Iowa's NATURE SERIES

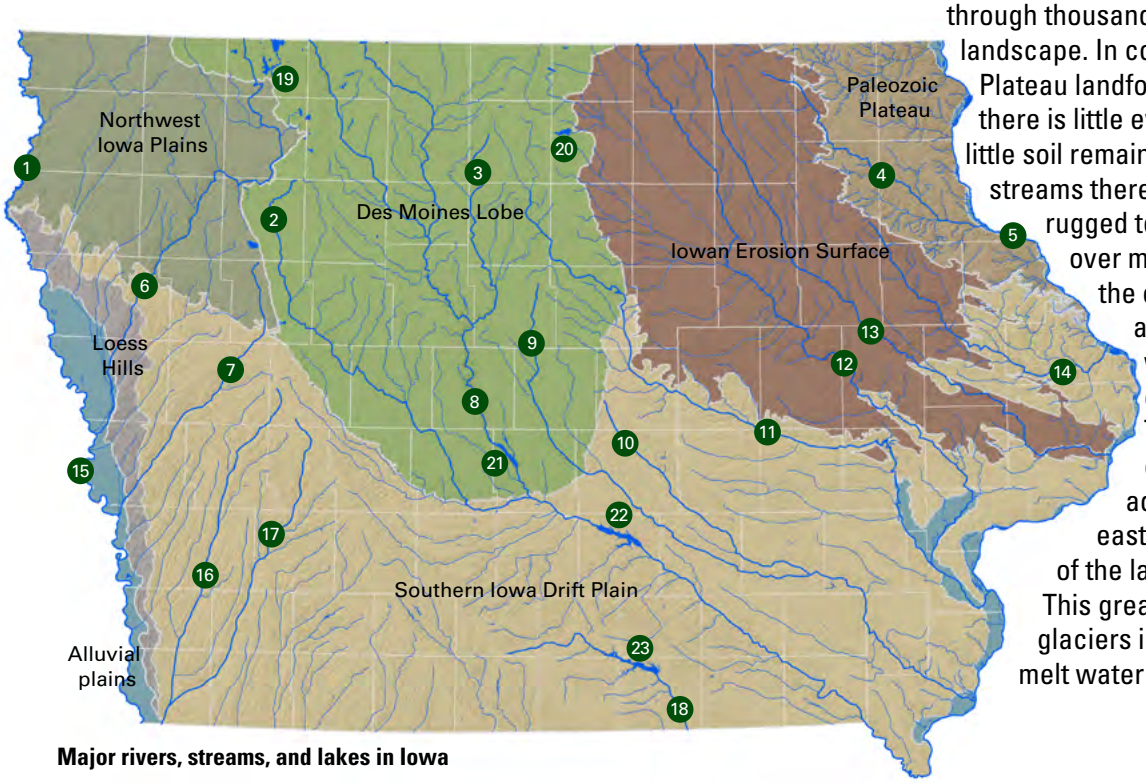
AQUATIC ENVIRONMENTS

Black Hawk Lake, Sac County

Iowa is rich in aquatic environments. From natural deep lakes, like Lake Okoboji in Northwest Iowa, to shallow marshes of the prairie pothole region, and the many rivers and streams that crisscross and serve as boundaries to Iowa's landscape, Iowa has diverse waters to explore.

Aquatic environments can be broadly broken down into those with running water like rivers and streams – called lotic ecosystems – and those with standing or still water – called lentic ecosystems – such as ponds, lakes, and marshes. Regardless of whether a waterbody has standing or running water, each body in the state has been shaped by periods of glaciation and erosive forces of wind and water through time.

The imprints of glaciers are most prevalent in central to north central Iowa on the Des Moines Lobe landform, the area most thoroughly covered and scoured by the last glaciation. The glaciers left the Des Moines Lobe relatively flat but covered with many shallow depressions referred to as "potholes" that fill with abundant spring rains and movement of shallow underground water. The Southern Iowa Drift Plain is a geologically old landscape, with hillsides and a high density of streams, which through thousands of years created a dissected landscape. In contrast, in the Paleozoic Plateau landform in Northeast Iowa, where there is little evidence of ancient glaciation, little soil remains over the bedrock and the streams there have carved and shaped the rugged topography and rocky bluffs over millennia. Northeast Iowa is the only area of the state with an abundance of clear, fast moving, winding, coldwater streams, often bounded by rocky bluffs. The mighty Mississippi River overshadows all other Iowa aquatic environments. It forms the eastern border of Iowa and has one of the largest watersheds in the world. This great river was also formed by glaciers in the last ice age, carved by the melt water as they receded.



Major rivers, streams, and lakes in Iowa

1. Big Sioux River 2. North Raccoon River 3. Boone River, 4. Turkey River 5. Mississippi River 6. Little Sioux River
7. Boyer River 8. Des Moines River 9. South Skunk River 10. North Skunk River 11. Iowa River 12. Cedar River
13. Wapsipinicon River 14. Maquoketa River 15. Missouri River 16. West Nishnabotna River 17. East Nishnabotna River
18. Chariton River 19. Lake Okoboji 20. Clear Lake 21. Saylorville Lake 22. Lake Red Rock 23. Rathbun Lake

The majority of the western border of Iowa is formed by America's longest river, the Missouri. It starts in the Rocky Mountains of Montana and flows south and east until it joins the Mississippi at St. Louis, Missouri.

Iowa waterbodies continue to develop and change over time. The water cycle is a major influence on the evolution of our aquatic environments. Liquid water evaporates into the atmosphere and condenses to create precipitation in the form of rain or snow. This is the greatest input of water into our rivers, lakes, and wetlands. The amount of water in the system shapes the structure of the waterbody and determines the types of plant and animal communities it supports. The changing climate influences the water cycle by changing evaporation rates and where, when, and how much precipitation falls.

