Iowa's NATURE SERIES

VERTEBRATES

Peregrine falcon

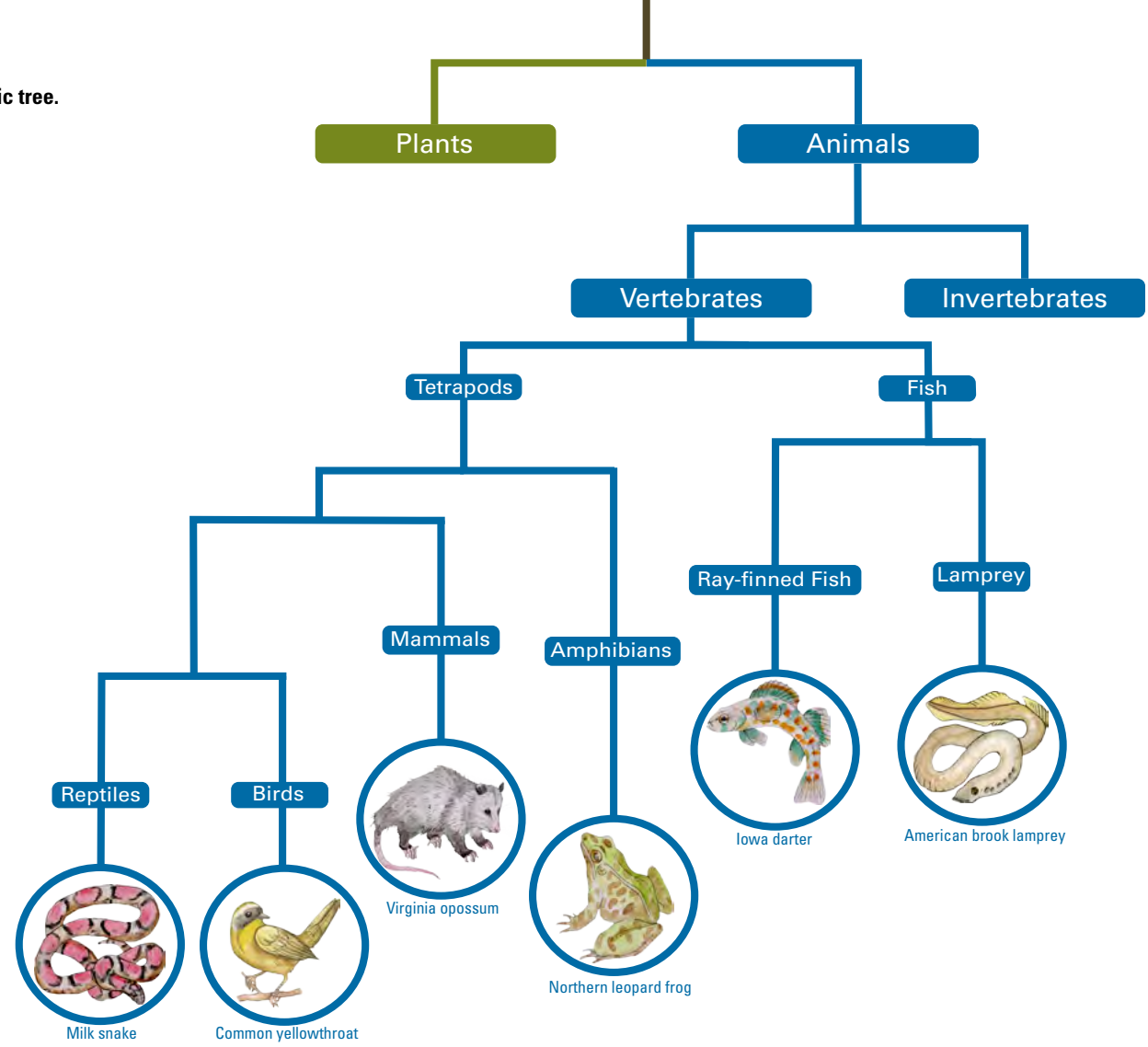
The richness of Iowa's wild places and wild things spans a wide gradient from the microscopic animals in our water and soil to towering trees in forests and cities. But when asked to picture the breadth of this diversity, many immediately think of those animals we share the most similarities with: the vertebrates. In this group of animals, we find all shapes and sizes of creatures, living in all places in Iowa: in the water, in the trees, in the soil, and even in houses, because this category not only includes familiar wild animals, but also people.

Vertebrates are important members of Iowa's natural environment. Some create habitats that support other animals and plants. All vertebrates are vital members of complex food webs that are an essential part of healthy functioning ecosystems. Our vertebrate neighbors also provide services to Iowans, such as controlling weed seeds, suppressing populations of insect or other vertebrate pests, pollinating plants, and even providing food for families that hunt or fish. Vertebrates create a diversity of opportunities for outdoor recreation like hunting, fishing, bird watching, and bird feeding that in some parts of the state are critical to supporting local economies and livelihoods. Perhaps the most important vertebrate in Iowa is humans, not because we have any inherent value greater than other creatures, but rather because our actions impact each vertebrate, invertebrate, and plant in the state. Each human has their own important role to play to help conserve vertebrates and all the organisms that make up the beautifully complex and diverse Iowa landscapes.

Table 1: Groups of Iowa's vertebrates and some of their common characteristics.

	FISH		TETRAPODS			
	Lamprey	**Ray-finned fishes**	**Amphibians**	**Reptiles**	**Birds**	**Mammals**
Number of species in Iowa (approximate)	4	144	22	46	430	58
Species examples	American brook lamprey, silver lamprey	Bluegill, northern pike, mottled sculpin	Gray tree frog, tiger salamander, American toad	Spiny softshell turtle, prairie skink, milksnake	Bald eagle, barn swallow, wild turkey	Hoary bat, white-tailed deer, short-tailed shrew
Skeletal structure	Non-bony	Bony (except paddlefish and sturgeon)				
Jaw structure	Jawless	Jaws				
Thermal strategy	Cold-blooded				Warm-blooded	
Breathing strategy	Gills	Gills and lungs		Lungs		
Embryo protection	Anamniote			Amniote		
Birthing strategy	Eggs	Eggs or live birth	Eggs	Eggs or live birth	Eggs	Live birth

Vertebrate taxonomic tree.



VERTEBRATE TAXONOMY

The taxonomists that classify the world's species into related groups have identified nine different types, or classes, of vertebrates that all share a bony or cartilaginous structure down the middle of their backs called vertebrae. Among the nine classes of vertebrates, six are found in Iowa. The remaining three groups, including sharks for example, are found mostly in the ocean. The six classes of vertebrates found in Iowa are lampreys, ray-finned fishes, amphibians, reptiles, birds, and mammals. The central nervous system, and the vertebrae that support it and the rest of the body in these animals, sets them apart from invertebrate animals. But beyond those shared characteristics, we find a remarkable diversity of appearances, life-history strategies, and habitat preferences among Iowa's vertebrates. Collectively, more than 700 different species of vertebrates are found in Iowa, each with their own fascinating traits and behaviors.

