Effects of Edge Types on Indigo Buntings

Indigo Buntings (Passerina cyanea) are one of the most abundant and widespread breeding birds in Illinois. Their characteristic song can be heard even in the midday heat in habitats that range from forest interiors to shrubby areas in grassland and on farms. Although the bunting is dependent on edges for nesting, these edges can range from hedgerows and abrupt boundaries between agricultural fields and forests to small natural openings in forests created by treefalls or disturbances associated with streams. We examined the effects of different kinds of edges on nest predation rates and levels of brood parasitism by Brown-headed Cowbirds (Molothrus ater) in a variety of sites in extreme southern Illinois. We were particularly interested in determining if nesting success was higher along gradual or “soft” edges along natural openings (for example, treefalls or streamsides) than it was along abrupt, permanent edges created by human activities (for example, forest-farm boundaries or forest openings created by conservation managers). These data might prove useful for managers seeking to increase populations of wildlife that depend on habitat edges rather than forest or grassland interiors.

We conducted this study from 1989–1993 in the western Shawnee National Forest, the Trail of Tears State Forest, and the Cache River Bioreserve. Because we had five years of data from several sites, we were also able to examine effects of annual variation in levels of predation and parasitism.

Based on our review of the literature, we predicted that nest predation rates and cowbird parasitism levels would be higher along abrupt, permanent edges. Populations of many nest predators are widely believed to be enhanced in habitats with permanent edges, and it has been hypothesized that abrupt edges increase the searching efficiency of predators and cowbirds.

Results strongly supported our prediction for predation rates but not for cowbird parasitism levels. Cowbird parasitism showed strong annual and site-to-site variation but no differences related to edge type. Nest predation rates showed the opposite pattern, with strong differences among edge types but no significant differences among years and study sites. Daily nest predation rates were nearly twice as high on abrupt, permanent edges along agricultural land, old fields, and openings created by conservation managers than they were on more gradual, natural edges along treefalls and streams. Nest predation rates were also comparatively low along regenerating openings created by selective logging. Predation levels were so high along abrupt edges (75–90%) that these habitats might be considered “ecological traps” that attract edgenesting birds but fail to provide safe nest sites.

Our results suggest that managers developing strategies to promote edge-breeding wildlife should consider the kinds of edges being created. Permanent edges such as those that have been made around small (<3 acre) wildlife openings may pose problems for some wildlife populations by increasing the number of nest predators. More gradual, “feathered” edges may be preferable to abrupt edges. Selective logging might mimic natural disturbances effectively, at least for some species.

Color Patterns as Camouflage in Fishes

Unrelated animal species commonly share similar color patterns. One pattern that is particularly common in bottom-dwelling fishes has four saddles (dark, rectangular blotches on the back) with three lighter intervening spaces, the largest of which is closest to the head. Examples of the four-saddle pattern are found in both freshwater and marine fishes throughout the world. Examples in Illinois include the rainbow darter, hog sucker, banded sculpin, walleye, and the extirpated crystal and stargazing darters. No explanation of why this pattern is so common or why it almost always consists of four saddles has been suggested. Because the pattern is found in several fishes that have declined in abundance in Illinois, survey scientists investigated the function of the pattern by examining the ecology of fishes exhibiting it and by comparing the spacing of the saddles on several species.

Saddles or other dark bars can serve to camouflage animals in two ways: obliterative countershading and disruptive coloration. Obliterative countershading works as a camouflage because of the way the eye perceives the pattern and not the background against which the animal is viewed. A zebra seen in broad daylight, for example, is conspicuous; however, predators of zebras are most active at dawn and dusk in lower light levels. In low light, the zebra's stripes are too close together for the eye of a predator to resolve the pattern, and the zebra disappears into the background. Disruptive coloration, on the other hand, depends entirely on the background against which the animal is viewed because the color pattern breaks the configuration of the animal into elements similar to those of the background.