TYPES OF AQUATIC ENVIRONMENTS IN IOWA

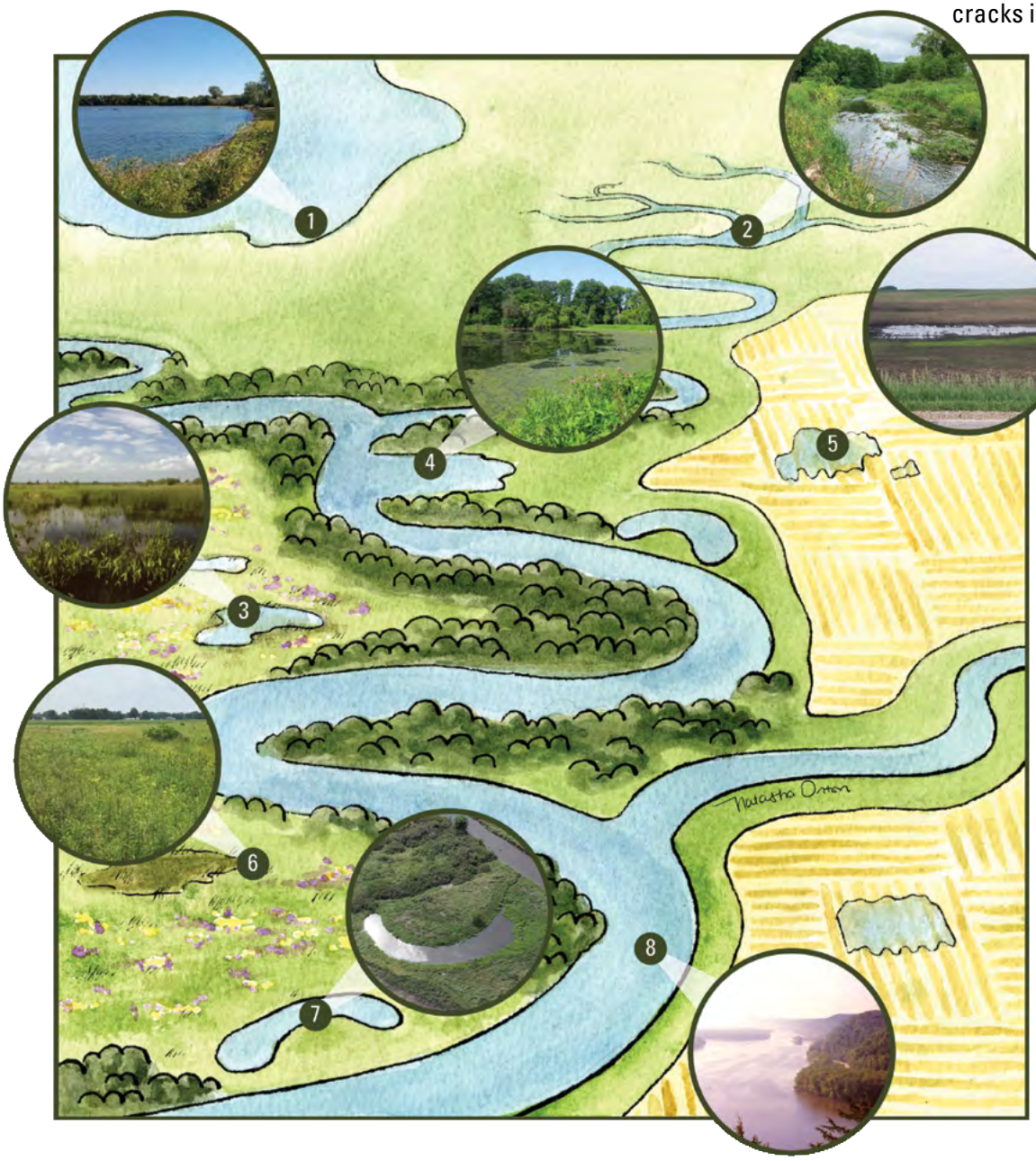
From headwater streams to large lakes and reservoirs, Iowa has a rich diversity of aquatic ecosystems created by long-gone glaciers, meandering rivers and the sediments they carry, wildlife, and people. This diversity of aquatic ecosystems can be categorized into three main types: rivers and streams, lakes and ponds, and wetlands.

Rivers and Streams

Rivers and streams are formed from water flowing within a channel from a higher to a lower elevation. They vary in size and permanence across the state and within a watershed. Headwater streams start as a trickle and grow into small channels like creeks, ditches, and streams before flowing into small rivers and then into bigger "downstream" rivers until they eventually meet the Gulf of Mexico by way of the Mississippi River. If a river or stream flows into a basin surrounded by land with a higher elevation, it can form a standing waterbody like a wetland or lake.

Underground Streams and Springs

In northeastern Iowa, limestone bedrock is more often exposed than other parts of the state because it hasn't recently been glaciated and covered in a deposit of till, ground up soils mixed with stones. Water exploits cracks in limestone, creating crevices and caves that sometimes have water coursing through. Parts of Northeast Iowa watersheds have significant amounts of surface water draining underground via sinkholes and losing streams – streams that trickle underground and dry out at the surface. This water can collect and flow underground, much like streams on the surface. When they exit a cave, the flow of water outside the cave may be considered the start of a stream called a spring. Spring-fed waters bubbling from the ground are cold and often clear. Springs are important for coldwater fisheries including native brook trout, sculpin, and introduced sport fish such as rainbow trout and brown trout.



There are a diversity of aquatic environments in Iowa.

