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Freshwater Collaborative of Wisconsin

Undergraduate Research Opportunities

Summer 2022

University of Wisconsin-Madison
Summer Research Opportunity Program

Project Title	Energy footprint of desalination globally
PI Name	Mutlu Ozdogan ozdogan@wisc.edu
PI Affiliation	UW-Madison
Project Description	The purpose of this project is to calculate the energy footprint of desalination globally with a view towards a high impact publication. This form of analysis has never been conducted. Given continued scarcity of freshwater, particularly in arid parts of the planet, desalination will continue to be an important part of freshwater resources in arid regions but with unknown amounts of energy consumption and carbon footprint. This project aims to close this gap. The PI has access to a global database of desalination plants and their technology details. The student will work completing the calculations using a spreadsheet.
Qualifications Required	Intermediate to advanced skills in using spreadsheet (Excel and/or Google Sheets) including copy, paste, functions, cell calculations, graphing, basic statistics, and pivot tables. The student does not need to have prior knowledge on desalination or energy footprint calculations. Ability to do literature search and read numbers from published tables.
In-Person Tasks	None
Virtual / Remote Tasks	The student will use a spreadsheet program (Excel and/or Google Sheets) to calculate/graph data using an existing database. The student will also be asked to do literature search and extract certain numerical parameters from published tables/works.
Approx. Work Hours / Week	10-20 hours
Keywords	Freshwater, desalination, energy use, carbon footprint, arid regions

Project Title	Diversity and dynamics of harmful cyanobacterial blooms in Lake Mendota
PI Name	Trina McMahon trina.mcmahon@wisc.edu
PI Affiliation	UW-Madison, Civil and Env Eng
Project Description	Lake Mendota in Madison, WI, is plagued with noxious blue green algae (cyanobacteria) blooms each summer. These blooms are known to produce toxins in varying abundance and chemical composition. This student will conduct an independent project to collect water samples multiple times per week and measure water quality characteristics (e.g. nutrient concentrations, cyanobacterial pigments). They will learn field sampling skills, microscopy, water chemistry analysis, and general microbiology skills. They will work with a team of graduate students and other undergraduates studying the lake.
Qualifications Required	At least one year of courses including STEM topics
In-Person Tasks	Field sampling and lab analyses
Virtual / Remote Tasks	The student will use a spreadsheet program (Excel and/or Google Sheets) to calculate/graph data using an existing database. The student will also be asked to do literature search and extract certain numerical parameters from published tables/works.
Approx. Work Hours / Week	10-20 hours
Keywords	Freshwater, desalination, energy use, carbon footprint, arid regions

Project Title	Riverbed biogeochemistry
PI Name	Eric Roden eroden@geology.wisc.edu
PI Affiliation	UW-Madison, Department of Geoscience
Project Description	Field and laboratory experiments to study the input, transport, and transformation of organic matter and solutes that influence biogeochemical cycling in near-surface sediments of river ecosystems within (e.g. the Wisconsin River) and beyond (e.g. the Columbia River in Washington State) Wisconsin.
Qualifications Required	Preference is for students working toward B.S. degree in any field of natural science, physical, biological, or chemical. However, anyone with curiosity and an open mind may apply. Possibilities exist to develop outreach or other creative projects that interface with society and community in the context of natural freshwater resources.
In-Person Tasks	Field trips to work in rivers; lab experiments with river sediments.
Virtual / Remote Tasks	Literature searches; numerical modeling.
Approx. Work Hours / Week	10-20
Keywords	river ecosystem biogeochemistry field lab

