2024

Water@UW–MADISON

Art & Science Poster Session

Presenters & abstracts

Water@UW-Madison Fall Art & Science Poster Session

Wisconsin Insitute for Discovery

November 11, 2024

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Presenters & abstracts

Listed in order of department and poster number

Krogmeier, Claudia

Water Color

Filmed with an underwater go-pro and liquid food coloring, "Water Color" video art was created to be beautiful and colorful during 2020 and has since been displayed in public across the Midwest. It can be viewed here: https://vimeo.com/506904331

Follow the QR to view the video.

Individual

Randle, Leo

Sitting Without Leaning Forward

My work is a black and white photograph of lake Mendota extremely zoomed in on a patch of moss, to the point of which it almost looks like ambient art. It is unmistakably water though. The photograph is suspended by film negative brackets, so that portions of the image are extremely in focus while others parts are blurred. It represents a turning point in my relationship with a good friend.

Individual

Johnson, Hailey

Green Sea

Green Sea is a multi-layered wood cut reduction print. The print is rendered in color gradients. Green Sea was inspired by how water can be a wide variety of colors and shades depending on the conditions of water. I chose the color green to help represent the presence of algae and other forms of life in water that normally are not represented directly. Green sea utilizes shades of pthalo green and different shades of blue to help create a cohesively colored that invokes the liveliness of water.

Individual

Ataei Ardestani, Baran

Relentless Waves of Tormenting Memories

For most of the survivors, memories of assault become obscured, altered, and repressed over time, a kind of defense mechanism over the trauma. But it resurfaces with various moments in life; each time they recall, they may bring different details and emotions. In my artistic process, I represent my own emotional struggles arising from revisiting my childhood photographs and recovering those repressed memories.

In my recent work, Relentless Waves of Tormenting Memories, I depict the process of fighting the memories and healing from them by confronting them constantly. I actively erase the aggressor's presence in each image, but despite this useless effort, his shadow persists, and the memories of trauma continue to hurt me like a wave hitting the shore. I print on delicate paper to reflect my fragility and vulnerability when recalling these moments. However, through this repeated confrontation, the process gradually becomes empowering. This repeated engagement allows me to gradually weaken his hold on me, like the slow, steady erosion of waves against a rock. Healing may be a slow process, but it becomes possible through this ongoing confrontation with my past.

I depict this dichotomy of hurting and healing by using water. Water, as an element that can be healing or threatening, sometimes pictures the intense and often destructive emotions coming from reminiscence, and sometimes is a cleanser of pain. The projection of water onto semi-transparent and delicate paper creates a blurry and changing effect which allows viewers to see through the layers, but the image is never fully sharp. This duality symbolizes the tension between remembering and repressing memories.

Eventually, the memory of assault remains and drowns me, but water washes away my soul, then heals, and continually helps me to move forward. Through my art, I aim to create a space where the viewer can engage with their own memories, find empowerment in confronting their past, and see that even in the face of immense pain, there is the potential for healing and strength.

Individual, Inter/cross/trans disciplinary

Choy, Peggy

Dreams of the Abandoned Daughter: A Dance Film About the Climate Crisis

I will exhibit a publicity poster for my new dance film, "Dreams of the Abandoned Daughter"--about the Climate Crisis, and also show a brief video "teaser" about the film. The dance film is inspired by an ancient Korean myth of Princess Bari (Barigongju), the Goddess of the Underworld. Infant Bari's abandonment is re-imagined by Choy in a world of social and environmental crisis, a story that speaks to an ancient past as well as to our troubling present. Princess Bari is the 4th girl to be in the palace. Hoping for a male heir, the King and Queen order that the newborn be left in a forest to die. She survives as a forager and hunter. Following her longing to go to her kingdom, she faces the brutal urban crisis—having to kill or be killed. Unbeknownst to Bari, the Mycelia--the branching thread-like filaments that form fungal networks in the soil and countless living things--protect her from death. They carry her down into earth, their astonishing micro-biome. Barigongju and the Mycelia concoct a medicine that she takes back to the palace amidst worsening chaos, not knowing if she will be welcomed or again rejected. The film dance story is danced by 6 dancers cross-trained in Asian and African diasporic dance, Hip Hop dance styles, and martial arts.

Individual

Shatara, Fuad

Fuad Shatara, Azul Kothari, Saurabh Gupta, James Rice, Kiyoko Yokota, Nimish Pujara, Erica Majumder

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Influence of Microplastics on Cyanobacterial Growth and Transport

The increase in agricultural and urban runoff contributes to Harmful Algal Bloom (HAB) formation in the Great Lakes and nearby water systems by stimulating growth of HAB causing species with nutrient and pollutant inputs. Microplastic pollutants are being detected at increasing concentrations in this runoff and downstream in lakes and surrounding watershed. The direct effect of microplastic pollutants on HAB formation, toxin production and transport are largely unknown. Statistical Design of Experiments was used to elucidate microbe-plastic interactions in vitro, using cyanobacteria isolates obtained from a HAB event in Lake Erie. This experiment measured the impact of differing sizes, concentrations, and UV-ageing times of polyethylene, polypropylene, and cellulose fibers on the chlorophyll-a content of Anabaena variabilis and Microcystis aeruginosa and microcystin-LR content in M. aeruginosa. Results suggested that polymer type and size decreased chlorophyll content over the course of four weeks. These results were inverse for polypropylene polymers which underwent photooxidation prior to inoculation. Members of each of these microbial communities displayed adhesion to the polymers during this study. Using a novel sampling device capable of filtering microplastics >100 µm in size, water was filtered from the near shore of Lake Superior to enrich the particle bound community. Ongoing work studies the influences of adhesion of cyanobacteria and other lake isolates to microplastics, including the impact on fate and transportation of the microplastic bound community.

