2.0 Wildlife Ecology

2.1 Introduction

Wildlife are the animals that live wild in a country. Animals include amphibians, reptiles, fish, mammals, birds, and invertebrates. Invertebrates are generally not included as wildlife, with the exception of crustaceans that are used by humans for food or bait. Only animals native to the country are usually considered wildlife and **domesticated** animals that have become **wild**, or feral, are usually not included.

The term wildlife is arbitrary depending upon who is using it. Today most government wildlife management agencies in U.S. have an interest in reptiles, amphibians and small animals that are not used by humans nor are seen as pests, as well as being interested in traditional game species. In the past, wildlife management agencies were only concerned with **game** and **vermin**. However, game and vermin species are still the major focus of wildlife management agencies. Partially this is a result of the history of interest and greater quantities of research into these species. Since we know much more about these animals, it is much easier to make management decisions regarding them. Non-government agencies that are interested in the conservation of wildlife may use a very broad definition of wildlife, focus specifically on the non-game species or take a non-utilitarian stance on game species. As our societies have begun to express the wider interest utilitarian and non-utilitarian values of animals, the term wildlife has become more inclusive.

Regardless of your definition of wildlife, all living organisms have needs for the continual survival of their species. These needs are grouped together and called **habitat**, which includes food, water, shelter and space. Animals are **adapted** to their environment and therefore may have specific habitat requirements that may be different or overlap with others. Animals with overlapping requirements can sometimes find themselves in **competition** for limited resources. The **carrying**

capacity of the habitat as well as predator and disease influence the population of wildlife. Populations normally fluctuate and some **populations** follow cyclical patterns of high population followed by decreases to a low population at which time the populations start to grow again until they hit a high number and start to decrease again. A constant population size is not in a natural equilibrium.

The term "habitat" describes the environmental conditions where wildlife species live. Food, water, cover, and space all contribute to the basic habitat needs for all organisms. These factors are responsible for determining species numbers and distribution and, when in short supply, can be the limiting factor (Environment Canada, 2013).

- **Food** – a requirement to meet an animal's energy demands: growth, reproduction, predatory avoidance, surviving long winters and migrations. Certain species are more specific to what food item they invest time into locating and consuming (i.e. specialist vs. generalist).
- **Cover** – shelter is required to either protect the animal from the elements, avoid predation, or raise young. Dense vegetation is the most common, but downed woody debris, cavities, pits, mounds, and rock piles can also serve similar purposes.
- **Water** – an essential requirement for all living organisms. Certain species obtain water from their diet/food and some are required to ingest it directly. Like humans, without water many species are unable to survive as it forms the basis of their biological functions.
- **Space** – animals need space to survive. Overcrowding increases competition for food, cover, and water but can also lead to the rapid spread of disease or parasites. For example, whitetail deer (*Odocoileus virginianus*) require a mix of open and forest cover to protect their fawns and bald eagles (*Haliaeetus leucocephalus*) require large trees in proximity to shorelines to raise their young. All species are, to a certain extent, territorial to ensure proper spacing and prevent overcrowding.
- **Abiotic –** non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems
- **Biotic** – the living things that shape an ecosystem

2.1.1 Wetland Habitat

Wetlands are important habitats for many terrestrial and aquatic organisms. In Illinois, approximately 42 percent of all the native plant species are wetland species (Illinois Department of Natural Resources 1994). There are also are a number of plant species usually associated with upland areas that can survive in wetlands. The US Fish and Wildlife Service has identified a total of 6,728 species of plants that occur in wetlands throughout the United

States (Reed 1988). Because wetlands are highly productive and support a diversity of plant life, they are an important source of food and habitat for wildlife. This productivity helps support commercial and recreational fish and waterfowl harvests throughout the Illinois and the rest of the world (Illinois Department of Natural Resources 1997).

There are several species of animals dependent upon wetlands for their day to day survival. Most people readily identify some of these animals, such as frogs and ducks, as wetland species. There are, however, many other species of wildlife usually associated with upland or deep water areas that depend on or use wetlands for feeding, spawning, and/or resting grounds at some point in their life cycles. Most people do not readily identify these various species of shiners, sunfish, bats, and terns with wetlands. They also do not realize many well-known species, such as bald eagles and bobcats, are also commonly found in and around wetlands.

Photo by: Illinois Natural History Survey, Forbes Biological Station staff

In rivers, streams, and most lakes the constant flow of water washes away many of these nutrients. But in marshes, and other wetlands, nutrients tend to remain and accumulate. In northern regions, where water levels are relatively stable, nutrients often become trapped in the bottom sediments; but in southern regions they are released each year during spring flooding. This is one of the reasons why wetlands in southern regions are so productive and why they attract so many forms of wildlife. Wetlands also provide necessary and valuable services to humans.

2.1.2 Forest Habitat

An ecosystem's ability to support wildlife depends on the amount of forest cover, size of individual forest patches, forest type, and linkages to other patches in a landscape. Mammals and forest interior birds require extensive forests. More is known about the habitat requirements and distribution of forest birds than any other group of wildlife, and for this reason they are most often used as an indicator of the quality of the forest.

Wood Thrush on nest, Source: All About Birds website

2.1.3 Riparian Habitat

Riparian areas are the zones along water bodies that serve as interfaces between terrestrial and aquatic ecosystems. Riparian ecosystems generally compose a minor proportion of the landscape. Typically, however, they are more structurally diverse and more productive in plant and animal biomass than adjacent upland areas. Riparian areas supply food, cover, and water for a large diversity of animals, and serve as migration routes and connectors between habitats for a variety of wildlife (Manci 1989).

Aerial photograph of an environmental corridor. (Reprinted from Conservation Corridor Planning at the Landscape Level Handbook, USDA NRCS.)

Riparian areas are important in mitigating or controlling nonpoint source pollution. Riparian vegetation can be effective in removing excess nutrients and sediment from surface runoff and shallow ground water and in shading streams to optimize light and temperature conditions for aquatic plants and animals. Riparian vegetation, especially trees, is also effective in stabilizing streambanks and slowing flood flows, resulting in reduced downstream flood peaks.

Riparian areas are often important for their recreation and scenic values, such as hunting, fishing, boating, swimming, hiking, camping, picnicking and bird watching. However, because riparian areas often are relatively small areas and occur in conjunction with watercourses, they are vulnerable to severe alteration.

Riparian ecosystems throughout the United States have been heavily impacted by human activities, such as highway, bridge, and pipeline construction; water development; channel modifications for flood control; recreation; industrial and residential development; agriculture; irrigation; livestock grazing; logging; and mining. Offsite disturbances in the watershed that change watershed hydrology can also have adverse effects on the composition and productivity of riparian plants and corresponding animal associations (Manci 1989).

2.2 Food Chains & Species Interactions

Within an ecosystem there are **food chains** and **food webs**. Both of these systems organize organisms based on a trophic level system (Figure 3). The basis of a food chain is a primary producer which is an organism that produces organic compounds from inorganic compounds. Plants undergoing photosynthesis by utilizing carbon dioxide and energy from the sun to produce oxygen and complex sugars are a good example of this. **Primary consumers**, also known as **herbivores**, are organisms which feed solely on these primary producers. An excellent example of an herbivore is the white-tailed deer (*Odocoileus virginianus*). Moving up the food-chain we have our secondary and tertiary consumers. Some of these consumers are **carnivores**, organisms which feed solely on other animals (e.g. wolves). Some carnivores are **predators**, as they hunt other animals as **prey**, while other carnivores are **scavengers**, feeding on the carcasses of dead animals. Lastly, **omnivores** are animals which feed on both plant and animal matter, for example, black bears (*Ursus americanus*) (Schraer & Stoltze, 1993). Omnivores can be secondary or tertiary consumers.

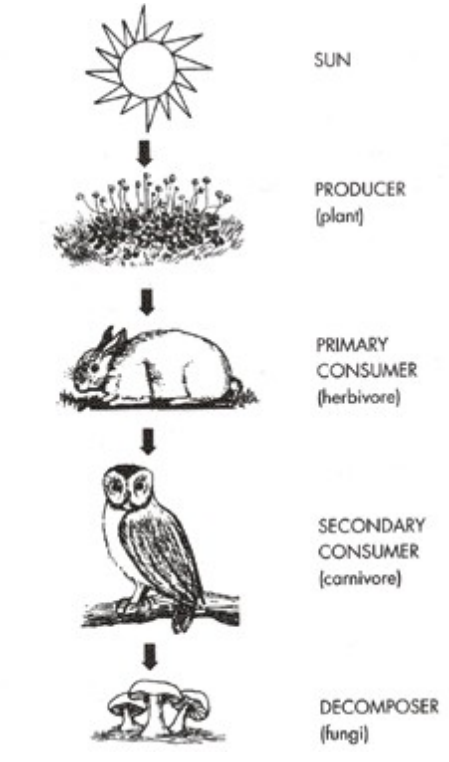


Figure 3. Simple Food Chain (Study Everywhere, 2015)

The soil food web (Figure 4) is the community of organisms living all or part of their lives in the soil. A food web diagram shows a series of conversions (represented by arrows) of energy and nutrients as one organism eats another.

All food webs are fueled by the primary producers: the plants, lichens, moss, photosynthetic bacteria, and algae that use the sun's energy to fix carbon dioxide from the atmosphere. Most other soil organisms get energy and carbon by consuming the organic compounds found in plants, other organisms, and waste by-products.

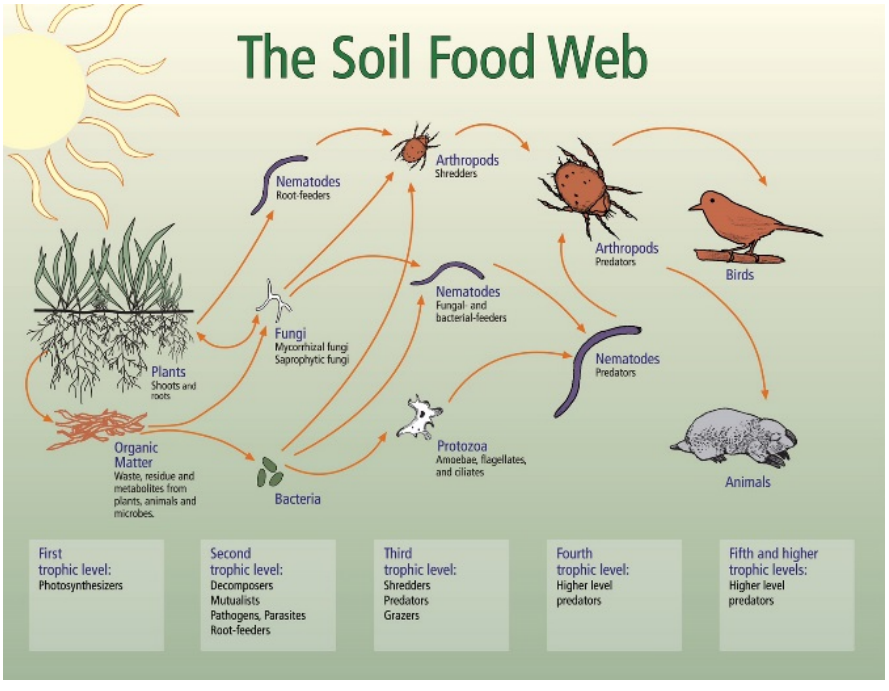


Figure 4. NRCS Soil Biology Primer

As organisms decompose complex materials, or consume other organisms, nutrients are converted from one form to another, and are made available to plants and to other soil organisms. All plants - grass, trees, shrubs, agricultural crops - depend on the food web for their nutrition.

2.2.1 Species Interactions

Symbiosis is the close and long-term interaction between two different biological species. Mutualism, parasitism and commensalism are different examples of symbiotic relationships.

Mutualism is the way two organisms of different species exist in a relationship in which each individual benefits from the activity of the other. These species work together which each benefiting from the overall relationship. A great example of a mutualistic relationship is the bee and flower. Bees fly from flower to flower gathering the nectar which they make into food. During this process they also pick up pollen from one flower and transfer it to the next one, helping to pollinate the plant.

