance of controlling their population, and the need for scientific research to maintain healthy ecosystems and fisheries. Communications efforts include in-person

interactions with the public (e.g., outreach events), school visits and programs, engagement with the press, development and maintenance of the Commission's website, public interactions via social media, and development of various products including videos, fact sheets, brochures, activity booklets, and press releases. Targeted audiences include elected officials and their staff, sister organizations, the media, NGOs, specialized groups, stakeholders, and the general public. The reach of the Commission's communications program is broad, especially owing to national and international media attention. While strongly beneficial to the Commission's work, there have been unintended consequences to conservation efforts for lamprey species elsewhere, including sea lampreys in their native range and Pacific lampreys. This presentation will focus on the Commission's communications goals, audiences, messages, and methods, including the important nuances in messaging to maintain clear and accurate communications.

Unlocking the secrets of Pacific Lamprey (Entosphenus tridentatus): A multidimensional approach

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Management and conservation of Pacific Lamprey (Entosphenus tridentatus) is limited by gaps in knowledge of species' ecology and biology. Not only does this cartilaginous species lack hard parts, such as bone and otoliths, used to estimate age and growth, but there are limited species-specific monitoring tools. Therefore, we explored alternative approaches to provide pertinent ecological information. First, we evaluated the potential of lamprey statoliths, which are calcium phosphate structures analogous to otoliths, to provide information on age and growth. We observed strong, positive relationships between body and statolith size for larvae. However, there were no such relationship for any post-metamorphic life stages, indicating that statolith growth slows or ceases after metamorphosis. Second, we applied traditional band-reading methods to known-age lamprey with limited accuracy (33%). However, a nonlinear classification approach (Random Forest) correctly assigned ages to ~75% of known-age larvae and juveniles based on fish length, origin system, and statolith. Third, earlier efforts to characterize natal origins of juvenile emigrants based on statolith chemical signatures (strontium:calcium, barium:calcium, and 87Sr:86Sr) were expanded to provide information on relative source contributions throughout northern Oregon and southern Washington. Fourth, given the lack of utility of statoliths to provide information during marine residence, we examined stable isotopes (δ13C and δ15N) within the eye lenses of adult Pacific Lamprey to determine if lens layers reflected the freshwater-marine transition. Individual chronologies of δ13C and δ15N tracked transitions of individuals from riverine to marine waters, highlighting the potential to reconstruct spatial movements and feeding during the marine phase. Finally, we explored the potential for leveraging monitoring tools traditionally used for Pacific salmon, i.e., rotary screw traps, to provide information on the relative catch and migration patterns of Pacific Lamprey within the Central Valley, California. Collectively, these alternative approaches help address important knowledge gaps and advance conservation and recovery efforts.

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. 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.

Same Streams in a Different Forest? A Long-term Dataset Reveals Relationships Between Fish Habitat, Landscape Geomorphology, Climate, and Management Legacy in a Temperate Rainforest

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Time can appear to stand still in Southeast Alaska's Tongass National Forest, where streams supporting valuable anadromous and resident fish populations course through ancient stands of spruce, hemlock, and cedar. However, anthropogenic activities are contributing to dynamic change in northern forested ecosystems despite their remote location. Intensive timber harvest began in the Tongass in 1947 and climate change is causing transitions from snow to rain dominated hydrologies that may increase vulnerability of fishes to events such as winter floods. To explore how aquatic habitats on the Tongass National Forest have changed over time, we assessed long-term datasets of stream habitat conditions to 1) understand the natural range of habitat variability, 2) elucidate legacies of watershed management, and 3) anticipate changes due to ongoing effects of climate change across spatial management units. We analyzed relationships among a suite of 13 stream habitat metrics and landscape, management, and climate variables for 850 stream habitat surveys collected over 30 years across coastal watersheds of the 17-million-acre Tongass National Forest. Immutable landscape variables such as channel process group and watershed geology were important

factors driving patterns of variation. Our results revealed decreasing trends over time in harvest area and harvests occurring in riparian buffers, which directly follows forest management practices over time. Patterns of stream habitat metrics were also linked with management variables revealing a negative association between riparian timber harvest and undercut banks and a positive association between old growth forest and pool density. Sites where habitat restoration had occurred had similar wood densities to other sites but had lower values for pool-related metrics suggesting that pool formation had not had time to take place after wood was placed in streams. We found that snow-dominated catchments had slightly more large and key wood densities than rain-dominated ones. This suggests a need to refine river hydrologic classification systems or that hydrologic regimes that may result in temporary pulse disturbances with fewer persistent measurable effects on stream habitats. Our results can help managers identify degraded streams for habitat restoration and manage for resilience of salmonid populations amidst future changes to the climate and forest environment.

Documenting early development in Surf Smelt (Hypomesus pretiosus) for future studies on ocean acidification and cardiotoxicity.

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Documentation of early development in healthy fish larvae is necessary when examining developmental instability due to toxins and climate change driven alterations in the environment. Ongoing studies investigating cardiotoxicity in surf smelt (Hypomesus pretiosus) required accurate information about the structure and cadence of normal heart beats. This information could not be found to the satisfaction of the researchers after an exhaustive literature search so an experiment was set up to gather needed data. We observed development in surf smelt embryos from 24 hours post fertilization through hatch at ambient water temperature. Developmental milestones were documented with still and micro videography and rendered in pen and ink. This presentation will illustrate anatomical comparisons of several larval fish used in ecotoxicology studies with emphasis on surf smelt.

The Progression of Naturalization: Using Parentage-Based Tagging to monitor the reintroduction of spring Chinook salmon to Lookingglass Creek, OR

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Populations of anadromous salmonids have been dramatically reduced throughout the Pacific Northwest, especially in the Columbia River Basin, where extensive alterations to the hydrosystem have resulted in the extirpation of populations across subbasins and species. When the cause(s) of an extirpation event are addressed, natural recolonization may occur, but often reintroductions must rely on hatchery stocks to supplement productivity. Reliance on hatchery fish has inherent risks, largely due to potentially reduced fitness associated with domestication selection. In Lookingglass Creek, a tributary to the Grande Ronde River in northeastern OR, a spring Chinook reintroduction effort was initiated via captive broodstock releases in 2000, and the population continues to be supplemented by local, hatchery-origin (HOR) fish. To monitor the progress of naturalization in this

system we used parentage-based tagging methods to evaluate the fitness of reintroduced natural-origin (NOR) fish relative to their HOR counterparts when spawning naturally. We used two pedigree reconstruction methods (SNPPIT and COLONY) to identify the number of adult and juvenile progeny attributed to every naturally spawning adult from 2008-2016. These data informed GLMs, which quantified the expected number of progeny by spawners of different origins and sexes within each year, while controlling for other factors that may influence fitness and accounting for differences in the frequency of successful spawning events. We found NOR fish produced significantly more progeny (both juvenile and adult) across all sex and year combinations. Also, return day and fish size were significant predictors of reproductive success (juvenile progeny only). Additionally, we found some relationship between the number of juvenile and adult progeny per spawner, but this was highly variable by year, and therefore likely not sufficient to be predictive. Results suggest that fish which possess HOR ancestry can adapt to the local environment within relatively few generations. Reintroduction programs relying on hatchery efforts would therefore likely benefit by implementing management practices rooted in supplementation and restoration.

Riparian Conservation through Habitat Conservation Planning

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Habitat Conservation Planning, a regulatory tool used by federal agencies for decades, is gaining popularity in Oregon. HCPs have been used to preserve habitat, maintain wildlife corridors and environmental processes, and guarantee mitigation for incidental take of federally listed species. Over the past several years, the State of Oregon and private industry have been developing a number of forestry HCPs. Although they are all forestry-based, there are significant differences between the HCPs. One is a proposed research forest, another for State Lands, and another for private lands. The Elliott State Forest is a proposed research forest. The design was created with significant stakeholder involvement and intends to provide an area focused on conservation, another based on ecological-forestry, and another on economic forestry. The Western Oregon State Forest HCP identifies areas for conservation - Habitat Conservation Areas and Riparian Conservation Areas. The proposed HCP was developed with biologists and foresters across State and Federal agencies. Conservation areas are set aside for conservation and have limited activities in the areas. The riparian conservation areas establish a buffer and severely limit activities. The timber harvest across the proposed permit term remains equal to or an increase as compared to the current Forest Management Plan. The Private Forest Accord, the base for a private lands HCP throughout the State of Oregon, covers 10 million acres on industrial private land and small woodlots. Riparian buffers, limited use of the riparian area, protections for steep slopes and landslide initiation sites are a focus of the conservation in the proposal. Finding a balance between economics and ecology by providing regulatory certainty while ensuring long term funding for conservation is why the HCPs are sought by both industry and conservation. Recognizing the important economic role of timber while addressing endangered species issues is the driving underpinning of the HCPs.

Prioritizing eDNA monitoring sites for nonnative Atlantic salmon via habitat modeling in streams of Patagonia and Washington State

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Early detection methods are critical for the effective management of biological invasions. Escapes from salmon aquaculture facilities can lead to the naturalization of nonnative species. Massive escapes from aquaculture net-pens (approximately one million fish per year), predominantly Atlantic salmon Salmo salar, occur in Southern Chile. Similarly, introduced Atlantic salmon have been found in freshwaters of British Columbia in Canada, but little is known about its current occupation in streams of Washington, USA. The development of increasingly sensitive eDNA detection techniques can help monitor nonnative species in freshwaters, though it is essential to prioritize monitoring sites within regions that would be unfeasible to sample comprehensively. Here, we propose using habitat intrinsic potential (HIP) modeling to prioritize eDNA monitoring sites for nonnative Atlantic salmon in Washington and Southern Chile in areas nearby aquaculture net-pens facilities. We developed species-habitat relationships based on published studies describing geophysical habitat requirements (e.g., discharge, gradient, and valley constraint) for juvenile life-stages of Atlantic salmon. We mapped and quantified the availability of high-potential habitats and ranked eDNA monitoring sites at watershed (~18 km2) and basin levels. In 2018, we sampled 16 Washington streams at four river basins of the Olympic Peninsula (i.e., Elwha, Pysht, Hoko, East Twin, and Dungeness) and the Skagit River, and 16 streams in Southern Chile from 3 river basins (i.e., Petrohué, Puelo, Cochamó), all proximate to net-pen aquaculture activity. Although further lab- and fieldwork is warranted for elucidating nonnative salmon occurrence patterns, modeling habitat potential proves to be a rapid and cost-efficient tool for the spatial prioritization of monitoring efforts at large geographic extents.

