2009 Field Station ANNUAL REPORT





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On the Cover: Aerial photo showing the locations of 609 coverboards used for a study of the state-threatened Butler's gartersnake (*Thamnophis butler*) at the Field Station. Coverboards were in place 2008-2009, and a total of 416 Butler's gartersnakes were captured over the course of the study. See abstract by Eric Hileman.

Director: Manager/Staff Biologist: Maintenance: Administrative Assistant:	James A. Reinartz Gretchen A. Meyer Lou A. Nelson 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

2009 Highlights

• 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.

• Bat surveys using an Anabat detector coupled with a global positioning system were initiated at the Field Station in spring and fall of 2009.

• Use of Downer Woods on campus for education and research continues to increase.

• Dr. Karron's screenhouse and garden facility was relocated to the experimental area and the previous location was restored

• The bridge on the main trail southeast of the office was reconstructed

• 50 research projects conducted in 2009.

• Over 10,000 student hours of instruction and group use in 2009.

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 292 scientific publications and 136 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 assessment of bumblebee populations in 2009 indicated that the area could support relocation of Dr. Karron's screenhouse and garden facility to that area.

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 (Melilotus spp.), motherwort (Leonurus cardiaca), Oriental bittersweet (Celastrus orbiculatus) and garlic mustard (Alliaria petiolata) are all present, and being controlled in the Field Station natural areas. Friends of Cedarburg Bog volunteer workdays and our regular stewardship volunteer, Dennis Goldsmith, contributed about 30 person days during 2009 to help Field Station staff with our efforts to control invasives. Only glossy buckthorn in the Cedarburg Bog and Oriental bittersweet in the southeastern portion of the Station and private properties to the south, 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 – 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

• 50 active research projects conducted at the Field Station in 2009.

• Including: 11 M.S. thesis, 2 Ph.D. and 15 studies by researchers from outside of the University.

• 13 papers published during 2009. 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 beechmaple 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 longterm studies of avian vocalizations, including their organization and function.

• GIS system developed for the Field Station area.

Educational Programs

• Over 10,000 student hours of instruction and group use in 2009.

• Eight 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 (699 projects).

• Programs for the public on: Winter ecology, Spring frogs and woodcocks, Bird migration, Spring flora, Plants of the Bog, Mud Lake ecology, Bird banding, Cedarburg Bog Ecology, Beech-maple woods Ecology, Native orchids, 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.

The 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 2009 the Friends raised funds and reconstructed the public access at the north end of the Bog to make it handicapped accessible. They also sponsored 17 educational events for the general public. Volunteers from the Friends contributed over 100 person-days of labor, including natural area management and boardwalk construction, 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!



The Effects of Temperature and Food Abundance on Breeding Season Length in Single-brooded and Double-brooded Birds

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Recent evidence suggests that the breeding season (spread in laying dates) may be getting shorter for single-brooded birds and longer for double-brooded birds. Temperature and insect phenology may contribute to this, but few previous studies have investigated such effects in both the insect (prey) and bird (predator) populations. During the 2009 field season, we examined the relationships between temperature, food supply and length of season in a single-brooded species, the tree swallow (Tachycineta bicolor) and a double-brooded species, the eastern bluebird (Sialia sialis). For both species, we recorded laying date, clutch size, number of chicks hatched, and number of chicks fledged. Additionally, we recorded number of nesting attempts and duration of the interval between clutches for bluebirds. Insects were caught by sweep netting and through the use of a suction trap to estimate food abundance for bluebirds and tree swallows, respectively. Local air temperature was recorded by a weather

station located at the Field Station. We also performed a food supplementation experiment to determine if increased food abundance influences the number of broods or the duration of the interclutch interval in bluebirds. Because breeding season length may restrict the number of broods that can be produced, it can have potentially strong effects on reproductive success. Understanding how species with different life history strategies respond to environmental changes may help us to understand how climate change might be influencing reproductive success in birds. Support for this project was provided by the American Ornithologists' Union, the Wisconsin Society for Ornithology, the Bluebird Restoration Association of Wisconsin, and the Ruth Walker Grant-in-Aid, a UWM Biological Sciences award. Field procedures were approved by the UWM Animal Care and Use Committee (Protocol 08-09 #23). M.S. thesis Research, Peter Dunn, Major Professor.

Invasion and Displacement of Native Vegetation by *Rhamnus* cathartica: Toward a Mechanistic Understanding

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Rhamnus cathartica (common buckthorn) has aggressively invaded many Eastern Deciduous forests of the United States, including those in Wisconsin. Buckthorn commonly forms dense thickets and appears to exclude native woody vegetation by reducing light to levels below which natives can regenerate. Alternatively, buckthorn may exclude native vegetation by below-ground competition or allelopathy. The extent to which buckthorn excludes natives and the exact mechanisms by which it accomplishes this remain unknown. Using a combination of experimental approaches, we are testing the degree to which buckthorn excludes the regeneration of woody plants and by what mechanism. In one experiment, we are testing whether buckthorn does indeed exclude native vegetation and whether this effect varies among species. To accomplish this, we are following the growth of buckthorn recruits and native woody species in 12 paired plots; for each pair, we have removed existing buckthorn from one plot but allowed it to remain in the other. In a second experiment, we will test whether buckthorn prevents native vegetation from establishing via above- or below-ground effects. To test for below-ground competition from this invasive, we will monitor the growth of buckthorn seedlings and woody plants in buckthorn thickets in which the buckthorn is tied back to reduce aboveground competition from it. We will compare seedling establishment and growth from this treatment to that of seedlings in paired plots in which we have removed buckthorn but simulated above-ground competition using shade frames. Preliminary results show that removing buckthorn significantly increased native seedling recruitment (Wilcoxon, p =0.011). Removal also increased buckthorn recruitment, but the difference between treatments was only marginally significant (p = 0.077). These findings show that buckthorn is excluding native species and its own seedlings, but to a lesser extent. M.S. Thesis research, Stefan Schnitzer, Major Professor

Macroinvertebrate Community Structure Surveys of Selected Ephemeral Ponds in Support of a Long Term Monitoring Strategy

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The Wisconsin Ephemeral Pond Project (WEPP) supports conservation of ephemeral pond wetland habitat. WEPP has several components including mapping potential ephemeral ponds, ground-truth and baseline surveys, and in-depth monitoring at selected ephemeral pond reference sites. Reference ephemeral ponds are chosen across Wisconsin to represent a variety of pond types, disturbance levels and landscape settings, and are on permanently protected lands.

Here we collect basic inventory data on freshwater macroinvertebrates at six reference sites in Ozaukee County, including three ephemeral ponds associated with the UWM Field Station and the Cedarburg Beech Maple Woods State Natural Area. The objectives for this inventory are to complete macroinvertebrate community structure surveys in order to characterize different types of ephemeral pond habitats based on their hydrologic regime, plant community and associated wildlife; to collect physical and chemical information to support the community structure survey; and to document the presence of any invertebrate species listed in Wisconsin's Strategy for Wildlife Species of Greatest Conservation Need.

Each pond was surveyed monthly during the growing season, until the pond dried, using multi-habitat searches, bottle traps and dip net collections. Taxa represented include mollusks, annelids, fresh water sponges, 34 insect families and 6 non-insect arthropod families. Voucher identification to genus (and species whenever possible) continues. We plan to continue surveys in 2010 and expand to additional reference sites.

