

2009-2010 AQUAGUIDE

Welcome to the Tennessee Aquarium! We hope you enjoy your visit. This guide is designed to help prepare your class for their field trip or to lead your group as they explore the exhibits in the Aquarium. **Questions and featured animals are highlighted in bold.** *Answers are given in italics.* At the end of each section, you'll find a "Who's Who" list of the species typically found in the gallery. However, due to the nature of a living collection, we cannot guarantee that you will see each animal when visiting.

TROPICAL COVE

Tropical rainforests are areas of high humidity, rainfall and temperature located along the equator between the Tropic of Cancer and Tropic of Capricorn. The Tropical Cove recreates this spectacular habitat in a 30-foot tall sunlit space filled with lush tropical plants and 20-foot tall palms. Engage all of your senses as you encounter the sights and sounds of animals from the treetops to forest pools, touch a shark or marvel at brightly colored butterflies.

Hyacinth Macaws

The **Hyacinth macaw** is the largest member of the parrot family. Adults grow to approximately 40 inches in length with a wingspan of up to 50 inches. Their natural lifespan is estimated to be 30 – 50 years or more.

Q: The hyacinth macaw has two important tools : its strong beak and its nimble feet. Observe the macaws. **How do they use these tools to help them survive?**

A: Hyacinth macaws have very strong beaks for cracking nuts and seeds. They can exert more than 300 pounds of pressure per square inch (psi) when biting. How do other animals stack up? A human can exert 170 psi when biting, while large alligators exert more than 2000 psi.

Macaws use their agile feet like hands, even using them to lift food to their mouths. When moving around, they use their feet and beaks for grasping.

Shark Island

Shark Island is the Aquarium's largest encounter exhibit, offering students the opportunity to touch a shark, guitar fish or stingray. Please prepare your students for their encounter by directing them to gently touch the animals with two fingers.

Q: Sharks and stingrays are related, both having a skeleton made of flexible cartilage rather than bone. Observe them, then gently touch them. **How are rays different than sharks? How are they similar?**

A: Sharks feel rough. Their scales are dermal denticles, flat plates buried in the skin with a raised portion exposed. The cownose rays lack scales and feel smooth to the touch. Stingrays have rows of teeth arranged into a grinding plate. The bamboo sharks possess many small individual teeth used to feed on bottom-dwelling invertebrates. Sharks and stingrays are flattened on their bellies because they spend much of their time on the ocean floor. Other differences include their color, swimming styles and methods of defense.



Butterfly Garden

Observe the **butterflies** as you walk among the plants in the Butterfly Garden. What are they feeding on? The majority of the butterflies prefer nectar from flowering trees and plants. They need lots of energy to stay in flight and prefer plants where they can gently rest while gathering nectar. You might notice that some butterflies prefer to feed on rotting fruit.

These butterflies are seeking minerals and nutrients in the fruit juices that will help in breeding success.

Nature's Artistry

Butterflies make use of the color, shape, pattern and motion of their wings to create some of the most effective and dazzling visual displays in nature. They also use muted colors for camouflage.

Q: Find a butterfly that is brightly colored. What is the purpose of its bright color?

A: Bright colors advertise to predators that it is not good to eat. They can also be helpful in attracting a mate.

Q: Some butterflies have circles on their wings called eyespots. Find a butterfly with eyespots. What is their purpose?

A: Scientists think the large spots might resemble eyes. A predator might think the butterfly is a much larger animal and be frightened away.

Conservation Note: The butterflies housed in the exhibit are not collected from wild populations. They are raised on butterfly farms in a sustainable manner. Most tropical butterfly farmers realize that their business depends upon healthy, protected native habitat. Land that is used to farm butterflies is saved from being clearcut and developed.

