

2010

FIELD STATION
ANNUAL REPORT



Table of Contents

About Us

2010 Highlights	1
UWM Field Station.	1
Natural Areas	1
Research and Teaching Facilities	2
Field Station Programs	3
The Friends of the Cedarburg Bog	4
Abstracts of Research	5
Recent Publications & Theses	34
Cooperation with Other Groups and Agencies	38
Natural History Workshops	39
Class and Group Use	40
Meteorological Data for 2010	42

On the Cover: Dr. Tim Grundl and his Field Hydrology class (UWM, Geosciences) install a new ground-water monitoring well at the Field Station in November 2010.

Director:	James A. Reinartz
Manager/Staff Biologist:	Gretchen A. Meyer
Maintenance:	Lou A. Nelson
Administrative Assistant:	Cynthia K. Boettcher
Field Station Committee:	Douglas Cherkauer, Peter Dunn, Timothy Ehlinger, Glen Fredlund, Tim Grundl, Jeffrey Karron (Chairman), Craig Sandgren, Stefan Schnitzer, Thomas Schuck, Linda Whittingham, Erica Young

About Us

2010 Highlights

- The Natural Resources Foundation and the Friends of Cedarburg Bog held a major "BioBlitz" event at the Field Station in July. Over 35 scientists and almost 100 citizen-scientists participated in the day-long event.
- The Field Station collaborated with the Southeastern Wisconsin Invasive Species Consortium (SEWISC) to design and teach workshops on invasive plant management for parks personnel and for right-of-way workers. This is an expansion of our Natural History Workshop program. The workshops were very well attended and received.
- Dr. Gretchen Meyer, along with collaborators Dr. Sara Hoot and Dr. Mai Phillips, received funding from the Research Growth Initiative at UWM for her study "Genetic structure of an invasive plant in its native and introduced ranges".
- The Neda Mine Bat Hibernaculum was featured in two segments on Outdoor Wisconsin (produced by Wisconsin Public Television). Dr. James Reinartz and Dr. Gretchen Meyer discussed the management of the mine and current research projects. These segments aired in 2010.
- Dr. Tim Grundl, UWM GeoSciences, installed new ground-water observation wells at the Station.
- The Field Station again hosted a two-week-long permaculture workshop that attracted international participants.
- Use of Downer Woods on campus for education and research continues to increase.
- 45 research projects conducted in 2010.
- Almost 12,000 student hours of instruction and group use in 2010 is near an all-time high.

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 1965. Research at the Station has produced 303 scientific publications and 138 theses since 1970.

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 carrs, 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 is part of the national system of Experimental Ecological Reserves established by the National Science Foundation and The Institute of Ecology. A "Guide to the Natural History of the Cedarburg Bog," which serves as a ready introduction and reference source for researchers and educators using the Bog, is available from the Field Station and on our website.

The Cedarburg Beech Woods State

Natural Area – 80 acres of one of the finest mature beech-maple forests in southern Wisconsin. The beech-maple forest and the Cedarburg Bog are each State Natural Areas, and are classified as National Natural Landmarks by the Department of Interior.

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 over the past 40 years is maintained. Six separate areas in the old fields have been planted with prairie species native to Wisconsin. A new experimental prairie area planted in the “North Hay Field” in the fall of 2005 is now very well established and serves as the location for Dr. Karron’s screenhouse and garden facility.

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*), meadow parsnip (*Pastinaca sativa*), purple loosestrife (*Lythrum salicaria*), sweet clover (*Mellilotus* 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. Friends of Cedarburg Bog volunteer workdays and our regular stewardship volunteer, Dennis Goldsmith, contributed about 30 person days during 2010 to help Field Station staff with 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 control seems intractable with the hand and mechanical methods we are using elsewhere. Fruiting-sized glossy buckthorn has been removed, and continues to be excluded, from a 6-acre plot and a 45-acre plot at the center of the Bog. The Wisconsin Department of Natural Resources also removed glossy buckthorn from large

areas of the northern portion of Cedarburg Bog during the winters of 2006-07 and 2007-08.

Research and Teaching Facilities

General Facilities

- Office/classroom building with meeting rooms, teaching lab, and computer lab.
- A new Research Lab constructed in 2004
- Service building – machine shop & woodshop
- The Farm House for researcher & student housing – The kitchen was redecorated/painted in 2008
- Natural areas marked with a permanent grid – Accurately GPS-located in 2005
- Boardwalk to the center of the Cedarburg Bog – Complete 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

- Large outdoor experimental aviary
- Live traps & animal holding facilities
- Extensive arrays of bird nest boxes
- Insect collection, small mammal & bird study skins

Experimental Garden

- 9 fenced research gardens
- 1 acre Experimental Garden with water &

electricity

- A 30' x 60' screen house, relocated in 2009, 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 the largest bat hibernaculum in the Midwest. Up to 200,000 bats of four species (Little brown bats, Big brown bats, Eastern pipistrelles, and Northern long-eared bats) use the hibernaculum. The hibernaculum has the infrastructure and instrumentation to be a productive facility for research on the behavioral ecology of bats at a major hibernaculum. An infrared beam system provides continuous counts of bat flights through the entrances to the mine and we have monitored bat activity continuously since 2000. 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.

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. Since that time we have been working very hard to control the garlic mustard, buckthorn, and honeysuckle with funding provided by the University.

Field Station Programs

- 45 active research projects conducted at the Field Station in 2010.
- Including: 7 M.S. thesis, 2 Ph.D. and 14 studies by researchers from outside of the University.
- 12 papers published during 2010. 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. The Station gathers long-term records, which include species lists, weather data, phenological observations, hydrologic studies, small mammal population studies, population fluctuation of certain avian species and ecological studies of various plant communities. Examples of our databases include:

- Vascular plant flora of the Field Station area (including approximately 720 taxa) & excellent herbarium.
- 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.
- A complete, quantitative, survey of the vegetation of the Cedarburg Bog, first conducted in 1991 and repeated in 2006.
- Phenological observations on leaf-out and flowering of standard genotypes of 6 species in a phenological garden, and 26 naturally occurring species at the Station since 2001.

- Long-term weather records from a standard US Weather Service weather station and a Bowen-Ratio energy flux monitoring system.
- Continuous monitoring of bat activity levels at the Neda Mine Bat Hibernaculum since 2000 and of temperatures in the mine since 1997.
- The Charles Weise 30-year study of Dark-eyed Juncos, including mark-recapture estimates of population size, age and sex composition, and seasonal and daily physiological changes in the wintering population.
- The Charles Weise 27-year intensive study of the Black-capped Chickadee, with a color-marked population of approximately 300 birds. This study involved precise monitoring of population changes throughout each year, analyses of dispersal mechanisms of juvenile birds, survival rates of juveniles and adults, dominance rank of flock members, and key-factor analyses of causes of fluctuation.
- The Charles Weise 26-year breeding bird survey of the Cedarburg Bog & upland woods from 1971 to 1996, repeated in 2006, 2007, and 2008.
- The Charles Weise 30-year bird-netting and banding program conducted in fall.
- The Field Station is a major site for long-term studies of avian vocalizations, including their organization and function.
- GIS system developed for the Field Station area.

Educational Programs

- Almost 12,000 student hours of instruction and group use in 2010.
- Nine workshops on advanced topics in natural history were filled to capacity
- Two new workshops on Invasive Plant Management for parks personnel and for right-of-way managers were developed and taught in cooperation with SEWISC (Southeastern Wisconsin Invasive Species Consortium).
- Four undergraduate student interns or independent research studies.
- Programs for the general public on: Winter

ecology, Spring frogs and woodcocks, Bird migration, Spring flora, Plants of the Bog, Mud Lake ecology, Bird banding, Ecology of the Cedarburg Bog, Ecology of the Beech-maple woods, Nature photography, Owls, and the Night Sky.

- The guidebook to the Bog is available to teachers using the boardwalk for instruction.
- Several field ecology exercises developed for the Field Station are available to instructors

Friends of the Cedarburg Bog

The mission of the ***Friends of Cedarburg Bog*** is to help preserve and study the Cedarburg Bog and to make the public more aware of its uniqueness. Specifically, their objectives are:

- To support research, including long-term monitoring.
- To assist in land preservation, management and stewardship.
- To develop formal and informal opportunities for public education.
- To generate volunteer labor for natural area management, education, public events, monitoring and research, and facility development and maintenance.
- To raise funds to support the activities of the group as defined above.

In 2010 the Friends installed welcome signs and weather-proof brochure holders at the public access points at both the north and south ends of the Bog. They also added interpretive signs to the handicapped accessible trail at the north end, and sponsored 13 educational events for the general public. Volunteers from the Friends contributed many person-days of labor, including natural area management, publishing a newsletter, raising funds, and sponsoring and providing staff for events. 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!

Abstracts of Research

The Effects of Habitat and Food Availability on Reproductive Success in Eastern Bluebirds (*Sialia sialis*)

Medhavi Ambardar, Peter O. Dunn, and Linda A. Whittingham

Department of Biological Sciences, UWM, ambardar@uwm.edu, pdunn@uwm.edu, whitting@uwm.edu

Habitat type can dramatically affect wildlife by influencing availability of resources (such as food) or occurrence of predators. Golf courses have recently been considered as areas of potential conservation value, but others claim that because of chemical pesticide application, low arthropod abundance decreases the quality of the habitat. We investigated reproductive success in eastern bluebirds (*Sialia sialis*) nesting in two golf courses (MeeKwon Golf Course; Hawthorne Hills Golf Course) and two natural areas (Riveredge Nature Center; UWM Field Station) during 2009 and 2010 in Ozaukee County, Wisconsin. Golf courses had significantly lower natural insect abundance, but were more productive than natural areas in terms of proportion of bluebirds that had more than one successful brood, and in terms of fledging success. This was due to fewer nests lost to predation by raccoons (*Procyon lotor*). When foraging, bluebirds made more successful captures on golf courses than in natural areas, but this was



not related to the probability of double brooding or fledging success at the individual level. These results suggest that with proper management, golf courses can provide valuable habitat for bluebirds. This research was funded by the American Ornithologists' Union, the Bluebird Restoration Association of Wisconsin, and the UWM Department of Biological Sciences. MS Thesis Research, Peter Dunn, Major Professor

Evaluating the Roles of Propagule Pressure, Biotic Resistance and Environmental Conditions in the Spread of an Invasive Wetland Plant

Jason Berg

Department of Biological Sciences, UWM, jaberg@uwm.edu

The success of an introduced plant species to invade a novel ecosystem is determined initially by its ability to disperse, followed by the establishment of a self-sustaining population, and then expansion across community boundaries. To predict patterns of invasion for an introduced plant species, it is necessary to examine both germination success and the propagule pressure exerted (for this study, the amount of seed deposition) by that species across



a range of community types. Germination success is dependent on the inherent biotic and abiotic factors that define any given community. These ecological factors will determine the community's ability to resist invasion, and they must be examined to evaluate the potential for invasion by an introduced plant species. It has been suggested that an introduced species may overcome high resistance in a community with an increase in propagule pressure. In this study, we will measure propagule pressure (using seed traps) and germination success (by sowing establishment plots in the field) of the introduced invasive woody shrub, *Frangula alnus*, in the Cedarburg Bog. In recent decades, *F. alnus* has been aggressively spreading across adjacent wetland community types within this relatively undisturbed State Natural Area in southeastern Wisconsin. By quantifying seed

deposition and germination rates in sites that display high densities and low densities of *F. alnus* adults, we will determine whether propagule pressure is able to overcome resistance to invasion. This will be one of the few studies to examine invasion across several community types by quantifying both propagule pressure and germination success. This study will attempt to answer the following questions: 1) Why do some sites remain uninvaded or have low densities of *F. alnus*? 2) How do propagule pressure and site resistance interact to determine susceptibility to invasion? 3) Which of these two mechanisms of invasion limits the spread of *F. alnus*? The results of this study will provide information on communities that are particularly susceptible to invasion by *Frangula alnus*. M.S. Thesis Research, Dr. Gretchen Meyer and Dr. Erica Young, advisors.



