Abstracts of presentations at the Oregon Lakes Association conference
Corvallis, November 15 & 16, 2023

Oregon Reservoirs: Science and Management
Reservoir Biology

Keynote Lecture

Phytoplankton to fish: An ecological exploration of reservoirs

Christina A. Murphy
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Large dams (>15-m height) have long been recognized as having profound implications for aquatic ecosystems. The reservoirs they create alter sediment and nutrient dynamics, change productivity and associated harmful algal blooms, impede fish migrations, and facilitate the establishment of invasive species. They also provide unique opportunities for fish growth and novel food webs. This presentation will discuss 7+ years of reservoir research focused on the ecology of Upper Willamette River Reservoirs in Oregon and highlight lessons learned and knowledge gaps across taxa and trophic levels as well as differences expected when comparing to reservoirs at the same latitude in Maine.

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Linking concepts of adaptive capacity to ESA-listed salmon and steelhead populations in tributaries of the Upper Willamette River with high-head dams

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Adaptive capacity is an emerging concept in climate change science and considers the abilities of biological and human systems to persist in the face of altered environments. Two on-going recovery efforts for ESA-listed species, Upper Willamette Valley Chinook salmon and winter steelhead, translocate adult fish each year above dams without fish passage to spawn. The efforts generate several conservation benefits and management challenges, and we summarize elements of our past work in the context of adaptive capacity and climate impacts. First, trap-and-transport translocation of adults above dams increases adaptive capacity but has been associated with high rates of pre-spawn mortality in several locations, leading to evaluation of alternative protocols to minimize thermal exposure and disease using empirical monitoring and decision support-modeling tools. Second, offspring encounter and must pass reservoirs and dams as juveniles during downstream migration. Surprisingly, many juveniles reside in reservoirs, achieve high growth rates, and express 'novel' reservoir life history pathways that are thought to be associated with higher marine survival. Such life history diversity increases the adaptive capacity of the population depending on how dam structures and operations affect passage survival and life history composition, and we have developed modeling tools to evaluate alternative assumptions and future scenarios. Lastly, a combination of behavior and genetic monitoring revealed a complex metapopulation structure among natural-origin ESA-listed winter steelhead and hatchery-origin summer steelhead above and below dams. Taken together, while dams and reservoirs have strongly negatively impacted native salmonids, several past and on-going efforts have enhanced the adaptive capacity of both ESA-listed species on the current landscape. More broadly, we contend that consideration of adaptive capacity elements and the

connections and feedbacks among physical, biotic, and social system components can enhance mechanistic understanding and identify conservation opportunities under current and future conditions.

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Unexpected Threats: Parasite Infections in Reservoir-rearing Juvenile Chinook Salmon in Willamette Basin Reservoirs

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Juvenile Chinook Salmon hatched above Willamette Valley Project dams often rear in reservoirs and grow significantly larger than their stream rearing counterparts. This is believed to impart a significant survival advantage to juvenile salmon once they reach the ocean. However, we found that these reservoir-rearing juvenile salmon can be severely infected by the ectoparasite *Salmincola californiensis* and a parasitic nematode, *Philonema* spp. We found *S. californiensis* infection rates in upper Willamette Basin reservoirs exceed 80% and *Philonema* infections in 42% of the fish we sampled. There was also evidence of parasite associated host mortality for reservoir-rearing Chinook salmon associated with severe infection loads of both parasite species. Laboratory studies further indicated that gill damage caused by juvenile stages of S. *californiensis* negatively affected the ability of juveniles to osmoregulate when exposed to saltwater up to four months post infection. This suggests that reservoir-rearing salmonids may experience high mortality upon ocean entry. Our results indicate that parasite infections that occur in reservoirs could contribute significantly to population declines of Chinook salmon that rear in these systems.

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Northwestern Pond Turtles in and below Reservoirs: Management and Information Needs.

