EMERGING TECHNOLOGIES INFORMATION SESSIONS

2025 WEBINAR SERIES

Presented By: Pacific Northwest Aquatic Monitoring Partnership and StreamNet

Schedule at a Glance

Modeling and Analysis Session – Wednesday, January 8th, 2025, 9:00 AM – 11:00 AM (PST)

- *An Overview of GitHub for Data Analysis Projects* - **Ben Staton**; Columbia River Inter-Tribal Fish Commission
- *Utilizing R Shiny Within the Likely Suspects Framework*- **Graeme Diack, Jon Emery, and Colin Bull**; Missing Salmon Alliance
- *Models Facilitate Comparison of the Social-Ecological Tradeoffs Among Puget Sound Management Alternatives* - **Caitlin Magel**; University of Washington Puget Sound Institute

Artificial Intelligence and Machine Learning Session – Wednesday, January 15th, 2025, 9:00 AM – 11:00 AM (PST)

- *AI for Capture Recapture Data: Individual Instance Pattern Recognition Tools and the GrouperSpotter Platform* - **Brice Semmens**; Scripps Institution of Oceanography, UC San Deigo
- *Exploring Monitoring Methods Using Text Clustering and LLMs* - **Tomas Bird and Minh Doan**; Department of Fisheries of Canada
- *Improving Hydroelectric Dam Operations Through AI-Powered Fish Monitoring* - **Aaron Legge**; Innovasea

Data QA/QC Session – Wednesday, January 22nd, 2025, 9:00 AM – 11:00 AM (PST)

- *Enabling Real Time Data Collection, Quality Control, Reporting, and Visualization to Enhance Field Data Collection Across the West* - **Justin Welty**; U.S. Geological Survey
- *Data QA/QC for Spawning Ground Surveys Using Survey 123 and ArcGIS Enterprise* - **Brock Lipple**; Idaho Department of Fish and Game
- *UI Design for Getting Better Quality Data* - **Chris Harrington**; Idaho Department of Fish and Game

Genetics Session – Wednesday, January 29th, 2025, 9:00 AM – 11:00 AM (PST)

- *Updating Genus Classification and Species Diversity in the OG Fish* - **Kellie Carim**; U.S. Forest Service Rocky Mountain Research Station
- *How Might Restoration Efforts Help Bring a Bumper Return of Pacific Lamprey to the Columbia River?* - **Jon Hess**; Columbia River Inter-Tribal Fish Commission
- *Sharing Biological Information Across Generations: Parallels Between Indigenous Knowledge and Genetics for Fisheries Recovery in the Columbia River Basin* - **Jeremy FiveCrows;** Columbia River Inter-Tribal Fish Commission
- *Integrating Genetics into Crayfish Conservation* - **Zanethia Barnett**; USDA Forest Service

Remote Sensing Session – Wednesday, February 5th, 2025, 9:00 AM – 11:00 AM (PST)

- *Developing Autonomous eDNA Detection* - **Edgar Rudberg, Ph.D.**; Nucleic Sensing Systems
- *Early Predication Method for Native Migratory Fish Presence at Small Culverts* - **Courtney Zambory**; Oregon Department of Fish and Wildlife
- *Why on Earth Would We Put Ocean Color Sensors on a Geostationary Weather Satellite?* - **Ryan Vandermeulen**; NOAA Fisheries

Presentation Abstracts by Session

Modeling and Analysis Session

Wednesday, January 8th, 2025, 9:00 AM – 11:00 AM (PST)

Ben Staton; Columbia River Inter-Tribal Fish Commission

An Overview of GitHub for Data Analysis Projects

Version control systems (VCS) have been used for decades by software developers to track the progression of code-based projects and is a widely accepted best-practice within that field. Modern data analysis projects are increasingly reliant on computer code, yet the uptake of VCS in the natural resource sciences has been slower, perhaps resulting from a lack of exposure during our statistical training. Git has emerged as a widely used VCS, and popular platforms like GitHub have made this tool accessible to users without formal software development training (presenter included). Although accessible, there remains some mystery among analysts about what GitHub is and how it can be used to facilitate data analyses, particularly in a collaborative setting. Benefits offered by GitHub for data analysis projects include the transparency of file diffs (visualize line-by-line file changes), rigor of commit histories ('track changes' for code as a time series) linked to documented issues, the safety of branching (freeze a main version while exploring changes on a duplicate), and the convenience of centralized hosting/archiving – all of which can lead to enhanced collaboration. This webinar will provide an overview in introductory topics in the use of GitHub for data analysis projects, with the intent of highlighting these benefits and clarifying the lingo (repositories, commits, branches, merges, pushing/pulling, etc.). Recommendations for ways to get started will be provided.

