Responses to Nest Predation and Brood Parasitism in a Migratory Songbird

Birds have evolved life history traits that tend to maximize lifetime reproductive success, and these traits include behavioral responses to factors limiting reproductive success. Behavioral responses may be especially important for birds breeding in highly fragmented landscapes where increased nest predation and increased brood parasitism by Brown-headed Cowbirds can greatly reduce reproductive success.

I studied color-marked populations of Prothonotary Warblers (Protonotaria citrea) in the fragmented bottomland forest of the Cache River watershed during 1993–2000 to determine whether or not these birds responded to nest predation and brood parasitism in ways that reduced the negative effects of each. Experimental and non-experimental data demonstrated that individual Prothonotary Warblers returned to sites between years in response to their reproductive success (as limited by nest predation). Between-year site fidelity increased with an increase in the number of broods produced with approximately 80% of double-brooded males and females returning. Individuals returned at rates of approximately 30% and 50% when they produced zero or one brood, respectively. Brood parasitism by cowbirds reduced the reproductive success of Prothonotary Warblers as a result of decreased hatching success of warbler eggs and decreased survival of warbler nestlings. The warblers accepted brood parasitism and did not choose nest sites inaccessible to cowbirds, defend nests during the egg-laying period, desert parasitized nests, or avoid returning to sites where they had been parasitized. The results of this research indicate that these birds may be able to avoid chronically high rates of nest predation by not returning to areas where nest predation elimi-

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The Role of Insect Flower Herbivory in Native and Restored Prairies

Several studies have shown that insect herbivory on an inflorescence can limit not only the number of seeds but also can influence seedling recruitment in a population, ultimately having an impact on the size of a population. However, the absence of insect herbivores can result in a plant species becoming very abundant and on some occasions weedy. In an ongoing study, the impact of insect flower herbivory (i.e., presence or absence) on the reproductive output and regulation of population size is being addressed using the prairie species *Eryngium yuccifolium* Michx. (Apiaceae), rattlesnake master (Fig. 1).

Rattlesnake master is a very striking prairie species, having leaves similar to the yucca plant and prickly white flower heads (Fig. 1). This species can be found in the southeast portion of the Great Plains and is found in 80% of Illinois. In Illinois, particular interest is placed on this species because it serves as a food source for the extreme abundance of this species in some prairies? Can the size and degree of isolation of a rattlesnake master population determine the presence or absence of this flower herbivory? Do we find the same flower herbivores in all rattlesnake master populations? Is the lack of flower herbivory the reason for the extreme abundance of this species in some prairies? Can the size and degree of isolation of a rattlesnake master population determine the presence or absence of this flower herbivory? Do restorations of different ages have the same level of flower herbivory? Do restorations of different ages have the same level of flower herbivory? Do restorations of different ages have the same level of flower herbivory?

To answer these questions, I have been gathering data on 20 rattlesnake master populations in Champaign, Ford, Livingston, Vermilion, and Will counties. Ten of these populations are found in native prairies and 10 in restored prairies. Both native and restored populations range from a few individuals to thousands, and all populations are in isolated prairie fragments. In the case of restored prairies, I am using restorations that are 6 to over 25 years old. For each of these sites I am also collecting data on species diversity. At each site, I collect 3 flower heads from 20 individuals, when possible, and determine percent flower herbivory and percent fruit. In the process of determining percent flower herbivory and percent fruit set, I have discovered that many of the populations have some degree of flower herbivory (Fig. 3). This is detected by the presence of holes in the fruits or the entire ovary being gone. However, it is too early in the study to determine differences between native and restored prairies or patterns associated with size and age of restorations.

Why should we be spending time studying this plant-insect interaction? As with plant-pollinator interactions, plant-herbivore interactions can be used as an indirect way to measure success for prairie restorations. For example, if herbivores are contributing to the long-term population control of a species and they are found in our restorations, then it suggests that the restorations are resembling native prairies. So what was presumed to be negative interaction (herbivory) can be viewed as positive interaction and can be used as an indicator to determine the health of a prairie.
In North American aquatic ecosystems, turtles often make up a large portion of the biomass. Even so, relatively few long-term research projects currently examine life history and ecology of aquatic turtle populations. Programs conducted in Michigan (E.H. George Reserve) and South Carolina (Savannah River Ecology Laboratory) demonstrate the need for long-term studies of turtles.

Beginning in 1992, researchers at the INHS Great Rivers Field Station began to examine turtle demographics, reproductive ecology, and life history strategies. Primarily, studies focused on the red-eared slider (Trachemys scripta elegans) because that species is the dominant riverine turtle in Pool 26 of the Mississippi River, where this study was done. Nonetheless, data were gathered on eight other less commonly encountered species as well.