We examined the substrate (and, thus, the background) preferences of North American freshwater fishes to determine which camouflage method four-saddled fishes employ. We hypothesized that if four-saddled species relied on obliterative countershading, they would live as commonly on homogeneously colored substrates (sand or mud) as on more complex substrates (gravel). If the fishes were using disruptive coloration, they would be found only on gravel, with the lighter spaces mimicking rocks and the darker saddles blending with shadows or gaps between rocks.

We determined substrate preferences for 269 species in four large groups of North American fishes: suckers, catfishes, darters and sculpins. Of these, 49 species have the four-saddle pattern, and all 49 prefer gravel substrates as predicted by our disruptive coloration hypothesis. In further support of disruptive coloration, whenever we captured banded sculpins over sand, they did not have saddles but were uniformly colored instead.

The exact placement of the four saddles on the bodies of five species of fishes were compared to determine whether spacing was important. The exact placement of the saddles differed statistically among the species, but the saddles were always unevenly spaced. In four of the five species, spaces between saddles increased in size toward the head. Because rocks come in various sizes and are randomly scattered, a fish is more cryptic (likely to be concealed) with an uneven pattern than with an even one. Because a fish's body tapers from head to tail, the longest spaces on the widest part of the body tend to produce round or square spaces that blend effectively with a gravel substrate (most rocks are round rather than oblong).

The fifth species, the checkered madtom (a catfish), had a more evenly spaced pattern of saddles. Apparently, checkered madtom can sacrifice the increased crypsis provided by an uneven pattern because they are active only at night and have poison glands at the bases of their fin spines to discourage predators.

Because the four-saddle pattern has evolved in fishes that live on gravel substrates, their survival may be negatively affected by increased siltation in streams. As silt covers the gravel, the substrate becomes a uniform color and saddled fishes become increasingly visible. Interestingly, two of the most endangered fish species in the United States, the snail darter and the Maryland darter, exhibit the four-saddle pattern. In Illinois, the crystal darter and the stargazing darter are extirpated, and the range of the rainbow darter has decreased. Siltation is a factor in the decline of these fishes for many reasons, possibly including a decrease in their ability to hide from predators.
Potato Leafhopper: A Serious Migratory Pest in Illinois

The potato leafhopper (*Empoasca fabae*), a serious pest of alfalfa as well as other legume crops in Illinois, is a small wedge-shaped pale green insect about a quarter inch long. During the summer, it can often be seen on windows at night or around porch lights. Gardeners occasionally find these insects damaging their snap beans.

Each year potato leafhoppers migrate into central Illinois in late April or May. Their source has been traced to the southern states, primarily Louisiana. Because these insects do not overwinter in northern states, initial populations must develop each year from a spring migration. Survey researchers, in cooperation with entomologists in other states, are studying spring migration as well as interhabitat migration between various crops and woodlands. Large numbers of leafhoppers move from the South with weather fronts, and when conditions are favorable, they fall to earth. Management of agricultural crops influences movements within and between fields. To study this movement, sticky yellow traps are placed in and around various habitats to collect migrating adults.

Growers of alfalfa need to be aware of the potential for damage by this insect on the second and subsequent hay crops. The adults cause v-shaped yellowing of alfalfa leaves, but by the time yellowing is evident, the plant has already been damaged. The damage is characterized by a loss of protein content and a stunting that reduces hay yield.

Populations of potato leafhopper usually decline in late August, but reductions may occur earlier as a result of a naturally occurring fungal pathogen. This pathogen produces infective spores which when they come into contact with a leafhopper, usually in its immature stages, germinate and grow through the skin of the insect. The fungus continues to grow and spread throughout the body cavity of the infected host until it kills the insect, in about three days. By the time the insect dies, it has been attached to the surface of the plant by small strands of the fungus which have grown out of the insect's body. These strands continue to grow until they have covered the insect with a cottony mass. During periods of high humidity, this mass produces more spores that infect other leafhoppers. Some infected insects produce overwintering resting spores within their body cavities, and these ultimately end up on the surface of the soil where they will germinate the following season to repeat the cycle.