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There is keen attention being focused on the status and population features of the Northwestern Pond Turtle (*Actinemys marmorata*) because it is now under review for Federal listing as a threatened species. Although we now know a fair amount about its distribution, ecology and status, there is scant information available for populations in reservoirs and only one study of them downstream from dams. Dams create a variety of reservoirs, and those with major level fluctuations appear to have few turtles. Accumulated knowledge suggests a need to create better habitat both in reservoirs and in dam-impacted rivers downstream. Currently there is no overarching active program for habitat restoration for turtles. Recent evidence shows that many turtles live to 20 or more years in the wild, with a few over 55 years of age. This demands a new approach for their protection. Management and recovery plans for populations will need to cover decades, and few of us think on such scales. Given their status, and changing human impacts,

there is a dire need to find and quantify populations and their essential habitat, especially in proximity to reservoirs and dammed rivers.

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Reservoir Management and Monitoring

Keynote Lecture

History and Evolution of Water management at the Willamette Project, OR

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The U.S. Army Corps of Engineers (USACE) operates and maintains a system of 13 dams and reservoirs within the Willamette River basin of northwestern Oregon. Each dam contributes to a water resource management system providing flood risk management, hydroelectric power generation, water quality improvement, irrigation and municipal water supply, recreation, and ecosystem habitat benefits on the Willamette River and many of its tributaries (authorizations). System operations often require balancing across the multiple authorized purposes. Achieving this balance is complex and has changed over the life of the Willamette Project. Often, objectives to support one fish life history, species, or authorized purposes conflict with another. This presentation explores the history and evolution of managing the system with an emphasis on current operations and future plans.

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A time of change for Upper Willamette Valley reservoirs

Brett VandenHeuvel
VandenHeuvel Strategies

It is a time of great change and opportunity for salmon and the Upper Willamette Valley reservoirs.

The U.S. Army Corps of Engineers owns and manages 13 dams in the Upper Willamette Valley in the Middle Fork Willamette River, McKenzie River, South Santiam River, and North Santiam River subbasins. A federal judge ruled that the Corps violated the Endangered Species Act, stating, “Far short of moving towards recovery, the Corps is pushing the UWR Chinook and steelhead even closer to the brink of extinction.” The Court enjoined the Corps to modify operations to promote juvenile salmon outmigration including deeper and longer drawdown for some reservoirs.

The future of hydropower for these dams is uncertain. First, hydropower is uneconomical here. The dams were built primarily for flood control and, according to Bonneville Power Administration, “generate a small amount of power relative to their operating costs.” The Corps predicts that hydropower costs will exceed revenue by a stunning $939 million over the next 30 years under the Corps’ preferred operating system. Second, managing the reservoirs for hydropower is harmful to juvenile salmon.

One solution is for the Corps to prioritize salmon recovery over hydropower. By implementing deep drawdown for significant parts of the year, the Corps can greatly increase juvenile salmon survival and begin to restore the species. The Corps can operate some reservoirs as run-of-the-river to promote juvenile outmigration. Congress can deauthorize hydropower for the dams, which will help the Corps to prioritize salmon, while maintaining flood control protection.

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Biological and environmental studies in Lookout Point Reservoir: a case study highlighting multi-disciplinary research and the need for information synthesis

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Substantial research investments into the ecology of Lookout Point Reservoir (Willamette River Basin, Oregon) have occurred during recent decades and these efforts have provided numerous useful insights for resource management while also revealing additional unknowns. Studies have focused on reservoir use by both endangered native and prolific non-native fish species, food web interactions, thermal ecology, and other factors that contribute to the overall ecology of the reservoir. These studies have lain strong foundation for setting long-term management goals and priorities and have helped provide important ecological context for evaluating new reservoir operations that are currently being implemented. This presentation will provide an overview of the science that has been conducted in the Lookout Point Reservoir as a case study to highlight the need for multi-disciplinary research to improve future management of reservoirs and their ecology. We will also emphasize the need for efforts to synthesize and distill information to increase the usefulness of research investments.