Herbivory on Invasive Buckthorn and Honeysuckle Compared to Native Shrub Species

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The mechanisms that allow introduced plants to become invasive are poorly understood. The Enemy Release hypothesis

holds that some exotic plants become invasive in their introduced range because the specialized natural enemies that control them in their native range are absent. I tested the Enemy Release hypothesis and the additional hypothesis that thick leaves can deter herbivory using three invasive shrubs (Rhamnus frangula, Rhamnus cathartica, and Lonicera tatarica) compared to native shrubs in the same environment. R. frangula was sampled at a wetland site (Cedarburg Bog), while R. cathartica and L. tatarica were sampled at an upland site (Paul Gihring Trail, New Berlin, WI). Native shrubs sampled at Cedarburg Bog were Cornus stolonifera, Betula pumila, and Ilex verticillata, while Ribes cynosbati was the native shrub included at the Paul Gihring trail. Ten sample shrubs of each species were censused for herbivory during a six week period between June 22 - July 27, 2009. Percent leaf damage was estimated

and herbivores visible on the plants were recorded. Specific leaf area was measured for each shrub. Shrubs at the bog site experienced a higher number and variety of herbivores compared to the Paul Gihring Trail. At the Cedarburg Bog, *C. stolonifera* had the most leaf damage and *B. pumila* the lowest, with *R. frangula* intermediate. *L. tatarica* had the highest leaf damage at the Paul Gihring trail. These results do not support the Enemy Release hypothesis.

The exotic shrubs tended to have higher specific leaf area than the native shrubs. *B. pumila* had both the lowest specific leaf area and the least amount of leaf damage, suggesting that thick leaves play a role in protecting shrubs against herbivory. Undergraduate independent study project, Gretchen Meyer, advisor.

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

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The success of invasive alien species is determined by their ability to disperse, followed by the establishment of a selfsustaining population and finally, expansion of geographic distribution. To predict patterns of invasion for an exotic plant, it is necessary to measure propagule pressure and germination success and how the two mechanisms may interact with one another. Germination success is determined by both biotic and abiotic factors. These factors control the resistance to invasion at a given site. A site with high resistance to invasion will require more propagule pressure by the invader to become established at that particular site. In this study, we will measure propagule pressure (using seed traps) and germination success (by sowing establishment plots) of an invasive woody shrub in a relatively undisturbed wetland. Sites that have either high densities or low densities of the invader will be studied to determine how propagule pressure is able to overcome site resistance. For a model, we will study glossy buckthorn (*Rhamnus frangula*), a woody shrub native to Eurasia that has become a noxious invader in many wetlands in the United States. The Cedarburg Bog is one of the largest intact and undisturbed wetlands in Wisconsin. For the last few decades, glossy buckthorn has been aggressively



spreading throughout the Cedarburg Bog. This situation presents an ideal opportunity to study the early stages of invasion by quantifying both dispersal ability and germination success simultaneously. This data will allow us to answer the following questions: 1) Why do some sites remain uninvaded or have low densities of glossy buckthorn? 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 buckthorn? The results of this study will provide information on the early stages of invasion by an exotic species. M.S. Thesis Research; Dr. Gretchen Meyer and Dr. Erica Young, advisors.

Hine's Emerald Dragonfly Conservation Genetics Study at Cedarburg Bog

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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. To date we have microsatellite genotypes from 24 individuals collected as wing clips from Cedarburg Bog

Wisconsin Herp Atlas

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The Wisconsin Herp Atlas tracks the distributions of amphibians and reptiles in Wisconsin. The Atlas was initiated in 1986

in 2008. Collection efforts at Cedarburg Bog were made on three occasions in 2009 by personnel from Cedarburg Science, LLC beginning 10 July. Largely because of poor weather conditions, no Hine's emerald drag-



onflies were seen in flight at Cedarburg Bog during the 2009 field effort. One presumed road-killed individual was collected on 29 June 2009 and this specimen was analyzed in the same manner as the 2008 wing clips. Funded by Illinois Tollway Authority, 1355 Extension Hine's Emerald Dragonfly Study.

at the Milwaukee Public Museum, with the cooperative support of the Natural Heritage Inventory Program (WDNR) and The Nature

Conservancy (Wisconsin Chapter). The Atlas is a computerized database of amphibian and reptile distribution, based on records obtained from museum collections, field surveys, 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.

Reproduction in Cedar Lake Blanding's Turtles

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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 2008 two adult females were tracked throughout the season and into hibernation. One did not reproduce but successfully recovered from injuries suffered when hit by a car in 2007. This ordeal likely prevented reproduction

in 2008, although we did observe a male actively courting her on August 12, which hopefully will result in reproduction in 2009. The second adult female was captured on June 13, 2008, and probably had already nested. Activity of both adults was tracked, and both hibernated in deep holes in a cattail marsh, which were frequently used in the past by these and other radioed turtles. A young (ca. 6 years old) Blanding's turtle was also found dead on the road in late July, 2008. The study is being conducted with volunteer participation. No nests were found in 2009 and we will try again in 2010. Funded by Cedar Lakes Property Owners Association.

Wildlife Ecopassage Monitoring

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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, and American toad. Funded by C.D. Besadny Conservation Grant, Natural Resources Foundation of WI, and Wisconsin Department of Transportation.

Morphology of Gartersnake Populations in the Wisconsin Zone of Overlap Between Thamnophis butleri and Thamnophis radix

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Butler's gartersnake, *Thamnophis butleri*, was described in 1889. This species is closely related to the Plains gartersnake, *Thamnophis radix*, but is ecologically more



Photo by Gary Casper specialized and narrowly distributed. These two species are distinguished morphologically through color, pattern, scale count, and

size differences, except in a narrow hybrid zone in southeastern Wisconsin, a finding mirrored by genetic studies. The present study applied prior morphological analysis techniques to evaluate more precisely how animals in a subset of populations of special management concern in this putative hybrid zone scored on eight morphologic characters. A total of 452 snakes were examined and scored for phenotypic variation from fourteen populations in the putative hybrid zone, and five reference groups removed from the hybrid zone. Strong T. butleri phenotypes were present in all hybrid zone populations, albeit at differing proportions. Phenotypic T. butleri individuals thus are likely present throughout the hybrid zone in some proportion, but in genetically segregated hybrid populations. Combined with genetic information, these findings may better inform conservation policy. Funded by Wisconsin DNR.

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, 58 institutions are participating in the HerpNET community, with an open ended invitation to institutions who would like to join. Fifty three 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. A database was posted in 2008 and georeferencing completed in 2009. Funded by the National Science Foundation and a Global Biodiversity Information Facility DIGIT grant to the University of Kansas Center for Research Inc.

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

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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 2009 we continued reforestation, wetland restoration and invasive species control on OWLT properties. We continued a herp monitoring program and began a bird monitoring program. We hosted training workshops on herp 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.