Inter/cross/trans disciplinary

Chatman, Chamia

Chamia Chatman, Erica Majumder

Exposure of agricultural chemicals disrupts chicken cecal microbiome

Humans and livestock are constantly exposed to numerous contaminants in our environment simultaneously. However, there is a lack of effective predictions of health outcomes from subjection to that exposome specifically on the gut microbiome. We identified a frequently co-occurring set of agricultural chemicals detected in Wisconsin groundwater that is used for drinking water from private wells and for rearing livestock. We hypothesized that cecal microbiomes exposed to nitrate, atrazine and imidacloprid would result in perturbations to the cecal microbiome. We assessed the synergistic effects of pairs of these chemicals on broiler chicken cecal microbiome samples using checkerboard assays which indicated that combinations of 10 µg/mL of imidacloprid + 10 µg/mL atrazine and 10 µg/mL atrazine + 1.25 µg/mL of nitrate causes the greatest growth inhibition. We then exposed Caco-2 cells to this mixture which revealed that an equipotent agricultural chemical mixture did not lead to decreased cell viability after 24 h. This suggests that long-term exposure to this complex mixture of agricultural chemicals will lead to adverse health effects to the livestock microbiome.

Individual

Pettinger, Catherine

C. Pettinger, C. Harris, E. Majumder

Source identification of fat, oil, and grease in the Madison Metropolitan Sewerage District

Fat, oil, and grease (FOG) accumulation in the Madison Metropolitan Sewerage District (MMSD) causes ongoing maintenance costs to remove FOG. MMSD maintains hundreds of miles of sewer pipe and 65 pumping stations that transport more than 13 billion gallons of wastewater annually. We have worked in close collaboration with our community partner MMSD on source identification through fatty acid source tracking and microbial source tracking. Our laboratory has performed fatty acid extractions and identification from across the sewerage district and note a wide variety of profiles especially in percentage of fats that are myristic, palmitic, stearic, oleic, and linoleic. This indicates different sources which we are actively comparing against potential FOG sources e.g. meat, dairy, and vegetable oils to reveal potential sources. We also are comparing microbial populations at various sites in the sewers where FOG accumulates e.g. pumping stations, air release valves, and grease traps. These microbial communities were noted to be most similar to each other based on location within the sewer (i.e. air release valve versus pumping station), suggesting that different sources may influence eventual fate of fatty acids and FOG accumulation. Our results are pointing to certain sources of the FOG causing the clogs. This will direct MMSD educational prevention materials towards FOG sources that cause the most issues within the region.

Collaborative, Community-driven, Conducted in partnership with external groups

Olawumi, Ruth

Ruth Olawumi, Darren Henrichs

Developing An In Situ Method for Microplastic Detection and Quantification

Since the discovery of plastic fragments in the ocean, researchers have been using methods like Fourier-Transform Infrared Spectroscopy or Raman Spectroscopy to learn more about them. Current methods for imaging these particles have several limitations like requiring human interference and only being used in a lab setting so this project explores using Imaging FlowCytobots (IFCBs), which do not have these limitations, for the same purpose. Use of the IFCB for imaging coupled with a trained machine learning approach will be used to identify and quantify microplastics in seawater samples. Microplastic concentrations will be compared at different depths of the water column and in the incoming versus outgoing tide.

Microplastic samples were created in a lab and were run through the IFCB to create a training dataset for a machine learning model that would be used to identify microplastics in the field. 151,263 images of 129 categories of phytoplankton and one category of plastic were used to train the model to 91.7% after 160 training cycles were ran. Training has currently ceased to prevent over-fitting but can resume if the model is observed to be insufficiently trained.

When plastics are not properly disposed of, natural processes, such as exposure to sunlight, weathering, or wind, break them down into pieces small enough for accidental consumption, inhalation, and absorption into skin. When they inevitably end up in the human body, they have been proven to cause disruption to endocrine function, hinder gastrointestinal processes, and cause other adverse health effects.

Individual, Inter/cross/trans disciplinary

McAfee, Bennett

Bennett McAfee, Robert Ladwig, Abhilash Neog, Arka Daw, Cayelan Carey, Anuj Karpatne, and Paul Hanson

Unraveling Temporal Dynamics of Lake Water Quality with Modular Compositional Learning

Water quality is integral to lakes' ecosystem services but very challenging to predict due to the complexity of lakes at multiple spatial and temporal scales. Lake metabolism, the balance of primary production and respiration within the ecosystem, is a critical ecosystem-scale process driving essential water quality metrics, such as oxygen availability, organic matter turnover, and water clarity. Additional fluxes of oxygen and organic matter including atmospheric exchange and matter transport are also included in quantifying lake metabolism. Due to the modular design of process-based metabolism models, they are well suited to modular compositional learning (MCL). In the MCL methodology, uncertain process descriptions in process-based modules can be surrogated by machine learning modules to improve overall performance. By comparing the performance of different combinations of process-based and machine learning modules, we can gain a greater understanding of the dynamics of the associated ecosystem processes. We have created an MCL model coupling lake physics and metabolism to model dynamics of dissolved oxygen and organic carbon along the water column at hourly intervals over the course of 5 years within Lake Mendota. The metabolism model includes atmospheric gas exchange, net primary production, ecosystem respiration, and transport of organic matter within the water column. Numerous physics modules derived from previous work modeling lake thermal structure are also included. Different combinations of process-based and machine learning modules had their performance compared using observed water quality parameters as target variables. In our previous work using this approach to simulate lake physics, replacing the process-based diffusive transport module with a machine learning module in a hybrid MCL framework improved predictions of lake thermal structure relative to purely process-based and purely machine learning approaches. For our work on lake metabolism, preliminary results indicate that biological processes, production and respiration, are areas of potential advancement of understanding via MCL.

Collaborative, Inter/cross/trans disciplinary

Gorsky, Adrianna

Adrianna Gorsky, Hilary Dugan, Emily Stanley

Abrupt shift to clear water state and increase in spatial variability of water quality in Lake Wingra

Shallow lakes are one of the most abundant freshwater systems globally and are known to emit substantial amounts of greenhouse gases, such as carbon dioxide (CO2) and methane (CH4). However, emissions can vary greatly with high levels of within-lake spatial heterogeneity and distinct zones of open water and littoral habitats. Macrophytes play an important role in the function of these ecosystems by increasing habitat complexity and water clarity. Lake Wingra is a eutrophic, shallow lake that is fed by urban stormwater runoff and groundwater in Madison, Wisconsin and has an abundant macrophyte community. We measured surface dissolved concentrations of CH4, CO2, and nitrous oxide (N2O) at eight sites across the lake during both the open water and ice-covered season, and diffusive flux of CH4 and CO2 during the open water period. The relative biomass of macrophytes during the summer maximum ranged between sites from 0 to 227g. We expected the aquatic plant coverage, depth, and season to influence gas production. Preliminary results suggest gas production varies both spatially and temporally with higher CH4 and CO2 concentrations on the western compared to eastern sites and higher CH4 flux rates and lower CO2 flux rates in the summer than fall. Exploring the spatial variation of greenhouse gases across seasons will provide insight for future management priorities for urban shallow lakes.