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New USGS Water-Quality Monitor Informs the Timeline of Impacts from a 2023 Harmful Algae Bloom in the Ross Island Lagoon and Downstream Willamette River

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During the 2023 summer, a Harmful Algal Bloom (HAB) developed in Ross Island Lagoon (RIL) and entered the Holgate Channel and Willamette River downstream, spreading cyanotoxins including microcystins that resulted in a recreational use advisory lasting 7 weeks (Aug 9 – Sept 28). Prior to the HAB, a spring diatom bloom of beneficial phytoplankton – diatoms (*Aulacoseira*, *Asterionella*, *Fragilaria*) and green algae (*Pandorina*) – and zooplankton (Cladoceran) grazers – was observed in plankton net tows taken from the river. The bloom occurred a few weeks later than previous summers, likely from much higher-than-average snowpacks in the basin that resulted in high river flows and near-record-low water temperatures through April. This was followed by much higher water temperatures in spring and summer, which culminated in a heat wave and a HAB in RIL. *Microcystis* colonies were first identified in plankton net tows in mid-July, as the river was warming rapidly, reaching 15-year high temperatures in late July. Photos submitted by Ross Island Sand and Gravel in early August showed the HAB forming in the RIL. These visual indicators, supported by Sentinel-2 satellite imagery, were concern enough for the Oregon Health Authority (OHA) to issue a recreational use advisory for the RIL on August 9th. About one week before the bloom entered the Willamette River, spikes in phycocyanin fluorescence were recorded at the USGS continuous water-quality

monitor below the Holgate Channel at the Oregon Museum of Science and Industry (OMSI) dock (USGS 453027122400000). Toward the end of an outgoing tide on August 15th, the HAB began to flush out of RIL – in three waves – sending cyanotoxins downstream into the lower Willamette River. The HAB flushed out in three waves. Surface water temperatures spiked to over 27 degrees Celsius as the warm surface water that had accumulated in the RIL traveled past the monitoring station. Microscopic evaluation of plankton net tow samples that day found *Microcystis*, *Dolichospermum*, and other cyanobacteria at the OMSI dock station. Indicators of photosynthesis revealed an actively growing bloom, with pH registering over 9.5 standard units and 176% dissolved oxygen saturation during the peak emergence of the HAB into the Willamette River. Sentinel-2 satellite imagery on August 15th depicted the movement of this chlorophyll-and-phycocyanin-rich and warm HAB parcel as it spread downstream. Water samples collected by ODEQ on August 16th confirmed microcystin concentrations of 549 parts-per-billion (ppb) within the RIL, far exceeding the 8-ppb OHA recreational use value for microcystins in recreational waters. The microcystin concentration was 184 ppb about 5 miles downstream of the RIL near the Ash Grove Cement Company south of Lindbergh's Beach in northeast Portland. The decision was soon made to extend the recreational use advisory to include the full 8-mile reach in the lower Willamette River from the RIL to Cathedral Park. The bloom lasted for several weeks, but by early September, the bloom showed signs of senescing. Cyanobacteria colonies appeared decrepit, surface scums dissipated, and green algae and diatoms again dominated the phytoplankton assemblage. Cyanotoxin levels declined below advisory levels bringing a close to the event when the advisory was lifted on Sept 28.

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Lakes under Stress

Extreme events: the 2021 heat dome effect on an Oregon coastal lake

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Oregon coastal lakes are a fisheries conundrum. They provide critical rearing habitat for imperiled cold-water coho salmon (Oncorhynchus kisutch), while also hosting populations of invasive, predatory warm-water largemouth bass (Micropterus salmoides). Fish bioenergetic models of the lake environment may help to understand this apparent paradox by characterizing growth potential for each species throughout the year in shallow or deep areas. This research focused on patterns of dissolved oxygen (DO) and temperature at Tahkenitch Lake, Oregon. A railroad piling in one of the deepest areas of the lake was instrumented from April 2021 until May 2022 with dissolved oxygen sensors near the top and bottom, and temperature sensors along a vertical profile. The shoreline was instrumented with temperature sensors. Unexpectedly, this coincided with the 2021 heat dome event. During the heat dome months of June and July, DO in the upper 1.2m of the water column reached minimum, maximum, and average concentrations of 5.98, 10.16, and 8.47 mg L-1, respectively. Water temperatures in the middle of the lake reached a maximum hourly temperature of 23C while air temperature reached a maximum of 31C. However, maximum shoreline hourly water temperatures exceeded 25C. In situ temperature and dissolved oxygen measurements paired with data from nearby weather stations were used to assess temperature stability throughout the water column, to perform preliminary evaluations of the balance of ecosystem-level primary production and respiration, and to parameterize bioenergetic models of coho salmon and largemouth bass growth potential. Preliminary results indicate that Tahkenitch Lake is well-mixed by frequent coastal breezes resulting in similar temperatures throughout the water column, and limited differences in DO between the surface and the bottom. Models showed that growth potential for coho salmon peaked in fall and spring, whereas largemouth bass had a single summer peak.