Who's Who?

hyacinth macaw, brown-banded bamboo shark, guitar fish, Atlantic stingray, blue morpho butterfly, tiger longwing butterfly

PENGUINS' ROCK

Penguins' Rock takes you miles south of the Equator to a chilly world of ice and snow. Here we show you the top 10 reasons **Penguins' Rock!** There are 17 species of penguins in the world, all of which are found only in the southern hemisphere. This exhibit features the **Gentoo and Macaroni penguins**. **Penguins' Rock** contains 18,000 gallons of freshwater, chilled to 42 degrees, is equipped with a wave-making machine to simulate natural wave action and is painted with a mural of a rocky shore in the background.

Penguins range in size from a little over 2 feet to almost 4 feet tall.

Q: What size are our penguins?

A: *Gentoo and Macaroni penguins are mid-size birds that grow on the average from 24-30 inches tall. The largest penguin is the Emperor penguin and the smallest is the Little Blue penguin.*

All penguins belong to the Family *Spheniscidae*, from the Greek word meaning "little wedge", referring to their short, wedged shaped tails.

Q: How fast can penguins swim?

A: *The larger species such as Emperors and Kings are capable of bursts greater than 20 mph. They usually swim at a more leisurely 7 mph. The fastest Olympic swimmers reach speeds of just over 5 mph in a 100 meter race.*

Where have I heard that before?

The Macaroni penguin got its name from early English explorers for its yellow crest feathers which resembled those worn in the hats of young 18th century men called "macaronis". This label was used in the Revolutionary War song "Yankee Doodle".

Some penguins, such as the Emperors, are capable of diving to depths of 900 feet. Penguins breathe by "porpoising" like dolphins as they swim. They can waddle about 2 mph and some species are capable of making treks up to 20 miles to nesting sites.



Q. Why do penguins look like they are dressed in a tuxedo?

A: *This coloration is called counter-shading and it is used to camouflage a penguin in the water. From below, a penguin's white belly blends into*

the bright surface of the ocean while from above a penguin's dark back disappears into the inky blackness of the ocean below. This helps them avoid predators and catch prey.

Keeping the Chill Out

All penguins have a thick layer of insulating feathers and a thick layer of blubber or fat which are designed to keep them warm in winter, as heat loss in water is much greater than in air. They can also control blood flow to their extremities, reducing the amount of blood which gets cold, but still keep their extremities from freezing.

Q: What do penguins eat?

A: *Penguins in the wild eat squid, fish and krill. Here at the Tennessee Aquarium they are mainly fed capelin, but herring, squid, sardines, krill and silversides may also be used as food.*

Conservation Note: Penguins face many survival challenges including habitat loss, oil spills, reduced food supplies and climate change. The most endangered penguin species is the Galapagos penguin. Habitat destruction and loss of nesting grounds has caused the population to drop to just 600 breeding pairs. All 17 species of penguins are protected by law from hunting. You can help protect penguins by supporting conservation initiatives for all marine life.

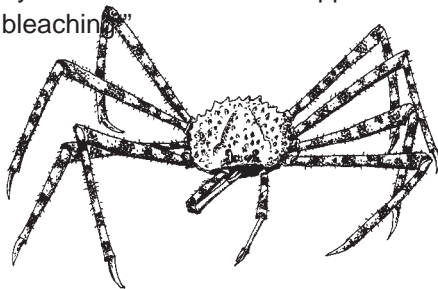
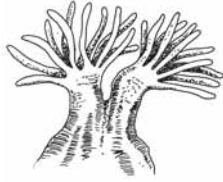
Who's Who?

gentoo and macaroni penguins

BONELESS BEAUTIES

Drastically different in appearance, the creatures found in Boneless Beauties all have one thing in common, the lack of a backbone. Scientists estimate that more than 95% of all known species on earth are invertebrates. From the microscopic rotifers at four hundred thousandths of an inch to the giant squid growing to more than 40 feet in length, these animals represent a vast array of shapes, sizes, and colors.