Hine's Emerald Dragonfly Conservation Genetics Study at Cedarburg Bog, Saukville, Wisconsin

Hugh Britten, Emy Monroe and Daniel Soluk.

Department of Biology, University of South Dakota, Hugh.Britten@usd.edu, Emy.Monroe@usd.edu, Daniel.Suluk@usd.edu

Hine's emerald dragonfly (*Somatochlora hineana*) is an endangered species that has been protected under the US Endangered Species Act since 1995. Although the species was historically distributed in several Midwestern states, habitat destruction has left the dragonfly largely confined to the vicinity of Chicago, IL, Door and Ozaukee Counties, WI, three counties in Michigan and one county in Missouri. The Cedarburg Bog site in Ozaukee County, WI, represents a potentially important site that is geographically intermediate between the remaining robust populations in Illinois and Door Co, WI. The goal of the project is to determine levels of genetic variability and to estimate genetic connectivity between dragonflies in the remaining occupied sites. Adults are captured with aerial nets and two small wing clips are taken for genetic samples. Once additional site and specimen data are taken, the dragonfly is released. The process takes less than two minutes per captured dragonfly. DNA is extracted from the wing clips and genetic variability is assayed at 10 microsatellite loci. Collection efforts at

Cedarburg Bog were made on 5 occasions in 2010 by Lesley Brotkowski of Cedarburg Science, LLC beginning 24 June and lasting until 13 July. Hine's emerald dragonflies were seen in flight at Cedarburg Bog and 10 adults were captured, 8 on 24 June and 2 on 2 July. All wing clips from 2010 were extracted and genotyped at 10 microsatellite loci at the University of South Dakota. To date we have microsatellite genotypes from 35 individuals collected from Cedarburg Bog 2008-2010. Funded by Illinois Toll Highway Authority, I355 Extension Hine's Emerald Dragonfly Study and the Illinois Department of Natural Resources.



Habitat Restoration and Wildlife Monitoring in Ozaukee and Washington Counties, Wisconsin

Gary S. Casper¹ and Shawn Graff²

¹UWM Field Station, gsc@uwm.edu, ²Ozaukee Washington Land Trust, sgraft@owlt.org

The Ozaukee Washington Land Trust (OWLT) initiated a Milwaukee River Basin project in the Lake Michigan watershed in 2004, to protect, restore, and enhance land in cooperation with local communities, through acquisition, protection, seeding, planting, and invasive species control. The project also addresses quality assessment through habitat and wildlife monitoring. In 2010 we continued reforestation, wetland restoration and invasive species control on OWLT properties. We continued herp and bird monitoring. We hosted training

workshops on wildlife monitoring, invasive species control and habitat restoration. We continued data analyses on herp and bird detection probabilities for use in modeling trends in the Milwaukee River Basin and determining species richness on OWLT properties. We continued disseminating project results through project reports, lectures, conference presentations, and workshops. Funded by the National Fish and Wildlife Foundation and a Great Lakes Watershed Restoration Grant.

Wisconsin Herp Atlas

Gary S. Casper
UWM Field Station, gsc@uwm.edu

The Wisconsin Herp Atlas is a distribution database of amphibians and reptiles in Wisconsin. The Atlas was initiated in 1986 at the Milwaukee Public Museum, with the cooperative support of the Natural Heritage Inventory Program (WDNR) and The Nature Conservancy (Wisconsin Chapter). The Atlas collects and verifies records obtained from museum collections, field surveys, the literature, and field notes provided by volunteer observers throughout the state. Over 450 new county records have been confirmed by the project. The data collected helps to map species distributions, document rare species occurrences, analyze distribution

trends, examine habitat requirements, and plan conservation priorities. In 2006 the Atlas was abandoned by the financially troubled Milwaukee Public Museum, and in 2007 it was re-established through the UWM Field Station, where it now resides, and currently houses 58,387 records. 3,201 occurrence records were added or updated in 2010.



Wildlife Ecopassage Monitoring

Gary S. Casper
UWM Field Station, gsc@uwm.edu

Wildlife ecopassages are designed to afford safe passage for wildlife across roadways, thereby reducing road mortality and improving traffic safety. Ecopassages allow wildlife to pass underneath the highway lanes, and maintain habitat and population connectivity on the landscape. This can be especially important in maintaining genetic interchange across highways for more sedentary wildlife such as amphibians and reptiles. Little data are available for evaluating the conservation effectiveness of these structures. This project installed wildlife cameras and is conducting surveys of 6 ecopassages in Waukesha and Racine

counties, Wisconsin, to collect data on patterns of wildlife use. Species documented to date include: raccoon, opossum, eastern cottontail, house cat, mink, woodchuck, gray squirrel, weasel (probably long-tailed), white-footed or deer mice, white-tailed deer, American robin, house sparrow, song sparrow, dark-eyed junco, barn swallow, eastern milksnake, snakes, painted turtle and American toad. We continued data collection and reporting in 2010. Funded by a C.D. Besadny Conservation Grant, Natural Resources Foundation of WI, and Wisconsin Department of Transportation.

HerpNET

Gary S. Casper¹ and Robert W. Henderson²
¹UWM Field Station, gsc@uwm.edu, ²Milwaukee Public Museum

HerpNET is a collaborative effort by natural history museums to establish a global network of herpetological collections data. Currently, 64 institutions are participating in the HerpNET community, with an open-ended invitation to institutions who would like

to join. Sixty-four institutions are available on the specimen searching portal, with data from over 5.5 million specimens available for searching. The mission of HerpNET is to bring the accumulated knowledge from more than four million specimens in world-wide

museum collections into currency for science and society by creating a distributed database with access from various portals. HerpNET will connect large repositories of information with smaller collections that have regional specializations. Similar efforts (e.g. MaNIS, FishNetII, MaPSTeDi, ORNIS) are being accomplished for other taxa and regions and the herpetological community is poised to make its own contribution to the study of biodiversity. HerpNET will bring together researchers from diverse institutions and will initiate and strengthen collaborations

among natural history collections, conservation biology, phylogenetics and biodiversity informatics. The Milwaukee Public Museum is bringing MPM herp collections data online. A database was posted in 2008 and georeferencing completed in 2009. Incorporation of georeferencing to the posted database began in 2010. HerpNET is funded by the National Science Foundation and a Global Biodiversity Information Facility DIGIT grant to the University of Kansas Center for Research Inc.

Reproduction in Cedar Lake Blanding's Turtles

Gary S. Casper
UWM Field Station, gsc@uwm.edu

This radio telemetry study is monitoring female Blanding's turtles to determine nesting sites and collect data on reproductive success in Washington County, WI. Study objectives are to build upon past data defining critical habitat needs for this population, and specifically identify nesting areas and collect data on nesting success. Prior

studies in this area have documented activity ranges, unsuccessful nesting, and important foraging and over-wintering sites. In 2010 two adult females were tracked throughout the season and into hibernation. No nesting was observed, but one suspected nesting area was identified. Funded by the Cedar Lakes Property Owners Association.

Genetic Variation and Environmental Heterogeneity: Studies on a Metapopulation of the Bdelloid Rotifer *Habrotrocha rosa*

D. Liane Cochran-Stafira and Tatiana C. Tatum
Department of Biological Sciences, Saint Xavier University, Chicago, Illinois, cochran@sxu.edu, tatum@sxu.edu

Environmental heterogeneity is ubiquitous in the natural world, and may well be one of the most important factors influencing species interactions and population dynamics. This study is part of a larger project that looks at the influence of environmental heterogeneity on the dynamics of ecological communities and the close interplay between processes at both local and regional scales. We focus on the population genetic structure and dispersal abilities of *Habrotrocha rosa*, an asexual rotifer that lives in the water-filled, pitcher-shaped leaves of the carnivorous pitcher plant *Sarracenia purpurea*. Each pitcher represents an ephemeral habitat patch within the bog landscape, and *H. rosa* exists as a metapopulation, persisting

through the colonization of new pitchers. We are attempting to correlate environmental variation within habitat patches with genotypic and phenotypic differences among clones. We hypothesize that the metapopulation is composed of multiple genotypes whose presence/absence is determined by colonization rate, calendar date, leaf age, and types of bacteria present. During July-September, 2008, and continuing in spring-fall, 2009, rotifer clones were established from pitcher fluid isolates. The sampling scheme was designed to provide samples from within habitats (pitchers), between habitats (pitchers on the same plant) and among locations on the bog (between plants); in other words the collecting protocol will

permit detection of alpha, beta and gamma level diversity respectively. Three rotifers were randomly selected from each pitcher sample, and each one became the founder of a clone representing one *H. rosa* genotype that was present in the pitcher on the date of collection. Sampling through the growing season permits selection of clones that have been exposed to environmental stresses such as periodic droughts and floods, extremes of temperature, and variations in food (bacteria) quality and quantity. Proteomic (cellulose acetate gel electrophoresis of isozymes) and genomic (sequencing sections of the *Cox1* and *Cob* genes) analyses are being used to detect variations among clones and the linkage between the variations and adaptations to environmental stresses. We are also measuring *r* at 19°C and 27°C to determine whether there are adaptations for growth and reproduction at either cool (spring, fall) or warm (summer) temperatures. Our results show 100% heterozygosity and identical migration patterns for phosphoglucose isomerase in all *H. rosa* clones; analysis of other enzymes is in progress. Other results show that early to mid-spring and fall clones, which have a high likelihood of freezing, exhibit higher levels of resistance to freezing and lower

resistance to desiccation. These traits are reversed in clones isolated during late spring and summer.



Influence of Larvae of the Midge *Metriocnemus knabi* on Population Dynamics of the Bdelloid Rotifer *Habrotrocha rosa* in Leaves of the Northern Pitcher Plant *Sarracenia purpurea*

D. Liane Cochran-Stafira

Department of Biological Sciences, Saint Xavier University, Chicago, Illinois, cochran@sxu.edu

The inquiline community that lives in the pitcher-shaped leaves of the northern pitcher plant *Sarracenia purpurea* has been used for many years as a model system for experimental studies in community and population ecology. This study described here is intended to contribute to our understanding of the basic ecology of the system. The midge *Metriocnemus knabi* (Coq.) is closely associated with *S. purpurea*; females lay their eggs exclusively in the rainwater-filled vase shaped leaves of this carnivorous plant. The decomposition

of prey within the pitcher provides the energy to support an inquiline community that consists primarily of microbes, protists, small invertebrates and dipteran larvae including the rotifer *Habrotrocha rosa*, flesh fly *Fletcherimyia fletcheri*, the pitcher plant mosquito *Wyeomyia smithii* and *M. knabi*. Midge larvae share a positive food processing chain commensalism with *W. smithii* larvae in which the midges help to physically break down the prey carcasses in the pitcher leading to higher numbers of bacteria that serve as food for the mosquito

larvae. The relationship between midge larvae and *H. rosa* is unknown, but by fostering bacterial growth, they may also provide food for rotifers. However, *M. knabi* may also negatively impact *H. rosa* population dynamics by feeding on their eggs. Beginning three days after hatching, each rotifer produces a single egg daily. In the lab, these eggs are "glued" to the sides of culture tubes or the bottom of petri dishes, and midges have been observed eating them. It is not known if eggs are attached to

the inside of the *S. purpurea* pitcher or the detritus within the pool of water, but if rotifer eggs are attached to the prey carcasses or other debris, it is not unreasonable to suspect that midge larvae may consume them as they continually crawl through the sediment at the bottom of the pitcher. I am currently working on a series of field and lab experiments that will permit me to determine whether midge larvae play a significant role in regulating *H. rosa* populations, along with *W. smithii* and *F. fletcheri*.

