PRESENTATION ABSTRACTS
OLA/WALPA Conference, Portland, OR, October 9-11, 2024

Abstracts are in alphabetical order of surname of the presenting author (**shown in bold**).
Oral presentations followed by poster presentations.
Student presenting authors are shown in bold red.

Oral Presentations

Norman Buccola[1], Theo Dreher[2], and Kurt Carpenter[3]
[1]Portland District U.S. Army Corps of Engineers, [2]Oregon State University, [3]U.S. Geological Survey Oregon Water Science Center

Investigating Cyanotoxin Drivers in Detroit Lake, Oregon

Lakes and reservoirs that are the primary source of municipal drinking water have been increasingly impacted by cyanobacterial harmful algal blooms (CyanoHABs) in recent decades. Detroit Lake (Oregon, U.S.) is a large reservoir (57 ha, up to 104 m deep) managed by the U.S. Army Corps of Engineers with an extensive, relatively undeveloped water catchment. In 2018, a CyanoHAB occurred in Detroit Lake, Oregon and resulted in cyanotoxins moving out of the reservoir and down the Santiam River, exposing the City of Salem and several smaller drinking water facilities to levels of cyanotoxin that exceeded the Oregon Health Authority (OHA) advisory thresholds. Dam operations were immediately adapted to minimize the downstream conveyance of cyanotoxins. However, questions remain about the pre-cursors and key drivers leading up to the 2018 event and what combination of conditions (i.e., meteorology, dam operations) might be best approached with informed caution in the future. A long-term monitoring dataset including phytoplankton (predominantly *Dolichospermum sp.* abundance), cyanotoxins (cylindrospermopsin and microcystin), meteorology, hydrology, and dam operations collected in Detroit Lake 2010-2022 were harmonized to weekly averages and analyzed using machine-learning techniques (RandomForest) to better understand key drivers and inter-annual variation for cyanotoxins. Statistical analysis has shown that lower inflow, lake elevation, and spillway flow coincided with *Dolichospermum* growth, while calmer wind conditions and the lack of non-prevailing wind events in recent years coincided with a shift from cylindrospermopsin to microcystin algal toxin production.

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Marisa Burghdoff[1], Shannon Farrant[2], Jennifer Oden[1], Shannon Brattebo[3]
[1]Snohomish County, [2]City of Lake Stevens, [3]Tetra Tech

Lake Stevens - A Restoration Journey

For nearly three decades, Snohomish County and the City of Lake Stevens have collaborated to restore and maintain the health of Lake Stevens. Lake Stevens is the largest lake in Snohomish County, WA located in the heart of the city with its namesake. The problems began back in the 1970’s and 80’s when the lake suffered from nuisance algal blooms that disrupted recreation. This talk will walk you through the lake’s restoration journey starting with the efforts to understand the sources of phosphorus fueling the algal blooms. The story continues with the 1994 installation of a hypolimnetic aeration system (the world’s largest at the time) and the science and costs that led to its eventual decommission and replacement with small alum treatments. The talk will conclude by sharing the findings of a 2022 study analyzing the efficacy of three-decade restoration effort and the next steps for the lake. Overall the study concludes that the restoration effort has been highly effective including significant improvements in water quality, an improved biological community and most importantly, a lake that is safe for lake residents and visitors keeping it a premier destination for lake recreation.

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Sarah Burnet, University of Idaho, US Army Corps of Engineers and Frank Wilhelm, University of Idaho

Synthesizing 35 years of water quality data from Willow Creek Reservoir, OR

Long-term ecological data allows us to examine complex functions and dynamics (drivers, resilience to disturbance recovery time, interactions among components etc.) and potentially contribute to ecosystem management. The value of long-term data increases proportional to the length of the period of collection when done systematically. Willow Creek Reservoir (WCR), located in the high desert of northeast Oregon, was constructed in 1983 for flood control and recreational purposes, but now also serves as an irrigation supply for agriculture. Because WCR is the only water body within a 60-mile radius, it is important for recreation including boating, kayaking, fishing, and swimming. However, it also suffers from annual blooms of harmful algae (HABs) that are typically toxic and result in no contact advisories. Limnological data (biological, chemical, and physical parameters) have been collected from WCR since 1984, offering a rich data set to explore potential causes of the blooms. Here we offer a partial analysis of this data set to show that HABs are linked most strongly to imbalances of the N:P ratio.

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John P. Buster, Aaron C. Pelly, and Sarah S. Roley

Estimating Decomposition Rates of Water Stargrass (Heteranthera dubia), A Potential N Sink in a Lowland Agricultural River

In streams, most nitrogen (N) removal occurs via assimilatory uptake, which results in the temporary removal of N. In some rivers, aquatic plants dominate N uptake and assimilation. In such rivers, aquatic plant decomposition rates and resultant N release influences N loads to downstream waterbodies. However, decomposition rates of aquatic plants are relatively unknown as most aquatic decomposition studies focus on allochthonous, terrestrial sources. We measured water stargrass (*Heteranthera dubia*, WSG) breakdown rates (-k) in the lower Yakima River (Washington, USA), where WSG grows across most of the channel width and heavily influences reach-scale metabolism and N uptake. We packed WSG in mesh bags then deployed six replicates each in coarse sediments (CS) and fine sediments (FS), which allowed us to determine if decomposition rates varied by substrate. Each replicate had five mesh bags of WSG, and we removed one bag per replicate each week for five weeks. We dried, then ground each sample to a fine powder, combusted a subsample in a muffle furnace at 550°C, then calculated the ash-free dry mass (AFDM) of each sample. We then regressed the natural log of percent AFDM remaining. The resulting slope provided the breakdown rate (-k) of WSG. We evaluated breakdown rates for coarse (CS -k = $0.0110 \pm 0.0021\ d^{-1}$, range: $0.0041, 0.0182\ d^{-1}$) and fine (FS -

k = 0.0158±0.0040 d^{-1}, range: 0.0076, 0.0296 d^{-1}) sediments, which revealed that there was no meaningful difference between groups, $t(10) = -1.0766$, $p = 0.307$, 95% CI [-0.014773, 0.005148]. Interestingly, WSG had a slower -k compared to some terrestrial litter and many aquatic plant decomposition rates. Our preliminary results revealed that some aquatic plants might decompose slower than some allochthonous litter, resulting in a gradual release of assimilated N to downstream aquatic systems.

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Ben Casscles, Bradley Roth and Terry McNNabb, Aquatechnex, and Ryan Van Goethem, EutroPHIX

Mitigating External and Internal Phosphorus Loading on Moses Lake, WA

EutroPHIX and AquaTechnex LLC. implemented a large-scale phosphorus mitigation project in 2024 on Moses Lake, WA to improve water quality and start addressing internal loading of phosphorus. One project component was mitigating soluble phosphorus loading from Rocky Ford Creek into the northern section of the lake utilizing an automated EutroSORB® WC injection system. The other project component was mitigating sediment phosphorus on 2000 acres in the northern section of the lake with application of EutroSORB® G (10% lanthanum modified bentonite). We also collected twice monthly samples for water column nutrients and algae communities. Sediment phosphorus fractionations of surficial sediments are being assessed pre and post treatment. We will be presenting an overview of implementation and results to date from monitoring parameters. The results from this project will be used to guide further short and long-term investments for water quality restoration.

