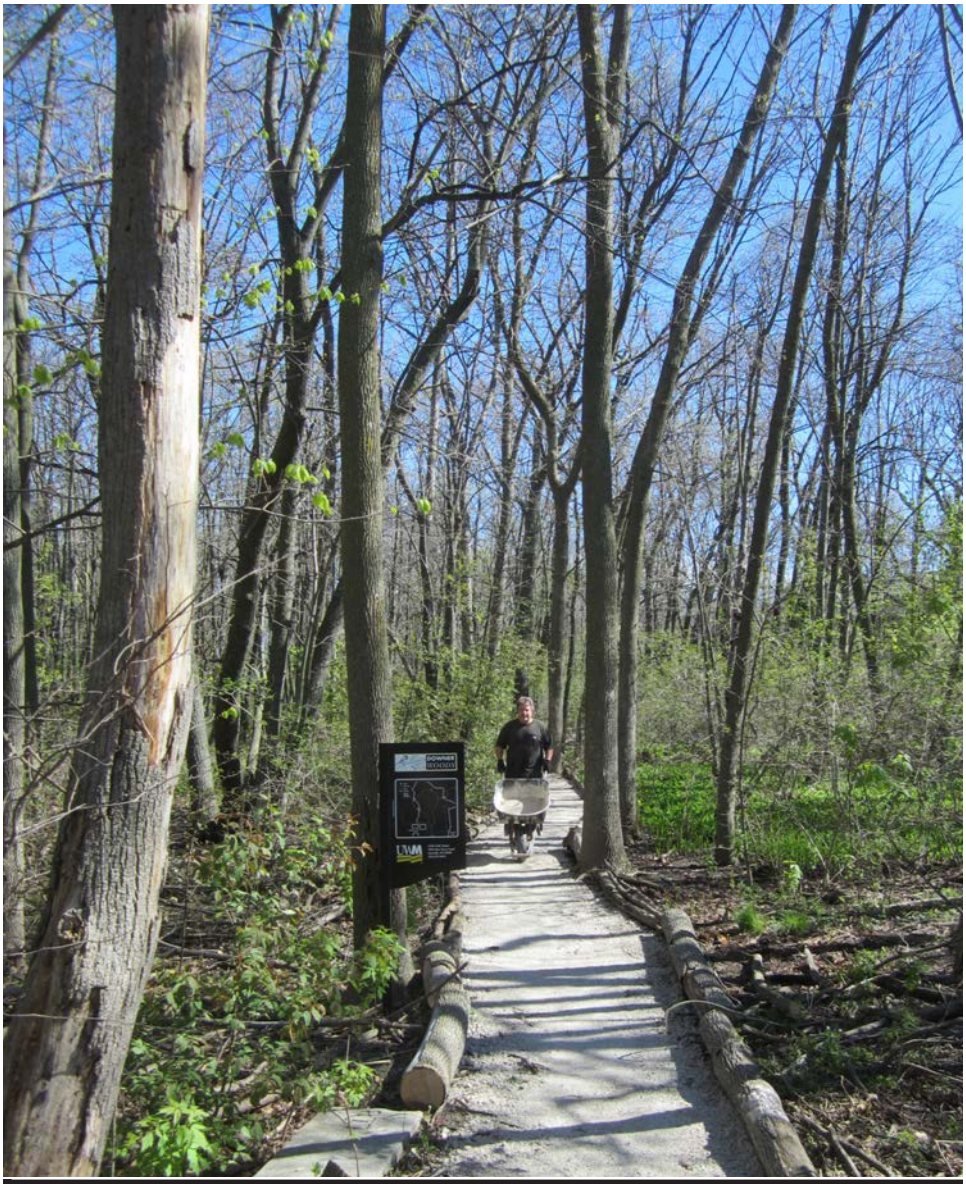
2020 Field Station Annual Report



UNIVERSITY of WISCONSIN
UWMILWAUKEE
Field Station

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On the Cover: Ben Glatzel uses a wheelbarrow to distribute gravel along the trails at Downer Woods. The entire trail system in Downer Woods was regravelled in 2020 (see Highlights). Photo by G. Meyer.

A digital version of the Annual Report with color photos can be found at the UWM Field Station website: https://uwm.edu/field-station/research/publications/annual-reports/.

About Us

The COVID-19 Pandemic

Normal life in 2020 was upended by the COVID-19 pandemic, and the Field Station was no exception. So much of what we do is based on people visiting our properties: to conduct research projects, to attend classes, or to participate in public events. Like so many other nature centers and educational institutions, we had to shut down in March of 2020. We had a full schedule of natural history workshops and public events planned for the spring and summer, but all of these had to be cancelled. We followed public health guidelines set by health departments and the university to determine what activities could be carried out safely, and adapted to the conditions created by the pandemic as best we could. We worked within these constraints to support research, education, and public outreach during the pandemic, although at a lower level than what we typically accomplish. Read on to see what we were able to do over this challenging year.

2020 Highlights

• The entire trail system in Downer Woods was regravelled by Field Station maintenance staff, Ron Tagye and Ben Glatzel. This trail maintenance is necessary because the soils of Downer Woods have a high clay content, making them muddy and slippery when wet. The trails in Downer Woods receive heavy use and require regular resurfacing. The newly gravelled trails have eliminated the wet, muddy areas that had previously developed following rainfall or snow melt.

• Peter Dunn was elected as a fellow of the American Association for the Advancement of Science for his work on evolutionary ecology of birds, particularly in sexual selection, mate choice and climate change impacts. Much of this work was conducted at the Field Station.

• The Prairie Enthusiasts, a non-profit group dedicated to the protection and restoration of prairies, entered into a management agreement with UWM to begin working to restore Benedict Prairie.

• The Friends of the Cedarburg Bog created a scholarship program to assist UWM undergraduates taking natural history workshops at the Field Station. The scholarship will pay the workshop fees for selected students. The first scholarships will be awarded in 2021, since natural history workshops had to be cancelled in 2020.

• The Researcher House was remodeled in 2020. The flooring in the living room was replaced and the living room and kitchen were painted, along with other improvements.

• The exterior of the garden shed was painted in 2020.

• We moved into fully online programming for the first time in 2020. This change was necessitated by the pandemic, but our online offerings proved to be popular and we will likely continue with some online events even when in-person programming is possible again.

• 27 research projects in 2020.

• Cancellations caused by the pandemic reduced our instruction and group use to 2564 hours, including both in-person and synchronous online use.

• The Friends of the Cedarburg Bog began producing educational videos. These videos are available for viewing on their YouTube channel.

The UWM Field Station

The UWM Field Station is used as an outdoor laboratory by researchers from various disciplines, including plant and animal ecology, evolutionary biology, ethology, taxonomy, geology, hydrology, and climatology. Located in the Town of Saukville, Wisconsin, about 30 miles (45 minutes) north of Milwaukee, the main Station facility has about 2000 acres including a wide variety of habitats available for research and teaching.

The University of Wisconsin-Milwaukee owns approximately 320 acres, most of which were donated by The Nature Conservancy in 1964. Research at the Station has produced 424 scientific publications and 153 theses since 1970.

The Field Station is also heavily used for teaching. Our Natural History Workshop program offers short courses (weekend to week-long) on various topics in field biology and environmental science. These workshops are open to non-credit students. They are popular with members of the general public and they provide continuing education opportunities for professionals. Many of our workshops are also open to UWM students for college credit, allowing UWM students to gain field experience and to interact with the non-credit students in the class. We also offer the semester class, Biological Sciences/Conservation and Environmental Science 451, Field Methods in Conservation, for UWM students. This class gives students an opportunity for hands-on learning in the natural areas available at the Field Station. Many classes from other universities and schools use our facilities and properties for field trips.

The Field Station has active outreach programs that invite the general public to visit our properties for hikes and other events. These programs are primarily sponsored by our Friends group, the Friends of the Cedarburg Bog.

Natural Areas at the Field Station

The Cedarburg Bog State Natural Area - One of the largest and the most biologically diverse of the wetlands in southern Wisconsin, is accessible to researchers and classes by the Field Station's boardwalk. Shallow and deep lakes, marshes, shrub communities, sedge meadow, hardwood swamp, conifer swamp, and the southernmost string bog in North America are just some of the vegetation types of the Cedarburg Bog. Populations of at least 35 species of higher plants and 19 birds are at or near the southern edge of their range in the Bog. The Bog has been designated a National Natural Landmark by the Department of Interior, a Wetland Gem by the Wisconsin Wetlands Association, and an Important Bird Area by the Wisconsin Bird Conservation Initiative. A "Guide to the Natural History of the Cedarburg Bog" serves as an introduction and reference source for researchers and educators using the Bog and is available online (https://dc.uwm.edu/cgi/viewcontent.cgi?article=1110&context=fieldstation_bulletins). In 2015, the DNR purchased 66 acres of land in the Cedarburg Bog from The Bog Golf Course, the first major addition of acreage to the State Natural Area in decades. As of 2016 emerald ash borer had killed essentially all the mature ash trees in the Bog. Approximately 12% of the trees in the Bog were black ash, accounting for 10% of total tree basal area, and 2% were green ash, 4% of basal area.

The Cedarburg Beech Woods State Natural Area – 80 acres of one of the finest mature beech-maple forests in southern Wisconsin. The scale insect associated with beech bark disease has been found in the Cedarburg Beech Woods, although the disease is not known to occur here yet. The emerald ash borer beetle was first detected in the woods in 2012 when adults were captured in traps at the Station. Essentially all of the white ash in the upland forest are now dead. White ash made up about 9% of the trees in the forest and 13% of the total basal area of trees. The Cedarburg Beech Woods SNA is likely to experience major changes within the next few years. The beech-maple forest is included in the National Natural Landmark designation for the Cedarburg Bog and is also included in the Important Bird Area.

The Sapa Spruce Bog State Natural Area – 12 acres of highly acidic black spruce/tamarack bog and 11 acres of swamp hardwoods. The southernmost black spruce bog in Wisconsin, the small, acidic, Sapa Spruce Bog provides an ecological contrast to the large, neutral-pH, Cedarburg Bog, with which it shares most of its flora.

Old Agricultural Fields – Over 100 acres in various stages of succession are available for experimental research. A history of the use and management of the fields is maintained. Six separate areas in the old fields have been planted with prairie species native to Wisconsin. Controlled burns of the prairie and old-field areas were last conducted in 2016.

Management – The primary management that Field Station natural areas receive is maintenance of trails and control of invasive exotic plants. Glossy buckthorn (*Rhamnus frangula*), common buckthorn (*Rhamnus cathartica*), Tartarian honeysuckle (*Lonicera tatarica*), autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*) meadow parsnip (*Pastinaca sativa*), purple loosestrife (*Lythrum salicaria*), sweet clover (*Melilotus* spp.), motherwort (*Leonurus cardiaca*), Oriental bittersweet (*Celastrus orbiculatus*) and garlic mustard (*Alliaria petiolata*) are all present, and being controlled in the Field Station natural areas. Purple loosestrife biological control beetles were released in Mud Lake in both 2012 and 2013. However, in 2017 the beetle population appeared to have been reduced and there was more flowering of the purple loosestrife again. Friends of Cedarburg Bog volunteers help Field Station staff with trail maintenance and our efforts to control invasives.

Only glossy buckthorn in the Cedarburg Bog and Oriental bittersweet on private properties south of the Station, are currently so widespread and abundant that their long-term control throughout the natural areas seems intractable with the hand and mechanical methods we are using elsewhere. Since 1991 fruiting-sized buckthorn has been cut and treated with herbicide in various selected control plots in the northern and central parts of the Bog by the Wisconsin DNR and the Friends of Cedarburg Bog. FOCB continues to work with grant funding for buckthorn control work in the Bog.