Documenting Occurrence of *Oecanthus* Tree Crickets at the Cedarburg Bog

Nancy Collins
yncancy2k@hotmail.com

I visited the Bog in the evening of September 11, 2010 to search for tree crickets in the genus *Oecanthus* (subFamily Oecanthinae). In particular, I was searching for the Tamarack tree cricket, *Oecanthus laricis*, which has only been documented in the U.S. in the states of Michigan and Ohio. They are found on Tamarack and Hemlock trees. This species has not been documented in Wisconsin; however, there is a very good chance they are here but have simply not been searched for in depth.

Three species were identified. A male Narrow-winged tree cricket (*Oecanthus niveus*) was located high overhead on a leaf of a large tree along the entrance road near the field house. It was recorded while singing and was identified by song pattern and photograph. This tree cricket was using a hole in the leaf as a baffle to intensify the volume of his song. I have witnessed another genus of tree cricket chew the edges of these holes to fit the outline of their opened wings. A singing male Pine

tree cricket (*Oecanthus pini*) was heard on a large spruce tree near the parking area. It was recorded and identified by number of pulses per second at a known temperature. A male Snowy tree cricket (*Oecanthus fultoni*) was heard in shrubs bordering the employee parking lot near the entrance. It was not recorded but this species has a distinctive chirping pattern and is the only species east of the Rocky Mountains with this song pattern. Two other oecanthines were recorded on cedar trees in two areas along the road outside the entrance area; however, they could not be identified and were not located for photos. It is possible they were *O. forbesi* (Forbes' tree cricket) but the recordings were not of sufficient quality to accurately count pulses per second, and the temperature of the spot where the tree cricket was calling from could not be measured with exactness. However, the estimates are 48 pulses per second with a temperature in the low 60's °F which rules out *O. laricis* (Tamarack tree cricket).



Oecanthus niveus using a hole in a tree leaf as a baffle to intensify the volume of his song. I have witnessed another genus of tree cricket chew the edges of these holes to fit the outline of their opened wings. I cannot say whether this male made this hole. It could be a hole formed by *Neoxabea bipunctata*

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

Peter O. Dunn and Linda A. Whittingham

Department of Biological Sciences, UWM, pdunn@uwm.edu, whitting@uwm.edu

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. This mismatch hypothesis predicts that reproductive success is maximized when animals synchronize their reproduction with seasonal peaks in food supply. Using data from tree swallows breeding at five sites over 24 years (37 site-years), we tested the assumptions of the mismatch hypothesis in tree swallows, whose timing of egg-laying has shifted earlier by nine days since the 1950's. Contrary to the mismatch hypothesis, the

start of egg-laying was strongly related to food abundance (flying insect biomass) during the laying period and not to timing of the seasonal peak in food supply. Overall, initial reproductive decisions in this insectivore appear to be based on the food supply during egg formation and not the nestling period. Thus, the mismatch hypothesis may not apply in environments with relatively constant or abundant food throughout the breeding season. Although climate change is often associated with earlier reproduction, our results caution that it is not necessarily driven by selection for synchronized reproduction. This research was supported by funds from the College of Letters and Science, UWM.

Sexual Selection and Immunity in Common Yellowthroats

Peter O. Dunn and Linda A. Whittingham

Department of Biological Sciences, UWM, pdunn@uwm.edu, whitting@uwm.edu

Female preferences for particular male ornaments may shift between populations as a consequence of ecological differences that change the reliability and detectability of the ornament, but few studies have examined how ornaments function in different populations and what they signal about male quality. We examined the signaling function of male plumage ornaments in a warbler, the common yellowthroat (*Geothlypis trichas*), breeding in New York (NY) and at the UWM Field Station in Wisconsin (WI), USA. Males have two prominent ornaments: a black facial mask pigmented with melanin and a yellow bib pigmented by carotenoids. Previous studies in WI indicate that the size of the mask, and not the bib, is primarily

related to female choice and male reproductive success. In NY, however, the pattern is reversed and attributes of the bib (size and color), and not the mask, are the target of sexual selection. We found that brightness of the yellow bib was the best signal of humoral immunity (immunoglobulin G) in NY and mask size was the best signal in WI, after controlling for breeding experience and capture date. Thus, similar aspects of male quality appeared to be signaled by different ornaments in different populations. This project was supported by grants from the National Science Foundation (to POD & LAW).

MHC Variation in Common Yellowthroats

Peter O. Dunn, Jenny Bollmer, Linda A. Whittingham and Chuck Wimpee

Department of Biological Sciences, UWM, pdunn@uwm.edu, bollmer@uwm.edu, whitting@uwm.edu, cwimpee@uwm.edu

As part of our studies of common yellowthroats, we are attempting to better understand the genetic benefits of extra-pair mating. One hypothesis is that extra-pair sires provide offspring with superior genes of immunity, in particular the major histocompatibility complex (MHC), which is a major component of the vertebrate immune system. Genes in this complex encode proteins that recognize foreign pathogens. Birds have between one and 7 confirmed MHC class II B genes, and the greatest diversity appears to occur in passerines. We used multiple primer sets on both genomic DNA (gDNA) and complementary DNA (cDNA) to characterize the range of class II B genes present in a passerine, the common yellowthroat (*Geothlypis trichas*). We confirmed 39 exon 2 sequences from

gDNA in a single individual, indicating the presence of at least 20 class II B loci. From a second individual, we recovered 16 cDNA sequences belonging to at least 8 transcribed loci. Phylogenetic analysis showed that common yellowthroat sequences fell into subgroups consisting of classical loci, as well as at least 4 different clusters of sequences with reduced sequence variability that may represent pseudogenes or nonclassical loci. Data from 2 additional common yellowthroats demonstrated high interindividual variability. Our results reveal that some passerines possess an extraordinary diversity of MHC gene duplications, including both classical and nonclassical loci. This project was supported by grants from the National Science Foundation (to POD & LAW).

Plant Species and Seed Bank Composition of Restored Wetland Sites at Indiana Dunes National Park

Glen Fredlund¹, James Reinartz², Gretchen Meyer², Mai Phillips³, Karl Pehkonen³, Jillian Meyers³,

¹Department of Geography, UWM, fredlund@uwm.edu, ²UWM Field Station, jimr@uwm.edu, gmeyer@uwm.edu, ³Conservation and Environmental Science, UWM, phillipm@uwm.edu, pehkonen@uwm.edu, jameyers@uwm.edu

The success of restoration efforts often hinges on the whether the plant communities that repopulate the restored sites are native to the area. This study attempts to discern the progression of restoration and recovery efforts of wetland sites at Indiana Dunes National Park. The specific objectives of the project are to survey and find out if any relationships exist between the below ground seed bank and above ground vegetation species composition; and what factors, if any, influence



seed banks and resulting plant communities. Soil plugs were collected from study areas and divided into upper and lower depths. The composition of the existing vegetation surrounding the location of each soil sample was recorded by counting all species and estimating their aerial cover in 4, 1m² plots located 1m from the sample in each cardinal direction. Upon returning to the UWM Field Station, the soil samples were placed in a greenhouse for germination. Emerged seedlings will be grown to the size that species can be distinguished from one another.

Good digital photographs and pressed specimens of each unique species will be documented at various stages of development. This will enable earlier identification of the species for any future studies of the seed banks. Analysis will be performed to determine if any correlation exist between the seedling count data and the seed bank "community" with the environment/location of the collected sample and the existing vegetation at that location. Funding for undergraduate researchers provided by the National Park Conservation Association.

Riparian Plant Communities of the Fifth Order Milwaukee River Floodplain and Islands

Jessica K. Goldsberry¹, James Reinartz²

¹Department of Biological Sciences, UWM, goldsbe2@uwm.edu, ²UWM Field Station, jimr@uwm.edu

The Milwaukee River Basin contains 766 km of streams, and drains 1,852 km² of watershed across parts of six southeastern Wisconsin counties. This study will describe the plant communities of the riparian zone along the fifth-order branch of the Milwaukee River (MR-5th), which is about

120 km extending from southern Fond du Lac County into downtown Milwaukee. The MR-5th riparian zone has well-developed examples of several geomorphic features found in major river systems, including bars (river-flats), natural levees, swales, first and second bottoms, backswamps, slopes and



terraces. The vegetation at 30 floodplain sites and islands within the MR-5th were surveyed on ten different landforms. The floodplain vegetation was then classified and ordinated into 16 regular plant communities, six bank tree-row communities and six river-flat communities. The condition of plant communities was assessed based on their diversity, Wisconsin Floristic Quality Index (WFQI), mean Coefficient of Conservatism (CC) for native species and prevalence of invasive species. The plant communities were analyzed to identify correlations with geomorphic features and elevation above the base flow of the river. Plant community data was also analyzed to determine distribution correlation with other environmental factors, such as canopy cover, distance upstream from the mouth of the river and distance to the river bank. Tree species from this survey were compared to the 1830s pre-settlement witness tree data

through analysis using ArcGIS shapefiles and data points to identify composition changes along the MR-5th. Results indicate that elevation above base flow, landform, distance upstream from the mouth of the river, distance from the bank of the river and prior disturbance such as cleared land do affect plant communities and plant species distributions along the MR-5th. There were changes in dominant tree species from 1830 to 2009, with an obvious decrease in elm species and an increase in box elder and ash species. The results indicating where native and invasive species currently exist in relation to elevation, landform and distance from the river and at varying distances upstream from the river mouth will be useful for future vegetation management along the Milwaukee River and similar riparia within southeast Wisconsin. M.S. Thesis research, J.A. Reinartz, Major Advisor.

Invasive Spread of Glossy Buckthorn (*Rhamnus frangula*) in the Cedarburg Bog Wetland: Abiotic Soil and Water Conditions Across Five Community Types

Megan A. Helt-Baldwin, Jason A. Berg and Erica B. Young
Department of Biological Sciences, UWM, jaberg@uwm.edu, ebyoung@uwm.edu

Spread of the non-indigenous invasive plant, glossy buckthorn (*Rhamnus frangula*) can contribute to reductions in native plant abundance within North American wetlands. Glossy buckthorn has increased in density over the last 15 years in the Cedarburg Bog, a relatively undisturbed, large wetland complex in southeastern Wisconsin. However, glossy buckthorn has been more successful in recruitment and establishment in some community types than in others. While vegetation composition may be important to glossy buckthorn success, abiotic factors such as soil or dissolved surface water nutrients may also play a role as we know that plants in the Cedarburg Bog may be limited by N and P availability. To analyze these abiotic conditions, 14 replicate soil and water samples were collected from 5 distinct wetland communities, 7 each from an area of high density and 7 from an area

of low density of glossy buckthorn. Dissolved surface water nutrients and total soil C and N content were measured and compared between these sites. In all communities, soil carbon and nitrogen content was high, indicating very organic soils typical of wetlands. C content was not significantly different across communities ($P > 0.05$) but soil N content was higher in strings, flarks and cattail marsh than in swamp forest and shrub carr ($P < 0.006$) and soil C:N ratios were also lower in cattail marsh and flarks than in soils from shrub carr ($P < 0.001$). In some community types, high density glossy buckthorn was correlated with soil N content: in shrub carr, soil %N was lower in low buckthorn density regions ($P < 0.05$) but within flarks, soil %N was higher in low buckthorn density ($P < 0.05$). Dissolved nutrient concentrations (nitrate, ammonium, phosphate) were very variable between

samples and no clear differences were seen between community types. Overall, the wetland soils in Cedarburg Bog are highly organic which may affect nutrient availability to plant roots and nutrient availability may be higher in lower-lying communities (e.g. flarks and cattail marsh). Due to high variability in nutrient concentrations, we recommend that higher sample replication is used for future characterization of such abiotic factors. Nutrient availability may also vary seasonally, with changing hydrology so repeated sampling over the year may provide useful insights. Undergraduate independent study project, Erica Young, advisor.