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Tim Clark, Herrera Environmental Consultants

A Spatial Screening Model for Identifying Priority Road Segments for Managing a Toxic Tire Chemical (6PPD-q)

In 2020, researchers in the Pacific Northwest identified 6PPD-q as the cause of urban runoff mortality syndrome (URMS), a phenomenon that had been mysteriously killing coho salmon for decades. Research into the presence, toxicity, and treatment of this chemical is still emerging, but regulations are imminent in Washington State and likely coming in other states.

King County and Herrera Environmental Consultants have developed an expert knowledge-based spatial model that classifies road segments by the relative expected amount of 6PPD-q delivered to the stormwater network. The model output is a cumulative score for each road segment across King County based on high-influence factors, including traffic intensity, types of vehicles, and the connectedness to the stormwater network. Output from this spatial model will be combined with additional spatial information, like nearby salmon habitat and known water quality impairments, to prioritize which road segments need treatment first and identify opportunities for multi-benefit projects. The components of this model are easily transferable to areas outside King County and these tools are all open-source and available online for audience members to explore after the presentation.

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Curtis DeGasperi, King County Water and Land Resources Division, Seattle, WA

Decreasing Fecal Indicator Bacteria in Lake Union and the Lake Washington Ship Canal

Environmental and public health officials have long recognized that pathogens in the surface waters of Lake Union/Ship Canal pose a risk to people who swim or play in the water. Waterborne pathogens are difficult to measure directly, so we typically monitor nonpathogenic FIB (e.g., fecal coliform, *Escherichia coli*), which are more easily detected and quantified. The occurrence of elevated bacteria levels in Lake Union/Ship Canal is due in part to the occurrence of combined sewer overflows (CSOs), but stormwater is also a source of bacteria inputs. FIB concentrations decreased significantly from 1980 to 2021. Decreasing FIB concentrations since the 1980s are likely due to progress in CSO control and improvements in stormwater management. However, for reasons that will be explained in this presentation, it is not possible to determine the relative contribution of these management measures to the observed decreases in indicator bacteria.

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Theo Dreher[1], Connie Bozarth[1], Kurt Carpenter[2], Norman Buccola[3]
[1]Oregon State University, [2]US Geological Survey and [3]US Army Corps of Engineers

Two species of *Dolichospermum* Define the Cylindrospermopsin and Microcystin Toxicity in Detroit Reservoir, OR

Two toxin-producing *Dolichospermum* strains have been significant presences in Detroit Reservoir over the last decade: *Dolichospermum* sp. DET69, which produces 7-epi-cylindrospermopsin, and *Dolichospermum* sp. DET73, which produces the [Dha7]MC-HtyR congener of microcystin. Genetic analyses from 2011-12, 2015-18 and 2019 support the hypothesis that the toxin profile in Detroit Reservoir is determined by these two *Dolichospermum* strains. Nontoxigenic *Aphanizomenon flos-aquae* and *Gloeotrichia echinulata* can also form blooms in the reservoir, and there is evidence of other Nostocales cyanobacteria that have to date been minor components but may have the potential to bloom in the future. We describe a shift in the toxin profile in Detroit Reservoir over the period 2011-2022 that we ascribe to changes in the populations of *Dolichospermum* sp. DET69 and *Dolichospermum* sp. DET73.

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McKenzie Frazier, Gretchen Rollwagen-Bollens and Stephen Bollens, Washington State University (Vancouver)

Assessing Differences in Phytoplankton and Microzooplankton Community Structure Between Detroit Lake and Bonneville Reservoir

Plankton form the basis of the aquatic food web and are known to be influenced by abiotic and biotic factors. Planktonic trophic structure is strongly associated with organism size and taxonomic composition, and this structure may vary seasonally as well as by the type of freshwater environment in question (e.g. lentic or lotic). As the primary producers in pelagic systems, phytoplankton communities in temperate freshwater environments often show a seasonal cycle, with springtime diatom blooms followed by mid-to-late summer communities dominated by green algae and cyanobacteria. Similarly, microzooplankton communities (e.g.

heterotrophic ciliates, dinoflagellates and small rotifers) may also follow seasonal patterns of abundance and composition that likely relate to their phytoplankton prey. In both cases, these seasonal variations may be influenced by environmental characteristics of the ecosystem. Many rivers in the Columbia River Basin are impounded to produce reservoir systems where water residence times, temperature, and nutrient concentrations may vary substantially, and thereby may differentially impact plankton community structure. As part of a larger project to measure the impact of microzooplankton community grazing on phytoplankton growth in Detroit Lake in the North Santiam River (storage dam) vs. Bonneville Reservoir in the lower Columbia River (run-of-river dam) from May to October 2023, we are also characterizing the abundance and composition of phytoplankton and microzooplankton communities in both reservoirs. Preliminary results indicate that taxa within these phytoplankton communities, such as diatoms, differ in their abundance between months, with *Cyclotella* being dominant in Detroit Lake in May then switching to *Asterionella* dominance in June, and between reservoirs, with Bonneville displaying a diverse community composition in both months and Detroit being dominated by mainly one taxon. This might suggest that because of these differing environmental and management characteristics, planktonic taxa are more abundance or diverse at different times of the season in these reservoirs.

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Emily V. French, Michael T. Brett, Curtis L. DeGasperi, Jeremy T. Walls, University of Washington

The King County Conundrum. Statistical Analysis of Long-Term Trends in Water Quality throughout Streams in King County, WA.

Since 1980, the population of King County, WA has almost doubled. Conventional knowledge would predict a corresponding decline in water quality due to increased anthropogenic impacts. It is, however, unclear if this is now the case. The King County Dept of Natural Resources and Parks has conducted a routine monitoring program for almost 5 decades, sampling 75 streams and rivers in the county. The program has compiled an exceptional database of stream water quality records, representing a wide variety of land cover types and stream sizes. This presents a unique opportunity to analyze long-term trends in water quality and identify potential drivers of change, especially in lower order streams. A statistical analysis of various water quality parameters was conducted, including nutrients, fecal bacteria, alkalinity, pH, and dissolved oxygen. The first analysis was of the overall distribution of trends in recent years versus their historic levels. Some parameters have decreased in most streams from their long-term averages, such as both dissolved and total nutrients, fecal coliform, and total suspended solids. Others, like turbidity, conductivity, pH, and temperature have increased in most streams. Despite relationships to previous parameters, dissolved oxygen and alkalinity showed no clear trend in either direction. Next, recent data was fit to statistical models that relate each parameter to the proportions of developed and other land cover types in each site's drainage basin. A few parameters exhibited strong a correlation, namely phosphate, alkalinity, and conductivity. Conversely dissolved oxygen, nitrate, and TSS had weak relationships with any land cover type. Finally, seasonal patterns in the monthly data were examined. Most parameters exhibited a strong overall relationship with the wet and dry seasons, though individual years and locations varied widely.

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Crysta A. Gantz[1] and Angela L. Strecker[2]
[1]Portland State University, Portland, OR
[2]Western Washington University, Bellingham, WA

Monitoring Change Over Time Through Paleolimnological Reconstruction of Cultural Eutrophication and Recovery in Medical Lake, WA

Because of the unique geophysical properties of lakes, paleolimnological techniques can be used to gather data from lake sediments on abiotic and biotic changes over time. Variables representing physical, chemical, and biological processes are effectively archived chronologically in lake sediments. Our objective was to investigate sediment total phosphorus changes over time, from periods of historical eutrophication through restoration attempts over the past three decades. We focus on Medical Lake in Washington state, which has a c. 150-year documented history of human development. The lake became eutrophic over time due to the lack of a municipal sewage system prior to 1964; the city relied upon septic tanks for waste disposal, which led to seepage into the lake. In the late 1980s, aeration treatments were successful in restoring water quality. A sediment core was collected from Medical Lake and submitted to an independent laboratory for 210Pb dating to determine a timeframe for sediment deposition. These analyses determined that sediment deposition occurred relatively slowly, with a depth of c. 12 cm corresponding to modern colonization of the region. Total phosphorus analysis of an additional sediment core revealed an increase in sediment phosphorus beginning with modern settlement and peaking prior to the institution of modern sanitation. A marked decrease of total phosphorus corresponds with mitigation methods (e.g., alum treatments, aeration). Additional investigation of *Daphnia* egg distribution in sediment revealed changes in density corresponding to patterns of eutrophication. This analysis provides a framework for understanding how management actions have impacted lake recovery over time.