Graeme Diack, Jon Emery, and Colin Bull; Missing Salmon Alliance

Utilizing R Shiny Within the Likely Suspects Framework

The Likely Suspects Framework (LSF), the flagship project of the Missing Salmon Alliance (MSA), aims to provide vital new knowledge on the drivers of salmon mortality from across their life cycle. This project involves multiple work packages, building knowledge and tools to achieve this goal and inform ecosystem based approaches to salmon conservation and recovery. For salmon managers to make evidence-based decisions, clear and concise information on the mechanisms driving variation in salmon stock abundance must be conveyed in an accessible format. With web application frameworks such as Python Streamlit and R Shiny it is possible to rapidly build proof of concepts that showcase improvements to accessibility, and also useability, of research inputs and outputs. These proofs can also develop into stable applications that can be rolled out to a wider audience. Within the Missing Salmon Alliance we have utilized R Shiny to make these kinds of accessibility improvements to the salmon research and data landscape. As a key example, whilst one arm of the LSF team have been developing a population model that simulates the impacts of stage-based growth and mortality rates on a single salmon cohort, another arm has been co-developing a web based user interface to bring this model into the hands of a wider research audience, including policy makers and catchment managers themselves. The result, a web based Decision Support Tool, a system to help the right stakeholders make management decisions in the right places. Our model and web application combined creates a full life cycle view that illustrates changes in salmon survival, provides a forward look for stock prospects, and a reporting framework which can inform management decisions at a catchment scale within the wider context of pressures elsewhere in the life cycle.

Caitlin Magel; University of Washington Puget Sound Institute

Models Facilitate Comparison of the Social-Ecological Tradeoffs Among Puget Sound Management Alternatives

Management actions should be guided by social, economic, and ecological objectives, but integrative decision support tools appropriate for complex coastal systems remain underutilized. The Puget Sound Institute is working with two such tools – a qualitative network model (QNM) and an integrated suite of quantitative biophysical models – which are being used to evaluate the multi-benefit outcomes of proposed recovery actions for Puget Sound. Both approaches derive from conceptual models and recovery plans, developed with regional scientists and stakeholders, that describe how human stressors, ecosystem components, and management interventions are connected to recovery objectives across the Puget Sound social-ecological system. We use QNMs to simulate proposed management actions related to stormwater runoff and regional development under varying degrees of coordination within watersheds, and track

responses of ecosystem stressors and recovery objectives through the networks. Results show tradeoffs and synergies associated with the outcomes of different management actions. For two culturally and ecologically important fish species, for example, the response of one (Pacific herring) was either unclear or converse to another (Chinook salmon). In addition, we identified key uncertainties in the dynamics of the social-ecological system that are well suited to further investigation using more complex models. For instance, future growth patterns (i.e., the amount of urban redevelopment compared to conversion of rural land) and the level of coordination between jurisdictions were key determinants of the response strength and direction of many recovery objectives. These QNM results are now being investigated using a linked suite of complex, quantitative models that simulate future land cover (using a state-and-transition simulation model), watershed hydrology (VELMA), estuarine biogeochemistry (Salish Sea Model), and food webs and fisheries (Atlantis). This work demonstrates the value of integrative analyses, such as QNMs and quantitative model suites, that leverage existing information and model frameworks to guide coastal management decisions and influence future research priorities.

Artificial Intelligence and Machine Learning Session

Wednesday, January 15th, 2025, 9:00 AM – 11:00 AM (PST)

Brice Semmens; Scripps Institution of Oceanogrpahy, UC San Deigo
AI for Capture Recapture Data: Individual Instance Pattern Recognition Tools and the GrouperSpotter Platform
Groupers are some of the most highly sought after reef fish, making them of particular management and conservation concern. Population assessments are critical, yet sufficient data do not exist to assess many grouper species across the globe, including Camouflage Grouper Epinephelus polyphekadion, Nassau Grouper Epinephelus striatus and Atlantic Goliath Grouper Epinephelus itajara, all of which are listed under the IUCN Red List. One promising approach to generate data for estimating key population metrics (e.g., abundance, mortality, movement, and growth) is to develop photo identification (ID) databases, where images of individual fish are probabilistically matched using patterned species instance recognition software. The individual encounter histories from these matches yield data that inform mark-resight models to estimate survival, recruitment and population size. Individual resightings in different locations can also inform movement rate estimates, and resightings from stereo camera images can be used to estimate growth. Here I introduce Grouper Spotter (http://www.grouperspotter.org), an artificial intelligence assisted Web platform for tracking individual groupers based on natural markings. I demonstrate that, for Nassau Grouper, natural markings on individuals persist and are uniquely identifiable even with more than seven years between captured images. I discuss the architecture of the Grouper Spotter platform, and the ongoing process to integrate the three grouper species mentioned above, in addition to Potato Grouper, Epinephelus tukula. Finally, I outline a path towards crafting Grouper Spotter into a global citizen science initiative.