Lampreys and ray-finned fishes are grouped together under a broad category considered fish. There are four species of lampreys found in Iowa, and taxonomists consider these to be the most primitive of all vertebrates in Iowa. Lampreys are primitive in many ways, including the absence of bones in their body that is instead supported only with cartilage, and the absence of a jaw and scales. Lampreys have long slender bodies and fins that are less pronounced than Iowa's ray-finned fishes, which can lead people to mistakenly think they are snakes swimming below the surface. Unlike lamprey, ray-finned fishes are

Fish Senses

Fish do not have external ears, but they can hear with inner ears located just behind the eyes, near the brain. These ears can sense very high-pitched sounds. Fish also have a lateral line system, which is a series of mucous-filled pits that run along the side of the fish from the gills to the tail. The lateral line organ is sensitive to very low-pitched sounds and vibrations. Most fish have a very good sense of smell. They have nostrils located in front of the eyes, but unlike the nostrils of mammals, fish nostrils do not connect with the throat. They end in sacs where special cells smell the molecules in the water. Fish also have taste buds on the tongue and mouth that distinguish sour, salty, and bitter tastes. Some fish, like catfish and burbot, have barbels which are whisker-like structures around the mouth that contain taste-buds. Barbels allow fish to search for food when they can't see through murky or dark water.

typically bony. Paddlefish and sturgeon, which have skeletons made of cartilage, are exceptions, but unlike lamprey they have jaws and fins supported by fin rays and thus are more recognizable as fish.

Fish have specific adaptations for their aquatic lifestyle: they have fins which they use like oars or paddles to propel and steer through the water and keep themselves upright. Most ray-finned fishes have bodies covered in scales, although some, like catfish, bullheads, and sticklebacks, have smooth, scale-less skin. Fish also secrete mucus from their skin, which further protects them from water-borne diseases and reduces friction during swimming. Most fishes breathe through gills. However, some fishes like bowfin, gar, and mudminnows, have specialized adaptations that allow them to also get oxygen from the air by gulping at the surface when oxygen isn't readily available in the water.

The rest of Iowa's vertebrates are called tetrapods, meaning they have four unique appendages like legs, arms, or wings. Amphibians are tetrapods that share several characteristics with fish. Amphibians similarly can breathe through the water with gills during some life stages, or for some species like the mudpuppy, throughout their entire life. Amphibians are named for their amphibious life which means they generally spend their youth or larval phase in water and adult phases split between water and terrestrial environments. Upon hatching, amphibians are in a larval stage in which they have gills and look more fish-like. Young amphibians go through a remarkable metamorphosis, or period of change, as they transition from the larval phase and into the more familiar appearance of adult frogs, toads, or salamanders. Most adult amphibians have lungs, but most breathing is done by absorbing oxygen through their smooth, moist skin.

Lizards

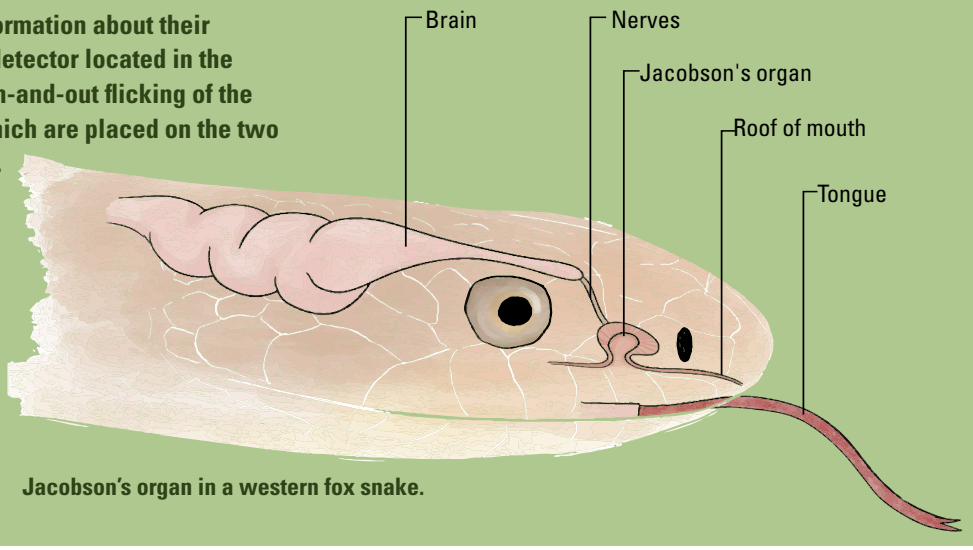
Lizards are closely related to snakes but unlike snakes most lizards have two sets of legs. One exception to this in Iowa is the slender glass lizard, which has no legs and looks almost exactly like a snake. But on close inspection, we find that unlike snakes, the slender glass lizard has external ear openings and functional eyelids like other lizards. Most Iowa lizards have a unique defense: their long tails are very loosely connected to the rest of their body so when a predator grabs them by the tail, it breaks off and keeps wriggling while the body of the lizard escapes. Within a few weeks, the lizard grows a new tail.

Slender glass lizards look like snakes but unlike snakes they have external ear openings and functional eyelids.

Amphibians and reptiles are often considered together in a category of wildlife called herptiles, although reptiles are more closely related to birds than amphibians. Reptiles have dry skin with scales on the outer surface. Their scales are made of keratin, just like fingernails. The scales of lizards and snakes can't increase in size as the animals grow, so they shed their skin and scales and replace them with a new set of larger scales throughout their lives. In contrast, turtle scales are enlarged and thickened by additional layers growing beneath. Reptiles in Iowa can

Jacobson's Organ

Snakes are able to use their tongues to pick up information about their environment. The Jacobson's organ is a chemical detector located in the roof of the mouth of snakes and lizards. The rapid in-and-out flicking of the snake's tongue picks up tiny chemical particles which are placed on the two openings of the Jacobson's organ for identification. Snakes use this organ to help find food, for navigation, and for reproduction.



Jacobson's organ in a western fox snake.

be fully aquatic, fully terrestrial, or split their time between aquatic and terrestrial habitats. Reptiles, amphibians, and fish are all similar in that they are cold blooded, or ectothermic heterotherms, meaning they derive their body heat from outside their body (ectothermic) and allow their body temperature to fluctuate widely (heterotherms). This distinguishes these vertebrates from the warm-blooded mammals and birds that are endothermic homeotherms, meaning they create their own heat that keeps them at a stable internal temperature.

Birds are warm-blooded tetrapods and covered in what evolutionary ecologists call modified scales and what the rest of us call feathers. Birds are found in every ecosystem in Iowa, but because of their ability to fly, are considered terrestrial. In Iowa, all birds are capable of flight, a behavior that is almost uniquely their own, except for mammalian bats, who evolved flight independently of birds. The southern flying squirrel found in many Iowa forests only glides and cannot truly fly like its name suggests. Although birds and bats share the characteristic of flight, birds are more closely related to reptiles than mammals.