Individual

Emch, Elizabeth

Elizabeth Emch & Hilary Dugan

Understanding chloride dynamics in the Lake Wingra watershed through climate and spatial variability

Salt pollution has become prominent over the past 80 years in freshwater ecosystems across the Midwest United States. This study investigates chloride dynamics in Lake Wingra through climate drivers. Lake Wingra is a eutrophic, urban, small, and shallow lake in Dane County, Wisconsin. Because of Lake Wingra's size, it responds rapidly to changes in chloride loading. Since the 1940s, chloride concentrations have risen 30-fold in Lake Wingra. Climate naturally drives ion concentrations in freshwater, and it is crucial to investigate inter-annual variability of precipitation with these concentrations. Using a dynamic model, this study integrates historical data on precipitation, road salt usage, and chloride concentrations with projected future scenarios of reduced road salt application. This model simulates chloride accumulation in Lake Wingra from 1960 to the present and predicts future trends under different climates and road salt applications. Results from this model provide insights into the long-term consequences of road salt use and the potential for sustainable management practices to preserve water quality in freshwater systems outside of Lake Wingra. Understanding the interplay of climate and human decision-making will allow us to assess the impacts of the strategies implemented and guide future advocacy efforts to protect, maintain, and further emphasize the importance of healthy freshwater ecosystems.

Collaborative, Community-driven

Bergman, Aletta

Aletta Bergman, Tyler Butts, Jake Vander Zanden

Impacts of an Invader on Sediment Flux and Chemistry in a North-Temperate Lake

Spiny water flea, Bythotrephes cederstroemi, are known to alter predator-prey dynamics within ecosystems. However, their impact on biogeochemical cycling is not well understood. Carbon cycling is important within aquatic ecosystems, influencing primary production and organic matter deposition which has implications for ecosystem-wide carbon storage. Additionally, changes in carbon and nitrogen cycling can have implications for bottom-up food web effects, specifically from sediment deposition. To assess changes in carbon cycling, we investigated long-term data from the North Temperate Lakes-Long Term Ecological Research Program (NTL-LTER) from sediment traps in Trout Lake, WI. We found lower rates of sediment deposition in the fall (when Bythotrephes is most active), suggesting an effect by spiny water flea. This trend was compared to other local NTL-LTER lakes to see if the change in deposition was just a regional change in climate or precipitation, but we found that it was specific to Trout Lake. We also processed sediment trap samples from Trout Lake to assess Carbon: Nitrogen ratios before and after invasions in the open-water and fall periods to further explore the impacts of spiny water flea on biogeochemical cycling. To ensure that the trend for Carbon: Nitrogen values is specific to Trout Lake and is not a landscape-wide change, we are currently analyzing samples from another local lake, Sparkling Lake, to compare C:N values from the two lakes.

Collaborative

LeBlang, Gabriel & Allen, Raymond

Raymond L. Allen, Gabriel H. LeBlang, Celeste Hockings, Gretchen Gerrish

Zaaga'iganan Kinship Project: Defining Human Relationships to northern Wisconsin Lakes

Management and stewardship of lakes and other bodies of freshwater has been occurring in the areas surrounding the Great Lakes for time immemorial. In contemporary times, groups and individuals controlling, managing, and researching these bodies of freshwater have changed, along with definitions of what constitutes a "healthy" lake. Simultaneously in northern Wisconsin, the number of individuals who visit (i.e., non-residents) the area and lakes seasonally has dramatically increased over the years, with a focus on seasonal recreational fishing and watercraft activities in the summer months. The number, background, affiliation, and activities of individuals interacting with these lakes continues to change, and a one-size-fits-all definition of how to steward lakes, especially in a changing climate, won't prepare the lakes and their non-human inhabitants for the future. This research aims to find out current relationships peoples in northern Wisconsin have with bodies of freshwater in the area, how lakes and their inhabitants have influence, and how they define a healthy lake in current and future times. By using semi-structured interviews of individuals (e.g., residents, researchers, etc.) and groups in the area, we will determine key definitions of a healthy lake and begin to propose and modify research and education that addresses these needs.

Collaborative, Inter/cross/trans disciplinary, Community-driven, Conducted in partnership with external groups

Anderson, Madelyn

Water Prayer

"Water Prayer" is an interdisciplinary piece that integrates science and art. By using Wisconsin DNR data to identify the state's impaired streams and displaying them visually through cyanotype, the print invokes a sense of responsibility towards our waterways. The phrase "will you wash us clean" combined with names of waterways facing environmental impacts prompts us to consider our impact on Wisconsin's waters. What will you do with your own two hands?

Individual, Inter/cross/trans disciplinary

Alexander, Aaron G., Yagmur Derin

Daniel Wright, Yagmur Derin, Lei Yan, Ankita Pradhan, MohammadSadegh (Mo) Abbasian, Benjamin Fitzgerald, G. Aaron Alexander, Yuan Liu, Yichen Tao, Kaidi Peng, Ashar Hussain, Sophie Van Alsburg

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Hydroclimate Extremes Research at UW-Madison

Stop by to see the work being carried out by the Hydroclimate Extremes Research (HER) group at UW-Madison. Project topics include stochastic storm transposition, hydrologic model uncertainty, urban climate adaptation, how extreme precipitation leads to extreme flooding, and much much more! Students and research scientists active in the HER group will be at the poster to tell you about our work and make connections

Collaborative

Hydroecology Lab

Poster

The Hydroecology Research Group at the University of Wisconsin Madison studies the interactions between water and the world around us. Our work focuses on both natural and human influenced systems in Wisconsin, the greater US, and abroad. Stop by to meet our lab members and learn about our current projects!

