Possible REU Mentors and Projects 2021

IMPORTANT: we do not yet know whether we will be able hold our REU program in person at the Biological Station. If not, we will offer an online version. However, if the program is online, the available mentors and projects will be different from those listed here, but we do not yet know what those projects will be; in most cases, mentors will provide students with data that were collected previously but not yet fully analyzed, interpreted, and presented. We apologize about this uncertainty, and encourage you to check back frequently for updates.

UMBS forest ecosystem study

Chris Gough, Virginia Commonwealth University and Chris Vogel, University of Michigan

Forests of northern Michigan provide ecosystem services including the capture and sequestration of carbon, retention of nutrients, maintenance of organismal and ecosystem diversity, and protection of surface and ground water quality. Our collaborative team conducts research on the scientific underpinnings of these ecosystem services, with particular emphasis on plant and ecosystem ecology, disturbance ecology, ecological succession, and carbon and nitrogen biogeochemistry.

We conduct this research in a variety of settings, including a 20-year experimental forest with a long-running carbon "flux" tower, two landscape-scale experimental disturbances in which >10000 trees were stem girdled, a pair of long-term chronosequences with stands from 20 to >200 years old, and a new experimental manipulation of disturbance severity in which tree mortality will range from 45 to 85 %.

REU student collaborators on the UMBS Forest Ecosystem Study team have numerous research options. Some examples include: 1) disturbance, climate, and forest age effects on carbon cycling; 2) mechanisms supporting carbon storage stability following disturbance; and 3) remotely sensed ecosystem structure-carbon cycling relationships.

Effects of climate-induced forest disturbance on insect communities

Brian Scholtens, College of Charleston and Dave Karowe, Western Michigan University

Temperate forests are likely to experience more and stronger disturbances due to future climate change. For instance, droughts, increased pest populations, and increased pathogen outbreaks may result in substantial mortality of some tree species. The FASET (Forest Accelerated Succession ExperimenT) at UMBS mimics these types of disturbances; approximately a decade ago, over 7,000 aspen and birch trees were selectively girdled and subsequently died within the 40-hectare experiment. Twenty subplots have been monitored closely since girdling, and represent a wide range of disturbance severity (depending on how many aspen and birch trees they initially contained). This allows researchers to ask how disturbance severity affects many other aspects of forest ecology. For instance, an REU student could design a study to determine whether climate-induced forest disturbance alters insect communities (flying, ground dwelling, or both), which physical changes in disturbed forests have the greatest impact (light, temperature, etc), and whether disturbance particularly benefits invasive species.

Songbird distributions and species interactions in a changing climate

Jason Tallant, UMBS and Jordan Price, St. Mary's College of Maryland

The wood-warblers (family Parulidae) represent North America's most spectacular adaptive radiation. These 27 songbird species are strikingly diverse in their plumage patterns and songs, and they have been the focus of numerous studies of ecological and behavioral differentiation. Climate change will result in altered geographic ranges as species redistribute themselves across the landscape. Although birds are highly mobile species, their dispersal will be constrained by the slower movement of less mobile species, such as the plants of their preferred habitats. Variable dispersal abilities among species will result in new ecological communities, leading to new interactions among species.

The Audubon Society recently published a report containing detailed predictions of future suitable habitat, and therefore future geographic range, for hundreds of North American bird species (Survival by Degrees: 389 Bird Species on the Brink; https://www.audubon.org/climate/survivalbydegrees). An REU student could download the data files used for this report and generate detailed maps of future geographic ranges of several species. These maps could then be used to calculate change in range overlap between pairs of species, which can be used to infer future changes in competition, predation, and hybridization among North American bird species. Field work could be included to evaluate and compare the plant communities that comprise current suitable habitat for bird species of interest.

Interaction of stream flow and benthic organisms

Paul Moore, Bowling Green State University

Stream flow is the primary abiotic factor influencing stream ecosystem function. Physical forces associated with the flow can affect in-stream organisms such as crayfish and macroinvertebrates. However, natural systems have increasingly been under siege through flow alterations in the form of dams, land use, and extreme precipitation events (storms and droughts) due to climate change. An understanding of the direct and indirect pervasive effects associated with the natural flow regime is crucial to identifying and predicting responses of organisms (and by extension ecosystem processes) to flow alterations. How organisms respond to flow can also enhance our interpretation of any evolutionary adaptations to flow. All of this is vastly important when we consider human influence on natural systems in the context of global climate change.

