Conservation and Management of a Rare Carnivorous Plant, *Pinguicula ionantha*, in the Florida Panhandle

It has been estimated that 600 species of carnivorous plants, belonging to 9 families and 19 genera, exist worldwide. Carnivorous plants are unique among flowering plants for their ability to capture and consume prey using highly derived traps. Such adaptations have allowed them to thrive in habitats with nutrient-poor soil such as bogs and fens in the temperate zone. Based on data generated by the International Union for the Conservation of Nature, of the 102 carnivorous plant species that have been evaluated, half, including members from the genus *Pinguicula*, are threatened due to natural and anthropogenic habitat changes.

Approximately 80 species of *Pinguicula* occur throughout the world. All have a rosette of carnivorous leaves and multiple stalks consisting of a single flower. Six of these species (*P. caerulea, P. ionantha, P. lutea, P. planifolia, P. primuliflora*, and *P. pumila*) are located in the Florida panhandle. Five of them are listed as endangered at the state level and one, *Pinguicula ionantha* R.K. Godfrey (Godfrey’s butterwort, Lentibulariaceae), also is listed as a federally threatened species. Populations of *P. ionantha* are restricted to herb bog communities in the wet flatwoods of six Florida counties along the Gulf Coast.

Prior research indicates that wet flatwoods are very sensitive to burn regimes and require a burn cycle of every two to three years to maintain ecosystem health. In the absence of fire, more aggressive species outcompete *P. ionantha*. While the effect of fire on *P. ionantha* has been addressed, research to understand specific biological and ecological interactions, such as plant-pollinator and plant-prey interactions, are absent and require immediate action to prevent further species decline.

In collaboration with Eastern Illinois University, Augustana College, the U.S. Bureau of Land Management, and other institutions, efforts are underway to conserve and manage populations of *P. ionantha*. This includes developing a comprehensive monitoring program, conducting restoration activities, and raising public awareness about the importance of conserving these unique plants. The ultimate goal is to ensure the long-term survival of *P. ionantha* and other endangered species in the Florida panhandle.
The Illinois River Valley Provides a Haven for Shorebirds During Fall

The Illinois River valley (IRV) hosts hundreds of thousands of migrating shorebirds during late summer and early fall. Shorebirds passing through Illinois come from as far away as the Arctic, and may be headed to the U.S. Gulf Coast or portions of Central and South America. Populations of many shorebird species appear to be declining in North America, and the quality of stopover habitats may be a contributing factor. Many shorebird species forage on mudflats or in shallow water with little or no vegetation. These wetland conditions can be abundant in the IRV during late summer and fall as backwater lakes, moist-soil wetlands managed for ducks, and floodplain areas of the Illinois River de-water and expose mudflats rich in benthic invertebrates.

During late summer and fall 2007–2008, we measured food resources available to migrating shorebirds in the IRV. Additionally, we experimentally collected four species of shorebirds (Killdeer [Charadrius vociferus], Least Sandpiper [Calidris minutilla], Pectoral Sandpiper [Calidris melanotos], and Lesser Yellowlegs [Tringa flavipes]) to determine body condition and food use and selection. We located foraging flocks of shorebirds, watched them feed for ≥10 minutes, and collected focal individuals using shotguns. Immediately after collection, we preserved ingested food and collected core samples at the foraging location and a random location within the same wetland. We obtained morphological measurements for each bird and identified, enumerated, and weighed invertebrate foods found in the digestive tract and in core samples.

Using morphological measurements to calculate condition indices, we determined that all species except Killdeer were in good to excellent condition. Shorebird diets were dominated by invertebrate taxa from the Orders Diptera (fly larvae) and Coleoptera (beetles). Invertebrate biomass at foraging and random sites was generally similar, indicating that birds did not select foraging sites within wetlands based on overall invertebrate biomass. Conversely, we found considerable evidence for selection of some invertebrate taxa within particular foraging sites, and consistent avoidance of aquatic worms (Order Oligochaeta). Overall, the dry mass of potential invertebrate foods in the IRV was 51.2 kg/ha, more than 25 times than what is assumed to be available by U.S. Fish and Wildlife Service regional conservation plans.