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Joan Hardy[1], Rob Plotnikoff[1], and Gopal Mulukutla[2]
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Unmanned Aerial Vehicle (UAV) Surveys of Harmful Algal Blooms

Unmanned Aerial Vehicles (UAVs) or drones are an effective tool for monitoring harmful algal blooms (HABs) over large water bodies, particularly in observing the gradual growth of algae that is hard to observe from the shoreline. This project investigated whether UAV monitoring could improve estimates of HAB size and duration to increase understanding of best management practices. Specifically, Cottage, Echo and Marcel lakes, King County, Washington, were sampled weekly from late July to late September 2022, for water quality and toxicity during drone surveys to enable linkage of visual assessment with toxicity. A drone pilot flew UAVs in transects using a DJI Air2S. Maps were stitched using freeware GNU Image Manipulation Program (Version 2.10.34) then examined for their hyperspectral signature. While no toxic blooms were reported, we determined the importance of factors associated with aerial photographs such as flight height, time of day, wind impact, sun reflection, and availability of reference points for stitching.

In 2023, we responded to bloom reports in Cottage and Echo lakes before deploying UAVs. Additionally, each of the four sample dates were aligned with flyover of one of two satellites from the Sentinel-2 constellation, whose multispectral imagery data product can be used to

estimate water quality measures. Signatures of chlorophyll-a, turbidity and phycocyanin were estimated from satellite data. Initial analyses of drone imagery indicate chlorophyll-a as the best performing indicator for the presence of heavy scum. While UAVs are useful in tracking surface blooms, we do not recommend incorporating county-wide weekly monitoring due to pilot and sampling costs. Instead, agency staff (instead of a consulting pilot) or lake volunteers could deploy UAVs to identify blooms in hard-to reach areas of a lake. Further, stitching photographs should be limited to shorelines known to have aggregation of HABs in place of whole-lake images using UAV transects.

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Will Hobbs and Shawn Ultican, Washington State Department of Ecology

Panel on Lake Alum Treatments

We are assembling several lightning talks with a discussion panel to follow. We envision inviting 3-4 conference registrants to speak on topics around lake alum treatments, including: pre-and post-monitoring, experiences on what makes a ‘successful’ treatment, and thoughts on possible negative ecosystem impacts. This session will provide information to those considering alum treatments and assist the Washington State Department of Ecology in further refining the permitting work with lake associations, applicators and consultants. Currently, Ecology requires a permit for the use of Alum (and lanthanum-based treatments), which has some monitoring requirements associated with it. This permit will be revised in 2026. Ultimately, the goal of the permit for in-lake treatments is to ensure effective restoration while preventing impacts to other components of the ecosystem.

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Todd Jarvis, Institute for Water & Watersheds, Oregon State University

Gaming the Grit: Societal Engineering in the era of Drying Lakes and the Dust Bowl Apocalypse

A new model of engineering, societal engineering, connects the fundamentals of engineering to other professions to improve the quality of life in all segments of society. Drying lakes such as the Aral Sea, the Great Salt Lake, and more locally at Lake Abert and Summer Lake in southeastern Oregon, are important stops for migrating waterfowl and related ecotourism. Dry lake beds are looming ecological disasters with dust pollution causing "white rain" events in Portland, changes in timing of snow melt that disrupts the ski industry and agricultural water rights in Utah, to requiring billions of dollars in engineered dust control measures at Owens Lake in California. Serious games are useful societal engineering tools which provide realistic virtual environments where society attempts to simultaneously “juggle” growing food, fiber, and fun, sustain the environment, and make a profit. Can a serious game slow the looming dust bowl apocalypse in southeastern Oregon?

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Bill Mann, In-Situ Inc. Fort Collins, CO

How Algae Sensors Work

Algae sensors are pivotal in understanding the complex mysteries of aquatic ecosystems, leveraging the fluorescence emitted by algae for insightful scientific analysis. However, it is essential to note that not all algae sensors operate identically! These sensors employ diverse methodologies that provide interesting perspectives on the unique characteristics of algal communities. By discerning the distinct signatures of chlorophyll, phycocyanin, and phycoerythrin, these sensors offer great insight into the dynamics of aquatic ecosystems. Through the integration of advanced optics and other technological features, alga sensors furnish real time monitoring and predictive capabilities, driving advancements in lake and environmental management.

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Jess Mitchell, Steve Bollens and Gretchen Rollwagen-Bollens, WSU Vancouver

Effects of Reservoir Type (Run-of-River vs. Storage) on Native and Invasive Zooplankton Assemblages

Impoundments (i.e., dams and their resulting reservoirs) hydrologically alter riverine systems by lengthening water residence time and altering water quality. Zooplankton are vital primary and secondary consumers in these systems and are an important prey base for the economically and ecologically important salmonids of the Pacific Northwest. Previous studies from our lab have determined that zooplankton assemblage structure is linked to seasonality and water quality, specifically in the Lower Columbia. Our recently funded NSF (DISES-DAMS) project aims to determine the ways that run-of-river and storage reservoirs differ ecologically from one another, including how zooplankton i) assemblage structure, ii) seasonality, and iii) presence of invasive species differ between reservoir type. We are therefore undertaking a two-year field effort of four impoundments within the Columbia River Basin, including both run-of-river (Bonneville, The Dalles) and storage (Cougar, Detroit) reservoirs. Triplicate zooplankton samples were collected at each site bimonthly, along with surface water quality data, and the collected specimens were identified to the lowest feasible taxon (typically species). One year into our sampling effort, non-metric multidimensional scaling (NMDS) ordination and PERMANOVA results indicate that variation in zooplankton assemblage is significantly different between reservoirs and months, with temperature and conductivity being significant factors explaining community composition. Additionally, absolute seasonal abundance patterns are evident, with generally higher total abundance occurring in the summer months. Finally, invasive zooplankton taxa (e.g., the copepod *Pseudodiaptomus forbesi*) have been observed in the two run-of-river reservoirs, but not in the two storage reservoirs.

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Gopal Mulukutla[1], Violette Lafferty[1], Josh Heinlen[1], Rhonda Harris[2], Joan Hardy[3], James Gawel[1], Emese Hadnagy[1]
[1]University of Washington Tacoma, [2]Green River College, [3]Lake Advocates

Remote Sensing as a Tool to Understand Harmful Algal Blooms in Western Washington Lakes

The use of satellite remote sensing to assess lake water quality has shown to be a valuable tool for water resource managers, public health jurisdictions and the public in general. However, in regions like Western Washington it can be challenging with its often cloudy and wet weather, widely varying characteristics of lakes, and complex terrain. This work describes steps taken towards operationalizing the use of satellite remote sensing by evaluating four water quality indicators: chlorophyll-a, turbidity, phycocyanin, and temperature extracted from multispectral satellite imagery. Data from two satellite constellations – Landsat and Sentinel-2 – is used to evaluate the performance of the underlying water quality index extraction algorithms using a mix of historical and targeted water quality measurements in King, Pierce and Snohomish County lakes. We discuss the results of analyses comparing different statistical measures (lake-wide averages, point measurements, limited radius average measurements etc.) of the satellite water quality indicators, how they compare to in situ water quality measurements and how they vary with various lake geophysical and water quality measures (lake size, volume, trophic status etc.). We expect that these results will be of interest to resource managers and the public health community for planning water quality improvement and climate change resilient mitigation measures and that they will help inform the development of statistical models to quantify the risk of bloom emergence.