Research and Teaching Facilities

General Facilities

- Office/classroom building with meeting rooms, teaching lab, and computer lab
- A Research Lab constructed in 2004
- Service building – machine & wood shop
- The Farm House for researcher & student housing
- The Researcher House for longer stays by individuals and groups
- Natural areas marked with a permanent grid – Accurately GPS-located in 2005
- Boardwalk to the center of the Cedarburg Bog – Reconstruction completed in 2009
- 14 aquatic mesocosms (200 gallon tanks)
- Several small boats, canoes, and trailers
- Global Positioning System equipment
- Extensive map and aerial photo collection
- Geographic Information System (GIS) for the Field Station area

Hydrology, Meteorology & Phenology

- Extensive array of environmental sensors recorded by a digital data logger
- Phenological observation garden & native plant observations maintained
- Lysimeter pit in the old-growth forest
- Transect of piezometers from upland to Bog

Animal Ecology & Behavior

- Sound room facility for studies of frog communication and vocalizations
- Live traps & animal holding facilities
- A large array of snake cover-boards
- Extensive arrays of bird nest boxes
- Flying squirrel nest boxes
- Insect collection, small mammal & bird study skins

Experimental Garden

- 7 fenced research gardens
- 1 acre experimental garden with water & electricity
- A 30' x 60' screen house for studies of pollination biology
- A screen house for studies of plant-insect interactions
- Greenhouse & garden building
- High capacity irrigation well
- Farm & cultivating machinery

Plant Ecology

- Herbarium & plant lists
- Plant identification lab
- Vegetation sampling & surveying equipment
- Fenced deer exclusion plots in various plant communities and habitats

Outlying Natural Areas

Neda Mine Bat Hibernaculum State Natural Area - An abandoned iron mine, located on the Niagara Escarpment near Mayville and Horicon, Wisconsin, is among the largest bat hibernacula in the Midwest. Up to 150,000 bats of four species (Little brown bats, Big brown bats, Eastern pipistrelles, and Northern long-eared bats) used the hibernaculum. 2015 was the first year that the fungus that causes white-nose syndrome in bats was positively detected at the Neda Mine Hibernaculum. The disease was confirmed in the bat population in 2016, and the population of bats in the mine has declined. The mine is also of geological interest; its cliffs provide an excellent exposure of the Niagara Dolomite and the only accessible exposure of the Neda Iron formation.

Neda Beechwoods State Natural Area - Lies on the Niagara Escarpment, just north of Neda Mine and is a well-developed stand of American beech (*Fagus grandifolia*) at the western boundary of its range.

Benedict Prairie - Near Kenosha, is a 6-acre tract of virgin prairie along a railroad right of way that has a remarkably diverse flora. A vascular plant species list for Benedict Prairie has been published in the Field Station Bulletin. Woody plants were cut from the prairie and controlled burns were conducted in spring of both 2012 and 2013. More extensive woody plant brush removal was conducted in 2014, and the prairie was burned in the spring of 2015 and again on 14 April 2016. The Prairie Enthusi-

Gated entrance at Neda Mine. Photo by Joseph Hoyt.

Prairie Enthusiasts volunteers visiting Benedict Prairie. Photo by G. Meyer.

asts assumed management of the prairie in 2020, under a management agreement with UWM. Multiple work days to cut brush at the prairie were conducted in 2020.

Downer Woods Natural Area - An 11.1 acre fenced woodlot, is an island of forested natural area in an intensely urbanized setting on the UWM campus. The Field Station assumed management of Downer Woods in 1998. Field Station management of the woods includes control of invasive plants, trail clearing and maintenance, and managing use of the woods. In 2016 the Field Station obtained a grant from the Southeastern Wisconsin Invasive Species Consortium to continue eradication of invasive shrubs and garlic mustard in Downer Woods. We completed that funded control project in 2017, and invasive plant control work in Downer Woods has entered a new maintenance phase requiring substantially less annual effort. The trails in Downer Woods receive heavy use and they can become muddy and slippery when wet. The entire trail system in the woods was regravelled in 2020, to eliminate the wet, muddy areas that had been developing following rain fall or snow melt.

Field Station Programs

• 27 active research projects conducted at the Field Station in 2020.

• Including: 2 UWM M.S. theses, 4 UWM Ph.D. projects and 8 studies by researchers from outside of the University.

• 9 papers published during 2020. Several others are in press.

Database Development - The collection of a variety of long-term data is an important part of the Field Station's research program. Examples of our databases include:

• Vascular plant flora of the Field Station area (including approximately 720 taxa) & excellent herbarium.

• Lists of vertebrates, including birds, mammals, and reptiles and amphibians.

• A complete, quantitative, survey of the vegetation of the Cedarburg Bog, first conducted in 1991 and repeated in 2006.

• A working map of the Cedarburg Bog basin depth.

• A complete stem map and diameter measurements of all trees in 5.5 acres (2.25 hectares) of the beech-maple woods first

censused in 1987.

• Repeated surveys of the entire beech-maple forest at the permanent grid locations.

• Phenological observations on leaf-out and flowering of standard genotypes of 6 species in a phenological garden, and 25 naturally occurring species at the Station since 2001.

• Phenocams for monitoring phenological changes in vegetation. Cameras are mounted both at the Field Station property in Saukville and in Downer Woods on the UWM campus.

• Long-term weather records from a standard US Weather Service weather station and a Bowen-Ratio energy flux monitoring system. Dr. Mark Schwartz' research relating climatic parameters to seasonal development of plants has contributed to this long-term database.

• Drs. Peter Dunn and Linda Whittingham have conducted long-term studies on tree swallows and other bird species.

• The Field Station was a major site for long-term studies of avian vocalizations, including their organization and function, by Dr. Millicent Ficken.

• Herpetological research has been a major research area at the Field Station for over a decade. Knowledge of our amphibian and reptile populations has been contributed by Dr. Gerlinde Höbel, Dr. Gary Casper, and Dr. Joshua Kapfer.

• Dr. Jeffery Karron's research on pollination mechanisms has contributed to long-term information on the pollinators of the Field Station.

• Monitoring of bat activity levels at the Neda Mine Bat Hibernaculum from 2000-2019 and of temperatures in the mine since 1997.

• Records of long-term (30 year) research projects conducted by Dr. Charles Weise, on Black-capped Chickadees and Dark-eyed Juncos.

• GIS developed for the Field Station area.

Educational Programs

• Over 2500 person-hours of instruction and group use in 2020 including both in-person and synchronous online classes and events

• One natural history workshop. The other planned workshops were cancelled because of the COVID-19 pandemic.

• Field Methods in Conservation, a UWM course taught entirely at the Field Station, has been offered in the Fall semester since 2017. The course was taught online in 2020.

• Long-time volunteer naturalist at the Field Station, Kate Redmond a.k.a. The Bug Lady, writes "Bug of the Week", which are essays on local bugs. There are now over 400 of these excellent and entertaining essays posted on the Field Station website (uwm.edu/field-station/category/bug-of-the-week/). Bug of the Week has become by far the most visited feature of our website.

• 1 undergraduate student project.

• 5 Friends of the Cedarburg Bog in-person programs for the general public on a variety of topics, conducted prior to the shut-down in mid-March.

• The Field Station Bulletin, covering various topics related to natural history in southeastern Wisconsin, is available online (https://dc.uwm.edu/fieldstation_bulletins/)

• Educational videos produced by the Friends of the Cedarburg Bog and available for viewing on YouTube (Youtube.com, Friends of the Cedarburg Bog).

The Friends of the Cedarburg Bog – 2020

The Friends of the Cedarburg Bog (FOCB) was founded in 2005 to support stewardship, understanding and appreciation of the Bog through land management, preservation, research and education. The FOCB Board of Directors continues to follow and adapt their strategic Action Plan focusing their effort in five areas:

• Strengthen Community Support for the Bog – Develop strong, informed community-

based support for sustaining the unique nature of the Cedarburg Bog through a focused outreach effort.

• Expand FOCB's Conservation Impact – Expand the FOCB's area of conservation focus to the Bog's natural boundaries through: (1) sustainable stewardship programs within that perimeter; (2) focused partnerships that work towards landowner commitment to conservation practices.

• Extend the use of the Bog as a Natural History Classroom and Laboratory – Support science-based understanding of the Bog and use its' unique character to foster a sustainable land ethic.

• Be a Good Partner – Establish strong, supporting relationships with our DNR and UWM partners; and also with like-minded organizations that further the FOCB's mission impact.

• Be a Healthy Organization – Have an active, focused, learning and mutually-supportive board and staff, with the competencies and capacity to advance the mission of the FOCB.

FOCB continued their work in 2020. Highlights for the year include:

• The Friends planned for a full schedule of educational programming for the general public in 2020, but were only able to conduct 5 events before the pandemic forced the cancellation of in-person events.

• With in-person events shut down, FOCB moved into online programming to maintain engagement with their membership. Twelve videos were produced and are available for viewing on the FOCB YouTube channel (Youtube.com, Friends of the Cedarburg Bog). These videos explore various topics related to the natural history of the Cedarburg Bog. Videos were also produced for the FOCB Annual Meeting, which was virtual in 2020. Together, the videos provide 2 hours and 23 minutes of content, and have received a total of 786 views as of March 22, 2021.

• FOCB continued the Bog Guardian Program. This multi-faceted program is designed to stop the advancement of 4 target invasive plants that are nearly absent from the Bog area, and that are spread primarily along roadways, before they reach the area. The populations of all 4 target species along roadways have been mapped in a 28 mi^2 area surrounding the Cedarburg Bog, and control of the known populations is ongoing. The program also engages neighboring land owners through education and outreach.

• The Friends continued to be the primary provider of stewardship of the Cedarburg Bog. FOCB has raised funding to remove buckthorn, an invasive shrub, from over 600 acres of native wetland plant communities. The ambitious goal is to prevent seed production in that treated area by removing buckthorn whenever they grow to near fruiting size.

• The Friends continued to produce their quarterly newsletter, The BogHaunter. Past issues of The BogHaunter can be found on the FOCB website (https://bogfriends.org/boghaunter/).

• The FOCB is stronger financially than ever due to memberships and private donations. The organization has developed a strategic action plan to look at long-term financial sustainability including building on the endowment.

• FOCB continues to support the Field Station's Natural History Workshops through annual sponsorship of $5,000.

• FOCB established a scholarshop program to assist UWM undergraduates taking natural history workshops at the Field Station. The scholarship will pay the workshop fees for selected students. The first scholarships will be awarded in 2021, since natural history workshops had to be cancelled in 2020.

If you are interested in the Field Station's programs and activities, or you wish to support the preservation of the Cedarburg Bog State Natural Area, please consider joining the Friends group. Contact the Field Station for information on how to become involved, or visit the FOCB website, www.bogfriends.org.

Abstracts of Research

Microbe-mediated Impacts on Food Web Stability and Ecosystem Function in a Tripartite Symbiosis

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Microbes are ubiquitous in natural and host-associated ecosystems, but the mechanisms underlying how they shape ecosystem function and support eukaryotic life are poorly resolved. This dissertation research takes advantage of the tripartite symbiosis between carnivorous pitcher plants, pitcher plant mosquitoes, and their associated microbiota as a tractable microsystem to address this knowledge gap. *Sarracenia*

Aldo Arellano examining pitcher plants

pitcher plants harbor a characteristic microbiota that is essential for prey digestion and nutrient assimilation. Female *Wyeomyia* mosquitoes obligately deposit their eggs in *Sarracenia* pitchers, where larvae develop into adults and aid the plant by processing captured prey. We seek to integrate high-throughput sequencing approaches with experimental studies of host and microbial function to characterize the (i) top-down effects of *Wyeomyia* on pitcher-associated microbes, (ii) bottom-up effects of pitcher-associated microbes on *Wyeomyia* fitness, and (iii) microbial taxa and products that promote digestive metabolism in the pitcher and growth of mosquito larvae. To this end, we recently conducted a field experiment in the Cedarburg Bog to compare microbiota assembly and functional potential in naturally occurring pitchers colonized by *W. smithii* larvae with uncolonized pitchers. Samples from this experiment are currently being processed to characterize microbiota assembly via high throughput sequencing of 16S rRNA (bacterial) and ITS (fungal) gene amplicons using established methods. Samples are also being processed to assess functional potential by quantifying the activity of key pitcher- and microbe-derived enzymes involved in prey digestion. Generation of a pitcher-derived microbial isolate library is also underway, which will facilitate future work to investigate the impact of different microbes on *W. smithii* fitness. Overall, our results will improve understanding of how specific microbial taxa and microbe-derived products shape the structure and stability of natural ecosystems. They will also provide novel insights into the biology of mosquitoes, which are insects of interest because they transmit disease-causing organisms to humans. Ph.D. dissertation research (Aldo Arellano), Dr. Kerri Coon, Major Advisor.