Coral reefs provide habitat for numerous fish and invertebrate species. Corals can be divided into two basic categories: hard corals and soft corals. Hard corals have cup-like skeletons that form the foundation of coral reefs. Soft corals have bits of calcium carbonate scattered throughout their bodies. Coral reefs are made up of colonies of individual invertebrate animals called polyps that all live together in a limestone skeleton structure. Each polyp is soft-bodied and resembles an upside-down jellyfish (a relative). Corals have a symbiotic relationship with algae living inside their tissue known as zooxanthellae. In this relationship, corals provide the algae a protected environment in which to live and the elements necessary for the algae to carry out photosynthesis. In return, 90% of the coral's food comes from the sugars and other compounds made by the zooxanthellae. The other 10% of their nutrition comes from extending a circle of tentacles, to capture plankton. Coral gets its color from the algae or zooxanthellae living deep within the polyps' tissue. If the coral were to become stressed, it would expel the zooxanthellae, and the colony would take on a white appearance known as "coral bleaching."

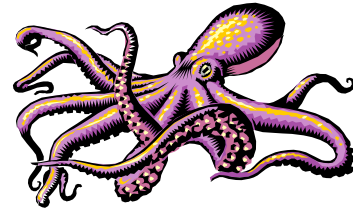


Did You Know?

- Octopuses and cuttlefish have blue blood.
- The octopus uses its suckers to help it detect prey such as crabs, snails and fish. Once its prey is captured, the octopus injects a toxin through its beak to help dissolve the prey, making it easier to ingest.
- Jellyfish, nautilus, cuttlefish, and octopuses move using a form of jet propulsion. As water is pushed out of their bodies in one direction, the animals move in the opposite direction.
- Octopuses and cuttlefish protect themselves by expelling a jet of ink into the water while they exit in the other direction.
- The spider crab is the largest arthropod, weighing up to 44 pounds with a leg span of 12 feet and a body that can reach 15 inches in diameter.
- The nautilus' spiral shell is divided internally into gas-filled chambers that provide buoyancy.

How'd They Do That?

Octopuses are considered the most intelligent of all invertebrate animals, comparable to a house cat. They are often shy but curious and will explore their environment and whatever is in it. Octopuses are often difficult to keep in collections as they are excellent escape artists. Securing their tank is a challenge. How does our husbandry staff keep them from escaping? They surround the inside of the exhibit with astro-turf (yes, like a football field!). The octopus' suction cups cannot stick to this material, thus preventing octopuses from climbing out.



Color Changers

Octopuses and cuttlefish are able to change colors to blend in with their environment. Cuttlefish use special cells called chromatophores to rapidly alter their color.

Q: How many cuttlefish can you find in the exhibit? What do they blend in with? How does their ability to quickly change color help them survive?

A: They usually change color in response to predators or other disturbances. The ability to blend in with their surroundings helps them virtually "disappear" from predators.

Who's Who?

giant Pacific octopus, giant spider crab, cuttlefish, emperor nautilus, moon jellyfish, sea nettles.



SECRET REEF

In the waters of the Gulf of Mexico, about 115 miles south of Texas, lies a coral reef teeming with life. The Flower Garden Banks National Marine Sanctuary is the northernmost coral reef in the United States and boasts the highest percentage of coral cover compared to most reefs around the world. Representing the Flower Garden Banks, the Tennessee Aquarium's **Secret Reef** exhibit contains over 600,000 gallons of artificially created saltwater. Over 3,500 fish make their home among the corals and sponges in the exhibit. No, the corals in this exhibit aren't living. The Tennessee Aquarium's reef was artificially created using cement, then molded and painted to look realistic.

Amazing Fish Adaptations

As you look at the fish in the Secret Reef, you may notice that no two fish are the same. They come in many different sizes, shapes and colors. Why? Fish are built for a specific lifestyle. Explore some of these adaptations as you observe the coral reef fish.