The term mammal refers to the female's mammary glands, which produce milk to feed her young, a trait unique among mammals that, along with their hair and fur, distinguishes them from other warm-blooded vertebrates. All of Iowa's mammals give birth to live young. Mammals also chew their food, whereas most vertebrates tear or swallow their prey whole instead. Each mammal goes through two sets of teeth in their lifetime. Like birds, all of Iowa's mammals are considered terrestrial because even the most water-loving among them, such as North American river otters and beavers, still rely on the adjacent terrestrial features outside water bodies.

Bird Nests

All bird species lay eggs in some form of a nest, although nests vary greatly depending on the type of bird. Killdeer simply lay their eggs on bare or rocky ground, while orioles weave intricate baskets in tree branches. Belted kingfishers excavate three 8-foot long burrows into vertical banks, primarily along rivers and streams. Some birds use nests that another bird built a previous year. Some birds, like the brown-headed cowbird, don't build their own nests but rather lay their eggs in the nests of other species in a behavior called nest parasitism.

Killdeer nest.

Marsupials

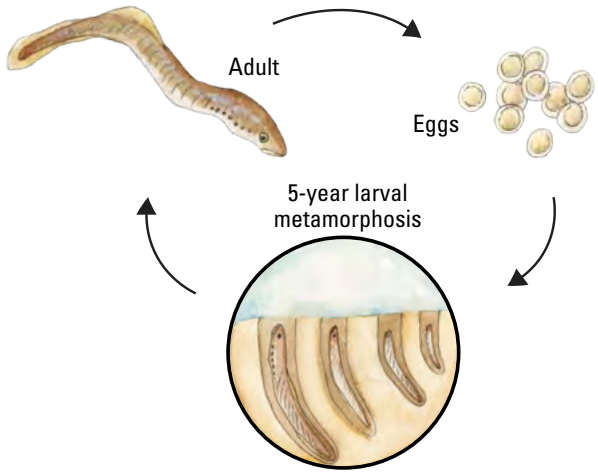
The Virginia opossum is the only native marsupial in Iowa and in all of the United States. The most well-known of the marsupials are the kangaroos and koalas of Australia. Marsupials are unique because they have pouches where they raise their young. Marsupial young are born very early before they are fully developed. After they are born, they climb into their mother's pouch, and she provides milk while they continue to grow. Baby opossums live in the pouch for up to two months until their eyes open.

Mother opossum with her young. When young are old enough they climb out of the pouch and travel on their mother's back.

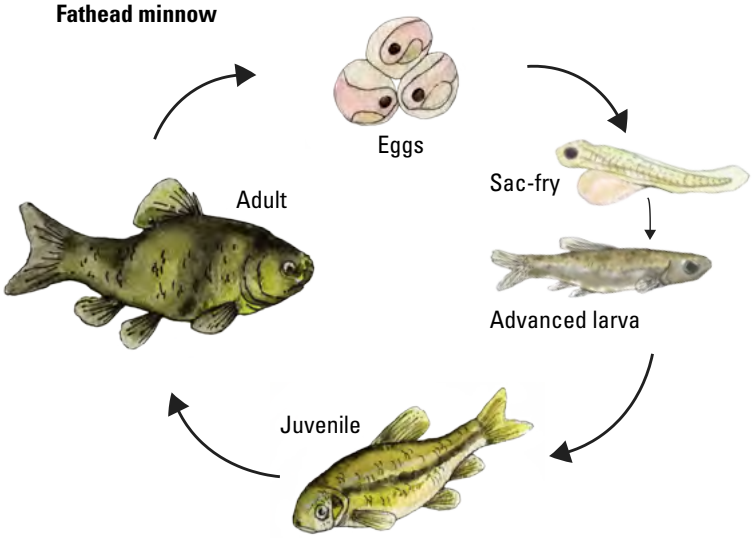
VERTEBRATE LIFE PHASES

Vertebrates go through various life phases from the time they are born to when they mature into adults. Amphibians drastically change in physical appearance as they mature. This period of transformation is called metamorphosis. Lamprey also go through a type of metamorphosis as they change from larvae to adults. Other vertebrates, like birds and fish, change in size and sometimes also in appearance as their feathers or scales change color during their development. Reptiles and mammals often look like smaller versions of adults when they are born.