Intraspecific Variation in Herbivore Infestation on *Monarda fistulosa* Genotypes from Resource-divergent Origins

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Intraspecific variation in plant traits can strongly structure insect herbivore communities. This may often result from variation in secondary metabolites, which are often produced by plants as a means of defense against herbivory and yet are also used by different guilds of arthropods for searching for host plants. Chemical defense may vary with geographic origin due to spatial variation in resource availability. In turn, secondary metabolites should reduce herbivory from generalist insects, yet may increase abundance of specialists that utilize these compounds to locate suitable hosts. Here we examined damage and abundance of insects colonizing plants in an experimental plot of *Monarda fistulosa*, a native perennial herb defended primarily by terpenoid compounds, planted in 2019 as a common garden experiment at the University of Wisconsin-Milwaukee Field Station. The plants in the field station garden had been grown from seed collected from resource-rich mesic grasslands in southeastern Wisconsin and resource-poor arid grasslands in western Montana. We previously showed

Research plot at UWM Field Station. Photo by Phil Hahn.

that terpenoid concentrations were nearly twice as high in the populations originating from low- vs. high-resource environments. In 2020, we compared patterns of leaf damage, galling by a specialized cecidomyiid fly and infestation by *Aphis monardae* aphids on the plant populations originating from low- and high-resource environments. Leaf damage predominantly inflicted by generalist herbivores was greater on high-resource populations. Galls were more abundant on low-resource populations, and aphid infestation was greater on high-resource populations. This work shows that variation in resource availability that have important impacts on plant chemical phenotypes can subsequently structure insect communities that damage and colonize their host plants. Funded by the National Science Foundation.

Aphids being tended by ants on the *Monarda* plants. Photo by Joseph Cammarano.

Bioacoustic Monitoring

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Bioacoustic monitoring for frogs and toads continued throughout the western Great Lakes region in national parks and private preserves, with work in 2020 focused on refinements to data analysis procedures and the development of automated breeding bird classifiers. Additional acoustic bat data was also collected in southeastern Wisconsin. Funding was provided by the National Park Service, Kohler Foundation, Ozaukee County Planning and Parks, Milwaukee Audubon Society, Friends of Wehr Nature Center, and several private property owners.

National Park Service Great Lakes Network Amphibian Monitoring Program

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The goal of this project is to implement amphibian monitoring in seven national parks in the western Great Lakes region. A protocol utilizing automated recording systems is now fully implemented in seven national parks. In 2020 annual data collection continued and we analyzed and reported on 2019 data. Funded by the National Park Service.

Wildlife Monitoring in Southeastern Wisconsin

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Wildlife monitoring in southeastern Wisconsin, dating back to the 1980s, continued in 2020 at a somewhat reduced rate due to the covid-19 pandemic. Monitoring was completed for several private landowners, Milwaukee Audubon Society, Ozaukee Washington Land Trust, and Wehr Nature Center. A review of wildlife biodiversity in the Cedar Lakes watershed was also begun. These data inform habitat management and expand regional understanding of wildlife distribution and status. Projects include sampling for breeding birds, mammals, herptiles, invertebrates, and botanical inventories. In 2020 notable populations of grassland birds were documented in Belgium (Ozaukee County, Wisconsin), including the state-threatened Henslow's sparrow, and additional occurrences of the rare evening bat were obtained. These studies are funded by a variety of grants and private donations.

Wildlife monitoring with flying squirrel nest boxes

Field Guide to Amphibian Eggs and Larvae

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In 2019 we produced a field guide to the eggs and larvae of the amphibians of the western Great Lakes region for the National Park Service. The guide provides new identification keys, and species accounts with full color photographs of all life stages, for 23 species including all Michigan and Wisconsin species. In 2020 we completed a revised edition for sale to the general public, supported by Midwest Partners in Amphibian and Reptile Conservation, Wisconsin Wetlands Association, and Deborah S. Kern. It will be available for purchase in February 2021.

Sound Production in Turtles

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We continued investigating sound production in embryonic turtles in Wisconsin, building on 2019 discoveries that both northern map turtle and snapping turtle embryos emit sounds while in the egg with sound production increasing just prior to hatching. In 2020 we began analyzing data from two species of softshell turtle nests.

Native and Non-native Temperate Deciduous Shrub Phenology in Downer Woods

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This is an ongoing research project in which we observe and record the timing of spring and autumn phenology of a suite of native and non-native temperate deciduous shrubs in Downer Woods. In addition, Downer Woods has been selected as one of a hundred global locations to test a newly launched earth observing micro-satellite known as VENμS (Vegetation and Environment monitoring on a New Micro Satellite). We will use the phenological observations to validate the effectiveness of the high resolution multispectral VENμS vegetation product at capturing ecosystem dynamics. Funded by the UWM Research Growth Initiative.

Fruit of native burning bush *(Euonymus atropurputeus)*. Photo by Alison Donnelly.

Effects of Food Abundance on the Timing of Breeding in Tree Swallows

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Understanding the mechanisms influencing the timing of reproduction has taken on new urgency as climate change is altering environmental conditions during reproduction, and there is concern that species will not be able to synchronize their reproduction with changing food supplies. In 2020 we completed the 24th year of study of the reproductive ecology of tree swallows at the UWM Field Station. One of our main goals is to determine how environmental factors, particularly temperature and food abundance, influence the timing of breeding and reproductive success. A prominent hypothesis predicts that reproductive success is maximized when animals synchronize their reproduction with seasonal peaks in food supply. This mismatch hypothesis does not seem to be supported in tree swallows, and many other species. Instead, reproductive success appears to be more closely related to the absolute levels of food, rather than to the timing of food. We thank Ron Tagye and Gretchen Meyer for their assistance, particularly in collecting data.

North American Insect Abundance Survey

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A growing number of studies have found declines of insects and, as a consequence, there is concern among ecologists that this might have cascading effects throughout the food web. Most of these studies of insects have been in Europe; we have little evidence of widespread insect declines in North America, although there are some studies showing declines among butterflies, bees, and mayflies. To address the lack of data, we have organized researchers at over 30 sites, including the UWM Field Station, to monitor insect abundance using Malaise traps. The sites stretch from New Brunswick to Alaska and south to North Carolina. This study aims to standardize collection methods so we can directly compare abundance of insects in different areas and over time. Preliminary analyses of data from two years (2019 & 2020) suggest that, early in the spring, sites in the eastern US and Canada have greater total biomass of insects than sites in the Central and Western parts of the continent. However, this pattern reverses later in the season (mid-June). We plan to conduct another season of sampling in 2021 to see if these are consistent patterns. The data will be published next year and will provide a baseline for future studies of changes in insect abundance.

Malaise trap at the UWM Field Station

Mate Preferences and Choosiness Vary Independently in Eastern Gray Treefrogs (*Hyla versicolor*)

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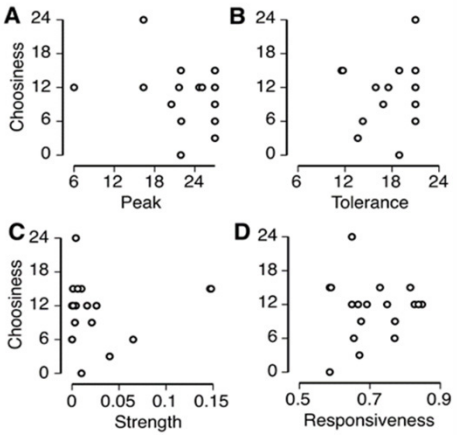
Mate choice is an important cause of natural and sexual selection, driving the evolution of ornaments and promoting diversification and speciation. Mate choice decisions arise from the interaction of several components, and knowledge of whether they interact, and how, is crucial for understanding their contributions to selection. Here we focus on the relationship between preference functions (attractiveness ranking of prospective mates) and choosiness (effort invested in obtaining the preferred mate) and test the hypothesis that they are independent components of mate choice decisions. We examine individual variation in preference functions and choosiness for call duration in female *Hyla versicolor* treefrogs; and show that measures describing preference functions and choosiness are not correlated. We further show that both components are influenced by different factors: while variation in preferences was associated with variation in body measures (size, condition), variation in choosiness was associated with variation in hormonal state (testosterone, corticosterone). Independence of preference and choosiness suggests that the joint study of variation in both components is required to gain a complete understanding of how mate choice contributes to sexual selection and speciation. Funded by a Field Research Grant in Herpetology (Society for the Study of Amphibians and Reptiles), a Student Research Grant (Animal Behavior Society) and a Joseph G. Baier Memorial Scholarship (UWM). M.S. Thesis research, Dr. Gerlinde Höbel, Major Advisor.



Preference function traits and choosiness are independent components of the mate choice decision of female Eastern Gray Treefrogs. Choosiness is not correlated with peak, tolerance, strength, or responsiveness.

Fifty Shades of Grey in Treefrogs: Investigating Multimodal Signals in *Hyla versicolor*

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Animal signals are often composed of multiple signal modalities, such as vocal, visual, or tactile components. For example, male eastern gray treefrogs are known to employ energetically expensive advertisement calls to entice females, although they also produce two visual traits: gray throats and yellow inner legs. These visual traits are interesting because they (throat/leg) differ in their degree of sexual dimorphism (yes/no), pigment type (melanin/carotenoid), and pigment acquisition (genetically/environmentally). Mating phenotypes and behaviors are often driven by sex hormones (such as testosterone), while stress hormones (such as corticosterone) aid in meeting the associated metabolic demands. To search for connections between visual and acoustic traits, we used hormones to explore mechanisms of covariance between displays. Mechanistic links may provide insight into the possible behavioral implications and intended receivers of these visual displays. Preliminary results found a lack of consistency between hormonal influences on call and color traits, which suggests that they are likely not redundant signals. More specifically, results suggest that thigh color is an indicator of foraging ability, yet throat results were inconclusive. This project improves upon the current understanding of how hormone-driven ornament expression influences trait evolution through sexual selection. Funded by a Field Research Grant in Herpetology (Society for the Study of Amphibians and Reptiles), a Student Research Grant (Animal Behavior Society) and a Joseph G. Baier Memorial Scholarship (UWM). M.S. Thesis research, Gerlinde Höbel, Major Advisor.

Phenological Change among Three Trophic Levels: Birds, Insects and Plants

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Climate influences the phenology- the timing of biotic life cycle events- of plant and animal species. The impacts of climate change on the phenology of organisms at different trophic levels can vary, resulting in synchrony or asynchrony between organisms and their food sources. Temporal and spatial mismatches due to differing phenological responses between predators and prey can result in cascading asynchronous phenological change within food webs and alter ecosystem dynamics.

By studying the phenology of life events throughout the annual cycles of organisms, researchers are able to better understand how species respond to changes in climate and local weather over time. A species' ability to alter the timing of life-cycle events in response to climate change is not a standalone determinant of success, as organisms do not exist in solitude, but rather, they exist in ecosystems wherein complex multi-trophic interactions occur.

The objective of this study is to examine phenological change at the UWM Field Station and nearby sites in Ozaukee and Milwaukee Counties by investigating indicators of spring phenology among three trophic levels; birds, insects, and plants. Due to the complexity of multi-trophic phenology, this research seeks to first investigate the influence of local weather variables and regional weather patterns on each trophic level in isolation to unveil general trends related to climate change over time. Then, associations between trophic levels will be

assessed in order to examine ecosystem-level phenological change.

This will be accomplished by adding contemporary data to and filling gaps in long-term phenological datasets from a myriad of sources. Historic bird banding data recorded by Dr. Chuck Weise at the UWM Field Station during the late 1960s through the early 1990s will be analyzed for trends in aspects of bird breeding phenology such as the timing of brood patch development in passerine females. Findings will be compared to contemporary bird banding data from current and ongoing research projects in Ozaukee and Milwaukee counties.

In order to investigate indicators of phenological change among insects, this project will utilize and contribute to an aerial insect dataset spanning 19 years, initiated in 1997 at the UWM Field Station by Dr. Peter Dunn and Dr. Linda Whittingham. Similarly, a dataset initiated in 2000 by Dr. Mark Schwartz containing 16 years of observations recorded by Dr. Gretchen Meyer on the spring phenology of several native tree and shrub species at the UWM Field Station will be utilized to investigate phenological change among plants at the bottom trophic level. PhD. dissertation research, Dr. Alison Donnelly and Dr. Mark Schwartz, Major Advisors

Diverse Microbial Communities Hosted by the Model Carnivorous Pitcher Plant *Sarracenia purpurea*: Analysis of Both Bacterial and Eukaryotic Composition Across Distinct Host Plant Populations

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The pitcher plant *Sarracenia purpurea* supplements nutrient acquisition through carnivory, capturing insect prey which are digested by a food web of eukaryotes and bacteria. The food web invertebrates are well studied, and some recent studies have characterized bacteria, but detailed genetic analysis of diversity is lacking. This study aimed to compare eukaryotic and bacterial composition and diversity of pitcher communities within and between populations of host plants in nearby but distinct wetland habitats, and to characterize microbial functions across populations, and compare with other freshwater communities. Pitcher fluid was sampled from Cedarburg and Sapa bogs, and community DNA was extracted while rRNA amplicons were sequenced and data processed for community-level comparisons. Bacterial diversity in the small pitcher volume rivaled that of larger aquatic communities. Between pitcher plant populations, several bacterial families were significantly higher in one population. Predicted pitcher bacterial functions were distinct from other freshwater communities, especially for amino acid metabolism, but most functions were similar across all the pitchers. This suggests some bacterial functional redundancy, and that different bacterial composition achieves similar food web processes. Sequencing identified a previously under-appreciated high diversity of ciliates, Acari mites, fungi and flagellates in pitcher communities. Two thirds of eukaryotes were identified as food web inhabitants and a third as prey organisms. Although eukaryotic composition was not significantly different between populations, different species represented core taxonomic groups in different pitchers. Wetland habitat differences may provide distinct taxa available to colonize new pitchers. Eukaryotic composition was more variable than bacterial composition, and there was a poor relationship between bacterial and eukaryotic composition within individual pitchers, suggesting that colonization by eukaryotes

may be more stochastic and that bacterial recruitment to pitchers may involve factors other than prey capture and colonization by eukaryotic food web inhabitants. Ph.D. dissertation research, Dr. Erica Young, Major Advisor.