Abundance and Survivorship of Butler's Gartersnake (*Thamnophis butleri*) in Wisconsin

Eric T. Hileman
Department of Biological Sciences, UWM, ehileman@uwm.edu

Accurate estimation of population parameters and structure is important in understanding how environmental and demographic stochasticity can affect population dynamics and species viability. Knowledge of how individual life history characteristics contribute to population responses can be instructive in elucidating ecological and evolutionary processes and is critical to successfully managing threatened or endangered species.

In the current conservation strategy for the Wisconsin state-threatened Butler's gartersnake (*Thamnophis butleri*), survivorship (Φ), abundance (N), and population density estimates for adults and juveniles are key missing parameter estimates for making realistic predictive models related to population growth for this species. The aim of this two-year study was to estimate Butler's gartersnake adult and juvenile Φ , N, population density, and sex ratios using open system mark-recapture methodologies. The data analyzed were collected from three Wisconsin populations and include 3,870 snake captures, representing 2,761 individually marked snakes.

Across sites and years adult Φ ranged

from 0.75 to 0.87. Juvenile Φ differed little from adults (0.75 to 0.86). Based on 2009 estimates, in order of increasing abundance, adult individual N was 830 (Saukville, 15.62 ha), 2,054 (Brookfield, 12.46 ha), and 2,098 (New Berlin, 5.59 ha). Juvenile individual N estimates were 2,336 (Saukville), 2,818 (New Berlin), and 7,469 (Brookfield). Adult density (number of individuals/ha) estimates were 53 (Saukville), 165 (Brookfield), and 376 (New Berlin). Juvenile density estimates were 150 (Saukville), 504 (New Berlin), and 600 individuals (Brookfield). Sex ratios were close to 1:1 (female: male) for adults and juveniles.

This study fills critical gaps in our current understanding of *T. butleri* life history characteristics by providing parameter estimates of its survivorship, abundance, density, and sex ratios. The resulting baseline demographic information should be incorporated into future management decisions related to the conservation of this species in the state of Wisconsin and throughout its range.

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Terrestrial Gastropods -- New Records for the UWM Field Station and Ozaukee County

Joan Jass and Barbara Klausmeier

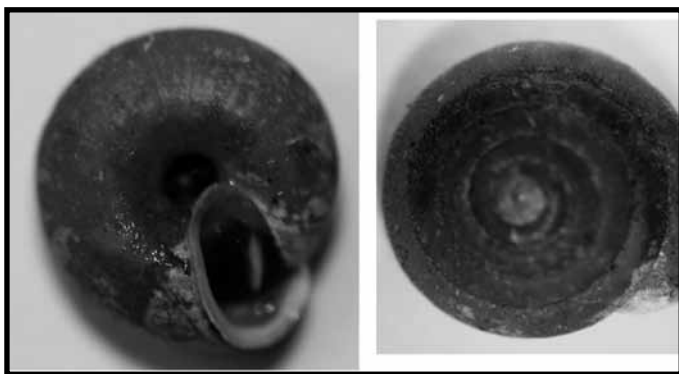
Invertebrate Zoology, Milwaukee Public Museum, jass@mpm.edu

During a multi-year Field Station invertebrate survey, gastropods were collected from meter by meter leaf litter quadrats at six terrestrial sites, supplemented by hand-picking. Specimens were deposited in the MPM mollusk collection. Meter by meter sampling yielded 20 species from 11 families (Field Station Bulletin 13 (1):1-3). Identification of the undetermined other specimens was begun in 2009, to record species not previously known from the Field Station and Ozaukee County.

Two snails were collected in an unwooded area near grid point C4S D4N on 14 June 1978. The thin pillar *Cochlicopa lubricella* (Cionellidae) is generally considered native, though genetic studies may prove that some populations are European introductions. The native dentate supercoil *Paravitrea multidentata* (Zonitidae) has a S2S3 Natural Heritage Working List ranking, ranging between imperiled and rare or uncommon in Wisconsin. This record adds Ozaukee to other counties in which it has previously been found: Brown, Calumet, Door and Kewaunee.

Two members of the family Succineidae, found adjacent to the bog boardwalk on 27-28 July 1978, were tentatively determined as the blunt ambersnail *Oxyloma retusum* and the oval ambersnail *Novisuccinea ovalis*. Ambersnails, not identified to species, had been reported from 5 of the 6 meter by meter samples (definitive succineid identifications would require investigation of reproductive system traits). Another native species from the same site and time is the upland pillsnail *Euchemotrema fraternum* (Polygyridae), initially reported in the 2009 Annual Report and shown in the photos here.

The lovely vallonia *Vallonia pulchella* (Valloniidae) was collected when sampling gravel adjacent to the greenhouse on 18 September 1987 for terrestrial isopods (Field Station Bulletin 20 (2):17-21). This newly recorded snail has a Holarctic distribution and is found in gardens and nurseries.



Use of Mark-Recapture Techniques to Estimate Milksnake (*Lampropeltis triangulum*) Populations in the Upper Midwest

Joshua M. Kapfer¹ and Timothy J. Muehlfeld²

¹Departments of Environmental Studies and Biology, Elon University, Elon, NC, jkapfer@elon.edu,

²tcmuehlfeld@tds.net

Published data on population characteristics of milksnakes (*Lampropeltis triangulum*) are rare, with most focused on estimates of density per area in populations from the western portions of its range. Information on Wisconsin populations does not exist, despite the importance of such baseline data for future conservation efforts. The UWM Field Station contains a rich herpetofauna that previous surveys have determined includes milksnakes. We studied several



population parameters of these snakes through the use of mark-recapture methods. Surveys consisted of four periods, each lasting ca. 2 h, over two days in late May/early June. Each survey involved checking cover objects and conducting random visual encounter surveys throughout 6.1 hectares of Field Station property. Surveys were

either conducted by JMK and TJM, or in conjunction with a Field Herpetology course conducted at the Field Station in 2006, 2008 and 2010. To-date, five annual sampling efforts have been completed (2006-2010). Upon capture, snakes were marked with Passive Integrated Transponder (PIT) microchips, a commonly employed technique to mark snakes for future identification. In 2006, a total of nine novel adult individuals were captured and five recaptures were made. This resulted in an estimated adult population of 12.4 individuals, and a density of approximately 2 per hectare. In 2007, a total of seven novel adult individuals were captured and four recaptures. This yielded an estimated adult population of 9.3 individuals, and a density of approximately 1.5 per hectare. In 2008, five new individuals were captured (0.82 per hectare) with no recaptured individuals, and an estimation of population size was not possible. In 2009, seven new individuals were captured, and recaptures occurred on seven occasions, resulting in an estimated population of 11 individuals (1.8 per hectare). In 2010, five new individuals were captured, and recaptures occurred on one occasion, resulting in an estimated population of 6 snakes (0.8 per hectare). Small vertebrate populations are dynamic, and the variation in results obtained over time further support the notion that long-term datasets are critical when analyzing population parameters. Therefore, it will be important to continue this research for a number of years to determine if discernable trends have occurred.

Increased Relative Abundance of an Invasive Competitor for Pollination, *Lythrum salicaria*, Reduces Seed Number in *Mimulus ringens*

Jeffrey D. Karron¹, Rebecca J. Flanagan² and Randall Mitchell³

¹Department of Biological Sciences, UWM, karron@uwm.edu, ²Division of Natural Sciences, Blinn College, Bryan, TX, becca.flanagan@blinn.edu, ³Department of Biology, University of Akron, Akron, Ohio, rjm2@uakron.edu

When exotic plant species share pollinators with native species, competition for pollination may lower the reproductive success of natives by reducing the frequency and / or quality of visits they receive. Exotic species often become numerically dominant in plant communities, and the relative abundance of these potential competitors for pollination may be an important determinant of their effects on the pollination and reproductive success of co-occurring native species. Our study experimentally tests whether the presence and abundance of an invasive exotic, *Lythrum salicaria* L. (Lythraceae), influences reproductive success of a co-flowering native species, *Mimulus ringens* L. (Phrymaceae). We also examine the

mechanisms of competition for pollination and how they may be altered by changes in competitor abundance. We found that the presence of *Lythrum salicaria* lowered mean seed number in *Mimulus ringens* fruits. This effect was most pronounced when the invasive competitor was highly abundant, decreasing the number of seeds per fruit by 40% in 2006 and 33% in 2007. Reductions in the number of seeds per fruit were likely due to reduced visit quality resulting from *Mimulus* pollen loss when bees foraged on neighboring *Lythrum* plants. This study suggests that visit quality to natives may be influenced by the presence and abundance of invasive flowering plants.

Beyond the Edge: Evolution of Marginal Populations of an Invasive Vine Increases the Likelihood of Future Spread Under Global Environmental Change

Francis F. Kilkenny and Laura F. Galloway

Department of Biology, University of Virginia, Charlottesville, VA, ffk5p@virginia.edu, lgalloway@virginia.edu

Biological invasions are homogenizing the Earth's biotic communities. To predict future invasions it is critical that we understand how the ongoing evolution of invasive species interacts with other processes of anthropogenic environmental change. This study compared Japanese honeysuckle (*Lonicera japonica*) plants from the well established core (100-150 years old) and the more recently established margin (65 years old or younger) of the invaded range in the United States at sites beyond the current range edge (University of Wisconsin at Milwaukee Field Station and G. H. Gordon Biological Station run by Hillsdale College) to determine whether recent evolution can affect future range expansion. These data were also compared to data from previous work in this system at sites at the margin and in the core of the range to determine the effect of increasing temperature on

L. japonica spread. At sites beyond the range edge, populations originating from the margin of the range reached greater size, had 36% more branches and 27% more biomass, and had 54% greater final survival than populations from the core of the range. Across-range winter mortality was predicted by latitude, temperature, growth year and origin. Across all sites, winter mortality increased with increasing latitude, and across the range core plants had 39% greater winter mortality than margin plants. These results show that evolution has occurred in this system, and that populations at the current range margin may be pre-adapted to further spread beyond the range. Temperature strongly affects mortality in *L. japonica*, and increasing temperature due anthropogenic environmental change is likely to increase the area in which viable populations can establish.

Determinants of Alternative Mating Tactics in *Hyla versicolor*

Son Young Kim, Dept. of Biological Sciences, UWM, sonyoung@uwm.edu

Advertisement calls are used by male *Hyla versicolor* to attract potential mates. Males unable to effectively compete using attractive calls will resort to alternative mating tactics, otherwise known as satellite behavior. Satellite males will position themselves near an attractive calling male and attempt to intercept females attracted to the caller. During the 2009 and 2010 breeding season, I investigated the factors that mediate the expression of alternative mating tactics in *H. versicolor*. Caller and satellite male pairs were collected and recorded to analyze phenotypic traits between males. I found that satellite males are smaller than calling males but did not differ in body condition.

When comparing call traits, I found that satellite males did not significantly differ from callers in call duration, but that the callers with a satellite had significantly longer calls than control males. Longer calls are preferred in female choice trials, suggesting that these males would be more attractive to females. Satellite males also produced higher frequency calls and their calls were highly variable. I will continue to investigate alternative mating tactics in gray tree frogs in the 2011 field season at the University of Wisconsin-Milwaukee Field Station. M.S. Thesis research, Dr. Gerlinde Höbel, Major Professor.