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Lake Abert: Migratory Bird Population Dynamics at Oregon's Salty Desert Oasis

Haley Tobiason (student)
Oregon Natural Desert Association

Ongoing, long term monitoring efforts of shorebird and waterfowl populations at Oregon's sole hypersaline lake have revealed drastic fluctuations in population dynamics of a myriad of species over the years, likely linked to changes in biotic and abiotic factors at the lake. Lake Abert is a key stopover and oasis for many migratory bird species along the Pacific Flyway due to the abundance of brine shrimp (*Artemia franciscana)* and alkali flies (*Ephydra hians)* as a food source. Drought and extreme saline conditions have historically disrupted the balance and function of this rare ecosystem, and in recent years record low numbers of bird species known to use the lake have been observed, in concurrence with low water levels at the lake. Lake Abert is an endorheic lake, with its only freshwater inflow from the Chewaucan river, which runs through a reservoir directly above Lake Abert and provides water to local ranches. In this presentation, historical and current shorebird and waterfowl population data will be discussed in the context of environmental conditions at Lake Abert, and the need and importance for continued monitoring and conservation efforts of this extraordinary ecosystem will be highlighted.

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Rethinking Laws, Rights of Nature, Roles of Leadership, and Reservoirs as Responses to Drying Lakes

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In a surprising bipartisan effort Sen. Merkley [D-OR], Sen. Rosen [D-NV], Sen. Romney [R-UT]; Sen. Cortez Masto [D-NV], Sen. Wyden [D-OR], and Sen. Feinstein [D-CA] championed the Saline Lake Ecosystems in the Great Basin States Program Act of 2022 (Saline Lakes Act) providing $25 million to the US Geological Survey (USGS) over the next few years to study lakes in the Great Basin. Drying lakes pose an ominous threat to public health and safety in the form of dust. The dry lakebed of California's Owens Lake is the largest single source of dust pollution in the United States. Record snowpack in the western United States spanning the Wasatch Mountains in Utah to the Sierra Nevada in California has temporarily slowed the great drying. The rise in water levels is expected to last only a couple of years. Is this enough time to reevaluate responses to the great desiccation?

Redefining the Waters of the United States (WOTUS) by the Supreme Court of the United States (SCOTUS) in *Sackett v. EPA* reduces the regulatory toolbox to respond to drying lakes. However, the SCOTUS decision may serve as an opportunity to rethink legal, leadership, and engineered responses to drying lakes. This presentation provides an overview of global responses to drying lakes. Earth system law, personhood, corporations, areas of critical concern, property law, water law, water czars, water shepherds, and water engineering are approaches being proposed, individually or collectively, for management of saline lakes and salinization of reservoirs.

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General Lake Science

Making Your Lake Data Shine - Dashboards for Data Visualization and Interpretation in R Shiny

Timothy Clark
Herrera Environmental Consulting

Lake monitoring generates vast and varied datasets vital for informed decision-making. However, these data can often be inaccessible and overwhelming for planners and decision-makers. Thurston County Environmental Health maintains routine monitoring programs for 32 streams and 11 lakes, and in the past, County staff were tasked with writing annual reports each year, updating graphics, and uploading a static PDFs to the web. This was a cumbersome effort and did not leave resource to interpret the findings, merely to present it.
Thurston County contracted Herrera to update their reporting structure, and we developed dynamic dashboards to visualize new and historic data for with just a few clicks. R Shiny can be used to develop interactive dashboards that can be specifically tailored for lake data visualization. The Shiny dashboards can empower stakeholders to analyze data in real-time alongside experts, enhancing understanding and decision-making.
This presentation will discuss the benefits of accessible and interactive data, data dashboard options, and tips for developments.