Project Title	Partnering with citizen scientists to understand urban pond water quality
PI Name	Grace Wilkinson gwilkinson@wisc.edu
PI Affiliation	Center for Limnology
Project Description	Lakes and ponds act as biogeochemical factories in the landscape by receiving nutrients, organic matter, and contaminants from the watershed and transforming, storing, or moving that material further downstream. The combination of climate change and eutrophication are modifying these processes and diminishing the ecosystem services that inland waters provide. The main goal of this project is to identify the mechanisms controlling nutrient cycling rates in hypereutrophic ponds which are under extraordinary anthropogenic pressure. To address this research goal, we are developing a citizen science monitoring program for urban pond water quality in the Madison area. The REU student on this project will work with our team to develop the sampling methods that will be used by the citizen scientists and lead the validation efforts for those methods. If there is interest, we also welcome assistance or leadership from the REU student in developing educational materials for the citizen scientists. Additionally, the student will assist the project team with water sample collection and laboratory analysis on the focal research ponds located around Madison. By the end of the summer the student on this project will gain valuable experience in sample collection, processing, laboratory analysis, and conducting independent research.
Qualifications Required	Interest in working outdoors under variable weather conditions, comfortable being on the water, experience working a laboratory setting (experience gained through coursework acceptable), willingness to work closely with a collaborative team, interest in science communication and/or citizen science programs
In-Person Tasks	Water and sediment sampling in various urban ponds around Madison, sample preparation and analysis in the laboratory, data entry, data analysis, developing educational materials (if interested)
Virtual / Remote Tasks	none
Approx. Work Hours / Week	up to 40 hours/week depending on the student's schedule and other program obligations
Keywords	lake, carbon, eutrophication, citizen science

Project Title	Sustainable Aquaculture
PI Name	Andrea Hicks hicks5@wisc.edu
PI Affiliation	UW-Madison, Civil and Env Eng
Project Description	Aquaculture provides an opportunity for local farmed fish production (and in the case of aquaponics also vegetable production), as a way to provision protein with a lower environmental impact than the comparative terrestrial sources. With a growing world population and increasing food needs, providing sustainable food is critical. This project with focus on determining the environmental impact of cold weather aquaculture and aquaponics, and may focus more on particular areas such as life cycle assessment, economics, survey, or outreach, dependent on the skills and interests of the applicant. The overarching goal of this project is to reduce the environmental impacts of food production through an increased dependency on aquaponics.
Qualifications Required	A quantitative background, across all areas of STEM and business.
In-Person Tasks	Collaborating with the Hicks research lab, Literature review, Data collection, Data Analysis
Virtual / Remote Tasks	Student must be in Madison, WI for the summer.
Approx. Work Hours / Week	10-20 hours per week (depending on interest and agreed upon scope)
Keywords	sustainability, aquaculture, food, aquaponics

Project Title	Monitoring and modeling water fluxes in Wisconsin Central Sands combining remote sensing data, machine learning, and Citizen Science data
PI Name	Jingyi Huang jhuang426@wisc.edu
PI Affiliation	UW-Madison, Department of Soil Science
Project Description	Professor Huang's lab (Soil Sensing & Monitoring Lab, https://soilsensingmonitoring.soils.wisc.edu/) has been developing high-resolution soil moisture and water flux (e.g., evapotranspiration) models in collaboration with colleagues by combining remote sensing imageries, maps of land surface parameters with machine learning algorithms. The models are being validated in Wisconsin and nationwide. Currently, Dr. Huang' lab is collecting Citizen Science data and integrating them into the soil moisture and water flux models for mapping field-scale variations of soil moisture and evapotranspiration in Wisconsin Central Sands. The lab is looking for undergraduate researchers who are interested in soil moisture monitoring and modeling to collect Citizen Science data using handheld soil moisture probes across Wisconsin Central Sands regions during the summer of 2022 to improve the accuracies of the models for water resources management in Wisconsin. The undergraduate researchers will obtain hands-on experience on collecting soil moisture data in the field and have the opportunity to learn R programming for applying machine learning models for soil moisture and water fluxes mapping.
Qualifications Required	Be able to drive a UW vehicle to collect field based soil moisture data; interested in water-related research; experiences in programming in R is desirable but not necessary; interested in learning R programming for machine learning modeling;
In-Person Tasks	Using handheld soil moisture probes to collect ground-truth soil moisture data cross the Wisconsin Central Sands irrigation district; Using the collected soil moisture data (Citizen Science data) for calibrating soil moisture models pre-established using remote sensing data and machine learning models
Virtual / Remote Tasks	Optional: learning machine learning modeling using R software. Reference course materials: Soil Sci. 585 (Summer Semester, Online): https://soilsensingmonitoring.soils.wisc.edu/teaching/
Approx. Work Hours / Week	20
Keywords	Soil moisture; Irrigation; Machine Learning; R Programming; Citizen Science;

