2017 Science Day Abstracts

ORAL PRESENTATIONS

Jewelweed in Wisconsin: Are traits environmentally or genetically determined

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The landscape around us is changing at an unprecedented pace. Plant populations rely on their traits to respond and adapt to changes in their environment, especially since they can only relocate through seed and pollen dispersal. Trait variation within a species can result from temporary responses to the environment or encoded genetic differences. I used a classic common garden experiment to assess which mechanism controls trait variation in *Impatiens capensis* (jewelweed), a native Wisconsin herb, and to look for fitness differences between populations. I collected jewelweed seeds from 12 lowland forests and marshes in Wisconsin and grew them in the UW–Madison Arboretum. Even though plants were all grown in the same location, they showed significant differences in height, survival, and seed production depending on the population they were collected from. This suggests that populations harbor unique genetic differences. Understanding the mechanism and spatial patterns of trait differentiation within species helps to inform conservation decisions and predict plant responses to environmental change.

Vegetation and earthworm community changes in hardwood forests of the UW–Madison Arboretum

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Forests in the northern temperate region of the United States lack native earthworms, but many European and Asian earthworms are now prevalent in much of North America. Non-native earthworms significantly increase the rate of leaf litter decay and influence nutrient cycling by mixing the organic litter layer with the mineral soil, and have been shown to decrease plant species richness. In 2013 a new Asian earthworm genus, *Amynthas*, was found in the UW–Madison Arboretum in Wisconsin. This genus had previously invaded parts of the southeast and northeast United States, but was not present in Wisconsin, and little ecological information is known about *Amynthas* species. Understory vegetation and earthworm communities were surveyed in 2015 and 2016, showing a clear trend in the spread of *Amynthas*, but negligible impacts to plants and leaf litter. European earthworm communities have shifted along with the spread of *Amynthas*, suggesting potential earthworm competition and showing a need for future research on this newly invasive genus.

When two invasive species meet: potential interactions between Asian jumping worms and common buckthorn

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While most invasive-species research focuses on single species, the areas we live are often home to multiple invasives. These species can interact to cause even greater changes than they would individually, complicating management and conservation. My research explores potential interactions between two invasive species in the greater Madison region – common buckthorn and Asian jumping worms – and what this means for the surrounding environment and people. Buckthorn, a widespread shrub, is among the most harmful invaders in Midwestern U.S. forests, creating dense thickets that reduce carbon storage, impede recreation, and shelter harmful crop pests. The Asian jumping worm, discovered in Wisconsin in 2013, is a largely unstudied species of earthworm expected to impact local forests. In addition to their individual impacts, however, jumping worms and buckthorn may interact such that each species increases the success of the other. In collaboration with the UW–Madison Arboretum, I conducted paired field experiments to study both sides of this interaction: the effect of the Asian jumping on buckthorn germination and establishment. I will present the preliminary results of this field experiment, as well as future directions for Asian jumping worm research in Madison.

Invasive buckthorn degrades a classic animal-habitat relationship

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Understanding how animals use their habitat is a fundamental aspect of ecology that informs conservation and restoration efforts. However, invasive plants can radically change animal behavior, and as a result classic animal-habitat relationships are often weakened or non-existent in areas with invasive plants. By weakening animal-habitat relationships, invasive plants may challenge our ability to predict the effects of animals on plant communities. We investigated the potential for invasive buckthorn (*Rhamnus cathartica*) to alter small mammal use of woody debris, which provides important shelter from predators. To test this, we removed buckthorn from 7 of 15 plots in the Lost City and placed 200 tagged red oak seeds in each plot in November 2014. After five months, tags were recovered to track spatial patterns of small mammal seed consumption. In habitats without buckthorn, most seed consumption occurred near woody debris. In habitats with buckthorn, small mammals rarely consumed seeds near woody debris and seed predation occurred farther from the plot center. These results illustrate that using “old rules” of animal habitat use to predict animal activity can be misleading in habitats with invasive shrubs. Additionally, the changes we observed in animal habitat use were associated with increased small mammal space use, suggesting that seeds may need to disperse farther in invaded habitats to avoid being consumed. Ultimately, efforts to predict hotspots of animal activity in invaded habitats will need to incorporate potential behavioral changes caused by invasive plants.

The UW Urban Canid Project

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In its third year, The UW Urban Canid Project is researching urban red foxes and coyotes in Madison to better understand the relationship between these species, their habitats, and humans. By radio-collaring and tracking foxes and coyotes, researchers can better understand the day-to-day ecology of these animals, including habitat use, activity periods, and mortality. The project also relies on the help of the community for reported observations of red foxes and coyotes in Madison, which are used to learn more about how urban canids interact with humans to promote a positive co-existence between humans and urban wildlife.