Collaborative

Wu, Ziyan

Ziyan Wu, Sarah E. Janssen, Michael T. Tate, Haoran Wei, Mohan Qin

Detecting low micrometer microplastics in lake using a plasmonic membrane sensor

Low micrometer microplastics (LMMPs), typically ranging from 1 to 10 µm, make up a significant portion of microplastics (MPs) in freshwater systems. Detecting individual LMMPs in environmental water is challenging due to their low concentrations and the complexity of the environmental matrices. To address this, we developed a plasmonic membrane sensor designed for single-particle detection of LMMPs in environmental water matrices. The sensor is fabricated by coating a plasmonic layer onto a polymeric membrane, which acts both as a filter to concentrate LMMPs and as a Raman spectroscopic sensor for rapid, sensitive detection. Among the four polymeric membranes tested, polycarbonate track-etch (PCTE) membrane sensors—characterized by their flat, homogeneous surfaces—demonstrated superior imaging performance compared to other membranes with fibrous, inhomogeneous surfaces. PCTE membrane sensors allow for precise chemical characterization of individual LMMPs in just 0.01 seconds and can generate Raman maps within 1 minute over a 100 × 100 µm area. Further analysis revealed that the distribution of LMMPs on the PCTE membrane remains uniform despite slight shifts in surface hydrophilicity after applying the plasmonic coating. The thickness of the plasmonic layer is positively correlated with surface enhancement, while the pore size of the membrane inversely affects this enhancement. Crucially, the complex chemical and particle compositions of lake water did not significantly interfere with the sensor's imaging or chemical analysis capabilities, underscoring its robustness in environmental matrices. Overall, these membrane sensors offer a rapid and reliable dual-function tool for both concentrating LMMPs and enabling single-particle detection in complex environmental water samples.

Collaborative, Inter/cross/trans disciplinary

Gorman, John

John Gorman, Ben Hein, Haoran Wei

Exploring ligand exchange on colloidal gold nanorods using surface-enhanced Raman spectroscopy for water quality monitoring

Due to its ease of use and low cost, surface enhanced Raman spectroscopy (SERS) holds great potential as an environmental monitoring technique. SERS is highly dependent on the ability to isolate target analyte into hot spots, which is influenced by substrate size, morphology, and surface chemistry. Gold nanorods (AuNRs) are a common SERS substrate due to their easily controllable size and morphology, colloidal stability, and positive surface charge; however, due to their anisotropic nature, there are two adhesion regimes. AuNR sides provide a larger surface area for adhesion while AuNR tips provide better hot spot formation and enhancement. In this study, two aspect ratios of AuNRs were synthesized using a seed-mediated growth method and stabilized using cetyltrimethylammonium bromide (CTAB). The aspect ratio of AuNRs was controlled by altering the amount of silver nitrate during the rod formation. CTAB concentration for SERS was optimized to prevent irreversible aggregation while still allowing for controlled hot spot formation, with excess CTAB removed via repeated washing. Potassium sulfate salt was optimized to reduce unnecessary scattering while still encouraging controlled aggregation and hot spot formation. The optimized AuNR colloid was used to analyze SERS spectra of 4-mercaptabenzoic acid (4-MBA), 3-chloroaniline (3-CA), and 3-chlorobenzoic acid (3-CBA), three common analogues for environmental contaminants with different charges and functionalities resulting in various affinities toward gold surfaces. SERS intensities at relevant analyte bands were identified and compared to that of both cetyltrimethylammonium (CTA+) and bromide (Br-) ions. Br- ions were determined to preferentially bind to AuNR tips whereas CTA+ ions were found to preferentially adhere around the sides of AuNRs, indicating Br- displacement is essential for optimal contaminant detection. Insights into the ligand exchange between the model chemicals and CTAB are used to guide the SERS analysis of environmental pollutants, such as 2,4-dichlorophenoxyacetic acid and per- and polyfluoroalkyl substances.

Individual

Milani, Alissia

Aquatic Chemistry at UW-Madison: Fate and transformation of organic contaminants

Organic contaminants, such as pesticides, pharmaceuticals, and industrial chemicals, enter the environment through processes like agricultural runoff and stormwater. Additionally, contaminants in our wastewater will enter the environment if they are not effectively removed or degraded in our wastewater treatment plants. These contaminants can have negative impacts on the environment and can be harmful to human health if found in drinking water sources. Once in the environment, these compounds may degrade via photochemical reactions (reaction with sunlight), microbial processes, or oxidation via naturally occurring minerals. Certain compounds like some PFAS (per- and polyfluoroalkyl substances) do not have any known natural degradation pathways, and therefore pose a serious concern to human and environmental health. In engineered systems, processes are designed to remove certain organic contaminants. In the Remucal research group, we study how these organic contaminants behave in the environment and their potential treatment processes.

Collaborative, Conducted in partnership with external groups

Swenson, Jenna

Jenna Swenson, Lily Thatcher, Emily Valentine, Ann McGrath-Flinn, Matt Ginder-Vogel, Christy Remucal

The role of molecular structure on changes to phenol oxidation kinetics by manganese oxides in natural waters

Manganese oxides are redox active minerals that are found ubiquitously in the environment. These minerals can oxidize harmful phenolic contaminants (e.g. pharmaceuticals, industrial chemicals) in natural waters and water treatment processes. In environmentally relevant systems, the oxidation rate of these contaminants can be increased or decreased relative to laboratory controls in ultrapure water, due to the presence of dissolved organic matter (DOM) and inorganic ions. Additionally, characteristics of the contaminant structure appear to be important; however, little is known about what molecular characteristics drive observed changes in oxidation rate in environmentally relevant systems. We address this knowledge gap by measuring the oxidation rate of 20 diverse phenolic contaminants in four natural water samples. Using the relative rate constants measured in each system, we evaluate linear correlations between molecular characteristics and changes in oxidation kinetics within each water sample. This data set will be used to better understand the transformation of these harmful contaminants in natural systems.

Collaborative

Braun, Katie

Katie Braun & Christian Andresen

Heterogeneity in ice-wedge permafrost degradation revealed across spatial scales

The degradation of ice-wedge terrain is altering permafrost landscapes across the Arctic Coastal Plain of Alaska. The uneven progression of degradation produces complex spatial patterns of thermokarst and complicates assessment of both permafrost vulnerability and its impact on carbon cycling. Pairing remote sensing detection of ice-wedge permafrost thaw over time with field surveys of the biophysical characteristics influencing thaw will better allow us to characterize ice-wedge landscape evolution and improve forecasts of carbon cycling in the Arctic.