In this study, shorebirds did not appear to select habitats based on overall biomass of individual foods (third-order selection); however, they did appear to select several invertebrate taxa and consistently avoided aquatic worms (fourth-order selection). We suspect that potential food was so abundant in the IRV that shorebirds did not need to select foraging sites, but were able to select certain food items within foraging sites that were preferable. We suggest shorebirds may forage opportunistically when food densities are low, but may become more selective when food densities are high. Additionally, shorebirds were abundant on privately owned wetlands, especially those managed for dabbling ducks. Many privately owned wetlands are currently not assumed to contribute to estimates of foraging habitat availability for shorebirds and are seldom surveyed. Thus, the IRV may support far greater numbers of shorebirds during fall migration than previously assumed.
In September, the Illinois Natural History Survey said goodbye to longtime Entomologist/Insect Systematist Don Webb, who passed away on September 5th at the age of 73. Dr. Webb joined the survey in 1966 and was actively involved at INHS even after his retirement in 2007. Don pursued his interests in systematics and ecology of aquatic, semi-aquatic, and terrestrial insects all over the world. He was an author of nearly 100 journal articles, book chapters, monographs, and proceedings. In addition to his career in science, he was a musician and an avid sports fan. He played racquetball, softball, golf, and pool.

Don was born on July 12, 1939, in Brandon, Manitoba, to Orville and Ivy Webb. He married his high school sweetheart, Lois (Kelly) Webb on May 12, 1961; she survives.

Also surviving are daughters, Janice (Mark) Wettstone and Diane (David) McClain; grandchildren, Maggie McClain, Bradley McClain, Evan Wettstone, Ryan (Laura) McClain and Christopher McClain; great-grandchildren, Tyler and Aiden McClain.

Don earned the North American Benthological Society (NABS) Distinguished Service Award in 1999.

Don served the Society of Freshwater Science as Chair of the Literature Review Committee for nearly 30 years and, in collaboration with Ron Hellenthal, was responsible for converting the annual bibliography to a searchable database.

Rosemary Mackay wrote in her history of NABS “...Don liked to come across as a crusty curmudgeon but he always had a twinkle in his eye to let everyone know that it was all in good fun.”

And, Don had a rejoinder to Will Rogers’ saying that “I never met a man I didn’t like.” A bumper sticker on Don’s office door stated, “Will Rogers never met Bobby Knight.”

Don was the life of any gathering whether professional meeting, INHS luncheon, or watercooler encounter. Almost always, you left his presence with a smile. He was a character in every sense of the word.

He was preceded in death by his parents and brother, Barry.

Lesser Yellowlegs collected and processed by Aaron Yetter. Photo by INHS Forbes Biological Station staff

Randy Smith, Joshua Stafford, Aaron Yetter, Michelle Horath, Chris Hine, Heath Hagy, INHS

Photo from INHS Image Archives
Biofuels Production and Mosquito Populations

There is a growing interest in biofuels as the alternative solution to the world’s energy needs. In the U.S., the major biofuel is ethanol derived from corn. Because corn production requires more fertilizers and pesticides than any other major U.S. food or biofuel crop and energy inputs that may limit the desired energetic benefits over fossil fuels, there is increasing interest in biofuel crops that can produce high-energy yields per hectare under low-input methods. These “second generation” biomass feedstocks, which include several perennial grasses, may offer economic and environmental advantages by requiring less energy, water, fertilizers and pesticides, as well as increasing carbon sequestration and improving habitat for wildlife. *Miscanthus (Miscanthus x giganteus)* and switchgrass (*Panicum virgatum*, Fig. 1), are among the leading candidates for second generation biomass feedstocks, which require fewer inputs and offer increased yields over “first generation” biomass feedstocks such as corn. Restored native prairie polycultures have also been targeted because they are well adapted to the climate and soils of the central U.S., require fewer inputs, and offer substantially higher conversion efficiency than corn.

Ecological changes associated with biofuel production can also affect human health by altering the transmission dynamics of vector-borne diseases. Transitions from one crop to another can alter the local microclimate and create new breeding sites that may favor production, survival, and development of vector populations, such as mosquitoes. The chemical and nutritional composition of surrounding aquatic habitats may also be altered by inputs of senescent tissues of biofuel plants, affecting their suitability as breeding sites for vector mosquitoes. Further, ecological changes associated with crop transitions may influence vector diversity and abundance by changing the availability and density of preferred vertebrate hosts (the blood meal sources). For example, the establishment of row crop agriculture has decreased the diversity of associated avian populations, while providing forage for large flocks of bird species that are highly competent reservoirs for West Nile Virus (e.g., Common Grackles and American Crows).