What can juvenile redband trout tell us about future patterns of anadromous salmonid rearing in the Upper Klamath Basin?

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Dam removal will return anadromous salmonids to the Upper Klamath Basin (UKB). Future management and restoration will increasingly need to consider the juvenile rearing ecology of anadromous salmonids and which habitats will facilitate adult recruitment. Adfluvial redband trout are ecologically similar to anadromous salmonids and distributed across the UKB, making them useful surrogates, yet their juvenile life history is poorly understood. Here I will present collaborative research with Oregon State University, Oregon Department of Fisheries and Wildlife, and The Klamath Tribes in which we study the energetics, movement ecology, and interspecific interactions of juvenile redband trout across 20 sites over three years. Our research could help managers anticipate opportunities and challenges for salmon recovery across the UKB's heterogeneous landscape.

Pacific Lamprey Recolonization following Dam Removals

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Removal of two dams in the Elwha River basin, Washington, started one of the largest river restoration projects ever attempted in the Pacific Northwest. These dams had eliminated Pacific Lamprey Entosphenus tridentatus populations upstream. We applied genetic stock identification (GSI), parentage assignment (PA), and sibship assignment (SA) methods to (1) determine the origins of Pacific Lamprey larvae and juveniles, (2) quantify the increase in numbers of successful Elwha River spawners (NB) and assess whether the current numbers of spawners have reached levels equivalent to those of neighboring undammed basins, and (3) determine the relative productivity of streams within the Elwha River and how overall productivity originating from this system may be distributed across the broader surrounding region. Our results showed that a single stream tributary was the source of 41% of larval and juvenile production in the Elwha River. Our Nb estimates for the Elwha River indicated a 12-fold increase in Nb during the 3 years after dam removal, with recent Nb estimates matching those of neighboring Olympic Peninsula basins. These results indicate rapid recolonization within the Elwha River suggests that restoring passage to adequate habitat is a highly effective approach for re-establishing populations of Pacific Lamprey in coastal systems.

Tribal Fishers Contribution to Research and Management Efforts of Columbia River White Sturgeon – 25

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Prior to 1995, population assessments of Columbia River white sturgeon in Management Zone 6 (i.e., Bonneville Dam to McNary Dam) were only conducted by state fisheries staff from Oregon and Washington, tribal staff were not involved in the process of field work. Consequently, results were met with some skepticism. Researchers had only initiated white sturgeon life history and population dynamics research in the late 1980's, however tribal fishers had decades more experience catching white sturgeon and understanding movements and habitats. Columbia River Inter-Tribal Fish Commission staff joined the Bonneville Power Administration White Sturgeon Project 1986-050-00 in 1994 and soon incorporated the tribal fishers in the stock assessment program. Tribal fishers use their boats, crews, and gear to capture and tag white sturgeon during December and January; compensation based upon days worked and number of sturgeons tagged and released. Data recorded by a Yakama Nation Fisheries technician assigned to each fisher. Winter field sampling has a variety of conditions, mostly in inclement weather. Some years only a few weeks on the river were possible, while in other years, fishers reached the objective of 3,000 fish in less than two weeks. The overall sturgeon program benefits from their participation both qualitatively and quantitatively; but most importantly, fishers' direct participation in population assessment has created greater acceptance of the results by the tribal fishing community. The working relationship between Tribal and state biologists has benefitted, due in large part from the dedicated efforts of participating tribal fishers.

From Zoop to Poop: Microfibers in zooplankton from grey whale feeding areas, confirmation of trophic transfer in an important baleen species

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Microplastics have been documented in multiple coastal species, but research quantifying microplastics in zooplankton is lacking. Zooplankton form the base of the marine food web and ingest microplastics mistaken for food, which raises concerns for higher trophic level species that may accumulate plastics from prey. Zooplankton in coastal Oregon are the target prey of foraging gray whales, which support valuable coastal tourism industries. As filter-feeding animals with large appetites for zooplankton, whales are particularly susceptible to high levels of microplastic ingestion, as evidenced by documentation of microplastics in the intestines of baleen whales. Potential health impacts to marine organisms include ingestion of indigestible particles that block adequate nutrient absorption and mechanical damage to the digestive tract. To address this knowledge gap, our team identified individual zooplankton from samples collected via light traps near gray whale feeding areas, and sorted them to species level. Samples were then processed, digested, and filters sorted under clean conditions (e.g. laminar flow with HEPA, cotton lab coats) and a subsample of suspected plastics identified using FTIR. Results demonstrate that Pacific Northwest zooplankton are primarily internalising microfibers, with anthropogenically-sourced fibers (synthetic, semi-synthetic, and natural) occurring in the majority of samples. This has important implications given that fibers are detected at high levels globally and may be more toxic than other plastic shapes (e.g. compared to spheres). Recent work focused on the extraction of microparticles and microfibers in whale fecal samples collected from gray whales foraging in the areas from which zooplankton were sampled. Results demonstrated that gray whales are ingesting large quantities of microplastics in film and fragment form, and suggest the presence of internal buildup of plastics in the gut. This work addresses a growing need for the study of microplastic and microfiber contamination across trophic levels.

Turning up the heat on Oregon's fisheries managers

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Warming temperatures and drought pose serious threats to cold water fishes and ever-growing challenges for fisheries managers. Prolonged or extreme high temperatures can stress salmonids, compelling managers to close or limit fisheries where angling could exacerbate impacts to stocks of concern. Warmer water also favors the spread of pathogens in both natural and hatchery environments and can affect the survivorship of fish at all life stages. Wildfires and drought can further impact hatchery operations. Here, we discuss these real-world challenges, their impacts to fisheries, recent responses taken by Oregon's fisheries managers, and prospects for the road ahead.
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The intersection of forests and fish

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Land-water interactions in western North America highlight the complexities of understanding human impacts and human values from land-use, where forest harvest practices are regulated intensively to protect important fisheries and streams. In this region, forests, fish, and clean water are highly valued socially, ecologically, and economically. The distribution boundary at the upper extent of fish receives extra attention in North America because stream reaches with fish receive greater protections and wider treed riparian buffers than fishless reaches. However, despite the abundance of literature describing conditions associated with fish habitat, physical conditions influencing the upper boundary of fish remain poorly understood. Results will be presented from a variety of projects that all aim to better define the upper extent of fish. eDNA results extend the upper fish boundary by up to 250 m in over half of the sampled streams effectively extending the upper extent of fish potentially higher. Modeled results reveal that landscape and climate features drive the location of the last fish boundary, with an emphasis on features that capture stream size, gradient, elevation, and temperature. If there is an overestimation in the upper extent of fish, then ecosystem services and protection of species will be realized across a broader extent and potentially less forest would be harvested. Whereas, if there is an underestimation, then there is the potential for an increased area of forest harvest and an underprovision of ecosystem services and species protections where they are warranted. Managers and decision-makers can make informed decisions about the upper distribution of fish using these results which have implications for species conservation and forest management.

eDNA metabarcoding uncovers hidden aquatic biodiversity in streams

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Biodiversity has long-been a proxy for assessing environmental change, however comprehensive assessments of biodiversity have been hard to achieve. Environmental DNA (eDNA) metabarcoding is revolutionizing how we survey biodiversity by making species identification possible with high precision and accuracy. Here, we compare the detection of fishes and amphibians using eDNA metabarcoding of stream water with taxon-general and taxon-specific primers on a multi-parallel PCR platform followed by high-throughput sequencing to traditional backpack electrofishing to understand its value as a proxy for species-level identification of biodiversity in four neighboring watersheds. We also collected eDNA metabarcoding information from upstream sites to detect lesser-studied taxon including crayfishes, macroinvertebrates, bivalves, and pathogens in addition to information on aquatic vertebrates. We uncovered the hidden biodiversity in streams by detecting a sparsely-distributed amphibian pathogen Batrachochytrium dendrobatidis and newly discovered cryptic lineages of sculpins suggesting a cryptic species complex with ramifications for fish conservation, potential as-of-yet pockets of endemism, and the possible identification of new species. eDNA detects a longitudinal shift in the aquatic assemblage-from fish to amphibians-with less species at lower reads in upstream locations. Salmonids are detected further upstream with eDNA than expected suggesting an extension of their upper distributions. One watershed had high ecosystem biodiversity for species richness, eDNA number of reads, and electrofishing numbers suggesting it supports more interactions among organisms. Our work broadens the scope of eDNA information by allowing for a comprehensive assessment of aquatic biodiversity leading to the potential for data-driven prioritization of conservation actions for species and ecosystems.

Ecosystem response to the removal of Elwha River dams, Washington State, USA.

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Worldwide aquatic restoration efforts cost billions annually. These projects are typically local-scale activities that do not have a measurable effect on ecosystem function or services. One ecosystem restoration technique that can have a large-scale effect is dam removal. This single action allows for the re-connection of ecosystem processes such as upstream and downstream organism movement, the rapid transformation from lentic to lotic conditions in former reservoirs, rapid shifts in community structure and food webs, and accelerated habitat creation through sediment deposition. We present results from the Elwha River, where the largest dam removal ever undertaken resulted in measureable ecosystem changes. The release and subsequent downstream transport of tens of millions of metric tonnes of sediment from former reservoirs has resulted in the transformation and rebuilding of estuarine and riverine habitats. The resumption of free passage for aquatic organisms has re-established anadromous fishes to areas that have been void of such species for 100 years, prompting rapid increase in salmonid life history diversity. One example is the "re-awakening" of summer steelhead, which is likely owing to the harboring of alleles for run timing in up-river resident O. mykiss populations. Short-term changes due to large changes in sediment supply resulted reductions in the egg to fry survival stage for Chinook salmon but has recently rebounded. Following dam removal, marine derived nutrients increased, entered foods webs and altered the migration patterns and fecundity of an aquatic song bird. Our results demonstrate the importance of maintaining longitudinal connectivity for watershed processes and ecosystem services.