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Brooke Penaluna, Pacific Northwest Research Station, USDA Forest Service

Exploring Freshwater Biodiversity with eDNA

Global freshwater biodiversity is in crisis and there has been a recent call to action to develop methods to better assess the current state of biodiversity globally. Until recently standard methods to assess biodiversity in freshwaters included netting or electrofishing for animals and often of one species and taxon limiting our understanding of a full community assessment. Another method that is gaining interest in the science community is environmental DNA or eDNA, which looks for genetic material shed by living organisms in the environment, including in water. In this keynote, we will learn about the latest eDNA research and how it provides insights into the presence and diversity of fishes, amphibians, mammals, macroinvertebrates, and pathogens in rivers, reservoirs, lakes, and streams.

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Toni Pennington, Environmental Science Associates (ESA) and Lars W.J. Anderson, Tahoe Keys Property Owners Consultant

Sequential Use of Multiple Methods to Control of Aquatic Weeds in the Tahoe Keys, South Lake Tahoe, CA

In 2022 a three-year “Control Methods Test” (CMT) project began in the Tahoe Keys lagoons in South Lake Tahoe, CA. The purpose of the CMT is to determine the effectiveness of several non-herbicide methods as a follow up approach to controls achieved from a one-time application (Year 1 only) of Endothall (dipotassium salt) and Triclopyr TEA (triethylamine salt) to manage the aquatic invasive plants (AIP) Potamogeton crispus, Myriophyllum spicatum, and Ceratophyllum demersum. The non-herbicide (Group B) methods included: UV-C light, bottom barriers, and Diver Assisted Suction Harvesting (DASH). Extensive monitoring was required to determine effects on water quality and efficacy of the herbicide and the non-herbicide methods. Herbicide treatments resulted in control of the target AIPs and left native *Elodea canadensis* largely unaffected. Continued reduction of most targeted AIP previously treated with herbicide was observed in 2023, compared to control sites. UV-C treatments in 2022 and 2023 were also effective. Group B methods used in 2023 in small areas within the original treatment sites successfully reduced AIP in most sites when compared to control sites and when compared to AIP outside the Group B treatment areas. However, movement of *C. demersum* into the DASH and UV-C spot treatment areas somewhat countered the utility of these methods. Bottom barriers were effective while in place, but upon removal in the fall (2023) some areas were encroached by *C. demersum*, and some had sprouted P. crispus turions. In 2024 (the last planned year of the CMT), Group B methods will be continued along with extensive monitoring of AIPs and water quality parameters.

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Katey Queen and Angela Strecker, IWS, Western Washington University

Terrestrial Carbon Linkages to Aquatic Communities Following the 1980 Mount St. Helens Eruption

Ponds created by the 1980 Mount St. Helens volcanic eruption are in early successional stages, characterized by limited nutrient availability and the slow reestablishment of coniferous forests. These ponds are predominantly surrounded by deciduous vegetation. As the forest develops and climate change warms the region, an increase in terrestrial organic carbon in water bodies, known as brownification, is expected to alter pond habitats. Zooplankton communities may experience significant habitat and resource changes due to the anticipated shift from deciduous to coniferous vegetation. Our study examines the variability of terrestrial influences across 12 ponds within the debris-avalanche region, focusing on the impact of deciduous and coniferous vegetation on zooplankton community assemblages, dissolved organic carbon (DOC), and dissolved oxygen (DO) levels. Ponds in the Hummocks and Maratta regions were sampled once in July and August to assess zooplankton communities (abundance, biomass, richness) and trends in temperature, dissolved oxygen, pH, and nutrients. Our findings indicate that ponds with higher terrestrial vegetation generally exhibit increased DOC concentrations. We observed that increased tree vegetation, particularly alder, contributes to higher DOC levels, leading to lower DO concentrations. This relationship underscores the significant role of early successional vegetation in shaping the biogeochemical dynamics of these unique aquatic ecosystems. Studying these ponds' current carbon quantity and qualities can fill a knowledge gap in understanding terrestrial-aquatic ecosystem linkages undergoing early succession and experiencing stress from climate change. The early successional landscape provides insight into zooplankton community structure and function amidst predicted forest turnover and brownification, elucidating the connection between the two systems.
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Jacob Rose, Center for Lakes & Reservoirs, Portland State University

Prioritizing Early Detection Work for Aquatic Nuisance Species

The early detection of aquatic nuisance species (ANS) is crucial for maintaining the health of our aquatic ecosystems and protecting access for recreation. However, water managers across the state have limited resources to go out and search each individual water body for the variety of problematic introduced plants and animals. My research focuses on identifying and prioritizing water bodies across Oregon for targeted early detection efforts. This approach prioritizes water bodies that 1) have habitat suitable for select ANS, 2) are near known populations of ANS, and 3) provide a home to rare native species.

My work at Portland State University's Center for Lakes & Reservoirs (CLR) adapts and applies methodology from the New York Natural Heritage Program (NYNHP). NYNHP's methods rely on datasets which are specific to the northeast and assess each water body in New York. In my analysis for Oregon, I target water bodies included in the Oregon State Marine Board Boater Survey and incorporate other, regionally-specific datasets. Both analyses rely on invasive species data from iMapInvasives and iNaturalist, rare species data from NatureServe's Biotics, and habitat suitability models. While research is ongoing, the early findings of this research are significant for Oregon as they offer a strategic approach to sampling for and managing ANS threats more efficiently. By focusing early detection efforts on the most at-risk water bodies, we can improve our chances of preventing the establishment and spread of invasive species, thereby preserving the ecological integrity of Oregon's lakes and rivers. This presentation will detail the methodology used in the prioritization process, highlight key preliminary findings, and discuss implications for future ANS management strategies. Attendees will come away with a better understanding of how to allocate resources for early detection work as well as a systematic approach to justifying where to survey.

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Megan Skinner, U.S. Fish and Wildlife Service

Cyanotoxins in Upper Klamath Lake, Oregon

Upper Klamath Lake (UKL) is a large, shallow, and hypereutrophic freshwater lake in southern Oregon, USA. Although there is evidence that UKL was historically eutrophic, changes in numerous water quality parameters indicate a shift to hypereutrophy during the early 20th century. Simultaneously, cyanobacteria were observed in UKL for the first time. By the 1960s, annual phytoplankton blooms were described as an *Aphanizomenon flos-aquae* (AFA) "monoculture." Cyanobacterial blooms typically begin in UKL in late spring or early summer and persist through the fall. The cyanotoxin microcystin (MC) has been detected as early as mid-May in shallow areas and bays of UKL, with recreational advisories following shortly after. Despite the presence of cyanobacteria genera capable of producing a wide range of cyanotoxins, UKL was only routinely monitored for MC. In 2021, MC, cylindrospermopsin, anatoxin-a, and saxitoxin were detected in nearby waterbodies receiving UKL water for irrigation purposes. Additionally, a 2023 synoptic Solid Phase Adsorption Toxin Tracking (SPATT) monitoring effort resulted in the first consistent detections of anatoxin-a in UKL. In 2024, U.S. Fish and Wildlife Service and the Oregon Department of Environmental Quality will collaborate on a simultaneous SPATT and water sample monitoring effort for multiple cyanotoxins in UKL. This oral presentation reports the findings of this collaborative monitoring effort, which will inform conservation efforts to benefit numerous natural, cultural, subsistence, and economic resources associated with UKL.