Genetic Variation and Environmental Heterogeneity: Studies on a Metapopulation of the bdelloid rotifer *Habrotrocha rosa*

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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 March 2009, rotifer clones were established from pitcher fluid isolates. Pitcher fluid was inoculated into EcoPlates to establish physiological profiles of the bacterial assemblages within the pitcher fluid. These assemblages differed distinctly among pitchers, but showed some within-pitcher consistency in physiological profiles across the time. Genetic analysis involves cellulose acetate gel electrophoresis of isozymes and Cox1 and Cob gene sequencing. Initial results show significant similarity among H. rosa clones isolated from the same leaf at different times within the growing season. Surprisingly, there appears to be a certain degree of homogeneity among clones isolated from leaves on different plants during this time. Preliminary results suggest however, that clones that must endure a period of freezing during the winter months exhibit considerable phenotypic and genetic variation compared to those prevalent during the warmer months.

A New Inventory Species, Carex buxbaumii, in Cedarburg Bog

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Carex buxbaumii. dark-scaled sedge, was discovered June 22, 2009 growing along the plank walk approaching the river at the Cedarburg Bog. C. buxbaumii usually grows in calcareous marshes and prairie swales and was also collected in the Chiwaukee Prairie, a sand prairie, and UW-Milwaukee Field Station's Benedict Prairie, a clay prairie, both in Kenosha County. The Cedarburg Bog specimen exhibited fasciation, an altered morphology with flattened thick culms and multiple spikes. The specimens were verified as C. buxbaumii by Dr. T. Cochrane of the UW-Madison Herbarium, Dr. Andrew Hipp, curator of the Morton Arboretum Herbarium, Lisle, Illinois, and Dr. Anthony Reznicek, curator of UM- Ann Arbor Herbarium. This brings the site inventory number of Carex in Cedarburg Bog to 50 species. Other Carex specimens collected from near the river area included C. comosa. C. interior, C. pseudocyperus and C. stricta. The plants were photographed, scanned, and parts micro-imaged for the author's next book about Carex of bogs, fens, coniferous swamps, and wet prairies of the upper Midwest



Aggression, Plumage and Extra-Pair Mating in Tree Swallows

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In 2009 we completed the second year of a study of aggression, plumage and extra-pair mating in tree swallows. 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); however, the factors that influence extra-pair mating in this species remain unclear. These birds are very aggressive in

defending nest boxes from rival swallows, other cavity-nesting birds, and predators. In this study we will determine whether female aggressiveness influences the number of extra-pair males she mates with. We predict that more aggressive females will exhibit higher levels of extra-pair mating than less aggressive individuals. A second part of this study is to examine how male plumage color and brightness influence the male's success gaining extra-pair fertilizations. We expect that brighter males will sire more extra-pair young than duller males.

Analysis of the Genetic Status of Populations in the Zone of Overlap between *Thamnophis butleri* and *Thamnophis radix* based on AFLP analysis

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Butler's gartersnake, Thamnophis butleri, was described in 1889. This species is closely related to the Plains gartersnake, Thamnophis radix, but is ecologically more specialized and narrowly distributed. These two species are distinguished morphologically through color, pattern, scale count, and size differences, except in a narrow hybrid zone in southeastern Wisconsin, a finding mirrored by genetic studies. The present study applied AFLP genetic markers to evaluate more precisely the question of whether animals in a subset of populations of special management concern in this putative hybrid zone were genetically mixed or if they contained animals of distinctive

Butler's ancestry. We studied 252 snakes from 15 populations in this area as well as control snakes from each species. All snakes were provided by the WDNR and while sample sizes were limited, we found animals with more than 90% Butler's ancestry in nine populations and animals with more than 75% Butler's ancestry in 12 populations. The populations with no such animals had small sample sizes and no confidence can be given to these negative results. We conclude that animals of primarily Butler's gartersnake genetic composition occur throughout the entire zone, although the relative density of these animals differs widely. Funded by Wisconsin DNR.

Interspecific Pollinator Movements Reduce Pollen Deposition and Seed Production in *Mimulus ringens* (Phrymaceae)

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We investigated the effects of invasive Lythrum salicaria on conspecific pollen deposition and seed set in Mimulus ringens, a wetland plant native to southeastern Wisconsin. We used experimental arrays of potted plants to address the following questions: (1) Does inconstant pollinator foraging decrease conspecific pollen deposition and resulting seed set in *Mimulus*? (2) Does inconstant pollinator foraging increase heterospecific pollen deposition on Mimulus? To quantify interspecific pollen transfer between *Mimulus* and *Lythrum*, we placed potted plants of each species in linear arrays, each with two Mimulus plants on either side of a single Lythrum plant. We removed a total of 44 arrays one at a time from a pollinator-free screenhouse and placed them outside, allowing the first free-flying

bumblebee worker that arrived to forage solely on the array. We recorded the species and sequence of flowers that each pollinator visited and tagged the final Mimulus flower visited in each array. We collected the stigma of each tagged Mimulus flower 48 hours following pollination to compare the number of *Mimulus* and *Lythrum* grains on Mimulus stigmas resulting from a Mimulus to Mimulus transition versus a transition in which there were visits to an intervening *Lythrum* plant. To quantify the relationship between pollen deposition and Mimulus reproductive success, fruits on tagged flowers were left to ripen and seed number per fruit was counted. Pollinator flights between these species significantly reduced the amount of conspecific pollen deposited on Mimulus stigmas and the number of seeds

in *Mimulus* fruits, but did not influence the number of heterospecific grains deposited on *Mimulus* stigmas. These results suggest that pollen loss is an important mechanism of competition for pollination. Although pollen loss is often attributed to pollen wastage on heterospecific floral structures, our findings suggest that grooming by bees as they forage on a competitor may also significantly reduce outcross pollen export and seed set in *Mimulus ringens*. This research was supported by a grant from Applied Ecological Services. Ph.D. Dissertation research, Jeffrey Karron, Major Professor.

Riparian Plant Communities of the Milwaukee River

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The Milwaukee River Basin contains 766 km (476 miles) of streams, and drains 1,852 km² (715 square miles) 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 (from about seven river-miles north of West Bend to downtown Milwaukee). River landscapes and riparian vegetation are dynamic – constantly changing. There is no study of a similar river system that could substitute for an inventory and description of the Milwaukee to inform the current



efforts to enhance this river corridor, and the Milwaukee riparian zone was essentially unstudied prior to this study. The Milwaukee River riparian zone has well-developed examples of several of the geomorphic features found in major river systems, including bars, natural levees, swales, first and second bottoms, backswamps and terraces. The vegetation at 30 floodplain sites and islands within the Milwaukee River were surveyed on nine different landforms. Elevation readings were taken of the base flow of the river, the 2008 flood and each sample unit surveyed. The floodplain vegetation along the fifth order branch of the Milwaukee River was surveyed, classified and ordinated into 16 regular plant communities, six bank tree-row communities and six river-flat communities. The condition of plant communities were 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. Plant community data was also analyzed to determine possible correlation with distribution due to other environmental factors, such as distance upstream from the mouth of the river and distance of sample unit to the river. There was a strong correlation between elevation and plant community type. The results are still being summarized, but data will be useful for future vegetation management along the Milwaukee River. Results indicate that elevation, landform and prior vegetation disturbances do affect the plant

communities along the Milwaukee River. This survey provides detailed information about the vegetation present in the 2008 and 2009 summers and will stand as a quantitative survey for comparison to future studies along this river that may change with spread of the Emerald Ash Borer, dam removals and other disturbances to the Milwaukee Floodplain. MS Thesis research, J. A. Reinartz, Major Advisor.