Project Title	Environmental fate of aquatic pesticides
PI Name	Christy Remucal remucal@wisc.edu
PI Affiliation	UW-Madison
Project Description	Pesticides are routinely added to surface waters, such as lakes and rivers, to control invasive species. For example, 3-trifluoromethyl-4-nitrophenol (TFM) is added to tributaries of the Great Lakes to control the parasitic sea lamprey. Our team is studying the environmental fate of TFM, including degradation processes and physical transport. During the summer of 2022, we will study the fate of TFM when it is applied by US Fish & Wildlife staff to at least one tributary of either Lake Michigan or Lake Superior. We will also conduct field experiments using well-characterized chemical tracers at the treated site. Samples will be collected and brought back to UW-Madison for analysis, where we will also conduct laboratory photodegradation and sorption experiments. This project is a collaboration between Prof. Christy Remucal (UW-Madison; chemical analysis and degradation) and Prof. Adam Ward (Indiana University; hydrologic modeling). The undergraduate student will work closely with a UW-Madison graduate student and will spend part of the summer in the field working alongside 2-3 other students. This project is an opportunity to gain experience both in the field and in the laboratory, as well as to work on an interdisciplinary team to study chemical fate in aquatic systems.
Qualifications Required	The undergraduate should be pursuing a degree in environmental engineering, environmental science, chemistry, or a related field. A driver's license and good driving record (>2 years) is required to drive field vehicles. Prior laboratory and/or field work is helpful, but not required; we will teach all needed sampling and analytical skills.
In-Person Tasks	The undergraduate student will be part of a team studying TFM fate in at least one river during the summer of 2022 Part of the summer will be spent at the field site (location and timing TBD, but likely in the upper peninsula of Michigan in the first part of the summer); housing will be provided through the research project while in the field. Specific field tasks include water and sediment sample collection, as well as assisting with field tracer experiments. The rest of the summer will be spent on the UW-Madison campus in the Water Science and Engineering Laboratory, with housing arranged by the student using SROP funds. The student will assist with analyzing field samples for TFM and the tracers using high-performance liquid chromatography, as well as with conducting laboratory photodegradation and sorption experiments.
Virtual / Remote Tasks	The research opportunity is meant to be fully in person. However, there will be opportunities for flexible work location when processing data and reading papers.
Approx. Work Hours / Week	40
Keywords	Pesticides, environmental fate, water quality, invasive species, chemistry

Project Title	Autonomous Electrochemical-Photothermal System for Energy, Nutrient, and Water Recovery from Animal Manure
PI Name	Mohan Qin mohan.qin@wisc.edu
PI Affiliation	UW-Madison, Civil and Env Eng
Project Description	Manure, generated by animals grown to produce agricultural products such as milk, meat, and eggs for human consumption, is one of the most complex waste streams to manage. Animal manure is considered as valuable agricultural resources, since it is a primary source of plant-available nutrients including nitrogen and phosphorus. However, inappropriate application of animal manure might lead to serious air, water, and soil contamination. In addition, conventional technologies, such as anaerobic digestion and incineration, are incapable of sufficient resource recovery, owing to their technical challenges and high energy cost. The proposed research will develop a self-sustained bioelectrochemical-photothermal system to overcome the challenges associated with the conventional animal manure treatment and implement a dual purpose zero liquid discharge and resource recovery. Zero liquid discharge of animal manure, which eliminates any liquid waste from the facility boundary, can minimize the volume of manure and produce clean water for reuse. In addition, valuable resources such as nutrients and diverse forms of energy can also be extracted from animal manure, making it a renewable resource pool.
Qualifications Required	n/a
In-Person Tasks	Water quality analysis, operation of lab-scale reactors
Virtual / Remote Tasks	Reading papers, writing progress report
Approx. Work Hours / Week	30
Keywords	Resource recovery, sustainability, bioelectrochemical systems, membrane