Tomas Bird and Minh Doan; Department of Fisheries and Oceans, Canada
Exploring Monitoring Methods Using Text Clustering and LLMs
Navigating complex, multi-source datasets with varying standards is a common challenge in interoperability. The differing standards adopted when building each system create obstacles for new users trying to find necessary information across systems. The Method Assessment Support System (MASS), powered by Large Language Models (LLMs), aims to streamline data exploration and organization, offering a solution adaptable to various databases.

MASS utilizes techniques such as recursive clustering to organize data hierarchically, keyword tagging for efficient cross-referencing, and SME (Subject Matter Expert) input to continuously refine accuracy. These features help users quickly locate relevant information, such as specific habitat monitoring methods tailored to a species and environment, saving time and allowing more focus on research rather than searching. With recursive clustering, MASS also generates a data-driven ontology that enhances data relationships, enabling richer exploration of related content. This allows users to navigate through the ontology and find clusters of methods of interest.

Additionally, the system introduces semantic search functionality, enabling users to input natural language keywords or phrases to retrieve the most relevant results, without needing exact keyword matches. Semantic search facilitates data discovery across similar sources that use different naming conventions or domains with varying vocabularies.

By integrating these processes, MASS significantly improves how professionals interact with and utilize large, varied datasets. This adaptable solution addresses the growing need for enhanced data structuring, organization, and exploration across diverse industries, making it a valuable tool for researchers and data professionals alike.

Aaron Legge; Innovasea

Improving Hydroelectric Dam Operations Through AI-Powered Fish Monitoring

Hydropower is currently the most reliable and predictable form of renewable energy for the grid. However, monitoring fish activity to ensure their safe passage through dam infrastructure remains a significant challenge.

Innovasea, formerly known as Vemco, has been a global leader in acoustic telemetry for aquatic animal researchers for nearly 40 years. Their products are essential tools, cited in hundreds of scientific research papers. Innovasea is dedicated to developing innovative technologies that enhance our understanding of ocean and freshwater ecosystems.

Innovasea is now poised to improve hydropower operations in North America with its latest fish monitoring solution, HydroAI. This automated system provides unprecedented insights into fish activity around hydro facilities. HydroAI leverages artificial intelligence to help hydro dam operators enhance environmental compliance and operational efficiency. The AI-powered camera solution autonomously counts and identifies fish with 95% accuracy, offering dam operators a clearer understanding of fish behaviors and providing regulators with more accurate data than ever before. Additionally, when combined with Innovasea's established acoustic telemetry equipment, regulators can gain a deeper understanding of fish migrations at their operations.

Data QA/QC Session

Wednesday, January 22nd, 2025, 9:00 AM – 11:00 AM (PST)

Justin Welty; U.S. Geological Survey

Enabling Real Time Data Collection, Quality Control, Reporting, and Visualization to Enhance Field Data Collection Across the West

Mobile digital devices and field data collection apps have revolutionized field data collection over the last decade. While digital data collection is now widely used, accessing and utilizing this digital information for quality control, visualization, and reporting is still something that generally isn't done until after the field season instead of during the field season while the information is fresh. Current technology now allows us to connect directly to the field data as soon as it's submitted to produce maps, charts, graphs, summaries, and reports in near real-time to assist with data quality control, in-season field decisions, and real-time adaptive management. Since 2022, the USGS has partnered with various federal and state agencies across the west to provide a single platform that collects, centralizes, standardizes, and displays terrestrial monitoring data. In 2024, we recorded information from over 1,500 monitoring plots across the west using over a dozen different monitoring protocols. We will provide an overview of the process and applications we use for real time data collection, visualization, summarization, and quality control. We'll also demonstrate how we continue to grow and evolve the monitoring platform to allow for "opportunistic monitoring" in addition to the randomized set plots that are part of any traditional monitoring protocol.