Genetic Variation and Environmental Heterogeneity: Adaptations in the bdelloid rotifer *Habrotrocha rosa*

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We are investigating the influence of environmental heterogeneity on the dynamics of ecological communities. Our model system is the detritus-based aquatic food web composed of microbes and invertebrates that develops in the vase-like leaves of the carnivorous pitcher plant Sarracenia purpurea. Each pitcher represents an ephemeral habitat patch within the bog landscape, and the rotifer Habrotrocha rosa exists as a metapopulation, persisting through the colonization of new pitchers. We hypothesize that the metapopulation is composed of multiple clones whose presence/prevalence is determined by environmental factors such as temperature and food quality/quantity which vary temporally. During July-September, 2008, rotifer clones were established from pitcher fluid samples. We are looking for differences in life history and stress tolerance among clones, as well

as variations at the genetic and molecular level. Our results will provide insights into the role of genetic variation in the survival of species that live in fragmented habitats. Mean life span and egg production per day did not differ significantly for July and September clones. Under natural conditions rotifers are exposed to environmental stresses such as freezing and desiccation. We exposed the animals to gradually decreasing temperatures and froze them at -20° C. After thawing at 2-4°C there were no survivors. In contrast, 41% of the September animals survived freezing at -75°C and rapid thawing at 37°C. No July animals survived. Neither clone survived desiccation at 22°C for seven days followed by rehydration. This suggests that there may not be a significant time difference between July and September clones under natural conditions.

Spring Bat Survey of the UWM Field Station

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The bat fauna of the Field Station properties is poorly known, because bats are small, nocturnal, and difficult to observe. Special methods are needed to survey bats, and one promising technique relies on acoustic surveys. Bats emit ultrasonic calls as they fly, and these calls can be recorded using specialized equipment and identified to species. I worked with the Wisconsin Bat Monitoring Program (overseen by David Redell of the Wisconsin DNR, http://wiatri. net/inventory/bats/index.cfm) to conduct acoustic surveys for bats at the Field Station during spring of 2009. I used a hand-held bat detector combined with a global positioning system and personal data assistant to record bat calls while walking survey routes at night. Data were uploaded to the Wisconsin Bat Monitoring program website so that calls could be identified, and maps were generated showing the route surveyed and the location and identity of all bats recorded. Seven surveys were conducted at the Field Station from April 3 - May 29, 2009. No bats were recorded on the earliest surveys (April 3 and April 9). The first bats were recorded on April 15 (*Myotis sp.* and Big Brown Bat, *Eptesicus fuscus*). The two latest surveys (May 28 and May 29) were the most productive, with a total of 4 bat species recorded: Northern long-eared myotis (*Myotis septentrionalis*), Big brown

bat (*Eptesicus fuscus*), Eastern red bat (*Lasiurus borealis*), and Hoary bat (*Lasiurus cinereus*). Undergraduate independent study project, Gretchen Meyer, advisor.

Urban versus Rural: An Examination of Earthworm Species Diversity

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Earthworms are important components of ecosystems, as they influence the soil and can affect plant communities. Earthworms occurring in the Great Lakes region were introduced by the early settlers, as the worms native to this region disappeared during the last glaciation. The distribution of these introduced earthworms in our area and their effects on plant communities are currently questions that need more study. Little is known about the earthworm populations at the Field Station, and how the species diversity of earthworms varies along urban to rural gradients. I conducted surveys for earthworms at 4 urban sites in Milwaukee and at 4 sites at the Field Station. I originally planned to use a mustard liquid extraction method to census earthworms but I found that this method was ineffective and did not result in worms

coming to the surface at any of the sites. I therefore collected worms using the "flip and strip" method, which consists of walking the site and turning over logs, leaves, and rocks. Earthworms that were present were collected and identified to species. A total of 6 specimens were collected from the urban sites, and 16 specimens were found at the rural sites. Three species were found at the urban sites (Rose worm, Aporrectodea rosea, night crawler, Lumbricus terrestris, and small leaf dweller, Lumbricus rubellus). These same three species plus an additional species, the angle worm (Aporrectodea caliginosa), were found at the rural sites. Sites with high soil moisture and larger amounts of leaf litter seemed most likely to support earthworms. Undergraduate independent study project, Gretchen Meyer, advisor.

Robust Population Estimation, Demography, and Spatial Analysis of Butler's Gartersnake

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Estimation of population parameters is important for understanding species ecology and viability. This is particularly true for threatened or endangered species. The aim of this two-year study is to estimate population density and demography of the Wisconsin state threatened Butler's gartersnake (*Thamnophis butleri*) using robust mark-recapture methodologies. Collected from three populations in Ozaukee and Waukesha counties, these data will be extrapolated to infer density estimates for similar habitats within the state and





their potential for supporting sustainable populations.

In spring 2008, we emplaced 1305 plywood coverboards (2 X 122 X 81 cm) in 15 X 15 meter grids spanning the three study areas. The use of coverboards for collecting biodiversity and population data on secretive, terrestrial herpetofauna is well known. Captured snakes were uniquely branded with medical cautery units. Prior to release, coverboard code, snake ID. species, sex, mass, snout-vent length, tail length, and reproductive condition were recorded. Biotic and abiotic factors observed directly beneath coverboards that potentially influence T. butleri density and habitat distribution were recorded during regularly scheduled survey periods and included 1) ant mound surface area 2) mammal and crayfish burrows 3) surface annelids 4) rodent, shrew, and amphibian species (presence/absence), and

other snake species (included in markrecapture). We sampled sites weekly from July to October 2008 and May to October 2009, with a minimum of 48 hours between sampling periods to deter snakes from becoming "trap shy." Gravid snakes may be disproportionally attracted to coverboards due to the solar thermal radiation coverboards absorb. Therefore, assuming a 1:1 sex ratio, T. butleri sexes will be separated during analysis, as will age classes, to address unequal capture probabilities. Thirty-seven samples collected from the UWM field station yielded 416 confirmed T. butleri captured individuals (170 males, 242 females, and 4 unknown sexes) and 128 recaptured individuals.

Funded by a Wisconsin State Wildlife Grant and the RZS Thomas Torhorst Wildlife Conservation Fund. MS thesis research, James Coggins, Major Professor.

Reinforcement and Behavioral Plasticity

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In the evolution of reproductive isolation, an important source of selection is thought to arise when species that have diverged in allopatry, but are still partially inter-fertile, come into secondary contact. The process of reinforcement is then predicted to lead to reproductive character displacement (RCD), a pattern of geographic variation in sexual traits wherein species differ more in areas of sympatry (where selection against inter-breeding is present) than in allopatry. When testing for RCD, geographic variation is usually interpreted as genetic divergence. However, work showing that mate choice can be influenced by experience suggests that the pattern of RCD may also arise from plasticity in the expression of sexual traits. Consequently, tests of RCD should evaluate plasticity in sexual communication traits.

I evaluated whether experience of communication environments (conspecific / heterospecific calls) influences the expression of mate preferences and contributes to patterns of geographic variation resembling RCD. The focal species was the tree frog



Hyla cinerea, the subject of one of the most comprehensive tests of RCD to date. The research presented *H. cinerea* females from

two allopatric sites (Texas, Louisiana) and two sympatric sites (Alabama, Georgia) with playbacks of simulated conspecific or heterospecific communication environments, and tested for variation in their preferences due to variation in their experiences.