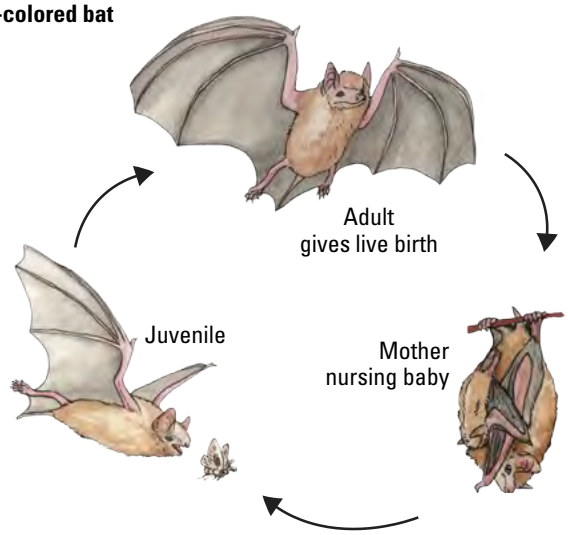
Chestnut lamprey



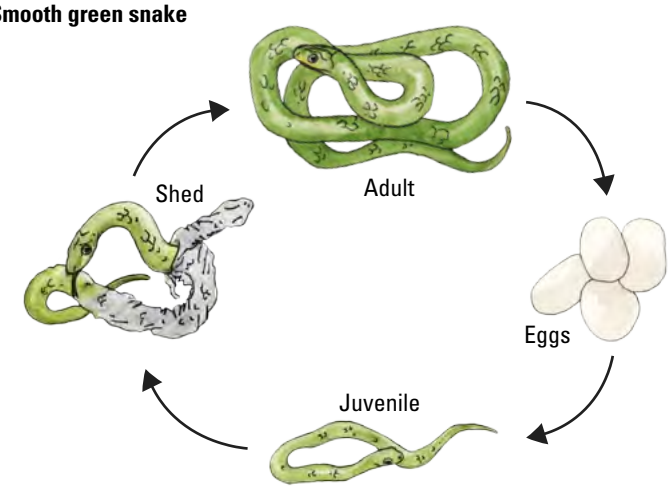
Fathead minnow



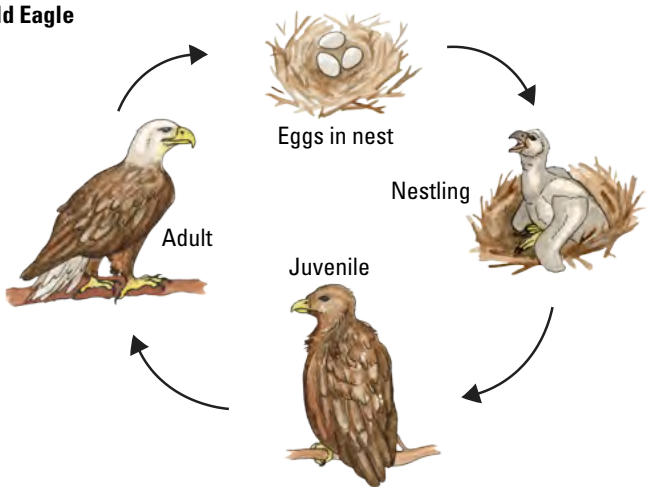
Tri-colored bat



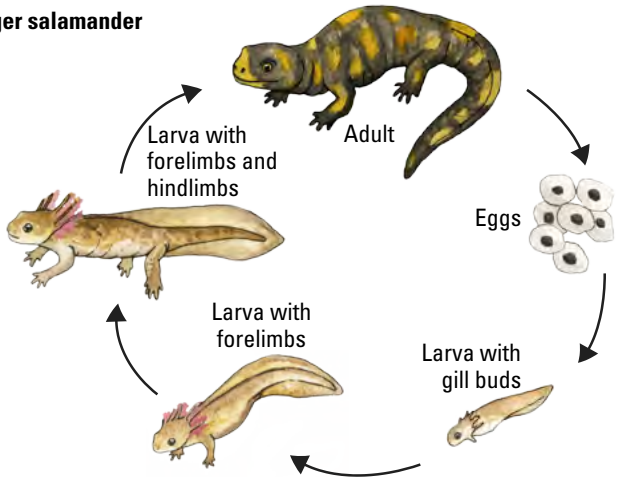
Smooth green snake



Bald Eagle



Tiger salamander



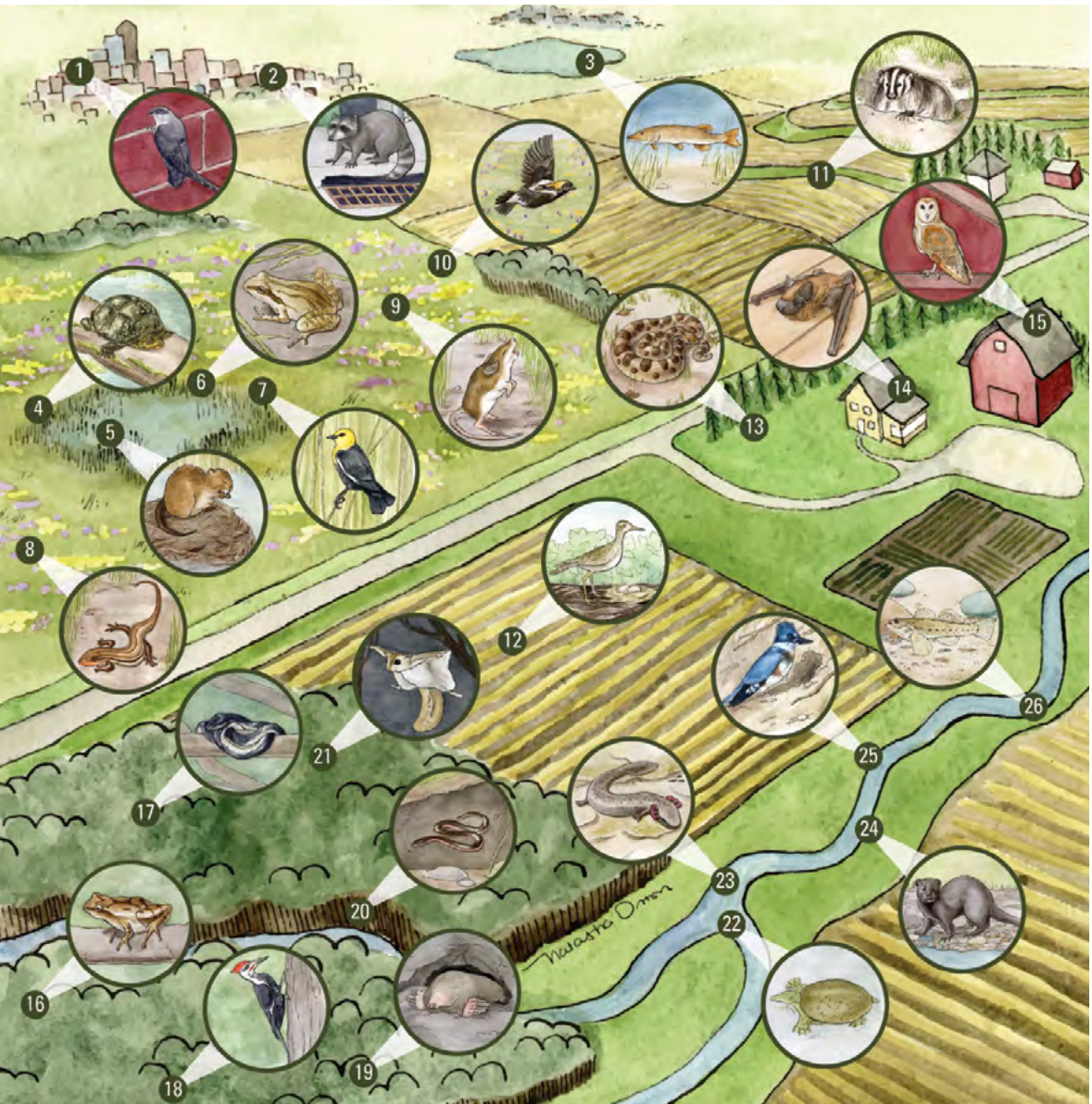
HABITATS

Vertebrates are found in varying densities in every environment in Iowa. We ordinarily think of wild vertebrates occurring in our natural areas, like aquatic ecosystems, forests, or prairies and indeed we find the greatest diversity and numbers of most vertebrates there. But we also find vertebrates persisting where people live, on our farms, among city streets, and in human dwellings or buildings, even though these are not the environments they are naturally adapted to.

Vertebrates are found everywhere in Iowa. Many species are generalists, occurring in natural areas like forests and grasslands, on farm edges, or in city parks. Little brown bats can just as likely be seen at dusk swooping around catching insects in the glow of a street light as they can be seen over ponds or prairie openings in wooded areas in the countryside. Canada geese and painted turtles can be found in almost any area that has at least a medium-sized pond, including cities or rural areas. These types of animals are very adaptable and can call many different places home.

Some of Iowa's vertebrates have adapted especially well to human environments like cities and agricultural land. The familiar raccoon often calls storm sewer systems home and chimney swifts can be seen over towns and cities where open chimneys provide nesting and roosting sites. The plains pocket gopher is commonly found in pastures and roadsides and vesper sparrows often build their nests in row crop fields. Perhaps the most extreme adaptors to humans are those that share our own spaces with us, like the big brown bat, whose scientific name translates to house flyer and the barn swallow, named for its affinity for building nests of mud on the sides of barns and other structures.