When potato leafhopper nymphs are infected on a current hay crop, future adult populations will be reduced and will often remain below the economic threshold for the remainder of the season. The potato leafhopper fungus occurs only in northern latitudes and appears to be limited by higher temperatures in the South. Researchers hope to discover a strain of the fungus that is more heat tolerant. If they succeed, this natural control of the potato leafhopper can begin its work in the southern states, the source of Illinois leafhoppers.

New Publications from the Survey

The Survey is pleased to announce four new publications. Each can be ordered from the Distribution Center, Illinois Natural History Survey, Natural Resources Building, 607 East Peabody Drive, Champaign, Illinois 61820. Descriptions and prices are given below.

**The Wetland Resources of Illinois: An Analysis and Atlas** was released as Special Publication 15 and sells for $4.00. Coauthored by Liane Suloway and Marvin Rubbell, the 88-page book is a valuable reference for resource planners and managers, environmental scientists, policy makers, and others interested in wetland resources. Its 23 maps provide detailed information on the character, extent, and distribution of wetlands and deepwater habitats in Illinois. The publication reizes on geographic information system technology and provides much needed baseline data for future wetland research as well as for the restoration and creation of wetlands.

**Biological Notes 139, Behavior, Dispersal, and Survival of Male White-tailed Deer in Illinois** was written by Charles M. Nixon and colleagues from the Survey, the Missouri and Illinois departments of conservation, and Western Illinois University. It reports on ten years of research at three widely separated sites in Illinois. The publication is priced at $3.00.

**Mighty Miniatures**, an educational package for teachers, youth leaders, and parents, introduces elementary and middle school students to the world of insects. The package includes a poster large enough for coloring and a 20-page activity guide. The poster is printed on both sides. One side describes...
Survey Retirees: A Double Adieu

This past summer brought the retirement of two of the Survey's scientists of long standing, Dr. Wallace E. LaBerge and Charles M. Nixon. Both men have achieved national prominence in their fields, and both are respected by their colleagues within the state and throughout the country. They will be missed at the Survey, but their contributions will stand as a record of their achievements.

Wallace E. LaBerge (left) and Charles M. Nixon (right) retired from the Survey this past summer. Each served the Survey and the state for more than a quarter of a century, and they will be missed both professionally and personally by their colleagues.

After twenty-nine highly productive years at the Natural History Survey, Dr. Wallace E. LaBerge retired on 30 June 1994. He has been granted an emeritus appointment to the Board of Natural Resources and Conservation and will continue as head of systematics research on the family Andrenidae (solitary bees) for which he is world renowned.

Dr. LaBerge received a doctorate in entomology from the University of Kansas in 1955 and accepted an appointment to the Survey in 1965 following teaching positions at the University of Kansas, Iowa State, and the University of Nebraska. During his distinguished career, he has published 69 papers (more than 3,000 pages) pertaining to the systematics, ecology, evolution, and zoogeography of native bees and ants. His 70th paper is soon to be published. Dr. LaBerge has maintained an outstanding record for obtaining funds to support his research and has consistently obtained grants from the National Science Foundation.

In 1969, Dr. LaBerge achieved the rank of Professional Scientist at the Survey and was named Adjunct Professor at the Urbana-Champaign campus of the University of Illinois. In addition to his remarkable research career, he has served in several administrative capacities—as head of the Section of Faunistic Surveys and Insect Identification from 1979 through 1989, as Acting Chief of the Survey in 1980, and as Director of the Systematics Program at the National Science Foundation during 1982.

When the insect collection at the Natural History Survey exceeded the capacity of its storage facilities, Wally was chiefly responsible for obtaining funds to purchase the compactors that would accommodate the accelerated growth of this important collection of 6,000,000 specimens.

Wally's dedication to the Survey and his many contributions to the field of entomology have been exemplary. He has served his fellow scientists well and has provided an outstanding role model for younger members of the staff. The Survey has indeed been fortunate in his long tenure, and his colleagues are pleased that he will continue his research during his retirement.