Preliminary results from experiments

conducted in 2009 strongly suggest that experience can alter female preferences. This is an ongoing project, with the goal of testing a total of 8 populations over the next years.

This project was supported by a grant from the Research Growth Initiative at UWM.

Slugs & Snails (Gastropoda) Native to Wisconsin

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The slugs most frequently seen in Wisconsin, including State Natural Areas such as the Cedarburg Beech Woods (Field Station Annual Report 2004: 14), are nonnative species. In 2009, a search was made for slugs of the native family Philomycidae. For eastern U.S. philomycid species, upland woods habitats have been identified as those typical for this family. On 14 August after late summer rains, the Field Station's beech woods in the vicinity of the ephemeral wetland area at grid point B3S/C3N was one of the sites in the state surveyed for slugs, but no philomycids were found.

More common than its native slugs are Wisconsin's native land snails, a diverse group of 15 families. Many of these were reported from the Field Station as part of a 3-year invertebrate survey which included meter by meter leaf litter samples subsequently dried and sorted in the lab for terrestrial gastropods (Bulletin Vol.13, No.1: 1-3). Other snails collected by hand-picking during this 1978 survey as well as during subsequent projects were deposited in the Milwaukee Public Museum mollusk collection for later determination, a project begun in 2009. Initial results for these specimens collected by hand-picking have



Slug: Deroceras reticutum

revealed previously unreported species, such as the upland pillsnail, *Euchemotrema fraternum* (Polygyridae), a new record for Ozaukee County.

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

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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 attempted to study several population parameters of these snakes through the use of mark-recapture methods (e.g., Unbaised Lincoln-Petersen estimator). 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. Upon capture, snakes were marked with Passive Integrated Transponder (PIT) microchips, a commonly employed technique to mark snakes for future identification. This work began in June 2006 in association with a field herpetology class and has continued for several years. To-date, four annual sampling efforts have been completed (2006 - 2009). 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). Because surveys have resulted in variable success, and small sample sizes have been achieved. I believe it will be important to continue conducting this research. In this way, long-term trends in population size and characteristics of milksnakes at this location can be assessed, which will produce valuable information.

Pollinator Visitation Patterns Strongly Influence Among-flower Variation in Selfing Rate

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Adjacent flowers on *Mimulus ringens* floral displays often vary markedly in selfing rate. We hypothesized that this fine-scale variation in mating system reflects the tendency of bumble bee pollinators to probe several flowers consecutively on multi-flower displays. When a pollinator approaches a display, the first flower probed is likely to receive substantial outcross pollen. However, since pollen carryover in this species is limited, receipt of self pollen should increase rapidly for later flowers. In order to link floral visitation sequences with selfing rates of individual flowers, we established replicate linear arrays, each composed of plants with unique genetic markers. This facilitated unambiguous assignment of paternity to all sampled progeny. We permitted a single wild bumble bee to forage on each linear array, recording the order of floral visits on each display. Once fruits had matured, we harvested 120 fruits (four flowers from each

of five floral displays in each of six arrays). We genotyped 25 seedlings from each fruit and unambiguously assigned paternity to



all 3000 genotyped progeny. The order of pollinator probes on *Mimulus* floral displays strongly and significantly influenced selfing

rates of individual fruits. Mean selfing rates increased from 21% for initial probes to 78% for the fourth flower probed on each display. Striking among-flower differences in selfing rate result from increased deposition of geitonogamous (among-flower, within-display) self pollen as bumble bees probe consecutive flowers on each floral display. The resulting heterogeneity in the genetic composition of sibships may influence seedling competition and the expression of inbreeding depression.

An Investigation of the Potential for *Lonicera japonica* to Spread Beyond its Current Northern Range

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The purpose of my research is to determine the growth and survival of the invasive vine Japanese honeysuckle (Lonicera japonica) beyond the current North American range edge. With this work, I am asking several questions. First, can L. japonica survive beyond the current range edge? And if so, what life history stages are most likely to survive conditions beyond the range edge? To answer this question I am tracking the survival and growth of seeds, seedlings, and juveniles through two winters. Seeds were planted in the spring of 2008. Seedlings and juveniles were planted in the fall of 2008. Survival and growth were measured in the spring, summer and fall of 2009, and will be measured in the spring of 2010. Second, are L. japonica populations pre-adapted to

conditions beyond the current range edge or are they evolving to adapt to new conditions during the course of the range expansion? Plant stock for the entire experiment was collected from naturalized populations from the northern edge and the core of the current North American range. If populations are evolving to new conditions, then plants from the edge of the range should perform better than plants from the core, whereas if the L. japonica is pre-adapted, plants with different geographical origins should survive equally well. Together, these data will indicate whether the range of L. japonica will continue to expand northward, as well as help identify life history stages which land managers can target to help slow the spread.

Determinants of Alternative Mating Tactics in Hyla versicolor

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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. Alternative mating tactics have been attributed to the following evolutionary strategies: alternative, mixed and conditional. Alternative strategies are genetic polymorphisms while mixed strategies are determined by phenotypic plasticity, but both are under frequency-dependent selection and result in equal fitness for different mating tactics. In contrast, conditional strategies are determined by individual responses to status or local environmental conditions and are believed to result in unequal fitness levels for different mating tactics. I investigated the determinants of alternative mating tactics in *H. versicolor* as a conditional strategy. During the 2009 field season, caller and satellite male pairs were collected and morphometric data were recorded to analyze condition trends in a natural setting. Males were then placed through acoustic playback trials for behavioral responses in a controlled environment to establish mating tactic choices. In order to manipulate body condition as a determinant of alternative mating tactics, males were placed in high and low food treatments for two weeks. At the end of their food treatments, males were placed in playback trials to measure differences in behavior due to body condition. I will continue to investigate alternative mating tactics in gray tree frogs as a conditional strategy in the 2010 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 Fringed Orchid, [*Platanthera leucophaea* (Nutt.) Lindl.] at Cedarburg Bog

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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.

Monitoring began in 2001 and 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.

Threats to the population continue to be the invasive shrub, glossy buckthorn (Rhamnus frangula), and lack of legal protection to the State Natural Area. The extent and density of giant reed grass (*Phragmites australis*), a native but potentially invasive species, is increasing in areas with good orchid habitat and may pose an additional threat.

Condition Effects on Female Mate Choice in an Anuran

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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 will be continued in 2010. M.S. thesis research, Dr. Gerlinde Höbel, Major Professor.



Atlas of North American Amphibians

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This is a book project with the University of California Press. The Atlas of North American Amphibians will present detailed distribution maps and brief species descriptions of each of the 293 currently recognized amphibian species in the United States and Canada. The intended audience will be professionals, including researchers, teachers, land and wildlife managers, natural resource technicians and administrators, nature center staff, zoo staff, wildlife health staff, various federal and state agencies such as forest service, park service, environmental quality and agricultural departmental staff, and amateur naturalists. Funded by the Indiana University School of Medicine.

