2023 Research Symposium Abstracts

Talks

Seasonal extremes: Understanding the role of macrophyte phenology on water quality in Lake Wingra
Adrianna Gorsky, PhD student, Freshwater and Marine Sciences Program, UW–Madison

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 and methane. However, emissions can vary greatly with high levels of within-lake spatial variation and distinct zones of open water and littoral habitats. Macrophytes or aquatic plants play an important role in the function of these ecosystems by increasing habitat complexity and water clarity. Lake Wingra is a shallow lake that is fed by urban stormwater runoff and groundwater in Madison, Wisconsin, and borders the Arboretum on its southern shore. Lake Wingra has undergone key management interventions, such as a carp removal in 2008, which has led to the recovery and establishment of a healthy macrophyte community and a clear-water-phase. This study aimed at increasing our understanding of greenhouse gas production on a scale similar to the life cycle of a macrophyte. In particular, we were interested in answering: how spatial heterogenous is gas production across Lake Wingra? And how does the annual phenology of macrophytes influence emissions? Exploring the spatial variation of greenhouse gases across seasons will provide insight for future management priorities for urban shallow lakes.

Coauthors: Hilary Dugan and Emily Stanley

Carbon dynamics of a long-term litter manipulation experiment in Curtis Prairie
Mia Keady, PhD student, Nelson Institute for Environmental Studies, UW–Madison

Soil contains the greatest stock of terrestrial carbon, yet factors contributing to how carbon accumulates and persists are still being disentangled. Large stocks of carbon are stored in soil organic matter (SOM) – the living, dead, and decomposing soil fraction. The UW–Madison Arboretum's long-term research trial, Detrital Input and Removal Trial (DIRT), provides an opportunity to study changes in soil carbon under additions and removal of litter and roots. DIRT plots were established in 1956 in the Arboretum's restored Curtis Prairie, Noe Woods, and Wingra Woods, and they serve as important long-term monitoring sites. In Curtis Prairie, treatments include: bare (no litter or roots), harvested (plant biomass removed each fall and added to mulched sites), mulched (no living plants, litter added from harvested treatment), burned, and control. Preliminary results indicate that after 66 years, all treatments with below-ground or above-ground inputs have significantly greater SOC concentration in the surface 10 cm than bare treatments (ANOVA & TukeysHSD $p < 0.05$). This indicates that both below-ground and above-ground inputs are important to building SOC at the surface, yet we observed differences in the rate of carbon accrual over time by treatment. Further analyses will determine if these trends are consistent in deeper soils and will assess different pools of carbon, which are important for understanding mechanisms for SOC change. My findings provide a long-term assessment of factors contributing to carbon accumulation and have the potential to aid management to increase carbon stocks in the face of climate change.

Coauthors: Randall D. Jackson, Thea Whitman

Environmental education and behavior change

Ben Douglas, PhD student, Department of Psychology, UW–Madison

Despite the dire need to promote sustainability and responsible land stewardship, many individuals have not yet realized their full potential towards these efforts. I will review psychological mechanisms to promote behavior change, how those can be implemented within the field of sustainability, and how these actions can be implemented within community settings, such as the Arboretum. To this end I will discuss recent findings from a study in which we tested how moral values can be used to frame the discussion around pro-climate policies. Moral Foundations Theory suggests that certain moral values appeal to individuals differentially based on their political affiliation. Two moral foundations, proportionality and liberty, were recently proposed and were also expected to appeal to those on the political right without backlash from the political left. We recruited 1,088 participants to complete an online survey in which they were exposed to one of three videos about pro-climate policy. Participants watched a video which evoked the proportionality moral foundation, the liberty moral foundation, or no moral foundation. We found that watching the proportionality and liberty videos increased participant's policy support, likelihood to contact their representative regarding the act, and their endorsement of the video's message. I will discuss how these findings can inform future studies and increase engagement with environmental education programs.