Charles M. ("Chuck") Nixon, Professional Scientist with the Natural History Survey, retired 15 July 1994, after nearly 25 years with the Center for Wildlife Ecology. Born in Massachusetts, Chuck received degrees in biology and wildlife management from Northeastern University and Penn State University, respectively. Before coming to the Survey, he was employed as a research biologist for the Ohio Department of Natural Resources from 1959 to 1970.

Chuck's primary research interests are in forest wildlife ecology, a field in which he has become a national leader. During his Ohio tenure, he conducted research on white-tailed deer and, since 1976, has also involved in studies on small mammals, the ring-necked pheasant and ruffed grouse, and amphibians and reptiles. At the Survey, Chuck led the research on gray and fox squirrels and white-tailed deer and, since 1989, has headed cooperative research on the raccoon with fellow scientists from Western Illinois University and the College of Veterinary Medicine at the University of Illinois.

While at the Survey, Chuck has authored or coauthored some 37 refereed publications. Major contributions have been studies on the distribution and abundance of the gray squirrel in Illinois, squirrel hunting in Illinois, managing forests to maintain populations of gray and fox squirrels, and ecology of white-tailed deer in an intensively farmed region of the state. He has also contributed five chapters to books.

Chuck and his wife Eileen plan to continue to live in Monticello. The word is out that fish in east-central Illinois are advised to keep their mouths shut now that Chuck has retired.
Goose Lake Prairie: A Visit to the Past

Vast expanses of tallgrass prairie once covered central and northern Illinois. Unfortunately, more than 99 percent of that prairie is now gone and the little that remains is found only in small patches, typically less than five acres. A notable exception is Goose Lake Prairie State Park in Grundy County. Over 1,600 acres of prairie make this area unique in Illinois. Here we can view a virtually uninterrupted expanse of tallgrass prairie and verify the observations of early settlers who equated the prairie with "a sea of grass." The grassland undulates in the breeze, punctuated by small dips and hollows occupied by marshes and ponds.

The park was established in 1969 and originally contained more than 600 acres of farmland that has been maintained to produce forage for waterfowl and other wildlife. The Illinois Department of Conservation, however, soon began converting small parcels of farmland to prairie. In recent years, perhaps a reflection of our changing conservation values, these restorations have accelerated and now include the entire 600 acres.

Goose Lake is also used for research, including the effects of browsing deer on prairie flora and the effects of fire on prairie insect populations. On-going programs track some of the largest populations of prairie birds in Illinois, a group that has been declining precipitously since the 1950s. From midsummer through first frost, many of the more spectacular prairie wildflowers are in bloom. Lead plant, blazing star, and rattlesnake master are followed by late season coreopsis, prairie dock, and a host of others. Rare Henslow's sparrows hiccup atop the flower stalks of prairie dock. Summer hikers will also see white-tailed deer and an array of prairie butterflies, including the great spangled fritillary.

A visitors center provides interpretive exhibits and is open from 10 A.M. until 4 P.M., seven days a week. To reach Goose Lake Prairie State Park, take Route 47 south from Morris to Pine Bluff Road. Head east for about seven miles to the park and enter a landscape that time has forgotten—the tallgrass prairie of Illinois.

Mark Schwartz, Center for Biodiversity, and Michael Jeffords, Center for Economic Entomology

Soy Beans: Key to a New Mosquito Larvicide?

Some of the most dreaded diseases are carried by blood-sucking mosquitoes. In Illinois, 62 species are either nuisances or, much more seriously, transmit pathogens that cause disease in man and animals. Options for control, however, are decreasing at an alarming rate because mosquitoes have developed resistance to chemical formulations, because of growing environmental concerns related to the use of insecticides, and because of the cost associated with the federal registration of new products.