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

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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 Co 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 the first specimen discovered from the Cedarburg Bog area recovered the same haplotype as found in Door County, suggesting possible recent contact between these areas. The availability of 16 specimens recovered in 2001 and 5 in 2002 from Cedarburg provides an opportunity to expand these genetic studies on Hine's Emerald and perhaps resolve some longstanding problems, such as past dispersal patterns and normal levels of genetic diversity for populations. Samples from the Cedarburg population will be included in on-going genetic studies of Hine's Emerald Dragonfly.



The Structural and Functional Characteristics of Ecosystems Dominated by Exotic Plants

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Recent work on exotic species in island ecosystems has revealed that many exotic woody plants are capable of totally dominating forests where they occur, resulting in significant changes to forest structure and nutrient cycling. Despite some observational accounts, however, few empirical examples of exotic dominance exist in northeastern forests. Common buckthorn (*Rhamnus cathartica* L.) is known to choke temperate forest understories but its degree of dominance has been described only anecdotally. In a series of studies at several mesic and wet sites in Southern Wisconsin, including the UWM Field Station, we found evidence for monotypic dominance by buckthorn, which we found has caused several dramatic changes to forest structure and ecosystem function. In sites where buckthorn attains canopy dominance, we found that nearly all forest biomass is allocated to small-sized buckthorn trees (30 cm dbh and smaller) rather than large native trees (> 50 cm dbh) that constitute most forest biomass in Southern Wisconsin. As a result, we found that buckthorn-dominated sites are likely to store significantly less carbon in aboveground forest biomass than the native forests that are being replaced. Buckthorndominated sites are also nearly devoid of leaf litter throughout the year, as their nitrogen-rich leaves are consumed almost immediately by earthworms. Although buckthorn is shorter in stature than a majority of native and some exotic trees, mean relative density and basal area for buckthorn among the eight exotic sites exceed that reported for four other woody invaders found in the northeast United States, suggesting a prominent role for this species in forest leaf area, biomass, and functional characteristics, including nutrient and carbon cycling. Funded by Applied Ecological Services and UWM. Ph.D. Dissertation research, Stefan A. Schnitzer, Major Professor.

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

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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 using molecular techniques to directly examine genetic structure of S. gigantea in its native and introduced ranges using our existing plant collection. We will use molecular markers to examine which North American haplotypes are invasive in Europe, and to assess the number and sources of the introductions to Europe. We will also explore the ecological characteristics of the haplotypes that we identify, by linking the molecular data to our extensive datasets on secondary chemistry, susceptibility to herbivory, and growth and reproductive characters on the plants in our existing collections. Finally, we will develop 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.

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

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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.



Below-ground Defenses of Native and Invasive Genotypes of *Solidago gigantea*.

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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 woolv aphid (Eriosomatidae) were estimated. Rhizomes were retained for chemical analysis, which is currently in progress. Below-ground secondary chemistry and levels of herbivory will 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.

Collection of Water-Quality Data from Occupied Hine's Emerald Dragonfly Larvae Habitat

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Water-quality samples were collected from multiple locations where Hine's emerald dragonfly larvae are found in Wisconsin and Illinois. Locations in Door County, WI, and Will and DuPage County, Illinois, were studied, along with one location at Cedarburg Bog. Samples were collected quarterly, beginning in Summer 2008 through Summer 2009. Major ion chemistry was analyzed, including anions, cations, and nutrients. Water-quality dataloggers were installed at all monitoring locations, and collected pH, specific conductance, dissolved oxygen, turbidity, and temperature several times per day. No analysis has been performed on the data at present, and no publications have been released. Funding was provided by the Illinois Department of Transportation and the Illinois Toll Highway Authority.

Autumn Bat Monitoring at the Cedarburg Bog – UW-Milwaukee Field Station

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The Wisconsin Bat Monitoring Program utilizes the help of volunteers to gather data on bats in a variety of Wisconsin locations. As part of this Monitoring Program, scientists from Cedarburg Science (Bill Mueller, Ginny Plumeau, and Cindy Kowalchuk) monitored bats along the Cedarburg Bog boardwalk and along the edge of Blue Goose and St. Augustine Roads, on September 1, 2009. The hand-held ANABAT device records bat echolocation/vocalizations while stamping the date and time of each bat encounter. Combined with a global positioning system (GPS), the detector records the position (latitude & longitude) of each bat passing the surveyor, mapping the route traveled during the survey. Attached to the detector, a personal data assistant (PDA) then provides real-time tracking of the bat as it echolocates (as a change in frequency over time), and stores the data for later analysis by David Redell and John Paul White at the Wisconsin Department of Natural Resources. Most encounters produce a record that can be identified to a species, but some are narrowed down only to a

"species group" (See third record included below). During the survey conducted on September 1st, we recorded the following bat species: Eastern red bat (*Lasiurus borealis*) (5 detections); Northern long-eared myotis (*Myotis septentrionalis*) (3 detections); Big brown bat (*Eptesicus fuscus*)/ Silver haired bat (*Lasionycteris noctivagans*) (1 detection); Little brown myotis (*Myotis lucifugus*) (1 detection); and Silver-haired bat (*Lasionycteris noctivagans*) (1 detection). Additional surveys are tentatively planned for 2010.



Cedarburg Bog and Upland Woods Migration Point Counts

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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 2009, counts were conducted at least once per week in spring (May 5 - June 5) and fall (August 22- October 20). We documented 97 bird species that utilized the Bog habitats during spring and fall migration and 103 species that utilized the Upland Woods. A total of 122 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-three species of birds (18.9 % 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 American bittern, King and Virginia rails, Sora, Greater vellowlegs, American Woodcock, Wilson's snipe, Olive-sided and Willow flycatchers, Wood thrush, Blue-winged and Goldenwinged warblers and Henslow's sparrow. Ten species are listed as Bird Species of Greatest Conservation Need in Wisconsin. Eight species are listed as being at risk in both national and state conservation plans. William P. Mueller initiated these counts in 2007. A number of people assisted with the migration counts in 2009 including Seth Cutright, Carl Schwartz, Tom Schaefer and Joan Sommer. The migration point counts will continue in 2010.

Pre- and Post-hibernation Weight Assessment of Bats Using Major Hibernacula in Wisconsin

David Redell and Paul White

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White-nose syndrome (WNS) is a recently emerging issue for cave dwelling species of bats and has been observed in the eastern United States. WNS is currently present in 9 states and has affected six species of cave dwelling bats. One of the signs associated with the syndrome includes bats exiting hibernacula earlier than expected (late winter/ early spring) with depleted fat reserves. Thus, one question is whether bats are entering hibernation with sufficient fat stores to survive through the winter. We collected baseline weight and standard measurement data on bats from unaffected hibernacula in Wisconsin including the Neda Mine State Natural Area. On average, the little brown bat captures indicate a 2.7g and 3.0g loss for males and females respectively, which

represents a 27% to 30% mean drop in body mass by the end of hibernation. Funding provided by the United States Fish & Wildlife Service and Wisconsin Department of Natural Resources.



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

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Tamarack grows in a very wide variety of wetland plant communities found in the Southeast Glacial Plains (SGP) 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. M.S. thesis Research, James Reinartz, Major Professor.



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

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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.

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

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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.