1. Lake
2. Headwaters
3. Pothole
4. Riverine wetland
5. Farmed wetland
6. Fen
7. Oxbow wetland
8. River

Lakes and Ponds

Lakes and ponds are bodies of standing water created naturally by the influx of water from surrounding lands, by water left behind by glaciers in depressional areas, or artificially by the installation of a dam on a river, stream, or valley. Lakes and ponds are generally made up of mostly permanent, deeper water but may support vegetation in the shallower water along the banks and floating vegetation throughout. Most lakes and ponds found in Iowa today were created by humans damming rivers, streams, and valleys such as the familiar reservoirs like Saylorville, Red Rock, and Rathbun. But some natural lakes are found in the glaciated Des Moines Lobe such as Clear Lake in Cerro Gordo County and from large disconnected channels along the Missouri and Mississippi Rivers such as Blue Lake in Monona County. Thousands of ponds created to water cattle, slow erosion, or provide recreation dot the Iowa landscape, with the greatest concentrations found in southern Iowa.

Wetlands

Wetlands are relatively shallow basins of water over special hydric, or very wet, soils. Wetlands can hold water permanently but are often defined by their tendency to hold water only during certain periods of the year. Indeed, what really makes wetlands unique is their tendency to occasionally go entirely dry. They support a thriving diverse community of plants adapted for wet conditions and hydric soils. Many types of wetlands are found in Iowa. Prairie pothole marshes are found in the Des Moines Lobe and form in very shallow depressions on the landscape left behind by retreating glaciers. Riverine wetlands are found where rivers spread from their banks into adjacent floodplains. Oxbows are found where old river channels are cut off from the main channel and convert to a lentic system. Fen wetlands are found where groundwater seeps to the surface. Farmed wetlands occur where shallow potholes or wetlands once were but are today farmed. Many farmed wetlands surprisingly play an important role as habitat for some migratory birds. Lacustrine wetlands border the edges of large lakes with emergent and submersed plants. Constructed wetlands are built to treat water contaminated by urban or agricultural activities.

Wetlands take many forms in Iowa.

Prairie pothole

Riverine wetland

Oxbow

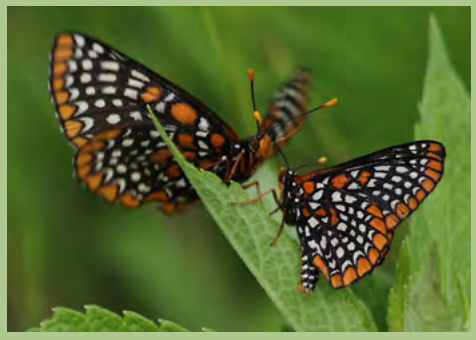
Fen

Farmed wetland

Lacustrine wetland

Fen Wetlands

Fens are a unique, rare type of wetland often found on hillsides and fed by groundwater. They most often have no pooled water, and the groundwater is very alkaline which can lead to deposits of calcium carbonate, called marl or tufa, on the ground. Walking through a fen has a unique spongy feel caused by the production of peat from non-decomposed vegetation. Around the world, fens are most present in more northern latitudes. This uniquely created wetland harbors unique plants and animals as well. One example is turtlehead, the sole host plant (food plant for caterpillars) for the Baltimore checkerspot butterfly. Some public fens in Iowa include Silver Lake fen in Dickinson County and Clear Creek fen in Allamakee County.



Baltimore checkerspots start life by eating turtlehead, a plant primarily found on fens.

AQUATIC COMMUNITY CHANGES THROUGH TIME

Aquatic ecosystems are all highly variable over time and in their location on the landscape. They change through the forces of moving waters, periods of drought or inundation, or shifts in plant or animal communities, including notably, at the hand of people. The modest Iowa River in its headwaters in north central Iowa is a drastically different environment than the mighty Iowa River that meets the Mississippi near Wapello. Over that space and through time, the Iowa River changes from a small head-water stream fed by flowing waters and their nutrients from adjacent grasslands, forests, and fields into a fully-fledged complex aquatic ecosystem with unique niches for a diversity of organisms at its outflow. The river is changed not just by the landscape, but also by manipulations made by people who, in the head-waters, have worked to straighten the channel and quicken the movement of water downstream. The river fights back to these modifications on occasion, eroding away banks during times of high flow and working to reconnect with the adjacent floodplain where it once roamed. These constant struggles between land and channel define flowing aquatic ecosystems and create much of the remarkable diversity we find within and along the edges of rivers and streams.

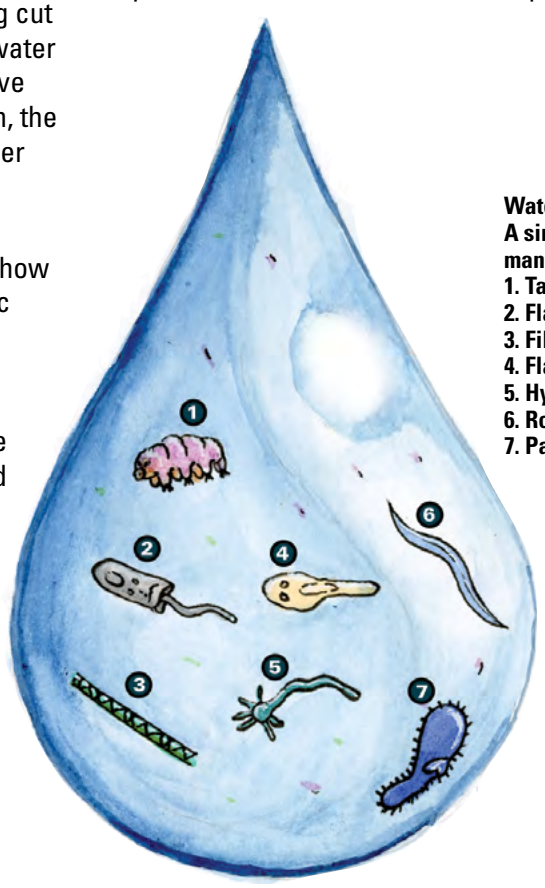
Rivers are always eroding and transporting sediment with water. Downriver, these sediments construct floodplains where the water channel may become more winding. Humans straightening the water channel or natural phenomena like rainier climates can cause bank erosion and too much sedimentation. Often, this process results into the stream bed continually being cut deeper and creating steep crumbling banks. When water channels and floodplains are in equilibrium, they move their water and sediments without excessive erosion, the waterbody offers consistent habitats for fish and other aquatic life.