We examined patterns and trends of ice-wedge degradation using a combination of field sampling, drone multispectral surveys, and satellite remote sensing along the Dalton Highway in the North Slope Borough of Alaska. We trained a machine-learning U-Net algorithm to detect ice-wedge troughs in high-resolution satellite imagery, with training data informed by drone and field surveys; resulting maps of ice-wedge troughs have a pixel accuracy >90% and mean Intersection-over-Union value of >0.5. Mapping ice-wedge trough network evolution from 2006-2023 revealed that ice-wedge troughs become wider and wetter, indicating a hydrogeomorphic shift to degradation. These hot spots of degradation preferentially occur in the higher elevation portions of the Arctic Coastal Plain. The high spatial heterogeneity in ice-wedge degradation found in this region demonstrates the need to expand beyond single-site studies and consider disturbance regimes across scales, so that we can improve our understanding of where and why permafrost undergoes thaw and estimate how continued degradation in the Arctic will impact ecosystem function.

Collaborative

May, Jacob

Jacob May & Christian Andresen

Detecting aquatic vegetation in small arctic ponds with deep learning methods

The northern slope of Alaska is covered in wetlands comprised of numerous small bodies of water. Various forms of vegetation grow in these ponds that may play a role in changing CO_2 and CH_4 emissions. Satellite imagery from Worldview 2 and 3 provide the sub-meter resolution necessary to monitor changes in this vegetation. Using deep learning image recognition methods, including UNets, we have attempted to map the extent of vegetation within these arctic ponds.

Collaborative, Individual

Roden, Eric

Thais Altenberg-Vaz, Manasi Passi-Simhan Marissa Cartwright, Matt Ginder-Vogel, Eric Roden

New insights into linked transport and metabolism particulate organic matter and dissolved oxygen in Wisconsin River sediments

Understanding how particulate organic matter (POM) infiltrates and degrades in porous stream and riverbed sediments is important for quantifying and predicting biogeochemical processes and their impact on water quality in aquatic-terrestrial interface environments. This study examined POM degradation and transport processes in the uppermost layer of sandy sediments of the Wisconsin River near Spring Green, WI. Concentrations of POM decreased with depth in sediment cores, indicating a source of POM input at the sediment surface. Column experiments were conducted with bulk riverbed sediment to examine the relationship between advective fluid flow, dissolved oxygen (DO) concentration, and dissolved organic and inorganic carbon (DOC and DIC) dynamics. The experiments demonstrated a dynamic equilibrium between DO consumption and replenishment from the ARW that was dependent on flow rate and distance from the column inlet. Column outlet concentrations of DOC, an intermediate in POM metabolism, remained constant with changing flow rate, except when anoxic conditions arose after cessation of flow when they increased 2-4 fold. In contrast, DIC, an end-product of POM metabolism, showed an increasing trend with decreasing flow rate, reflecting a shift in the balance between release and advective transport through the column. The development of anoxic conditions in the columns motivated field and laboratory measurements to assess in situ DO concentrations, and to examine the influence of downward oxygenated fluid flow on DO concentration under conditions that approximated the in situ riverbed environment. Field deployments of optical DO sensors revealed that surface sediments are oxygenated despite the presence of high rates of DO consumption. A laboratory experiment was conducted in a 5-gallon bucket containing riverbed sediment where the water layer overlying the sediment was stirred with a propeller to produce a downward fluid flux intended to model potential ripple-induced fluid advection in the riverbed. Anoxic conditions arose quickly in the absence of stirring, whereas DO increased immediately in response to initiation of stirring. The results of this study demonstrate that infiltration of fresh POM stimulates microbial metabolism riverbed surface sediments, and that downward fluid advection is likely to play a key role in supplying DO for aerobic microbial metabolism and associated biogeochemical processes in permeable riverbed sediments.

Collaborative

Nghiem, Athena

Athena Nghiem, Savannah Finley, Logan Goulette, Juyong Bak

Water and Trace Element Research (WATER) Lab

The Water and Trace Element Research (WATER) Lab led by Prof. Athena Nghiem explores the drivers for the release, fate, and transport of trace elements and contaminants across different reservoirs in the environment with lab, field, and modeling methods. The group currently focuses a wide range of topics including investigations of: geogenic versus anthropogenic sources of molybdenum and arsenic in Southeastern Wisconsin groundwater, arsenic speciation and temporal changes in arsenic concentrations in Wisconsin groundwater, and sediment geochemistry and reactive transport modeling of arsenic in deltas in Vietnam. We are especially interested in quantifying hydrological and biogeochemical cycling impacts on groundwater and to address community-motivated questions related to the sustainability of water resources.

Collaborative

Breunig, Rachel

Rachel Breunig, Michael Cardiff, Ken Ferrier

From hillslope to stream: investigating the chemical evolution of the shallow Critical Zone in layered stratigraphy

Observations of the chemical evolution of water from hillslopes to streams are sparse, particularly in catchments where water in streams interact with heterogeneous stratigraphy. Layered sedimentary stratigraphy represents a dominant portion of Earth's shallow subsurface, and the feedbacks between solid and aqueous phase geochemistry, capacity for flow and transport, and nutrient availability underpin the importance of building an understanding of how layered sedimentary Critical Zones evolve. We leverage the shallow layered stratigraphy, crosscut by a stream, at Wyalusing State Park (Driftless Area, WI) to investigate the degree to which stream chemistry reflects the solid and aqueous chemistry in the unsaturated hillslopes from which they originate. Our study area is a small (0.24 sq. km) headwater catchment whose underlying stratigraphy is composed of, in top-down order, dominantly siliceous loess, authigenic terra rossa clay, and dolomite. We collected new measurements to follow water through its introduction to the landscape as precipitation through stages of its interaction with the landscape as soil/ rock moisture in a hillslope, spring, and stream with continuous time series observations of water abundance and temporally correlated aqueous chemical compositions of precipitation, soil/ rock moisture, and stream flow. Here, we present a combination of these new measurements with previously performed analyses of chemical mass transfer indices from cores collected in the study area to connect evidence of chemical erosion in hillslopes on hydrologic and geomorphic timescales with the chemical response of a stream.