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

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

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Recent discoveries about the genetic architecture of sexually-selected traits are prompting a re-examination of hypotheses dealing with the evolution of mate choice. the course of sexual selection, and their consequences for the process of divergence. Specifically, the presence of genetic variation in the reaction norms of sexually-selected traits (i.e., genotype x environment interaction, GxE) has brought potential solutions to key problems in sexual selection theory. but it has also brought new challenges. Our objective in this project is to test a hypothesis that is the basis for the potential of GxE to revolutionize how we understand sexual selection and divergence. This hypothesis is that GxE will disrupt the genetic covariance between male and female sexual traits that forms the most basic mechanism of sexual selection. This is a necessary first step that will provide the empirical foundation for my broader goals of developing theory for the relationship between sexual selection and divergence that can account for emerging knowledge on the patterns of genetic

variation that seem to prevail in nature. To this end, we collected *Enchenopa binotata* treehoppers (Hemiptera: Membracidae; 40 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 one species of linyphiid spider (Araneae: Linyphiidae; 69 adult females) for an experiment on memory of prey captured by the spiders. This experiment was conducted in the lab, and involved giving prey to the spiders (crickets acquired commercially) and then experimentally removing them from the spiders' webs to describe the elicited searching behavior. This searching behavior varies with the features of the prey that are stored in the spiders' memory.

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

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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 intercorrelated 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 intercorrelation. 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 intercomparisons. 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

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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 (staring 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

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The objectives of this study are to gather baseline data on the reproductive success of Cooper's Hawks (*Accipiter cooperii*) in the urban metropolitan Milwaukee area, to describe urban nesting habitat, and to compare these data with other Cooper's Hawk studies in Wisconsin. Long-term objectives are to determine Cooper's Hawk nest site fidelity, breeding population mortality and recruitment, population growth trends, immigration and emigration patterns, and natal dispersal patterns for the same urban population. In 2009, 34 of 42 laying pairs produced 122 young to a bandable age (ca. 16 days; 2.90 young/laying pair, 3.59 young/successful pair, 81.0% nesting success). All nestlings (58 males, 64 females) were banded. No second nesting attempts (i.e., re-nests) were found (i.e., for first nesting attempts that failed). Twenty-two adult (i.e., breeding) Cooper's Hawks (11 males, 11 females) were trapped, banded, measured, colormarked, and processed for additional analyses at 14 different nest sites. The nest at Downer Woods (UW-Milwaukee) produced three young. Both adults were trapped at the Downer Woods nest site and were new breeding birds. The adult male for this breeding area was banded as a nestling on 1 July 2007 and, therefore, was a two-year-old bird (age: TY [third-year]). The distance of this natal dispersal was 3.30 km, and the direction was SE (137°; the hatch site was 3.30 km NW). The adult female was a one-year-old (age: SY [second year]) unbanded bird. This project was supported, in part, through the Wisconsin Society for Ornithology (WSO) Small Grants Program.



Breeding pair of Cooper's Hawks. The male is in adult, after-second-year plumage, and the female is in juvenile, one-year-old plumage. Photo by W.E. Stout.

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

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We established a long term citizen based monitoring program for snakes and turtles 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. Funded by Citizen based Monitoring Partnership Program, Prairie Biotic Research Program, and the Milwaukee County Zoo.

Hydrolytic Enzyme Activity of Microbial Communities Within Pitchers of Sarracenia purpurea in Cedarburg Bog

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The Northern Pitcher Plant, Sarracenia purpurea, grows in wetlands across northern North America. The plants supplement their mineral nutrition by trapping insect prey in modified leaves formed as pitchers which fill with rainwater. The insect prey drowns and is degraded, releasing nutrients for plant uptake. The pitchers support a community of invertebrates and microbes for which the insect prey forms the basis of a detrital food web. The invertebrate communities have been well studied, but less is known about the microbial communities in pitchers. Breakdown of insect prey is dependent upon a range of hydrolytic enzymes produced by the microbes within the pitchers. This preliminary study examined the microbes and the enzymes they produce. The activity of key hydrolytic enzymes of the classes phosphatases, proteinases and chitinases were readily detected using substrate assays of pitcher plant water. In S. purpurea plants transferred to the greenhouse, activity of chitinases and proteinases were dramatically increased over 24 h in response to addition of Drosophila flies to pitchers, although phosphatase activity was less responsive. Preliminary analysis of the bacterial diversity was carried out using community DNA isolated from pitchers and genomic sequencing of PCR amplicons using 16S rRNA probes. A wide diversity of bacterial orders was identified including N2-fixing and chitin-degrading taxa and

both aerobic and anaerobic taxa. Ongoing research on the pitcher plant communities will involve more diversity analysis and functional profiling. This research was supported by an undergraduate DIN research award to Jessi Sielicki.



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 pollenmediated 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 (*Geothylpis 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.



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.

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. Town of Saukville. J. Reinartz serves on the Town's Gravel Pit Review Committee.

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

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

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

13. Sierra Club-Milwaukee Chapter. The Field Station provides a site for the Club's annual retreat, and volunteer opportunities for members.

14. The Nature Conservancy. Jim Reinartz serves on the Science and Stewardship Committee of the Wisconsin Chapter.

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

16. Wisconsin Department of

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

17. Urban Ecology Center—Milwaukee.

G. Meyer serves on the Citizen Science Advisory Council.

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

19. Wisconsin Task Force on Invasive Species. Reinartz serves on the task force and on the Science and Research Subcommittee of the task force.

20. Wisconsin Phenological Society. G. Meyer serves on the Board of Directors.

21. Society of Wetland Scientists. Jim Reinartz and Dr. Tim Ehlinger served as Program Organizers of the Symposia for the 2009 meeting of SWS held in Madison.

22. Southeastern Wisconsin Invasive Species Consortium (SEWISC). Reinartz serves on the Board of Directors, and the Field Station cooperated with SEWISC to develop and conduct invasive plant management workshops for parks personnel and for right-of-way workers.

2009 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 2009. 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 9 & 10
Wildlife Inventory and Monitoring	Gary Casper	May 29 & 30
Aquatic Invertebrates	Gretchen Meyer	June 12 & 13
Vegetation of Wisconsin	James Reinartz and Marc White	June 15 - 20
Ecological Geology	Roger Kuhns	July 6-10
Wisconsin Butterflies and Moths: Natural History and Identification	Susan Borkin	July 24 & 25
Grasses: Identification and Ecology	Robert Freckmann	July 31 & August 1
Aquatic Vascular Plant Identifica- tion and Ecology	Tim Gerber	August 7 & 8
Birds, Migration and Bird Banding	Vicki Piaskowski	September 12 & 13