In contrast, some of Iowa's vertebrates have specialized needs and live in very specific environments. These specialists often require places that have been less influenced by human activities. The cerulean warbler requires large tracts of undisturbed forest, like those found in northeastern Iowa, while the Great Plains skink lives only in large prairies in southwestern Iowa's Loess Hills. The brook trout and our two sculpin species require cold flowing water found only in spring-fed streams of northeastern Iowa.



CITY
1. Chimney swift
2. Raccoon

LAKE
3. Northern pike

WETLAND
4. Blanding's turtle
5. Muskrat
6. Boreal chorus frog
7. Yellow-headed blackbird

PRAIRIE
8. Prairie skink
9. Grasshopper mouse
10. Boblink

AGRICULTURAL FIELD
11. American badger
12. Upland sandpiper

FARMSTEAD
13. Western fox snake
14. Big brown bat
15. Barn owl

FOREST
16. Spring peeper
17. Black rat snake
18. Pileated woodpecker
19. Eastern mole
20. Western worm snake
21. Southern flying squirrel

STREAM
22. Spiny softshell turtle
23. Mudpuppy
24. American mink
25. Belted kingfisher
26. Johnny darter

Most people are familiar with the animals they can see roaming on land and flying through the air. However, there are several vertebrates that are less conspicuous because they are fossorial or live underground. Out of the five salamanders found in Iowa, blue-spotted, tiger, and smallmouth salamanders are fossorial. They are seldom seen, but can be abundant in certain ecosystems. The eastern mole is a completely fossorial mammal. Plains pocket gophers also spend most of their time underground. Both species have specific adaptations for their underground lifestyle including extremely small eyes and large strong front legs with claws for burrowing.

Many physiological adaptations of vertebrates determine which ecosystems they can thrive in. For example, waterfowl like ducks and geese have webbed feet that help propel them through wetlands, lakes, and rivers to feed and rest. Pied-billed grebes, Virginia rails, soras, and American coots live in similar environments, but have lobed toes rather than webbed feet because they are more useful for navigating through thick marshy plants. Wading birds like great egrets and great blue herons have long legs, bills, and necks that allow them to search for insects and fish without swimming. Similarly, shorebirds typically do not swim but have long legs for scurrying around quickly along the edges of aquatic habitats where they probe for food with custom-sized and shaped bills fit for narrow ranges of conditions for feeding in soil, water, sand, or rocks.

Although all fish have specific adaptations for living in the water, some also have unique adaptations suited for where they live and eat. As their family name implies, suckers have sucker-like mouths with thick fleshy lips that are pointed downward on their head, allowing them to scour food items, like invertebrates and algae, from the substrates at the bottom of streams, rivers, and lakes. In contrast, topminnows are small fish that swim and feed near the surface of the water with their upturned mouths.

Barn swallows build nests made of mud on the sides of barns and other structures.

Eastern moles have small eyes and large strong front legs with claws that are suitable for burrowing underground.

Blue-spotted salamanders are seldom seen because they spend most of their time underground

Fish like the white sucker (left) have downturned mouths that are useful for getting food from the bottom of the stream, river, or lake. In contrast, fish like the blackstripe topminnow (right) have upturned mouths that are useful for feeding from the surface of the water.

Keystone Species

Ecologists use the term keystone species to describe organisms that are important for the survival of other species in an ecosystem. When keystone species are lost, a cascade effect often results in drastic changes to the composition of plants and animals within that ecosystem. Woodpeckers are an example of a keystone species found in Iowa. Woodpeckers have long chisel-like beaks and extendable tongues that they use to excavate the trunks, limbs, and bark of trees to catch insects and other animal prey. Each spring, woodpeckers carve out nesting cavities in snags or dead trees, and throughout the year they create holes in trees for foraging. These cavities and holes provide important habitat for numerous other birds like wood ducks, bluebirds, and black-capped chickadees; mammals like flying squirrels and bats; amphibians like tree frogs; reptiles like the black rat snake; and insects, like cavity-nesting bees. All these secondary cavity users, which use cavities or holes for their life cycle but cannot make them themselves, take advantage of woodpeckers' hard work in creating holes in trees. Without them they would not be able to use Iowa's forests.

Other examples of keystone species include plains pocket gophers and largemouth bass. Digging activities of pocket gophers create habitat for many prairie plants and animals, while the gopher itself is food for dozens of other animals. The presence of largemouth bass, a predator at the top of the food web, is essential to maintain the health of freshwater lakes, regulating minnow and sunfish numbers, which allows smaller animals like zooplankton to survive and control algae growth.

Each of these species, and dozens more, take advantage of cavities created by woodepckers in trees.

Gray treefrog

Black rat snake

Little brown bat

Southern flying squirrel

Wood duck

Prothonotary warbler

The pileated woodpecker is one of seven woodpeckers found in Iowa that serve as keystone species.

REPRODUCTION

Courtship

Courtship behaviors are an important part of vertebrate reproduction in many species. The purpose of courtship is to get noticed by a mate, so many of these are also behaviors that are often conspicuous and thus observed by people. Courtship is diverse and unique for different species. Most vertebrates that participate in courtship rely on sight and sound to attract a mate, although some species use pheromones, which requires use of a sense of smell.

Perhaps the most familiar mating behaviors are the sounds of birds, frogs, and toads that echo through Iowa during spring and summer. Most male birds sing their songs in the morning, before day time temperatures get too warm, whereas male frogs and toads take the stage at night with their choruses and trills. Species of birds, frogs, and toads are often easily distinguished from each other simply by listening to their songs. Songbirds have an especially intricate syrinx, or vocal organ, with specialized membranes controlled by several muscles that allow them to sing unique and sometimes very complex songs that are pleasant to the ears of their potential mates and human onlookers alike. The wood thrush has a soft, ethereal, flute-like song whereas the common grackle has a loud harsh song that resembles metallic screeching. Usually first heard in March, the call of a single spring peeper resembles sounds made by baby chicks, while a large chorus of these frogs increases to the deafening sound of ringing sleigh bells.

In addition to songs, some birds make other sounds to get themselves noticed during mating season. Each spring, all seven of Iowa's woodpecker species use their chisel-shaped bills to create rhythmic drumming sounds that serve as both enticements for mates and warnings to other woodpeckers to stay clear of their territory. The drumming of each species is unique, and woodpeckers tend to use drumming sites, like a tall hollow tree or the metal rain-gutter on a house, to broadcast their messages over great distances. The ruffed grouse creates a low-pitched drumming sound by flapping his wings at an increasingly rapid rate while perched on a fallen log in the forest, to announce his territory and to attract a mate. The "sky dance" of the American woodcock occurs during twilight and on moonlit nights; its aerial mating song created by air rushing past the male's wing feathers, making a twittering sound during its downward spiraling flight.

Male ruffed grouse performing courtship behavior.

Even some fish use sound during mating rituals. Iowa has one member of the mostly marine drum family–the freshwater drum, which, as the name implies, can make a drumming or croaking sound with its gas bladder, which they do during summer courtship.