Inter/cross/trans disciplinary

Le, Vy

Vy Le, Erin Berns-Herrboldt, David Hart, Grace Halstead, Callie Karsten, Amy Workman, Christopher Zahasky

Exploring the influences on temporal variation in phosphorus transport and release in the hyporheic zone of the Wisconsin River

Abstract

Elevated phosphorus (P) in surface waters can lead to eutrophication and impact aquatic health, human health, and local economies. Hyporheic zones represent an important reservoir for P storage. River stage fluctuations, groundwater surface-water interactions, seasonal climate variability, and biogeochemical processes can influence the transport, transformation, and sorption of P in the hyporheic zone. Phosphorus fate and transport are expected to be especially complex on managed rivers where sudden and episodic pulses of water from dam releases or large precipitation events may cause reversals in hyporheic flow and impact the stability of P sorbed in the hyporheic zone. This study aims to evaluate P fate and transport as a result of transient river stage changes associated with a dam-controlled reach of the Wisconsin River north of Wisconsin Dells. Sediment and pore water samples were collected quarterly to characterize the temporal variability of P quantities and phases in aqueous and sediment samples and to evaluate mechanisms of competitive sorption to sediments. Results highlight that changes in river stage lead to changes in biogeochemical redox conditions, which transform the phase and affect the mobility of phosphate adsorbents. Understanding how episodic water fluxes in the hyporheic zone control P transport and transformation may have important implications for land and water management decisions.

Collaborative, Conducted in partnership with external groups

Ceballos, Cassandra

Cassandra E. Ceballos & Emily H. Stanley

Aquatic plant communities and increasing water levels: long-term patterns in Fish Lake, Wisconsin, USA

Fish Lake, a core study site in southern Wisconsin for the North Temperate Lakes Long-Term Ecological Research (NTL-LTER) program, provides an opportunity to investigate the consequences of rising lake levels. Surface water elevation has steadily risen >5m since the 1960s with a 3m increase occurring in the last decade. Rising water has displaced the shoreline and inundated houses, roads, trees, and other terrestrial areas to create a larger, deeper lake with novel littoral habitats. Our objective was to determine how the macrophyte communities have responded to rising water levels by identifying where plants have colonized the novel littoral habitat. We carried out a point-intercept survey encompassing the current surface area of 1.14 km2 by expanding a grid established in 2012 when the surface area was 1.02 km2. The maximum depth where rooted plants colonized was 4.42 m in 2024, slightly increasing since 2012 when it was 3.96 m. Although plants are found in slightly deeper waters, the number of sites that are shallower than the maximum colonization depth decreased > 60% since 2012. The frequency of macrophyte occurrence in sites shallower than the maximum colonization depth remained at 45% since 2012 despite the overall habitat availability decreasing in that time. The number of species did not change between 2012 and 2024 with 6 species identified during each survey year. In contrast, the diversity of the macrophyte community has changed and the Simpson's Diversity Index value increased from 0.6 in 2012 to 0.8 in 2024. Macrophytes have established in the newly flooded littoral habitat, but colonization throughout the entire lake is sparse and may be limited by the availability of sites where the water depth and substrate are conducive for plant growth.

Collaborative, Individual, Conducted in partnership with external groups

Cheng, Jianru

Jianru Cheng & Huifang Xu

Extreme hydroclimate events between early-1100s and mid-1200s recorded in Deep Springs Lake, California

Southwestern North America witnessed extreme hydroclimate events during the Medieval Climate Anomaly (MCA) and sequential periods. Due to the lack of historical documents, the verification for traditional indices based on tree rings, submerged stumps and lake shorelines is limited. Although geochemical characteristics of primary lacustrine carbonate minerals is widely applied for paleoclimate reconstruction, mineralogy is barely scrutinized before geochemical analyses and is seldom considered as an independent quantitative index. Here, aiming to investigate the potential of carbonate minerals as an independent climate change indicator, we collected a series of sediments from Deep Springs Lake (DSL), California, a spring-fed alkaline playa without a deposition gap. We examined and quantified minerals with X-ray diffraction (XRD) and scanning transmission electron microscopy (STEM). At the depth of ~65 cm, there is a detrital-free, white layer with ~70% of Ca-bearing magnesite and ~30% of dolomite, above which are layers with dolomite, aragonite and calcite, suggesting that an extreme drought is followed by a severe pluvial event. A new quantitative drought index, the Carbonate Dryness Index (CDI), is established by assigning weights to different carbonate minerals based on Mg:Ca ratios they require to precipitate. The CDI curve demonstrates a spike of dryness corresponding to the magnesite-rich layer, which is calibrated to the lowest lake level of nearby Owens Lake in the early 1100s. The amplitude of this drought during 1090-1150 is unparalleled over the past 1,000 years, which is consistent with nearby local records but different from regional tree-ring records. Furthermore, we suggest that the carbonate minerals in the DSL sediments recorded ~500-year wet/dry cycles driven by periodic solar activities and ENSO activities. The CDI proposed by us is the first quantitative index based on carbonate phases and can be further applied to lacustrine primary carbonates for constraining the extent of droughts.

Collaborative, Conducted in partnership with external groups

Bierbrauer, Anna Marie

Anna Marie Bierbrauer, Morgan Haak, Chris Noll, Go Green Team at LabCorp

LabCorp Green Campus Initiative

The LabCorp Green Campus Initiative, a partnership between the UW-Madison Department of Planning and Landscape Architecture (DPLA) and LabCorp's Go Green advocacy group, is working to advance ecological improvements on a light industrial campus in North Madison. With a strong focus on water resource management, ecological restoration, and employee stewardship, the initiative addresses environmental concerns in the Starkweather Creek watershed—a site significantly impacted by PFAS contamination and downstream flooding. Over the summer, the team worked collaboratively to evaluate site conditions, project possibilities, and employee capacity. This collaborative planning approach identified areas for ecological intervention while aligning with Madison's citywide flood management efforts. From this work, project priorities were established: improve ecological health of prominent green spaces; infiltrate more stormwater in pedestrian areas; and convert parking lot islands into vegetated swales. Currently, the DPLA team is developing a design and implementation plan to assist in converting a large turf grass area into a pollinator garden in Spring 2025. Additionally, the DPLA team is providing stormwater calculations and cost estimations to help inform the next phase of the project. Supported by Water@UW funding, this initiative is providing students with valuable research and fieldwork opportunities, and will contribute to future coursework on ecological planting and green infrastructure design. Go Green's organizational capacity is also being built as employees, facilities, and senior management galvanize around sustainable private property management. Ultimately, the LabCorp Green Campus Initiative is fostering a replicable framework for corporate environmental stewardship within light industrial zones, setting a precedent for environmental stewardship and private-sector contributions to urban watershed restoration.