**Demographic studies:** Technicians of the fisheries component of the Long-Term Resource Monitoring Program collect large numbers of aquatic turtles in nets set to track fisheries resources in Pool 26. Size, sex, and specific identity data on these turtles are collected in the field. Moreover, many of these turtles are brought back to the laboratory where more detailed measurements can be made. After being individually marked, they are returned to their capture site. Recaptures allow population demographics for pool-wide backwater use to be determined.

**Reproductive ecology:** Beginning in 1994, turtle studies were expanded to include a component on reproductive output. Studies are conducted by collecting nesting females at Stump Lake in Jersey County and in Swan Lake and Pohlmans Slough in Calhoun County. These females lay their eggs in the laboratory where the eggs are then weighed, counted, and incubated. Data collected allow comparisons of reproductive output among years and between sites.

We have found that reproductive output varies among years, with years following extensive flooding tending to coincide with lowered reproductive output. We have also found differences between sites in reproductive effort. At sites with extensive aquatic vegetation (an important food resource for aquatic turtles), the turtles tend to lay more but smaller eggs than do turtles from sites with little or no aquatic vegetation. The evolutionary implications of these findings are now under experimental examination.

**Life history strategies:** The eggs that female turtles lay hatch in our laboratory after incubation. Many of these hatchlings are then released at the site of their female parents. Some, however, are used in nondestructive experiments designed to examine life history strategies. Our main focus is to identify variables that influence hatching survivorship. Thus, we have performed experimental releases each year beginning in 1995. Our findings suggest that larger hatchlings are more likely to survive than smaller ones. We also found that predation by birds is a major source of mortality in migrating hatching turtles. Other experiments have examined responses to subfreezing temperatures, competition, and variable incubation environments.

Our efforts have resulted in research publications in general interest journals such as *Ecology, Journal of Evolution Biology,* and *The American Midland Naturalist.* Moreover, our findings have appeared in international herpetological journals such as *Journal of Herpetology,* *Herpetologica,* and *Copeia.* Overall, our findings have appeared in more than 50 publications in less than 10 years. Importantly, our program has also afforded graduate and undergraduate students opportunities to complete research projects. Student projects not only provide experience in field biology but also advance our understanding of chelonian biology.

**John K. Tucker, Center for Aquatic Ecology**
The soybean aphid, *Aphis glycines*, was discovered in northern Illinois and southern Wisconsin in late July 2000. By September its presence had been documented in 11 states. This year, 2001, was the first opportunity to observe this species throughout an entire growing season and there have been many surprises. One of the first surprises was the discovery of large populations on the perimeter of where the aphid had been relatively abundant in 2000. In New York and Pennsylvania and the province of Ontario, where the aphid had not been recorded, early spring populations appeared, as did in many areas of Minnesota, Wisconsin, and Michigan where it had been found but had not been abundant in 2000. In most of these areas, high populations developed and were sprayed with insecticides. By September it was known from southeastern North Dakota to one county in Virginia. It is clear that this aphid is here to stay and that it has the potential to become a serious pest of soybeans.

When exotic organisms like the soybean aphid arrive in North America, their populations may explode and they can become pests. Often this is because the natural enemies that kept populations under control in their native habitats are absent in their new home. One way of controlling exotic organisms is to search for these natural enemies in the native habitats and, after proper testing to ensure these natural enemies will not also become pests, introduce them in our infested habitats. This is called classical biological control.

In July, one group of scientists from the University of Minnesota went to China and Bob O’Neil of Purdue and David Voegtlin of INHS went to Japan in search of natural enemies of the soybean aphid. The focus of these trips was to find small wasps that parasitize aphids. These tiny wasps, called parasitoids, kill aphids by laying an egg into the body of an aphid, the egg hatching into a larva that feeds on the inside of the aphid, eventually killing it. The mature larva spins a cocoon inside the aphid and turns into a pupa that emerges later as another adult wasp, one wasp from one aphid. When the parasitoid larva spins a cocoon inside the aphid body, the aphid takes on a puffed-up appearance and is called a mummy.

In Japan, collections were made by myself and Bob O’Neil in both cultivated (*Glycine max*) and wild (*G. soja*) soybeans at approximately 60 sites in the northern part of Honshu. Field size varied but fields were generally larger than those in Japan. Only cultivated soybeans were sampled for aphids, and only aphidiine parasitoids were observed and collected. These mummies have the color and texture of a brown paper bag. As in Japan these mummies were found in aphid colonies of all sizes.