How does color help a fish survive? Color may camouflage a fish from predators, or help it sneak up on prey. Color could also help attract a mate.

Some fish are opportunistic, feeding on many types of food. Some fish have mouths designed to eat a very specific diet.

Q: Find three fish with different mouths. What might they feed on?

A: Answers will vary. Here are some to get you started! Sharks and barracuda are predators, using sharp teeth to catch their prey. Sharks feed on eels, rays, octopuses and small fish, while barracuda feed mainly on smaller fish. Stingrays use crushing plates to break apart hard-shelled invertebrates. Butterflyfish have small pointed mouths that aid them in eating algae on hard surfaces.

How can you tell where in the water column a fish feeds?

Fish with mouths on the bottoms of their bodies feed at the bottom of the ocean (stingrays, etc.) If its mouth points upward, the fish is a surface feeder (barracuda, tarpon, etc.). Fish with forward-facing mouths feed all up and down the water column (permits, jacks, etc.)

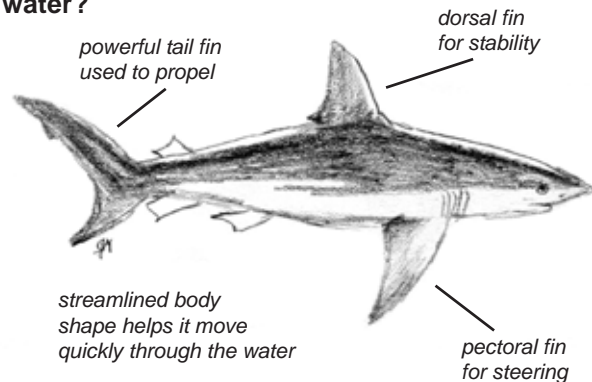
Q: Fish protect themselves in a variety of ways. Look closely and describe at least two methods of defense.

A: Sharks use large teeth to bite when threatened. A stingray can inject a mild venom using a serrated spine on its tail. Pufferfish swallow water or air to inflate their bodies so they look larger; some also have spines that stick out like a pincushion. A surgeonfish has a tail spine that can deliver a razor-sharp slice. Did your students find others?

Q: You go to school and so do fish! Well, actually, they swim in groups called schools. Watch the fish in the Secret Reef. What types of fish do you observe swimming in a school? What are the advantages to schooling?

A: Jacks, cottonwicks and lookdowns swim together in schools. There are several advantages. A predator is less likely to attack a large group of fish because large numbers confuse the predator or because the school can resemble a large fish. The large numbers can be confusing because the members can scatter, making it harder for an attacking predator to catch individual fish. Schools make it easier for the fish to find food because there are more individuals looking, and because less successful individuals can follow more successful ones.

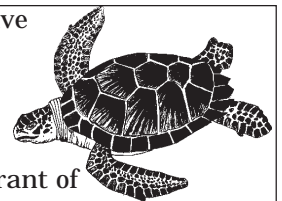
Sharks seem to move effortlessly through the water. They swim in an S-shape motion. Observe a shark as it swims. **How do its fins help it move through the water?**



Conservation Note: Coral reefs are being lost at an alarming rate. Threats such as destructive fishing practices, coastal development, sedimentation, sewage and rising global temperatures are responsible for their decline. Why should we care? The ocean influences our climate and storms, creates oxygen and is used indirectly by humans in thousands of ways. The contributions of coral reefs to human nutrition and health are only beginning to be explored. How can you help? Only buy tropical fish that have been collected in a sustainable way. Don't buy dead or dried marine souvenirs. Participate in a local trash cleanup. Be responsible at home by make sure your car doesn't leak oil and using caution when applying pesticides or fertilizers to your lawn.