Project Title	PFAS Sensors for Water Quality Monitoring
PI Name	Haoran Wei
PI Affiliation	UW-Madison, Environmental Chemistry and Technology,
Project Description	Per- and polyfluoroalkyl substances (PFAS) are a family of over 4,000 man-made chemicals that have been released into the environment for decades. Because they are extremely difficult to break down in natural environments, PFAS are also called the "forever chemicals". PFAS have been detected in the blood samples of 97% Americans and considered an urgent concern for human health. One of the major routes for human exposure to PFAS is via drinking tap water. For this reason, a growing number of states across the US are regulating PFAS in drinking water. To alert people of PFAS contamination in tap water, fast, cheap, and onsite detection of PFAS is required, which, unfortunately, cannot be fulfilled by the current grab-sampling and laboratory-based analytical methods. The overall goal of this project is to develop an innovative sensor for inexpensive and rapid PFAS analysis in drinking water supplies. To achieve this goal, hollow molecules that can strongly and selectively bind with PFAS will be used to enrich PFAS onto the sensor surface via “lock-and-key” interactions. Subsequently, the sensor will generate light signals that contain the identity and concentration information of PFAS. How the background molecules in tap water affect PFAS detection will also be carefully investigated. The sensor developed in this project could be deployed in field to monitor the spatial and temporal fluctuation of PFAS concentrations in drinking water supplies and provide guidance for data-driven action plans for PFAS contamination and for reducing human exposure to PFAS.
Qualifications Required	None
In-Person Tasks	Conduct experiments in the laboratory.
Virtual / Remote Tasks	Analyze data, give presentations
Approx. Work Hours / Week	10-20 hours/week
Keywords	PFAS, Sensor, Water

Project Title	Investigating the ability of micro- and nanoplastics to contaminate groundwater systems in Wisconsin
PI Name	Christopher Zahasky czahasky@wisc.edu
PI Affiliation	UW-Madison
Project Description	Massive quantities of micro- and nanoplastics (collectively termed colloidal plastics) exist in the environment due to the degradation of macroplastic waste in terrestrial and aquatic environments. Transport and retention in simplified porous media has been well constrained and mechanistically described. However, we lack quantitative understanding and prediction of how colloidal plastics travel in dynamic geologic systems where they are influenced by a complex combination of variable fluid flow conditions and physical and chemical heterogeneity. As a result, there is a critical need for understanding dynamic colloidal plastic transport to determine the vulnerability of groundwater systems to contamination by these very small plastic particles. The objective of this project is to develop a better understanding of how colloidal plastics travel in the subsurface. The project will focus on acquiring laboratory measurements of the transport of plastics particles through representative geologic materials so that it will be possible to better quantify the potential risks of micro- and nano-plastic contamination in groundwater systems. The work will emphasize hands-on experimental measurements and data analysis, with opportunities for more advanced modeling depending on student interest. The student will collaborate with other undergraduate students, graduate students, and faculty to complete this project.
Qualifications Required	None but experience with Excel and/or programing (any language) is a plus.
In-Person Tasks	Run column experiments measuring the amount of plastic that is transported through different soils and geologic media from WI. Column or core preparation, possibly including laboratory rock coring.
Virtual / Remote Tasks	analyze data
Approx. Work Hours / Week	As many as desired
Keywords	hydrogeology, groundwater, water resources, contaminants