Collaborative, Conducted in partnership with external groups

Rubinetti, Victoria

Victoria Rubinetti, Nan Li, Annie Jones

Sustaining Black Ash Basket Weaving Among the Menominee Tribe of Wisconsin and Beyond

Black Ash trees are critical to the northern hardwood forested wetlands in the Great Lakes region, thriving in headwater wetlands, large wetland complexes, and drain-ways along streams. These wetlands support water quality, quantity regulartion, and carbon sequestration. Black Ash trees also hold cultural significance for Indigenous communities as the primary source of materials for traditional basket weaving. However, the invasive Emerald Ash Borer (EAB) threatens Black Ash habitats, threatening both ecological balance and Indigenous cultural heritage. Climate change exacerbates these pressures, potentially transforming the landscape and damaging invaluable traditions.

This project, in part funded by Water@UW and the Morgridge Center for Public Service, partnered with Menominee artist Sherri LaChapelle-Corn (Pitapanukiw) to harvest the remaining Black Ash trees before they vanish and teach basetweaving. In addition, the project seeks to enhance public awareness of the complex impact of EAB on black ash wetlands using culturally relevant and inclusive messaging that integrates science, storytelling, and Indigenous art.

Community-driven, Conducted in partnership with external groups

Gupta, Saurabh K

Saurabh K Gupta, James Rice, Fuad Shatara, Erica LW Majumdar, Nimish Pujara

Design and Characterization of Turbulence Tank for microplastic and microbe interaction for large water bodies

Isotropic stationary turbulence is the simplest case of turbulence with unique characteristics and has been widely used in theoretical analysis of turbulent flows1. Water-or wind-tunnel oscillating grid turbulence (OGT) is another method used to generate isotropic stationary turbulence by a planar grid/mesh vibrating perpendicularly to its plane. Recent studies have shown that OGT-based experiments can be designed to replicate the turbulence conditions seen in large bodies of water. Similar experiments can be used to study the interaction between turbulence and microplastics distributed in large bodies of water. The Great Pacific Garbage Patch is one such collection of marine debris in the North Pacific Ocean. These patches are formed by non-degradable plastic and can be found in any large water bodies viz. Lake Superior, Lake Erie. These plastics remain on the surface, decompose into microplastics, and cause algal growth below the surface which is dangerous for marine life. This study aims to replicate lake-type turbulence using a turbulence tank with an oscillating grid and analyze the flow using particle image velocimetry (PIV) to better understand how particulates may suspend and settle in turbulent lake flow.

Collaborative

Azeem-Angel, Marian

Marian Azeem-Angel, Paul Block

Extreme precipitation and community perceptions on flooding in Madison

The limited consideration of both social and physical factors in the development of stormwater infrastructure can lead to unequal resource management across a city or even neighborhoods. Extreme precipitation events can exacerbate these inequalities through more frequent and intense flooding and limited local adaptive capacity, often disproportionately affecting low-income households and communities of color across the U.S. This work considers the inclusion of physical and social factors to better characterize and understand flooding in Madison. Using Census data, we construct a localized flood-specific social vulnerability index, based on various physical, health, environmental, and socioeconomic factors and compare with traditionally developed indices. Additionally, we leverage survey and interview data collected to capture localized community experiences and perceptions regarding flood impacts and current management strategies using a Likert scale. Findings and results are subsequently applied to weight individual factors to construct a localized, representative flood-specific social vulnerability index. This allows an explicit assessment of how well residential perceptions align with existing, traditional indices. These findings can highlight the benefits of integrating local perceptions into social vulnerability indices, contextualize heterogeneity, reveal neighborhood-level disparities, and offer insights for consideration of equitable infrastructure redevelopment.

Individual, Inter/cross/trans disciplinary, Community-driven, Conducted in partnership with external groups

Bart, David

Groundwater Extraction Is the Most Important Predictor of Floristic Quality in Dane Co. Fens

Calcareous fens are rare, groundwater-fed wetlands with extremely high floristic quality, and therefore are prone to degradation from groundwater extraction. However, the importance of extraction compared to other stressors is little explored. Here I examine the importance of groundwater extraction, historic land-use legacies, non-hydrologic indicators of urbanization, patch characteristics, and indicators of non-native propagule pressure in predicting various metrics of floristic quality in all accessible Dane Co. fens. Partial Least Square Regression (PLSR) demonstrated that high groundwater extraction and land-use legacies were the best predictors of low floristic quality, with population density and proximity being significant but minor predictors. The declines related to extraction were mostly caused by the loss of rare and highly conservative species and an increase in non-native or ruderal plants. The impacts of land-use legacies were limited to the rural fringe of the county, while the groundwater extraction was slightly more concentrated in urbanizing areas. These results suggest that groundwater extraction through municipal and agricultural wells is having a negative impact on fens throughout the county, while historic land use diminishes quality on the rural county fringes.