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The dark underside of floating solar panels: Iterative runs of CE-QUAL-W2 models as an assessment tool for understanding the effects of floating photovoltaic arrays on reservoir limnology

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The development of renewable energy options is a pressing concern worldwide, and solutions that tie into existing power infrastructure and utilize previously disturbed environments are promising. Floating photovoltaic (FPV) arrays on hydroelectric reservoirs meet these criteria and have gained attention as an option that may be more efficient at capturing solar energy than traditional land-based installations. However, there has been limited research understanding of the effects these structures will have on limnological processes. Changes to incoming solar radiation and reduced interaction with surface wind can impact circulation dynamics, thermocline depth, and surface water temperature. In turn, these effects may impact algae growth, dissolved oxygen levels, and fish habitats. To estimate how some of these complex aspects of the reservoir may respond to the installation of such an array, we used the mechanistic modelling software CE-QUAL-W2 to assess how lake processes might change due to large scale FPV. We implemented a routine in R that runs repeated iterations of the same reservoir model with adjustments to shade and wind sheltering variables that relate to FPV arrays of different sizes. We extracted several response variables from each iteration to quantify how the modelled reservoir responds to different array sizes. This assessment was repeated across multiple selected reservoirs that represented a suite of climate conditions, bathymetry, and hydrologic inputs. Consistent decreases in surface water temperature occurred as responses to larger FPV installations across sites. We also observed shifts in stratification and water temperature in the reservoir outlets tied to season, but this pattern was inconsistent across reservoirs. While the results from this work need real-world validation, our models suggest that reservoirs' limnological processes will have unique and important responses to FPV arrays that may warrant further study in light of the growth of this renewable energy resource.

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Paleotemperature, Vegetation Change, Fire History, and Lake Productivity for the Last 14,500 Years at Gold Lake, Oregon, USA

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The postglacial history of vegetation, wildfire, and climate in the Cascade Range (Oregon) is only partly understood. This study uses high-resolution analysis from a 13-meter, 14,500-year sediment core from Gold Lake to reconstruct forest vegetation, fire, and climate using four traditional palaeoecological methods: pollen, charcoal, organic matter variables, and a biological variable chironomid (midges living in the lake). As the response of these proxies differs, this multiproxy approach is vital to have a complete picture of past environments. The occurrence of three tephra layers, including a 78-cm airfall Mazama tephra and highly laminated segments, allows us to study tephra impacts at a fine temporal resolution. This study is the first attempt in Oregon to reconstruct paleotemperature using chironomids.
The high-resolution macroscopic charcoal and pollen analysis reveals minimal variation in pollen spectra during the Late Glacial and Younger Dryas periods. However, the early Holocene shows a sudden increase in *Pseudotsuga*, indicating warmer conditions, while the late Holocene shows an increase in *Tsuga heterophylla* and *Tsuga mertensiana*, suggesting the onset of moist conditions. The charcoal data indicate periods of large fire peaks during the Late Glacial, pre-, and post-Mazama eruption and since 4,000 years ago. Surprisingly, low fire activity is observed during the early Holocene, which contradicts expectations based on regional evidence of warmer and drier summers. The deposition of the Mazama tephra resulted in changes to the non-arboreal pollen composition, while arboreal taxa were minimally affected. The paleotemperature reconstruction reveals variations in taxon richness of chironomids. The reconstructed midge-based mean July air temperature (MJAT) at Gold Lake ranged between 9.4 and 13.2°C, with the Late Glacial period being 2-3°C colder than present. The transition into the early Holocene indicates a temperature increase with MJAT varying between 10.7°C and 13.1°C. The analysis of organic geochemistry reveals variability in δ^{13}Corg and δ^{15}N, reflecting changes in aquatic productivity. The base of the core following deglaciation shows low terrestrial input and high aquatic productivity, while the Holocene warming period is associated with decreased δ^{15}N and increased input from cyanobacteria. The thick Mazama tephra enhances diatom production and subsequent fluctuations in mass accumulation rate. The late Holocene exhibits high aquatic productivity, potentially influenced by increased forest fires and nutrient runoff.