Understanding Intraspecific Variation in Plant Defense Across Resource Gradients

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A paradigm in the plant defense literature is that defending against insect herbivores comes at a cost to growth, thereby resulting in negative correlations between growth and defense. Although growth-defense trade-offs are common among plant species, there is less support for growth-defense trade-offs within species. Several mechanisms can account for this but teasing them apart requires explicit comparisons of growth and defense relationships within *and* among species, an approach seldom employed. We collected seed of three perennial herbaceous plant species from populations originating from low- and high-resource regions. Populations in the low-resource region were located in intermountain grasslands in western Montana that receive low summer precipitation. Populations in the high-region were located in tallgrass prairies in southern Wisconsin, including the University of Wisconsin-Milwaukee Field Station

Research garden at the UWM Field Station. Photo by Joseph Cammarano.

(UWMFS) and Benedict Prairie (Kenosha County, Wisconsin), which receive high summer precipitation. In 2020, we grew seeds sourced from these different resource regions in a reciprocal transplant common garden experiment. Common gardens were located in western Montana and southern Wisconsin (UWMFS). We measured growth rates and herbivore damage on plants within both garden locations. This is the first year of a multi-year study. In 2021, we plan to supplement the common garden with additional species and continue to measure plant traits, herbivore damage, and insect abundance in both gardens. By studying populations of multiple species sourced from divergent resource regions grown in a reciprocal transplant experiment, we can examine both genetically based and plasticity in plant growth and defense traits within and among species. This work should be a step towards reconciling different evolutionary patterns often documented within vs. among plant species. Funded by the National Science Foundation.

White-nose Syndrome Dynamics in Neda Mine

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White-nose syndrome (WNS) has caused massive mortality in bat populations across the eastern United States and is continuing to spread across North America. The disease is caused by the pathogen *Pseudogymnoascus destructans*, which first invaded Wisconsin in the winter of 2013/14. Despite the devastating population impacts suffered by bats across this region, several colonies of bats still persist post-WNS invasion. However, the mechanisms allowing some colonies to persist while others are extirpated remain unknown. Our research seeks to understand the mechanisms underlying population persistence, which can help determine the most effective management strategies that may yield the greatest benefit for each population and species. Our work at Neda Mine collectively explores differences in bat behavior, mine environmental conditions, and host physiological responses to assess their respective roles in bat survival with WNS. At Neda Mine, we find that fungal loads on bats over winter increase at a slower rate compared to sites with similar early winter temperatures. This may be partly explained by the sharp decrease in bat roosting temperature over the hibernation season (from 11° C to 5° C). Our preliminary data from Neda Mine also show substantial differences in fall activity patterns among sexes which may contribute to higher infections in females observed during early winter. Our future work will continue to explore the role of bat resistance and hibernation phenology in determining bat survival with WNS. Funded by the U.S. Fish and Wildlife Service and the National Science Foundation.

Identification of a *Rhodopseudomonas* Isolate from *Sarracenia purpurea* Pitchers and Evaluation of its Role in the Nitrogen Economy of the Pitcher Inquiline Community

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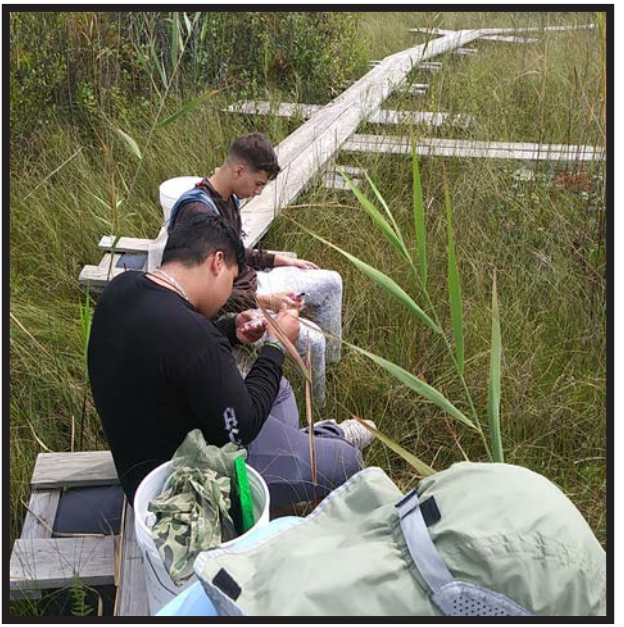
The fluid filled leaves of the carnivorous pitcher plant *Sarracenia purpurea* are home to a diverse group of obligate symbionts that includes larvae of three dipterans, a mite and a bdelloid rotifer. Among numerous bacteria is a recurring photosynthetic facultative anaerobe, *Rhodopseudomonas* sp. We hypothesized that the species for

this isolate would be either *R. palustris* or *R. acidophilus* both of which share nutrient poor wetland environments. We looked at this microbe's ability to fix nitrogen to determine its significance to the survival of the plant and the inquiline community. We used the Biolog (Hayward, California) Gen III system to produce a physiological profile for the *Rhodopseudomonas* isolate. Since this genus is not in the Biolog database, we are using the literature to match the physiological profile to a species. We tested for the ability to fix nitrogen by growing the organism on media lacking a nitrogen source, using *E. coli* as a negative control.

Rhodopseudomonas was found in over 80% of pitchers sampled during one growing season at Cedarburg Bog in southeastern Wisconsin. We isolated a pure culture of this bacterium and are in the process of determining the species identification based on its physiological profile. In addition to utilizing multiple carbon sources, the isolate also grew on nitrogen-free medium indicating that it is capable of nitrogen fixation. Since the leaves actively attract prey for only 28 days, a reliable source of nitrogen for both the plant and its inquilines after this period is not assured. Field sampling data show that *Rhodopseuodomonas* numbers peak at approximately the same time that prey capture declines. This suggests that nitrogen fixation may be an important reserve system for ensuring sufficient nitrogen for the inuqilines and the plant.



Ragheb Alkilani and Alejandro Jimenez-Baeza working with pitcher plants along the Field Station boardwalk. Photo by Liane Cochran-Stafira.

Strong Support for Bateman's Principle in a Hermaphroditic Plant

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Variation in male fitness is fundamental to models of reproductive trait evolution, yet is rarely quantified in flowering plants. Bateman (1948) hypothesized that male fitness variation will often exceed female fitness variation since it is usually limited by mating opportunities, rather than by resources. Although Bateman's principle has largely been studied in dioecious animals, Bateman hypothesized that it could be extended to hermaphroditic flowering plants. Here we quantify male and female reproductive success and mate diversity to test Bateman's two key predictions: 1) Variance in male reproductive success should be greater than the variance in female reproductive success. 2) The number of independent mating events should have a greater effect on male reproductive success than on female reproductive success. We established an experimental population of 49 *Mimulus ringens* (monkeyflower) plants, each trimmed to a single flower. Flowers of this species only last for a single morning, and are pollinated by wild bees. To control for position effects, we re-randomized plant positions each day of the experiment. Male parentage was successfully assigned to 98% of the sampled seeds. As Bateman predicted, male reproductive success in monkeyflower is highly variable and is strongly correlated with mate number (a positive Bateman gradient). By contrast, female reproductive success is less variable and is not associated with mate number. Funded by the National Science Foundation.

Impact of Changing Snow Cover and Frozen Ground Regimes on Groundwater Recharge

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Development of seasonal snowpack leads to groundwater recharge associated with spring snowmelt, which often accounts for a large percentage of annual groundwater recharge in the Midwest. The objective of this study is to determine the extent to which freeze and thaw cycles alter groundwater recharge. This study explores the relationship between winter precipitation, the soil thermal regime, and groundwater recharge in the Midwest. Using historical groundwater levels, precipitation, and soil temperature records, we conduct statistical analysis to determine what direct and indirect environmental conditions best explain the relationships between winter precipitation and groundwater recharge. Soil temperature records, groundwater levels, and weather records previously collected from the UW-Milwaukee Field Station are being used as part of this study. By exploring these historical relationships, we aim to better understand how climate variability will impact groundwater recharge in the future. This project is funded by the Wisconsin State Water Resources Research Institute Program through the UW Aquatic Sciences Center.

Wood Duck/Hooded Merganser Nest Box and Owl Nest Box/ Roost Box Project

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Under the auspices of the Friends of the Cedarburg Bog (FOCB), a total of 28 duck nest boxes are monitored in and around the Cedarburg Bog. The purpose of the FOCB Duck Nest Box project is to increase the populations of the two species of cavity nesting ducks in southern Wisconsin -- wood ducks and hooded mergansers. Sixteen of these duck boxes were installed by and are maintained by the FOCB; the other 12 duck boxes were put up on private property by landowners in consultation with the FOCB. In coordination with the FOCB, these landowners monitor and maintain their boxes. Five additional nest or roosting boxes are being monitored by the Friends for use by barred owls, eastern screech owls, and northern saw-whet owls. The five owl boxes have been installed on trees. Half of the duck boxes (14) have been installed on trees, and half are on 10 foot poles driven down into the ground or into the substrate of a pond or lake. All of the duck and owl boxes (with the exception of two large barred owl nest boxes) are equipped with predator guards designed to prevent access by raccoons or squirrels.

Usage data for 22 of the duck boxes was available at the time of this report. Fifteen of these boxes provided evidence of egg laying (a 68% usage rate) and 12 of these boxes produced fledglings. This is a fledging success rate of 54%, which is significantly higher than the approximately 35% success rate recorded in previous years. Twelve boxes were solely occupied by wood ducks and one box exclusively consisted of hooded mergansers. The remaining two boxes had mixed broods -- hooded merganser ducklings and wood duck ducklings hatched out and fledged from the same box. Mixed broods are fairly common and occur when a hen of one species deposits some or all of her eggs in the nest of another hen of a different species, who then incubates all of the eggs until they hatch out. She then provides parental supervision to all of the ducklings until they are independent. Two nests with large clutches of eggs were abandoned. One possible explanation for this is "egg dumping" -- a term used to describe the fairly common phenomenon of a hen laying eggs in an empty box without the intent to incubate the eggs. Other possible explanations for nest abandonment include cold and wintery spring weather and/or the presence of predators such as Cooper's hawks. The most successful nest boxes continue to be those near to or over water.

Many species other than ducks also use the duck boxes. This year, once again, a gray phase eastern screech owl was found when the box was opened for monitoring and cleaning. Another duck box was occupied by a red squirrel; and a third box was taken over by paper wasps who may have evicted a hooded merganser hen sitting on a dozen eggs only a few weeks away from hatching.

There continues to be little to no evidence of owls using any of the owl boxes for nesting. In addition to the aforementioned eastern screech owl using a duck box for a roost,

Wood duck pair

two northern saw-whet owls also briefly roosted in small owl boxes. The small owls will use the boxes for temporary roosting; however, to date they clearly prefer tree cavities for nesting over the boxes. For the last six years, there is no evidence of barred owls showing any interest in using the large owl boxes constructed for them.

John O'Donnell checking a wood duck nest box

An Analysis of Temperate Deciduous Shrub Phenology in Downer Woods, UWM

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Shrub species, both native and non-native, are an important component of temperate deciduous forest ecosystems but are an often overlooked and under-studied functional group. Shrubs tend to leaf-out earlier than trees in spring and retain their leaves later in autumn thus extending the overall growing season and the carbon uptake period of the forest ecosystem. In this study, a range of 5 native and 3 non-native shrub species were identified in a deciduous urban woodlot, and the phenology was monitored over a 3 year period on the University of Wisconsin-Milwaukee campus. The aim of this work was to determine any variation in the timing (DOY) and duration (days) of key spring (bud open, leaf out, full leaf unfolded) and autumn (leaf color, leaf fall) phenophases between native and non-native species. Preliminary results revealed interesting findings with buckthorn *Rhamnus cathartica* (an alien invasive/non-native species) consistently leafing out later than most native species and taking longer to reach full leaf unfolded. Additionally, non-native species such as European privet (*Lingustrum vulgare)* have a longer growing season than native species ranging from 14 days to 35 days longer in nonnative species than native species across the three year period. This shows how non-native species can lengthen the fall season compared to native species. These results could add to the understanding of how non-native shrub species may gain a competitive advantage over native shrubs and may help inform future conservation management plans. M.S. thesis research, Dr. Alison Donnelly, Major Advisor.