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David Scheirman, Birch Bay Village Community Club Association

Integrating Diverse Resources to Better Understand and Manage the Aquatic Ecology of Water Bodies in a Private Community

Birch Bay Village (BBV) is a community in the northwest corner of Washington State's Whatcom County with 1,129 private lots and shared common areas including a golf course and five parks. It was established and developed around a coastal estuary in the 1960's on what were once traditional fishing grounds for the Semiahmoo Straits Salish band of First Nations people. BBV includes saltwater tidelands, a freshwater creek, and a private 250-slip marina. There are also two freshwater impoundment ponds each exceeding 13 acres in size, a connected series of shallow golf course ponds, and a village-maintained stormwater drainage system that receives surface and overland runoff from county-maintained ditches and culverts.

The current lakes and ponds management plan was created with information obtained during the 2022 WALPA conference (Richland, WA). This support included over one dozen professional contacts who each graciously reviewed the community's general situation and helped the Birch Bay Village team establish an effective path towards resolving several issues of concern. To address recent challenges related to unwanted aquatic plants growth and harmful algal blooms, this effort has integrated the work of industry specialists, government agencies, industry service providers, professional staff and resident volunteers. This program has enabled the community to suppress algal blooms, develop a better knowledge base about the existing legacy population of imported grass carp (*Ctenoparyngodon idella*), establish metrics for a consistent water testing regimen, and properly apply calibrated amounts of available treatment compounds. To date these coordinated efforts have enabled the community to reach its goal of a less eutrophic state for its water bodies.

This presentation highlights the broad range of actions taken and resources applied to achieve this goal. It is hoped the information presented may enable other communities, organizations and locations that have similar challenges in these areas to benefit from the lessons learned.
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Ty Stephenson[1], Angela Strecker[1], Ashley Rawhouser[2], Hugh Anthony[2], Carmen Archambault[1,2], Rebecca Lofgren[3], John Boetsch[4], Kristen Bonebrake[4], Katherine Braun[4]
[1]Western Washington University, Institute for Watershed Studies; [2]North Cascades National Park; [3]Mount Rainier National Park, [4]North Coast and Cascades Network, National Parks Service

Non-Native Fish Removal: Macroinvertebrate Community Response in Historically Fishless Mountain Lakes

Mountain lakes are unique ecosystems globally. It has been estimated that 95% of lakes have been stocked with non-native trout in the western US. Aquatic food webs in these lakes are often topped with amphibians and predatory macroinvertebrates and can harbor a diverse assemblage of aquatic macroinvertebrates. Introduced fish drastically alter the community structure of the lakes, often eliminating amphibians and certain groups of conspicuous macroinvertebrates. We hypothesize that the proportion of macroinvertebrates with traits that make them more conspicuous will increase following fish removal, as well as the overall species richness. Over the past 20 years, Mount Rainier and North Cascades National Parks have used rotenone and gill netting to remove fish from select mountain lakes. From 2009-2015, samples were collected in

several mountain lakes before fish removal and for multiple years after fish removal to monitor the response of benthic macroinvertebrate assemblages. We observed shifts in community composition in terms of relative proportion of functional groups, following fish removal. Additionally, we observed that some orders of macroinvertebrates took several years to establish in some lakes. Introduced salmonids to fishless mountain lakes have significant impacts upon the community structure of the lakes. Thus, it's important to understand how and to what extent the macroinvertebrate community changes across different lakes following fish removal for best management of these unique environments.
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Katie Sweeney and Tim Clark, Herrera Environmental Consultants

A Lake That Flows Both Ways Part 2: The Implementation Game

Vancouver Lake is a eutrophic lake in southwest Washington state primarily nourished by its outlet. At WALPA 2023, we shared the story of Vancouver Lake in "A Lake That Flows Both Ways", which chronicled the many challenges in managing this dynamic lake, and shared our innovative solutions to those challenges.

In the 2023 Vancouver Lake Management Plan (VLMP), we recommended: 1) flushing channel enlargement to substantially increase Columbia River inflow and reduce HAB formation; 2) enhancing existing watershed programs; 3) low-dose alum treatments for near-term HAB prevention; 4) targeted algaecide treatments to prevent health risks and beach closures; 5) herbicide treatments targeting specific noxious weeds; and 6) water quality monitoring and AIS prevention programs.

In a whirlwind of a year, Vancouver Lake restoration is off to a running start! Championed again by local lake advocates, a second appropriation from the state legislature was awarded to implement the Plan's recommended management strategies. In this second phase, Herrera Environmental returns to Vancouver Lake with partners new and old to 1) develop a special use district governance structure for lake management and funding; 2) implement a Beach Management Plan including the targeted use of algaecide to minimize near-term risks to public health; 3) design flushing channel enhancements and alternatives; and 4) update and refine the linked hydrodynamic (HEC-RAS 2D) and water quality (WASP) model to further inform the feasibility of alternatives.

We're excited to return to OLA-WALPA in 2024 to share the early successes and challenges of this next phase of Vancouver Lake restoration.

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Jeffrey Tepper[1], Kyle Steelhammer[2], and Don Russell[3]
[1]University of Puget Sound, [2]Northwest Aquatic Management, [3]City of Lakewood Lake Monitoring Program

A Lake-Scale Test of Using Zero Valent Iron for Mitigation of Hazardous Algal Blooms, Lake Steilacoom, Washington

We present results of using zero valent iron (ZVI) to control HAB at Lake Steilacoom (320 acres, Z avg. = 11 feet, Z max. ~20 feet) in Lakewood, WA. The lake, formed in 1853 by damming of its outflow stream, is fed by groundwater springs and surface inflow from Ponce de Leon and Clover Creeks and has ~6 months residence time. Internal P loading is believed to be less important than external as both water inputs have high SRP (up to 50 ppb), which has led to frequent seasonal HAB and in some instances lake closures after September 1. This year, as an alternative to repeated algicide applications, the lake is being treated with ZVI in a two phase process.

In Phase 1 coarse (325 μm) ZVI was applied to groundwater spring areas with the goal of sequestering P at the point of entry to the lake. Data to assess the efficacy of this approach are not yet available but there is a noticeable lack of algae on the lake bottom in areas where the ZVI was applied. Phase 2 entails three steps: (1) biweekly monitoring of Secchi depth and algal populations to identify an impending bloom, followed by (2) algicide application, followed 2-3 weeks later by (3) application of ZVI to bind SRP in the water column released by algal decomposition. We are evaluating two ZVI products (30-45μm), applying one to each lake basin, with dosages calculated on the basis of basin volume, an assumed SRP of 40 ppb, and ZVI uptake capacities measured experimentally on samples from the inflow stream. ZVI application occured in mid-August and if successful should eliminate the need for late summer/early fall algicide treatments.