Brock Lipple; Idaho Department of Fish and Game

Data QA/QC for Spawning Ground Surveys Using Survey 123 and ArcGIS Enterprise

The Idaho Department of Fish and Game has begun using the ArcGIS Enterprise platform with Survey 123 for mobile data capture during the 2024 spawning ground survey season. This complements the existing in-house database and SGS III desktop application. By streamlining data capture and incorporating quality checks at multiple stages of the workflow, the department has improved the speed, quality, and precision of data entry with the ArcGIS Enterprise stack. This presentation will cover our approach, lessons learned, and future work based on results from the previous season.

Chris Harrington; Idaho Department of Fish and Game

UI Design for Getting Better Quality Data

The Idaho Department of Fish and Game has over a decade of experience with issues in entering ground survey data into a standardized database. Based on this experience, the SGS III application was developed to address the QA/QC limitations discovered with the old approach. The new application focuses more on the spatial aspects of spawning ground data and enhances the ability to visualize this data. This presentation will cover lessons learned from entering spawning ground survey data.

Genetics Session

Wednesday, January 29th, 2025, 9:00 AM – 11:00 AM (PST)

Kellie Carim; U.S. Forest Service Rocky Mountain Research Station

Updating Genus Classification and Species Diversity in the OG Fish

Accurate taxonomy is fundamental to the study and conservation of biodiversity. Recent phylogenetic examinations based on molecular characters for several groups of fishes have revealed taxonomic relationships that differ from classifications based solely on morphology. These inconsistencies are particularly apparent among lampreys, an ancient lineage of jawless fish that lack many of the morphological characters often used for taxonomic classification. We addressed the information gaps in the genus Lampetra with a focus on species observed in western North America. Phylogenetic analyses of all publicly available sequences data at two mitochondrial genes support designation of new genus to describe western North American brook and river lampreys formerly classified as Lampetra. Therefore, to more accurately represent diversity of North American lampreys, we assign them to a new genus, Occidentis. To explore species diversity within Occidentis, we performed a species delimitation analysis using all publicly available cytochrome b sequences. Despite different adult morphology and feeding behavior, results demonstrate that western brook lamprey (O. richardsoni) are best categorized as life history variants of the larger O. ayresii species complex. Results also revealed the existence of several cryptic taxa, with as many as six candidate (undescribed) species present in river basins of Oregon and California. We observed varying phylogeographic patterns within Occidentis, with some lineages and species endemic to a single river drainage, while other are widely distributed and highly diverse. Further genetic assessments across a broad spatial scale, along with morphological assessments are needed to determine whether candidate species constitute distinct species or divergent lineages within a species complex. Overall, this study demonstrates the benefits of genetic technology for accurate assessments of species taxonomy and biodiversity, with subsequent benefits to conservation and management of understudied freshwater fish.

Jon Hess; Columbia River Inter-Tribal Fish Commission

How Might Restoration Efforts Help Bring a Bumper Return of Pacific Lamprey to the Columbia River?

The Pacific Lamprey Entosphenus tridentatus is valuable to tribal culture and to the ecosystem, but its abundance in the interior Columbia River has been highly variable and muted in recent years. Translocation programs have been adopted as a proactive strategy to restore Pacific Lamprey abundance to the interior Columbia River, including the Snake River basin, and these efforts have been largely successful in increasing larval and juvenile abundance in the recipient watersheds and further downstream. We addressed whether adult translocation offspring from three Columbia River Treaty Tribe programs return to Bonneville Dam in numbers that support model predictions. Natal origins of Pacific Lamprey that returned as adults to Bonneville Dam and broadly distributed locations within the Columbia River basin were genetically identified to a precise natal site of volitional production or to a set of candidate parents from one of the translocation programs in the Columbia River. We showed that not only have Snake River translocation offspring returned as adults to Bonneville Dam in numbers proportional with model projections, but offspring from two other tribal translocation programs in the Umatilla and Yakima rivers were also detected in recent years. Translocation offspring were estimated to be 1065 fish in 2021, 2200 fish in 2022, and could reach much higher abundances by 2027, which is the year the model predicted a total run at Bonneville Dam could surpass 400,000 adults. Although Pacific Lamprey are known to lack precise natal homing, our results supported a preference by interior Columbia River Pacific Lamprey to return home and migrate toward their natal basins with some deviations into areas where tribal harvest

occurs. These results indicate benefits from Pacific Lamprey translocation programs that will not only increase abundance to targeted areas but will also increase opportunities for tribal harvest of this culturally important species.