This multiproxy approach significantly contributes to understanding climate change and ecosystem dynamics in the Cascade Range of Oregon based on high-resolution analysis of sediment records from Gold Lake.

Cyanobacterial Harmful Algal Blooms

Five years of monitoring cyanobacteria blooms in lakes and reservoirs of the Upper Deschutes Watershed
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Oregon Department of Environmental Quality

Increasing public concern has directed regulatory agencies in the United States to improve detection and mitigation of toxin-producing cyanobacteria blooms in freshwater ecosystems. In Oregon, state agencies have been working to improve the approach to detecting, monitoring, and informing the public about cyanobacteria blooms. Here we present the results of a five-year study led by the Oregon Department of Environmental Quality monitoring cyanobacteria blooms in lakes and reservoirs of the Upper Deschutes Watershed in central Oregon. We compared *in situ* time series data with data collected by the Sentinel 3 Ocean and Land Colour Instrument (OLCI) to assess how well satellite imagery captured the timing and magnitude of toxin-producing cyanobacteria blooms in a lake with high recreational value. During the springs, summers, and falls of 2019 - 2023, we monitored temperature, dissolved oxygen, chlorophyll *a*, phycocyanin, and pH at 15-minute intervals in several lakes and reservoirs that historically experience cyanobacteria blooms (Odell Lake, Crane Prairie Reservoir, Lake Billy Chinook, and Lava Lake). For comparison, we monitored Crescent Lake, an oligotrophic lake in the same physiographic setting. We acquired corresponding OLCI-derived cyanobacteria cell counts from the US Environmental Protection Agency CyAN project. Satellite derived cyanobacteria cell counts exhibited the similar temporal patterns as water quality data collected in all monitored waterbodies, although satellite data were slightly more variable due to interferences such as cloud cover. Our results suggest that increasing the use of satellite-derived information can help water quality managers improve the timing of public health advisories for blooms of toxin-producing cyanobacteria and help identify lake conditions and watershed factors that trigger blooms.

Assessing HAB Risk Using Explainable AI
Matthew Titus
ClearWater Analytica

Monitoring for harmful algal blooms is relatively expensive and the turnaround time hinders rapid response if cyanotoxins are detected. Therefore low-latency methods of monitoring and prediction are being pursued at local, regional, and federal levels. Recent work with Carollo Engineers and the Water Research Foundation (WRF) attempts to come at the problem using machine learning and multiple modes of data to provide short-term forecasts of cyanobacteria abundance. Our approach uses explainable artificial intelligence (XAI) to predict future HAB risk in a transparent way, displayed in an interactive web tool, so that the end user can interpret and modulate the XAI prediction with their own domain expertise.

Predictive performance of the models is investigated; in addition to out-of-sample validation we investigate the relationship between included predictors, dataset size, and performance. Feature importance of different environmental variables are provided across a number of waterbodies, indicating key drivers of HAB risk in the studied water systems. The relationships between the high-impact predictors and the cyanobacteria population confirm some known relationships and raise new questions. We end by noting source water monitoring practices that would enable further progress in applied ecological modeling.

Proof of concept: Volatile Organic Compounds Reveal Community Composition and Microcystin Contamination

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Toxins produced by cyanobacterial blooms in freshwater lakes are a serious public health problem. The environmental conditions leading to toxin production are unpredictable, thereby requiring expensive sampling and monitoring programs globally. We explored the potential of volatile organic compounds (VOCs) to indicate presence and concentration of a hepatotoxin, microcystin, as well as microbial community composition in Upper Klamath Lake, OR. Among all environmental samples, proton transfer reaction time-of-flight mass spectrometry identified 229 mass values (*m/z+1)* which correspond to unique VOCs. A machine learning based regularized regression, elastic net, selected 29 of the 229 detected values for retention in models predicting microcystin contamination. These models outperformed regression models based only on environmental parameters, including chlorophyll, pH, and temperature. Several mass values selected by elastic net were putatively identified as saturated fatty aldehydes, which defend cyanobacteria against oxidative stress. Elastic net also identified unique sets of mass values that predicted the relative abundance of the dominant bacterial phyla, classes, and cyanobacterial genera. VOCs appear to reveal the physiological status of cyanobacteria during toxic blooms and may be a key component of lake monitoring strategies.