My lab takes a broad approach to aquatic ecology in lakes and streams. We have done projects on predator-prey interactions with bass and crayfish, social behavior in crayfish, ecotoxicology in flowing and stagnant systems, and aquatic habitat restoration. Students working with the lab will get the chance to design projects on a variety of areas addressing the effects of climate change on aquatic ecology. For instance, an REU student could conduct an in-depth examination of the response of benthic organisms (e.g. caddisflies, mayflies, and stoneflies) and/or crayfish to changes in stream flow regime (velocity, magnitude or rate of change, drought, etc.).

Climate change and the ecology of damselflies

Jordan Price, St. Mary's College of Maryland

Climate change is likely to affect stream ecosystems in a variety of ways, including water temperature, flow rate, and vegetation composition. Dark-winged or Ebony Jewelwing damselflies (*Calopteryx maculata*), which develop as larvae in streams and live as adults at the land-water interface, are therefore likely to be affected as well. An REU student could investigate the effects of various stream parameters on damselfly morphology, behavior, and infections by gregarine parasites. This project would involve fieldwork, behavioral observations, damselfly collection, and analysis of parasite loads.

Climate-induced forest disturbance and biogenic volatile organic compounds

Steve Bertman, Western Michigan University

The forests of northern Michigan have undergone much change in the last 100 years. Currently regrowing from widespread clearcutting, they are strongly affected by the changing climate. Future species distribution will depend on how temperature and soil moisture change in the next several decades, and emissions of biogenic volatile organic compounds (BVOC) into the atmosphere will depend on species distribution. BVOC drive the atmospheric chemistry that determines the composition of the atmosphere near the earth's surface. For example, production of tropospheric ozone, the third most abundant greenhouse gas, is strongly affected by the amount and the mixture of BVOC emitted into the atmosphere. Surveys of white pine saplings in two UMBS forests have determined that intermediate forest disturbance influences the physiological response of BVOC production. The limited range of disturbance currently available hampers the strength of conclusions that can be drawn, so a new large-scale experiment will start this summer. We will look at BVOC composition in paired plots with a prescribed level of disturbance. An REU student would collect samples from different species in all the plots and measure the concentrations using GC-MS.

Global atmospheric change and carnivorous plants

Dave Karowe, Western Michigan University

Fossil fuel burning results in emissions of nitrogen-containing gasses into the atmosphere, and this nitrogen eventually returns to the land surface. Depending on the emissions scenario we follow during the 21st century, nitrogen deposition from the atmosphere could increase or decrease. Carnivorous plants, such as pitcher plants and sundews, use their leaves to capture both carbon and nitrogen. However, they experience a trade-off between these two goals, since green tissue is best for photosynthesis but red tissue is best for prey attraction.

An REU student could determine whether, in response to altered availability of atmospheric nitrogen, carnivorous plants are able to adjust their investment in nitrogen capture traits vs. carbon capture traits. For instance, an REU student could design a study to ask whether pitcher plants alter the ratio of red to green leaf tissue when exposed to future higher amounts of atmospheric nitrogen deposition.

Global change impacts on forest soil: the Detrital Input and Removal Treatments (DIRT) project

Knute Nadelhoffer, University of Michigan and John Den Uyl, University of Michigan

Globally, soil contains more carbon than the atmosphere and all living biota combined. A large fraction of this carbon is stored in the form of soil organic matter (SOM), which consists primarily of decomposing plant and animal tissues and soil microorganisms including bacteria and fungi. As climate change continues to threaten the integrity of our ecosystems, it is increasingly important to understand the mechanisms behind SOM development and stability. SOM plays a critical role in ecosystem function, contributing significantly to water and nutrient retention, pollution mitigation, and carbon sequestration. Small changes in the balance between nutrient fluxes between the soil, biosphere, and atmosphere can have considerable impact on global carbon and nitrogen cycles.

The Detrital Input and Removal Treatments (DIRT) at the University of Michigan Biological Station were established in 2004 to investigate how differential inputs of detritus (in the form of roots, wood, and leaf litter) contribute to the formation, degradation, and stability of SOM in north temperate forests. After more than 15 years of continuous organic matter manipulations, DIRT provides a unique environment to conduct research aimed at broadening our understanding of how forest soil may respond to future global change. There are numerous research opportunities to investigate how these manipulations influence forest carbon cycling, soil water chemistry, and earthworm communities. REU student collaborators involved in our field and lab work will conduct guided research and gain fundamental skills in forest ecology and ecosystem science relevant to careers in research, education, and resource management.