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Jacob Utrie, CD3 General Benefit Corporation

Online Boater Led Check-In/Check-Out AIS Prevention Tool

Due to the high cost of high pressure, heated water decontamination, reducing the spread of aquatic invasive species (AIS) often relies upon the adoption of best management practices at the individual level. An important driver of that adoption is AIS outreach and education. This presentation will outline a case study of a free digital AIS prevention engagement tool to educate boaters on hand cleaning different types of watercraft and trailers. In addition, the presentation will go over the biological efficacy for doing so.

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Ryan Van Goethem, Scott Shuler, and Byran Fuhrmann, EutroPHIX

Advancing Lab Analysis of Sediments for Phosphorus Mitigation in Lakes

Lake sediments are often sampled and analyzed during development of lake management plans and phosphorus (P) mitigation strategies. Key questions we often want to address are the amount of P, what is P bound to, releasability and burial dynamics, and spatial heterogeneity within a waterbody. There are many physical and biogeochemical processes that impact the availability of phosphorus in sediments and performance of P mitigation methods. EutroPHIX has been working to advance sediment analysis approaches by analyzing a novel assemblage of sediment parameters and creating calculated indices (SePRO Level 3 Phosphorus Fractionation, patent pending). Parameters include detailed phosphorus fractionation and parameters related to sediment diffusion, iron and redox P release, organic P release, aluminum and pH release, organic P burial, and stable mineral formation. This sediment analysis approach allows for 1) more complete interpretation how phosphorus is released, processed, or buried, 2) selecting P sequestration methods and calculating dosing, 3) consider spatially heterogeneity and 4) tracking changes through time after water quality improvements. Utilizing this advanced analysis in combination with increased sampling efforts allows for better characterization of lake sediments for lake management and P mitigation programs.

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Scott A. Wells, Department of Civil and Environmental Engineering, Portland State University

Conceptual Model for Taste and Odor Compounds in Lakes and Reservoirs

Taste and Odor compounds include the volatile compounds 2-Methylisoborneol (MIB) and geosmin (GSM). Oxylipins and Polyunsaturated fatty acids (PUFA) derivatives have also been associated with taste and odor problems. Both cyanobacteria (planktonic and benthic) and Actinobacteria (aerobic, filamentous, spore-producing bacteria that thrive in an environment with high concentrations of organic compounds) are the primary producers of taste-and-odor compounds such as MIB and GSM. Oxylipins are produced by most algae groups, but only a few cyanobacteria groups.

As a result of climate change, some reservoirs used for municipal water supply are experiencing a rise in taste and odor volatile compounds. This study was an attempt to develop a conceptual model of these volatile organic compounds improving on earlier studies. The model is dependent on modeling cyanobacteria and other algae groups as well as Actinobacteria. The results of the conceptual model are presented and will be incorporated into more complex water quality models for lakes and reservoirs.

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Oxygen Saturation Technology for HAB Control in Washington Lakes

Rob Zisette, Timothy Clark, and Katie Sweeney, Herrera Environmental Consultants

Oxygen Saturation Technology (OST) is a relatively new type of hypolimnetic oxygenation system that pumps pure oxygen from an onshore generator to a device at the bottom of the deepest point in the lake where water is supersaturated with oxygen and injected back into the hypolimnion. OST systems can maintain dissolved oxygen levels as high as 20 mg/L directly over and into the sediments to efficiently bind iron with orthophosphate and reduce internal phosphorus loading at a lower cost than traditional aeration and oxygenation systems. For three small lakes in western Washington, we have recommended OST systems for long-term control of harmful algal blooms (HABs) over phosphorus inactivation by alum or lanthanum treatments because they are less expensive and more sustainable. We are presently designing and permitting an OST system for Spanaway Lake, which we expect to be the first OST system in Washington. For two other lakes, we recommended other techniques for HAB control due to various factors unique to those lakes. This presentation will compare internal phosphorus loading estimates and HAB control recommendations for five cyanobacteria management plans recently prepared for lakes in Washington.

Posters

Zoe Chavis, Oregon State University

Sensitivity and Uncertainty of Parameters in Cyanobacteria Models

As land use and climate change continue to evolve, harmful cyanobacterial blooms (HCBs) have been increasing in severity and frequency, with important environmental and human health impacts. Impacts include the public health threat posed by the production of toxins, anoxic conditions induced from the decay of dead algae, and economic loss associated with treating the degraded water quality, decreased recreational activity, and the closure of fisheries. Models of algal dynamics are essential to developing mitigation strategies for HCBs, but they are subject to fundamental uncertainties. Uncertainties arise as a result of data collection, model algorithms, parameterization of key variables, and/or model calibration. Often, complex dynamics are simplified in water quality model algorithms, and these simplifications must be evaluated in order to understand their effect on key water quality outputs. Errors in model results can translate to substantial economic costs of failed mitigation projects, policies that fail to protect human health, and degraded ecosystems. Therefore, the broad goal of this study is to quantify the relative uncertainty of algal biomass and chlorophyll a (chl a) production due to the uncertainty in the parameterization of algal kinetic rates, and parameters related to temperature, light, and nutrient availability. More specifically, this study aims to conduct a sensitivity analysis of a hydrodynamic water quality model (CE-QUAL-W2) with the objective to: 1) evaluate the relative sensitivity of total cyanobacteria biomass, chl a, dissolved oxygen, and pH to parameterization of algal kinetic rates, nutrient recycling functions, and particulate organic matter and dissolved organic matter decay rates; 2) estimate error associated with default and literature constants in algae parameters in representing local conditions being simulated by the model, and; 3) identify how limnological conditions impact error from algae parameters.
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Pilar Deniston and Angela Strecker, Institute for Watershed Studies at Western Washington University

Assessing the Efficacy of the Washington Ban on Phosphorus Fertilizer

Freshwater lakes are essential ecosystems, providing crucial services for humans, plants, and animals. However, eutrophication poses a significant threat to lake health and water quality. To mitigate excess phosphorus and eutrophication, many states, including Washington, have implemented bans on phosphorus-containing fertilizers. Our study evaluates the efficacy of Washington State's 2013 phosphorus-containing fertilizer ban, focusing on 47 lakes in western Washington. Our study organized, filtered, and analyzed data from multiple counties' monitoring programs to examine total phosphorus concentrations before and after the ban. To address additional sources of phosphorus, our study also examined land use changes and precipitation. Finally, Secchi disk and chlorophyll-a measurements were analyzed to provide insight into the relationship between water clarity, algae, and nutrients. Preliminary analyses suggest that following the ban, significant reductions in total phosphorus were observed when assessing periods of 4 to 9 years before and after the ban; however, the effect lessens over longer periods (>9 years). The results showed that while there is a negative relationship between land cover changes and phosphorus concentrations, it is not significant, suggesting other factors may

influence total phosphorus concentration. Although water clarity showed little to no relationship with total phosphorus, chlorophyll-a concentrations closely mirrored total phosphorus concentrations. While the phosphorus-containing fertilizer ban has shown promise in some areas, its effectiveness varies across time and requires further investigation. Future research should explore additional factors like public awareness campaigns, septic systems, and land use changes that influence lake phosphorus concentrations and should consider broader implications for freshwater ecosystem management.
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Danny Gibson[a], Jay Ewing[b], and Samuel B. Fey[a]
[a] Reed College, Department of Biology
[b] Reed College, Department of Physics