Social Causes of Variation in Mating Signals and Mate Preferences

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We are using laser vibrometry and vibrational playback experiments to study the causes of variation in the communication system of *Enchenopa* treehoppers that may promote speciation. *Enchenopa* are plant-feeding insects that communicate with plant-borne vibrational signals. Surprisingly for an insect, *Enchenopa* have a complex system of male-female communication, with social and ontogenetic causes of variation in their mating signals and mate preferences.

Enchenopa binotata treehoppers on the host plant *Viburnum lentago*

We have discovered one way in which small animals with small brains may process complex signals. *Enchenopa* have mechanisms of "combinatorial" signal processing. In other words, they have "rules" for which specific combinations of signal elements are acceptable or not, as with basic syntax or phonology in humans. Such processing had only been documented in animal communication in some birds and mammals until this discovery. To find combinatorial processing in an insect suggests that the basic building blocks from which human communication evolved (and complex song in bird and mammals) are much more widespread than previously anticipated. It also offers an explanation for how animals can handle the spectacularly complex signals and courtship displays that some species have evolved.

On the basis of prior work about the social-ontogenetic causes of variation in *Enchenopa* mating signals and mate preferences, we are currently testing a hypothesis that offers a simple solution to a problem in the theory of speciation: how distinct "packages" of ecological and sexual traits originate as populations begin to diverge. The most straightforward solution (change in a single gene that causes both the use of different environments and reproductive isolation) is often not applicable, because speciation often involves divergence in traits controlled by many genes in linkage disequilibrium, which is liable to break up due to gene flow. We are focusing on the hypothesis that *social plasticity generates signal-preference co-divergence*, as if by a single-gene mechanism. We are analyzing the form of plasticity in signals and preferences generated by contact between closely related species and contrasting it with the change in signals and preferences that result from genetic hybridization. Funded by the National Science Foundation.

PhenoCam Monitoring of Seasonal Plant Development and Senescence At Downer Woods and the UW-Milwaukee Field Station

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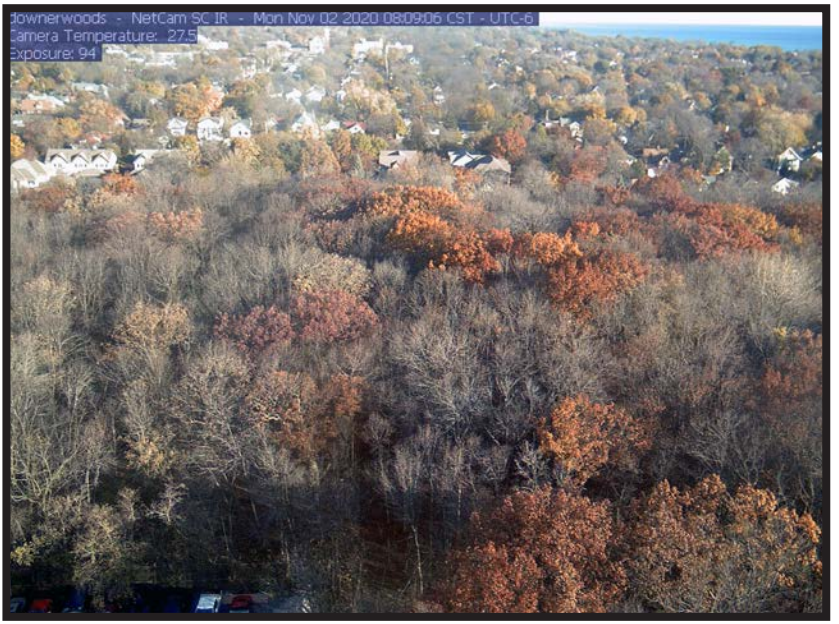
An exciting new development in phenological science is the use of fixed cameras to provide continuous near-surface remote sensing observations of seasonal development and senescence within small patches of vegetation. The PhenoCam Network is a global project (P.I. Andrew Richardson, Harvard University, sites primarily in North America) that is designed to coordinate this type of data collection. The PhenoCam website is: http://phenocam.sr.unh.edu/webcam/

UW-Milwaukee added two nodes to the PhenoCam network with cameras installed in March 2013 on the Sandburg East Tower (viewing north toward Downer Woods, see http://phenocam.sr.unh.edu/webcam/sites/downerwoods/) and at the UW-Milwaukee Field Station (viewing a small grove of trees north of the main buildings, http://phenocam.sr.unh.edu/webcam/sites/uwmfieldsta/). The cameras record an image once every half-hour during daylight hours in both the visible and near-infrared. These data will be added to the traditional ground-based visual phenology observations and climate data collected at both sites to continue efforts to better understand phenological changes, as well as bridge the spatial and methodological gaps between visual phenology and remote sensing-derived measurements.

Downer Woods, March 4, 2020



Downer Woods, November 2, 2020

Understanding the Mating Consequences of Flowering Phenology and Patterns of Flower Deployment in Monkeyflower

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In angiosperms, the degree to which an individual's flowering phenology coincides with that of conspecifics can have important consequences for reproductive success and fitness. The date of flowering onset, the duration of flowering, and the size of the daily floral display often vary widely and may influence the number and quality of mates. Large floral displays enhance pollinator attraction and promote pollen export and receipt, but plants with large displays also often experience higher levels of among-flower within-plant self-fertilization because pollinators tend to visit multiple flowers sequentially on a single plant. In populations with substantial inbreeding depression, selection should favor plants that produce small displays over many days because their flowers have greater fitness than those of plants that produce large displays over few days. This temporal pattern of flower deployment may be dependent on branching architecture. Furthermore, plants may alter patterns of branching and/or flowering to compensate for resource limitation.

In the wild, populations of monkeyflower vary widely in selfing rate, inbreeding depression, and total flower production as well as pollinator identity and visitation rates. My research utilizes common garden studies to tease apart the influence of genetic and environmental factors in variation in flowering strategies and reproductive success. At the UWM Field Station, I estab-

lished experimental arrays of plants from 9 monkeyflower populations and quantified the extent of variation in components of flowering phenology, such as the date of flowering onset, flowering duration, and total flower number. I also tracked patterns of flower deployment across the flowering season and established whether the size of the daily floral display influences population selfing rate. Finally, I investigated the extent of phenotypic plasticity on vegetative growth and flowering patterns in response to resource limitation. Funded by the James and Dorothea Levenson Ecology and Field Biology Fellowship (awarded to Wendy Semski) and a Prairie Biotic Research Grant (awarded to Wendy Semski). Ph.D. dissertation research, Dr. Jeffrey Karron, Major Advisor.

Garden plots for pollination study at the Field Station. Photo by Ron Tagye.

An Urban Cooper's Hawk Nesting Study in the Metropolitan Milwaukee Area

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The objectives of this study are to gather baseline data on the reproductive success of Cooper's hawks (*Accipiter cooperii)* in the urban metropolitan Milwaukee area, to describe urban nesting habitat, and to compare these data with other Cooper's hawk studies in Wisconsin. Long-term objectives are to determine Cooper's hawk nest site fidelity, breeding population mortality and recruitment, population growth trends, immigration and emigration patterns, and natal dispersal patterns for the same urban population.

In 2020, I monitored over 60 Cooper's hawk nesting territories. Thirty-six of these sites were occupied nesting territories; eleven sites were occupied with evidence of birds in the area but no nesting attempt was found. Twenty-five were active nest sites (laying pairs) with eggs laid. Twenty-two of

the 25 active nests produced 65 young that I was able to band and age (bandable age = ca. 18 days; 37 males, 28 females). The young were too old to band or had fledged in the other 3 nests, but I was able to get an accurate count of the young. Twenty-two of the 25 active nests produced 73 young (2.920 young/laying pair, N = 25; 3.476 young/successful pair, N = 21; 84.0% nesting success). A nesting attempt was found in Downer Woods on 5/24/2020 with a female Cooper's Hawk on the nest in an incubating posture. She also was on the nest on 6/01/2020 and there was no white wash under the nest tree. On 6/20/2020 no adult was on the nest or in the surrounding area. No young hatched from this nest and no white wash was found during several visits; therefore, this nesting attempt failed on eggs. Based on human activity in and near Downer Woods, it is possible that the human activity caused the failure. The number of breeding birds that I found in 2020 is more than the previous two years. These two years, 2018 and 2019, may have been affected by weather during the time period in which adult Cooper's Hawks mate and lay eggs. No adults were trapped during 2020.

Number of Young in Nest	Number of Nests	Total Young
0	4	0
1	1	1
2	2	4
3	8	24
4	6	24
5	4	20
Total	25	73

Blue 28/A (28 over A) was banded at her (a female) breeding nest site in 2011 as an ASY (after second year) bird. She was breeding again in 2020 at the same nest site as in 2011 as an A11Y (after 11 year) bird. This Cooper's Hawk was at least an 11 year old bird, relatively old for a Cooper's Hawk. Photo by William Stout.

Woe is the Loner: Female Frogs Prefer to Have Options Even if it Means Rejecting an Isolated "Hotshot"

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Lekking is a puzzling phenomenon, as it is not obvious why signalers or choosers should aggregate. It has been hypothesized that signalers enjoy higher per capita reproductive success because choosers prefer to sample among dense configurations that are easier to compare. While female preferences as well as the signal features of attractive males are well characterized in many chorusing species, we know little about how mate sampling is influenced by the spatial dynamics within communal displays. Here we ask how female Eastern Gray Treefrogs (*Hyla versicolor*) respond to isolated and clustered call stimuli in a simple 1 vs. 3 playback design. We explored i) whether females exhibit a general preference for call clusters, ii) whether spatial preference is robust to call-feature preference, and iii) how this affects the relative success of attractive and unattractive males in different spatial combinations. We found generalized spatial discrimination against lone callers but did observe fine-scale assessment of call features within clusters. The prominence of the spatial preference impacts the attractiveness of males, conferring particular advantage to attractive callers within clusters, while reducing attractiveness of isolated males regardless of their acoustic features. Our findings indicate that female frogs navigate complex choruses by initially orientating toward call aggregates, and then assess call-features within them. This study provides novel insight into the mate choice heuristics involved in animal choruses. Ph.D. dissertation research (Kane Stratman) and undergraduate research project (Emma Oldehoeft), Gerlinde Höbel, Major Advisor

Identification of Microorganisms and their Metabolites at the UWM Field Station

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Microorganisms that were isolated from soils and insects collected at the UWM Field Station were cultured in the medium broth. To classify the bacterial strains, the 16S rRNAs of the isolated bacteria were sequenced. Housekeeping genes were further sequenced on some bacterial strains for classification purposes. The housekeeping genes for multilocus sequence analysis (MLSA) were extracted from genome samples. The maximum likelihood inference was performed using PhyML. The natural compounds produced from the microorganisms were evaluated for their inhibition of the growth of plant pathogens, such as *Erwinia* and *Botrytis* species. Potential compound candidates are analyzed by mass spectra and nuclear magnetic resonance spectroscopy for their chemical structures. Funded by the United States Department of Agriculture-National Institute of Food and Agriculture (NIFA) and T3 Bioscience LLC.