Class and Group Use

Winter - Spring 2009

Number of Student Hours

Schlitz Audubon Center – School group. 140 Wisconsin Wetlands Association – Frogs of the Bog 40 Hine's Emerald Dragonfly Meeting 40 U.S. Forest Service Realty Group tour 60 Milwaukee Institute of Art & Design – Ecology 30 Milwaukee Area Technical College – Natural Landscaping 50 Carroll College – Aquatic Ecology. 40 UWM – Biology of Invasive Species 60 UWM – Plant Systematics and Evolution 70 TOTAL 2,270 Summer 2009 Aquatic Invertebrates Workshop 1,240 Ecological Geology Workshop 900 Butterflies and Moths Workshop 360 Vegetation of Wisconsin Workshop 360 Grass Identification and Ecology Workshop 360 Friends of Cedarburg Bog – Summer Solstice Walk 50 Friends of Cedarburg Bog – Summer Solstice Walk 50 Friends of Cedarburg Bog – Bog Ecology. 60 Friends of Cedarburg Bog – Bog Ecology. 60 Friends of Cedarburg Bog – Bird Banding demonstration. 30 Friends of Cedarburg Bog – Bird Banding demonstration. 30 Friends of Cedarburg Bog – Canoe Mud Lake	Ecology and Physiology of Plants in Winter Workshop Wildlife Inventory and Monitoring Workshop Winter Ecology Hike and Friends Chili Dinner Friends of Cedarburg Bog – Spring frogs and woodcock Friends of Cedarburg Bog – Natural History of the Bog Friends of Cedarburg Bog – Meetings Riveredge Larsen Legacy Committee Riveredge Nature Center Bog Tour Urban Ecology Center Staff Retreat Urban Ecology Center – Photo club	360 340 550 60 60 90 20 80 130 50
Hine's Emerald Dragonfly Meeting 40 U.S. Forest Service Realty Group tour 60 Milwaukee Institute of Art & Design – Ecology 30 Milwaukee Area Technical College – Natural Landscaping. 50 Carroll College – Aquatic Ecology. 40 UWM – Biology of Invasive Species 60 UWM – Biology of Invasive Species 60 UWM – Plant Systematics and Evolution 70 TOTAL 2,270 Summer 2009 360 Vegetation of Wisconsin Workshop 1,240 Ecological Geology Workshop 900 Butterflies and Moths Workshop 360 Grass Identification and Ecology Workshop 360 Friends of Cedarburg Bog – Summer Solstice Walk 50 Friends of Cedarburg Bog – Summer Solstice Walk 50 Friends of Cedarburg Bog – Bog Ecology. 60 Friends of Cedarburg Bog – Breeding Birds 90 Friends of Cedarburg Bog – Canoe Mud Lake 70 Friends of Cedarburg Bog – Canoe Mud Lake <t< td=""><td>Schlitz Audubon Center – School group</td><td>140 40</td></t<>	Schlitz Audubon Center – School group	140 40
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Fall 2009

Number of Student Hours

Bird Migration and Bird Banding Workshop	360
Friends of Cedarburg Bog – meetings	80
Friends of Cedarburg Bog – Annual Meeting & potluck	160
Friends of Cedarburg Bog – Northern Cross stargazing event	170
Friends of Cedarburg Bog – Fungi walk	60
Friends of Cedarburg Bog – Poetry in nature	50
Friends of Cedarburg Bog – Owl survey & walk	30
Kettle Moraine Lutheran High School	50
Alverno College – Wetland Ecology	30
University of Illinois-Chicago– Ecology field trip	320
UW – Platteville – Geology	260
UW – Whitewater – Ecology	30
UWM – Geography – Soils	110
UWM – Geology – Hydrogeology	90
TOTAL	,800
TOTAL 2009 Class & Group Use Hours 10	,020



Meteorological Data for 2009

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 2	600											
	JAN	FEB	MAR	APR	МАΥ	NUL	JULY	AUG	SEP ¹	ост	NOV	DEC
Temperature (C°)												
Average Daily Maximum	-6.7	0.1	5.6	12.0	18.9	23.3	23.9	24.4	21.2	11.4	10.5	-1.3
Average Daily Minimum	-16.0	-9.6	-4.3	1.3	8.1	11.9	12.7	13.6	9.5	3.8	1.4	-8.5
Dailv Average	-10.7	-4.2	0.7	9.9	13.6	17.7	18.5	19.1	15.2	7.5	5.9	-4.5
Highest (Date)	3.3 (31)	13.4 (10)	23.2 (17)	28.9 (24)	28.9 (20)	33.7 (24)	28.6 (10)	30.5 (14)	25.5 (15)	19.6 (30)	21.4 (7)	10.6 (1)
Lowest (Date)	-26.6 (13)	-20.5 (4)	-16.6 (3)	-4.2 (12)	2.0 (17)	1.5 (4)	9.0 (8)	4.6 (31)	1.0 (30)	-3.7 (11)	-3.9 (11)	-18.0 (10)
Degree Davs												
Sum at 5°	0.0	6.1	18.1	75.4	267.8	380.2	419.5	436.6	254.8	92.1	54.7	0.0
Sum at 10°	0.0	0.0	4.2	25.0	116.1	230.5	264.5	281.6	133.5	11.1	9.3	0.0
Radiation (kW/m ²) -												
Mean	0.08	0.12	0.15	0.19	0.24	0.26	0.24	0.21	0.18	0.08	0.07	0.04
Maximum	0.51	0.66	0.85	0.97	1.06	0.99	0.99	0.93	0.87	0.75	0.57	0.45
Relative Humiditv												
Hour 00-06 mean	78.6	82.9	82.0	75.4	75.5	86.6	89.4	92.3	95.9	89.2	85.3	87.0
Hour 06-12 mean	76.3	75.2	70.4	60.6	58.6	65.5	68.4	72.8	76.6	82.9	76.1	83.2
Hour 12-18 mean	66.0	64.6	61.3	51.8	48.7	56.6	55.8	62.6	64.5	73.3	67.3	77.6
Hour 18-24 mean	74.3	78.4	76.6	66.3	66.5	79.8	79.7	85.9	93.1	85.0	81.2	83.5
- Number of Days												
Precip. 0.25mm or more	7	80	5	6	80	13	6	14	7	15	80	10
Max Temp 32° and above	0	0	0	0	0	2	0	0	0	0	0	0
Max Temp 0° and below	27	14	4	0	0	0	0	0	0	0	0	19
Min Temp 0° and below	31	25	24	14	0	0	0	0	0	9	12	30
Min Temp -18° and below	10	2	0	0	0	0	0	0	0	0	0	-
Pressure (mbars)												
Mean	1015.41	1017.02	1018.81	1014.62	1015.08	1012.46	1014.38	1015.80	1019.36	1014.15	1017.76	1015.19
Precipitation (mm)												
Total	17.0	50.0	105.3	114.3	71.0	84.8	46.3	81.8	49.6	131.2	33.3	111.0
Greatest (24 hrs) (Date)	4.0 (4)	22.0 (26)	27.0 (8)	42.0 (26)	24.8 (13)	48.5 (8)	16.8 (30)	29.0 (25)	18.8 (22)	30.2 (23)	9.9 (26)	37.0 (25)
- Mind												
Mean Speed (m/s)	NA^2	2.2	2.1	2.3	2.0	1.4	1.3	1.3	NA^3	1.6	1.5	1.6
Maximum Speed (m/s)	NA	5.6	6.1	6.7	6.3	4.7	4.1	4.8	NA	6.0	4.8	6.7
1 - Except for precipitation,	data from S	tept. 10 -14	are missin	g.								
2 - NA, not available. Anen	nometer not	recording c	orrectly at I	east from J	an 9-18.	-	-					
3 - NA, not available. Data	missing Sep	ot. 10-14. A	nemomete	r may not h	ave been re	ecording co	rrectly Sep	t. 27-30.				





Field Station

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