Parasitism is a non-mutual relationship where one organisms gains while the other suffers. The parasite (gain) attacks the host (sufferer), and may cause sickness but unlikely death. One such example is the deer tick, which feeds on deer blood and may cause sickness to the deer.

Commensalism is where one species benefits while the other is neither helped nor harmed. The benefits for the one organism can be food, shelter, transportation or seed dispersal. One example would be beavers making dams to create a new water body that fish, waterfowl and many other animals can use for food, water, shelter and raise their next generations.

2.3 What Makes Habitat Suitable?

Scientists have been studying particular species for many years to understand their habitat requirements and how to manage them. *Habitat Suitability Index Models (HSI)* provide habitat information for evaluating impacts on fish and wildlife habitat resulting from water or land use changes. These models are used to serve as a basis for improved decision-making and increased understanding of habitat relationships because they specify hypotheses of habitat relationships that can be tested and improved (Source: USGS National Wetlands Research Center, n.d.).

2.4 Carrying Capacity

Carrying capacity is the maximum quantity of a species an area will support without deteriorating (Merriam- Webster, 2015). As mentioned previously, populations which become too large typically decline drastically or "crash" when their habitat is no longer able to support them. Fortunately, predator-prey relationships often regulate population numbers to decrease the chances of exceeding the carrying capacity. Similarly, the predator population is also kept in check by the size of the prey population and fluctuates accordingly. It is evident that predator-prey relationships are essential in regulating populations and therefore preventing the carrying capacity from being exceeded (Source: McGraw-Hill Companies, n.d.).

Illinois is home to some 58 mammal species, 383 different resident and migrant birds, 104 types of reptiles and amphibians, 174 species of fish, and some 27,000 types of insects, mussels, and other invertebrates. There are more than 2500 species of plants and more than 1,000 species of fungi and algae, and hundreds of lichens and mosses. (Sources: Illinois Environmental Council, Illinois Department of Natural Resources, and the Illinois Ornithological Society)

Case Study – Raccoons and Songbirds in Illinois

Biodiversity is crucial to maintain healthy, resilient ecosystems. A variety of stable wildlife populations is a common indicator of ecosystem health and is important for all species in a food web.

Case Study Paper (See Illinois Envirothon Wildlife Manual Toolbox):
Nest Predation and Population Declines in Illinois Songbirds: a Case for Mesopredator Effects
Researcher: Kenneth A. Schmidt

This case study illustrates the potential impacts on songbirds when the top predator is removed or declines in numbers allowing for the potential increase in mesopredator numbers. A mesopredator is defined as a medium-sized predator which often increases in abundance when larger predators are eliminated. When wolves were present in Illinois, they were considered a top predator, and coyotes were a mesopredator and were prey of wolves. However, with the expatriation of wolves from Illinois, coyotes are now a top predator throughout Illinois.
In regions of Illinois where coyote populations have been severely reduced by means such as hunting, disease, or malnutrition, other mesopredators such as raccoons, skunks, foxes, and opossums can increase in numbers. As these mesopredator numbers increase, there is an increased pressure on prey species that these mesopredators can more easily access that the primary predator may have passed up as prey, or had indirectly helped the prey numbers by keeping the mesopredators in check. This, in turn, can have a detrimental effect on the prey species that the mesopredators prey on, such as songbirds.

As seen in this case study many factors – including, but not limited to genetics, food sources, disease, and the presence of other wildlife species, such as predators – are highly influential in population dynamics in a habitat. One species can have a tremendous impact on another which reiterates the importance and value of increased biodiversity (McGraw-Hill Companies, n.d.).

2.5 Indicator Species

An **indicator species** is an organism whose presence, absence and/or abundance reflect specific environmental conditions. Indicator species can show a change in a specific ecosystem through biological conditions. By studying indicator species you can assess the health of an ecosystem (Jaffe et. al., 2012).

Examples of indicator species include:

- **Insects:** Honeybees and butterflies are pollinators that indicate and strongly influence the health of plant populations. They are highly sensitivity to a plethora of factors, including temperature and weather, parasites, and air, water and soil quality. All of these factors can help assess the overall health of an ecosystem (Libal and Media, 2015).
- **Frogs**: Their shell-less eggs, absorbent skin, moisture dependence, predatory feeding, and their amphibious life cycles make them vulnerable to changes on land and in water. They are often used to monitor and track changes in water quality, and overall environmental health (Libal & Media, 2015).
- **Lichens:** They are indicator species for air quality due to different types of lichens being susceptible to different pollutants. Certain compounds can affect certain species differently when in an ecosystem. Some compounds can cause a certain species population to grow at exponential rates whereas that same compound could cause other species to die (Libal & Media, 2015).

2.6 Seasons and Wildlife

The change in seasons has a huge impact on behaviors of wildlife. From migration to hibernation, animals have to adapt to changes in the ecosystem in order to survive.

2.6.1 Migration

Migration is the seasonal movement of animals from one area to another area. Migration may be a means of avoiding harsh environmental conditions, to find food, or to travel to breeding grounds (Parry, 2010). Many animals throughout North America and the world practice migration, from large mammals to small insects. The act of migration may be carried out by flight, through water or on land.

Bird Migration

Over 1000 bird species in the US are considered to be 'migratory' (US FWS, 2010). Nearly all of these birds migrate north to the US to breed and raise their offspring, and migrate south to favorable environmental conditions, food and habitat for the winter months. Some birds have relatively short flights, migrating across North American borders into the southern United States and Mexico for winter, while others travel much farther such as the arctic tern, whose journey spans nearly from pole to pole (The Arctic Tern Migration Project, n.d.).

Examples of Illinois migratory birds

- Sandhill Crane (*Grus canadensis*)
- American Golden Plover (*Pluvialis dominica*)
- American White Pelican (*Pelecanus erythrorhynchos*)
- Canvasback Duck (*Aythya valisineria*)
- Ruby-throated Hummingbird (*Archilochus colubris*)
- Turkey Vulture (*Cathartes aura*)

American Golden Plover

During late April, nearly all of the American golden-plovers on the planet congregate in Illinois' open fields. There are only about 150,000 of these rare birds on Earth today due to market hunting in the 19th and early 20th centuries. Each spring, they migrate from South America up through North America to their summer breeding grounds in the Arctic. Along the way, they stop in Illinois to feed in fields and prairies, such as the Conservancy's Kankakee Sands. In fact, the American golden-plover makes one of the longest migratory journeys of any shorebird. (Top Five Must-See Migrations in Illinois, The Nature Conservancy)

Figure 5. American Golden Plover (*Pluvialis dominica*) (Audubon Guide to North American Birds)

2.6.2 Mammal Migration

Birds are not the only wildlife that migrate, some mammals migrate as well. These include marine mammals such as seals and whales, flying mammals such as bats, and terrestrial mammals such as caribou and polar bears. Bat species in Illinois are triggered into a migration caused by cool temperatures in the fall, forcing them to travel to either caves, or warm tree cavities much farther south in order to hibernate for the winter months (Hinterland, 2005).

Bats are the only mammals that actually migrate in Illinois, and only two species of the 12 species found in Illinois do an annual migration- the Evening Bat (Nycticeius humeralis) and the Hoary Bat (Lasiurus cinereus).

Figure 6. Evening Bat (*Nycticeius humeralis*) (Heather Kaarakka/Wisconsin Department of Natural Resources

Evening bats roost in buildings (in attics or walls) and trees (under loose bark or in cavities). Maternity colonies in buildings can include hundreds of females, which typically give birth to two young in June. Evening bats are early evening fliers, and eat beetles, flies, leafhoppers, and moths. Evenings bats are a rare bat in Illinois, and may migrate long distances to warmer regions in the autumn. (Source: Joyce E. Hoffman, Illinois Natural History Survey)

2.6.3 Invertebrate Migration

Many different species of insects including beetles, dragonflies, butterflies and moths migrate. Most invertebrate species found in Illinois have developed strategies to withstand the cold such as entering into dormant states, using a type of 'antifreeze' or simply having adults die off leaving larval stages of the invertebrate to lie dormant and overwinter (McDonough, 2011). For some species, however, avoiding the winter entirely has been the strategy to survive the cold, harsh winters Illinois provides. These invertebrates often travel by flight from Illinois to the southern states of the U.S., however some make a much further journey, such as the monarch butterfly travelling into Mexico (The Nature Conservancy, 2015b).

Examples of Illinois Migratory Invertebrates:

- Monarch Butterfly (*Danaus plexippus*)
- Green Darner (*Anax junius*)
- Giant Swallowtail Butterfly (*Papilio cresphontes*)
- Black Saddlebag (*Tramea lacerata*)

Monarch Butterflies

One of the most well-known species of migratory insects is the monarch butterfly (*Danaus plexippus*) (Figure 7). Though there are different populations, eastern populations of monarch butterflies migrate annually from their winter home in Mexico to the United States and Canada once the weather begins to change. Female monarchs lay their eggs in their northern residence between March and April, giving life to the first new generation of monarchs (The Nature Conservancy, 2015b). However, only monarchs that are born late in the summer have a prolonged life span and make the 2796 miles journey to Mexico in autumn (WWF, n.d.). Western populations behave in a similar manner; however they migrate west of the Rocky Mountains and overwinter in California (WWF, n.d.).

Figure 7. Monarch Butterflies - *Danaus plexippus* (Smith, 2015)

2.7 North American Flyways

No two bird species travel the exact same migration route or distance and many migration routes have varying levels of complexity. Despite these differences, bird migrations all tend to follow general land masses such as coast lines, mountain ranges, and large river systems. These North and South migration routes have been given the name 'flyways' and have been divided into four distinct routes based on geographic structure (e.g. mountain ranges or water sheds), habitat requirements (e.g. tall grass prairie, wetlands), and/or food requirements (Figure 8).

Pacific Flyway

The Pacific Flyway stretches from the Arctic Archipelago, through Alaska, British Columbia, the Yukon, and throughout the western states of the U.S. (with some species travelling to Mexico and beyond) (Ducks Unlimited, n.d.). This flyway covers diverse terrain from the arctic tundra, through the Rocky Mountains, as well as desert regions further south. Species like the varied thrush (*Ixoreus naevius*), snowy plover (*Charadrius nivosus*) and least tern (*Sternula antillarum*) migrate along this flyway (Audubon, 2015).

Figure 8. North American Flyways (Ducks Unlimited, n.d.)

Central Flyway

The Central Flyway covers many arctic islands south to Central and South America, travelling through the Prairie Provinces in Canada, as well as the mid-western Great Plains states. Many grassland species such as the lesser prairie-chicken (Tympanuchus pallidicinctus) and whooping crane (*Grus americana*) migrate along this flyway (Audubon, 2015). Modern agriculture has resulted in the disappearance of many grasslands, which is threatening the existence of these migrating birds found along this flyway (Audubon, 2015).

Mississippi Flyway

The Mississippi Flyway is quite geographically flat, with no significant ridges, mountains or hills large enough to interfere with bird migration (The Nutty Birdwatcher, 2001). The flyway encompasses Illinois, Saskatchewan, Manitoba, and the central-eastern states (Ducks Unlimited, n.d.). This flyway also encompasses the Great Lakes as well as the large Mississippi river system and the Gulf Coast. Nearly half of North America's bird species spend at least some time on the Mississippi flyway (Audubon, 2015). Species such as the mottled duck (*Anas fulvigula*), little blue heron (*Egretta caerulea*), and brown pelican (*Pelecanus occidentalis*) use this flyway during migration (Audubon, 2015).

Atlantic Flyway

The Atlantic Flyway encompasses Newfoundland, Labrador, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and some of the eastern US. This flyway is used by small land birds such as wood thrushes (*Hylocichla mustelina)*, prothonatary warblers (*Protonotaria citrea*), and American woodcocks (*Scolopax minor*), as well as sea and shore birds such as the Arctic tern and the piping plover (*Charadrius melodus*) (Audubon, 2015). This flyway is the most densely populated by humans, and therefore most susceptible to human interference (Ducks Unlimited, n.d.).