Individual, Inter/cross/trans disciplinary

Students of Ripon College's Catalyst 220: Art & Environment

Ashley Anadell, Oumar Bah, McKenzie Bestor, Teagan Fregosi, Maggie Glaus, Cielo Gutierrez Kuhaupt, Matt Hegge, Lainie Heizler, Cooper Herr, Sophia Larson, Rocco Luczak, Finley Manning, Alexander Mosqueda, Logan Neuendorf, Evan Olson, Katy Peterson, Yeva Pipan, Natalie Rauwolf, Connor Reiner, Isaac San Diego, Catherine Skoglund, Mykenzi Uhlers, Bri Young, Haley Young

Group Poster Designs by Ripon College Students

Using a piece of historical propaganda as the basis for their compositions, students at Ripon College produced posters focused on local water issues. Green Lake is about seven miles west of Ripon and is the deepest lake in the state. The lake & some of its tributaries which flow from Ripon are listed as impaired waterways. Taylor Haag from the Green Lake Association (GLA) educated the students about the issues of most concern to the health of Green Lake including phosphorus & invasive species. Small groups of students created new visual campaigns using Adobe Illustrator & made changes based on feedback from the GLA to make their messages more effective. The Ripon College students were enrolled in Catalyst 220: Art & Environment. The course asks students to examine issues through the lens of multiple disciplines.

Collaborative, Conducted in partnership with external groups

Veregin, Howard

Veregin, Howard, Matt Noone, Cory Rich, Melissa Michaud, Matt Krempely, Mike Hasinoff, Param Bhandare, Jean Traudt, Lance Green

Starkweather Creek Community-Based Chloride Monitoring Initiative

A team composed of UW-Madison researchers and local partners is in the process of establishing a chloride monitoring program in Starkweather Creek on Madison's east side. The goals of the project include continuous chloride monitoring at numerous locations along the creek, engaging with stakeholders and community members to educate them about the creek and sources of chloride contamination, and beginning to establish a model for cooperation and engagement to ensure the long-term health of the creek. Another goal of the project is to expand on existing partnerships with Operation Fresh Start (OFS), a regional leader in providing alternative pathways for young individuals who may have dropped out of high school or come from disadvantaged communities. Through OFS, these individuals complete high school and achieve real-world training opportunities to become prepared to enter the workforce. Through the project, OFS Conservation crews will receive additional training in water quality monitoring and the basic principles of modern GIS-based mapping for environmental applications.

Collaborative, Inter/cross/trans disciplinary, Community-driven, Conducted in partnership with external groups

Sundance, Juniper

Precious Water

Words have power! This collage of images and phrases portrays the many ways humans depend on and appreciate water. Give thanks to water each day for Water Is Life.

Individual

Gorski, Patrick

Patrick Gorski, Tim Asplund, Meghan Williams, Sean Strom, Steve Elmore, Melanie Johnson

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Site Investigations of Per- and Polyfluoroalkyl Substances (PFAS) by the WI Natural Resources (DNR).

Per- and Polyfluoroalkyl Substances (PFAS) are anthropogenic organic compounds first manufactured in the 1940's. Due to their widespread use in industry, PFAS are now ubiquitous in the environment and at high concentrations have been associated with deleterious health effects. Wisconsin DNR has been collecting and analyzing samples in drinking water, ground water, surface water and wildlife (mainly fish) samples statewide to quantify their concentrations and investigate sites of potential contamination when higher concentrations are found. Since PFAS are found in all environmental matrixes, the WI DNR utilizes a cross-programmatic approach (in these examples, Drinking Water and Groundwater, Water Quality and Fisheries Management programs) to share results when a potential site is identified, and then implement follow-up sampling by collecting PFAS in the corresponding matrix (e.g., drinking water, surface water, fish tissue). Here we present WI sites from a surface water perspective that have been characterized. In some instances, PFAS remain confined to certain matrices or areas, in others, PFAS is pervasive. These results can then be used to quantify the risk to the environment or human health.

Collaborative

Gannon, Katherine

Katherine Gannon, Matthew S Janssen, Jon K Miller

Breakwater Wave Transmission and Shoreline Response

Graveling Point Beach, a public beach within Little Egg Harbor Township, New Jersey, has been experiencing long-term erosion. To address the issue, a living shoreline project consisting of four low-crested rubble-mound breakwaters and a beach nourishment was constructed beginning in fall 2022 (structures) and finishing in spring 2023 (beach nourishment). A variety of field methods were used to investigate the influence of the breakwater system on wave transmission and beach fill evolution. The observations are then compared to common empirical estimations. A median wave transmission coefficient of 0.4 was measured for incident waves with a median height and peak period of 9 cm and 2 sec, respectively. The observed transmission coefficient was higher than that predicted by models such as Briganti et al. (2003) and Van der Meer and Daemen (1994) suggesting other processes such as diffraction may be influencing the results. Structure from Motion (SfM) was used to generate a series of Digital Elevation Models (DEMs) which show salients forming behind the structures. The resulting salient growth was compared to the model of Suh and Dalrymple (1987), which was shown to overpredict the amplitude of the salient at Graveling Point. However, the expected relationship of breakwaters with increased offshore distance having shorter salient lengths was generally observed. The equation was refit using the field data at Graveling Point and laboratory data with similar wave heights and periods from Suh and Dalrymple to derive a modified model that may be more appropriate in low-energy environments.

Individual

Smale, Mike

Mike Smale, Madeline Magee, Cherie Hagen

Assessing the climatic sensitivity and resiliency of Lake Superior coastal wetland habitats.

Great Lakes coastal wetlands are diverse and dynamic ecosystems that have developed to function under disturbances at the interface of terrestrial and aquatic systems. Climate change is projected to alter these disturbances outside their historical ranges, subjecting wetlands to warmer temperatures, more extreme precipitation events, larger fluctuations in lake levels, and increased wind and wave action. These anticipated changes pose as an uncertain risk to coastal wetland habitats and are therefore challenging for natural resource managers who have limited resources for wetland management, preservation, and adaptation efforts. With the guidance and input of regional and state-wide wetland professionals, we have developed several frameworks to quantify the relative sensitivity of Lake Superior coastal wetland habitats to the anticipated effects of climate change. Data from the Coastal Wetlands Monitoring Program (CWMP) and state databases (e.g. Wisconsin National Heritage Inventory, Wisconsin Wetland Inventory) are used to assign sensitivity scores to each wetland. Vegetation, fish, and bird habitat sensitivity rankings for 38 coastal wetlands in the Lake Superior basin of Wisconsin will be presented. By eventually combining sensitivity and adaptive capacity scores, estimates of overall wetland resiliency may assist in the prioritization of climate adaptation efforts and distribution of limited funds in the Lake Superior basin, which can then be replicated on other Great Lakes systems.

Collaborative