Zanethia Barnett; USDA Forest Service

Integrating Genetics into Crayfish Conservation

Understanding the relationship between multi-scale processes driving community- (i.e., richness) and population-level (i.e., population genetics) diversity can guide conservation efforts. While the importance of population-level diversity is widely recognized, it is rarely assessed for conservation planning, and positive correlations with community-level diversity are often assumed. In addition, community- and population-level diversity metrics can be decoupled due to differing responses by biodiversity metrics to environmental gradients and fragmentation. Further, we assessed evidence for parallel processes, operating at hierarchically nested levels, within connected and fragmented systems. These findings show no or negative relationships between community- and population-level diversity, indicating that community-level diversity cannot be used as a proxy for population-level diversity. Thus, we use population genetic techniques to assess fragmentation and crayfish population structure within aquatic and terrestrial systems. Findings, show that population structure has occurred within some crayfish populations within short timeframes due to impoundments, agriculture, and urbanization. Understanding the genetic diversity of populations is key to conserving species and highlights the most at-risk populations, thus guiding conservation efforts.

Jeremy FiveCrows; Columbia River Inter-Tribal Fish Commission

Sharing Biological Information Across Generations: Parallels Between Indigenous Knowledge and Genetics for Fisheries Recovery in the Columbia River Basin

Indigenous tribes of the interior Columbia River have developed a mutual relationship with native fishes since time immemorial. However, extensive disruption to the natural ecosystem has occurred as European settlement of North America extended westward to utilize abundant natural resources in ways that conflicted with millennia of indigenous protection. This anthropogenic disturbance has led to dramatic declines in native fish species that are central to tribal cultures, but efforts are underway to enable these fishes and the people that rely upon them to persist for future generations. Here, we describe how pairing indigenous knowledge and western science have been applied to assist with fisheries recovery in the Columbia River. Parallel understanding of information passed across generations is central to this effort, from tribal elders with their historical grasp of the natural ecosystem and fisheries, to molecular genetic approaches that track DNA that is passed from parents to offspring and subsequent generations. Examples are provided that illustrate how both indigenous knowledge and genetic tools have been applied to support fisheries recovery in the Columbia River Basin.

Remote Sensing Session

Wednesday, February 5th, 2025, 9:00 AM – 11:00 AM (PST)

Edgar Rudberg, Ph.D.; Nucleic Sensing Systems

Developing Autonomous eDNA Detection

For nearly four decades, scientists have been developing instruments to measure environmental, biological activity via nucleic acid residues (eDNA/RNA). The underlying promise of this technique is that it can be done without direct observation of the organisms, viruses, or bacteria of concern. The Tracker is the world's only continuous-flow eDNA detection machine invented at the University of Montana. It was designed for onsite field analysis. In this presentation, we will discuss recent advances in multiplex detection (the simultaneous detection of multiple species) and the results of field deployments.

Courtney Zambory; Oregon Department of Fish and Wildlife

Early Predication Method for Native Migratory Fish Presence at Small Culverts

Oregon Fish Passage laws stipulate 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 law. We developed 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 culverts into '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.

Ryan Vandermeulen; NOAA Fisheries

Why on Earth Would We Put Ocean Color Sensors on a Geostationary Weather Satellite?

Satellite remote sensing of ocean color yields a uniquely synoptic vantage point of living and non-living components of the aquatic environment and offers critical insights into ecosystem variability, function, health, and vulnerability. However, data-informed decision making from this data stream remains hindered by several limiting technological factors, e.g. infrequent overpasses, persistent cloud cover, sub-optimal resolution, etc. Recognizing these challenges, the upcoming Geostationary Extended Observations (GeoXO) mission, developed through a partnership between NOAA and NASA, promises to enhance the operational utility of ocean color by conducting these observations from two positions in geostationary orbit using new state of the art hyperspectral radiometric sensors. While it may seem counterintuitive, placing a satellite at over 50 times the distance from our current generation of ocean color sensing satellites and into a geostationary Earth orbit provides a significant advancement in observational capabilities. Launching in 2032, the GeoXO mission represents a long-term investment that the United States is making to create an integrated and dynamic space monitoring system, converging at a cadence and resolution of data designed to better support decision making with ecosystem science. The presentation will offer a detailed examination of the ocean color sensors onboard the future GeoXO platform, as well as highlight NOAA's development of a complementary program to host hyperspectral radiometers onboard NOAA's fleet of ships.