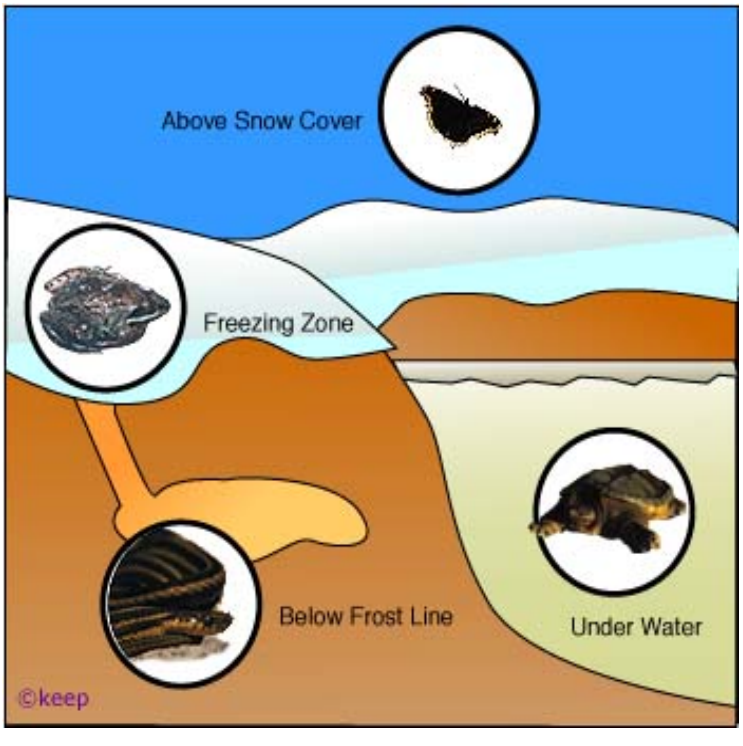
Geese in formation in December, DeWitt County, IL, E. Burns

2.8 Hibernation

Hibernation is a response to colder temperatures, in which an animal finds or makes a living space that protects it from winter weather and predators, and so that the animal can slow its metabolism using only its stored energy sources to survive the winter (Scientific American, 1997). Animals hibernate in a living space called a **hibernacula**.

Animals that hibernate in Illinois:

- Amphibians
  - Frogs – hibernate within mud, under leaf litter, or in cracks and crevices of logs or rocks and emerge in spring
- Reptiles
  - Turtles – hibernate underwater in ponds, rivers, wetlands and other freshwater sources and emerge in spring
- Mammals
  - Meadow Jumping Mouse- hibernates in 20 inch deep small earthen chambers plugged with earth and curled up in a nest of dry plant fibers. Many do not survive hibernation because of insufficient fat reserves.
  - Little Brown Bat – hibernates and over winter in caves or abandoned mines that are above freezing



Surviving Winter with different strategies:

Mourning Cloak *(Nymphalis antiopa) Winters as an adult in cracks in tree bark or under roof shingles.*

Wood Frog *(Rana sylvatica) Can freeze beneath forest litter.*

Garter Snakes *spend winter below the frost line in holes or rock caves.*

Snapping Turtle *(Chelydra serpentina) Can breathe underwater during winter!*

(Source: Nature North website)

3.0 Humans and Wildlife

3.4 Global Change

Five main changes are expected to occur across the globe that will have impacts on the diversity of species found within Illinois. These changes and impacts are outlined in Table 1. Global change will not only have local impacts on biodiversity, but will impact the levels of biodiversity worldwide leading to a massive decline in the number of plant and wildlife species.

Table 1. Impacts of Global Change on Biodiversity (Sage 2008)

Expected Changes	Impacts of Changes
1. Atmospheric Carbon Dioxide Enrichment	• increased photosynthesis
	• faster plant growth
	• reduced transpiration
	• increased occurrence and intensity of
	• change in competitive patterns
	• altered quality of forage
	• ocean acidification and calcification
2. Climate Change -warming of 1.5-2 degrees F in Illinois in the long-term	• drier soils
	• warmer winters
	• disruptions in natural cycles
	• increased frequency of storms
	• altered photosynthesis
3. Land Use Change	• increased agricultural production
	• reduced diversity of crops
	• increased occurrence and intensity of
4. Terrestrial Eutrophication -increase in the amount of terrestrial nitrogen through use of fertilizers	• increased growth of weeds
	• reduced biodiversity due to the lack of ability to compete with weeds
5. Invaders	• infected and consume natives
	• altered hydrology of an area
	• altered soil properties
	• altered regional climate
	• loss of species
	• altered disturbance regimes
	• out-compete native species

The above impacts of global change can ultimately have devastating impacts on local **biodiversity**. Reduced resiliency of an area can result in increased **vulnerability**. With fewer species contributing to the overall functioning of an ecosystem there is a reduced ability to respond to large disturbances.

3.2 Threats to Wildlife

The threats facing Illinois's plant and animal species are constantly increasing. There are five main threats that are impacting all species across Illinois: habitat loss, pollutants, invasive species, unsustainable use, and climate change.

3.2.1 Habitat loss

Habitat loss and degradation are perhaps the most important pressures facing wildlife today. Certain types of habitat are disappearing at a tremendous rate in almost all parts of Illinois. Wetlands are being filled in, forests are being fragmented and clear cut of forested areas and grasslands have been plowed under. Unfortunately, these mechanical means aren't the only harm humans are causing.

One of the greatest contributors to habitat loss is **population expansion,** or urbanization. Urbanization has converted many species' habitats into neighborhoods, industrial plants, airports, and shopping malls (Champagne, 2005). Although urbanization has destroyed many species' habitats, it has not removed species altogether. Many species, such as coyotes and raccoons, have adapted to these human interferences, which unfortunately, has resulted in more negative human-wildlife interactions.

3.2.2 Pollutants

There are few places left on the planet where there is an absence of human impact. In addition to the effects that urbanization has on wildlife habitat loss, the by-products of our daily lives (sewage, exhaust, trash, agricultural and lawn chemicals, industrial emissions and more) make their way into the natural environment through the air and water (NWF, 2015). As pollutants enter these systems, they make their way through the ecosystem and into wildlife species living in that area.

Illinois residents have depended on and continue to depend to a great extent on chemical products as part of their modern lifestyle. These products may be used in industry, around the house, and/or in agriculture both historically and currently (e.g. PCBs, DDTs, dioxins, fertilizers, and pesticides). Unfortunately, these some of these products in the past posed, and in some cases continue to pose, a serious risk to the health of wildlife species directly and indirectly (Champagne, 2005).

Some of the banned pollutants that have affected aquatic and terrestrial wildlife are:

- Mercury
- Polychlorinated biphenyls (PCBs)
- Dioxins
- Mirex/photomirex
- DDT – pesticides
- Toxaphene

The issue with some pollutants and their metabolites entering the water systems is that they are hydrophobic (water-hating) and lipophilic (fat-loving), meaning they are not easily diluted with water and they like to attach to the fatty tissue of organisms.

These characteristics lead to bioaccumulation. **Bioaccumulation** (Figure 6) is the build-up of persistent contaminants in an organism from poisons in water, sediment and/or food sources. Bioaccumulation occurs within an organism, where a concentration of a substance builds up in the tissues and is absorbed faster than it is metabolized or removed.

Biomagnification refers to an increase in the concentration of a substance as it moves up the food chain. This often occurs because the pollutant is persistent, meaning that it cannot be, or is *very* slowly, broken down by natural processes. These persistent pollutants are transferred up the food chain faster than they are broken down or excreted (Van Der Hoop, 2013). For example, a Polar Bear, as the top predator (tertiary consumer) in a food chain, will consume the greatest accumulated amount of chemical (see Figure 9).

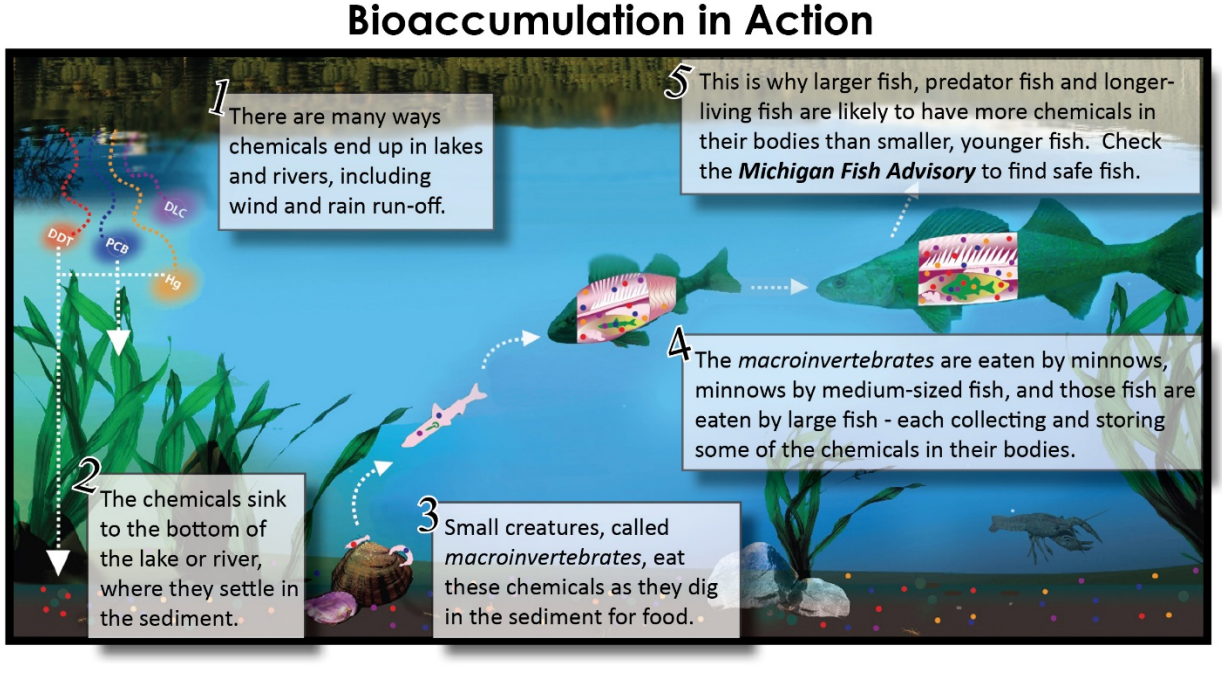


Figure 9. Bioaccumulation and Biomagnification (Michigan State Department of Health)

3.2.3 Invasive Species

Non-native species or "**alien** species" are species or subspecies which are introduced, often by human activity, to an environment which is outside of that species' natural past or present distribution. Non-native species can be non-invasive or **invasive**. Invasive non-native species refer to those that spread and cause damage to the introduced ecosystem and can also damage the economy and human health. Invasive species pose a huge threat to biodiversity by outcompeting native species and altering ecosystems (OFAH & OMNR, n.d.). Some examples of non-native invasive species are the Asian carp, European green crab, purple loosestrife, zebra mussel, sea lamprey, emerald ash borer, didymo, gypsy moth, Asian long-horned beetle, and round goby.

Invasive species are becoming more and more of an issue in Illinois. The spread of invasive species can have negative effects on the environment, the economy and society. These species often compete with native Illinois species over resources and habitat, resulting in a reduction of native flora and fauna. One example of such a species is the zebra mussel (Figure 10). This fresh water mussel as introduced into Illinois's lakes and has disrupted ecosystem composition and structure, clogged water intake pipes and effected public beaches.

Figure 10. Zebra Mussel (World Customes Organization, 2007)

Many non-native species such as the European starling have become very common (Figure 11). It was first introduced to North America in 1890 when 60 of them were released in Central Park in New York. While native to Europe and Asia they thrived in North America and spread across the continent. These aggressive birds compete with native species, claiming native birds' nesting sites and displacing the birds and their eggs. They also compete with native birds for food and are responsible for spreading disease, ticks, and mites which are detrimental to native bird populations. They're especially well adapted to urban areas and farmland, and have decimated crops (Royal BC Museum, 2011).