Mercury bioaccumulation in terrestrial carnivores

Jill Witt, University of Michigan, Flint

Coal-fired electric power generator plants are one of the main anthropogenic sources of atmospheric mercury worldwide. Inorganic mercury, once deposited, can become biologically available as methylmercury and transfer into both aquatic and terrestrial food webs. Toxicity can occur when mercury is transferred up the food chain, biomagnifying as it moves from primary producer, to prey, to predator, and high tissue concentrations can result in detrimental physiological and behavioral effects on top consumers. Mercury deposition in terrestrial ecosystems, and the potential for conversion to a biologically available methylmercury, can vary regionally and by forest cover, potentially leading to differing risks in bioaccumulation and toxicity for wildlife. In a previous study of terrestrial mercury, we found that mercury is bioaccumulating in hair and tissue of American marten (*Martes americana*), a predator species found in mature forests from across northern Michigan and the Upper Peninsula. An REU student would have the opportunity to explore his/her own questions of how future climate scenarios, which differ in the extent of switching from coal to clean energy sources, could influence atmospheric mercury deposition and therefore impact bioaccumulation of mercury in terrestrial food chains. Additionally, the student could assess mercury bioaccummulation in relation to diet, habitat, or other factors, and he/she could develop and test non-invasive methods of mercury sampling in terrestrial carnivores. The selected student would gain experience in laboratory chemical analyses, field data sampling, and/or GIS spatial analyses.

How will fluctuating Great Lakes water levels affect the ability of coastal wetlands to mitigate nutrient pollution?

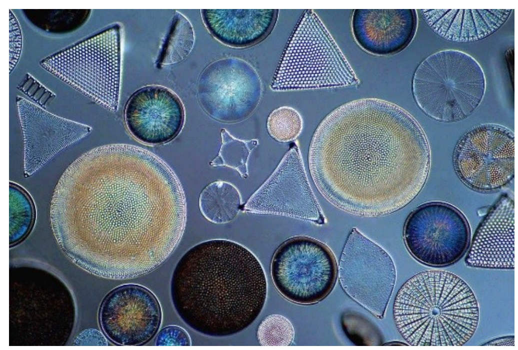
Shane Lishawa, Loyola University Chicago and Beth Lawrence, University of Connecticut, Storrs

Coastal wetlands play an essential role in mitigating nutrient pollution input into the Great Lakes. Due to climate change, future Great Lakes water levels are predicted to be much more variable, with both more high water periods and more low water periods. It is not yet known how fluctuating water levels will affect the ability of coastal wetlands to retain nutrients such as phosphorus (the limiting nutrient for most freshwater ecosystems). An REU student could evaluate the role of Great Lakes coastal wetlands, such as the nearby Cheboygan Marsh, in mitigating nutrient pollution under climate change induced water level extremes. For instance, an REU student could use controlled mesocosm experiments to measure phosphorus retention under various combinations of manipulated extreme water levels, dominant plant species, and soil types. These experiments could be supplemented by field work looking at connectivity and water movement between open lake and interior of wetlands and/or vegetation change along transects sampled during a previous low-water period.

Paleolimnological signals of climate change

Rex Lowe, Faculty Emeritus, BGSU and Pat Kociolek, University of Colorado

As the climate warms in northern Michigan concomitant changes occur in northern lakes. There are longer ice-free periods in winter and more intense thermal stratification during the summer. This potentially leads to changes in the quality and quantity of phytoplankton in lakes. The history of these changes can be investigated in lake sediments as microorganisms fall to the bottom of lakes. An REU student could examine the relationship between recent climate change and phytoplankton communities in Douglas Lake at UMBS by taking a core of the sediments, analyzing the diatom community and examining correlations with environmental parameters such as temperature and precipitation.



Effects of climate-induced changes in streamflow on algal communities

Bob Pillsbury, University of Wisconsin-Oshkosh, Dave Karowe, Western Michigan University, and Paul Moore, Bowling Green State University

Algae that attach themselves to solid substrates such as rocks and woody debris (benthic algae) are the base of the food chain in many temperate streams. Streamflow - the velocity and turbulence of water flowing in these ecosystems - is a primary factor shaping benthic algal communities. Streamflow regimes are already being affected by anthropogenic climate change. In the future, climate change is very likely to result in further increases in the frequency and severity of extreme precipitation events, and therefore extreme streamflow events. Increasing periods of both high and low flows may have dramatic effects on the community composition of benthic algae. An REU student could use the UMBS

Stream Lab to experimentally expose native algal communities to altered streamflow regimes and use microscopy to answer questions about changes to algal species, genera, and communities. For instance, do certain species benefit from increased high flow periods? Increased low flow periods? Are there morphological or phylogenetic characteristics that predict species responses to altered flow regimes?