Wetland communities change through two forms of succession. The first one is routine and is related to how water and nutrients fluctuate in these highly dynamic ecosystems. The second form is gradual and occurs as silt fills in a basin and can potentially, over many years, convert it to a terrestrial ecosystem. Wetland ecosystems are defined by their water levels and the amount of time the water persists in the basin, called a hydroperiod. These water conditions influence the vegetation and animal communities found there and lead to dynamic shifts in vegetation communities and wetland function over time. In one year, we may find a wetland rich with aquatic life and plants. After just a few years of static or high-water levels due to above average precipitation that same wetland could look more like a pond, with little vegetation and reduced animal diversity. Similarly, periods of drought can completely drain wetlands of their water while breathing life-sustaining oxygen into the soils so that wetland life comes thriving back when the water returns. These natural fluctuations and disturbances are critical for the diverse life adapted to wetland environments. This, along with natural disturbances like fire, grazing, or trampling by animals, including a wetland's own grazer the muskrat, create the diversity of niches available within wetland ecosystems.

LIFE IN THE WATER

Plankton

Plankton are small organisms that have very limited powers of locomotion. The name plankton comes from the Greek word 'planktos' meaning 'wanderer' or 'drifter', which appropriately describes how they move simply by drifting through the water. Plankton fall into two groups: zooplankton, which are unicellular or multicellular animals that are often five mm or smaller, and phytoplankton, which are microscopic organisms less than a millimeter in size that photosynthesize to make their own food from the sunlight. Phytoplankton often are the greatest source of primary production (the base of the food chain) in many aquatic environments. Zooplankton often eat phytoplankton and can keep their numbers in check. Zooplankton also are a vital link in the food chain of aquatic environments as they are consumed by larger organisms such as small fish, amphibians, and aquatic invertebrates. Blue-green algae, green algae, golden-brown algae, diatoms, daphnia, cladocerans, and dinoflagellates are common members of plankton communities in Iowa's aquatic environments.



Water is teeming with life. A single droplet can contain many organisms including
1. Tardigrades
2. Flagellates
3. Filamentous green algae
4. Flatworms
5. Hydra
6. Roundworms
7. Paramecium

Plants

Many species of plants are adapted to living in aquatic environments. They provide habitat for wildlife, produce oxygen, and act as another important basis of the food web. Plants also help improve water quality by slowing down the flow of water and capturing nutrients, chemicals, and sediments. Aquatic plants have a variety of adaptations to allow for growth in the water ranging from emergent plants found on the edges of water bodies like cattails, emergent plants within water bodies like American lotus, or fully submersed plants emerging only at the surface to flower, like coontail. Emergent vegetation, like spike rush, roots in the water but has stems and leaves that extend above the water surface. The plant structures of submersed plants, like pondweed and coontail, are mostly under water. The only part that is out of the water are the flowers which are pollinated at the water's surface.

Animals

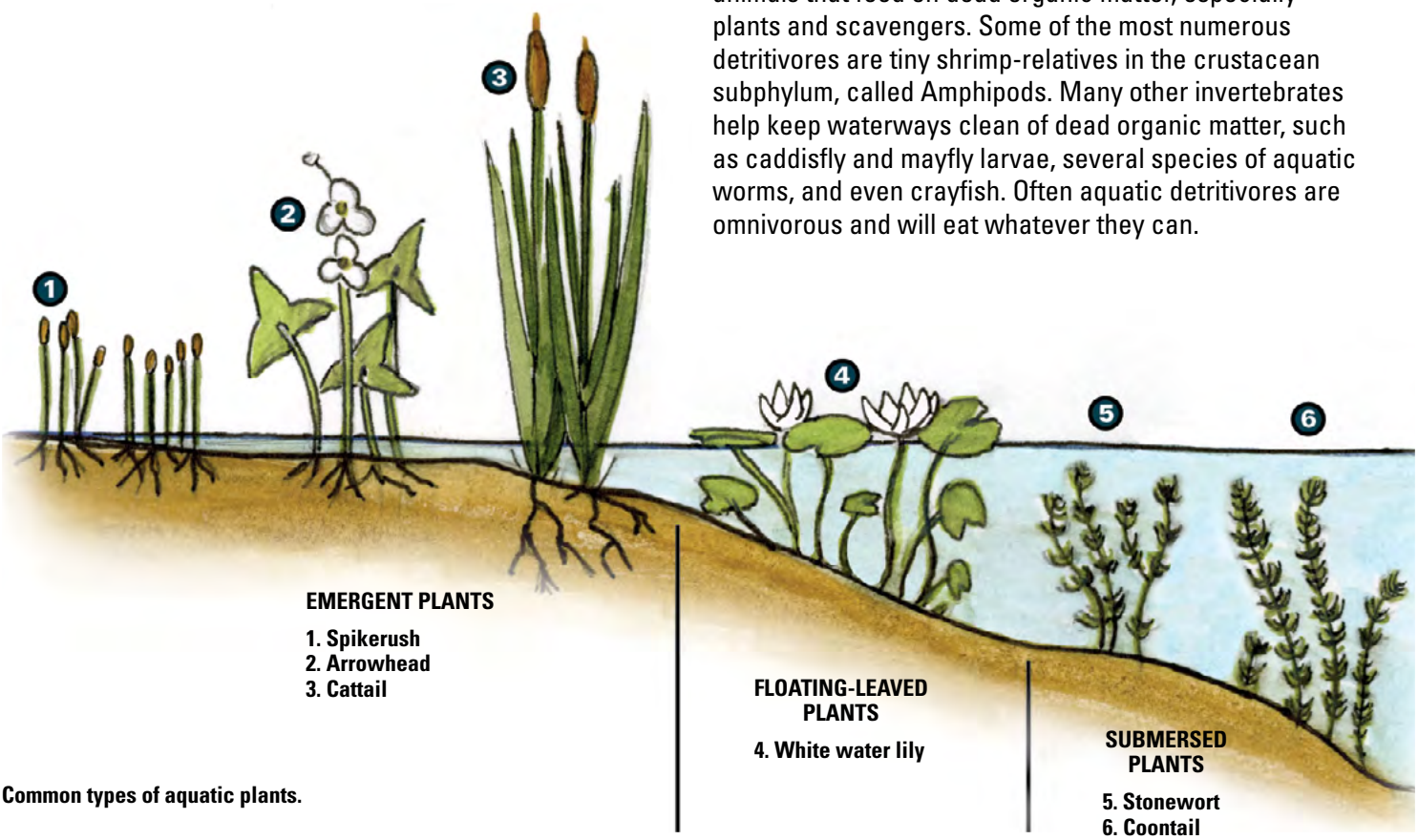
Along with a diversity of aquatic environments and plant communities comes a diversity of animals. All animals need water of some kind, including large land-based animals like white-tailed deer, but there are animals much more connected to water, such as Iowa's fish and mussel species. Many more species, like the 16 species of Iowa frogs and toads, split their time between land and water.