This study used a model system consisting of the yellow fever mosquito *Aedes aegypti* (Fig. 2) and the Asian tiger mosquito *Aedes albopictus* to examine the effect of first generation (corn) and second generation (switchgrass and *Miscanthus*) biofuel crops on mosquito survival and oviposition site selection. We conducted oviposition choice experiments where blood-fed females were housed in paperboard cages and provided access to three oviposition cups containing leaf infusions of one of three biofuel crops. First instars of the two species were also reared in infusions of the three crops at varying intra- and interspecific densities (*Ae. aegypti*: *Ae. albopictus*: 10:0, 20:0, 40:0, 10:10, 20:20, 0:40, 0:20, and 0:10). Both mosquito species laid significantly fewer eggs in *Miscanthus* compared to the corn infusion (Fig. 3). In addition, *A. aegypti* females laid more eggs in the switchgrass infusions than in the *Miscanthus* infusions. These findings provide evidence that biofuel crops can potentially influence the population dynamics of vector mosquitoes by altering the attractiveness of aquatic habitats to gravid females. Further, although corn infusion was the best oviposition attractant, significantly fewer larvae survived to adulthood in the corn infusion compared to the switchgrass and *Miscanthus* infusions. Thus, it appears that attraction of gravid females to corn infusions might present an “ecological trap,” a phenomenon that occurs when there is a mismatch between habitat attractiveness and its value for survival and reproduction. This was unexpected because corn is composed of rapidly degrading starches that should promote microbial growth—the major food base for mosquito larvae. Corn production in the U.S. relies heavily on pesticides, and residual systemic neonicotinoid insecticide in senescent corn leaves may have contributed to the observed mortality. Further research is needed to examine this possibility, but our findings are a good starting point to address the potential impact of second generation biofuel crops on mosquito population dynamics and the risk of mosquito-borne disease.

Ephantus J. Muturi and Joseph Spencer, INHS; Brian F. Allan, UIUC
Monthly Visitation Rates of River Otters at Two Latrines in East Central Illinois

When Illinois achieved statehood in 1818, the North American river otter (*Lontra canadensis*) was widely distributed throughout the prairie state. However, several decades of unregulated trapping and habitat destruction left fewer than 100 river otters in Illinois by the 1980s. The population of river otters in Illinois is now estimated to exceed 15,000 individuals, following successful recovery and relocation efforts implemented by the state between 1994 and 1997.

Small mammal population estimates are often based on observation of animal signs (e.g., tracks, scat, scent marks). Otter latrines are terrestrial sites where river otters scent mark by depositing scat, urine, and glandular secretions. Data collected from latrine sites have been used as an otter population monitoring tool to improve our understanding of river otter distribution and other population characteristics. In Illinois, otter latrine surveys are conducted from August to October. Seasonal variations in visitation rates at latrine sites may influence the likelihood of detecting otter signs in a latrine during these months. The goal of this study was to compare otter visitation rates at two adjacent latrine sites in the Vermilion River Conservation Opportunity Area (VRCOA) of central Illinois.

Two adjacent latrine sites (<50 meters apart) in the VRCOA were selected based on detection of river otter scat. Latrine 1 was located on a dam close to a one-acre fish pond and Latrine 2 was located on the south bank of the Salt Fork of the Vermilion River. We expected similar patterns of visitation rates at the two latrine sites because they are in close proximity and connected by an animal-made trail used by river otters.

We placed one SPYPOINT™ PRO-X digital game camera at each latrine site to record visitation rates of the river otters (Fig. 1). We visited each site on a weekly to bi-weekly basis from August 2011 until August 2012 to collect video data and check the equipment. Visitation rates were estimated based on the number of otter sightings in the videos/month in relation to the number of working camera days (days that the camera was capable of recording data) per month. We defined a night visit as activity between sunset and sunrise, and a day visit between sunrise and sunset. Multiple otters observed in a single video were considered multiple visits (i.e., three otters in one video were classified as three visits).

We recorded a total of 183 otter visits to the two latrine sites between August 2011 and August 2012. Cameras operated for a total of 192 camera days at Latrine 1 (dam) and 188 camera days at Latrine 2 (river). Although we expected similar visitation rate patterns at the two latrine sites, this was not the case. Otter visitation rates were highest at Latrine 1 during the winter months, peaking at 2.5 visits per camera day in December (Fig. 2). On the other hand, visitation rates at Latrine 2 were highest during fall and late winter, peaking at 0.6 visits per camera day in March (Fig. 2). Months of observed peaks in visitation rates at Latrine 2 (river) were consistent with other studies of river otter latrine sites in river corridors.