Estimating Proportion of Hatchery Origin Steelhead in the Elwha River: Influence of Spatial and Temporal Differences

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The removal of two large dams in the Elwha River released a century worth of sediment that was expected to result in lethal suspended sediment concentrations. To protect listed winter steelhead, a hatchery program was included as part of the recovery effort. Understanding the proportion of hatchery-origin spawners (pHOS) is important to evaluate natural-origin (NOR) stock recovery and evaluate potential risks of hatchery programs. Unfortunately, there are few examples for estimating pHOS, especially for systems with remote roadless areas in the basin. We assess the spatial and temporal patterns of hatchery-origin (HOR) and NOR steelhead and provide an example of estimating pHOS for winter steelhead in the Elwha River. We used a combination of tangle-net sampling and SONAR escapement estimates to meet our objectives. Tangle netting estimated the distribution and relative abundance of HOR and NOR steelhead, which was used to determine the most appropriate sites for estimating the daily fraction of HOR and NOR steelhead passing two SONAR units. The daily pHOS estimates were derived using a P-spline method that accounted for temporal differences in HOR and NOR entry timing. NOR steelhead had a more protracted run timing and were present throughout the sampling (January – June), while HOR steelhead were rarely observed until March. In addition, NOR steelhead appear to use a much greater proportion of the watershed than HOR steelhead, based

on their distribution in our sampling reaches, limiting the area providing the least biased pHOS estimates. This resulted in a reduced sample size and wide credible intervals for overall pHOS estimates from 2019 to 2021 (i.e., 95% credible interval range ~ 0.33). Thus, spatial and temporal differences among HOR and NOR steelhead should be considered when deriving pHOS estimates. The wide credible intervals for pHOS estimates may affect management options and the ability to adaptively manage recovery.

When does fin damage first occur in hatchery Steelhead Trout?

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Hatchery-reared steelhead (Oncorhynchus mykiss) often exhibit fin damage. This may cause various infections and may have an impact on mortality and overall health. The purpose of this study was to determine when fin damage first appears and whether the fins could recover. We sampled steelhead from alevin to parr over a period of three months, starting after the fish had visible fin buds. We performed this experiment at the Oregon Hatchery Research Center in Alsea, OR and at the Fish Performance and Genetics Laboratory in Corvallis. Each facility raised the fish in two temperature treatments. “Chilled” fish were hatched and reared at 6.8-7.3 ℃, and “ambient” fish were hatched and reared at 12.8-13.4 ℃ until the fish were ponded. Once ponded temperatures at OHRC ranged between 9.4 ℃ and 20 ℃ for both groups and at FPGL temperatures ranged from 12.8-13.4 ℃.. Steelhead raised in chilled water hatched later and were therefore a smaller size than the ambient group at any given sample date. Steelhead were collected weekly, eighteen from each group, then euthanized in MS-222. Six fish from each treatment were stained using Fluorescein and observed and photographed under a blacklight to better show fin damage. They were then placed into 10% buffered neutral Formalin solution for clearing and staining. Six fish were placed directly into buffered neutral Formalin for clearing and staining to control for the Fluorescein, and six fish were placed into Dietrich’s Fixative for future histology. Results showed that at the OHRC, fin damage started to occur in the ambient group by 1750 TUs, and in the chilled group by 1629 TUs. Size rather than age appears to be the determining factor as to when fins start to be damaged. Fish isolated after fin damage occurred were able to successfully regenerate their fins.

Differential effects of a catastrophic wildfire on downstream fish assemblages in an aridland river

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Few studies have evaluated the effects of large wildfires on downstream non-salmonid fish assemblages. Using multi-year (2009–2015) data from fish assemblage surveys and high-frequency water quality monitoring, we analyzed within-site responses of a cypriniform-dominated fish assemblage at two sites located > 20 km downstream of a 633 km2 wildfire in 2011 in the Rio Grande watershed in New Mexico, USA. Season had a weak influence on fish assemblage (fish) catch rate, richness, and evenness at the upstream site, but it had a strong negative influence (during

spring/winter) on fish catch rate and richness at the downstream site. Fish species richness and evenness at both sites were not strongly affected by the wildfire, despite numerous post-fire sags in dissolved oxygen (including short-lived hypoxia < 2 mg/L and anoxia—0 mg/L) during subsequent monsoon seasons. Although fish catch rate was negatively impacted by the wildfire at the upstream site, it was unaffected at the downstream site. Fish catch rate, richness, and evenness at the upstream site were suppressed following a major flood event that occurred 26 months post-fire, but the downstream fish assemblage was resistant to the flood disturbance. Our study provided a rare opportunity to evaluate how aridland riverine fishes respond to disturbance from wildfire and subsequent flooding. Larger and more severe wildfires are occurring due to climate warming, and responses of water quality and fish community assemblages require study and assessment.

Diagnosing and Diverting Diseases Developing Due to Disturbances. In Fishes.

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Diseases in fishes develop due an imbalance in the relationship between an organism and its environment. Here we discuss how infectious and non-infectious diseases change with environmental disturbances. Environmental factors such as water flow, water availability, and water temperature affect disease presentation via pathogen interactions with the fish host. Examples taken from hatchery cases such as parasitic and bacterial infections. Non-infectious diseases can also develop due to environmental disturbance. We discuss egg quality from stressed broodstock, as well as thiamine deficiency in fry due to altered food availability in the oceans. With the current trending climate and environmental changes, we should expect augmented disease states to be the new normal in the future for our managed fisheries.

Historical and Contemporary Patterns of Fire Severity along the North Fork of the Santiam River in the western Cascades of Oregon

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Large, wind-driven high-severity wildfires have an infrequent but ecologically important impact on riparian and surrounding landscapes in western Oregon. While the 2020 Labor Day fires were by far the most severe fires the region has experienced in over half a century, their size and severity were not outside the historical range of variability. Historical accounts and maps from early forest inventories document large wildfires in the late 19th and early 20th century, but little is known about fire severity and forest recovery in riparian areas, or how these compare to surrounding uplands. We use dendroecological data, early forest survey maps, and historical aerial photos to investigate fire history and patterns of severity along a 30 km stretch of the North Fork of the Santiam River near Detroit, Oregon. We then assess and compare patterns of remotely-sensed burn severity in the 2020 Beachie Creek Fire. Maps from forest surveys in the early 1930s indicate most of the area was in an early seral condition of regenerating conifers, likely established after a large high-severity fire in the early 1900s. High severity fire effects and variable recovery were evident in the 1939 aerial photos across most of the riparian area, adjacent uplands, and upper elevations slopes and ridges. The extent and distribution of high-severity fire effects were similar in the 2020 Beachie Creek fire, however

several small existing patches of old-growth forest in the 1939 photos were reduced in size and extent by the 2020 fire. Evidence of widespread, high-severity in the early 1900s indicate that the impacts of the 2020 fire were not unprecedented impact on this part of the North Fork Santiam River, and suggest that riparian areas likely experienced similar fire effects as uplands during wind-driven fire events.

Genetic life history expression of Coastal Cutthroat Trout and hybridization with steelhead at the southern end of their range

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Coastal Cutthroat Trout (Oncorhynchus clarki clarki) are an often-overlooked salmonid, as they are not federally listed and have no commercial fishery. However, this understudied fish expresses a diverse array of life histories across its range from Alaska to northern California, filling niches the ubiquitous steelhead/Rainbow Trout (Oncorhynchus mykiss) has not. We will assess if Coastal Cutthroat Trout have a similar region of the genome as has been identified in steelhead/Rainbow Trout, OMY5, that partially controls whether a fish stays in freshwater or migrates to sea. RAD sequencing of Coastal Cutthroat Trout tissue samples from putative anadromous individuals in the estuary and putative residents above barriers to anadromy will help elucidate this question for populations at the southern end of their range. An additional goal of this study is to explore the genetic architecture of Coastal Cutthroat Trout and steelhead/Rainbow Trout hybridization and assess genetic, environmental, and anthropogenic factors that control the incidence of hybridization. Coastal Cutthroat Trout and steelhead/Rainbow Trout have lived in sympatry since the last ice age, as isolation mechanisms such as assortative mating, and spawning location preference and timing have limited the occurrence of hybridization. Understanding the factors controlling hybridization, and if a genetic association with life history exists is integral to the successful management and conservation of Coastal Cutthroat Trout. The current study focuses on northern California, but is expanding into southern Oregon in 2022, and will be working in parallel with similar hybridization research in Washington.

Multi-criteria evaluation of wildfire risks to downstream water supply

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The primordial role of forests in the provision of downstream freshwater supply is an accepted fact worldwide, and yet the same forests face an ever-growing number of perturbations that threaten their role in the hydrological cycle. Wildfires, in particular, have recently received an increased attention due to their potential for widespread and long-lasting negative effects on forest health, and, consequently, on watershed functioning. But our capacity to appraise and monitor wildfire risks to forest sources and downstream water supply over large regions remains limited due to numerous reasons linked to data gaps and modeling challenges. In this study, we used a multi-criteria evaluation (MCE) approach to characterize wildfire risks to drinking water sources in Canada. MCE technics combine robust conceptual modelling with flexible data aggregation techniques, a method that have proven useful to generate large-scale risk information in complex environmental settings for decades. We used several variables accounting for downstream water demand, water yield from upstream

forests, and wildfire hazard to rank wildfire-watershed risk in HUC12 catchments. Our final composite index provides a fine-grained metric that can be easily incorporated within broader efforts towards source water protection, including the safeguarding of fisheries.