Herbivores, which are plant eaters or primary consumers, in Iowa's aquatic environments are diverse in size and habits. Some, such as filter feeding adult mussels, are mostly sedentary on the bottom of waterbodies. Others like muskrat and beaver are much larger and more mobile, living on both land and in the water. Waterfowl like the dabbling ducks can move through waterbodies in huge numbers, relying on a bounty of aquatic vegetation during migration each fall and spring.

Aquatic environments also support a large diversity of secondary consumers who feed on the smaller animals. Many species of aquatic insects are voracious predators, such as both the larval and adult life stages of dragonflies and damselflies. The paddlefish is a unique-looking and large fish found in Iowa's largest rivers. They swim through the water filter feeding, consuming tiny zooplankton. Most small fish and aquatic reptiles and amphibians, such as painted turtles and northern leopard frogs, thrive on insects and other invertebrates. All of these animals in turn provide food for other aquatic predators.

The top predators or tertiary consumers in Iowa's aquatic environments interact with these environments in a variety of ways. Fish such as walleye, muskellunge, and gar prey on other fish, amphibians, and crayfish in the larger lakes and waterways while bass hunt prey in both large and small waterbodies. Snapping turtles, especially as they grow large, consume fish, amphibians and even waterfowl. River otters use river corridors to travel across the landscape in search of fish, crayfish, and mussels. From the shallows, great blue herons and American bitterns hunt for fish and amphibians while bald eagles and ospreys catch fish on the wing.

Aquatic environments also have detritivores, which are animals that feed on dead organic matter, especially plants and scavengers. Some of the most numerous detritivores are tiny shrimp-relatives in the crustacean subphylum, called Amphipods. Many other invertebrates help keep waterways clean of dead organic matter, such as caddisfly and mayfly larvae, several species of aquatic worms, and even crayfish. Often aquatic detritivores are omnivorous and will eat whatever they can.



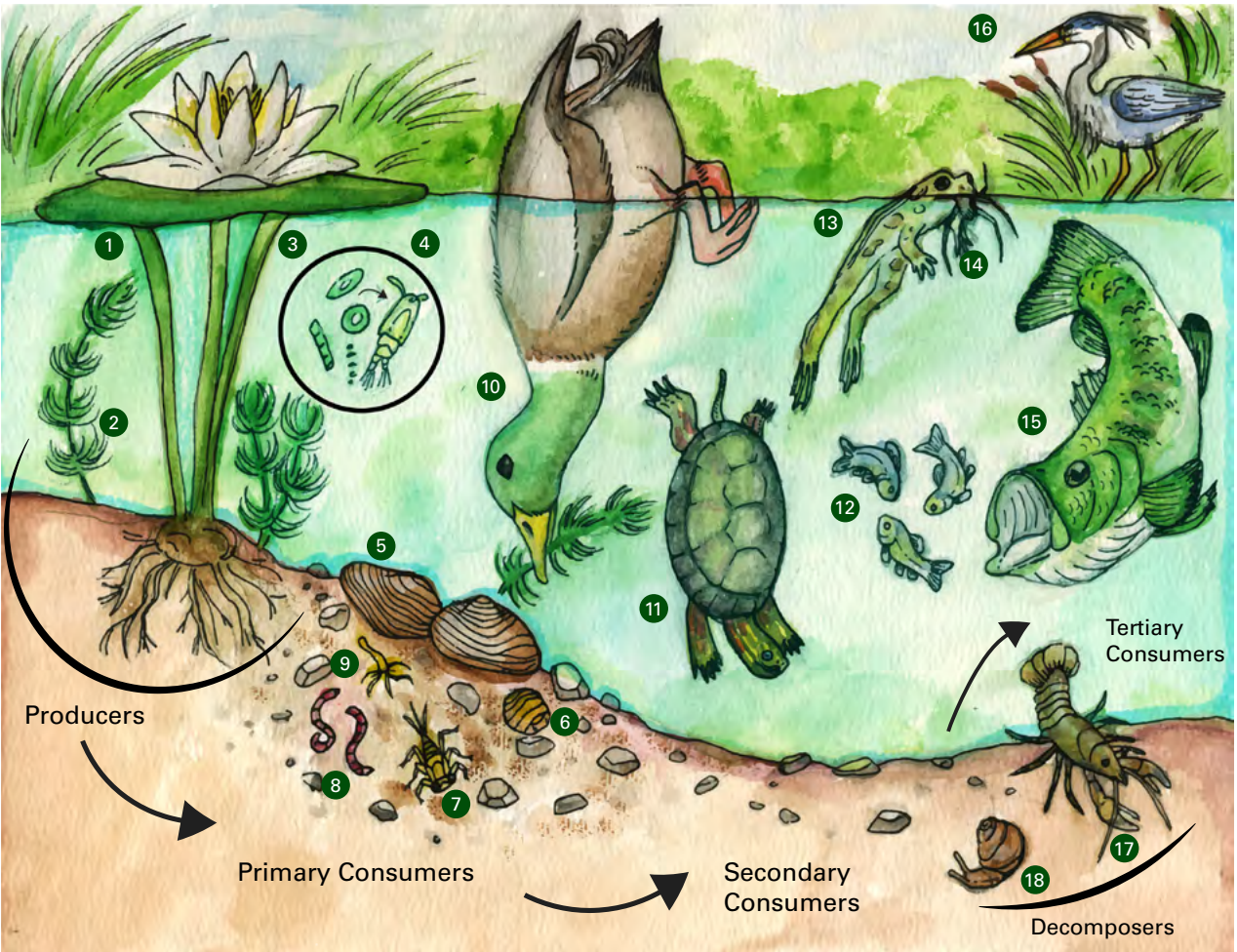
Common types of aquatic plants.