Figure 11. European Starling (Royal BC Museum, 2011)

3.2.4 Unsustainable Use

Unsustainable use is the harvest of individuals at a rate higher than can be sustained by the natural reproductive capacity of the species. Reduction in population levels due to harvesting can have dramatic impacts on the population, such as reduced genetic variability. Wildlife managers attempt to control harvesting rates by using permits and licenses for certain game species. (Refer to the Illinois Envirothon Wildlife Manual Toolbox – Illinois Hunting and Trapping Guide).

3.2.5 Climate Change

Current concerns regarding climate change and the impacts on the environment have focused a great deal on impacts on biodiversity. Increasing global temperatures will result in altered conditions and changing landscapes. These changes will result in changes in habitat for many plant and animal species. Climate change is expected to impact biodiversity in the following ways:

- insect and/or disease breakout patterns may change or become more severe (European Gypsy Moth spread);
- plant species will change their distribution, resulting in new types of forest (Kudzu spread northward in Illinois) ;
- animal species distributions will continue to change (movement north in Illinois of the Nine-Banded Armadillo) ; and,
- an increase in the frequency of extreme events may affect habitats (droughts and floods) .

Impacts of Climate Change on the Midwest

"The Midwest's agricultural lands, forests, Great Lakes, industrial activities, and cities are all vulnerable to climate variability and climate change. Climate change will tend to amplify existing risks climate poses to people, ecosystems, and infrastructure. Direct effects will include increased heat stress, flooding, drought, and late spring freezes. Climate change also alters pests and disease prevalence, competition from non-native or opportunistic native species, ecosystem disturbances, land-use change, landscape fragmentation, atmospheric and watershed pollutants, and economic shocks such as crop failures, reduced yields, or toxic blooms of algae due to extreme weather events. These added stresses, together with the direct effects of climate change, are projected to alter ecosystem and socioeconomic patterns and processes in ways that most people in the region would consider detrimental.

Most of the Midwest's population lives in urban environments. Climate change may intensify other stresses on urban dwellers and vegetation, including increased atmospheric pollution, heat island effects, a highly variable water cycle, and frequent exposure to new pests and diseases. Further, many of the cities have aging infrastructure and are particularly vulnerable to climate change related flooding and life-threatening heat waves. The increase in heavy downpours has contributed to the discharge of untreated sewage due to excess water in combined sewage-overflow systems in a number of cities in the Midwest."
(NCA Highlights, p.74)

3.3 Species at Risk

A species at risk is the classification of any wildlife species that is at-risk of extinction or extirpation (USFWS, 2005). In Illinois, the **Endangered Species Protection Board (ESPB)** is responsible for determining which species should be listed at-risk (IDNR). The Board may list, as endangered or threatened, species of animals or plants which have reproduced in or otherwise significantly use, as in migration or overwintering, the area which is now the State of Illinois, if there is scientific evidence that the species qualify as endangered or threatened as defined by the Act. Federally designated endangered and threatened species are automatically placed on the Illinois List. The first Illinois List was published in 1981. Since then, there have been six 5-year reviews and revisions of the entire List, as well as some administrative and editorial revisions, resulting in the current (2015) Illinois List of 480 endangered and threatened species. (Source: Illinois Department of Natural Resources ESPB)

The **United States Fish and Wildlife Service (USFWS)**

The U.S. Fish and Wildlife Service's mission is, working with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. This is the only agency of the U.S. Government with that primary mission. The Service's origins date back to 1871, when Congress established the U.S. Fish Commission to study the decrease of the nation's food fishes and recommend ways to reverse the decline. The Service helps protect a healthy environment for people, fish and wildlife, and helps Americans conserve and enjoy the outdoors and our living treasures. The Service's major responsibilities are for migratory birds, endangered species, certain marine mammals, and freshwater and anadromous fish. (Source: USFWS)

A series of codes has been developed to identify the current status of each listed species in the USFWS endangered species database. See below for descriptions of some of the more commonly used codes.

E = endangered. A species "in danger of extinction throughout all or a significant portion of its range."

T = threatened. A species "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

C = candidate. A species under consideration for official listing for which there is sufficient information to support listing.

Emergency Endangered - A temporary (240 days) listing for emergency purposes when species is at significant, immediate risk.

Delisted - Species that has been removed from the list due to recovery, original data in error, or extinction.

Species of Concern (SC) - Species that have not been petitioned or been given E, T, or C status but have been identified as important to monitor.

Species at Risk in Illinois

CRITERIA FOR STATE LISTING 1) Species or subspecies designated as federally endangered or threatened , 2) Species proposed for Federal Endangered or Threatened status that occur in Illinois, 3) Species that formerly were widespread in Illinois but have been nearly extirpated from the State due to habitat destruction, collecting, or other pressures resulting from the development of Illinois, 4) Species that exhibit very restricted geographic ranges of which Illinois is a part, 5) Species that exhibit restricted habitats or low populations in Illinois, or 6) Species that are significant disjuncts in Illinois i.e., the Illinois population is far removed from the rest of the species' range.

- 19 endangered and 16 threatened fish species
- 3 endangered and 6 threatened amphibian species
- 10 endangered and 8 threatened reptile species
- 24 endangered and 7 threatened bird species
- 5 endangered and 4 threatened mammal species
- 44 endangered and 10 threatened invertebrate species
- 251 endangered and 73 threatened plant species

(IDNR Final Checklist, 2015) For an official and up to date lists of species at risk in Illinois refer to the Illinois Envirothon Wildlife Toolbox Resources.

3.3.1 Why are they at Risk?

The number of Illinois wild plant and animal species that are at-risk of disappearing is growing. Species face a number of ongoing threats that vary in complexity, although the destruction of their habitat and contamination of their environment through human involvement is most prevalent (Environment Canada, 2014). Other factors involved with the decline of species population include the spread of diseases, invasive species infringement on natural habitats, and overexploitation of exhausted species for food, clothing and trophies (Hogan, 2014).

The international trade of millions of plants and animals is estimated to be worth billions of dollars annually. This wildlife trade is diverse and is comprised of live plants and animals, along with a vast array of wildlife products derived from them. Some species have become heavily exploited. As a result, those species and their products gain higher trading values, which, combined with other factors (e.g. habitat loss), is enough to severely deplete at-risk populations, bringing these species close to extinction.

Questions for Discussion

1. Are there any species at risk in your area? What is the main reason for the decline of this species? How can your school try to help recovery efforts?
2. How have humans impacted local plant and wildlife populations in your region? List both the positive and negative impacts.
3. Can you think of any major or minor disturbances/natural disasters that have occurred in Illinois in your lifetime? What were its impacts on biodiversity in your area?

What Makes a Bird a Bird?

STUDENT'S GUIDE

There are more than 9,000 species of birds in the world. More than 400 species have been recorded in Illinois. Birds are warm-blooded vertebrates. They have three characteristics that distinguish them from other animals: feathers; hard-shelled eggs; and hollow bones.

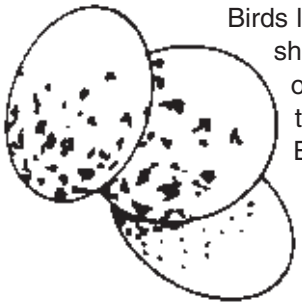
WARM-BLOODED

Like mammals, birds are warm-blooded, meaning that their body temperature stays the same no matter how hot or cold it is outside. This characteristic allows birds to maintain the high levels of energy needed for flying.

FEATHERS

Birds use their feathers in many ways, such as flight, regulation of body temperature (thermoregulation), protection of the body, attraction of mates and identification of species.

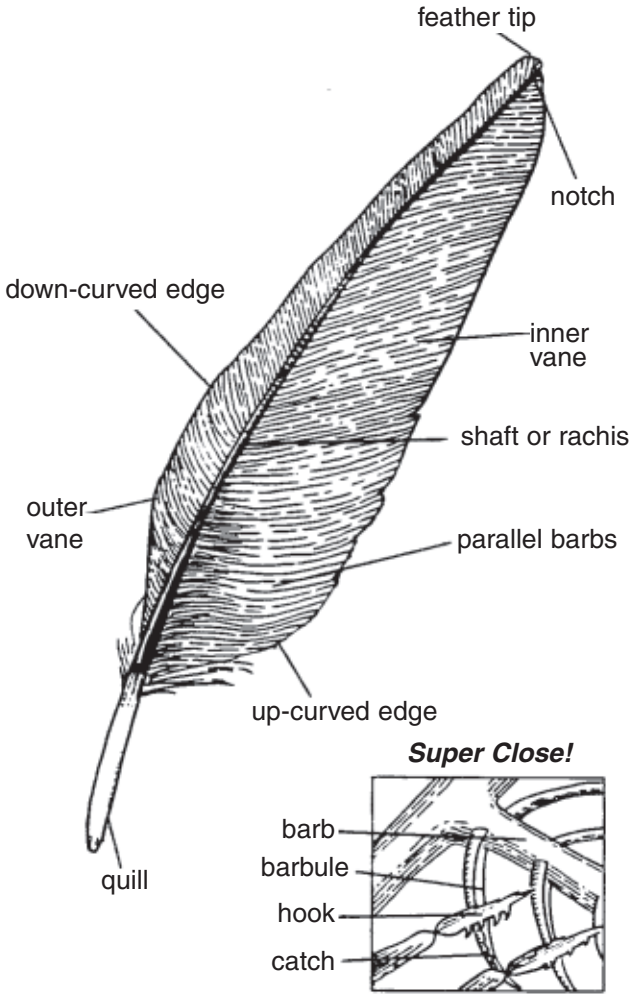
Contour feathers cover the body of a bird and have a strong, hollow shaft and network of hooks. Down feathers are small and are located under the contour feathers. The purpose of these feathers is to insulate the bird from the cold.



HARD-SHELLED EGGS

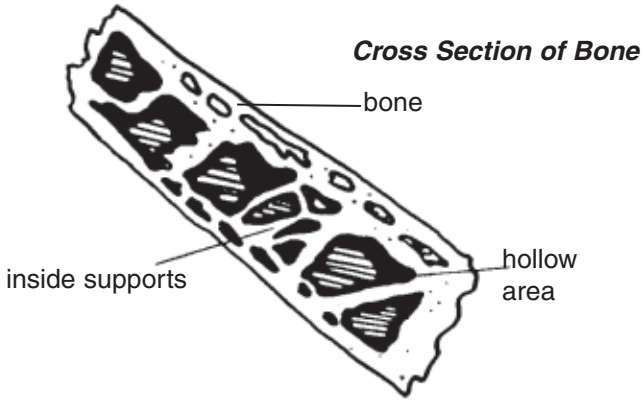
Birds lay hard-shelled eggs. The hard shell keeps an egg from drying out and allows parents to sit on the eggs during incubation. Even though bird eggs are hard-shelled, they have microscopic pores that allow oxygen to pass into and carbon dioxide to exit the shell.

Eggs come in a variety of colors, patterns, shapes and textures. Colors and patterns on eggs vary depending on the need for camouflage. The shape of the egg depends on where the bird nests. Most eggs are oval. Birds that lay their eggs on ledges need eggs with a pointed end so they will not roll off the ledge. The texture of an egg may vary from smooth (hummingbirds) to coarse (chicken, *Gallus gallus domesticus*).



HOLLOW BONES

Simply having feathers does not permit birds to be creatures of the sky. Extremely lightweight bones are also necessary for flight. Bird bones are strong and hollow with inside supports.



Home Tweet Home

STUDENT'S GUIDE

Habitat consists of cover, shelter, water and space. These are all components necessary for all living things to survive. Food is the material a species takes in allowing it to perform life functions. Cover provides protection for animals, such as places they use to nest, hide, sleep and travel. All wildlife needs water. The area required by an animal to survive is called space.

Illinois has four basic habitat types: wetland; forest; grassland; and urban (cities and towns).

Wetlands, which are low-lying areas filled with water at least part of the year, support water-loving plants. A variety of foods are available in wetlands including fishes, frogs and aquatic plants. Shelter for birds living in wetlands may include natural vegetation or humanmade structures.

Forests are classified by the main species of tree in the community. They provide a variety of foods for resident and visiting birds. Fruits, berries, nuts, insects, worms, mice and small birds are all common foods for woodland birds. Birds live in the branches of trees and on the ground. Some birds live in tree holes.