Visitation rates of river otters in both Latrine 1 and Latrine 2 occurred more frequently at night (Fig. 3a and 3b), consistent with previous findings of river otters in Pennsylvania, Tennessee, and Ohio.

Our results suggest a large variation in visitation rates even at latrines within close proximity of each other, highlighting the need for large-scale otter latrine studies within the VRCOA. Understanding the relationship between space use and latrine use can inform management decisions based on latrine surveys. Furthermore, evaluating river otter behavior at latrine sites could shed light on the biology that underlies seasonal variation in visitation rates at latrine sites in this region.

Katie Monick, a James Scholar student at INHS and UIUC Animal Sciences; Nohra Mateus-Pinilla, Samantha K Carpenter INHS; Michelle L. Green, INHS and UIUC Animal Sciences.
The silhouettes of a group of bats flying through the evening sky, swooping to capture flying insects raised many questions for me — How much do they eat? Where do they go during the day or in winter? What about vampire bats and diseases? How can I see more bats? Determined to find out, I turned to Jean Mengelkoch, a mammalogist at INHS.

According to Jean, there are approximately 1,200 bat species worldwide, all belonging to the order Chiroptera, meaning hand-wing. The wing is made up of elongated forearm and finger bones covered by a strong, thin membrane. The thumb is not covered by the membrane and has a claw to allow grasping.

Approximately one-third of bat species eat fruit or nectar, serving as pollinators and seed dispersers in the process. The largest species of bat, the Malaysian flying fox, is a fruit eater, using its strong senses of sight and smell to locate food. These bats have a wingspan of over five feet.

The smallest bat species in the world is the bumblebee bat, with a body length of one inch and a wingspan of only six inches. The bumblebee bat and two-thirds of all bat species are insectivores, finding prey by echolocation — emitting sound waves and sensing their reflection. Bats have voracious appetites, with individuals capable of eating 1,000 small insects per hour. All 13 species of bat found in Illinois are insectivores and consume large numbers of insects whose larvae destroy farm crops, including cutworms, rootworms, and leafhoppers.

There are only three species of "vampire" bats, all living in Latin and South America. Unlike most bats, vampire bats are capable of walking or running, allowing them to sneak up on their prey. They do not suck the blood of their prey, rather they bite and lap up the blood, needing only about a teaspoon per meal. The saliva of these bats has a potent enzyme that is capable of dissolving blood clots, allowing blood to flow freely. This enzyme is used in medicines to dissolve blood clots in human stroke victims.

**Roosting**

During the spring, summer, and fall, bats roost in a variety of places — in trees, under tree bark, or in buildings and caves. Some bats, including the eastern red bat and the hoary bat, roost in solitary, while others gather in colonies. Bat feet, like those of many birds, are locked in a curved position, allowing them to hang with little effort. But unlike most birds, bats hang upside down. Scientists aren’t certain why they hang upside down, but one reason might be that the leg bones are too weak to support standing. Hanging upside down also allows the bats to attain flight quickly by releasing from their roost and flapping while free falling.

**Migration**

Most people are familiar with birds, and even some insects, flying south for the winter. Many Illinois bat species migrate between summer habitats and caves or mines for the winter.

Some bats, including the big brown bat, are considered sedentary, traveling only short distances, if at all, between summer and winter habitats.

Regional migrants, for example the eastern pipistrelle, Indiana bat, little brown bat, and northern bat, travel between 60 and 300 miles to the nearest hibernaculum. These subterranean habitats do not have to be to the south, so some bats will even migrate north to their winter caves. Long distance migrants are capable of traveling over 600 miles and include the evening bat, hoary bat, red bats, and silver-haired bats. Some of these migrate to areas where food is still plentiful in the winter months. In Missouri, red bats will actively feed during the winter and can take shelter in the leaf litter.

**Torpor**

Bats have a resting heartbeat of approximately 300 to 400 beats per minute (bpm), but are capable of dropping that rate to as low as 10 bpm to conserve energy during periods of limited food resources. Some species of bat can enter this state, known as torpor, for a few hours each day during the spring, summer, and fall. During the winter, torpor can last a few days to a few weeks, with periods of arousal.