Mummies from both Japan and China were brought back to a U.S. Department of Agriculture quarantine facility at Newark, Delaware. At present, the species from Japan, whose scientific name is *Aphelinus albopodus*, is being successfully cultured in quarantine. Before this parasite will be approved for release against the soybean aphid, it will have to undergo tests to demonstrate its host range for us to be certain the parasite will not itself become a problem.

Further trips are being planned to continue the search for natural enemies of the soybean aphid in the Asian region.

David Voegtlin, Center for Biodiversity
Effects of Excluding Birds on Illinois Prairies

Birds are conspicuous members of grassland ecosystems, as anyone entranced by the acrobatic and vocal territorial displays of Bobolinks can attest. However, the question remains, Do birds play any sort of significant ecological roles in grasslands? Existing data are contradictory. For example, based on their contribution to annual productivity (production of offspring, expenditure of energy, etc.) in shrub-steppe (shrubby grassland), ecologist John Wiens speculated that birds may be little more than “frills” in the ecosystem, not interacting with it in any particular way.

In contrast, several studies have found that grassland birds can significantly reduce the numbers of grasshoppers. Because grasshoppers can be abundant and voracious herbivores, their suppression has the potential to port a greater abundance and diversity of animals that ultimately depend upon primary production.

To address this issue, colleagues from the University of Illinois at Chicago and I set up an experiment in an ongoing prairie restoration experiment conducted at The Morton Arboretum in Lisle, IL. The original experiment was designed to look for effects of avian and mammalian grazers on initial prairie restoration establishment (effects of both birds and mammals were found). The main focus now is on how mammalian herbivores (voles) affect community composition and productivity.

In our experiment, we erected bird exclosure cages within the replicated prairie restoration plots. The cages are constructed with half-inch-diameter rebar, PVC plumbing pipe, and monofilament nylon gill netting. The mesh of the netting is large enough for virtually all insects to access the interior of the cage, but it is small enough to exclude birds. If birds significantly reduce the numbers of insects, then presumably herbivory should be of greater magnitude inside of cages than in comparable control areas outside of cages. If this is the case, then it is also possible that plants outside of cages will experience decreased insect herbivory, and in turn may experience elevated productivities.

To sample insects, we collected them with a gas-powered vacuum eight times during the growing season of 2001, with usually about two or three weeks separating collection dates. Insects were identified to Order (e.g., Orthoptera), counted, and returned to the site of capture. To sample herbivory and its potential effect on plant productivity, we examined all the stem leaves on individual plants of the species stiff goldenrod that were both inside and outside the cages. In addition to estimating loss of leaf tissue on each stem leaf of each stem of each individual, all flower heads were counted. Later, randomly selected flower heads will be collected and seed mass estimated.

Although the data have not yet been analyzed, several tantalizing findings seem apparent. First, on some sampling dates, but not others, more insects appeared to be captured inside than outside the cages. If this is so, it suggests that the effects of birds on insect population abundances may blink on and off during the growing season (this was also found in a similar experiment conducted in an oak forest in Missouri). Second, we found that the composition of the insect community could vary considerably between consecutive sampling periods separated by only two weeks. The changing insect community composition could be both a consequence and the cause of the variable bird effect. Third, although not insects, spiders were collected and counted. Spiders, which along with birds are also insect predators, usually appeared more numerous within cages. So when insect numbers were greater within cages, this is despite what appears to be increased spider predation within cages. If all of these impressions hold, our conclusion will be that birds, despite having low annual productivities themselves, are certainly more than just frills in these experimental communities.

Christopher J. Whelan, Center for Biodiversity
Collectively, salamanders of the family Ambystomatidae are referred to as mole salamanders, but it is *Ambystoma talpoideum* that is known commonly as the mole salamander.

Like the mole for which it is named, this salamander spends a great deal of its life underground. It might also be found wandering the forest floor on rainy nights, or under a log or among forest debris and leaf litter during the day. It is rarely seen outside the breeding season—December through February—and finding a specimen is often a matter of luck, unless one knows of a breeding site and keeps tabs on it throughout winter and spring.