A Design for a Mesocosm Array to Simulate Thermally Variable Pond Environments

Temporal and spatial variability in temperature are key habitat features that have important implications for the ability of organisms and populations to persist amid global climate change. Diel and seasonal temperature fluctuations mediate the impacts of transitory extreme heat and cold events on organisms while also giving phenological cues. Meanwhile, spatial variation in temperature can provide thermal refuges that allow organisms to avoid physiologically stressful conditions. While numerous laboratory and mesocosm studies have addressed the impacts of fixed temperature increases on aquatic populations and communities, few have investigated the role of temperature variability in mediating the impacts of climate warming and other stressors. To address these questions, new tools are needed to produce and control thermal variability in an experimental context. Here, we present a design for a mesocosm array to simulate pond environments with different magnitudes of spatial and temporal temperature variability. We fitted 75-liter LDPE trash cans with two band heaters each, positioned on the upper and lower sections of the can, which are operated independently. The mesocosms are controlled with a programmable logic controller (PLC) that receives input from thermocouples and modulates heater power based on a PID algorithm. An assessment of the setup indicated that the mesocosms are capable of simulating a hot (at least 35 °C), stratified pond environment with inter-unit variability generally <1 °C. We were able to produce a vertical temperature gradient of up to 12.4 °C across 54 cm of water depth, as well as diel fluctuations of up to 12.2 °C in the surface water layer. The mesocosms' ability to simulate these relatively extreme conditions demonstrates their utility for ecological experiments that seek to manipulate vertical stratification and/or diel fluctuations. We also demonstrate the feasibility of using the mesocosms for other applications, including ramping experiments and constant temperature increases, in order to assess key physiological thresholds and ecological rates.
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John A Harrison, Stephen M. Bollens, Michael Brady, Kirti Rajagopalan, Gretchen Rollwagen-Bollens, and Jon Yoder, Washington State University, Vancouver

Dynamics of Integrated Socio-Environmental Systems: Dams as Adaptive Management Systems (DISES: DAMS)

Dams and reservoirs are ubiquitous, widely used to improve human well-being, a key player in regional and global biogeochemical and ecosystem dynamics, and rapidly increasing in number and influence. Further, dam and reservoir management decisions can have unintended environmental consequences that, in-turn, have the potential to influence dam and reservoir management. The Dynamics of Integrated Socio-Environmental Systems, Dams as Adaptive Management Systems (DISES DAMS) project, a new, multi-year, National Science Foundation-funded project based at Washington State University will use a convergence research approach to achieve an integrated understanding of the dynamic, reciprocal relationship between environmental and social (institutions and values) systems by examining dam and reservoir operations, the decision-making process governing those operations, and feedbacks between this decision-making process and the environment. Through a suite of coordinated field-based measurements in focal Pacific Northwest reservoir systems, mining of available data, and consultations with a community of stakeholders, we are addressing the overarching question: Under what conditions are individuals, groups, and institutions likely to follow rules "to the letter" versus exercising discretion or making new rules? The DAMS project will use reservoir water management as a test-case to understand how the environment and society interact to shape rule-following, rule-reformulation and discretionary behaviors, and how, in-turn, these behaviors affect reservoir greenhouse gas emissions, water quality, harmful algal blooms, and aquatic invasive species. In pursuing these goals, this project will generate fundamental new knowledge about how environmental conditions affect environmental management, and, in-turn, how resource management decisions affect environmental conditions. This poster will elaborate on project goals, early results, and planned activities.

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Harrison Jones, **Miranda Kubek**, Naoyuki Ochiai, and Samuel B. Fey
Reed College, Department of Biology

Investigating Environmental Controls on the Growth and Toxin Production of *N. Pruniforme*

Nostoc pruniforme is a photosynthetic, nitrogen-fixing cyanobacterium which forms large spherical colonies in the benthos of nutrient-poor alpine lakes and streams. These colonies consist of an outer layer of photosynthetic and nitrogen-fixing cells with a watery, gel-based interior. While predominantly reported in the Arctic, a rare documented non-polar population exists in Oregon's Mare's Egg Spring. Despite *N. pruniforme*'s importance as a nitrogen fixing species, the impacts of light availability on colony metabolism and toxin production are poorly understood. This is of particular concern for the Oregon population, which may be at elevated risk of light competition from runoff-caused limnetic algal blooms. To understand the implications of light availability for *N. pruniforme*, we incubated colonies with varying levels of light inhibition (in the form of mesh covering their enclosures) and measured responses in their photosynthetic O_2 production, nitrogen fixation rates, and microcystin levels over five weeks. We also employed fluorescence microscopy to relate data to colony structures. O_2 levels were characterized with an injectable PreSens O_2 probe inserted at 1mm, 10mm, and 20mm below the colony surface. N fixation levels were measured by proxy at the end of the study using an acetylene reduction assay. Toxin production before and after treatment was measured with an ELISA targeting microcystins. In colonies subjected to light inhibition, photosynthetic O_2 production sharply decreased at 1mm and 10mm, while N fixation rates only weakly correlated to treatments. Microcystin production was not related to light availability, but was higher in damaged colonies. Microscopic analysis suggested photosynthetic cells concentrate between

1mm-10mm below the colony surface, elucidating the response observed in that range. Microscopy also provided unexpected insight into colony development, from which we propose a model for the growth of new *N. pruniforme* colonies from the surface of established colonies.
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Violette Lafferty and Josh Heinlen, University of Washington Tacoma

Predicting Algae Blooms by Remote Sensing in Washington Lakes

Efficiently monitoring harmful algal blooms (HABs) in lakes is essential for the safety of recreational users. HABs are indicated by high concentrations of phycocyanin, the photosynthetic pigment of cyanobacteria. Cyanobacteria produce cyanotoxins which can be deadly to humans and animals at high concentrations. To monitor these blooms in a cost-effective, timely manner, a remote method is needed that will allow public health agencies to predict algae blooms without a physical visit to the lakes. Traditional methods of monitoring these blooms involve physical sampling and laboratory analysis which can be time consuming and costly resulting in less frequent monitoring. Our research aims to test the use of remote sensing data, consisting of multispectral imagery from the Sentinel-2 satellite, to estimate temperature, chlorophyll-a, turbidity, and phycocyanin levels in Washington lakes over 30 acres in size. Remote sensing allows for continuous monitoring of lakes which delivers a larger spectrum of data to help estimate upcoming potential HABs. We report here our comparison of satellite data with *in situ* chlorophyll and turbidity measurements in Snohomish and Pierce County lakes to examine the agreement between the two data sources. These results will ultimately be used to create an index based on satellite data to estimate lake water quality more efficiently, which can be used by the WA Department of Health to communicate potential health risks to the public to ensure the safety of lake users.

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Baxter Millsap, Northwest Youth Corps/Americorps, Wesley Noone, Lawrence Ashton& Kevin Weldon, Bureau of Land Management, Prineville District Office, Prineville, OR

Restoring Oregon Spotted Frog Habitat: Satellite Data as a Tool to Monitor Oxbow Hydrology in Floodplains of the Little Deschutes River

The Oregon spotted frog (*Rana pretiosa*) is endemic to the Pacific Northwest and was listed under the ESA as threatened in 2014. Its critical habitat includes seasonal wetland areas, such as oxbows around the Little Deschutes River, near Lapine, Oregon. Oregon spotted frogs rely on these habitats to provide the vegetative and hydrologic conditions associated with egg-laying sites during the breeding season, typically between April and June. We propose adaptive management and habitat restoration to maintain and expand high quality breeding habitats to promote local recovery of the Oregon spotted frog. Many commo methods in observation and data collection to monitor aquatic habitats may be insufficient regarding time and cost, which leads land managers to explore alternative options. Here, we identify an application of the Wetland Evaluation Tool (Donnelly 2022; Western U.S. beta version 2.4) as a tool to monitor oxbow hydrology in Oregon spotted frog critical habitat. We compare the results of satellite imagery to pressure transducer data collected through traditional in situ methods of data collection. Our results indicate that the overall utility and context provided by satellite imagery may provide a useful tool as land managers search for efficient and cost-effective methods to monitor outcomes of restoration and adaptive management. We present the utilization of satellite imagery to inform and create management solutions further benefiting the Oregon spotted frog and many other species.