Prairies are fire-dependent communities of grasses and flowering plants. Prairie soils are very rich and have been almost entirely changed to agricultural land. Today, many of our remaining prairies are in small areas, such as along cemeteries, roadsides and railroad tracks. Many of the birds found in these areas are insect-eaters or seed-eaters. Grassland birds find nesting shelter within the thick grasses.

Cities and towns are also homes for birds. Parks, cemeteries, golf courses, ponds and backyard habitat areas all provide habitats for birds. Animals common to city areas tolerate humans. They even change to find foods and home sites in the city.

Birds of a Feather

STUDENT'S GUIDE

Birds that have similar characteristics are placed in a category known as a "family." The major families of birds common to Illinois are listed below.

heron
large body; eat fishes; wade rather than swim

duck, goose, swan
live in wet areas; usually have webbed feet

hawk
diurnal (active during the day); catch prey to eat

pheasant, turkey
relatively short, rounded wings; more likely to walk than fly

owl
nocturnal (active at night); catch prey to eat

pigeon
plump body; small head; small beak; known for "homing" ability

cuckoo
heavy, curved bill; two toes face forward and two toes face backward

nighthawks
fly at night to feed by sweeping insects out of the air; weak bill; large mouth

hummingbird
small body; very long, thin bill; hover when feeding

kingfisher
large bill; dive into water to catch fishes; large head

woodpecker
strong beak is used to drill into trees for insects; two toes point forward and two backward

flycatcher
flat bill with bristles at base; catch insects while flying

Natural Tools

STUDENT'S GUIDE

The bird world contains an amazing variety of beaks (bills). Beaks are used for eating, defense, feeding young, gathering nesting materials, building nests, preening, scratching, courting and attacking. The shape and size of each species' bill is specific for the type of food it gathers. Northern cardinals have a heavy, thick bill used to crack seeds. Meat-eaters, like the eagle, have a sharp, hooked bill to tear flesh. American robins have a varied diet and a bill shape that permits eating a variety of foods (worms, fruits). Ruby-throated hummingbirds have a thin bill to sip nectar.

Birds use their tongue for a variety of jobs, also. Tongues are used in drinking and also to hold, pierce and tear food.

Since birds consume great amounts of food, they have a crop (sac) which stores food until it moves to the gizzard. Small stones and grit in the gizzard grind the food. The gizzard is made of strong muscles. In the wood duck those muscles can break down a whole acorn.

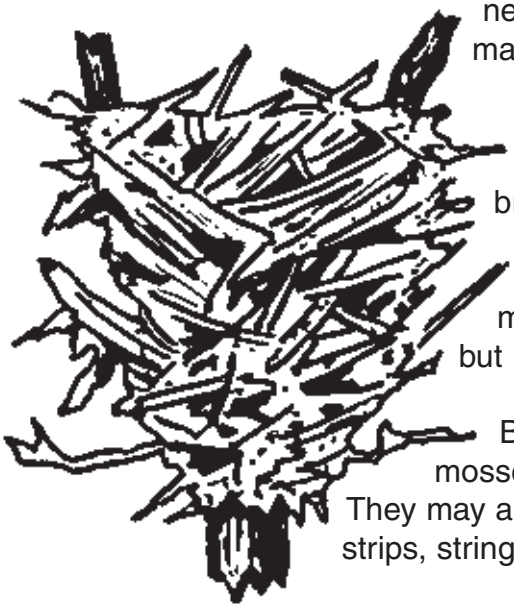
Birds have a high metabolic rate and must eat often to survive. Most birds must continually search for food. Only a few birds, such as American crows and nuthatches, store food for future use.

House Plans

STUDENT'S GUIDE

Birds spend varying amounts of time and energy constructing their nest. Some spend days or weeks building a nest, while others simply scrape a small depression in the soil or pile a few twigs together.

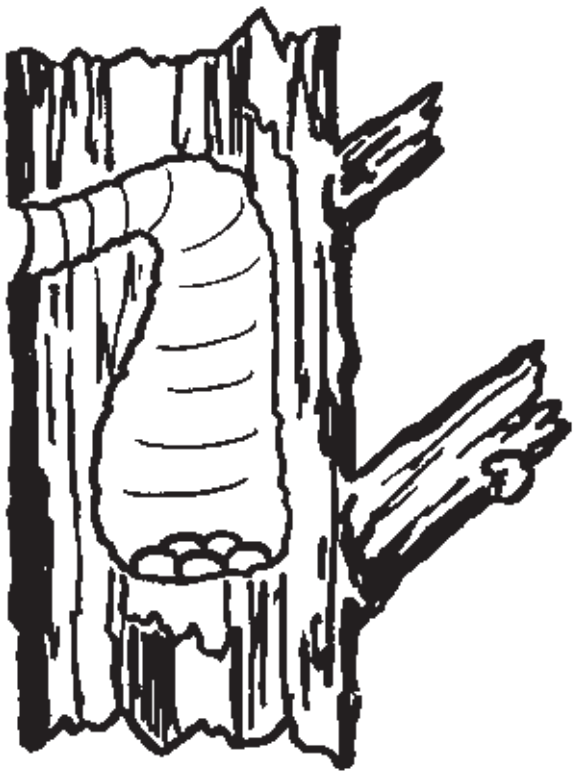
Birds use a variety of materials to build their nest. The area the bird lives in determines the type of nesting materials used and the location of the nest. Some prairie birds use grasses for nesting material and make their nest on the ground. City birds may nest in chimneys, stop lights and business signs. Some wetland birds may construct nests on floating mats of vegetation.



Some woodland birds make their nest of plant fibers, twigs and leaves. Some locate their nest above the ground in the branches of bushes and trees, while others nest on the ground or inside a tree cavity. Some birds, like the great horned owl, do not build their own nest but use the old nest of other animals. Brown-headed cowbirds also do not make their own nest but lay their eggs in other birds' nests.

Birds use a variety of natural materials in their nest such as mosses, mud, lichens, plant seeds, hair, snake skins and feathers. They may also use humanmade items in nests, such as yarn, plastic strips, string, paper and aluminum foil.

Eggs are laid over many days. A nest of eggs is called a clutch. The time from when the last egg is laid until the last egg is hatched is called the incubation period. Hatching may take several hours or even days.



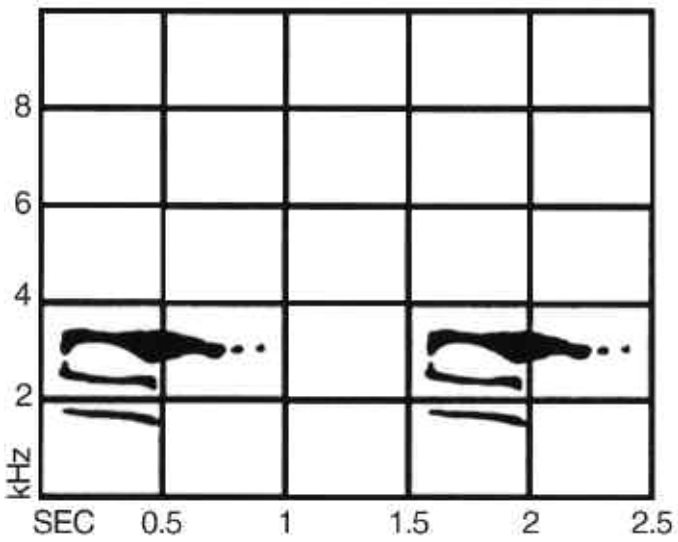
Care and protection of young birds takes a lot of time. Some chicks are born fully feathered and able to see (precocial). Ring-necked pheasant chicks are able to follow their parent and feed themselves soon after hatching. Other birds are born with their eyes closed and without feathers (altricial). American robins remain in the nest to be fed by a parent.

Raising chicks is an endless, daily chore for the parents. Nonstop flights are made to gather food and clean the nest. To survive, some chicks must eat half their body weight in food each day. Some may eat thousands of insects before they leave the nest.

Bird Banter

STUDENT'S GUIDE

blue jay song pattern



Birds communicate by songs and calls or other noises, like tapping and drumming. Courtship flights and dances are other ways birds communicate.

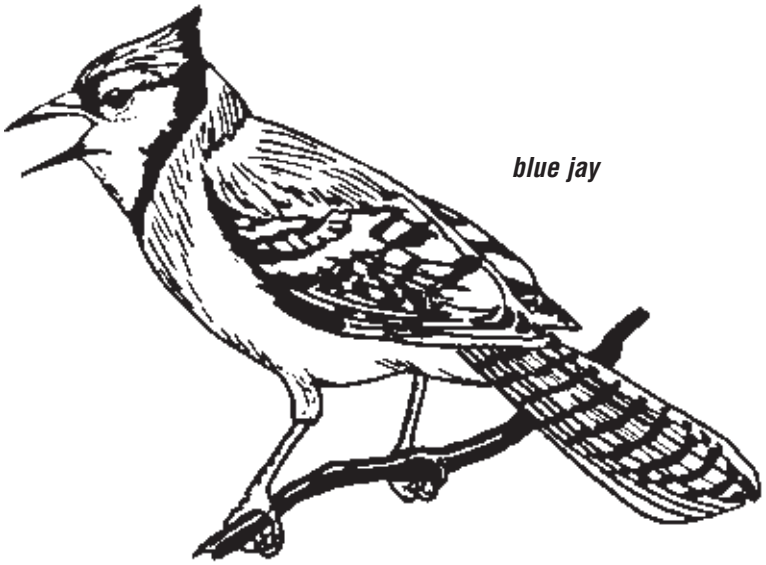
Songs are specific patterns of notes repeated with few variations. Songs are used to attract mates and mark the territory necessary to raise young. Each species has its own specific song or songs. Some birds have over a dozen calls and songs (northern cardinal). Some birds are able to mimic the songs of other birds (gray catbird, northern mockingbird), humans and car alarms (European starling). Some birds are born knowing how to sing. Others must listen to calls of adult birds of their kind and practice the calls before perfecting them.

When alerting others of danger, birds call. Calls are also made when feeding or migrating. Precocial (independent) young communicate with their parents through a location call. When a covey of northern bob-white is split up, they locate each other and rejoin the group through a gathering call.

Birds do not have vocal cords. To produce sounds, vibrations are sent across the syrinx (voice box) of a bird. The more muscles a bird has attached to the syrinx, the more sounds it can make. For instance, northern mockingbirds have many muscles and can produce a variety of sounds, while rock pigeons' singular pair of muscles results in only the single "coo" sound.

A variety of other types of communications are used by birds. Hungry nestlings peck at their parents' beak or open their mouth widely to beg for food. Male ruffed grouse "drum" and greater prairie-chickens "boom" to attract a mate. Sandhill cranes and American woodcocks have elaborate mating dances and flights. A male wild turkey will spread its tail and drop and "rattle" its wings to attract a mate.

Communication is very important to birds. Without communication, many birds would starve, lose their way during migration or be unable to defend a territory or find a mate.



blue jay

ACTIVITY PAGE

Hello, Mate

Make one copy of this page. Cut out the cards and distribute one to each student. The students move around the class and compare clues until they think they've found their correct mate. Students share with the class who they think their bird match is and explain why.