Petroleum distillates have been used for nearly a century to control insect pests that endanger public health as well as those that damage greenhouse plants, fruit trees, and vegetable crops. Fuel oils (kerosene or diesel fuel) mixed with crankcase oils, mineral oils, and surfactants (surface-active agents) were once a common means of controlling mosquitoes in aquatic habitats—swamps, marshes, sewage lagoons, rain barrels. Most of these highly refined mixtures of petroleum distillates are able to mix with water after the addition of emulsifiers. The oil kills the insect by interfering with its respiration, eventually causing it to suffocate. Petroleum-based oils, however, are not readily biodegradable and can harm nontarget insects and other animals and plants. Petroleum-based oils were once a mainstay for mosquito control, but now all but one of these products is off the market.

We hope to demonstrate that soy oils can replace petroleum-based formulations for the control of mosquitoes. Our initial investigations will screen soy oil formulations along with a variety of additives meant to enhance the physical, chemical, and insecticidal properties of the basic soy oils. Tests will also tell us how well various formulations spread and mix with water and how long their effectiveness persists. After products have proved successful in the laboratory, we will evaluate their performance under field conditions, including the metabolism and breakdown of the oils and additives, the impact on nontarget organisms, and toxicity to pest insects other than mosquitoes.

A multidisciplinary approach is essential if this project is to be successful. The research team consists of Dr. Robert Novak, a specialist in mosquito ecology, surveillance, and control; Dr. David...
As this photograph clearly shows, the thirteen-lined ground squirrel has an effective camouflage. Its body outline almost disappears in its grassy habitat. Mention the thirteen-lined ground squirrel to researchers on the South Farms at the University of Illinois and they quickly shout, “You have to have border rows and try a plastic snake or owl!” I speak from experience—last season ground squirrels ate 1,640 of 1,900 hills of oats from my research plots.

The thirteen-lined ground squirrel, *Spermophilus tridecemlineatus*, is a tan or buffy color with thirteen whitish stripes, some continuous and others interrupted to form rows of spots. The alternating pale and dark stripes break up the body outline, offering camouflage amidst the grass stems, patches of bare soil, and shadows of its grassy habitat. These squirrels range in size from 7 inches to a foot and have a tail half the length of head and body. In Illinois, they occur north of a line between Madison and Clark counties, an area that corresponds to the Shelbyville glacial moraine. South of there, the soil is shallow with an underlying hardpan that may prevent these squirrels from digging burrows that are deep enough.

These squirrels live underground, but their burrows, unlike those of their ground-dwelling relatives, are not marked by a soil mound. When they excavate, they fill their cheek pouches with earth and carry it some distance before scattering it. Soil around the burrow entrance is packed down, often with the top of the squirrel’s head. Burrows are 1 to 1.5 feet underground. Hibernation burrows are deeper, several inches below the frost line, and are used from mid-November to March.

Ground squirrels mate in mid-April, and young are born mid-to late May. Young in litters of five to eight are born hairless with poorly developed limbs. By three weeks their eyes are open, and after a month they emerge above ground to tumble and play with their siblings. They soon establish burrows of their own and put on fat for the coming hibernation.

Thirteen-lined ground squirrels are diurnal and spend most of their time foraging and carrying food to underground storehouses. Their diet consists not only of my oats but includes grasses, seeds, weeds, and insects. They live in grasslands where vegetation is low; when they sit up on their hind legs, they can see over the top of the vegetation. Thus grassy areas that are cut, such as cemeteries, large lawns, and closely cropped pastures, make ideal habitats. Unlike many animals that have declined with human development, this squirrel has found the managed landscape we humans are so fond of equally to its liking.

**Teacher’s Guide to “The Naturalist’s Apprentice”** (facing page)

**OBJECTIVE**

To understand what constitutes a habitat and to find homes for plants and animals that live in three broad habitats (prairies, forests, and wetlands).

**SKILLS AND PROCESSES**

Deduction, seeing relationships

**VOCABULARY**

Habitat, adaptation, canopy

**MATERIALS**

Multiple copies of *Match That Habitat* (facing page), colored pencils or crayons

**COMMENTS**

Begin by discussing what makes a habitat. In its simplest terms, a habitat is the place where an organism lives. Habitats may be as relatively uncomplicated as your front lawn or as complex and diverse as a local woodland. A more complete definition would be that a habitat contains everything an organism needs to survive—food, water, shelter, and space. Illinois has more than 90 different types of habitats, including seeps and bogs, hill prairies and flatwoods. For *The Naturalist’s Apprentice*, however, we will clump all Illinois habitats into three groups: forests, prairies, and wetlands.