Changes over time of the Curtis Prairie plant community

Mary-Claire Glasenhardt, MS student, Nelson Institute for Environmental Studies, UW–Madison

Ecosystems change over time. For conservation ecology, the goal is the preservation of the earth's native ecosystems and the biodiversity that they contain. To accomplish these goals, long-term monitoring is essential as it reveals trends. As one of the first scientifically guided tallgrass restoration projects, Curtis Prairie is the focus of this research. Adding to a history of plant community surveys dating to 1946, my lab partner Isaac Bailey-Marren and I collaboratively resurveyed Curtis Prairie in the summer of 2021. With the help of volunteers, we surveyed 1,011 m^2 plots collecting data on species abundance.

This is a summary of changes in Curtis Prairie since the first complete survey in 1951 with primary focus on change since the last survey (2002) almost 20 years prior. We asked: How has diversity changed since the last survey? How has the composition (list) of species changed? Which species have increased/decreased in abundance? Is Curtis Prairie becoming wetter? Are invasive species increasing in abundance? This evidence could provide valuable insights into the development of prairie restorations in general, as well as provide management targets for the UW–Arboretum.

Coauthors: Isaac Bailey-Marren and Paul Zedler

Spatial patterns in the vegetation of Curtis Prairie
Isaac Bailey-Marren, MS student, Nelson Institute for Environmental Studies, UW–Madison

Since ecological restoration began at the Arboretum in 1934, the patterns of biodiversity present in Curtis Prairie have been of interest to those who manage it. In the past, measures of biodiversity relied on taxonomic classification of plant species. While taxonomic data can be informative in telling us how many species occupy a space, their capacity to inform us how species do or do not coexist is limited. The advent of cheap(er) genomics has made it possible to quantify the evolutionary relationships of plant species found in Curtis, and trait data opens a window into how these plants survive the stresses they encounter every growing season.

This research combines plant survey data collected in Curtis Prairie by Mary-Claire Glasenhardt and myself, with trait data that was sourced from the TRY plant traits database as well as a phylogeny constructed by Spalink et al. It aims to answer some of the following questions: Where can we see plants facilitating/excluding their close relatives in Curtis? What traits are being favored/disfavored in certain regions of Curtis? How are these new measures of diversity useful when planning seed mixes?

Coauthors: Mary-Claire Glasenhardt, Paul Zedler

Posters

Stem density of invasive shrubs facilitate increased winter seed removal by small mammals
Mark Fuka, PhD student, Department of Integrative Biology, UW–Madison

Exotic plants can lead to significant changes in native habitats they invade. A growing body of evidence suggests that many ways exotic shrubs impact native plants is through indirect effects that may be of critical importance. For example, exotic shrubs may modify the structural complexity of invaded habitats, leading to increased activity of rodents and consumer pressure on seeds. This change in rodent granivory is important to understand because it can generate significant increases in seed consumption. While invasive plant modified granivory can be significant, it can also be highly variable among seasons and may coincide with when native seeds are most vulnerable. We manipulated the presence of a common widespread invasive species, *Rhamnus cathartica* (buckthorn), to examine seasonal effects of invasive shrubs on rodent seed removal. We used seed removal depots in summer, autumn, and winter to quantify seasonal trends in rodent granivory of three native tree species, *Tilia americana* (basswood), *Prunus serotina* (black cherry), and *Acer saccharum* (sugar maple), and the invasive shrub *Rhamnus cathartica*. Our results reveal a significant interaction of season and invasive shrubs: in summer and autumn, there was no effect of invasive shrubs on seed removal, but removal was 21% greater in invaded habitat in winter that varied by seed species. Habitat characteristics, like stem density, could be an important driver in seasonal seed removal within invaded habitats when vegetative cover is no longer present. Because the effects of invasive shrubs were greatest in the winter, understanding when seeds are most vulnerable may have important implications for overwinter seed survival.