Note to teacher: *Consult this complete sheet for the answers. Matching cards are printed in left/right pairs. If additional clues are needed, print half of the bird name on each card of the pair.*

RED-BELLIED WOODPECKER	"I live in trees and get insects out of trees with my sharp beak. My tail is stiff and serves to prop me up as I move up and down the tree."	"I love to eat insects and have a very hard bone on my forehead that keeps me from getting a headache when I get my lunch."	"I am a very small bird and make my nest in a chimney of a house."	"I have a very small house that I make with my mate and if there are no other places for our nest, we build it in part of people's houses."	CHIMNEY SWIFT
BALD EAGLE	"I am a very large bird and make an enormous nest in the top of a tree."	"I am a symbol of the United States, and my nest in a treetop can be 10 feet wide and 10 feet high!"	"I have long legs and eat fishes and other wetland species."	"Look at my lovely plumes hanging from my neck. I migrate in the spring and summer and live in wetlands."	GREAT BLUE HERON
WOOD DUCK	"I live in wetlands. I eat plants and have short legs and webbed feet."	"Check out my fabulous colors and my handsome crest! I nest in hollow trees in wetlands."	"I nest in hollow trees. I am one of the most successful species on earth, but many people don't like me because I'm noisy."	"I'm a noisy, small bird with an attractive feather coat which reflects iridescent colors. I can imitate the beautiful songs of dozens of birds."	EUROPEAN STARLING
CEDAR WAXWING	"I get my name from the red waxy tips on my wings. I am usually in a flock with others of my species."	"Large flocks of us can be seen feeding on the fruits of trees each fall."	"I have good night vision, so I hunt for my food at night."	"I can turn my head 3/4 of the way around so I can almost see behind me. I fly nightly on silent wings to catch mice and other nocturnal species."	OWL
YELLOW-BELLIED SAPSUCKER	"I am a winter resident in Illinois and peck neat horizontal rows in the bark of trees. I eat the inner bark of the tree and return later to eat the sap."	"I am a type of woodpecker. My name describes both the color of my belly and my preferred food."	"Watch me move headfirst down the tree. I find foods that other birds have missed."	"I am a cavity-nesting bird and have a different view of life than other birds."	WHITE-BREASTED NUTHATCH
BLACK-CAPPED CHICKADEE	"I eat several hundred insect eggs each day. Look for me hanging upside down."	"I call out my name. I am one of the smallest birds in the woods, but I am noisy and fun to watch as I hang upside down."	"My mate and I both have a crest on our head, but I am red. I live in Illinois year-round, and people think I look pretty against the snow."	"I am brown and have a crest on my head. I use my heavy seed-eating bill to gather food throughout the year."	NORTHERN CARDINAL
RED-WINGED BLACKBIRD	"I don't look anything like my mate. I am the male and am black with bright red shoulder patches. Look for me in wet areas."	"I am drab compared to my mate but that helps me protect my nest and young. I often build my nest in cattails."	"People call me the buffalo bird because I followed herds of buffalo to eat the ticks off their backs. Many people don't like the way I nest."	"I am a nest parasite, which means I look for nests of other birds and lay my eggs there so I don't have to care for my young."	BROWN-HEADED COWBIRD
HOUSE SPARROW	"We've only been in North America for about 150 years but have become one of the most common bird species."	"We've really made ourselves at home in this new land! Some people don't like us because we take nesting sites from some native species."	"My natural habitat was cliffs and rocky ledges, but I do very well living on the ledges of city buildings and bridges."	"I have been domesticated by man for thousands of years. I can fly more than 80 miles an hour but still like to live downtown."	ROCK PIGEON

Moving Day

STUDENT'S GUIDE

More than one-third of the world's birds migrate. Migration is an instinct triggered by seasonal changes in weather and lack of food.

What causes the urge to migrate? Changes in the angle and amount of sunlight may trigger migration. Low pressure areas in the fall trigger a southward migration. High pressure in the spring encourages movement to the north. A lack of food in the fall and winter may also send birds toward areas where food supplies are more readily available.

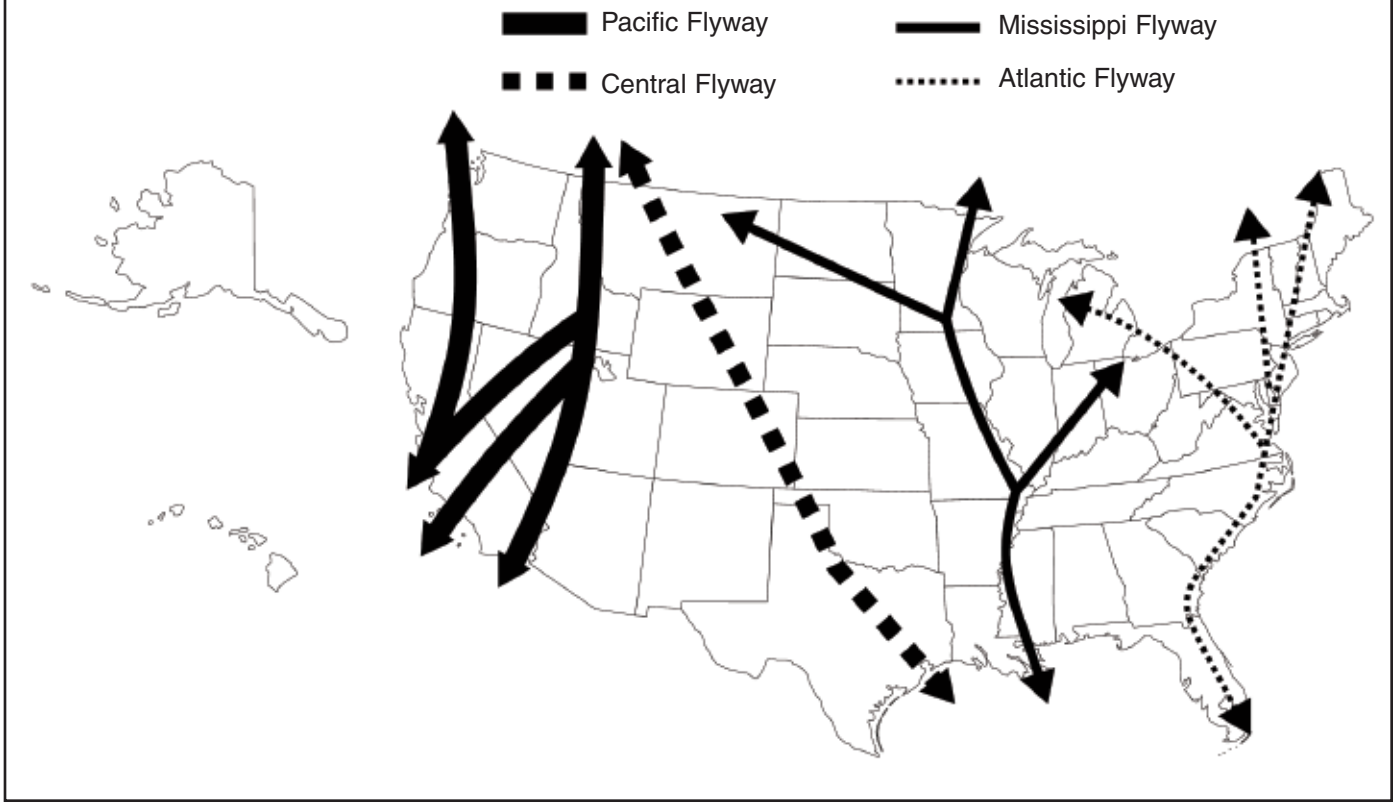
Birds migrate during the day or night. Daytime, or diurnal, migrators are generally larger (geese) or are predators (hawks). These birds navigate by sight and have few, if any, predators. Songbirds migrate in darkness (nocturnal). Their daylight hours are spent searching for food and resting for the next leg of their trip.

The ability of birds to migrate great distances and return to the same general area year after year is a subject which has fascinated people for centuries. Diurnal migrators fly along broad air routes established by physical features such as major rivers, coastlines, mountains and lakes. The position of the stars and moon and the earth's magnetic field are used by nocturnal migrators.

Birds encounter many hazards during their migration. Nocturnal and low-flying migrants risk flying into humanmade objects such as tall buildings, power lines and towers, windows and aircraft. Songbirds may encounter predators (hawks) migrating at the same time. Habitat destruction and pollution are also migrational hazards.

Storms during migration kill migrant birds. Hunting seasons are established for some species (ducks, geese, mourning doves) during the fall migration. Even though birds are harvested, hunting is only allowed within limits that a population can withstand.

migratory bird flyways



Right or Wrong – You Decide

STUDENT'S GUIDE

We cannot open a newspaper or watch the evening news without seeing stories on the environment. Often the news is sad: an oil spill killing marine life for miles; leaky underground storage tanks affecting water supplies; acres of quality habitat falling under the bulldozer; or the thinning of the ozone layer. We have the power to change those stories!

Conservation of our natural resources is critical. One part of conservation is preservation of habitat. We must also reverse and change actions that degrade or destroy quality habitat. Conservation of natural resources may require new laws. The U.S. Fish and Wildlife Service is responsible for migratory species. This agency works with state agencies to establish guidelines for harvest and protection of waterfowl. It also designates and protects species considered threatened or endangered at the national level.

What roles do people play in the conservation of natural resources?

- report natural resource violations;
- work toward legislation to protect and manage resources and vote for legislators who support it;
  –boycott the purchase of wild-captured parrots and finches;
- purchase hunting licenses and habitat stamps;
- contribute to the Wildlife Preservation Fund;
- pay taxes;
- become a member in organizations that purchase and manage habitats;
- leave "orphaned" wildlife alone;
- practice organic farming;
- use environmentally-friendly pesticides.

Can you name others?

BIRDING ETHICS

- Leave nests alone and don't get close--you could cause the parent to abandon the nest or lead predators to the eggs or young.
- Show respect for landowners and lands. Respect the rights of others observing nature.
- Leave "injured" and "orphaned" birds alone. The parent is often nearby and will return to care for the young.
- Understand and obey hunting regulations.
- In nature, you are the guest. Be quiet and orderly. Move slowly.
- Don't "chase" birds. Observe birds from a distance using your binoculars to bring them close.
- Leave no litter. Some litter, especially fishing line, plastic soda can and bottle rings, bubble gum and cigarette butts, can be harmful to birds.
- If you are feeding birds, maintain fresh and adequate food supplies for them. Don't feed birds your food—they are healthiest when they eat natural foods.
- Don't bring predators along. Your dogs and cats belong at home.

Here Today... Gone Tomorrow

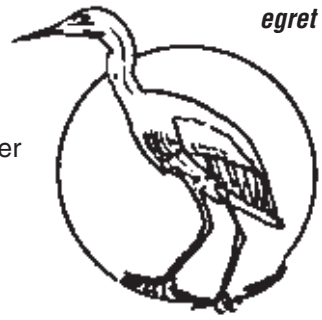
STUDENT'S GUIDE

Today, more than 9,900 species of birds inhabit the world, with than 1,240 species listed as endangered, threatened or vulnerable as of 2010. In the United States, 92 bird species are listed as endangered or threatened. Illinois lists 25 bird species as endangered and five as threatened species.

Flocks of passenger pigeons *(Ectopistes migratorius)* once blackened the skies of North America for hours during their migrations. Passenger pigeons were a popular food item in the 1800s and were killed and shipped in large quantities to metropolitan areas. By 1895 these birds were considered rare. The last passenger pigeon died in the Cincinnati Zoological Gardens on September 1, 1914.

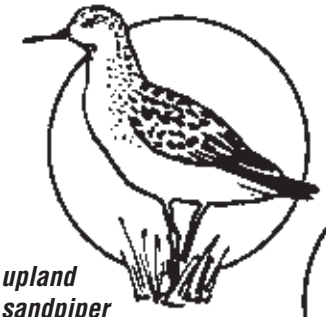
Numbers of the upland sandpiper, a state endangered species, have plummeted because of the loss of prairie. Today, these birds may be found sporadically throughout the state, but the largest known concentration of nesting birds is in Will County at the Midewin National Tallgrass Prairie. Large expanses of short grass prairies or open pastures such as found on dairy farms or airports would provide attractive nesting habitats.

Why are species listed as threatened or endangered? By law, changes to the endangered/threatened species list for the state must be based on scientific evidence. Factors that are considered when evaluating a species include changes in population size, changes in range in the state, whether it occurs at protected sites, any known threats to its existence, as well as features of its life history which might have a bearing on survival. The Endangered Species Protection Board may remove from the Illinois endangered/threatened species list any nonfederally-listed species for which it finds satisfactory scientific evidence that its wild or natural populations are no longer endangered or threatened in Illinois. A public hearing is held to consider the Board's action of listing, delisting or changing the list status of a species.