RESTORATION AND MANAGEMENT OF AQUATIC ENVIRONMENTS

The maintenance of healthy, diverse aquatic ecosystems is of paramount importance to humans and all the living organisms, which depend on water. Conservation practices start at the watershed level and help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Conservation practices can include activities such as constructed wetlands, conservation tillage, terraces, cover crops, and buffer strips. All of these activities work with the landscape to slow water movement and increase water infiltration. This prevents soil from being washed away and ending up in aquatic environments. Aquatic environments in Iowa have been modified extensively. Researchers estimated around 95% of all wetlands that were once found in Iowa are today drained or modified. Rivers and streams have been straightened dredged to allow for swifter flow of waters out of the state and altering their ecology. Introduction of exotic species or nutrients and other contaminants has also created challenges for aquatic environments. Therefore, many people in Iowa are engaged in a diversity of important management and restoration practices to try to improve the health of our remaining aquatic ecosystems for the benefit of people and the plants and animals that depend on them.

Prairie Potholes and Flyways

The Prairie Pothole Region is a large area in the northern Great Plains that contains many shallow wetlands called "potholes." These shallow depressions were created by the retreat of the glaciers during the last ice age 10,000 - 15,000 years ago. Pothole wetlands are generally shallow and don't usually hold water year-round. This creates a mosaic of different water depths and a shifting pattern of diverse emergent and submersed vegetation. This environment is ideal for vast flocks of migrating waterfowl in the spring. Tens of thousands of birds use these wetlands to refuel, rest, and court mates on their way to their northern breeding grounds in Canada and Alaska. Iowa's Prairie Pothole Region is essential for sustaining healthy waterfowl populations across North America.



PRODUCERS
1. White water lily
2. Coontail
3. Phytoplankton

PRIMARY CONSUMERS
4. Zooplankton
5. Pond mussels
6. Water penny
7. Mayfly larva
8. Midges
9. Hydra
10. Mallard

SECONDARY CONSUMERS
11. Painted turtle
12. Fathead minnows
13. Northern leopard frog
14. Water strider

TERTIARY CONSUMERS
15. Largemouth bass
16. Great blue heron

DETRITIVORES/ DECOMPOSERS
17. Northern crayfish
18. Pond snail

Stream Restoration and Dam Removal

When streams and rivers in Iowa go out of balance, heavy erosion can occur, which leads to poor water quality and stream habitat. Restoring them to balance can be complex, requiring careful study of the causes. The benefits of stream restoration are stable habitat for fish, mussels, and other aquatic wildlife, as well as improved water quality, on-water safety, and water recreation activities.

There are many pieces to the stream restoration puzzle. It might require reducing high, steep stream banks, increasing channel depths, or removing levees so the river can flood again naturally. Allowing flooding into a restored floodplain can create crucial habitat for some fish species that use these events for spawning, survival through all life stages, and feeding. Establishing native vegetation along rivers also helps stabilize banks and provide habitat for species of wildlife that use both the banks and water, such as many reptiles and amphibians. Finally, restoration on upstream headwaters can benefit rivers downstream.

Oxbow restoration is a unique and specific type of restoration that takes place along streams. An oxbow wetland is an old meander of a river that has become separated from the flowing water. Oxbow wetlands store excess water that might otherwise lead to flooding, naturally filter water to improve water quality, and provide habitat to a wide variety of wildlife. Over time, some oxbows fill in with sediment due to erosion in surrounding areas and cease to provide these benefits. Restoration of degraded oxbows improves natural floodplain function and backwater habitat. Oxbows can be restored by removing sediment to increase water depth so they hold water year-round.

Restored oxbows in Iowa provide valuable habitat to over 50 fish species and countless birds, mammals, amphibians, and other aquatic critters. Healthy oxbow wetlands are critical for the survival of the federally endangered Topeka shiner (*Notropis topeka*), a small minnow endangered due to loss of habitat. Topeka shiners require backwaters, like those provided by oxbows, to escape predatory fish and complete their life cycle.

Eroding, cut banks are one of major problems affecting water quality. Planting vegetation and stabilizing eroding banks helps prevent too much silt input into waterways.

Male Topeka shiner. ©Lance Merry, Missouri Department of Conservation.