Coauthor: John Orrock

Using warming chambers to understand plant community assembly

Michelle Homann, PhD student, Department of Integrative Biology, UW–Madison

Though established tallgrass prairies are composed primarily of perennial grass and forb species that maintain their populations through vegetative spread, sowing seeds is an integral step in the early stages of prairie restoration. Grasses are an inexpensive and resilient addition to seed mixes used for prairie restoration, and they serve important functions including stabilizing soil, reducing erosion, out-competing non-target species, and providing fuel for establishing a fire regime. However, dominant bunchgrasses seeded at high densities can lead to low-diversity restorations that lack desirable levels of forb richness and abundance by exerting priority effects, or the impact that arrival order of species has on long-term plant community composition. A changing climate is likely to impact native prairie grasses and forbs differently, creating pressures that alter plant-plant interactions, and potentially changing the magnitude of priority effects. To understand the impacts that arrival order and climate conditions have on prairie plant community assembly during the early stages of restoration, I will conduct a two-year study at the UW–Arboretum mesocosm. Beginning in March of 2024, I will sow pairwise combinations of four common prairie species into soil surrounded by plexiglass warming chambers and supplement growing-season precipitation in a subset of chambers. When compared to species planted in ambient conditions, I expect increased temperature to reduce priority effects, and increased precipitation to increase priority effects. The results of this study will inform management practices, namely when to sow seeds to achieve desired plant community composition.

Coauthor: Ellen Damschen

Do invasive shrub removal techniques affect small mammal granivory?

Eren Wolf, undergraduate student in Environmental Science and Conservation Biology, UW–Madison
Alexa Hanson, undergraduate student in Environmental Science, UW–Madison

Non-native invasive shrubs can rapidly colonize and disturb habitats with negative consequences for native flora and fauna. The Lost City invasive shrub management experiment at UW–Madison Arboretum models the dynamic effects of manual shrub removal and forestry mowing, with and without prescribed fire on native plants and small mammal behavior This model is further influenced by the presence of invasive jumping worms (*Amynthas* spp.), which affect soil structure and leaf litter layers. Do these combined factors influence the foraging behavior of granivorous small mammal species? We studied these behaviors by establishing trail cameras near feeding depots in 25 buckthorn management plots, in which animals could feed on the seeds of four common oak savanna plant species and jumping worm cocoons. The results can inform best land management practices for areas with interacting jumping worm and buckthorn populations.

Coauthor: Brad Herrick

Differential effects of shrub removal methods and prescribed burning on understory plant communities

Maxwell D. Nuckles, undergraduate student in Environmental Science, Edgewood College
Timothy R. Kuhman, associate professor, Division of Biological Sciences, Edgewood College

Restoration and management of oak woodlands in the Upper Midwest often involves the removal of non-native invasive shrubs to open the understory and promote regeneration of native understory vegetation. Prescribed burning is frequently used in combination with shrub removal methods to limit regrowth of woody invaders and favor fire-adapted understory forbs and graminoids. While hand-clearing of woody shrubs has long been used for mechanical removal of woody invasive plants, the use of forestry mowers by land managers has become increasingly common, particularly on larger restoration sites. However, little is known about the differential effects of hand-clearing and forestry mowing on the regeneration of native and non-native understory vegetation, and even less is known about how these methods impact the efficacy of using prescribed fire to promote restoration of forest understory communities. Forestry mowing results in the accumulation of course woody debris that is left on the ground following clearing, whereas hand clearing typically involves the complete removal of the cut shrubs. The differences in litter quality and quantity therefore can differ greatly between the two clearing methods and differentially affect understory plant regeneration. This study aims to compare these two shrub-removal methods and consider how each, with and without prescribed burning, might impact regrowth of native and non-native understory vegetation. Five sites were selected at the UW–Madison Arboretum's Lost City Forest in spring of 2021. At each site, five 20x20-m plots were established. Pre-treatment vegetation sampling was conducted in summer 2021. In fall of 2021, two plots at each site were hand cleared, two were cleared using a forestry mower, and one was left uncleared as a control plot. One hand-cleared and one mowed plot at each site were randomly selected to be burned in spring of 2022. Post-treatment vegetation sampling was conducted in summer 2022. Initial results suggest that while the percent cover of non-native invasive shrubs (especially common buckthorn, *Rhamnus cathartica*) was significantly reduced by both clearing methods, the number of new seedlings significantly increased in both the hand-cleared and mowed plots compared to the control plots. There was little effect of burning on percent cover or seedling recruitment. Impacts on native vegetation are still being analyzed, but preliminary results suggest that continued active restoration efforts such as native seeding, repeated burning, and/or subsequent removal of woody invasive species will likely be necessary for successful restoration of native understory plant communities.