Long-term Monitoring of the Eastern Prairie White-fringed Orchid, [*Platanthera leucophaea* (Nutt.) Lindl.] at the Cedarburg Bog

Joanne Kline, Wisconsin Department of Natural Resources, Joanne.Kline@wisconsin.gov

P. leucophaea is one of the largest and showiest of the native North American orchids. Loss of wet prairies and fens, where the orchid was once widespread, greatly reduced the orchid's range and led to its listing as a Federal Threatened and a State Endangered Species. Populations

rely on pollination by sphinx moths for long distance out-crossing, which is more effective where many orchids grow over a large area. Insuring the stability of these highly viable populations is a major objective for recovery of the species and for removal of its threatened and endangered status.



The Cedarburg Bog population is the largest in Wisconsin and the largest in a peatland plant community nationwide.

The orchid occurs in two distinct habitat types within the string bog. In the 'open' string bog, where the linear hummocks of trees and shrubs are relatively far apart and the canopy is open, the plants are more abundant, compared to in the 'closed' string bog, where linear hummocks of woody plants are closely spaced. Monitoring in both habitats includes an annual census of flowering plants, and tracking the demographics of individual plants for life span, flowering history, pollination success and impacts of herbivory. Based on tracking individual plants for 8 years most plants take at least 2 years to flower and then flower

for 2 to 4 consecutive years before they disappear. One plant has flowered for at least 7 years.

Threats to the population continue to be the invasive shrub, glossy buckthorn (*Rhamnus frangula*), and lack of legal protection to the State Natural Area. Glossy buckthorn seedlings thrive at the edge of hummocks in full sun, which coincides with typical orchid habitat. Within two years buckthorn seedlings overtop the leaves of young orchids and the increased shade puts them at a disadvantage. The extent and density of giant reed grass (*Phragmites australis*), a native but potentially invasive species, has measurably increased in the open string bog since 2006 and may pose an additional threat.

Condition Effects on Female Mate Choice in an Anuran

Robb Kolodziej and Gerlinde Höbel

Dept. of Biological Sciences, UWM, rck@uwm.edu, Hoebel@uwm.edu

Understanding the mechanisms behind female mate choice is critical in developing a holistic framework from which to assess its impacts on sexual selection. Many mechanisms affecting mate choice variation are currently being explored related to life history traits or prior experience. In a system in which mate choice is costly or requires great investment it could be argued that female condition is the most important. If variation in condition is linked to variation in mate choice, then this can be a source for maintenance in variation in strength and direction of sexual selection and ultimately variation in male traits.

Using Grey treefrogs, *Hyla versicolor*, I designed two experiments to quantify the effects of condition on female mate choice, one using the natural variation in female condition and a second manipulating female condition. The first experiment simply assessed preferences of females in their natural state. For the second experiment, 60 females from experiment 1 were randomly assigned to food treatments designed to

alter their condition and retested to relate manipulated condition to any changes in female choice. The 2009 field season produced data for 92 females assessing natural variation in condition with mate choice. Experiment 2 gathered data for 11 females assessing preferences relative to manipulated body conditions, in which better body conditions correlated to the high food treatment. The project was continued in 2010. M.S. Thesis research, Dr. Gerlinde Höbel, Major Professor.



Genetic Studies of the Hine's Emerald Dragonfly Population at Cedarburg Bog

Meredith J. Mahoney and Everett D. Cashatt
Illinois State Museum, Research and Collections Center, mjmahoney@museum.state.il.us,
cashatt@museum.state.il.us

Previous studies have examined the mitochondrial DNA of Hine's Emerald Dragonfly from populations along the Des Plaines River, Illinois, and from wetlands in Door County, Wisconsin. Only one genetic variant was recovered from several individuals sampled from Door County, and the Door County variant was not found in Illinois, despite the fact that this latter population contained a number of other variants. The population of Hine's Emerald at Cedarburg Bog is located between those in Door County and the Des Plaines River valley. Genetic analysis of a single specimen recovered from the Cedarburg Bog area found the same haplotype as seen in Door County, suggesting possible

recent contact between these areas. Four additional samples collected as 'road kill' specimens from the area of the Field Station were analyzed in 2010. Three samples had the same Door County variant. The fourth sample had a genetic variant matching a museum specimen from a site in Ohio where Hine's Emerald is now extirpated. These results support the connection between Cedarburg Bog area and Door County and also indicate an historic connection to populations in Ohio that was likely disrupted by modifications to the landscape. Including additional samples from Cedarburg Bog area is likely to improve our knowledge of genetic diversity and dispersal patterns of Hine's Emerald Dragonfly in this region.

Beech Scale Detected at the UW-Milwaukee Field Station

Bill McNee
Wisconsin DNR Forest Health Program, Green Bay, bill.mcnee@wisconsin.gov

Beech bark disease, a disease of American beech trees (*Fagus grandifolia*) caused by a scale insect (beech scale, *Cryptococcus fagisuga*) and one of several species of canker-causing fungi, was first detected in Door County in 2009. Surveys to determine the distribution of beech scale and beech bark disease have continued since the initial detection. Beech scale has been found in Door, Kewaunee, Manitowoc, Marinette, Oconto, Ozaukee, Sheboygan and Washington Counties. In 2010, beech scale was found on the Field Station property at very low levels, but beech bark disease was not found. The disease will eventually be found at the Field Station, and is expected to result in the death of most of the large beech trees.

Scale populations were very low at all sites away from the initial detection area in Door County. It is believed that these

low populations are recent introductions. Wind and birds are likely dispersing immature beech scales from the Sturgeon Bay detection area, the generally-infested area of western Lower Michigan, and from isolated infestations in the Upper Peninsula of Michigan.



Long-term Monitoring of Bat Activity and Temperature at the Neda Mine Bat Hibernaculum

Gretchen Meyer and James Reinartz
UWM Field Station, gmeyer@uwm.edu, jimr@uwm.edu

The Neda Mine, an abandoned iron mine located near Iron Ridge in Dodge Co., supports about 150,000 bats each winter, making it among the largest hibernacula in the midwest. The mine is used primarily by little brown bats (*Myotis lucifugus*), with Northern Bats (*M. septentrionalis*), Eastern Pipistrelles (*Pipistrellus subflavus*), and Big Brown Bats (*Eptesicus fuscus*) found in smaller numbers. We have been monitoring bat activity at the mine since 2001 using an infra-red photo beam-break detection system that records the number of bats entering and leaving the mine on a 5-minute interval 365 days per year. We have been collecting temperature data since 1996 using

18 battery-powered temperature dataloggers spread within the mine and 2 dataloggers outside. We are also monitoring airflow in the mine. We are currently using these data to examine trends over time in winter temperatures in the mine, and the phenology of bat emergence in spring. We are currently collecting data on nocturnal aerial insect abundance at the Field Station to determine the relationship between night-time temperatures in spring and insect activity. These data will help us to interpret patterns of bat activity in the spring by providing information on how their aerial insect prey is affected by spring temperatures.

Genetic Structure of an Invasive Plant in its Native and Introduced Ranges

Gretchen A. Meyer¹, Sara B. Hoot², and Mai M. Phillips³.

¹UWM Field Station, gmeyer@uwm.edu, ²Department of Biological Sciences, UWM, hoot@uwm.edu

³Department of Conservation and Environmental Science, UWM, phillipm@uwm.edu

Invasive, exotic plants threaten natural ecosystems and can be problematic agricultural weeds. Genetic changes in exotic plants are driven by processes such as founder effects, genetic drift, mixing of plants from widely-separated populations, and hybridization, but more research is needed to develop a general theory of how these forces may stimulate invasiveness. We are investigating genetic variation of *Solidago gigantea*, a species native to North America and an invasive exotic in Europe. We have been working with this species for the past 10 years, and have plant material collected from throughout the range in Europe and North America and a substantial database on phenotypic characteristics of each plant in our collection. We have shown that plants originating from Europe have

altered patterns of anti-herbivore defenses and reproductive allocation compared to plants from North America; we assume that these differences are genetically-based because plants were grown in common gardens where the environment was held constant. We are developing molecular markers that can help us understand the genetic processes underlying the invasion of *S. gigantea* in Europe. We are also working on developing a molecular phylogeny of the *Solidago canadensis* complex (including the species most closely related to *S. gigantea*), to better understand the evolutionary history of *S. gigantea*, and to examine the role of hybridization in promoting invasiveness. Funded by the Research Growth Initiative, UWM.

Below-Ground Defenses of Native and Invasive Genotypes of *Solidago gigantea*

Gretchen A. Meyer¹ and Robert H. Johnson²

¹UWM Field Station, gmeyer@uwm.edu, ²Medaille College, Buffalo NY, robertj@medaille.edu

When plants are introduced to new areas, they may leave their specialized herbivores and pathogens behind. The evolution of increased competitive ability (EICA) hypothesis holds that this escape from natural enemies allows introduced plants to reduce their investment in defense, thereby freeing resources for growth and reproduction and increasing their potential for invasiveness. Most tests of the EICA hypothesis focus on above-ground plant defenses and herbivores; however plant roots and other below-ground structures are also subject to herbivory. In this study, we measured secondary chemistry and herbivory on rhizomes of late goldenrod (*Solidago gigantea*), which is native to North America and is an invasive exotic in Europe. Plants derived from 10 North American and 20 European populations were grown in a common garden at the UWM Field Station, where they were exposed to naturally-occurring above and

below-ground herbivores. At the end of the growing season, rhizomes were harvested and densities of a root and rhizome feeding aphid (*Pemphigus betae*) were estimated. European plants were more heavily infested with aphids than US plants. Further analyses will examine secondary chemistry of rhizomes for European and US plants, and will look for correlations between rhizome chemistry and aphid abundance. Below-ground secondary chemistry and levels of herbivory will also be compared to levels seen in leaves, which have previously been measured for the same clones of goldenrod used in this experiment. These data will provide a more complete picture of how defenses have changed in *S. gigantea* in its invasive range in Europe compared to native genotypes, as there are few studies that have examined both above-ground and below-ground chemistry and herbivory in an invasive plant.

Germination of Cultivars of Burning-bush (*Euonymus alata*) Under Field Conditions.

Brendon Panke and Mark Renz

Agronomy Department, University of Wisconsin-Madison, bpanke@wisc.edu, mrenz@wisc.edu

Euonymus alata is an introduced, commercially important species that has the potential to become invasive. The purpose of this study is to determine the relative establishment ability of the different horticultural varieties that have been developed in different hardiness zones to assess whether some varieties pose less risk of becoming invasive than others. This project was initiated in 2010. Six blocks were set out in the research garden of the University of Wisconsin-Milwaukee Field Station. Each block consisted of 6 plots, 5 of which contained 150 fruit from a single *Euonymus alata* cultivar and the remaining plot was blank. The 5 cultivars of *Euonymus*

alata studied are Chicago fire, Compactus, Fire ball, Nordine, and Tures. In spring 2011 these plots will be assessed for the percentage of fruit that have germinated and spring 2012 for the percentage of germinated plants that have survived. The UWM Field Station site is a portion of an experiment to rate cultivars of plants in terms of invasiveness based upon seed production, germination, and survival.

This research is supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture. This work is done in cooperation with University of Wisconsin-Extension Team Horticulture.