In addition to sounds, there are other unique and interesting things associated with attracting a mate that happens during mating seasons. Some fish show intensified and darkened coloration and others experience changes in body shape that help make them more attractive to a mate. Small fish called darters are typically drab colors of brown and tan, but in the spring as they begin courtship, their colors transform to brilliant reds and oranges and vibrant blues and greens. Male darters hold their fins erect and flash their brightly colored fins and scales to a female in courtship display. Males in the minnow and sucker families sometimes exhibit wart-like "breeding tubercles" on their head, body, and fins.

Greater prairie chickens perform their courtship behavior in specific areas called leks, which are traditional locations where the birds gather each year during breeding season. Males display to nearby females on leks by leaping and strutting about while stamping their feet, holding their pinnae feathers or "horns" erect, and inflating the orange sacs of skin on the sides of their necks. During this courtship dance, males perform what is called "booming" in which they emit deep cooing calls that can be heard as far away as four miles.

In spring, female snakes release a pheromone that attracts anywhere from a few to 100 males that intertwine with her in what is called a mating ball. Lamprey also gather in spawning aggregations during breeding. Hibernating species of bats including the little brown bat and Indiana bat similarly engage in large mating gatherings called swarms. During these swarms, male and female bats gather together outside their soon-to-be hibernation spots to court and copulate.

Accounts of the dramas of Iowa's vertebrates during courtship could go on for pages and feature stories of joint construction projects, epic fights for space or admiration, beautiful coloration and ornamentation, or even simply quality time spent in pairs.

Male greater prairie chickens displaying to females.

Producing Offspring

The way Iowa vertebrates form, nourish, and protect their offspring in eggs varies across two broad classes: amniotes and anamniotes. Reptiles, birds, and mammals are classified as amniotes, so named for the membranes, called amnion, that surround their embryos and help bring in oxygen and let out carbon dioxide and other waste during development. In mammals and some snakes, like the prairie and timber rattlesnakes, these membranes are inside the mother's body. For egg-laying amniotes like birds and most reptiles, egg shells provide the protection for the embryo and help support the amniotic membrane. Amphibians and fish are anamniotes, meaning their soft gelatinous eggs do not have amniotic membranes, and instead oxygen, carbon dioxide, and other wastes simply flow in and out of the eggs from the waters in which they are laid. Therefore, fish and amphibians must lay their eggs in water.

Development and growth of young from an egg takes time in all vertebrates. In mammals the period of time when young are developing inside their mother is called a gestation period. Gestation periods can range widely from about 18 days in the meadow jumping mouse to roughly nine months in weasels. Birds lay eggs and then care for them during the incubation period by rotating them and sitting on them to keep them warm while the young develop inside the eggs. The incubation period for birds varies from 10-14 days in small songbirds to about 35 days in bald eagles. Fish seek out appropriate places to lay their eggs that promote their development. Some care for, or guard their nests, while others produce many eggs and provide no protection. The eggs of most of Iowa's fish hatch after two days to two weeks. However, the eggs of some of Iowa's coldwater species take much longer, like the brook trout, which lays eggs that can take up to 100 days to hatch. Amphibians and reptiles similarly have a wide range of incubation periods, with amphibian eggs typically taking 6-21 days to hatch and reptiles 4-8 weeks. Some amphibian and reptile eggs hatch early if the embryos inside detect the vibrations of predator activity nearby. Many fish, reptiles, and amphibians lay their eggs in a nest and then leave them unattended to hatch and try to survive. But some, including all the skink species, mudpuppies, rattlesnakes, and fish such as smallmouth bass, do tend to their nest and protect them from predators and disturbances.

Amphibians and fish have soft gelatinous eggs that must be laid in water.

Species with shorter developmental periods sometimes reproduce multiple times in one year. Some mammals, like white-tailed deer, have longer gestation periods which requires them to mate in the fall, rather than in the spring. Bats breed in the fall but then have delayed implantation of fertilized eggs that do not start developing in the mother's uterus until the spring.

Parental Care

The role of parents varies greatly after a vertebrate lays an egg or gives birth. Several groups of vertebrates do not provide any parental care to their offspring at all. Most amphibians and reptiles lay their eggs and leave them for the young to hatch and live on their own. Some fish also immediately abandon their fertilized eggs, which will either float with water currents or, if adhesive, attach to objects encountered in the water such as rocks and woody debris. Since they do not provide protection, these species typically produce a lot of offspring, often laying hundreds, even thousands of eggs.

A few species that skip parenting have found other means for their young to be cared for. Some vertebrates use a strategy called nest or brood parasitism, in which they trick other parents into raising their young. Brown-headed cowbirds exclusively lay their eggs in the nests of different bird species. In some cases, the parents of these other species end up having to invest so much time in the cowbird young, which can be larger than the parent's own young, that the offspring of the other species are unable to survive. Parasitism of nests is a common strategy used by other species of birds who effectively hedge their bets by laying some of their own eggs in their own nests and some in the nests of other parents of the same species. In these examples the young still receive a fair amount of parental care, just not by the parent(s) who produced them. Bluegill, and some other sunfish species, have a similar behavior where they trick a parent within their own species to raise their offspring. Young male bluegill can sneak into the nests of more mature males by behaving like females. These young males then fertilize some of the eggs and leave. In these cases, the mature males then care for the offspring of the younger males.

Many vertebrates protect their nests or invest much energy into caring for their young. Nearly all birds that nest in trees and shrubs, and some ground-nesting birds, have altricial young that are born helpless and often without any feathers or down for warmth. Parents of such young must spend a great deal of time bringing food back to the nest. In contrast, precocial young, such as those from ducks, geese, and Northern bobwhites, hatch with thick downy feathers and good eyesight. They quickly begin to walk on their own after hatching and even start feeding themselves within hours of hatching. Parents of these young still protect them from predators and often help with temperature regulation during the earliest days of life by brooding them close to their bodies. Although most snakes abandon their eggs or leave baby snakes on their own, rattlesnakes are protective mothers, staying with their young and guarding them until after they have shed their skin for the first time. Some fish construct nests of small gravel, soft sediment, or aquatic vegetation. Multiple fish species, like bluegills, black bullhead, and largemouth bass, also care for newly hatched offspring.

Brown-headed cowbird egg in a wood thrush nest.

American beaver mother and young. Young beavers often stay with their mothers through their second or third winter.

Bluegill build nests and care for newly hatched offspring.

During the seven days that male bluegills care for the eggs and young, they are so dedicated to their task that they don't leave the nest to feed, and only eat insects that happen to float by the nest close enough to catch.

Although all mammals must nurse their young, they still demonstrate varying levels of parental commitment. Eastern cottontail rabbits visit their young once or twice a day to nurse, but otherwise leave them alone in their nest. Many rodents are weaned within a few weeks or a month and then leave home. However, some prairie vole young stay and help raise their siblings, and southern flying squirrel young often stay with their mother for a period of time after they are weaned. Young river otters stay with their mothers for several months and sometimes up to a year after they are born, and young beavers stay with their parents through their second or third winter. Many of Iowa's bat species raise their young in maternal nursery colonies, ranging in size from 20 females to up to 1,000 individuals depending on the species. Pregnant female bats do this to help maintain a more constant body temperature during gestation and to create a warmer environment for their young after they are born. Maternal colonies occur in hollow trees, caves, mines, buildings, and constructed bat houses.