New Fish to Fry: Fishing Community Perceptions of Connected Social-Ecological Disturbances Created by Oregon's Marine Reserves

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Fisheries are dynamic and tightly coupled social-ecological systems. Management and conservation actions, including those designed to respond to or buffer disturbance in one area of the system, have the potential to create new and oftentimes unintended disturbances in other areas. Oregon's marine reserves pose a unique case study to examine this potential. These conservation areas aim to conserve marine habitats and biodiversity through the closure of extractive activities. The no-take fishing restrictions that work toward those goals acted as a disturbance to nearby fishing communities. In response, these communities shifted their fishing effort elsewhere. A recent qualitative study identifies and describes how this effort shift created disturbances for these communities through various social and economic impacts. Further, the study highlights concerns from the communities that the marine reserves will create unintended disturbances that threaten the social-ecological system and its various intersections in the future. This presentation provides an overview of the social and economic impacts that fishing communities have already experienced from Oregon's marine reserves and offers insight into their concerns for further social, economic, and ecological disturbances that are yet to arise.

A Bayesian state-space approach on the effects of hatchery propagation, predation, and habitat conditions on winter steelhead recruitment in a mid-Columbia River subbasin

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For over 150-years, hatchery-origin anadromous salmon and trout have been reared and released throughout the Pacific Northwest to mitigate for lost habitat and sustain harvest opportunity. Some studies demonstrate that introgression of hatchery and naturally produced fish may constrain conservation efforts through maladaptive genetic processes. However, empirical demonstrations of the influence of these genetic interactions on population productivity are lacking, making it difficult to assess their importance relative to other drivers of productivity. We quantified the influence of hatchery metrics, avian and pinniped predator abundance, and habitat conditions on natural adult winter steelhead recruitment in the Hood River, Oregon over a 27-year period of record. Using a Bayesian state-space stock-recruitment approach, we accounted for variation in recruitment due to these factors, density dependence, and observation error. Winter steelhead productivity was positively associated with flow during juvenile rearing, ocean conditions, and hatchery fish release numbers, while negatively associated with pinniped abundance. Our analysis highlights the importance of quantifying the influence of hatchery programs on fish production relative to environmental factors known to affect natural-origin anadromous fish recruitment.

Landscape-Level Extent of Resident Fish Occupancy in the Alexander Archipelago

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We used high resolution LiDAR-derived variable-length channel reaches and statistical tree-based modeling (Random Forest) to predict upper limit of occupancy (ULO) for resident salmonids (Cutthroat Trout Oncorhynchus clarkii clarkii and Dolly Varden Char Salvelinus malma) at a regional scale. The modeling used 13 spatially explicit landscape predictors, 4,490 field survey points, and 373 last fish observations (LFO) from streams on Prince of Wales and Chichagof islands in Southeast Alaska. The final model was configured to account for imbalanced datasets and had 0.992 AUC (indicator of model performance), 87.6% sensitivity (percentage of presence correctly classified), and 98.7% specificity (percentage of absence correctly classified); resulting in an absolute average error distance from the field LFO to the predicted ULO of 66 meters. Model validation with independent survey data confirmed that the model correctly classified 98% of the reaches. Analysis showed the most important predictors of relative reach occupancy to be: channel gradient, basin area, and elevation. This research demonstrates a strong linkage of resident salmonid occupancy to persistent reach-scale habitat conditions across the landscape. The mapping of predicted fish distributions show population boundaries that inform conservation, management, and restoration objectives.

Modeling the effects of wildfire on aquatic ecosystems in the Pacific Northwest

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Wildfires are widespread disturbances that influence the structure of ecosystems in the forested landscapes of the western United States. After decades of natural resource policies that suppressed fire activity on the landscape, changes in climate and forest conditions are shifting fire regimes increasing the occurrence of large, high severity fires. Fires can have complex effects on aquatic ecosystems—affecting aquatic systems through a variety of physical and ecological processes and pathways. While previous research has evaluated the effects of fire largely via field-based observational studies, these empirical studies are often limited in the inferential ability to tease apart complex mechanisms and extrapolate findings across broader spatial extents. Here, we present two modeling efforts to help us better understand the complex effects of fire on aquatic ecosystems. First, we are applying the Aquatic Trophic Productivity model—a food web system dynamics model—to provide a mechanistic, process-based approach to synthesize the multiple pathways by which fires can affect aquatic ecosystems. Second, we are developing spatial analyses of wildfire risk to identify the relative vulnerability and resilience of watersheds across the Pacific Northwest. Taken together, these modeling platforms will contribute an improved understanding of the effects of fire on aquatic ecosystems that can help to develop new conceptual models, direct future empirical studies as well as guide management actions.

Large Woody Debris from the Bird's-Eye View: Considerations for Feature Extraction

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Large woody debris (LWD) is often an important component of a variety of aquatic ecosystems. It provides flow resistance and alters the shape and flow of streams, forming habitat for a variety of species, including salmonids. Estimating LWD traditionally requires ground surveys that are time consuming, costly, and often limited in spatial coverage. Because of this, the potential to remotely assess LWD offers substantial benefits. However, the extraction and estimation of LWD from remotely sensed data is a difficult task! Woody debris exhibits a variety of shapes, colors, sizes, and textures depending on species, age, and exposure. Additionally, the world of natural resources is nuanced, and no two study areas are exactly the same. Techniques that may work for one region or study may not be immediately adaptable to others due to differences in light angle, atmospheric humidity, plant community composition, etc. In this talk, we will present an overview of the trials and tribulations we have experienced attempting to extract and estimate LWD across floodplains for river systems in the Pacific Northwest using aerial imagery, structure-from-motion, and lidar point clouds. We discuss the pros and cons of multiple feature extraction methods including supervised and unsupervised classification, and both pixel and region-based assessments, and highlight the potential shortcomings and trade-offs for LWD estimation. Our work shows some of the difficulties in adapting methods and approaches from other systems, but also underscores the rapid advancements in the field of remotely sensed feature extraction. We conclude with recommendations for practitioners and for future research.

Wildfire Impacts on Water Quality and Aquatic Ecosystems and the Recovery that Follows

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While wildfires are a natural occurrence and ecosystems have evolved with fire, a changing climate is extending the wildfire season increasing the number, size and severity of fires in the western United States. Forest fires affect water quality in disrupted watersheds, which can impact aquatic ecosystems including sensitive macroinvertebrates and fish. This presentation will cover data from 172 fires in 153 burned watersheds in the western US used to identify common water quality response the first five years after a fire as well as field observations from two fires in southwestern Colorado, the 2013 West Fork Complex Fire and the 2018 416 Fire. Evidence from the 172 fires reveals significant increases in nutrient flux (different forms of nitrogen and phosphorus), major-ion flux, and metal concentrations are the most common changes in stream water quality within the first five years after fire. After the 2013 West Fork Complex Fire and the 2018 416 Fire, monsoon rain events caused erosion from disturbed hillsides increasing sediment concentrations and heavy metals in the rivers. Acute and dramatic fish kills occurred after both fires, where hundreds of trout were reported killed in a single day rain event. Despite elevated turbidity levels and metals concentrations that persisted for three years downstream of severely burned areas, the aquatic ecosystems in both burn areas appear to have recovered. Insect diversity and fish populations recovered to pre-fire levels and were similar to control sites. In addition to changes in biodiversity, macroinvertebrate monitoring after the 416 Fire revealed high concentrations of aluminum, iron, lead and nickel in their tissue, providing evidence that metals observed in the water column of fire-impacted streams were transferred to the benthic

communities. Aquatic ecosystems changed after both fires but demonstrated resiliency and recovered after three years.

Fire and smoke effects on headwater stream temperature, air temperature, dissolved oxygen, and light during the Holiday Farm Fire

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Wildfire is expected to become increasingly common and severe in forested landscapes across the western US, and streams within these landscapes are both directly (temperature increases from fire) and indirectly (decreases from smoke) impacted by fire as it burns adjacent uplands. Due to challenges involved with collecting data as the event occurs, most research to date exploring fire effects on streams has focused on responses months to years after the event as opposed to during and immediately after the fire. Acute increases in stream temperature can adversely affect aquatic biota if their thermal tolerance is exceeded, while persistent smoke can alter light conditions, decrease temperatures, and affect instream primary production. In this study, we report stream temperature, air temperature, dissolved oxygen (DO), and light across a series of eleven 2nd to 4th order streams in the western Cascade Mountains of Oregon one week before, during, and one week after an extensive wildfire in 2020. The presence of fire near the stream resulted in daily maximum stream temperature increases of up to 4.3˚C at the most severely burned sites but decreases of up to 0.56˚C at other less affected sites. DO daily minima decreased by 1.3 to 16.9 % saturation on the day of the fire, with magnitude of effect also corresponding to burn severity. Across all eleven sites, Rapid Assessment of Vegetation Condition (RAVG) of riparian and watershed areas were better correlated with stream temperature responses to immediate fire impacts than area of watershed burned or soil burn severity. Smoke effects were pervasive both spatially and temporally, resulting in declines in photosynthetically active radiation, stream temperature maxima, and diurnal variation in dissolved oxygen. Our results suggest that as fire becomes more prevalent and intense, direct temperature increases or DO decreases from fire will only approach tolerances for biota in small streams that experience high intensity riparian burning. Furthermore, our results indicate the extent and impact of smoke on light, temperature and DO will impose the largest short-term fire effects on stream ecosystems.