A forest is an area dominated by trees, usually with a closed canopy. A prairie is generally treeless and dominated by grasses. Wetlands have standing water for part of the year and may be grassy, shrubby, or forested.

**PROCEDURE**

1. Through discussion, help students to arrive at a working definition of habitat. Reinforce the concept by asking them to describe the habitat in which they live. What kinds of habitats do their pets (birds, fish, guinea pigs) occupy? Can they think of ways in which animals are restricted to particular habitats or denied others?

2. Distribute copies of *Match That Habitat* and ask students to draw a line from each plant or animal shown there to the picture of an appropriate habitat—the best place for that organism to live. Students will need to use a pencil or crayon of a different color to designate each habitat.

3. Discuss the choices made by the class. Is more than one habitat suitable for a given organism? List on the chalkboard ways in which the three habitats differ from one another. Do any of the organisms have special adaptations for living in a particular habitat? Briefly, adaptations are characteristics that make living in a particular place easier or even essential.
Study the three habitats and the plants and animals shown below and give each a name. Write the names of the habitats in the spaces provided. Draw lines from each plant or animal to the habitat where it is most likely to live. Use a pencil or a crayon of a different color for each habitat.

1. 

2. 

3. 

"The Naturalist's Apprentice" presents educational activities for middle school students. Teachers are invited to photocopy this page for classroom use.
Publications
continued from page 3

Larvicides
continued from page 5

Insects by nine characteristics: aquatic, beneficial, carnivorous, cryptic, herbivorous, mimics, pests, recyclers, and territorial. The other side pictures plants and the butterflies that are attracted to them. Both plants and butterflies are native to Illinois. The activity guide includes a general introduction to insects and five activities that can be adapted for young entomologists in grades three through eight.

Youngsters learn the major parts of an insect and interesting adaptations found in the insect world. Matching activities, outdoor fun, and opportunities for writing are included. A copy of the booklet and a set of 30 posters is available for $7.00. For information about other educational materials, request a copy of the Survey's publication catalog. To arrange workshops for teachers or classroom presentations for students, contact Michael Jeffords, Education Liaison, at the Survey.

The Survey's annual report for 1993-1994 is now available at no charge. It features one-paragraph summaries of the more than 200 research projects currently under way at the Survey and its field stations throughout the state. It also includes a bibliography of staff publications.

Seigler, an expert in the chemistry of biologically active plant compounds; and Dr. Robert Metcalf, a specialist in insecticide chemistry, pest management, and the chemical ecology of insects.

Because the larval control of mosquitoes requires a high level of surveillance and is labor intensive, we chose mosquitoes as the initial target insect. In addition, mosquitoes are restricted to well-defined areas for at least part of their life cycle. Insecticidal oils (primarily petroleum distillates) are effective controls, but environmental concerns and phytotoxicity have limited their use and few alternative chemical and nonchemical controls are available. Modern transportation also allows disease-carrying species like Aedes albopictus, the Asian tiger mosquito, to invade new areas and establish themselves rapidly. Finally, recent legislation to protect and promote wetlands virtually guarantees future problems with mosquitoes.

The use of insecticidal additives with oils combines the action of the oil with the slow release of insect toxicants. One group of additives that we will study includes such insecticidally active botanical derivatives as limonene, terpeneol, piperitone, and azadirachtin and biologically safe agents like Bacillus thuringiensis israelensis (Bti). These compounds and the oils of many plants also offer new sources of natural insecticides and repellents for mosquitoes and other insects. Because these chemicals come from natural sources and are biodegradable, they are likely to prove environmentally sound. Water and mosquitoes go hand in hand, and soy beans could play a major role in the control of this disease-carrying pest.

Richard Lampman and Robert Noskak, Center for Economic Entomology