Keynote address – Yahara 2070: Possible futures for the Yahara Watershed

Dr. Eric Booth, Assistant Research Scientist
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The Yahara River watershed – home to the UW–Madison Arboretum – is a complex social-ecological system facing many challenges related to land-use change, urbanization, climate change, and human demands. While researchers have learned a lot about how this system functions and has changed over the last several decades, predicting the changes to come in the next several decades is highly uncertain. How can we better prepare for the future given this complexity and uncertainty? We can start with scenarios, or provocative and plausible stories that guide quantitative simulations of the future. Narrative scenarios can help engage new and diverse audiences and foster creative solutions, while biophysical computer models can illuminate the logical consequences of these stories and their impacts on multiple ecosystem services. Together, these tools can help us understand how our decision-making today could impact our lakes and landscapes in the future.

This presentation will provide a summary of the scenario creation process and new model results that are a part of Yahara 2070 (Yahara2070.org), a set of scenarios created for the Yahara River watershed by the Water Sustainability and Climate Project at UW–Madison. It will also cover how the project has utilized data collected in three land-cover types within the Arboretum to improve performance of the biophysical model.

POSTERS

Sources and sinks for phosphorus in stormwater through a pond-prairie system

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Phosphorus in stormwater is an ongoing management problem in urban areas. The UW–Madison Arboretum is dedicated to research and restoration, but by virtue of its location (downslope from urban development and adjacent to Lake Wingra) it has had to manage the impact of increasing stormwater flows. Curtis Pond, a detention pond in the Arboretum, was designed to slow and treat stormwater discharge from several residential neighborhoods and a portion of highway. Effluent from the pond flows overland across portions of the restored Curtis Prairie before joining several other flow streams in an intermittent creek that flows into Lake Wingra. Previous monitoring through this system indicated that dissolved reactive phosphorus concentrations were sometimes higher in water leaving Curtis Prairie than concentrations leaving Curtis Pond. Since phosphorus sorption/desorption from soils and sediments can play a role in dissolved phosphorus levels, this study aims to quantify: (1) spatial and temporal variations in storm event phosphorus in the pond-prairie system and (2) the potential for pond sediments and prairie soil to affect phosphorus in stormwater. In 2016, concentrations of total phosphorus, dissolved reactive phosphorus, and total suspended solids were measured for eight storms at the inlet and outlet of the pond, and at the point where overland flow leaves the prairie. In addition, soil samples from three locations in the prairie and two locations in the pond were collected to be analyzed for equilibrium phosphorus concentrations (EPC0). Sediment and soil EPC) will be compared to dissolved reactive phosphorus concentrations in stormwater to evaluate potential phosphorus sources and sinks in the system.

The impact of soil pH, moisture, and the distance from the southern edge on species richness in Curtis Prairie at the UW Arboretum

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Species richness within a prairie plays a determining role in the overall health of the prairie ecosystem. Our research examined species richness along the southern edge of Curtis Prairie as it is affected by distance from the edge, soil pH, and soil moisture content. To test these factors, we sampled a total of 78 quadrats (1 m x 1 m) along 13 transects that ran from the prairie edge to 50 m north, towards the prairie interior. Within each quadrat, we recorded the species present, soil pH, and moisture content. We created a non-metric multi-dimensional scaling (NMDS) plot to illustrate patterns in community relationships from the data. We found that average species richness was greater along the edge versus the interior of the prairie. Quadrats near the edge (0 m and 10 m) showed more similarity to each other in species composition than to quadrats near the interior (20 m to 50 m), which were also more similar to each other. Average species richness was significantly greater in edge quadrats than in interior quadrats, and invasive species were more prevalent along the edge compared to interior. Our results did not suggest any significant relationship between pH and richness or between moisture and richness. The time of year likely influenced our results, and future studies should be conducted in the spring and summer to maximize species richness. Sampling a larger portion of the prairie could also provide a more conclusive overview of the prairie ecosystem as it is affected by the disturbance from the edge, soil, pH, and moisture.

Uncovering the secret winter life of the *Amynthas* jumping earthworm: cocoon abundance and temperature tolerance

Dr. Marie Johnston, Postdoc
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Invasive earthworms of genus *Amynthas* have presented an ongoing challenge for ecologists and professionals in natural resources conservation, first throughout the Eastern and Southeastern US and now recently in the Upper Midwest. These invasive earthworms are highly competitive in diet, grow rapidly to transform the soil to unconsolidated casts, and have a unique life cycle in which they overwinter as egg cocoons. Research is underway at the UW–Madison Arboretum to investigate (1) the abundance of *Amynthas* egg cocoons in the Arboretum forests, (2) the feasibility of rearing *Amynthas* earthworms in the laboratory, (3) the temperature limitations of their cocoon, and (4) the persistence of earthworm-worked soil aggregates. While much of this research is yet in progress, we have learned a few things. For example, a total of 1,711 *Amynthas* cocoons were sieved from soil from Gallistel and Wingra woods. The maximum abundance was 66 cocoons per 3" soil sample. Of these cocoons, more than 100 have hatched and the young earthworms are identical to adults except they are approximately 2 cm in length. We also now know that in captivity, 12 earthworms can produce more than 200 cocoons in 20 days. Cocoons produced via laboratory rearing have been exposed to varied heat and cold treatments over the last few weeks.