Genomic approaches reveal a healthy population and an unexpected origin for Foskett Spring Specked Dace

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Foskett Spring harbors a morphologically and genetically distinctive population of Speckled Dace (Rhinichthys osculus) long considered to represent one of Oregon's endemic native fishes. Previous studies concluded that Foskett Dace separated from populations in Oregon's Warner Valley 10,000 years ago and raised an enigma concerning the dace's surprising ability to persist for so long in such a tiny habitat. Though recently delisted due to successful implementation of its recovery plan and the establishment of a refuge at Dace Spring, maintenance of healthy population sizes appears to depend

upon regular manual removal of encroaching vegetation. To help monitor the effectiveness of such interventions and to investigate the phenomenon of the dace's persistence, we assessed genetic diversity among daces inhabiting Foskett and Dace springs and three nearby streams. Analysis of 2600 single nucleotide polymorphisms reveals higher effective population sizes in both spring populations than in any of the streams, with the highest Ne within Foskett Spring proper. Observed heterozygosity is lower than expected at all five sites, suggesting that all desert dace populations experience mild inbreeding, but not at a level of concern. These results confirm the genetic health of Foskett Dace and suggest that the lack of predators in their isolated habitat may bolster population sizes. Unexpectedly, results also reveal closer similarity between Foskett Dace and dace from a stream in Nevada's Coleman Valley than between Foskett Dace and dace elsewhere in Oregon. That close match indicates the Nevada population as the ancestral source of Foskett Dace and suggests a more recent isolation than previously suspected. These results help to solve the enigma of persistence by shortening the duration over which Foskett Dace have inhabited their isolated desert pool.

Distribution and Identification of Pacific, Western Brook, and Western River lampreys in Southwest Washington Tributaries of the Columbia River

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Lamprey populations are declining worldwide and determining status and distribution of Pacific (Entosphenus tridentatus), Western Brook (Lampetra richardsoni), and Western River (L. ayresii) lampreys in the Columbia River Basin is critical for conservation. Larval and juvenile lampreys are frequently encountered incidentally during salmonid monitoring including rotary screw trapping; however, crews seldom identify and collect key information on lampreys. We developed lamprey sampling protocols and field identification guides to assist with lamprey data collection at 12 rotary screw traps in spring of 2019 and 2020 that were operated by the Washington Department of Fish and Wildlife to monitor juvenile salmonid outmigration. Traps were located on lower Columbia River tributaries in southwest Washington from the White Salmon River downstream to the Grays River. Crews enumerated all captured lamprey, a sub-portion had life stage and total length recorded, a tissue sample collected, and photos taken of whole body, dentition, and tail pigmentation for subsequent genus identification (ID). Tissue samples were later genotyped to determine genus (Entosphenus vs. Lampetra) using a species ID SNP (LampSD_478) that was included with either a panel of 295 SNPs or 384 SNPs that were variable in Pacific Lamprey and Lampetra spp., respectively. Further, markers included within the Lampetra panel of SNPs were used to distinguish Western Brook versus Western River lampreys.
Pacific Lamprey and Lampetra spp. co-occurred in all 12 tributaries except the Kalama River, where Lampetra spp. were absent. Two Western River Lamprey were detected, one adult each in the Cowlitz and Grays rivers. Capture proportions of Pacific Lamprey and Lampetra spp. were similar in most tributaries, however Pacific Lamprey were more common in the Kalama, Cowlitz, and Grays rivers while Lampetra spp. were prevalent in the White Salmon River and Mill Creek. Overall, there was high concordance in genus identification made with photo- and genetic-based approaches.

Implications of Climate Change on Lower Columbia River White Sturgeon

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During the summer of 2015, nearly 100 sturgeon mortalities (≈80% adult) were reported within the lower Willamette River, The Dalles, John Day, and McNary Reservoirs. Although several possible contributing factors were identified, regional sturgeon experts agreed elevated water temperatures and subsequent declines in dissolved oxygen were the likely cause of death. Water temperatures again exceeded the norm throughout much of June and July in 2021. Again, several sturgeon mortality reports surfaced, a total of 29 mortalities (≈65% adult) were confirmed via staff observation. Similar events famously occurred in the Fraser River during the 1990s where temperature was identified as one of two "probable contributors." Degraded water quality due to pollutants, possible egg resorption in adult females related to temperature stress, and disease associated with prey species are also theorized to play a role in sturgeon mortalities. In addition to direct mortality of adult fish, sturgeon spawning and recruitment success can be affected by elevated water temperature and altered flow regimes. In the impounded lower Columbia River, water velocity, which is heavily influenced by dam discharge, appears to play a major role in White Sturgeon spawning success (Parsley 1993; Parsley et al., 1993a; Parsley and Beckman, 1994). Data from age-0 indexing, combined with dam discharge data, suggest that higher discharge rates (which create the physical conditions required for successful spawning by sturgeon) generally result in higher levels of recruitment to age-0 (Lovejoy et al. 2020). Climate change models predict continued warming of riverine environments and altered flow regimes. As more winter precipitation falls as rain and contributes less to snowpack accumulation, spring freshets tend to occur earlier in the year and diminished in magnitude, impacting the historic hydrograph. Recent data trends associated with recruitment indexing in the lower Columbia River will be presented along with hypothetical recruitment and spawning projections given future climate change scenarios.

Large Scale Lamprey Salvage during Habitat Restoration at Steigerwald Lake National Wildlife Refuge, with Documentation of Western River Lamprey

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Restoration of degraded aquatic habitat is becoming common and an integral part of any restoration plan should include salvage (i.e., capture of fish in an area that may dewater to prevent their stranding) of lampreys and boney fishes. However, such salvage operations can require significant planning and resources in terms of staff and equipment. In 2021, approximately 1,000 acres of historic Columbia River floodplain habitat in Steigerwald National Wildlife Refuge was restored and connected to the adjoining Columbia River. The refuge is owned and managed by the U.S. Fish and Wildlife Service and is designated as an urban refuge, to benefit the public, while still providing a high degree of ecological function. Gibbons Creek, a perennial stream that runs through approximately 2.3 km of the refuge, was mostly confined to an elevated canal. During restoration, the canal was removed and the creek was restored to a more natural flow pathway. Prior to hydrologic reconnection, fish salvage was required and conducted. The worksite was isolated with block nets to prevent any fish from reentering the site. Salvage protocols specific to lampreys and boney fish were both employed to maximize salvage efficiency. In total, over 37,000 lampreys and 9,000 boney fishes were salvaged, respectively. Salvage is also an opportunity to learn about lampreys and this salvage effort resulted in documentation of the rare Western River Lamprey at the refuge. Success of the fish

salvage effort was in large part due to planning efforts and the extensive field assistance provided by many people from various agencies as well as volunteers.

Sensitivity of salmon spawning habitat to instream wood loss and flood disturbance in southeast Alaska

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We estimate the influence of instream wood on Pacific salmon spawning habitat under contemporary and projected climate-induced increases in mean annual flooding in logged and unlogged watersheds of southeast Alaska. We parameterized predictive models of reach-average D50 with field data and digital elevation models to determine basin-scale spawning gravel availability for six combinations of flood magnitude and wood occurrence. Our simulations suggest that streambed coarsening as the result of wood loss from rivers could have a much greater effect on salmon spawning habitat availability than would increases in mean annual flood magnitudes of up to 30% that are projected to occur with climate change. Our analysis emphasizes the importance of restoring instream wood to increase habitat resilience to climate change in southeast Alaska.

History of the Collaborative Approach in Harney Basin

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In struggling rural communities, conservation can be a controversial issue, which was historically the case in Harney County Oregon where 75% of the county's 10,000 square miles is public land. In 2005 two unlikely partners, a local rancher and a wildlife refuge manager, starting meeting to explore possibilities in bringing together community members, tribal leadership, government, and environmental groups together to help them understand they had more in common than they had that divided them. What developed from this initial work to improve relationships between public and private land management is a community-wide commitment to working together to the benefit of Harney County. High Desert Partnership was formed to support to bringing people together to build relationships and cultivate collaboration to help solve complex problems facing southeastern Oregon. This organization supports several collaborative groups and utilizes collaboration to integrate social, economic and ecological values to bring best solutions forward. Harney Basin Wetlands Collaborative, a working group of High Desert Partnership, that is dedicated to enhancing this critical habitat of the closed lakes Harney Basin. This group of partners have been working together since 2011. There has been significant progress in addressing key limiting factors of wild flood-irrigated wet meadows and improving the aquatic health of Malheur Lake. In this presentation we will share some of the lessons learned from the experiences of working together across diverse groups, landscape scale management and obtaining funding to implement restoration in this crucial stopover for migratory birds on the Pacific Flyway.

Motive, means and opportunity: Could smallmouth bass be a major predator of Atlantic salmon?

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Smallmouth bass (Micropterus dolomieu) is an introduced nonnative fish widespread throughout Maine waters, and is known to be a predator of juvenile salmon during rearing and migration. The degree to which this influence is ecologically relevant, however, is unknown. During freshwater rearing, spatial overlap between the two species is limited, suggesting competition and/or predatory interactions. We will use GIS analysis of electrofishing data from 1956-2020 to assess the spatial and temporal overlap of Atlantic salmon and smallmouth bass in the river systems of Maine. In addition, changes in smallmouth bass distribution through time may inform projections of spatial overlap under climate change forecasts. As Atlantic salmon migrate seaward in the spring, high mortality is often observed in dam impoundments and habitat that supports smallmouth bass. We will use mark recapture techniques to assess smallmouth bass density and biomass in a high migratory risk area of the Penobscot River. These data will be used to model the scope of migratory loss of Atlantic salmon that smallmouth bass might be causal to.

Reflections: Two Decades of Hatchery Residual Steelhead Monitoring Strategies in the Wallowa River

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Hatchery Summer Steelhead smolts that fail to emigrate to the ocean, often referred to as residual steelhead, present a genetic risk to naturally-produced Oncorhynchus mykiss through spawning interactions. Through resource competition and predation, residual steelhead also present an ecological risk to other species. For this study, we evaluated several long-term data sets to determine the efficacy of current methods to reduce and quantify residual steelhead in the Wallowa sub-basin. Neither the abundance of residual steelhead recovered at the weir or the residual steelhead density in Deer Creek were significantly reduced following efforts to outplant yearling hatchery steelhead smolts remaining in acclimation ponds following a two-week volitional release when sex ratios were > 70% male ($P \geq 0.7$, $N = 18$). Furthermore, the residual steelhead densities in Deer Creek were not correlated with the number of residual steelhead recovered at the weir from corresponding release years ($P = 0.239$, $N = 19$). Recovery and analysis of 560 coded wire tags revealed a previously unknown age-structure of aged two – five-year-old residual steelhead. The older aged residual steelhead recoveries disproved an untested assumption that all residual steelhead returned to the weir in the year following their release. Overall, our results suggest that the current methods of reducing and quantifying Wallowa stock residual steelhead are not effective. Therefore, this evaluation provides an opportunity to develop more robust monitoring and evaluation strategies that can be used to better assess and understand the interaction of hatchery steelhead releases and environmental conditions that result in residual steelhead.