County Level Distribution of *Ixodes scapularis* in Wisconsin

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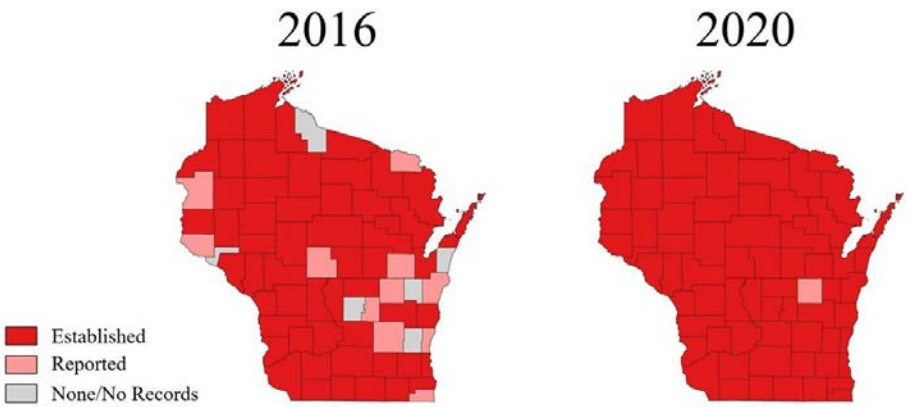
Ixodes scapularis, also known as the deer or blacklegged tick, is a vector for several tick-borne diseases including, but not limited to, Lyme disease, anaplasmosis, and babesiosis. The Medical Entomology Lab at the University of Wisconsin – Madison has aimed to determine the distribution of *I. scapularis* from counties that either lacked reports or did not have records of an established deer tick population based on Eisen et al. (2016). Dodge, in southeastern Wisconsin, is one such county. To be considered as a county with an established population, a county must produce either two *I. scapularis* life stages or six of one life stage in the timespan of a year. On June 25, 2020, we visited Mayville Ledge Beech Woods State Natural Area and sampled for ticks by dragging a 1-m^2 cloth sheet on the forest floor. One *I. scapularis* larva and one nymph were collected from the property. Based on these results, Dodge Co. is now considered to have an endemic population of *I. scapularis*. Residents and travelers should be aware of their *I. scapularis* exposure risk when they are in counties with established populations. Funding for this research is provided by the Centers for Disease Control and Prevention to the Midwest Center of Excellence for Vector-Borne Disease.



Recent Publications and Theses

Recent Publications Resulting from Field Station Projects

Berg, J. A., G. A. Meyer and E. B. Young. 2016. Propagule pressure and environmental conditions interact to determine establishment success of an invasive plant species, glossy buckthorn (*Frangula alnus*), across five different wetland habitat types. Biological Invasions 18(5): 1363-1373.

Casper, G. S. 2016**.** Geographic Distribution: *Necturus maculosus* (Mudpuppy). USA: Wisconsin: Washington Co. Herpetological Review 47(3): 417.

Casper, G. S. 2016. Geographic Distribution: *Hyla versicolor* (Gray Treefrog). USA: Wisconsin: Milwaukee Co. Herpetological Review 47(3): 419.

Casper, G. S. and Matthew Schmidt. 2016. Geographic Distribution: *Lithobates catesbeianus* (American Bullfrog). USA: Wisconsin: Green Lake Co. Herpetological Review 47(3): 420.

Casper, G. S. and R. D. Rutherford. 2016. Geographic Distribution: *Opheodrys vernalis* (Smooth Greensnake). USA: Wisconsin: Menominee Co. Herpetological Review 47(3): 428.

Casper, G. S. and P. Kleinhenz. 2016. Geographic Distribution. *Tropidoclonion lineatum* (Lined Snake). USA: Wisconsin: Dane Co. Herpetological Review 47(3): 429.

Henschen, A. E., L. A. Whittingham and P. O. Dunn. 2016. Oxidative stress is related to both melanin- and carotenoid-based ornaments in the common yellowthroat. Functional Ecology 30(5): 749-758.

Keyes, A. 2016. Home, sweet nest box: A comparison of detection methods for the southern flying squirrel (*Glaucomys volans)* in Ozaukee and Washington Counties, WI. Proceedings of The National Conference On Undergraduate Research (NCUR), University of North Carolina.

Kilkenny, F. F. and L. F. Galloway. 2016. Evolution of marginal populations of an invasive vine increases the likelihood of future spread. New Phytologist 209: 1773-1780.

Meyer, G. A., J. A. Senulis and J. A. Reinartz. 2016. Effects of temperature and availability of insect prey on bat emergence from hibernation in spring. Journal of Mammalogy 97(6): 1623-1633.

Rutherford, J. L., G. S. Casper and B. Graves. 2016. Factors affecting predation on Wood Turtle (*Glyptemys insculpta*) nests in the Upper Peninsula of Michigan. Chelonian Conservation and Biology 15(2):181-186.

Sorin, Y. B., R. J. Mitchell, D. W. Trapnell and J. D. Karron. 2016. Effects of pollination and postpollination processes on selfing rate in *Mimulus ringens*. American Journal of Botany 103 (8): 1524-1528.

Whittingham, L. A. and P. O. Dunn. 2016. Experimental evidence that brighter males sire more extra-pair young in tree swallows. Molecular Ecology 25 (15): 3706-3715.

Yu, R., M. D. Schwartz, A. Donnelly and L. Liang. 2016. An observation-based progression modeling approach to spring and autumn deciduous tree phenology. International Journal of Biometeorology 60 (3): 335-349.

Casper, G.S., C.E. Smith, S.M. Nadeau, and A.Lewanski. 2017**.** Geographic Distribution. *Acris blanchardi* (Blanchard's Cricket Frog). USA: Minnesota: Dakota Co. Herpetological Review 48(4):805.

Fowler-Finn K.D., D.C. Cruz and R.L. Rodríguez. 2017**.** Local population density and group composition influence signal-preference relationships in *Enchenopa* treehoppers (Hemiptera: Membracidae). Journal of Evolutionary Biology 30: 13-25.

Hallett, A.C., R.J. Mitchell, E.R. Chamberlain, and J.D. Karron. 2017**.** Pollination success following loss of a frequent pollinator: the role of compensatory visitation by other effective pollinators. AoB PLANTS 9: plx020; doi:10.1093/aobpla/plx020.

Henschen, A. E., L.A.Whittingham and P.O. Dunn. 2017. The relationship between blood parasites and ornamentation depends on the level of analysis in the common yellowthroat. Journal of Avian Biology 48:1263-1272.

Hileman, E.T., R.B. King, J.M. Adamski, T.G. Anton, R.L. Bailey, S.J. Baker, N.D. Bieser,

T.A. Bell, Jr, K.M. Bissell, D.R. Bradke, H. Campa, III, G.S. Casper, K. Cedar, M.D. Cross, B.A. DeGregorio, M.J. Dreslik, L.J. Faust, D.S. Harvey, R.W. Hay, B.C. Jellen, B.D. Johnson, G. Johnson, B.D. Kiel, B.A. Kingsbury, M.J. Kowalski, Y.M. Lee, A.M. Lentini, J.C. Marshall, D. Mauger, J.A. Moore, R.A. Paloski, C.A. Phillips, P.D. Pratt, T. Preney, K.A. Prior, A. Promaine, M. Redmer, H.K. Reinert, J.D. Rouse, K.T. Shoemaker, S. Sutton, T.J. VanDeWalle, P.J. Weatherhead, D. Wynn, and A. Yagi. 2017**.** Climatic and geographic predictors of life history variation in Eastern Massasauga (*Sistrurus catenatus*): A range-wide synthesis. PLoS ONE 12(2): e0172011. doi:10.1371/journal.pone.0172011.

Joneson, S. and H. O'Brien. 2017. A molecular investigation of free-living and lichenized *Nostoc* sp. and symbiotic lifestyle determination. The Bryologist 120(4): 371–381.

Reichert, M.S. and G. Höbel. 2017**.** Frequency channel-dependent selectivity for temporal call characteristics in gray treefrogs, *Hyla versicolor.* Journal of Experimental Biology 220: 1256-1266. doi:10.1242/jeb.152330

Piaskowski, V.D., J.M. O'Donnell, and G.A. Meyer. 2017**.** Bird use of the Cedarburg Bog Important Bird Area during spring and fall migration. Passenger Pigeon 79 (2): 139 – 161.

Underhill, V.A. and G. Höbel. 2017**.** Variation in nocturnal light levels does not alter mate choice behavior in female eastern gray treefrogs (*Hyla versicolor*). Behavioral Ecology Sociobiology 71:151. DOI 10.1007/s00265-017-2386-1

Ambardar, M., P.O. Dunn and L.A. Whittingham. 2018**.** Reproductive and foraging success of the Eastern Bluebird (*Sialia sialis*) in relation to vegetation height. Wilson Journal of Ornithology 130(2):362–370.

Casper, G.S. and R.D. Rutherford. 2018. Geographic Distribution: *Lithobates catesbeianus* (American Bullfrog). USA: Wisconsin: Shawano Co. Herpetological Review 49(2):282.

Casper, G.S. 2018. Geographic Distribution: *Ambystoma maculatum* (Spotted Salamander). USA: Wisconsin: Shawano Co. Herpetological Review 49(2):280.

Casper, G.S. and R.D. Rutherford. 2018. Geographic Distribution: *Hemidactylium scutatum* (Four-toed Salamander). USA: Wisconsin: Shawano Co. Herpetological Review 49(2):280.

Casper, G.S. and R.D. Rutherford. 2018**.** Geographic Distribution: *Notophthalmus viridescens louisianensis* (Central Newt). USA: Wisconsin: Shawano Co. Herpetological Review 49(2):281.

Casper, G.S. and R.D. Rutherford. 2018**.** Geographic Distribution: *Hyla versicolor* (Gray Treefrog). USA: Wisconsin: Shawano Co. Herpetological Review 49(2):282.

Clark, R.G., D.W. Winkler, R.D. Dawson, D. Shutler, D.J.T. Hussell, M.P. Lombardo, P.A. Thorpe, P.O. Dunn and L.A. Whittingham. 2018**.** Geographic variation and environmental correlates of apparent survival rates in adult tree swallows *Tachycineta bicolor.* Journal of Avian Biology 49 (6). DOI: 10.1111/jav.01659

Fowler-Finn, K.D., J.T. Kilmer, D.C. Cruz, and R.L. Rodriguez. 2018**.** Female mate choice of male signals is unlikely to promote ecological adaptation in *Enchenopa* treehoppers (Hemiptera: Membracidae). Ecology and Evolution 8: 2146-2159.

Gafvert, U. and G.S. Casper. 2018. Quality assurance plan for amphibian monitoring in the Great Lakes Network. Natural Resource Report NPS/GLKN/NRR—2018/1713. National Park Service, Fort Collins, Colorado.

Graham, L.E., M.T. Trest, S. Will-Wolf, N.S. Miicke, L.M. Atonio, M.J. Piotrowski and J.J. Knack. 2018. Microscopic and metagenomic analyses of *Peltigera ponojensi*s (Peltigerales, Ascomycota). Int. J. Plant Sci. 179(3):241–255.

Han, W.S., J.P. Graham, S. Choung, E. Park, W. Choi, and Y.S. Kim. 2018. Local-scale variability in groundwater resources: Cedar Creek Watershed, Wisconsin, U.S.A. Journal of Hydro-environment Research 20: 38-51.

Henschen, A.E., L.A. Whittingham and P.O. Dunn. 2018**.** Male stress response is related to ornamentation but not resistance to oxidative stress in a warbler. Functional Ecology 32:1810–1818.

Karol, K.G., M.S. Alix, R.W. Scribailo, P.M. Skawinski, R.S. Sleith, J.A. Sardina and J.D. Hall. 2018**.** New records of the rare North American endemic *Chara brittonii* (Characeae), with comments on its distribution. Brittonia 70(3):277-288.

Minnaar, C., B. Anderson, M.L. de Jager, and J.D. Karron. 2018**.** Plant-pollinator interactions along the pathway to paternity. Annals of Botany 123: 225–245.

Murphy, J.C., J.R. Downie, J.M. Smith, S.R. Livingstone, R.S. Mohammed, R.M. Lehtinen, M. Eyre, J.N. Sewlal, N. Noriega, G.S. Casper, T. Anton, M.G. Rutherford, A.L. Braswell and M.J. Jowers. 2018**.** A Field Guide to the Amphibians and Reptiles of Trinidad & Tobago. Trinidad & Tobago Field Naturalists' Club, Port of Spain, Trinidad and Tobago. R.J. Auguste (managing Editor).

Rodriguez, R. L., J.E. Wojcinski and J. Maliszewski. 2018. Between-group variation in *Enchenopa* treehopper juvenile signaling (Hemiptera Membracidae). Ethology Ecology & Evolution 30: 245–255.

Thompson, K.L., B. Zuckerberg, W.P. Porter and J.N. Pauli. 2018**.** The phenology of the subnivium. Environ. Res. Lett. 13: 064037.

Underhill, V.A. and G. Höbel. 2018**.** Moonlighting? - Consequences of lunar cues on anuran reproductive activity. Acta Oecologica 87: 20-28.

Underhill, V.A. and G. Höbel. 2018. Mate choice behavior of female Eastern Gray Treefrogs (*Hyla versicolor)* is robust to anthropogenic light pollution. Ethology 124: 537-548.

Whitehead, M.R., R.J. Mitchell and J.D. Karron. 2018. Plant mating systems often vary widely among populations. Frontiers in Ecology and Evolution 6:38.