Survey of the mosquito fauna of the UW Arboretum

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Mosquitoes (Diptera: Culicidae) are an abundant group of organisms known for the blood-feeding behavior of the females and associated pathogen transmission by some species. These insects play an important role in the ecosystems they inhabit; the larvae are aquatic and the adults feed on the nectar and other plant fluids, both with potential to serve as bioindicators of environmental quality. The mosquito fauna of Wisconsin was last revised comprehensively by Dickinson (1944); since then, a few other studies have been carried out in the state, such that the knowledge of our state fauna has remained fairly static. Thus, to revive these studies and in consonance with recent efforts to map biodiversity in other parts of the U.S., and in the world in general, we performed a brief survey of the mosquitoes of the UW–Madison Arboretum, a 1,200-acre plot of land dedicated to restoring and maintaining ecological habitats native to Wisconsin. We utilized two units of the CDC Miniature Incandescent Light Trap and one of the Miniature Downdraft Blacklight (UV) Trap to sample three different areas. The collections sites were: 1) Lost City Forest (43.0422413, -89.4162058), a densely covered deciduous forest habitat on the eastern side of the Arboretum; 2) Wingra Woods (43.0469557, -89.4267955), a mature deciduous forest habitat which was the northernmost of the three collection sites; and 3) Teal Pond (43.041038, -89.4248445), which is both a coniferous and deciduous forest habitat, and is at the southernmost point of the three collection sites. The collection events occurred two times per week for a total of six weeks. The location of the traps remained consistent throughout the study. Traps were deployed between 2:30 p.m. and 4:30 p.m. and retrieved the next morning between 7:30 a.m. and 9a.m. The collected mosquitoes were dry mounted and deposited in the Wisconsin Insect Research Collection, and are still being identified. So far, four weeks' worth of collection events have been identified, yielding a total of 21species; these are: *Aedes cinereus*; *Aedimorphus vexans vexans*; *Anopheles* (*Anopheles*) *perplexens*; *Anopheles* (*Anopheles*) *punctipennis*; *Anopheles* (*Anopheles*) *quadrimaculatus* s.l.; *Anopheles* (*Anopheles*) *smaragdinus*; *Coquillettidia* (*Coquillettidia*) *perturbans*; *Culex pipiens*; *Culex restuans*; *Culex territans*; *Culex salinarius*; *Culiseta* (*Culiseta*) *inornata*; *Hulecoeteomyia japonica japonica*; *Ochlerotatus* (*Culicada*) *canadensis canadensis*; *Ochlerotatus* (*Ochlerotatus*) *trivittatus*; *Ochlerotatus punctor*; *Ochlerotatus sticticus*; *Ochlerotatus stimulans* s.l.; '*Ochlerotatus*' ('*Protomacleaya*') *triseriatus*; *Psorophora* (*Janthinosoma*) *ferox*; *Uranotaenia sapphirina*. This taxonomic survey serves as an invaluable insight into the biodiversity, bionomics and ecology of the fauna of the area.

Wood frog responses to changing climatic conditions

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Winter is the season of resource scarcity and energy deficits. To escape the harsh winter weather, many plants and animals persist within a warmer and more stable environment underneath the snowpack, the subnivium. This stable climate of the subnivium is dependent on deep, persistent snow that provides lasting insulation and protection through the winter months. Within the Great Lakes Region, the subnivium is historically important, yet winter conditions are changing rapidly. By 2050, mean winter temperatures are predicted to be 3–4˚C warmer, which will lead to reduced duration in snowcover and shallower and denser snowpack, all of which will lead to a colder and more variable subnivium. This degrading subnivium will likely have the greatest impact on animals that rely on a narrow range of stable temperatures for survival. Within the Great Lakes Region, wood frogs (*Rana sylvatica*) are a representative hibernator within the subnivium, and have been identified as sensitive to warming winter conditions. Wood frogs exhibit a sequence of physiological events typical of many freeze-tolerant amphibians that overwinter. While important for surviving the winter, hibernation is energetically costly, and the continued loss of the subnivium may threaten many of these species.