Malheur Lake Water Quality: Past, Present, and Future

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Suspended sediment has been an intractable problem for restoration of Malheur Lake, and recent mesocosm studies point to potential strategies for improving light penetration and plant growth. USGS has partnered with US Fish and Wildlife Service and High Desert Partnership to study the currently turbid, non-vegetated state of Malheur Lake. High suspended sediment concentrations in the lake are negatively affecting the survival of aquatic plants, and therefore, the habitat and food resources for waterfowl. Data collected during 2017 and 2018 to develop a predictive light model showed that turbidity responds strongly to wind events that suspend bottom sediments. Nearly 100% of all suspended material was fine material (less than 63 µm) which strongly attenuates light through the water column. Data collection in 2019 and 2020 was aimed at understanding the nutrient dynamics in the lake, including the concentrations of nutrient fractions, external loading, and the effects of internal resuspension. Resuspension of fine sediments (and the nutrients sorbed to the sediment) occurs in the open water through wind/wave action, but resuspension also occurs as the shallow lake expands in area in response to a wet water year, inundating previously exposed land. Land use practices along the tributaries (such as water diversions and channelized reaches) affect nutrient and suspended sediment loading into the lake. In 2021, a mesocosm study was initiated in Malheur Lake to manipulate turbidity and light in the water column. Mesocosms were constructed to manipulate 1) wind/wave action with a wave reduction barrier, 2) suspended particulates through flocculation, and 3) a combination of both. Preliminary results show that wave reduction barriers functioned when the wind was blowing from the southwest, and that they caused localized sediment deposition, resulting in topographic heterogeneity. Flocculation substantially reduced the suspended material in the water column for multiple days. Results are being used to evaluate possible restoration strategies for portions of Malheur Lake.

Evaluating the viability of the use of two tag types on adult Arctic Lamprey

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Subsistence and commercial Arctic Lamprey (Lethenteron camtschaticum) fisheries in the lower Yukon River drainage rely on the ability to accurately track the species' return migratory run from the ocean to spawning grounds. In recent years, the late freezing of the Yukon River due to climate change has created new barriers for fisheries attempting to intercept the run, resulting in poor harvest. While Traditional Ecological Knowledge (TEK) provides valuable estimates for Arctic Lamprey upstream migratory timing in the Yukon River, little is currently known about Arctic Lamprey abundance, distribution, and life history. Telemetry and mark-recapture studies have the potential to be utilized for gathering information on Arctic lamprey migratory and dispersal patterns, population abundance, and spawning locations. The efficacy and retention of internal radio transmitters and external T-bar anchor tags was evaluated in a controlled laboratory setting. A sample size of 216 Arctic lamprey each received one of six treatments, including control, sham surgery, external T-bar anchor tag, and small, medium, and large internal transmitters. Surgical wound healing, survival, and tag retention was evaluated post-treatment. A subset of 60 Arctic lamprey was assessed for swim performance in a Brett-style swim-endurance chamber one day and 43 days after treatment. The results of this study will be used to determine if internal radio transmitters and external T-bar anchor tags are viable tools for tracking Arctic lamprey migratory run-timing and abundance, as well as determining the impact of harvest on resource sustainability.

Incorporating Local Knowledge into Wet Meadow Science and Conservation Planning

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The wet meadows of the Harney Basin provide critical wildlife habitat and economic returns to the region via grazing and hay production. Long term economic security and returns from agricultural production will provide the incentives to continue management activities to sustain these seasonal wetlands into the future. There was a flush of research on wet meadow forage production practices in the 1960's to the 1980's, but little research past that point. In the period since 1980, the plant composition of the wet meadows of the Harney Basin has changed dramatically, from native grasses, sedges and rushes to two introduced pastures species (meadow foxtail and reed canarygrass). We summarized the older research in a concise document and shared it with wet meadow landowners. We convened a set of workshops with experienced wet meadow managers and asked the following questions: 1) does the old research still apply, 2) what land management practices are currently being used on wet meadows, and 3) what are the biggest threats to long-term sustainability of the wet meadows? In a second series of workshops, we described the results of our vegetation sampling, and asked for input on a simplified state-and-transition model, which describes major vegetation states, and factors likely to cause transitions from one state to another. We will share the results of our interactions with landowners, how the agricultural landowners sustain and enhance the critical wildlife habitat features for fish and wildlife species and a little about our process of integrating scientific data with on the ground land management strategies and observations.

Aquatic ecosystem and vertebrate responses to the Holiday Farm Fire

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Wildfire is becoming more common and severe in forested landscapes across the western U.S. In severe fires where even riparian canopies are razed, stream ecosystems and habitat for aquatic biota may be dramatically altered. Removal of riparian cover and subsequent stream exposure can increase stream temperature, a key control on metabolic rates of biota, and can shift stream food webs towards autotrophic energy pathways. Replicated pre- and post-fire data sets are rare for severe wildfire studies, therefore responses of aquatic ecosystem processes and biota remain equivocal. We evaluated wildfire impacts on aquatic ecosystems in after the severe Holiday Farm Fire in 2020 resulted in complete riparian canopy removal at many streams in the McKenzie River Basin in western Oregon. We leveraged pre-fire measurements of stream temperature, chlorophyll-a, and populations and condition of fish and salamanders collected at six streams during the 2018 and 2019 summers. During the Holiday Farm Fire, three of the six sites burned, and we returned in summer 2021 to execute a replicated before-after-control-impact study design assessing post-fire responses. Preliminary findings indicate that, unsurprisingly, stream temperature and chlorophyll-a accrual increased, but surprisingly, we did not observe notable changes in abundance, biomass or condition of aquatic vertebrates due to riparian canopy changes caused by the fire. Our findings suggest that as wildfires continue to impact forested landscapes, we can expect increases in temperature and basal

food resources, but in the short-term, biomass and abundance of apex predators in headwaters may be unaffected.

Lessons from Reuniting an Old Growth Drainage: North Creek Aquatic Passage Project

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The North Creek Aquatic Organism Passage (AOP) Project reconnected 13 miles of fish habitat; providing an anadromous migration corridor for Oregon Coastal ESU Coho Salmon, Chinook Salmon, Steelhead DPS, Coastal Cutthroat, Pacific Lamprey, and Freshwater Mussels. The 4.4. sq mile North Creek drainage is situated on the Siuslaw National Forest and comprised primarily of old growth forest. It is a tributary of Drift Creek within the Siletz Watershed on the North Central Oregon Coast and contributes to one of the only tribal fishing sites left on the Oregon Coast. This unique watershed gets over 150 inches of rain annually and is one of the few locations in the western coast range with igneous geology. Cool summer stream temperatures along with quality riparian habitat contribute to excellent upstream aquatic conditions, creating the impetus for this major project.
The objectives of the project were to install an AOP structure, improve hydrologic and fluvial processes, provide streambank stabilization, and protect the FS road for public safety. The historic 62-year-old 11' corrugated metal pipe and degraded concrete weirs were a hydraulic barrier to aquatic passage and a significant impediment for sediment and large wood transport into Drift Creek. In 2019 the project removed these legacy structures and installed a 50' wide open bottom arch culvert and over 300' of streambed simulation. Revegetation of the adjacent road slope that provides sole access to a large camp facility and recreational access to Drift Creek was also completed. Observational results by winter of 2019-20 documented spawning fish seen in formerly degraded habitat downstream, within the culvert structure, and upstream. Lessons learned relate to wide-spread partnering and funding to complete the $1.1 million project, design to capture reference conditions in a human-altered landscape, contractor services, water and rock management during on-the-ground implementation, and ongoing site monitoring and review.

Are Pinnipeds 'sealing' the fate of White Sturgeon in the Columbia River?

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Historical records indicate pinnipeds were distributed as far up the Columbia River as Celilo Falls (rkm 323), which is now inundated by The Dalles Reservoir. These records also indicate distribution of pinnipeds in the lower section of the Columbia River estuary (Lyman et al. 2002). However, congregation of pinnipeds in the Bonneville Dam section of river (BON) was never documented prior to dam construction in 1938 and for six decades following dam construction (Keefer et al. 2012). It wasn't until the 1980s when California Sea Lions were first observed and not until 2003 when Stellar Sea Lions were observed in the BON section of river (Stansell 2004). Currently, the tailrace of Bonneville dam is frequented by both California and Stellar sea lion with occasional visits from harbor seals (Tidwell 2019). Since 2004, The US Army Corps of Engineers has documented predation of White Surgeon by Pinnipeds at the tailrace of Bonneville Dam, which also represents the primary

spawning location of White Sturgeon in the Columbia River. Negative correlation between Age-0 sturgeon abundance and sea lion abundance near BON has led to a hypothesis that pinniped predation is driving recent downturns in sturgeon recruitment. In this presentation we will consider this hypothesis in the context of long-term sturgeon abundance and physical environment datasets for the Lower Columbia and Willamette rivers.