Cedarburg Bog and Upland Woods Migration Point Counts

Victoria D. Piaskowski¹, John O'Donnell² and Carl Schwartz³

Friends of the Cedarburg Bog

¹vickip1023@wi.rr.com, ²nodjod@wi.rr.com, ³cschwartz3@wi.rr.com

Point counts were conducted in the Cedarburg Bog and Upland Beech Woods to determine the bird species using these habitats during spring and fall migration. All bird species seen or heard were counted at six points in the Bog and six points at the edge of and within the Upland Woods. Birds observed while walking between points were also counted. In 2010, counts were conducted at least once per week in spring (April 14 - June 2) and fall (August 24- October 19). We documented 109 bird species that utilized the Bog habitats during spring and fall migration and 98 species that utilized the Upland Woods. A total of 130 species utilized either the Bog or Upland Woods during migration. The importance of these habitats to birds during migration is indicated by the number of bird species of conservation concern that were detected. Twenty-four species of birds (18.5

% of the total) are listed as being at risk in either national or Wisconsin conservation plans. Thirteen species are listed as being of conservation concern in national (U.S./ North American) Landbird, Shorebird or Waterbird Conservation Plans. These species included the Pied-billed Grebe, American bittern, Virginia rail, Sora, Greater yellowlegs, Solitary sandpiper, American woodcock, Wilson's snipe, Willow flycatcher, Wood thrush, Blue-winged and Bay-breasted warblers and Rusty blackbird. Eighteen species are listed as Bird Species of Greatest Conservation Need in Wisconsin. Seven species are listed as being at risk in both national and state conservation plans. Marilyn Bontly, Joan Sommer and Tom Schaefer also assisted with the migration counts in 2010. The migration point counts will continue in 2011.

Environmental Influences on the Expression of Genetic Variation

Darren Rebar

Department of Biological Sciences, UWM, dwrebar@uwm.edu

My objective is to test the hypothesis that the expression of genetic variation of individuals is influenced by the social environment to which an individual is exposed both during development and as an adult. To this end, *Enchenopa binotata* treehoppers (Hemiptera: Membracidae; 50 mated females) and cuttings from *Viburnum lentago* host plants at the UWMFS were collected (20 plants, 20 cuttings per plant) and brought back to the lab to be propagated. The treehoppers and host plants are being established to set up three experiments: 1) how the phenotypic variation of male signals and female preferences is influenced by the

host plant's phenotype, 2) how the phenotypic variation of male signals and female preferences is influenced by the phenotypes of other individuals during development, and 3) how the phenotypic variation of male signals and female preferences is influenced by the signals of other males as adults. The mated females collected are being used to establish full-sib families for these experiments, and given promising results from the first year, most likely more females and plants will be collected in subsequent years to continue this research project. Ph.D. Dissertation research, Rafael Rodriguez, Major Professor

Reproductive Ecology of Tamarack (*Larix laricina*) in Southeastern Wisconsin

James A. Reinartz
UWM Field Station, jimr@uwm.edu

Tamarack grows in a very wide variety of wetland plant communities found in the Southeast Glacial Plains Ecological Landscape of Wisconsin, but reproduces in a much narrower range of wetland plant community types. We studied the condition of tamarack populations with particular emphasis on recent reproduction in 17 sites in southeastern Wisconsin. Growth rates of tamarack vary tremendously and in general tamarack age cannot be estimated even approximately based on the size of the tree. Trees less than 10 years-old can be aged by counting terminal bud scars on the stems. Older trees were aged approximately by collecting cores and counting annual growth rings. Evidence of recent tamarack reproduction was extremely rare in the stands we studied. Most of the stands showed that tamarack trees established as even-aged cohorts following disturbance

events. Exceptions to the general pattern of establishment only after disturbance events were found in relatively pristine bogs and calcareous fens where extreme hydrology appears to provide ongoing opportunities for establishment of individuals. Vigorously growing tamaracks on mineral soil wetlands and at the margin of larger wetlands were found to be important for maintenance of the meta-population dynamics of tamarack in the landscape. These vigorously growing trees have been lost from most of the wetlands in the SGP. Establishment of tamarack trees where they can grow vigorously at the margins of wetlands should be a very high priority in any plan for long-term management to enhance tamarack reestablishment in southeastern Wisconsin wetlands. This project was funded by a grant from the State Wildlife Grant Program.



Depth of Water Table Affects Growth and Physiology of Two Year Old Tamarack Saplings

Anne Reis¹ and James A. Reinartz²

¹College of Letters and Science, UWM, annereis@uwm.edu, ²UWM Field Station, jimr@uwm.edu

We investigated the effects of three water depths on the growth and total biomass of potted tamarack saplings in a mesocosm experiment. Using nine cattle tanks buried in the ground at the Field Station we manipulated the water levels and soil saturation conditions under which tamarack seedlings were grown. The potted tamaracks were maintained over the entire growing season, and the experiment was repeated during two seasons. At harvest, we measured total height, leader height, number of branches, dry weight of stems and dry weight of shoots. As expected, an ANOVA showed a significant difference among all treatments, with low saturation levels producing the

most growth and biomass. Interestingly, the number of branches for medium water levels did not vary significantly between high or low treatments. Some saturated trees grew adventitious roots so that there was a dead root zone below the soil level and a live root zone just above the soil surface of the pot. This study provides evidence that tamaracks are able to tolerate high water levels throughout the growing season and that they adapt to these conditions by producing adventitious roots, though the total biomass is less than what is physiologically possible. Further study on water table fluctuations will be conducted. M.S. Thesis research, James Reinartz, Major Professor.

Evaluating Five Site Preparation Treatments for Establishment of Tamarack by Direct Seeding

Anne Reis¹ and James A. Reinartz²

¹College of Letters and Science, UWM, annereis@uwm.edu, ²UWM Field Station, jimr@uwm.edu

We manually seeded 320 hummocks in three 30 X 10 meter plots (study sites) within the Cedarburg Bog to test different site preparation methods for tamarack restoration. Treatments included clearing all woody plant cover plus combinations of burning, glyphosate herbicide application, glyphosate and triclopyr herbicide application, soil scarification (raking) and control. Results indicate that the glyphosate only and burning treatments provided significantly higher

levels of germination across all three study sites. Germination also varied significantly among study sites. The success of the seedlings that have established in these plots will be monitored for another growing season. The results of this study will be valuable for efforts to enhance or restore tamarack populations in southeastern Wisconsin. M.S. Thesis research, James Reinartz, Major Professor.

Comparing the Distribution of Pre-settlement and Present Day Tamarack Swamp in Wisconsin's Southeast Glacial Plains.

Anne Reis¹ and James A. Reinartz²

¹College of Letters and Science, UWM, annereis@uwm.edu, ²UWM Field Station, jimr@uwm.edu

We developed a map of the pre-settlement distribution of tamarack swamps in the Southeast Glacial Plains (SGP) Ecological Landscape of Wisconsin using the data from the original land survey records. Comparison of the original distribution of tamarack swamps with the present day distribution as mapped by the Wisconsin Wetland Inventory (WWI) and the hydric soil data from the Soil Survey Geographic database allow us to estimate the extent of tamarack loss. Wisconsin Wetland Inventory has recently been updated for all counties in the SGP. Tamarack communities covered approximately 178,000 acres during pre-settlement times, with a potential to cover almost 350,000 acres. WWI indicates that 51,000 acres of tamarack swamp remain, which constitutes a 70% loss of tamarack in the SGP landscape. This map helps us prioritize conservation and restoration practices in the region. M.S. Thesis research, James Reinartz, Major Professor.



Ecology & Evolution of Vibrational Communication, Sexual Behavior, and Cognition of Insects and Spiders

Rafael L. Rodríguez

Department of Biological Sciences, UWM, rafa@uwm.edu

Our objective is to test the hypothesis that genetic variation in reaction norms (GxE) will disrupt the genetic covariance between male and female sexual traits that forms the basic mechanism of sexual selection. To this end, we collected *Enchenopa binotata* treehoppers (Hemiptera: Membracidae; 70 mated females) from *Viburnum lentago* host plants at the UWMFS to set up a host-shift experiment and describe variation in the reaction norms of male signals and female preferences. This ongoing experiment

involves rearing full-sibling families on both their native host (*V. lentago*) and a novel host (*Robinia pseudoacacia*).

We also collected other treehopper species (*Publilia* spp.; ca. 200 indivs.) for observations of their communication behavior during the late summer and fall (outside the spring mating season). These initial observations will help develop projects on the evolution of duetting behavior in systems of vibrational communication.

Intercomparing Multiple Measures of the Onset of Spring in Eastern North America

Mark D. Schwartz
Department of Geography, UWM, mds@uwm.edu

Measuring the onset and progress of vegetative growth during the spring season in temperate climates can be accomplished using multiple ground and satellite-based techniques. While all these measurements are valid (i.e., record a real characteristic related to plant development), they typically are poorly inter-correlated due to incompatible levels of spatial representation and differing methodologies. Given recent and likely future impacts of climate change on spring plant growth, the need to reconstruct past patterns, and the lack of standardized vegetation growth measurements around the world, more work is needed to determine the relationship between the various measures, and the degree to which they may serve as substitutes for each other.

We use measurements at two phenology "super-sites" in eastern North America (one is the UW-Milwaukee Field Station) and several other supporting sites to evaluate the relationships among multiple spring vegetative growth measures, and

explore strategies to standardize their inter-correlation. The results show that correlations among satellite-derived start of season (SOS) measures are generally high, and correlations among ground phenology measures are also high, but when ground phenology and satellite SOS are compared, there are few strong correlations, even at sites with extensive native species phenology available. Modeled phenology, based on daily temperature data (Spring Indices first bloom date) does as well as any of the direct native species measures, and is better suited to facilitate inter-comparisons. In order to effectively compare ground-based and satellite-derived SOS measures, it is clear that employing limited numbers of individual plants will be less effective. Given that satellite-derived measures are areal and at a scale of 250 m and larger, we suggest collecting ground phenology data at the same areal scale to make effective comparisons.

Bridging Spatial Scales Using Phenological Measurements to Improve Understanding of Springtime Atmosphere-Biosphere Interactions

Mark D. Schwartz
Department of Geography, UWM, mds@uwm.edu

As part of this project, 108 evenly distributed trees have been marked in Downer Woods (on the UW-Milwaukee campus) and are being phenologically observed both in autumn (starting in 2007) and in spring (starting in 2008). In addition, automatic air and soil temperature measurements are being collected at several locations to

support analyses of these phenological measurements. These measurements will also be compared to data being collected on at least one similar species (*Tilia americana*, Basswood) at both the UW-Milwaukee Field Station and at the primary study site of this project near Park Falls, WI. Funded by the National Science Foundation.

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

William E. Stout
Oconomowoc, WI, stoutw@hotmail.com

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 2010, 21 of 28 laying pairs produced 86 young to a bandable age (ca. 16 days; 3.07 young/laying pair, 4.10 young/successful pair, 75.0% nesting success). Eighty-five of 86 nestlings (42 males, 43 females)

were banded (one male was not banded because it fledged before I banded at the nest). No second nesting attempts (i.e., re-nests) were found (i.e., for first nesting attempts that failed). Twenty-nine adult (i.e., breeding) Cooper's Hawks (13 males, 16 females) were trapped, banded, measured, colormarked, and processed for additional analyses at 17 different nest sites. The nest at Downer Woods (UW-Milwaukee) produced four young; both adults were trapped. The adult male for this breeding area was the same breeding male as in 2009. This bird was banded as a nestling in 2007 and, therefore, was a three-year-old bird (age: 4Y [fourth-year]; natal dispersal: 3.30 km SE [137°]). The adult female was different from 2009; however, in 2009 she was breeding at an adjacent nest site. The distance of this adult dispersal for this female was 1.29 km, and the direction was N (3°; the 2009 breeding site was approximately 1.29 km S). This project was supported, in part, through the Wisconsin Society for Ornithology (WSO) Small Grants Program.