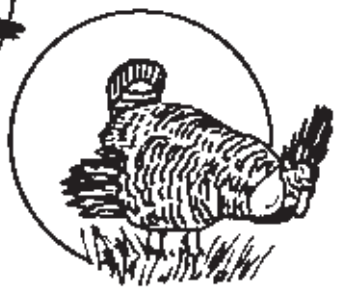
egret

Historically, species were jeopardized due to unregulated hunting, excessive use of animal products (egret plumes for women's hats) and pesticides. Today, loss or destruction of winter and breeding habitats is the primary reason for bird species' declines. Nest predation, nest parasites, loss of food sources and capture and sale of wild birds to pet shops affect some bird populations. Thousands of migratory birds are killed each year when they fly into tall buildings, television towers and electrical power lines and towers.



upland sandpiper

However, several species are now on the comeback trail. Scientific studies to understand the life requirements of the species, establishment of hunting regulations and public involvement in programs to preserve, protect and manage habitats and species are helping many birds.



greater prairie-chicken

Hibernation

STUDENT'S GUIDE

During harsh, cold winters like we have in Illinois, many of the foods mammals need become scarce or are not available. In order to survive these periods of limited food supply, some mammals hibernate. **Hibernation** is like a very deep, long sleep. This condition of **dormancy**, or inactivity, allows a mammal to live a long time on very little food.

The rate at which a living creature uses the energy it receives from food is called **metabolism**. During hibernation a mammal's rate of metabolism is slowed substantially.

Also during hibernation, a mammal's body temperature drops greatly as does its heart rate and breathing rate. While a normal body temperature may be 95°F, during hibernation it can drop as low as 36°F. A normal heart rate of over 100 beats per minute may drop to only four or five per minute. Breathing may slow to about one breath per minute.

Before they begin hibernation, mammals eat so much that they develop a thick layer of fat. This fat will supply them with the energy they will need during their long "nap." Some hibernating mammals will lose as much as one-third of their total body weight during hibernation. Mammals that do not hibernate deeply gather and store food to eat during wakeful periods.

Hibernation is never continuous. There are always periods of wakefulness, which become more frequent as the hibernation period comes to an end. For each species that hibernates there is a **critical temperature** above which they will wake, and they will wake temporarily if the temperature drops so low that they are in danger of actually freezing. Upon waking they can move to a deeper, warmer chamber or warm up a little by shivering or moving around until the temperature rises.

HIBERNATING THIRTEEN-LINED GROUND SQUIRREL

As spring approaches and the air warms, food is once again available, and the hibernating mammal will waken and return to normal activity.

CHALLENGE YOURSELF

1. Why do some animals hibernate?

2. What do hibernating mammals live on?

3. What will waken a hibernating mammal?

4. How do you think hibernation is different from regular sleep?

5. What do you think might be a disadvantage of hibernation?

VOCABULARY

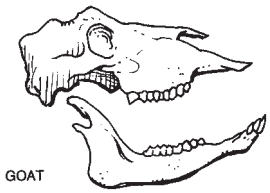
critical temperature
dormancy
hibernation
metabolism

The Right Teeth

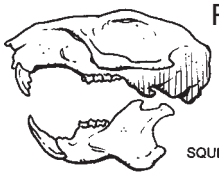
STUDENT'S GUIDE

Most mammals have three kinds of teeth: **incisors** used for grabbing, cutting and gnawing; **canines** used for stabbing and tearing; and **premolars** and **molars** for grinding and shearing. The type of teeth a mammal has will determine how and what it can eat. Mammals can also be grouped by what they eat.

Herbivores


GOAT

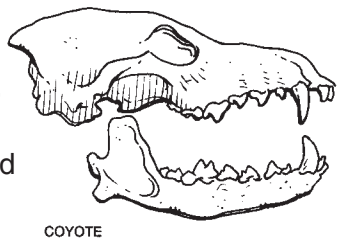
Mammals that eat only plants are called herbivores. There are two kinds of herbivores. Plant-tearing herbivores, such as deer and goats, have incisors only in their lower jaws, no canines and flat, sharp-edged premolars and molars.


SQUIRREL

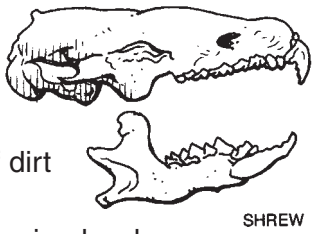
Plant-gnawing herbivores, like beavers and squirrels, have large, sharp incisors in both upper and lower jaws, no canines and flat premolars and molars.

Carnivores

Mammals that eat only other animals are called carnivores. Bobcats, foxes and coyotes are some Illinois carnivores. They have small but sharp incisors for grabbing and holding; long, fanglike canines for stabbing and tearing; and large, sharply edged premolars and molars for slicing through flesh, bone, skin, scales, fur and feathers.

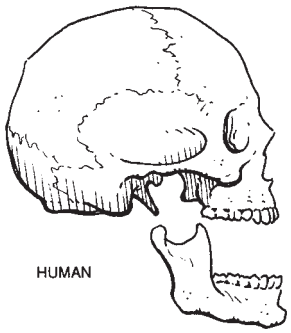

COYOTE

Insectivores


SHREW

Like shrews, moles and some bats, some animals eat only insects. They are called insectivores. They have long incisors for picking insects out of dirt and leaves and small, but very sharp canines, premolars and molars for chewing hard-shelled beetles, other insects and worms.

Omnivores


HUMAN

Some animals, like raccoons and humans, are called omnivores. They have all three types of teeth, allowing them to eat plants and flesh.

CHALLENGE YOURSELF

1. How do animals other than mammals—like birds, fishes, insects and reptiles—bite, chew and eat their food?

2. Can mammals in one category eat the food of mammals in other categories? Why or why not?

3. Explain the difference between the four feeding categories and give an example of a wild Illinois mammal in each category. (HINT: Use the "Species Sheets" to find the examples.)

VOCABULARY

canines
carnivore
herbivore
incisors
insectivore
omnivore
premolars/molars

The Predator-Prey Relationship

STUDENT'S GUIDE

Among the mammal species in Illinois are some we call **predators**. Predators are animals that catch, kill and eat other animals. The animals that are eaten are called **prey**.

Some predators, like bobcats, are called strict predators because they eat only other animals. Others, like raccoons and opossums, will, in addition to catching and eating prey, also eat a lot of berries, nuts and plants.

Most predators are themselves prey to other, larger predators. A weasel that eats a field mouse for lunch may itself be dinner for a bobcat. Those predators that are not prey to others are called **top predators**.

Both predators and prey are links in what is called a **food chain**. Food chains are the routes along which energy flows through the living world.

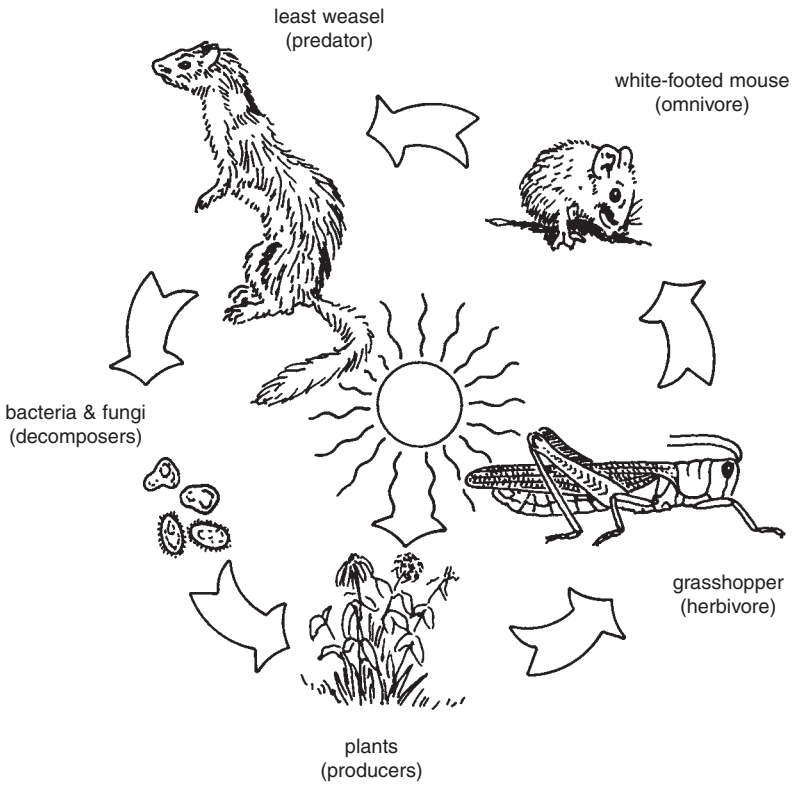
This energy always starts with the sun. Through a process called **photosynthesis**, plants are able to use the sun's energy to convert carbon dioxide, water and nutrients from the soil into food. Animals like rabbits and deer eat the plants and use the food energy for their own needs. When they become prey, the energy is transferred to the predator.

But the flow of energy doesn't end there. Even top predators eventually die, and then their bodies become food for **scavengers**, those animals that eat the bodies. The remains of all animals are broken down into their simplest compounds by microscopic bacteria and fungi. These compounds are the nutrients that plants then use for their own growth. The food chain becomes a closed cycle which begins all over again.

CHALLENGE YOURSELF

1. What are the two predators in the "A Food Chain" diagram?
2. What is the sun providing to the plants in the diagram?
3. What are two prey items in the diagram?
4. What is represented by the arrow between the least weasel and the bacteria and fungi?
5. Can a mammal be both a predator and a prey item? Explain and give an example.

A FOOD CHAIN



VOCABULARY

food chain	prey
photosynthesis	scavenger
predator	top predator

Endangered and Threatened Species

STUDENT'S GUIDE

When all members of a particular species have died, the species has become **extinct**. Dodo birds and passenger pigeons are extinct.

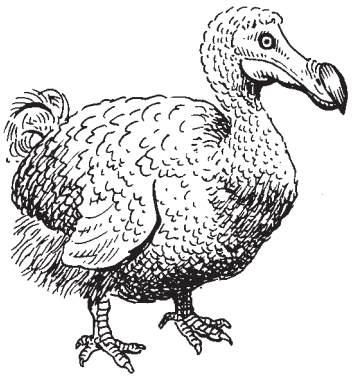
Extinction is a natural process and often has natural causes. If the climate changes greatly, as it has at different times in the past, many species unable to live in the new conditions will die. Many scientists believe this is what happened to the mastodon and other species during the last Ice Age.

Since the 1600s, several hundred species of wildlife, including the dodo bird and passenger pigeon, have become extinct directly or indirectly as a result of human activities. When humans excessively clear forests or other habitats for their own use, kill great numbers of animals for personal or commercial use or pollute the water and land, many species are driven toward extinction. Sometimes our activities interfere with natural migration routes or breeding behaviors. If we introduce a foreign or alien species into an ecosystem, it can change or even destroy the delicate balance of the food chain.

In Illinois one or another of these activities is threatening barn owls, spotted turtles, eastern woodrats, Indiana bats and other species.

When the number of a species is low but stable, we say it is **rare**. If its numbers are low and getting lower, and it is likely to become **endangered** as a breeding species within the foreseeable future, we say it is **threatened**. When it is threatened with extinction, we say the species is endangered. If it has been eliminated from a part of its historic range, it is **extirpated** in that area.

It is our responsibility to recognize and evaluate the consequences of our actions and, through planning and management of our natural and cultural resources, strive to correct and avoid them. Education, careful planning of construction and development projects, acquisition of critical land and more stringent environmental regulation may help to slow the process, but even these practices do not offer guaranteed results. There have been successful efforts, though. The reintroduction of the North American river otter to its historic habitats in Illinois has resulted in the establishment of this species that was once thought to be headed for extirpation.