Project Title	Examining Seasonal Patterns in Trace Metal Bioaccumulation in Algal Species from Madison Lakes
PI Name	Sarah Janssen sejanssen@wisc.edu; sjanssen@usgs.gov
PI Affiliation	USGS, UW-Honorary Associate
Project Description	Ecological successions of phyto- and zooplankton play an important role in temperate ecosystems, potentially altering the bioaccumulation of contaminants and the distribution of trace elements. This project aims to identify plankton species and concentrations of contaminant (Hg, Cd, Pb) and biologically relevant (Fe, Cu) trace metals over ecological succession in Lakes Mendota and Monona. Seasonal changes in plankton communities will be assessed via previously collected plankton samples (Winter-Spring 2022) as well as new samples collected through the summer. The student will work closely with graduate students currently examining Hg dynamics in the lakes to learn sampling and analysis procedures including plankton identification and metals analysis via mass spectrometry. In addition, the student will also learn trace metal clean techniques for processing samples and Hg analysis at the USGS Mercury Research Lab in Madison, WI. This interdisciplinary project will yield important information regarding plankton assemblages and changes in metal speciation that can be useful in informing fish consumption advisories across Wisconsin lakes.
Qualifications Required	Coursework in general chemistry and general biology including lectures and lab courses
In-Person Tasks	Collection of plankton samples from Lakes Mendota and Monona at minimum monthly, processing and analysis of samples using trace metal clean procedures, training and operation of instrumentation, group meetings
Virtual / Remote Tasks	Data processing and interpretation, writing
Approx. Work Hours / Week	40
Keywords	water chemistry, food web, limnology

Project Title	Interaction of Microplastics and Harmful Algal Blooms in Lakes
PI Name	Erica Majumder emajumder@wisc.edu
PI Affiliation	Bacteriology
Project Description	The increase in agricultural and urban runoff contributes to Harmful Algal Bloom (HAB) formation in the Great Lakes and nearby water systems. Both forms of runoff contribute to HABs by providing nutrients and pollutants to stimulate growth of HAB causing species, which produce neurotoxins such as microcystins and threaten water supplies and recreational use of waterways. Microplastics (MPs) are being detected at increasing concentrations in the runoff, lakes, and surrounding watershed, however, the direct effect of MP contamination on HAB formation and toxin production is largely unknown. To investigate the impacts of MPs on the growth and toxin production of HAB causing species, we have designed experiments to elucidate microbe-plastic interactions both in the environment and within lab cultures. Environmental studies will involve field sampling using a novel filtration device designed to separate particulate matter as it passes through the REASON project sensors in the Moses Saunders Power Dam across the St. Lawrence River, while lab studies will utilize statistical Design on Experiments to identify key characteristics of MPs which influence growth and toxin production of cyanobacterial strains isolated from a HAB in Lake Erie. Results from these experiments will be used to identify key opportunists who are growing and transporting on MPs in the St. Lawrence River while simultaneously characterizing the properties of MPs which play a role in HAB formation and intensity.
Qualifications Required	Coursework in (environmental) chemistry, microbiology and biochemistry is helpful but not formally required.
In-Person Tasks	Maintain and deploy our passive sampler for collecting particulate matter from lakes. Extract microbial biofilm and adhered small molecules from surface of plastics. Submit microbial DNA for community sequencing. Assist in chemical identification of plastics and attached small molecules.
Virtual / Remote Tasks	Some data analysis can be done remotely/virtual
Approx. Work Hours / Week	20-40
Keywords	microplastics, harmful algal blooms, toxins

Project Title	Classifying Ownership & Governance of American Water Utilities
PI Name	Manny Teodoro mteodoro@wisc.edu
PI Affiliation	La Follette School of Public Affairs
Project Description	This project will develop a system for classifying ownership and governance institutions for drinking water utilities in the United States. The American water sector is composed of roughly 50,000 community drinking water systems. These systems are operated by general purpose local governments, special districts, nonprofit cooperatives, private companies, and investor-owned corporations. A growing research literature demonstrates that different institutional structures create different institutional constraints and incentives for the operators of these critical systems. However, to date there is no comprehensive system for classifying these institutional structures. The student researcher will become familiar with water governance in the U.S. and participate in collecting and analyzing institutional data on a sample of approximately 1,500 drinking water utilities. The project's results will demonstrate the value of a comprehensive typology and advance our understanding of water sector governance by facilitating future research on the effects of ownership and governance on environmental and health outcomes.
Qualifications Required	Strong English language communication; basic statistics. Familiarity with American state and local government organization is a plus.
In-Person Tasks	Occasional meetings with the PI.
Virtual / Remote Tasks	Online data collection, compiling, reporting, and analyzing quantitative data.
Approx. Work Hours / Week	30
Keywords	Policy, governance, management, politics, institutions