Whittingham, L.A., P.O. Dunn, C.R. Freeman-Gallant, C.C. Taff and J.A. Johnson. 2018. Major histocompatibility complex variation and blood parasites in resident and migratory populations of the common yellowthroat. Journal of Evolutionary Biology 31:1544-1557.

Young, E.B., J.R. Sielicki, and J.J. Grothjan. 2018**.** Regulation of hydrolytic enzyme activity in aquatic microbial communities hosted by carnivorous pitcher plants. Microbial Ecology 76: 885-898.

Casper, G.S., T.G. Anton and R.D. Rutherford. 2019. Guide to Amphibian Eggs and Larvae of the Western Great Lakes. National Park Service, Fort Collins, Colorado. 100 pp.

Christopher D.A., R.J. Mitchell, D.W. Trapnell, P.A. Smallwood, W.R. Semski and J.D. Karron. 2019. Hermaphroditism promotes mate diversity in flowering plants. American Journal of Botany 106: 1131–1136. https://doi:10.1002/ajb2.1336

Desjonquères, C., J. Maliszewski, E.N. Lewandowski, B. Speck and R.L. Rodríguez. 2019. Social ontogeny in the communication system of an insect. Animal Behaviour 148: 93-103.

Desjonquères, C., B. Speck and R.L. Rodríguez. 2019. Signalling interactions during ontogeny are a cause of social plasticity in *Enchenopa* treehoppers (Hemiptera: Membracidae). Behavioural Processes 166: 103887. https://doi.org/10.1016/j.beproc.2019.06.010

Fitzpatrick, M.J., B. Zuckerberg, J.N. Pauli, M.R. Kearney, K.L. Thompson, L.C. Werner II and W.P. Porter. 2019. Modeling the distribution of niche space and risk for a freeze-tolerant ectotherm, *Lithobates sylvaticus.* Ecosphere, 10 (7):e02788. 10.1002/ecs2.2788

Geller, G.A., and G.S. Casper. 2019. Natural History Notes. *Chelydra serpentina* (Snapping Turtle). Hatchling sounds. Herpetological Review 50(4):768–9.

Geller, G.A. and G.S. Casper. 2019. Late-term embryos and hatchlings of Ouachita Map Turtles (*Graptemys ouachitensis*) make sounds within the nest. Herpetological Review 50(3):449–452.

Grothjan J.J. and E.B. Young. 2019. Diverse microbial communities hosted by the model carnivorous pitcher plant *Sarracenia purpurea*: analysis of both bacterial and eukaryotic composition across distinct host plant populations. PeerJ 7:e6392 http://doi.org/10.7717/peerj.6392

Huebschman, J.L., S.A. Hoerner, J.P. White, H.M. Kaarakka, K.L. Parise and J.T. Foster. 2019. Detection of *Pseudogymnoascus destructans* on Wisconsin bats during summer. Journal of Wildlife Diseases 55 (3): 673-677.

Stratman, K.D. and G. Höbel. 2019. Opportunity for female choice in the wild is frequently curtailed by low male trait variation in *Hyla versicolor*. Behavioral Ecology and Sociobiology 73(5): 59. https://doi.org/10.1007/s00265-019-2666-z

Christopher, D.A., R.J. Mitchell, D.W. Trapnell, P.A. Smallwood, W.R. Semski, and J.D. Karron. 2020. Edge effects and mating patterns in a bumblebee-pollinated plant. AoB Plants 12(4). https://doi.org/10.1093/aobpla/plaa033

Christopher, D.A., R.J Mitchell, and J.D. Karron. 2020. Pollination intensity and

paternity in flowering plants. Annals of Botany 125: 1–9. doi.org/10.1093/aob/mcz159

Desjonquères C., R.B. Holt, B. Speck and R.L. Rodríguez. 2020. The relationship between a combinatorial rule and a continuous preference function in an insect. Proceedings of the Royal Society B 287: 20201278. https://doi.org/10.1098/rspb.2020.1278

Donnelly, A., R. Yu, C. Rehberg, G. Meyer, and E.B. Young. 2020. Leaf chlorophyll estimates of temperate deciduous shrubs during autumn senescence using a SPAD-502 meter and calibration with extracted chlorophyll. Annals of Forest Science 77:30 https://doi.org/10.1007/s13595-020-00940-6

Hoyt, J.R., K.E. Langwig, K. Sun, K.L. Parise, Y. Wang, X. Huang, L. Worledge, H. Miller, T. Görföl, S.A. Boldogh, D. Fukui, M. Sakuyama, S. Yachimori, A. Sato, M. Dalannast, A. Jargalsaikhan, N. Batbayar, Y. Yovel, E. Amichai, I. Natradze, W.F. Frick, J.T. Foster, J. Feng and A.M. Kilpatrick. 2020. Environmental reservoir dynamics predict global infection patterns and population impacts for the fungal disease white-nose syndrome. Proceedings of the National Academy of Sciences 117 (13): 7255-7262. https://doi.org/10.1073/pnas.1914794117

Mueller, W. P., and G. S. Casper. 2020. Winter waterfowl abundance and distribution in the Milwaukee estuary and harbor. Passenger Pigeon 82 (1):7-19.

Rosenfield, R.N., A.C. Stewart, W.E. Stout, S.A. Sonsthagen, and P.N. Frater. 2020. Do British Columbia Cooper's Hawks have big feet? British Columbia Birds 30:10-14

Speck, B., S. Seidita, S. Belo, S. Johnson, C. Conley, C. Desjonquères and R.L. Rodríguez. 2020. Combinatorial signal processing in an insect. American Naturalist 196: 406-413

Yi, X., D.M. Donner, P.E. Marquardt, J.M. Palmer, M.A. Jusino, J. Frair, D.L. Linder, and E.K. Latch. 2020. Major histocompatibility complex variation is similar in little brown bats before and after white-nose syndrome outbreak. Ecology and Evolution 10(18): 10031-10043. https://doi.org/10.1002/ece3.6662

Recent Theses

Kolodziej, Robb C. 2014. The effect of female quality on mating preferences in Eastern Gray Treefrogs, *Hyla versicolor.* M.S. Thesis.

Graham, Jackson. 2015. Climate impact on groundwater flow processes in the Cedar Creek Watershed and Cedarburg Bog. M.S. Thesis.

Hallett, Allysa. 2016. Consequences of loss of an abundant pollinator: an experimental study. M.S. Thesis.

Servi, Jason S. 2016. Natural selection by insect pollinators and seed predators on floral head traits of *Helianthus grosseserratus* (Sawtooth Sunflower). M.S. Thesis.

Joynt, Emily K. 2017. Factors controlling diffusive CO_2 production and transport in the Cedarburg Bog, Saukville, Wisconsin. M.S. Thesis

Henschen, Amberleigh E. 2018. Plumage ornaments signal male physiological quality in common yellowthroats. Ph.D. dissertation.

Underhill, Victoria. 2018. Influence of natural and anthropogenic light levels on female preferences in eastern gray treefrogs (*Hyla versicolor)*. M.S. Thesis.

Rehberg, Chloe. 2020. An analysis of temperate deciduous shrub phenology in Downer Woods, University of Wisconsin-Milwaukee, Wisconsin, USA. M.S. Thesis

Cooperation with Other Groups and Agencies

Service to the local community, and to the state-wide community of individuals, groups, and organizations engaged in natural area study and preservation is a major part of the Field Station's mission. To the extent that our staff has time available, we provide natural area consulting services to the community. The demand for these services exceeds our capacity to help, but we feel that these cooperative efforts are a very important part of our mission.

1. Friends of the Cedarburg Bog. The Field Station cooperates with and helps to support this non-profit organization that has a mission to initiate and support activities that will enhance the natural history, public appreciation, and scientific study of the Cedarburg Bog in cooperation with the Wisconsin DNR and UWM.

2. Department of Natural Resources. The Station continued its wide range of planning and management activities in conjunction with the DNR. These activities include the day-to-day surveillance of the Cedarburg Bog performed by Station staff and some assistance with maintenance activities such as snowplowing. The Station also assists the DNR with bat monitoring programs at Neda Mine.

3. UWM at Waukesha Field Station. The Station cooperates with the Waukesha Field Station which is also part of UWM.

4. Wisconsin Phenological Society. G. Meyer serves on the Board of Directors and the Field Station hosts the Annual Meeting each spring. We were not able to hold the Annual Meeting at the Field Station in 2020 because of the COVID-19 pandemic.

5. Natural Areas Preservation Council. The Station participates in the State Natural Areas program, since the Station owns and manages five properties that have State Natural Areas status.

6. Regional School Systems. Biology classes and clubs from several high schools in the region (Milwaukee, Ozaukee, and Washington counties) use the Field Station for ecology field classes. These trips were cancelled in 2020 because of the COVID-19 pandemic.

7. National Oceanic and Atmospheric Administration – Milwaukee Office. Weather records are provided monthly and frost and snow depth data are collected in winter.

8. Organization of Biological Field Stations. The Station is an active member of this national organization and cooperates in the exchange of information on programs.

9. Ozaukee Treasures Network. The Field Station is cooperating with this consortium of over 30 environmental organizations to promote conservation in Ozaukee County.

10. The Prairie Enthusiasts. The Field Station has entered into a management agreement with this non-profit group to restore Benedict Prairie.

11. Upham Woods Outdoor Learning Center. Upham Woods is a residential field campus of the University of Wisconsin-Madison. G. Meyer serves on the Research and Innovation Advisory Committee.

Marsh Wren. Photo by Kate Redmond.

2020
Natural History Workshops

The Field Station workshop program offers intensive short courses (weekend to week-long) on specialized topics in natural history. All of these courses are offered to the general public, and many are offered to UWM students for credit as BioSci 562, Topics in Field Biology, with an additional, online component.

We had a full schedule of workshops planned for 2020. The first workshop offered was Introduction to Bird Song, taught by William Mueller, from February 5 – March 25. Students met at the Field Station one evening per week. The COVID-19 lockdown came midway through the class, and we moved it online at short notice. We had 7 additional workshops planned for the summer of 2020, including two that were new and being offered for the first time. All of these workshops had to be cancelled. We began exploring online and hybrid options for workshops to use in 2021, but did not have time to implement these strategies in 2020.

Semester Classes

UWM semester classes taught at the Field Station or by Field Sation staff.

1. Conservation and Environmental Science 471
Practicum in Natural Resources Management
Spring 2020

In this class, students work on a real-world environmental project in order to learn about preparing management plans and project proposals. The class was taught on campus by Dr. Neal O'Reilly. Dr. Gretchen Meyer led one project, where a team of students developed a management plan for Downer Woods.

2. Biological Sciences/Conservation and Environmental Science 451
Field Methods in Conservation
Fall 2020

This course is taught entirely at the Field Station by Dr. Gretchen Meyer. The course gives students interested in conservation biology and natural area management an opportunity for hands-on learning in the field. Students can go directly from the classroom to natural areas located on the Field Station property, where they practice techniques that have been presented in the lecture. The course was taught in an online format in 2020 because of the COVID-19 pandemic.

Class and Group Use

The Field Station operated normally until mid-March, when the COVID-19 pandemic forced us to cancel all of our remaining natural history workshops and events for the year. After mid-March, we shifted meetings, events and classes online whenever possible. The need to be online limited the number of events and classes that could be offered. The Friends of the Cedarburg Bog began making videos and posting them on a YouTube channel to allow people to enjoy the Field Station and Cedarburg Bog remotely.

In-person Use	**Number of Person Hours**
Alverno College - Ecology Class	21
Friends of Cedarburg Bog - How Do Trees Grow?	36
Friends of Cedarburg Bog - Natural History of North American Bears	72
Friends of Cedarburg Bog - Owl Prowl	48
Friends of Cedarburg Bog - Waterbirds of the Bog	30
Friends of Cedarburg Bog - Winter Hike and Chili Supper	345
Friends of Cedarburg Bog – meetings	58
Prairie Enthusiasts - Benedict Prairie management meeting	18
Prairie Enthusiasts - Benedict Prairie tour	21
Prairie Enthusiasts - Benedict Prairie work days	143
Riveredge Nature Center - Christmas bird count	6
UWM - Candlelight walk (Downer Woods)	360
UWM - Foundations of Biological Sciences (BioSci 152) Collect materials for online class	4
UWM - Introduction to Bird Song workshop[1]	252
UWM - Topics in Architectural Theory (Arch 533) - Class visits	143
UWM - Topics in Architectural Theory (Arch 533) Tour of Neda Mine	33
UW-Whitewater, Field Botany - Photographs for online class	8
Total	**1598**

1-Introduction to Bird Song was moved online in mid-March.