DODO BIRD – failure

NORTH AMERICAN RIVER OTTER – success

CHALLENGE YOURSELF

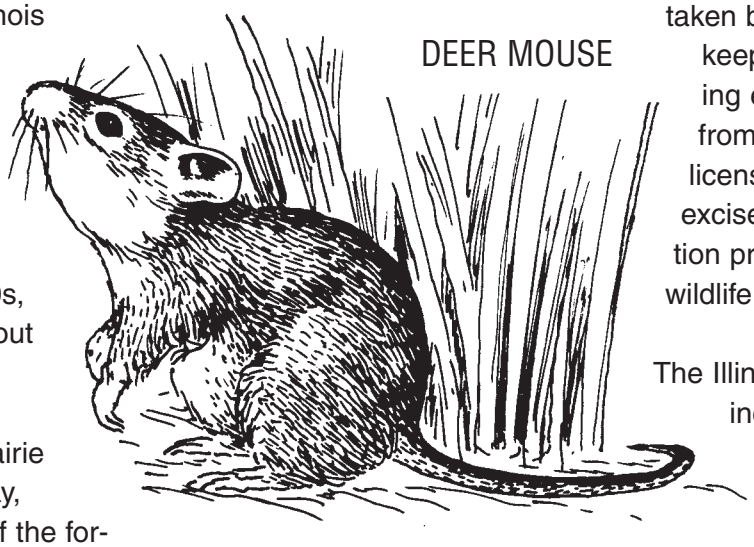
1. What is extinction?
2. What do you think would happen in an ecosystem if predators became extinct?
3. How can we help a species that is endangered?
4. Since extinction is a natural process, why would we be concerned about our actions and the problems our actions have caused?
5. The American bison has been extirpated from Illinois. What does this statement mean?

VOCABULARY

endangered
extinction
extirpated or extirpation
rare
threatened

Maintaining Mammals

STUDENT'S GUIDE



DEER MOUSE

Early settlers in Illinois found clear streams, sprawling prairies and vast forests, all inhabited by many kinds of wildlife. In the 1820s, forests covered about 38 percent of the state; the rest was mostly tallgrass prairie and wetlands. Today, about 14 percent of the forest and one percent of the grassland remain. More than nine million acres of wetlands have been reduced to less than 500,000 acres.

These changes mean a drastic loss of **habitat**, or natural environment, for wild mammals. Modern farming practices, urban sprawl, pollution, **habitat fragmentation** (dividing up natural environments by agricultural or urban development) and flood-control activities (which drain wetlands of water) are the most serious threats to the survival of Illinois' wild mammals.

People who have land they want to use to help provide habitat for wildlife can join a program called Illinois Acres For Wildlife. The person who owns the land gets help from a biologist in deciding what to do to make the land a better home for Illinois mammals and other wildlife.

Hunting and trapping are highly regulated activities in Illinois. Laws limit when, where and how many animals may be taken by hunters and trappers and keep these species from becoming endangered. Fees collected from hunters and trappers for licenses, special stamps and excise taxes go toward conservation programs which benefit all wildlife species.

The Illinois Nature Preserve System includes more than 350 nature preserves across the state (as of 2009). These preserves protect special habitats. Many of the state's rare and endangered species live in these preserves.

In addition, there are many other public and private conservation organizations and groups striving to understand, manage and protect our natural environment.

By making a commitment to the importance of preserving our natural heritage and to maintaining a wide range of plants and animals, we can all learn to share the world of living things.

CHALLENGE YOURSELF

1. How do you think each of the following factors affects the loss of natural habitat? Modern farming practices like chemical fertilizers and pesticides; expansion of urban and suburban development; pollution; flood-control programs.

2. What can you do to help maintain wild mammals?

VOCABULARY

habitat
habitat fragmentation

What could be the harm in transplanting an exotic species to your yard? Read on.

Invasive Exotic Plants in Illinois

Story By S. Raghu, Susan Post and Robert Wiedenmann
Photos By Michael Jeffords, INHS

(Photo By Joe McFarland.)

Humans have moved plants for their food, fiber and aesthetic needs throughout much of history, but the modern era of global trade and commerce has accelerated that rate to unparalleled levels. This presents great opportunities and threats.

On one hand, we have unprecedented access to plants from a vast array of exotic regions of the world; on the other hand, these plants can wreak considerable economic and ecological havoc. Just as any other region of the world, Illinois is not impervious to these opportunities and threats.

Almost every major crop grown in Illinois was introduced from some other region of the world. Given how vital those crops are to our subsistence, it is not surprising that many of these are accepted with little question as a part of our landscape. Seldom do these 'exotic' plants make the insidious transition and become 'invasive,' a term reserved for organisms that escape, cause problems and cost us money. Invasive plants often inflict irreparable harm to native species and ecosystems, and equally to regional and national economies. Recent estimates place the annual cost of the impact and management of invasive plants in excess of $35 billion.

Although probably introduced as an herb in the 19th century, it was only recently that garlic mustard became an aggressive invasive.

Significant invasive plants in Illinois are found in all habitats: woodland, wetland, prairie and roadsides. Invasive plants include kudzu, garlic mustard, musk thistle, Phragmites, reed canary grass, buckthorn, purple loosestrife, teasel and leafy spurge. Waiting at our doorstep are an ever-increasing list of invaders, including giant hogweed, mile-

a-minute weed and apple of Peru. The need to develop solutions to reduce the impacts of the current invaders, and anticipate and prevent impending threats, is obvious and urgent.

Given that not all exotic plants become invasive (see editorial on garlic mustard vs asparagus), an important step in managing exotic invaders is to understand why an introduced plant becomes invasive in the first place. Two significant, and related, reasons are thought to be important—that the invader is a significantly stronger competitor than native plants and that the invader, in being moved from its native range, has escaped from its natural enemies (usually specialist insects and pathogens) that kept its populations under control.

Freed from these natural checks and balances, the introduced plant can become a more-effective competitor, thereby gaining a foothold. The use of biological control, to reunite the weed with its natural herbivores, can be an effective and safe solution in managing the invader.

Biological control is the first step in reducing the population of the weed. The second step is to restore the habitat by replanting or managing native plants to keep the invader from coming back. Often, the sensitive nature of habitats invaded by exotic plants dictates that biological control may be the only safe management option. The purple loosestrife biological control program at the Illinois Natural History Survey (INHS) is an excellent example of the success of this method (see sidebar).

Significant research is being undertaken at INHS to understand why introduced plants become invasive and how to manage them. We highlight some of this research below.

Garlic Mustard

Possibly introduced as an herb from Europe in the 19th century, this forest invader is regarded among the most significant ecological threats in the eastern United States. Almost every wooded area in Illinois has been invaded by garlic mustard (*Alliaria petiolata*).

Mechanical control is futile, and chemical control is risky because of the sensitive nature of other plants in the forest understory. There is some promise on the biological control front. Several species of weevils are being evaluated in quarantine in Minnesota for their specificity, a step critical to the safety of this method to ensure that they will not feed on native or crop mustards. While this research in being done, INHS researchers are engaged in collaborative research on the population dynamics of this plant, its interaction with other forest herbs and shrubs, and the value of different management methods.

Leafy Spurge

Leafy spurge (*Euphorbia esula*) has been regarded as a problem since the early 20th century, but it is a relatively recent invader into Illinois. At least 20 populations have been discovered in the greater Chicago region. The success of this toxic Eurasian perennial is thought to be linked to its ability to produce chemicals that inhibit the growth of other plants.

Although predominantly a weed of agricultural lands, leafy spurge has been found in several natural areas (restored and natural prairie) in northern Illinois. As in the case of garlic mustard, the feasibility of chemical and mechanical control methods is limited in such sensitive habitats, thereby creating the need for development of biological control methods.

Several species of specialist flea-beetles have been successfully used in managing leafy spurge in other regions of the country. Research is ongoing at INHS to determine the most suitable and effective control agents, and to understand the vulnerability of different prairie species to the chemicals of leafy spurge. This research will help land managers select suitable species for restoration plantings.

(Photo By Susan Post.)

(Photo By Lori Schwab.)

Scientists attribute the success of leafy spurge—a native of Eurasia—to a chemical it produces that inhibits growth of other plants.

Teasel

Cut-leafed (*Dipsacus laciniatus*) and common (*D. fullonum*) teasels have been in North America for nearly two centuries, and were originally brought in from Europe to tease/comb wool. Their spread may be linked to increased use in dried flower arrangements, as a homeopathic medicinal item and as a component of bird seed mixes.

The use of teasel in bird seed mixes and dried flower arrangements may have helped spread this European plant.

These biennials have emerged as significant invaders of roadside and other open habitats in the last two decades, with cut-leaf teasel being the major species of concern in Illinois. Teasel differs from garlic mustard and leafy spurge in that it tends to invade marginal habitats (e.g. roadside right-of-ways, old fields), and therefore its economic and ecological impacts are less obvious. It may pose a risk to traffic safety, as the weed is known to lead to drifting snow along roadside edges.

Ongoing collaborative research between INHS and USDA scientists in teasel's native range (Europe) is focused on identifying suitable biological control agents. So far a moth whose larvae tunnel in the seed head and a flea-beetle that feeds on the leaves offer hope. Detailed ecological investigations also are under way to identify the teasel life-stage where management intervention would have the biggest impact.

Buckthorn

Buckthorn (*Rhamnus spp.*), a European species brought in as an ornamental hedge, is a major invader of almost every wooded natural area in northern

Are you managing garlic mustard?

The Illinois Natural History Survey is interested in learning from your experiences in managing garlic mustard. If you are interested in participating in a survey to share your experiences on garlic mustard management, email your complete contact details (address, phone number, email address) to Susan Post (INHS, 1816 S. Oak St., Champaign, IL 61820; spost@inhs.uiuc.edu).

Citizens to the rescue

The Illinois Natural History Survey's (INHS) Purple Loosestrife Biological Control project has flourished as a result of a strong partnership with land managers, students, educators—and homeowners such as Jack Mommsen and the late Beverly Mommsen of Crystal Lake. After learning about the school-based Galerucella beetle project, the Mommsens wondered why homeowner associations couldn't rear the beetles as well. Following a training workshop held in 2001, the Mommsens reared approximately 25,000 beetles (nearly 1,000 beetles per cage) for release in their subdivision.

During 2002 and 2003, the Mommsens recruited members of their homeowner association and provided invaluable assistance during workshops, sharing techniques for caging and potting plants. By 2003 their group had 68 cages in production, releasing tens of thousands of loosestrife-munching beetles into their wetlands.

The INHS Loosestrife team visited their site during 2004. Purple loosestrife—when it could be found at all—was stunted and showed evidence of beetle feeding. Native vegetation was coming back and the focus of the homeowner group then shifted to native plantings. For their efforts, the Mommsens were recognized as one of the 2004 Department of Natural Resources Volunteers of the Year.

(Photo By Bev Mommsen.)

Jack Mommsen and his late wife, Beverly, led their homeowner's association in a biological assault on purple loosestrife.

Illinois. This woody perennial outcompetes other plants for nutrients, light and moisture. The dispersal of seeds by birds feeding on its fruit, combined with the sensitive natural areas buckthorn invades, makes it a particularly hard species to control.

Recent discovery of buckthorn serving as a winter host for the invasive soybean aphid, has raised its profile as a major threat for economic and ecological reasons. This association of an invasive insect with an invasive weed has renewed interests in developing biological control options.

Used as an ornamental hedge, buckthorn has invaded northern Illinois woodlands to the detriment of native plants.

Future Invaders

Although significant strides are being made in the management of the current cohort of invasive plants, the increasing pace of global trade will require continuous monitoring and a proactive approach to anticipate the risks of species introductions. One step in this process was the establishment, in 2005, of the Illinois Invasive Species Council, an advisory group made up of INHS scientists and other experts working on various aspects of ecology and management of exotic species. The role of this group will range from helping coordinating early detection and management of new invaders, to reviewing exotic species introductions into Illinois in light of the Illinois Exotic Species Act.

Clearly, new economic opportunities in the nursery trade and agriculture will continue. However, equally clear is the need that these pursuits are made in a way that recognizes the economic and ecological risks that exotic invasive species pose to the diminishing Illinois wilds.

(Photo By David Voegtlin.)

Dr. S. Raghu heads the new Illinois Natural History Survey (INHS) Ecology and Biological Control of Invasive Plants laboratory. Susan Post is an INHS research biologist. Dr. Robert Wiedenmann served as the director of the Center for Ecological Entomology at INHS until March 2005 and is presently the head of the Department of Entomology at the University of Arkansas.