Finally, dams also pose challenges for streams and rivers. Dams prevent the movement of fish and mussels, causing their populations to decline and can also be dangerous for boaters and anglers. It is not always possible, but removing obsolete dams or converting them to rapids can be of major benefit to the quality of fisheries, aquatic habitats, and safe recreational opportunities.

Wetland Reconstruction

Wetland reconstruction is an important tool for managing and improving Iowa's aquatic resources. Many wetlands were altered through drainage or other disturbance in the past. During restoration, tile (pipe installed in the ground to drain areas of water) is removed or ditches are plugged, so water is restored to the wetland basin. The upland surrounding the basin is often planted to prairie plants, and nature then takes over to restore the wetland plant community. Wetland plants that return have been dormant in the soil or are transported there on the bodies of, or even in the digestive tract of, birds. As the wetland matures and other forces start to act (for example a muskrat or two moves in and begins eating sections of cattails), the vegetation evolves. After a few years, the wetland is functioning to clean water, hold back flood waters, and provide habitat for wildlife.

Aquatic Invasive Species

Invasive species pose an ongoing threat to Iowa lakes, rivers, and wetlands. Species such as Eurasian watermilfoil, zebra mussels, Asian carp, and rusty crayfish lead to the loss of biodiversity, hinder economic development, serve as vectors of disease, decrease the aesthetic value of waters, and prevent recreational activities.

Perhaps the most significant impact of invasive species is widespread change in habitat. Invasive aquatic plants, such as Eurasian watermilfoil, form dense mats that block sunlight and starve aquatic life of oxygen. These mats

often crowd out the native vegetation which provides food, shelter, and nesting areas for fish and other wildlife. Some invasive insects or animals may prey upon native species, compete with them for food and space, interbreed with them, or introduce harmful pathogens and parasites.

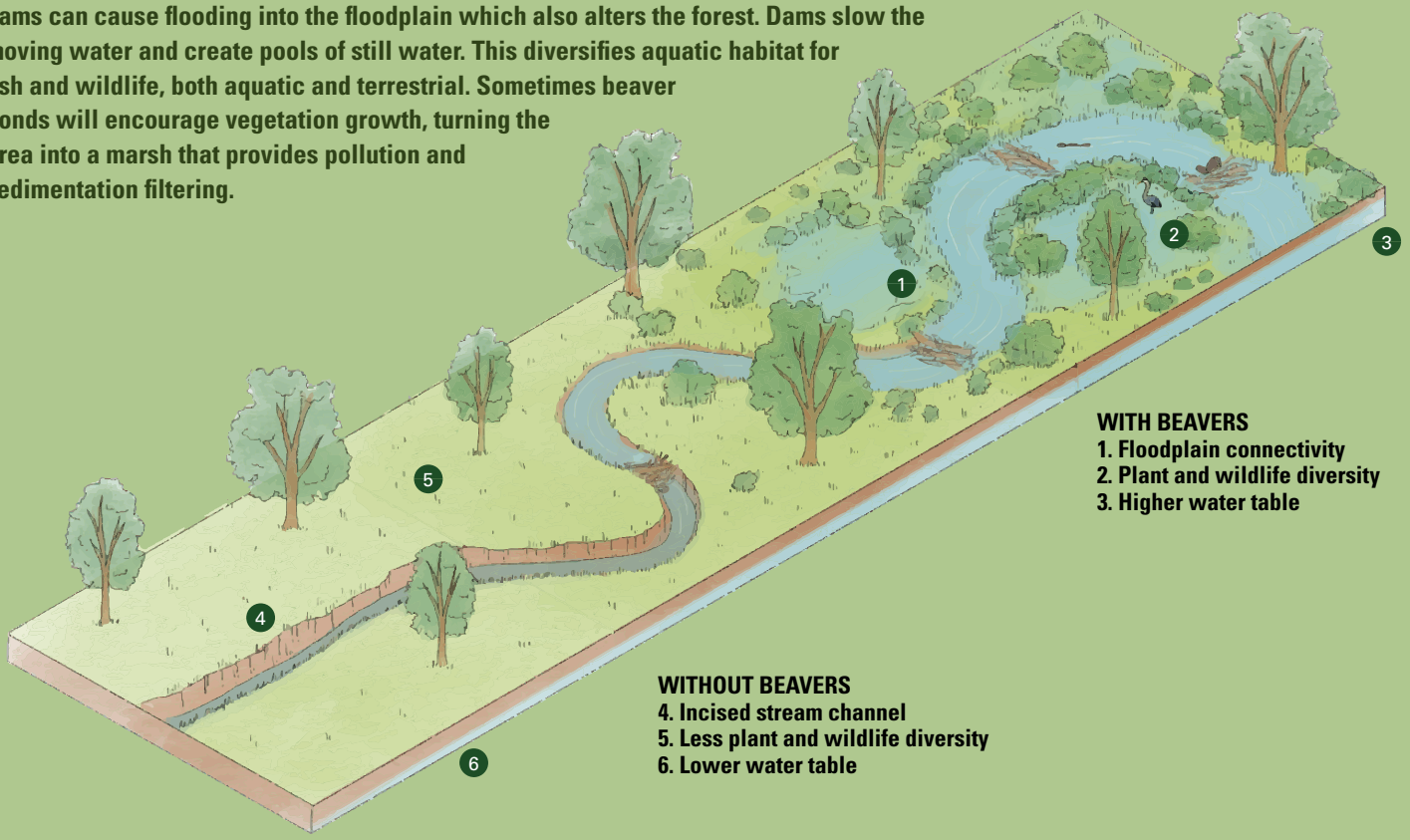
Aquatic invasive species spread through many different pathways, most of which are a result of human activity, including recreational activities, water gardening, and disposing of aquarium species. Everyone can help prevent the spread of aquatic invasive species by understanding and identifying threats from these species, knowing how to prevent their spread, and educating others about them. Professionals and volunteers talk to boaters and anglers at high-use boat ramps throughout Iowa in the summer to inform them of the threat of invasive species and steps to take to prevent their spread. Natural resource managers also work to control infestations of invasive aquatic plants using mechanical and chemical methods to reduce their impacts to aquatic environments.