Online use (synchronous)	**Number of Person Hours**
Friends of Cedarburg Bog – meetings	126
UWM - Field Methods in Conservation class (BioSci/CES 451)	840
TOTAL	**966**

TOTAL 2020 Class & Group Use Hours	**2564**

Friends of the Cedarburg Bog Videos	Number of Views[2]
Boardwalk hike with Jim Reinartz (33:35)	117
How to hold a frog (1:14)	32
Baby painted turtle crossing (2:38)	19
Two Leaf Miterwort (1:18)	20
Cedarburg Bog Drone Video Part One (12:54)	126
Cedarburg Bog Drone Video Part Two (9:56)	73
Cedarburg Bog Drone Video Part Three (12:17)	67
FOCB 2020 Annual Meeting Committee Videos (18:07)	36
FOCB 2020 Annual Meeting Officer's videos (9:41)	62
Mud Lake Islands (15:45)	86
Trees of Watts Lake (9:41)	72
Fall Odonata Survey at Cedarburg Bog with Julia Robson (16:04)	76
TOTAL.	**786**

2- Number of views as of March 22, 2021

Friends of the Cedarburg Bog Winter Hike 2020

Meteorological Data for 2020

This yearly summary is modeled, where possible, after the summaries provided by the National Oceanic and Atmospheric Administration (NOAA). Some differences between the two reports reflect differences in available equipment. Records for the Field Station are reported in degrees Celsius and in other metric measures. In addition, growing degree-days at 5° and 10°C, (see below for description) were substituted for the heating and cooling degree-days used by NOAA. The variables reported in the summaries are defined as follows:

Temperature

Average Daily Maximum: Monthly mean of the 30-min period in each day with the highest mean temperature.

Average Daily Minimum: Monthly mean of the 30-min period in each day with the lowest mean temperature.

Daily Average: Monthly mean of all 30-min means. (NOAA uses the midpoint between the daily minimum and maximum for this measure.)

Highest(Date): Highest 30-min mean temperature. (Day of month with highest temperature.)

Lowest(Date): Lowest 30-min mean temperature. (Day of month with lowest temperature.)

Degree Days

Sum at 5°: Sum of the number of degrees by which the daily average temperatures exceeded 5° C.

Sum at 10°: Sum of the number of degrees by which the daily average temperature exceeded 10° C.

Radiation (kW/m^2)

Mean: Mean of all 30-min means in the month.

Maximum: Maximum 30-min mean during the month.

Relative Humidity

Monthly mean of the 30-min means for each quarter of the day.

Number of Days

Precipitation of 0.25 mm or more

Temperature-Maximum

32° and above: Number of days with a maximum 30-min mean temperature of 32° C or above.

0° and below: Number of days with a maximum 30-min mean temperature of 0° C or below.

Temperature-Minimum

0° and below: Number of days with a minimum 30-min mean temperature of 0° C or below.

-18° and below: Number of days with a minimum 30-min mean temperature of -18° C or below.

Mean Pressure (mbars)

Mean of all 30-min means in the month.

Precipitation (mm)

Total: Sum of all precipitation during the month.

Greatest (24 hrs) (Date): Total precipitation on the day with the most precipitation and the date on which it occurred.

Wind

Mean Speed (m/s): Monthly mean of all 30-min means.

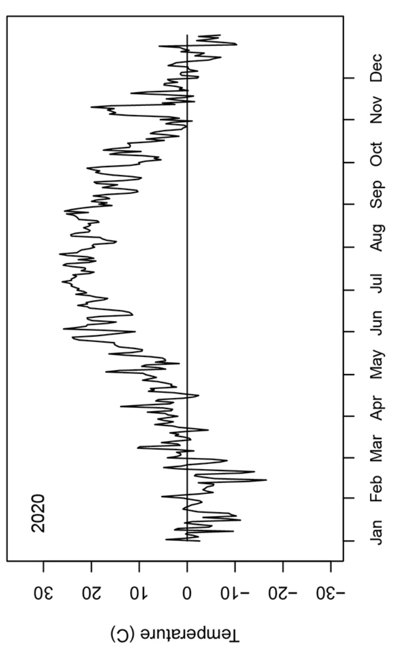
Maximum Speed (m/s): Highest mean wind speed during a 30-min period.

The Field Station can provide weather data in electronic format; datasets go back to 1989. Please contact us if you would like to receive the weather data.

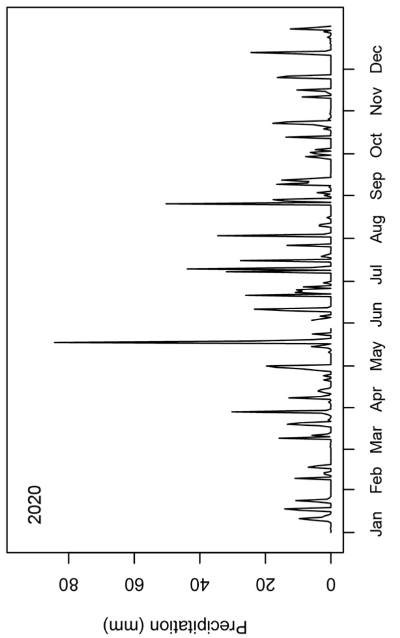
Meteorological Data for 2020

	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
Temperature (C°)												
Average Daily Maximum	1.0	0.1	6.7	10.6	17.3	25.2	28.0	26.6	20.5	12.5	11.7	1.5
Average Daily Minimum	-6.2	-8.6	-1.7	-0.1	6.6	12.7	17.1	14.7	10.4	1.7	1.1	-5.8
Daily Average	-2.6	-4.1	2.6	5.1	12.2	19.1	22.7	20.7	15.5	7.2	6.3	-1.9
Highest (Date)	9.8 (9)	10.1 (23)	16.6 (8)	25.0 (7)	29.8 (25)	32.8 (2)	33.1 (26)	31.7 (26)	26.8 (23)	26.9 (9)	24.5 (9)	12.9 (10)
Lowest (Date)	-17.7 (17)	-23.1 (14)	-8.3 (21)	-6.3 (15)	-3.0 (9)	4.5 (14)	13.2 (24)	9.3 (7)	1.5 (19)	-6.6 (31)	-6.0 (14)	-15.0 (31)
Degree Days												
Sum at 5°	0.0	0.3	13.6	42.8	227.5	422.4	549.8	485.3	313.6	99.8	97.0	0.9
Sum at 10°	0.0	0.0	0.4	3.9	110.9	272.4	394.8	330.3	164.2	32.2	48.5	0.0
Radiation (kW/m^2)												
Mean	0.05	0.12	0.12	0.18	0.24	0.29	0.27	0.23	0.15	0.11	0.09	0.05
Maximum	0.49	0.68	0.79	0.93	0.99	1.05	1.02	0.97	0.83	0.67	0.52	0.43
Relative Humidity (%)												
Hour 00-06 mean	86.3	74.6	82.2	82.6	83.3	86.4	91.8	90.5	88.8	81.3	76.4	82.1
Hour 06-12 mean	84.0	68.0	76.3	66.0	63.6	64.1	69.5	69.8	73.5	71.1	70.0	79.7
Hour 12-18 mean	76.8	56.3	65.7	55.3	53.2	55.8	60.8	59.3	64.5	57.1	57.1	72.0
Hour 18-24 mean	83.7	69.2	78.5	74.4	71.0	77.9	82.8	84.7	85.1	75.3	71.6	80.7
Number of Days												
Precip. 0.25mm or more	12	5	14	14	8	12	7	9	10	10	6	9
Max Temp 32° and above	0	0	0	0	0	1	1	0	0	0	0	0
Max Temp 0° and below	12	12	1	0	0	0	0	0	0	0	0	12
Min Temp 0° and below	28	27	21	16	5	0	0	0	0	14	18	29
Min Temp -18° and below	0	3	0	0	0	0	0	0	0	0	0	0
Pressure (mbars)												
Mean	1017.52	1016.82	1017.05	1012.58	1016.41	1014.97	1015.31	1015.49	1017.24	1017.27	1017.05	1015.29
Precipitation (mm)[1]												
Total	61.3	26.4	86.8	81.5	130.2	117.8	127.5	129.2	73.2	67.7	51.4	56.7
Greatest (24 hrs) (Date)	14.1 (18)	11.0 (9)	30.2 (28)	19.7 (30)	84.4 (17)	26.0 (20)	43.9 (9)	50.3 (25)	16.6 (8)	17.7 (22)	16.4 (24)	24.4 (12)
Wind												
Mean Speed (m/s)	1.5	1.8	1.8	1.8	1.7	1.3	1.0	0.9	1.1	1.3	1.8	1.6
Maximum Speed (m/s)	5.7	5.8	5.4	5.5	5.5	5.8	3.8	3.6	4.2	5.2	6.4	5.1

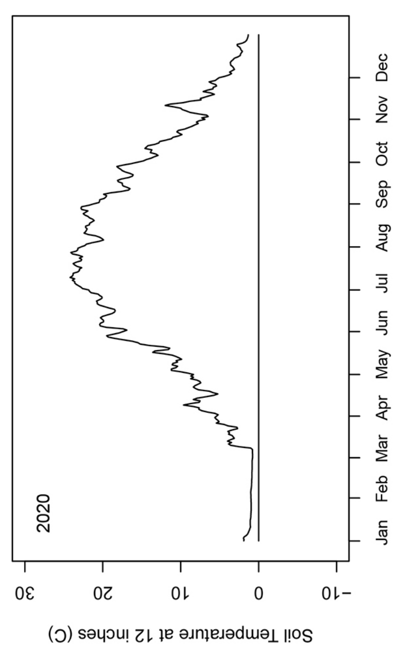
1 - Rainfall data are missing from May 28 - June 2.



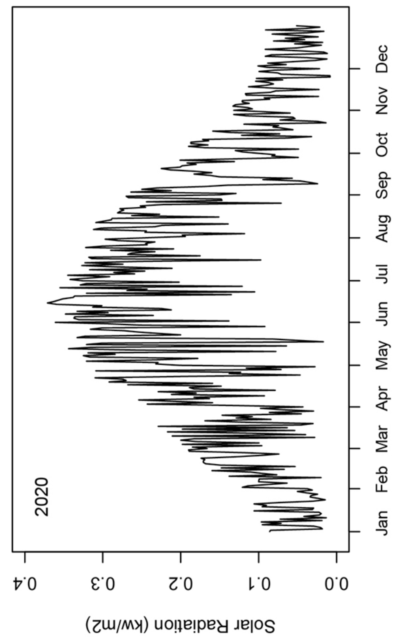
Mean Daily Temperature



Total Daily Precipitation



Soil Temperature at 12 Inches Depth



Mean Daily Radiation

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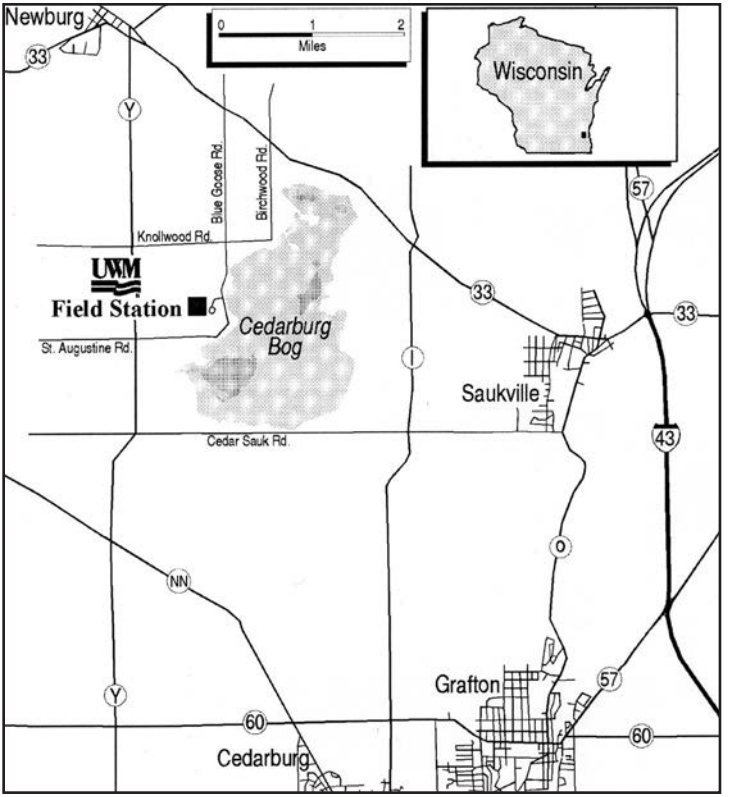

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