The Importance of High-Quality Underwater Pictures of Native Fishes In Situ

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Underwater photography is a powerful tool that can be used to correctly name fish species; confirm populations of rare and endangered fish; document fish behaviors; and can help to raise awareness of native fish and their habitats and communicate the need to engage in actions to protect habitats that in turn supply critical habitat for native fish. Obtaining high quality pictures than can engage and educate takes a combination of research, specialized equipment, practice, fish biology, determination, and technical skill. Methods used included literature review, correspondence with prior researchers and local biologists, field note review, preliminary field reconnaissance, and multiple visits at different seasons at multiple locations in Oregon to account for water levels and lighting conditions. Locations could be remote, and at times required backpacking a dry suit, camera, sampling equipment, and camping supplies. River, lake, and stream snorkeling is dangerous, and a buddy system was a preferred method. Occasional SCUBA diving was used. Nikon, GoPro, and Canon underwater systems were deployed with multiple lens and housing configurations. Video and still photography mediums were captured. By using multiple methods to correlate possibilities, we were able to find sites to deploy video and still photography at with particularly reliable results. By using innovative techniques, we were able to document populations of native fish, obtain juvenile growth stage pictures for accurate identification destined for use on various outlets for public education. Visually appealing pictures help viewers on various media sites identify and become interested in native fishes, and overall, we believe this to be a positive trend as far as societal awareness.

Observations of Fish Survival and Emergency Habitat Remediation in the Bootleg Fire in Southeast Oregon.

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The Bootleg Fire in Southeast Oregon was the third largest fire in Oregon's History burning 413,765 acres. Unfortunately, the fire burned during an unprecedented drought and at a high intensity that was most severe within riparian corridors. Fish biologists surveyed the streams using electrofishing and spawning survey methodologies to determine fish survival. The primary objective was to determine relative survival of five of the eight populations of Klamath Basin Bull Trout within the Bootleg Fire perimeter. The secondary objective was to determine survival of other fish species. Fish survival within the core area of spawning and rearing of Bull Trout was very low. Only five Bull Trout were captured in all surveys combined. Fish survival of other species was also very low in the Bull Trout core area. Survival of Redband Trout and Marbled Sculpin was zero at one site in the largest

river system in the fire, The North Fork Sprague River. Lamprey were detected at this site but not detected at sites within the Bull Trout core area. Conversely, survival of Brown and Redband Trout in streams downstream of beaver dams and ponds were exceptional. Using the gained information on the importance of beaver dams and associated conditions, habitat remediation was initiated immediately following the fire by adding numerous large wood structures with the goal of sediment deposition and ameliorating the affects of toxic levels of turbidity. Bull Trout in these streams have a very weak migratory life history and there is little or no mixing among the populations, therefore, population persistence is in serious jeopardy for all five populations. Managers are currently working with Bull Trout experts and utilizing modeling to develop reintroduction strategy of Bull Trout throughout the Klamath Basin with a new emphasis on restoring populations that were severely impacted by the Bootleg Fire.

Characterizing Genetic Connectivity and Investigating Sex-specific Distribution Patterns in Pacific Albacore Tuna (Thunnus alalunga)

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Albacore Tuna (Thunnus alalunga) are a highly migratory marine species that are harvested in commercial and recreational fisheries around the world. Within the Pacific Ocean, Albacore are currently managed as two stocks, North and South, which are assumed to be independently breeding populations. Vaux et al. (2021) recently demonstrated that despite low overall genetic differentiation, North and South Pacific Albacore can be distinguished based on variation at putatively adaptive genetic markers. Using a targeted amplicon sequencing method known as Genotyping-in-Thousands by Sequencing, this research will (i) evaluate genetic connectivity between Albacore sampled in the North and South Pacific Oceans, (ii) identify migrant individuals that have traveled between these oceans and hybrid individuals that exhibit mixed North-South ancestry, and (iii) investigate sex-specific distribution patterns. Fin clip tissue samples were collected from Albacore caught in 2020 and 2021 in waters offshore of Oregon, Washington, Hawaii, Japan, New Caledonia, and French Polynesia. Individuals will be genotyped at target genetic markers, and genetic structure will be analyzed through a combination of multivariate and model-based approaches. Results of this study, in conjunction with tagging and population dynamics data, may be used to evaluate stock delineations and other management decisions for Albacore in the Pacific Ocean.

Lamprey Conservation and Control Programs: Better together

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There are approximately 40 species of lampreys worldwide and half of them are found in the United States. It is thought that all of these lamprey species are native to their current distribution except one, the Sea Lamprey (Petromyzon marinus), which although is native to the East Coast of the U.S., invaded the Laurentian Great Lakes in the late 1800's. Native lampreys are affected by many threats including passage barriers, habitat degradation, and climate change. Conservation efforts are underway to reduce threats and reverse the declining abundance of many native lamprey

populations. Of note is the Pacific Lamprey Conservation Initiative (PLCI) which is a consortium of tribes, federal and state agencies and local organizations working together to address threats and conserve Pacific Lamprey (Entosphenus tridentatus) and other native lampreys from Alaska to California. Another largescale effort, the Sea Lamprey Control Program, administered by the Great Lakes Fishery Commission (GLFC), has been controlling the invasive Sea Lamprey population since the 1950's. The goals of these conservation and control programs appear to be worlds apart, but are they? The recently developed Lamprey Communication Committee (LCC), comprised of PLCI and GLFC members, is joining forces to advance the message of healthy ecosystems. The LCC is working together to create interpretive messaging and outreach content for the multi-faceted audiences of both programs. Partnerships such as the LCC are integral to the success of both native lamprey conservation and invasive lamprey control programs and above all, healthy ecosystems.

Cold-water fish persist in a stream system with elevated summer temperatures after a severe wildfire

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Studies have speculated about how potential increases in stream temperatures through the summer associated with climate change may affect native salmonids in the wild. While the magnitude of stream thermal responses to slow and steady increases in regional temperatures remains uncertain and hard to predict, wildfire is a clear and rapidly accelerating effect of climate change that can substantially increase stream temperatures. Therefore, fires act as natural experiments that allow us to better understand how fish in natural systems respond to thermal impacts (direct and indirect) of climate change. In our study system in the western Cascades of Oregon, the 2020 Labor Day Fires burned through the watershed and stream temperatures in summer 2021 were elevated. Over a 2-month time period in mid-summer, peak temperatures exceeded 16C every day and they exceeded 20C on 80% of days. While temperatures that fish experienced in these streams is not outside their maximum thermal tolerance based on laboratory studies, it is outside of the range that is commonly observed in wild coastal headwater populations. Reconciling laboratory and field results is important as we consider how temperature increases from wildfire and other direct and indirect impacts of climate change will affect populations and communities of cold-water fish. We found that despite elevated temperatures, the cold-water salmonid fish that dominate our study system, Cutthroat trout (Oncorhynchus clarkii), and Steelhead/rainbow trout (Oncorhynchus mykiss), did not decline through summer 2020. Local densities (# per m2 wetted stream area and per linear m of stream) actually increased in our study reaches. This result is noteworthy because it highlights the resilience of wild salmonid populations to persistent elevated and potentially stressful temperatures associated with post-fire stream conditions that are well outside of their common realized niche.

Geomorphic evolution of the Elwha River and its delta following dam removal

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The intentional removal of two large dams on the Elwha River (Washington, USA) exposed ~30 Mt of impounded sediment to fluvial erosion, presenting a unique opportunity to quantify source-to-sink river and coastal responses to a massive sediment-source perturbation. Here we synthesize the geomorphic evolution of the river and coastal systems during and after the sediment pulse. During the first 5 years following dam removal approximately 65% of the sediment was eroded, of which only ~10% was deposited in the fluvial system. This restored fluvial supply of sand, gravel, and wood substantially changed the channel morphology. The remaining ~90% of the released sediment was transported to the coast, causing ~60 ha of delta growth and fundamental changes to the coastal system. Although metrics of geomorphic change did not follow simple time-coherent paths, many geomorphic signals peaked 0.5–2 years after the start of dam removal, indicating combined impulse and step-change disturbance responses. Notably, the river recovered quickly after this large disturbance, while the coast is still evolving in response to the massive introduction of sediment.

Freshwater mussel considerations in fisheries science, conservation, and management activities

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Freshwater mussels are documented as one of the most imperiled group of animals throughout their range. The Western Ridged Mussel, one of Oregon's native species, has recently been petitioned for listing under the federal Endangered Species Act. As the agency with shellfish management authority, the Oregon Department of Fish and Wildlife's (ODFW) mission is to protect and enhance freshwater mussels and their habitats now and into the future. ODFW has enacted regulatory protections, including the prohibition of any recreational harvest, to help conserve freshwater mussels and is taking an active role with partners to understand the life history needs and population status throughout the state. Freshwater mussels are very intertwined with fish and fish habitats, and should be considered in fisheries science, conservation, and management activities. Freshwater mussels provide many benefits to healthy river, lake, and stream ecosystems, but are often overlooked during routine sampling activities and not usually considered during habitat restoration projects. Even with limited funding and staff time, there are several opportunities that can be exploited that will benefit the conservation of this important native species. Since fish research, monitoring, and habitat improvement projects are happening statewide, enhanced consideration for freshwater mussels could go a long way toward understanding how to implement appropriate conservation and management actions.

Are Mountain Whitefish sentinels of change?

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Mountain Whitefish (Prosopium williamsoni) are a historically common fish in the Willamette River Basin, Oregon that has been reported to be in decline elsewhere in its range. Here we examine more than 20 years of passage data from Leaburg Dam on the McKenzie River. We found a 10-fold decline in Mountain Whitefish counts since 2001, with the greatest drop in returns occurring during the summer of 2015, coincident with warm, low flow conditions. Other salmonids did not show similarly dramatic changes across the same interval. A trend towards increasing water temperatures have been

suspected as a contributing factor in whitefish declines elsewhere. After the decline observed in 2015, yearly totals have yet to exceed counts from 2014. Our findings suggest that additional studies on Mountain Whitefish populations in Oregon may be important to understanding current and future trends of this native and ecologically relevant species.