**Diseases**

Rabies is carried by less than 0.5% of wild bats, and even though this is relatively rare, NEVER touch a bat. If you find a bat flying around in your house, open the windows to allow it to fly out or if it has landed, put a pail over it and slide cardboard between the pail and the wall and take it outside to release. If you have large numbers of bats living in your home, there is the danger of a buildup of guano that can contain histoplasmosis. Consult the Bat Conservation International Web site for suggestions. http://www.batcon.org/
Over 25% of bat species are threatened or endangered, and in Illinois, all bats are protected by the Illinois Wildlife Code. Like many other species, habitat destruction or disturbance is a problem for bats. Pesticides used in the environment may be present in the insects eaten by the bats, and lead to poisoning. Disturbances during torpor may awaken the bats, which wastes energy and fat stores, and can lead to starvation.

The increase in wind turbines across the landscape has led to an increase in bat mortality. Some bats collide with the blades, while others, caught in the vacuum formed by the blades, experience a rapid change in pressure causing the lungs to expand and capillaries to burst.

A recently discovered threat, White-nose Syndrome (WNS), appears as a fungus on the muzzle and wings of infected bats. It is transmitted from bat to bat by direct contact, but it can survive on cave walls and floors and be carried from cave to cave by humans and other animals. Over winter, affected bats awaken more frequently, wasting energy reserves leading to starvation. More than 6 million bats have been killed by WNS in North America over the past six years.

With so many threats, bats need all the help we can give them, but remember NEVER touch a bat.

Things you can do:

• Avoid entering caves where bats are roosting, especially between October and April.
• Be sure to clean any shoes, clothing, or equipment that you use in a cave before going into another cave.
• Limit your use of pesticides.
• Build a bat house.

Bat Conservation International (http://www.batcon.org) has free plans for different styles of bat houses, but here is the basic Single-chamber Bat House:

Materials (makes one house)

• 2’ x 4’ piece of 1/2”-thick outdoor grade plywood
• One piece 1” x 2” (3/4” x 1 1/2” finished) x 8’ pine (furring strip)
• 20 to 30 exterior-grade screws, 1”
• One tube paintable latex caulk
• 1” x 4” x 28” board for roof
• Water-based stain

Instructions

• Measure and cut plywood into three pieces: 261/2” x 24”, 161/2” x 24”, and 5” x 24”
• Roughen inside of backboard and landing area by cutting horizontal grooves with sharp object or saw. Space grooves 1/4” to 1/2” apart, cutting 1/32” to 1/16” deep.
• Apply two coats of dark, water-based stain to interior surfaces. Do not use paint, as it will fill grooves.
• Cut furring strip into one 24” and two 201/2” pieces.
• Attach furring strips to back, caulking first. Start with 24” piece at top. Roost chamber spacing is 3/4”.
• Attach front to furring strips, top piece first (caulk first).
• Leave 1/2” vent space between top and bottom front pieces.
• Caulk all outside joints to further seal roost chamber.
• Attach a 1” x 4” x 28” board to the top as a roof.
• Apply three coats of stain to the exterior.
• Cover roof with shingles or galvanized metal (optional).
• Mount on building (south or east sides usually best).

Learn more about bats at http://www.inhs.illinois.edu/outreach/animals/bats.html
Management, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the U.S. Air Force, St. Joe Company, and the Florida Forest Service, we are conducting a multi-year project to better understand habitat requirements as well as biological and ecological interactions associated with *Pinguicula ionantha* and other *Pinguicula* species. During this period, we will be evaluating habitat suitability based on GIS technology, investigating plant-pollinator/prey interactions, determining population genetics, pursuing seed biology such as dormancy and seed banks, and assessing the impact of woody encroachment on reproduction.

The results of this study aim to fill gaps in the ecological understanding of *P. ionantha* and other *Pinguicula* species in order to create conservation goals and management strategies. A successful management plan will not only guarantee viable future populations, but will help to improve management decisions for all *Pinguicula* species in the area. Furthermore, these findings will broaden the ecological understanding of both rare and carnivorous plants.

Samantha Primer (MS-Plant Biology UIUC), Brenda Molano-Flores (INHS), Janice Coons (Eastern IL Univ), Jenna Annis (BS-Eastern IL Univ), Jennifer O’Brien (BS-Eastern IL Univ), and Jason Koontz (Augustana College)

A closer look of *Pinguicula ionantha* flowers. Photo by Jean Mengelkoch, INHS

Woody encroachment by swamp titi (*Cyrilla racemiflora*) is affecting *Pinguicula ionantha* habitat. Photo by Jean Mengelkoch, INHS

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