Water Quality Monitoring

Water quality monitoring is a fundamental tool in the management and protection of aquatic environments. Water quality is more than the amount of pollutant or chemical in an aquatic environment. It is the collective biological, chemical, and physical health of the water. Commonly monitored biological components include fish, bacteria, and aquatic invertebrates. Chemical components would include nutrients, metals, pH, and pesticides to name a few. Physical components often refer to measurements of water depth, clarity, and temperature. To understand overall health, it is important to examine many of these factors at the same time. Monitoring is the only way we know what the quality of the water is and how it is changing through time.

Beavers as "Ecosystem Engineers"

There are some species of wildlife that have such a significant impact on the environment through their normal actions they are called ecosystem engineers. One of the most important in aquatic environments is the beaver. Beavers build dams by cutting down trees along streams. Because they choose particular types of trees, they can change the forest tree composition, altering that terrestrial ecosystem. Their dams can cause flooding into the floodplain which also alters the forest. Dams slow the moving water and create pools of still water. This diversifies aquatic habitat for fish and wildlife, both aquatic and terrestrial. Sometimes beaver ponds will encourage vegetation growth, turning the area into a marsh that provides pollution and sedimentation filtering.



HUMANS AND WATER

Vast prairies, open savannahs, and woodlands once covered the landscape in Iowa. Many rivers and streams flowed through these ecosystems and were often bordered by thick woodlands. Both the prairie and woodland landscapes were dotted with wetlands. In the Des Moines Lobe wetlands were once the most common landscape feature. Amid all these natural aquatic ecosystems, Native American cultures in Iowa built close relationships with the plants and animals that occurred there. These people used wetland vegetation for building structures, rivers and streams for transportation and trade, and all aquatic communities to provided foods throughout the year. Historical maps from early contact between European colonizers and Native communities and research from Iowa archeologists have revealed that hundreds of Native communities were once distributed along the banks of Iowa's rivers and glacial lakes. Accounts of northern Iowa's landscape from European descendants moving into the state in the 1800s, referred to northern Iowa as the "thousand lake" region and these people celebrated these features as they named towns still around today like Curlew, Mallard, and Plover, all waterbirds that depend on lakes and wetlands.

The invasive Eurasian watermilfoil tangling up the propeller of a boat motor.

Zebra mussels growing on a native mussel's shell.

Aquatic ecosystems today continue to provide critical functions to people for goods and ecosystems services. Iowans can access dozens of natural and artificial lakes and 18,000 miles of navigable streams. Many people enjoy these areas while swimming, floating in tubes, kayaking, canoeing, and spending time on the water in various other watercraft. Along with just enjoying some time on the water, Iowans flock to lakes and spend hundreds of millions of dollars annually in their pursuit of fish. Nationally, fishing is one of the most popular outdoor activities. Fishing opportunities vary from bluegill in any pond or lake, to river catfish, to the trout in northeast Iowa streams. Ice fishing in winter is also a popular pastime. Iowans may also engage in the time-honored tradition of waterfowl hunting. Plentiful and well-managed wetlands are crucial to healthy waterfowl populations and rewarding hunting experiences. Trapping also relies heavily on quality rivers and streams. Three of the most popular species to harvest, beaver, otter, and mink, are tightly connected to the waterways and their banks. Watching aquatic wildlife, particularly birds, is also a popular activity. In short, time spent outdoors on or near the water is important to Iowan's quality of life and also provides many economic benefits to the state.

The aquatic communities of Iowa's landscape also provide critical services that keep communities of people safe and healthy. Wetlands clean surface waters of pollutants, nutrients, and other contaminants that could threaten drinking water supplies of downstream communities. Naturally meandering rivers and streams also provide many of the same water-purifying functions as wetlands. Many large cities and towns along rivers rely on surface waters for drinking water sources and thus rely on healthy, functioning ecosystems upstream. Wetlands, rivers, and streams with connections to their neighboring floodplains also provide critical roles in reducing flooding and thus protecting downstream communities in Iowa and all the way to the Gulf of Mexico. Finally, many of Iowa's surface waters today are still used for transportation of goods and services and thus are economically important. Most notably is the mighty Mississippi River, who's ports and barges ship agricultural and other goods downstream to possessors or even to the ocean and to other continents.

Eagle-shaped viewing platform at Otter Creek Marsh in Tama County.

SUMMING IT UP

Aquatic environments are an important part of Iowa's landscape. The rivers have helped shape the land and in many ways human culture and commerce, and continue to do so today. Wetlands have provided protection from floods, a buffer for our rivers and an important stopover for migrating birds. From West Lake Okoboji, created by a retreating glacier to Rathbun Reservoir, created by a dam on the Chariton River, lakes attract those who enjoy open water, human and wildlife alike. Iowa's huge variety of aquatic environments provide key services for all the life within the state's borders. They contain life ranging from the microscopic phytoplankton to the huge bulk of a muskie. There is very little that Iowans of all species rely on more than water and the state is fortunate in the diversity of rivers, wetlands, lakes, and ponds, it holds.

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Roger Hill—prairie pothole in aquatic types illustration; waterfowl on prairie pothole wetland

Mark Gulick—lacustrine wetland

Iowa Department of Natural Resources—riverine wetland; farmed wetland; fen; prairie pothole; invasive watermilfoil on boat motor; zebra mussel colonizing native mussel; eagle-shaped viewing platform

Iowa Chapter of The Nature Conservancy—oxbow wetland

Tom Schilke—Baltimore checkerspots

Nate Hoogeveen—bank restoration planting

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