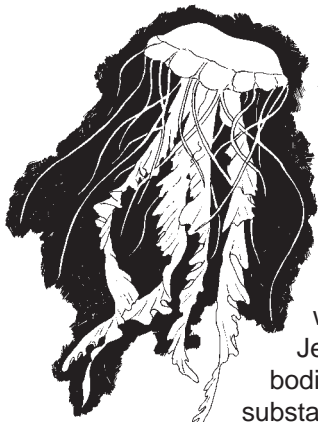
Sea turtles are reptiles that have adapted to life in the ocean. These animals spend almost their entire lives in the ocean.

Sea turtles have lungs and breathe air. They are very tolerant of low oxygen levels and can remain resting underwater for up to 3 hours at a time! The green sea turtle's name is derived from the greenish color of the fat inside its body, not the shell outside. Many sea turtles have been accidentally caught in the nets of shrimp fishermen. Federal regulations now require every large shrimp boat to install a Turtle Excluder Device, or "TED" in their net. TED's can be expensive and cumbersome, but also prevent net damage, increase the fishermen's catch, and save the lives of turtles and other large animals, including bottom dwelling sharks.



JELLIES: LIVING ART

Typically one views wildlife and art pieces separately, but in this unique gallery a collection of studio glass is exhibited with the very animals that were the artists' inspiration.



Jellyfish are perhaps the simplest yet most mysterious ocean dwellers. Despite bodies that are 97 percent water and a lack of eyes, ears or a brain, these phantoms of the deep are found in all the world's oceans.

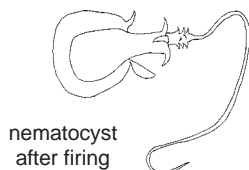
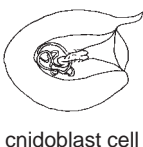
Jellyfish are invertebrates with bodies that consist of a jelly-like substance called mesoglea.

Despite limited sensory organs, jellyfish can smell, taste and remain balanced in the water. In a process similar to the balance-maintaining sacs found in the inner ear of humans, jellyfish maintain balance by using **statocysts** (STAT-o-cists) located on the bell rim. When a jellyfish shifts too far to one side or the other, the sacs stimulate nerve endings to contract muscles that re-orient the jellyfish in the correct direction.

Jellyfish also have **rhopalia** (roe-PAL-e-a), light sensing organs located around the rim of the bell. Although jellyfish cannot detect movement, shape or color, the rhopalia help to distinguish light from dark.

The King of Sting

How does a **jellyfish** sting? Clusters of cells called cnidoblasts are found along the tentacles, on the oral arms and even on the bell. A tightly coiled nematocyst is found within each cnidoblast. Each nematocyst is a mini-harpoon that is shot at high speed from its cell when stimulated by touch and chemical signals. Upon penetration, it delivers a protein toxin that paralyzes small prey and produces severe burning on most people's skin.



Despite the stinging cells, some animals eat jellyfish. The ocean sunfish (*Mola mola*) and sea turtles, such as the leatherback (*Dermochelys coriacea*), feed primarily on jellyfish, and some people consider jellyfish quite a delicacy!

Who's Who?

umbrella jelly, upside-down jelly, moon jelly, blubber jelly
sea nettle, comb jelly

Jellies have a complex life cycle. As adults, or **medusa** (me-DUE-sa), jellies have an oral cavity, located underneath the bell, which is surrounded by tentacles.

The medusa reproduce sexually to create **planula**

(PLAN-you-la), free-swimming larvae that float until they find a suitable hard

surface for attaching. At this point the jelly transforms into the **polyp** (POL-ip)

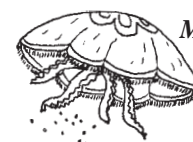
form and resembles a cone. The polyp may now reproduce asexually for a few

months, but may live for several years asexually producing clone polyps.

Eventually the polyps begin to form grooves that deepen until a stack of several organisms remains. Once this replication begins, the animal is called a **strobila** (STRO-ba-la)

and resembles a stack of pancakes. Eventually the pancake on top pops off, and becomes a free-swimming

ephyra (ee-FIE-rah). As each ephyra grows, it will transform into the more typical medusa body shape.