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Nathaniel Neal, Stephen Bollens and Gretchen Rollwagen-Bollens, Washington State University (Vancouver), Alexa Maine, Confederated Tribes of the Umatilla, Tim Counihan, United States Geological Survey

Distribution, abundance, and ecological associations of the Western Ridged Mussel (*Gonidea angulata*), Western Pearlshell (*Margaritifera falcata*), and Asian Clam (*Corbicula fluminea*) in the Columbia River Basin, USA.

Freshwater mussels are keystone species and ecosystem engineers in aquatic systems and are culturally important “First Foods” to many Native American tribes. Global freshwater mussel populations are in a state of decline due to anthropogenic effects, habitat loss, and invasive species, among other factors. Three freshwater bivalves are of particular interest in the Columbia River Basin, USA: the Western Ridged Mussel (*Gonidea angulata*) and Western Pearlshell (*Margaritifera falcata*), both native to the region, and the invasive Asian clam (*Corbicula fluminea*). To better understand the distribution and abundance of these bivalves, we conducted 50-m snorkel surveys at 68 study reaches and collected a range of environmental variables over a single field season in summer 2023. We assessed ecological associations through Poisson generalized linear mixed-effects models for bivalve live counts and binomial generalized linear models for bivalve species occupancy. We employed an information-theoretic approach to construct a set of 24 models representative of alternative hypotheses based on a literature review that includes null, univariate, and multivariate models. The models were compared via Akaike Information Criterion adjusted for small sample size (AICc). In preliminary analysis, *Corbicula fluminea* occupancy models indicated pH, 1991-2020 mean annual air temperature (°C), and water temperature (°C) as explanatory values. *Margaritifera falcata* occupancy was best explained by mean depth (cm), mean substrate size (mm), and *Gonidea angulata* presence. *Gonidea angulata* occupancy and variation in the live bivalve counts were best explained by the global model, which included all nine environmental variables. The strength of the global model indicates the necessity of additional sampling in summer 2024 to increase our sample sizes, which will likely bolster explanatory value of our statistical analyses. Nevertheless, preliminary conclusions already provide insights into bivalve management and interspecific pressures both between native mussels and regarding invasive clams.

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Kunal Rathore and James Watson, Oregon State University

Predicting rate of unreported exogeneous nutrients contributing lake eutrophication using hybrid ML model

Monitoring and forecasting the ecosystem states is a critical task for effective management of natural resources. However, a) the involvement of unknown or unreported quantities of infiltration such as sewage wastewater into a water body adds difficulties to effectively forecast the eutrophic state of the system; b) the inherent complexity of the system, characterized by

interacting components and feedback mechanisms, limits the prediction abilities of traditional parametric modeling techniques (Franke et al., 1999). Hence our primary goal is to efficiently predict the unreported amount of exogenous discharge into the lake ecosystem and thereafter forecast the state of algal concentrations.

To address these limitations, we develop a novel hybrid approach that combines parametric modeling with machine learning techniques to predict the quantities of interest (Rackauckas et al., 2020). We use a known mechanistic model which simulates the effects of nutrient discharge into a lake ecosystem. We reverse engineer this problem, by treating the input discharge as an unknown quantity. Provided the current state of the system and learned model, it becomes feasible to predict unknown discharge and forecast the future eutrophic state of the system. Our approach uses machine learning to capture the effects of environmental variability, states (e.g., detritus content, dissolved oxygen, nutrients, zooplanktons, and algal concentration) and species interactions by employing known functional form of the system.

We assessed our model using data sets simulated from a eutrophication model (Misra, 2007). Our hybrid machine learning approach outperformed standard parametric models at forecasting and predicting the unknown discharge rate. Our findings demonstrate that combining flexible machine learning models with prior information about a system's structure can improve forecasting for ecosystems with unknown quantities, specifically advantageous in systems with complex interactions. With this advanced hybrid model, we also aim to augment our capability to predict Harmful Algal Bloom (HAB) events.

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David R. Sherrod

Excel Spreadsheet Equivalent of Appendix B, Atlas of Oregon Lakes

The *Atlas of Oregon Lakes* (1985, 317 p.) has long been the gold standard for basic lake data. It’s the type of book many of us retain on our reference shelf even in a time when printed books are dismissed in favor of online data sources.

Online, however, there is no match for the all-in-one-place tabular data found in the Atlas’s appendix B. Basin characteristics, water chemistry, trophic state—all this information is arranged alphabetically for the 202 lakes discussed in the Atlas. But using this data for comparative purposes is stalled owing to its printed format. If the appendix B data were offered in spreadsheet manner (flat file), it would be easy to sort by any of the parameters in the database, such as lake area or volume, conductivity, or county, or geomorphic province.

Is Waldo Lake the most pure of Oregon’s lakes? If using conductivity as a guide, then a few other High Cascades lakes are as pure or more so, although the values are so low (4-5 μS/cm) as to be irresolvable if wishing to crown a champion. Are you giving a campfire talk at Cove

Palisade State Park and wish to know where Lake Billy Chinook stands, by volume, among the Oregon lakes? It's No. 12, and it and the ten larger lakes (exclusive of Crater Lake), would only amass about one-half the volume of No. 1, Crater Lake. The campfire audience might be interested. These and other natural-history questions are easy to resolve when querying appendix B in spreadsheet format. My poster presentation is to make available, to any interested persons, the Appendix B data (spreadsheet) and a metadata file (pdf file), as attachment to email enquiries.

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Sasha Vinogradova, Riley McElroy, Jim Gawel, University of Washington Tacoma

Using Lanthanum Modified Bentonite to Immobilize Arsenic in Lake Sediments

Human activities such as smelting, mining, and pesticide use increase arsenic concentrations in lake sediments and aquatic biota. Subsequently, this increases human exposure to arsenic and human health risks, including cancer, through ingestion of contaminated species and nearshore activities. Arsenic exposure has been found to be much greater in contaminated shallow urban lakes, making a case for the need to identify cost-effective remediation strategies. One proposed method for reducing arsenic in the water column uses lanthanum-modified bentonite (LMB), an approved treatment used to remove phosphorus. Due to the similar chemical properties of phosphorus and arsenic, LMB was previously tested for arsenic removal in laboratory studies. Our goal was to test the efficacy of LMB for arsenic removal in an in situ lake experiment. We deployed duplicate mesocosms having two different concentrations of lanthanum (La) modified bentonite (EutroSORB G, with a 10% La concentration by weight) and a control in Lake Killarney, WA, and then added periphyton samplers and seeded the mesocosms with Chinese mystery snails gathered from the lake. We collected water samples from each mesocosm June-September 2024 and recorded temperature, dissolved oxygen, pH, and conductivity. The water samples from surface and near bottom will be analyzed for arsenic and phosphorus. At the end of the treatment period, we will collect phytoplankton, periphyton, and snails to examine the effect of LMB treatment on arsenic uptake in aquatic biota. We hypothesize that LMB treatment will lower concentrations of arsenic and decrease human and ecosystem health risks.