Complete genome sequences of Gloeotrichia echinulata strains from the US Pacific Northwest reveal a species with relatively low genetic diversity

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Gloeotrichia echinulata is a cyanobacterium that commonly forms harmful algal blooms in Oregon lakes and reservoirs. We have completed the first genomes of *Gloeotrichia echinulata,* derived from strains from locations in three watersheds in Oregon and far-northern California: Dexter Reservoir on the Willamette River, Crane Prairie Reservoir on the Deschutes River, and Iron Gate Reservoir on the Klamath River. The three strains have ~99% pairwise average nucleotide identity (ANI) and share >80% of their gene content. They thus represent closely related members of a single species dispersed across a large part of southern Oregon. This contrasts sharply with the high genetic diversity and several species found among *Dolichospermum* in the same region. Gene synteny (the sequential arrangement of genes) and gene content is much more conserved among the *Gloeotrichia* genomes than among

Dolichospermum genomes. Thus, while *Dolichospermum* isolates from the Pacific NW variably include genes for the production of cylindrospermopsin, microcystin, anatoxin-a, geosmin, or none of these, all three *Gloeotrichia* genomes possess geosmin genes but lack cyanotoxin genes.

Posters

Discovery of diverse freshwater picophytoplankton populations using flow cytometry

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As important primary producers, picophytoplankton determine carbon and energy flow in aquatic ecosystems. One type of picophytoplankton, called picocyanobacteria, are known to be dominant in the open ocean but are still poorly understood in freshwater river systems. This project aims to analyze surface water samples taken from the Columbia and Willamette rivers in Portland, Oregon by quantifying and characterizing the microorganism populations present. Flow cytometry was used to detect and analyze cells based on their size and pigment fluorescence. The instrument provided a cell count used to calculate the concentration of cells over a year-long sampling time frame. I discovered seven distinct picophytoplankton populations that were present in both rivers at varying abundances over time. These distinct populations of cells assessed over space and time need to be statistically compared to environmental factors to understand the ecological relationship, thereby determining which populations contribute most to biogeochemical cycling.

Reservoir Management Can Begin at Home

Roger Edwards
Portland Water Bureau, retired

The increasing occurrence of heavy rainstorms has raised the possibility of local flooding in neighborhoods that previously had little concern about this risk. Capturing a portion of these storm waters is an obvious way to address this concern. Placing rain barrels beneath household downspouts is a simple strategy to achieve this goal. A single barrel will have little effect on the potential for flooding but the cumulative result of this tactic could become substantial. An acre-inch of rain contains 27,154 gallons of water so it would take 28 barrels with a capacity of 100 gallons to reduce this volume by 10%.

Household roofs with gutters and downspouts are efficient water collectors. Rain barrels then fill early in any storm and provide water for use later, thereby off-setting the cost of drawing on municipal supplies. The water collected avoids the contamination that comes with overland flow and can be easily disinfected if needed for domestic use. There is still some benefit if the water is just released after a storm. Houses have multiple downspouts, each of which can fill a rain barrel, and overflow can be directed to a serial barrel. Barrels collecting overflow need not be of a size that fit under the eaves. Rain barrels are gravity flow devices that don’t need the engineering design for excavation and pumping that cisterns require.

There are numerous rain barrels available commercially if a garbage can or 50 gallon barrel are deemed inappropriate. Key features include a drain at the bottom, mid-level, and for overflow; a capture inlet that can be adapted to filter out particulates; a barrel diameter that will fit under the house eaves, and an easy way to dump residual contents for periodic cleaning.