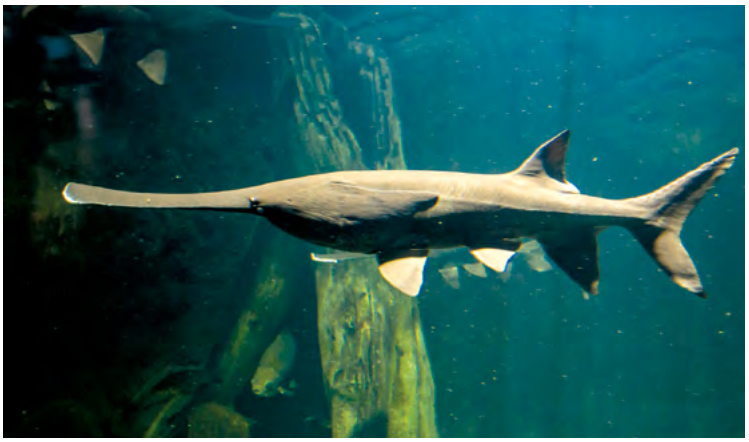
Vertebrate Lifespans

Lifespans of Iowa's vertebrates vary greatly. Mice and rabbits often live less than a year. Some of Iowa's bats, like big brown and northern long-eared bats, can live 18-20 years. Most of Iowa's fishes have relatively short lifespans. Most minnows live from two to three years, with sunfishes and catfishes usually living from five to seven years. Two of Iowa's primitive fish, however, are quite long-lived. Lake sturgeon can live up to 50 years and paddlefish can live more than 30 years. Tiger salamanders are relatively long-lived with lifespans that range from 10-16 years. Bald eagles have been documented to live up to 38 years in the wild, and a marked nesting female Blanding's turtle was known to be at least 75 years old. Unlike humans, vertebrates that live in the wild typically don't die of old age but rather succumb to one of many challenges to survival in the wild including starvation, disease, predators, extreme weather, habitat loss, or even human activity.

DIETS AND FEEDING STRATEGIES

The diets of Iowa's vertebrates are as varied as their appearance and life histories. Iowa vertebrates feed commonly at all levels in the food web. Herbivores include many species that eat plants like grasses and wildflowers. Some herbivores have specialized digestive adaptations to convert plant tissues into the nutrients they need to survive. The most extreme example of this specialization is found among white-tailed deer. Like sheep and cows, deer are ruminants. Ruminants have a four-chambered stomach that converts plant matter into digestible nutrients through a series of processing steps. Other mammals, including humans, are monogastric, meaning they have only one chamber in their stomach. Some monogastric herbivores like rabbits and hares have specialized adaptations to allow more time for the digestion of plants. Birds that eat mostly plants, such as Canada geese, also have similar adaptations in their digestive tracts, including elongated intestines. Herbivory in Iowa fishes is a bit rare. Examples of herbivorous fish in Iowa include stoneroller, brassy minnow, and southern redbelly dace. Herbivorous fish species have very long intestines to help digest plant material.

Most of Iowa's vertebrates are omnivores, consuming a diversity of both plants and animals throughout their lives. Omnivores often rely more heavily on plants or animals at different times of the year. For example, many species of birds feed on insects and other animal matter while they have high needs for protein to produce eggs and raise their young. They then switch to carbohydrate rich foods like fleshy fruits and seeds during winter to produce fats to stay warm when insects are not available.



Paddlefish can live more than 30 years.

Hummingbirds are considered omnivores because they eat insects and spiders, however, they are more known for their ability to drink nectar from flowers, a trait they share with some of Iowa's invertebrates like butterflies. These small birds, of which the ruby-throated hummingbird is the only species that nests in Iowa, have a long, thin beak, extendable tongue, and the ability to fly forward and backwards and hover in place, allowing them to fly up to and extract a flower's nectar.

Carnivores like bald eagles, river otters, or even grasshopper mice eat almost exclusively animal matter, whether that be invertebrates or other vertebrates. Carnivores are also called predators and their animal food is called prey. Many carnivores eat a variety of prey. Piscivores are carnivores that primarily eat fish, while insectivores primarily eat insects. The pike and mudminnow families include species that are predatory fish, some of which eat other fish in addition to invertebrates. Gars are also piscivores. Iowa's bats, several birds such as flycatchers and swallows, as well as shrews and moles, are insectivores. Most Iowa fish species are considered invertivores, which means they eat a variety of invertebrates (not just insects).

Turkey vultures are scavengers that eat carrion, which is the decaying flesh of dead animals. Carrion often contains insects, bacteria, fungi, and other microorganisms that would make most other animals sick. One reason turkey vultures don't get sick from their food is they have a unique set of bacteria and other microorganisms in their gut and on their faces that can kill, break down, or even eat bacteria, parasites, and invertebrates that the vultures consume with rotting meat. Animals that eat carrion are important parts of the ecosystem because they clean up carcasses that, if left to accumulate, could cause illness in animals not adapted to eating them.

Most carnivores kill their prey in order to eat them or they scavenge prey that is already dead. However, another type of carnivore, called a parasitic carnivore, eats its prey while it is still alive. Two of Iowa's lamprey species are parasitic and they feed by rasping a hole in the side of the host fish and sucking its blood. After several days, the lamprey drops off and the host fish usually does not die.

ACTIVITY PATTERNS

Timing of Vertebrate Activity

In addition to using a variety of environments, Iowa's vertebrates are also active at different times of the day. Nocturnal species, like owls, nighthawks, salamanders, bats, foxes, bobcats, badgers, opossums, and catfish, search for food at night. They have specific adaptations that allow them to navigate through their environment in the dark. Nightjars are a group of nocturnal birds whose feathers are various shades of buff, brown, gray, and black that serve as camouflage, allowing them to hide

White-tailed deer are herbivores and have a specialized digestive tract to help them process all of the plant material they eat.

Cedar waxwings are fruit specialists, finding food from a diversity of trees and shrubs including the "berries" of this eastern red cedar.

North American river otters are carnivores.

Nightjars like this common nighthawk have brown, gray, and black feathers that help camouflage them while they sleep during the day.

on the ground or perch on low horizontal branches in the woods during the day. Many nocturnal vertebrates have large eyes to pick up more light in their environment. Some, like bobcats, opossums, some amphibians, and walleye, also have eyes that appear to light up in the dark. This is the result of a special structure in their eyes called tapetum lucidum that reflects light back onto the cells in their eyes, allowing them to better use very low levels of light to see. The glowing eye light reflected back in the glow of a flashlight is different colors in different species. Bats use echolocation to navigate at night by making sound and listening as it bounces back off of things in their surroundings, like trees and insects, and returns to their ears. By using echolocation, they are able to tell how far away an object is as well as its size and shape. Most people are familiar with animals that are diurnal, or active in the day, but there are also crepuscular species that are most active during dawn and dusk. The most conspicuous crepuscular species in Iowa is probably the white-tail deer, but others, like rabbits, skunks, short-eared and great-horned owls, and American woodcocks also move about mostly in hours of twilight.