Loose, moist soils are most suitable for burrowing and therefore the mole salamander is found primarily in wet bottomland and swamp habitats, flatwoods, and near floodplains and low-lying areas. Found throughout much of the Coastal Plain of the southeastern United States, it is in its northernmost U.S. range at the southern tip of Illinois. Here, the mole salamander finds refuge in the bald cypress and tupelo swamplands and sloughs and ponds of the Cache, Mississippi, and Ohio River valleys. Much of the swamp habitat has been drained and fragmented, but the remaining fragments are protected in state conservation areas, nature preserves, and the Cypress Creek National Wildlife Refuge. While its range in Illinois is limited to Jackson, Pope, and Massac counties, the mole salamander is quite commonly found there. The mole salamander, like many other amphibians, needs water for breeding. Shallow, heavily vegetated and fish-free temporary ponds provide the most successful breeding environment. Breeding sites are sometimes shared with marbled, spotted, or tiger salamanders. Adults make their move, often during heavy autumn and winter rains, to breeding areas for courtship and egg laying. Male salamanders do not have breeding calls like frogs and toads, but they can be distinguished from females because they develop a swelling around the cloaca (the internal chamber at the base of the tail that receives the digestive, urinary, and reproductive tracts) during breeding. After fertilization occurs, the female attaches 200–400 small eggs, in jelly-covered clusters (containing up to 35 eggs each), to submerged twigs and leaves. Breeding is completed in just a few days.

During summer or autumn, eggs hatch into gilled larvae resembling small fish. Young larvae feed voraciously on small zooplankton; as the larvae mature they consume larger aquatic invertebrates. They will eventually complete metamorphosis and leave the water to mature on land, returning to ponds only to reproduce. Most individuals will return to the same pond in which they hatched. In certain populations of *A. talpoideum* the larvae mature sexually before metamorphosis, remain aquatic, and reproduce while retaining their larval characteristics. These individuals are called neotenic (from the term neoteny, meaning the attainment of sexual maturity by an organism still in its larval stage).

One of the smaller members of the Ambystomatidae family, a typical adult mole salamander is three to four inches long. The limbs and broad, bluntly rounded head seem disproportionately large. It has 4 toes on forelimbs, 5 toes on hind limbs, and 10 or 11 costal grooves (a vertical groove along the sides of the body between the front and back limbs).

*A. talpoideum* is the least distinctive looking salamander of the family. Its soft, moist, scaleless skin is fairly uniform in coloring, ranging from muted bluish gray to nearly black with white, gray, or silver flecking. Often it will have a white edge along the top of the tail. The belly is gray with light blotches. Overall, it resembles the small-mouth salamander.

Adult mole salamanders eat beetles, centipedes, slugs, worms, and other invertebrates, much like their mammalian namesake.
Adaptations for Life Underground

Many species of animals are adapted to burrowing underground. Below are just a few. Examine these pictures closely and list characteristics for each that you think may be adaptations for burrowing. Not all species will have the same adaptations, and some unrelated species may have similar adaptations. Try to find three characteristics for each of these species.

Here are some animals that do NOT burrow. List characteristics of each that you think would make them poorly adapted for life as a burrower.

Terms you may want to discuss:
• adaptation
• convergent evolution

Here are just a few adaptations for burrowing that some of the species have:
• large digging feet or claws
• small eyes
• streamlined body shape
• smooth skin or fur

Here are a few characteristics that make species poor burrowers:
• long and fragile legs
• delicate wings
• feathers (delicate and easily soiled)

Extensions

Look at pictures of other animals and discuss their adaptations to the ways they live.
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Warblers

In southern Illinois, including the Cypress Creek National Wildlife Refuge and Cache River State Natural Area, a long-term research project continues to provide a unique opportunity to incorporate the results of songbird research into management recommendations and the restoration plan. These recommendations will be validated as restoration proceeds. In the Cache River area, our previous research on the bird community has established the importance of connecting and enlarging existing tracts of forest, of restoring and managing a wide variety of floodplain habitats, and of the importance of bottomland forests for birds during the winter. In addition, we now know that the rate and amount of water-level fluctuations during the breeding season influence the rate of nest predation, in turn affecting season-long reproductive success and ultimately influencing the patterns of site and territory fidelity of birds breeding in bottomland and swamp forests.

Continued research on the bird community in the Cache River Wetlands will expand our knowledge of how the restoration of hydrology in off-channel wetlands affects the diversity, abundance, and nesting success of birds within the bottomland forest ecosystem. The Prothonotary Warbler will continue to be the focal species for determining the success of hydrologic restoration and also for determining the effect of bottomland forest restoration on brood parasitism by cowbirds. This research will increase our ability to effectively and efficiently restore hydrologic processes and manage bottomland forests for those avian species that are dependent on functioning bottomland forest systems. The results of this research will have broad application in the Mississippi ecoregions and will assist with other bottomland forest restoration efforts in Illinois (e.g., Emiquon and the Illinois River project and the Kankakee River restoration project).

Jeff Hoover, Center for Wildlife Ecology