Resolving Phylogenetic Relationships in Sequential Radiation: A Case study of the Gall-boring Beetle, *Mordellistena convicta*

Mizuki Takahashi and Warren Abrahamson
Department of Biology, Bucknell University, PA, mt027@bucknell.edu, abrahamsn@bucknell.edu

Biodiversity may beget further species diversification through ecosystem engineering in which organisms generate structural

complexity in available resources for new species to exploit. To test this "species beget species" hypothesis, our lab has studied

a goldenrod-insect system. We found that diversity in goldenrod host plants led to host-plant formation of a gall-inducing fly, *Eurosta solidaginis*, via the herbivore's specialization to specific host-plant species (*Solidago altissima* or *S. gigantea*). An intriguing possibility, predicted by the "species beget species" hypothesis, is that the gall-fly's diversification can facilitate further diversification of unrelated organisms via sequential radiation. More recent studies from our lab support this prediction: the primary radiation of the gall-inducing fly appears to have triggered the sequential radiation of *Mordellistena convicta*, a gall-boring beetle, via differential adaptation to the gall resources engineered on stems of the host plants. However, while the primary radiation of the gall-inducing fly is well-understood, the sequential radiation of the gall-boring beetle is relatively unexplored. In particular, our current research explores how the

divergence history of the primary radiation affects that of the sequential radiation. The primary radiation of the gall-inducing fly has likely undergone a single divergence event from *altissima* fly to *gigantea* fly in the northeastern USA. The sequential radiation of the gall-boring beetle may follow this pattern of the primary radiation if the beetle's divergence is closely facilitated by availability of resources (i.e., galls). Yet, recent evidence suggests the contrary: the beetle's divergence from *S. gigantea* to *S. altissima*. As a part of our geographic sampling from New England to Minnesota and Iowa, the beetle samples collected at the UWM Field Station during the winter in 2010 will contribute to our phylogenetic analyses examining the relationship between the divergence histories of the primary speciation and the sequential speciation.

Citizen-based Herptile Monitoring Program in Historic Riverside Park, Milwaukee

Timothy Vargo¹, Jesse Hill¹, Jenn Callaghan¹, Gary S. Casper², Craig Berg³ and Billie Harrison⁴

¹Urban Ecology Center, tvargo@urbanecologycenter.org, ²UWM Field Station, gsc@uwm.edu, ³Milwaukee County Zoo, ⁴Racine Zoo/Urban Ecology Center

We established a long-term citizen-based monitoring program for amphibians and reptiles in Riverside Park, Milwaukee. The program includes annual snake mark/recapture surveys using plywood cover boards, and tracking individuals of the state Threatened Butler's gartersnake (*Thamnophis butleri*) to determine life history parameters and population trends. Northern brownsnakes and common gartersnakes have also been recorded. We also conduct annual turtle visual basking surveys and mark/recapture surveys using traps. To date northern map turtle, painted turtle, common snapping turtle and spiny softshell turtles have been recorded. Calling frog surveys are also run. Funded by Citizen-based Monitoring Partnership Program, Prairie Biotic Research Program, Milwaukee County Zoo, and E.P.A. Great Lakes Restoration Initiative.



The Impact of Interpopulation Distance on Offspring Fitness in *Impatiens capensis* Meerb. (Balsaminaceae)

Marc C. White

Department of Biological Sciences, UWM, marc.white50@yahoo.com

Restoration, reintroduction, and hybridization rescue are important tools for the conservation of wild populations. There remains a great deal of uncertainty regarding the selection of appropriate source material for the conservation and restoration of plant populations. Of special concern are possibly detrimental genetic impacts that crossing between distinct populations may have on often small remnant populations. The potential for hybrid vigor and outbreeding depression limit our ability to apply many of these important conservation tools. Despite these concerns, little research has been conducted using wild populations to explore the relationship between interpopulation outcrossing distance and the level of hybrid vigor and/or outbreeding depression expressed in the offspring. In this experiment, thirteen wild populations of the common annual plant *Impatiens capensis* Meerb. (Orange jewelweed) were used to examine the effect of interpopulation distance on two generations of offspring fitness. The research design included the production of first and second-generation offspring by

randomized crossing between each of three local populations and two replicate populations from distances of 50, 100, 200, 400 and 800 kilometers. Fitness impacts are being assessed by comparing the fitness of individuals produced by crossing within each population (P1) with the fitness of hybrids produced by crossing between populations separated by increasing distances. The separate effects of hybrid vigor and two components of outbreeding depression will be partitioned by comparing the fitness of non-hybrid P1 plants with the fitness of both first generation (F1) and second generation (F2) offspring. Fitness trials were conducted at the UWM Field Station by growing experimental cross-types in one of the three local parental environments and in a more benign shade lattice environment. Data from these trials will be used to test theories in conservation genetics and inform biologists involved in habitat restoration, population reintroduction, and hybridization rescue efforts. PhD Dissertation research, James Reinartz, Major Professor.

Extra-pair Mating in Tree Swallows

Linda A. Whittingham and Peter O. Dunn

Department of Biological Sciences, UWM, whitting@uwm.edu, pdunn@uwm.edu

In 2010 we completed the 13th year of study of the reproductive ecology of tree swallows at the UWM Field Station. Our work has primarily focused on extra-pair mating and the effects of food and temperature on reproductive performance. In this socially monogamous species females engage in mating with males on other territories (extra-pair mating), which results in many young that are not sired by the social mate (extra-pair young). Almost 90% of female

swallows engage in extra-pair mating in our study population (based on genetic analyses of paternity) and unlike most other species, each female may have several different extra-pair sires in her brood. Our recent work suggests that this multiple mating may benefit females by increasing the proportion of eggs that hatch (Whittingham and Dunn 2010). This research was supported by funds from the College of Letters and Science, UWM.



The Friends of the Cedarburg Bog and Natural Resources Foundation of Wisconsin offered a BioBlitz at the Cedarburg Bog in July. This citizen-scientist event was designed as part educational event, part scientific endeavor and part festival, and brought together scientists, volunteers, and the public to see how many species could be tallied in a day-long biological survey. More than 380 species were counted, including 240 of the 300 known plants, 60 bird species, more than 15 butterfly and dragonfly species, lichen, algae and 3 species of fish at Watts Lake.

Recent Publications and Theses

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Recent Theses

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Holmquist, Karsten G. A. 2005. The effect of floral display and pollinator behavior on pollen-mediated gene dispersal in *Mimulus ringens*. Ph.D dissertation.

Hovick, Stephen M. 2005. Restoring forest in wetlands dominated by reed canary grass: the effects of pre-planting treatments on early survival. M.S. thesis.

O'Brien, Heather L. 2005. Assessment of white-tailed deer (*Odocoileus virginianus* Zimmerman) density and browse damage at University of Wisconsin-Milwaukee Field Station. M.S. thesis.

Redell, David N. 2005 Behavioral ecology of bats using the Neda Mine hibernaculum. M.S. thesis.

Garvin, Julia C. 2006 Male ornaments, extra-pair mating, and immunocompetence in the common yellowthroat. Ph.D dissertation.

Bott, Terry. 2007 Morphological diversity of the northern pitcher plant (*Sarracenia purpurea* L.) in two contrasting wetlands. M.S. thesis.

Hapner, Jill A. 2007. Factors influencing plant community development and wildlife use in

small conservation wetlands in southeastern Wisconsin. Ph.D dissertation.

Kapfer, Josh. 2007 The ecology of bullsnakes (*Pituophis catenifer sayi*) in upper midwestern prairies. Ph.D dissertation.

Maurer, Joan K. 2007 Detection of avian blood parasites in the common yellowthroat (*Geothlypis trichas*): A comparison of multiple methods. M.S. thesis.

Mitchell, Dan. 2007 Attractive males provide less parental care in two populations of the common yellowthroat. M.S. thesis.

Vasquez, Eric C. 2008. The effects of enemy exclusion and enemy damage on exotic and native plant species: a test of the enemy release hypothesis. M.S. Thesis

Flanagan, Rebecca J. 2009. Exploring the effects of competitors for pollination on the reproductive success of *Mimulus ringens*. Ph.D. dissertation.

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Hileman, Eric T. 2010. Abundance and survivorship of Butler's gartersnake (*Thamnophis butleri*) in Wisconsin. 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 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.

3. 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.

4. Ozaukee Washington Land Trust. The Land Trust is a non-profit, land conservancy for Ozaukee and Washington Counties. The Field Station helps to support the organization's activities in various ways. Jim Reinartz served on the Conservation and Stewardship Committees and aids in development of stewardship plans and natural area management. In 2010, The Field Station cooperated with OWLT on their "Treasures of Oz" event.

5. Invasive Plants Association of Wisconsin. This non-profit organization works to stop the spread of invasive plants in Wisconsin. Reinartz serves on the Board of Directors and is editor of the IPAW newsletter, "Plants out of Place".

6. Riveredge Nature Center. Gretchen Meyer and Jim Reinartz both serve on

the Riveredge Research and Stewardship Committee. Reinartz also cooperates with Riveredge to organize and direct the Riveredge Speaks Out monthly lecture series.

7. Regional School Systems. Advanced biology classes from several high schools in the region (Milwaukee, Ozaukee, and Washington counties) use the Field Station for ecology field classes.

8. Ozaukee County Department of Environmental Health. The Field Station continues to provide monthly rainfall totals from our weather station for use in soil test requirements.

9. Village of Saukville. Daily rainfall totals are provided on a regular basis to the Village of Saukville engineers.

10. Port Washington Power Plant. Weather records are provided monthly.

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

12. City of Mequon – Mequon Nature Preserve. Jim Reinartz serves on the MNP science and stewardship planning committee.

13. Wisconsin Department of Transportation. The Station raises beetles for biological control of purple loosestrife for WDOT.

14. U.S. Fish and Wildlife Service. G. Meyer provides support for monitoring efforts for the federally-endangered Hine's emerald dragonfly (*Somatochlora hineana*).

15. Urban Ecology Center—Milwaukee. G. Meyer serves on the Science Advisory Board.

- 16. Wisconsin Task Force on Invasive Species.** Reinartz serves on the task force and on the Science and Research Subcommittee of the task force.
- 17. Wisconsin Phenological Society.** G. Meyer serves on the Board of Directors.
- 18. Southeastern Wisconsin Invasive Species Consortium (SEWISC).** Reinartz serves on the Board of Directors and as Treasurer for the organization, and the Field Station cooperated with SEWISC to develop

and conduct invasive plant management workshops for parks personnel and for right-of-way workers.

19. Natural Resources Foundation. In 2010, the Field Station cooperated with NRF and the Friends of Cedarburg Bog to hold a major Bioblitz event for the public at the Field Station.

2010 Natural History Workshops

This is a series of intensive workshops on specialized topics which provide a continuing education opportunity and a meeting place for biologists. Nine workshop topics were offered in 2010. Each of our workshops was filled to the capacity of 20 people.