Surviving in Iowa During the Winter

Vertebrate activity varies throughout the year. As the seasons change, year-round residents adjust their behavior in response to weather conditions and migratory animals come and go from the state. The large drop in temperature associated with winter requires Iowa's vertebrates to have strategies for survival when it is challenging to stay warm and find food.

Iowa's vertebrates use various strategies to survive winter's frigid temperatures. Hibernation is a period of reduced body temperature and slowed metabolism, breathing rate, and even heart rate that allows some vertebrates to survive the winter months when food is scarce. Animals that hibernate find a place to wait out the cold temperatures and don't move around much during the winter. Some of Iowa's bats hibernate in caves, abandoned mines, or human dwellings. Other mammals that hibernate include woodchucks and ground squirrels. Hibernation requires vertebrates to build up fat reserves so they do not die during their period of inactivity. Some vertebrates, like the plains pocket mouse, badgers, and skunks, wake up to get food periodically instead of truly hibernating throughout the entire winter.

Many cold-blooded vertebrates brumate, which means they become inactive as cold temperatures arrive, similar to hibernation in warm-blooded vertebrates. Brumating animals still wake up occasionally during the winter, but typically don't move out of their wintering areas. Many species of amphibians and reptiles can survive partial or complete freezing due to the production of cryoprotectants which allow their cells to survive freezing without rupturing. Fish, which are also cold-blooded, are less active and eat less during winter.

Seasonal Migration

Migration is a well-known strategy used by some of Iowa's vertebrates to escape winter's cold temperatures and diminished food availability. Iowa's birds are especially remarkable for their tendency to come and go from the state during certain times of the year. For some species, like the dark-eyed junco and snowy owl, Iowa is a welcome reprieve from extreme weather in their northern breeding grounds during winter. Many of Iowa's breeding birds do the opposite, choosing to breed in Iowa and then travel hundreds of miles to the southern U.S. or thousands of miles to Mexico and Central and South America. Multiple species of bats, such as red, hoary, and silver-haired bats, travel up to several hundred miles each year to breed in Iowa during the summer and then return to warmer climates in the fall. Several vertebrates in Iowa migrate across much shorter distances. Snakes migrate to and from wintering areas in bluffs or rocky outcroppings that are deep enough to protect them from freezing temperatures. In the fall, fish often move to deeper water to avoid ice, find warmer water, or escape currents that would require more energy to stay put.

Eastern red bats migrate south for the winter.

American Eel

The American Eel, the only member of the eel family in North America, is a long, slender snake-like fish with extremely small scales and a fascinating life history. Adults spawn in the Sargasso Sea near Bermuda in the western Atlantic Ocean. The young eels move with currents in the Atlantic Ocean with some being carried to North America and some to Europe. When eels reach river mouths, males remain in brackish water, areas where salt and freshwater combine, while the females migrate up rivers to live and mature in freshwater. After up to 20 years of life in freshwater, the females move back down the streams and rivers to the Atlantic Ocean and return with the males to the Sargasso Sea to spawn and, presumably, die. Although seldom seen, the female American Eel is present in a number of rivers in Iowa.

Seasonal migration can also be associated with breeding. During the spawning season, some fish move short distances that range from a move to shallow water in lakes to swimming up small streams. American eels demonstrate migratory behavior when they swim hundreds of miles from North American rivers (including Iowa's rivers) to the Sargasso Sea in the western Atlantic Ocean to breed. Tiger salamanders are often seen crossing roads during their annual migrations to aquatic breeding areas. Canada geese and trumpeter swans have been documented to engage in what biologists call a molt migration during summer. During these migrations, non-breeding birds, unsuccessful breeders, and even some successful breeders will depart Iowa in mid-summer and fly into northern Canada to engage in the annual molt, or replacement, of flight feathers that renders waterfowl flightless for a few weeks. After completing the molt, these geese or swans then return on a migration to Iowa and often over winter with others of their species that stayed the whole year in the state.

SUMMING IT UP

Iowa's vertebrates can be found all around us, from those that live in close proximity, like the species we see in cities and towns or on farms, to the more elusive species that call our natural areas home. Although Iowa has many common vertebrate species, some are in decline, and all vertebrates face challenges associated with human activity. It is important for everyone to play a role in conservation efforts by helping to keep our land and water healthy, which is necessary for the survival of all vertebrates, including humans. Planting native vegetation and promoting native plant diversity can be done in rural areas as well as in cities and towns where backyards and parks can provide important resources that some vertebrates need. In addition to providing food and shelter, native plants can reduce soil erosion and reduce pollution, which helps maintain clean water for the diversity of aquatic and terrestrial species that depend on it.

Wetland and floodplain restoration can also increase wildlife habitat while reducing impacts of flooding to crops in rural areas and to homes and other infrastructure in cities and towns. Keeping livestock out of streams and making sure waste doesn't get dumped into storm sewers or Iowa's water bodies are also important for protecting our vital water resources that support all life in Iowa. Additionally, people can help Iowa's vertebrates by building bat and bird houses and leaving dead trees standing in areas where they don't pose a safety risk. Removing invasive species and avoiding planting or spreading invasive species are also important for supporting native ecosystems that remain valuable for Iowa's vertebrates.

Addressing direct threats from human activity is another important part of protecting Iowa's vertebrates. Reducing mowing frequency or setting aside areas that are normally mowed and converting them to prairie are great ways to both reduce risk to vertebrates and increase habitat. In addition to being much more attractive to wildlife, native prairie plants bring brilliant colors of white, gold, purple, orange, and pink to the formerly bland green landscape of a mowed lawn. Considering the timing of mowing and tree removal activities in relation to when Iowa's vertebrates are using certain habitats can help reduce the risk of destroying nests or killing and injuring young. Keeping cats indoors and preventing window collisions are often overlooked, but are important for the health and safety of Iowa's vertebrates as well. Reducing deadly vehicle collisions by being mindful of where roads are placed relative to wildlife habitat is important not just for large vertebrates, like white-tailed deer, but also for smaller vertebrates like amphibians and reptiles as they move to and from wetlands.

Conserving Iowa's vertebrates can be a community effort. Finding out about local volunteer opportunities like invasive species removal events or local citizen science opportunities for monitoring water quality or vertebrate populations are also valuable ways to contribute to conservation efforts.

Whether you're walking through your neighborhood, exploring a forest, wandering through a prairie, or out on the water, you're sure to encounter several of Iowa's many remarkable vertebrates. Next time you are outdoors see how many vertebrates you can find, both big and small, flying overhead, moving across the ground, or swimming in the water. You might be surprised to find some new species that you never noticed before, or some that you may not have even realized you could find in Iowa.

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