Estimating the genetic diversity of Pacific salmon and trout using multigene eDNA metabarcoding

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Genetic diversity underpins species conservation and management goals, and ultimately determines a species' ability to adapt. Using freshwater environmental DNA (eDNA) samples, we examined mitochondrial genetic diversity using multigene metabarcode sequence data from four Oncorhynchus species across 16 sites in Oregon and northern California. Our multigene metabarcode panel included targets commonly used in population genetic (NADH dehydrogenase 2, ND2), phylogenetic (cytochrome c oxidase subunit 1, COI) and eDNA (12S ribosomal DNA) screening. The ND2 locus showed the greatest within-species haplotype diversity for all species, followed by COI and then 12S rDNA for all species except Oncorhynchus kisutch. Sequences recovered for O. clarkii clarkii were either identical to, or one mutation different from, previously characterized haplotypes. The greatest diversity in O. c. clarkii was among coastal watersheds, and subsets of this diversity were shared with fish in inland watersheds. However, coastal streams and the Umpqua River watershed appear to harbour unique haplotypes. Sequences from O. mykiss revealed a disjunction between the Willamette watershed and southern watersheds suggesting divergent histories. We also identified similarities between populations in the northern Deschutes and southern Klamath watersheds, consistent with previously hypothesized connections between the two via inland basins. Oncorhynchus kisutch was only identified in coastal streams and the Klamath River watershed, with most diversity concentrated in the coastal Coquille watershed. Oncorhynchus tshawytscha was only observed at one site, but contained multiple haplotypes at each locus. The characterization of genetic diversity at multiple loci expands the knowledge gained from eDNA sampling and provides crucial information for conservation actions and genetic management.

Adapting Blue Catfish management to shifting biological and sociological dynamics in Virginia's Chesapeake Bay

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Blue Catfish (Ictalurus furcatus) were intentionally introduced into Virginia's Chesapeake Bay tributaries in the 1970's in an effort to create a trophy fishery. The success of these efforts has led to increasing abundance and spatial distribution of Blue Catfish within the Chesapeake Bay watershed and has prompted concern over the unintended impacts of Blue Catfish on native species. The Virginia Department of Wildlife Resources' long-term monitoring program for Blue Catfish monitors population demographics and supports collaborative research on movement, physiology, and impacts to native species. Ongoing partner efforts to develop a commercial low-frequency electrofishing fishery and increase market demand have been advanced as potential avenues for reducing Blue Catfish abundance. Management efforts have been constrained by what can at times be competing

objectives of managing a popular recreational fishery that is also widely acknowledged as an invasive species. The DWR recently launched a Blue Catfish movement ecology project in the James River that aims to address multiple management needs, including identifying aggregation areas, assessing impacts of the commercial fishery, and developing outreach and education materials for recreational anglers currently unreceptive to commercial harvest. In October 2021, 40 Blue Catfish ranging in size from 319 to 1134 mm total length were tagged with V13 and V16 acoustic tags, with a tag life of three and 10 years, respectively. An additional 40 fish will be tagged in October 2022, pending an assessment of signal collisions within Blue Catfish aggregation areas and with other species of tagged fish in the James system. Active and passive tracking efforts are ongoing to identify overwintering and spawning areas and assess seasonal movement patterns. Results of this project will be used in conjunction with long-term monitoring data to further the understanding and management of Blue Catfish in Virginia and wider Chesapeake Bay watershed.

The Leverage Effect: How small variations in spawn timing can generate large variations in emergence timing of Pacific salmon

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South-central Alaska is projected to warm by 2 to 3°C during the next 50 years with the greatest warming expected in winter, greatly reducing winter ice cover on rivers. Warmer winters may change emergence timing of Pacific Salmon and potentially lead to increased juvenile mortality. Spawn timing is highly heritable and can change rapidly in response to changing environmental conditions. However, we have little idea of how changes in spawn timing might interact with stream thermal regimes, potentially exacerbating or mitigating future climate change impacts. Thus, we examined how variability in spawn timing was reflected in modeled emergence timing using observed hourly stream temperatures combined with non-linear degree-day-based incubation models. We monitored thermal regimes in 33 streams across 3 geographic sub-regions between 2013–2018. Our results showed that time of spawning was a critical determinant of emergence date. This relationship was not linear in most streams. For example, shifting Sockeye spawning 15 days later delayed emergence by 31 days. We refer to this as “leverage” because small changes in spawn timing can “leverage” large changes in emergence timing. Overall, a 1-day change in spawn timing changed emergence timing for Coho Salmon by 1.5 days. Other species had larger leverage: Sockeye=1.9, even-year Pink=2.2, odd-year Pink=2.5, Chum=2.6, and Chinook=2.7. The leverage effect is a physical mechanism resulting from the interaction between spawn timing and a stream’s thermal regime. Because of the leverage effect, small variations in spawn timing may be highly adaptive, allowing spawning that is synchronized over a short period of time to generate a wide range of emergence times, some of which are likely to be optimal in any given year. The leverage effect might also serve as a compensation mechanism under a changing climate because small changes in spawn timing might accommodate large changes in stream thermal regimes.

Early Predication Method for Native Migratory Fish Presence at Small Culverts

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Oregon Fish Passage laws stipulates that artificial obstructions along Oregon waterways are subject to review by the Oregon Department of Fish and Wildlife (ODFW) and the Oregon Department of Transportation (ODOT) when maintenance is required. These agencies determine if the obstruction prevents the use and access of habitat of one or more of 32 native fish species categorized as migratory by the law. If so, a review of pertinent fish passage laws is triggered. This project aimed to develop a GIS-based tool to support the initial evaluation of a subset of these artificial obstructions – small (≤ 0.91m diameter) culverts that have been identified along the Oregon highway system. The culvert scoping tool We developed uses Light Detection and Ranging (LiDAR)-derived bare-earth digital elevation models, the National Hydrography Dataset Plus High Resolution, the ODFW barrier database, and species distribution models as inputs to determine if a target culvert would trigger the need for the fish passage law review. Results of the toolbox were evaluated against field surveys of randomly selected culverts within two basins that had appropriate LiDAR coverage and demonstrated the tool was successful at parsing fish call and non-fish call culverts. The culvert scoping tool is operable in ArcPro as an added toolbox and is intended to streamline ODOT's ability to plan projects so that fish habitat connectivity is preserved and improved throughout the state.

Salmon SuperHwy – Reconnecting Fish Habitat and Communities at a Landscape Scale

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Since 2010, a collaborative partnership has been working in the Tillamook-Nestucca subbasin under a national pilot uses a landscape scale, strategic approach to focus efforts to increase habitat connectivity, improve road-stream crossings, and increase climate resiliency in aquatic and transportation networks that benefit fish and wildlife species, as well as local communities. The project area encompasses the Tillamook Bay, Nestucca, and Sand Lake watersheds along the Northern Oregon Coast in Tillamook County. Salmon SuperHwy partners collaborate to provide technical expertise and leverage funding to work with public and private landowners to complete a portfolio of high priority fish migration barrier projects that provide the biggest habitat benefits for the funding investment. Using a strategic, scaled approach designed to maximize benefits and minimize costs, this unique community partnership developed a portfolio of 93 priority projects that will restore access to almost 180 miles of blocked habitat throughout six major salmon and steelhead rivers of Oregon's North Coast. Their completion will reconnect at least 95% of historic habitat for each species, reduce chronic flooding, improve recreation opportunities, and stimulate the local economy. Since 2012, Salmon SuperHwy partners have implemented 43 fish passage barrier removal projects, reconnecting over 115 miles of habitat, and leveraging $16 million of federal, state, local, and private funding. Nationally renowned for its salmon and dairy production, Tillamook County is comprised largely of federal, state, and industrial forest lands (92%) which interface with small woodlot forest land, residential, rural residential, and agricultural ownerships in the lowlands. The heavily forested mid and upper watersheds provide spawning and rearing habitat for native fish species including cutthroat and steelhead trout, coho, chinook, and chum salmon and lamprey. The lowlands are intensively used for agriculture, primarily for dairy production. A strong tradition of local habitat work, rich salmon and steelhead recovery potential, and experienced local capacity united public agencies, private non-profit organizations, and the community at large into the Salmon SuperHwy Partnership.

Rising from the ashes: An example of dam removal and sturgeon from the east

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Over the last decade a major river restoration project occurred in Maine's largest watershed, the Penobscot. This included the removal of two large dams, in 2012 and 2013, and improved fish passage at two others. In 2006, shortnose and Atlantic Sturgeon were discovered using the lower parts of the river and estuary system. These species had not been documented in the system since the 1970s. In the years pre-ceding the dam removals mark-recapture and acoustic telemetry studies indicated persistent use of the lower river with long-distance migrations to other river systems in the Gulf of Maine and beyond. Since the dams have been removed, subadult and adult sturgeon regularly use the newly available habitat, including potential spawning habitat, but spawning has yet to be documented in this system. Movement patterns and age distributions indicate interesting population dynamics in the Gulf of Maine for both species. For example, most aged individuals are between the ages of 4 and 15, suggesting most individuals are partial migrants from other river systems. Habitat use, age structure, and mark-recapture dynamics collected over the period of river restoration activities (2006 - present) will be used to describe these species' rise from the ashes in the Gulf of Maine.

What have we lost? American shad's impounded history.

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American shad (Alosa sapidissima) are native to the east coast of North America from the St. Johns River, Florida, to the St. Lawrence River region in Canada. Since the 1800s, dams have reduced access to spawning habitat. To assess the impact of dams, we estimated the historically accessed spawning habitat in coastal rivers (485,618 river segments with 21,113 current dams) based on (i) width, (ii) distance from seawater, and (iii) slope (to exclude natural barriers to migration) combined with local knowledge Estimated habitat available prior to dam construction (2,752 km2) was 41% greater than current fully accessible habitat (1,639 km2). River-specific population models were developed using habitat estimates and latitudinally appropriate life history parameters (e.g., size at age, maturity, iteroparity). Estimated coast-wide annual production potential was 69.1 million spawners compared with a dammed scenario (41.8 million spawners). Even with optimistic fish passage performance assumed for all dams (even if passage is completely absent), the dam-imposed deficit was alleviated by fewer than 3 million spawners. We estimate that in rivers modeled without dams, 98,000 metric tons of marine sourced biomass and nutrients were annually delivered, 60% of which was retained through carcasses, gametes and metabolic waste. Damming is estimated to have reduced this by more than one third. Based on our results, dams represent a significant and acute constraint to the population and, with other human impacts, reduce the fishery potential and ecological services attributed to the species.