Workshop	Instructor	Date
Ecology and Physiology of Plants in Winter: Surviving the Big Chill	James Reinartz	January 8 & 9
Field Herpetology: Identification of Wisconsin Amphibians and Reptiles	Josh Kapfer	June 4 & 5
Sedges: Identification and Ecology	Anton Reznicek	June 11 & 12
Vegetation of Wisconsin	James Reinartz and Marc White	June 14 - 19
Plant-Insect Interactions: Ecology and Evolution	Gretchen Meyer and Robert Clare	June 25 & 26
Dragonflies and Damselflies: Identification and Ecology	Robert DuBois	July 9 & 10
Ecological Geology	Roger Kuhns	July 19 - 23
Beetles: Identification and Ecology	Dan Young	July 30 & 31
Mushrooms and other Fleshy Fungi: Identification and Ecology	Alan Parker	September 18 & 19

Class and Group Use

Winter - Spring 2010 Number of Student Hours

Ecology and Physiology of Plants in Winter Workshop	360
Winter Ecology Hike and Friends Chili Dinner	560
Friends of Cedarburg Bog – Spring Frogs and Woodcock	60
Friends of Cedarburg Bog – The Bog in Spring	60
Friends of Cedarburg Bog – Meetings	90
Riveredge Nature Center Bog Tour	70
Natural Resources Foundation Staff Retreat	210
Wisconsin Wetlands Association – Frogs of the Bog	40
Milwaukee Institute of Art & Design – Ecology	30
Milwaukee Area Technical College – Natural Landscaping	50
Carroll College – Aquatic Ecology	40
UWM – Geography Spring Picnic and Hike	60
TOTAL	1,630

Summer 2010

Field Herpetology Workshop	360
Sedge Identification Workshop	380
Vegetation of Wisconsin Workshop	1,240
Plant-Insect Interaction Workshop	360
Dragonflies and Damselflies Workshop	360
Ecological Geology Workshop	900
Beetles Workshop	320
Friends of Cedarburg Bog – Late Migrant Bird Walk	60
Friends of Cedarburg Bog – Summer Solstice Walk	50
Friends of Cedarburg Bog – Breeding Birds	90
Friends of Cedarburg Bog – Butterflies at the Bog	40
Friends of Cedarburg Bog – The Bog in Bloom	60
Friends of Cedarburg Bog – meetings	60
Riveredge Nature Center – Wildlife Ecology	80
Riveredge Nature Center – Teacher Naturalist class	50
Natural Resources Foundation Bioblitz	860
Treasures of Oz Event	140
Ozaukee Washington Land Trust – Field Trip	80
Carroll College – Ecology	240
UW-Stevens Point – Permaculture Class	1,440
UW-Madison – Plant Ecology	180
TOTAL	7,350

Fall 2010

Number of Student Hours

Mushroom and Fleshy Fungi Workshop	360
Friends of Cedarburg Bog – meetings	80
Friends of Cedarburg Bog – Annual Meeting & potluck	160
Friends of Cedarburg Bog – Northern Cross stargazing event	150
Friends of Cedarburg Bog – Photography workshop	60
Friends of Cedarburg Bog – Owl Prowl	130
Biological Sciences/Field Station Picnic	120
Volo Bog Naturalist Group tour	40
USDA-Natural Resources Conservation Service – Bog Tour	60
Kettle Moraine Lutheran High School	50
Schlitz Audubon Center – School group	140
Alverno College – Wetland Ecology	30
University of Illinois-Chicago– Ecology field trip	650
UW – Platteville – Geology	240
UW – Parkside – Ecology Field Trip	220
UWM – Cambridge Commons LLC	30
UWM – Geography – Soils	110
UWM – Hydrogeology – Well installation	90
UWM – Geology – Hydrogeology	120
TOTAL	2,840

TOTAL 2010 Class & Group Use Hours 11,820



Meteorological Data for 2010

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/m²)

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 2010

Temperature (C°)

Average Daily Maximum	-3.6	-0.8	9.1	15.3	20.1	23.8	27.7	27.7	20.5	17.2	8.5	-2.2
Average Daily Minimum	-9.9	-8.3	-2.4	4.1	9.0	13.9	17.3	16.9	9.8	4.4	-1.6	-9.6
Daily Average	-6.6	-3.9	3.2	9.9	14.7	18.9	22.7	22.1	15.2	10.8	3.4	-5.7
Highest (Date)	4.9 (24)	2.8 (19)	24.8 (31)	26.9 (15)	31.5 (30)	29.9 (22)	30.8 (16)	32.1 (29)	29.6 (23)	28.2 (10)	17.6 (8)	11.5 (31)
Lowest (Date)	-18.8 (2)	-18.8 (12)	-12.4 (6)	-2.7 (9)	0.6 (10)	8.2 (7)	8.6 (1)	8.4 (26)	2.4 (27)	-4.0 (22)	-9.3 (26)	-21.6 (15)

Degree Days

Sum at 5°	0.0	0.0	34.7	152.8	301.5	415.6	548.2	531.1	306.2	182.2	30.6	3.8
Sum at 10°	0.0	0.0	7.6	59.1	170.2	265.6	393.2	376.1	158.1	64.6	1.6	0.0

Radiation (kW/m²)

Mean	0.07	NA ¹	NA	0.21	0.25	0.23	0.25	0.23	0.15	0.13	0.07	0.05
Maximum	0.52	NA	NA	0.96	1.01	1.12	1.06	0.89	0.84	0.69	0.55	0.53

Relative Humidity

Hour 00-06 mean	83.9	83.0	85.3	80.0	85.3	92.1	90.0	92.7	90.5	80.8	84.4	88.1
Hour 06-12 mean	80.8	78.4	69.9	62.1	65.9	74.1	72.2	73.1	74.9	65.0	75.6	84.7
Hour 12-18 mean	73.3	70.5	55.8	52.9	55.4	67.8	62.7	63.1	64.8	51.3	68.2	78.3
Hour 18-24 mean	80.5	80.4	77.9	71.3	72.2	86.5	84.2	87.6	87.3	75.3	80.5	86.1

Number of Days

Precip. 0.25mm or more
 Max Temp 32° and above
 Max Temp 0° and below
 Min Temp 0° and below
 Min Temp -18° and below

3	7	5	10	9	17	17	17	6	12	7	7	8
0	0	0	0	0	0	0	0	1	0	0	0	0
25	17	0	0	0	0	0	0	0	0	0	2	23
30	28	21	8	0	0	0	0	0	0	7	17	29
3	1	0	0	0	0	0	0	0	0	0	0	2

Pressure (mbars)

Mean	1017.74	1016.02	1015.42	1013.08	1015.43	1013.57	1015.09	1014.99	1014.74	1014.71	1015.96	1017.00
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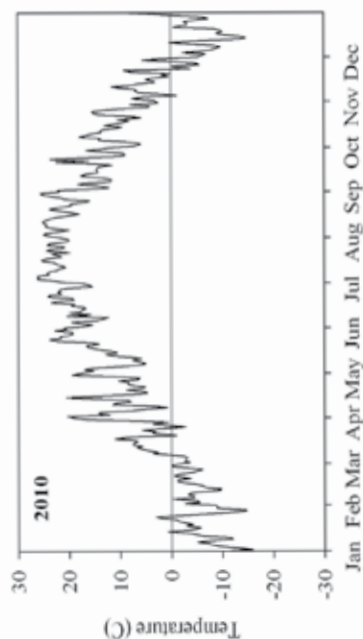
Precipitation (mm)

Total	30.0	35.0	21.0	143.5	77.8	92.1	200.3	41.4	71.4	47.7	25.0	58.0
Greatest (24 hrs) (Date)	19.0 (7)	16.0 (9)	7.5 (11)	37.6 (24)	29.7 (11)	38.0 (27)	65.7 (15)	13.0 (9)	23.0 (1)	17.4 (23)	9.0 (24)	42.0 (11)

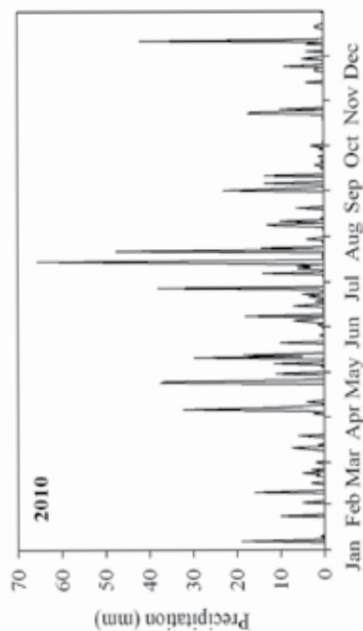
Wind

Mean Speed (m/s)	2.2	1.8	1.6	2.3	1.7	1.4	1.2	1.1	1.4	1.5	1.9	1.7
Maximum Speed (m/s)	5.2	4.5	5.1	7.5	5.7	5.4	4.3	4.4	4.7	6.8	6.1	4.1

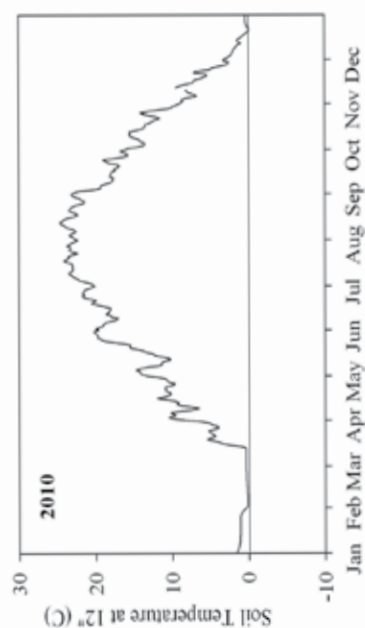
1 - NA, not available. Pyranometer removed for maintenance.



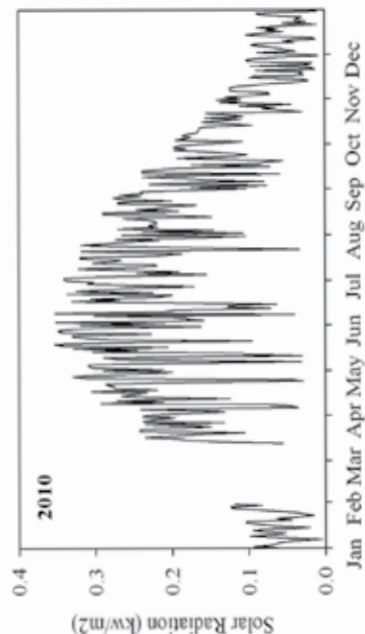
Mean Daily Temperature



Total Daily Precipitation



Mean Soil Temperature at 12\"/>



Mean Daily Radiation



Field Station

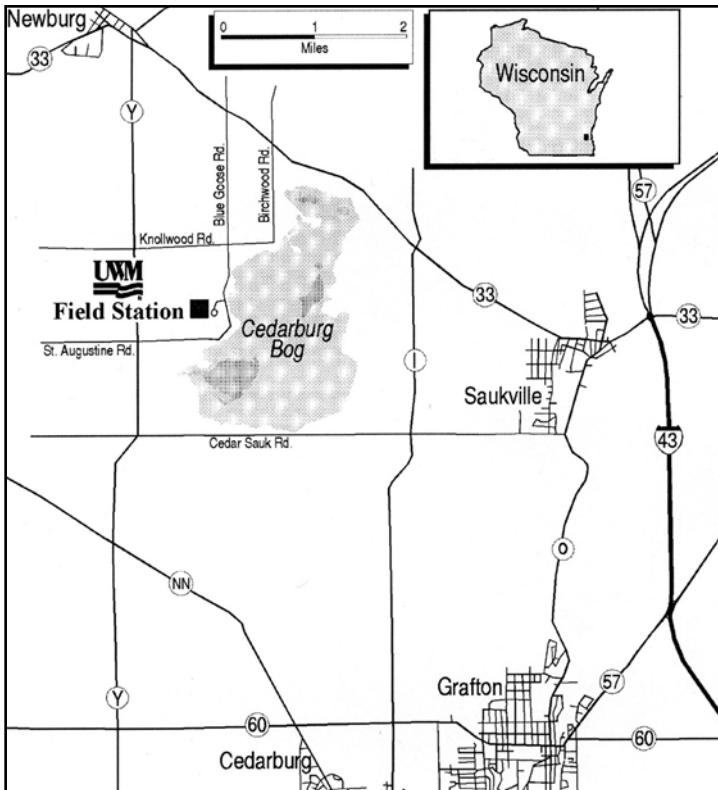
3095 Blue Goose Road
Saukville, WI 53080

Phone: (262) 675-6844

Fax: (262) 675-0337

E-Mail: fieldstn@uwm.edu

Web: www.fieldstation.uwm.edu





Field Station
P.O. Box 413
Milwaukee, WI 53201

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