Planula



Did you know?

A jelly's digestive system has only one opening, the mouth, for food to enter and waste to exit. You can often see the sides of the moon jelly's four stomachs as horseshoe shapes in its bell.

The collective noun used to describe a group of jellies is "smack."

Conservation Note: Humans can create a vicious cycle that, in the end, can make things more difficult for fisherman. Overfishing gives jellies an edge by removing predators from the food web. Additionally, some pollution actually adds nutrients to our oceans, feeding algae that in turn produce more zooplankton, a major food source for jellies. Jelly populations can increase dramatically, creating "swarms" that can consume large numbers of larval fish and decrease the number of fish to harvest or reproduce.

SEAHORSE GALLERY

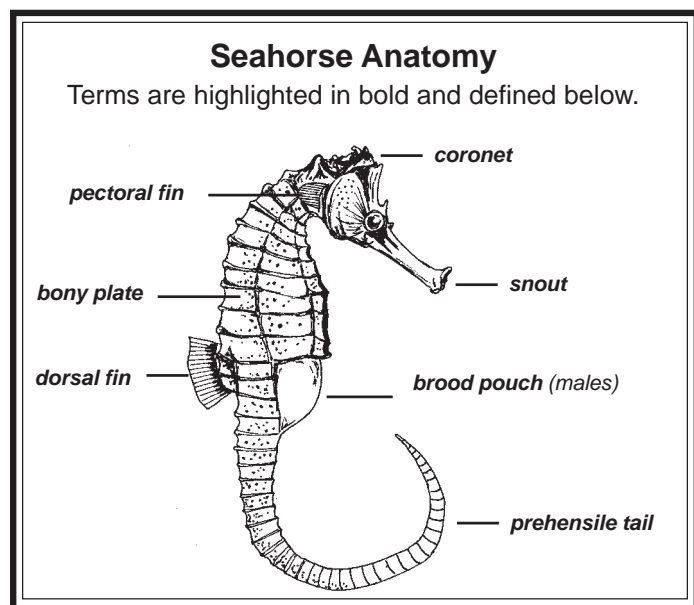
Most of us recognize a fish when we see one. We generally define a fish as an animal that breathes with gills, moves with fins, is covered by scales or skin and lives in aquatic habitats. Fish come in nearly any shape we can imagine and most of the colors of the rainbow. There are a few fish, however, that may leave us scratching our heads in wonder. Seahorses are just such a fish.

Q: What characteristics do seahorses share with other fish?

A: Answer can be found in the introductory text above.

Q: What makes a seahorse a seahorse?

A: Seahorses, sea dragons and pipefish all have bony plates covered with skin rather than scales. Their jaws are fused into tube-shaped mouths. Their bodies are elongated and the males carry the fertilized eggs. Seahorses are the only fish with a prehensile tail for grasping.



Proud Papas

Seahorses are the only example in the animal kingdom of male pregnancy. Male seahorses incubate eggs in a **brood pouch**, while seadragons and pipefish brood eggs under and on the sides of their tails. After 10 to 30 days, the male gives birth to several hundred babies at a time. Babies look like tiny adults, only 7 - 11 mm in length.

Conservation Note: Over the past several years, seahorse populations have declined tremendously. Some of the characteristics that make seahorses unique can contribute to their decline. In a group of 100 or more babies, it's not unusual for only a few to survive. Larger predators feed on juvenile seahorses. Storms at sea can pull the juveniles from their holdfasts and wash them up on shore.

Humans also affect seahorse populations. Overconsumption is the leading cause of decline. Many native fishers collect seahorses before they are mature and can reproduce. Males are collected while pregnant, thus removing the adult and all of its offspring from the habitat. Seahorses are collected for medicinal purposes, for home aquariums and for souvenirs.

Project Seahorse is a program of conservation and management that works to ensure long-term survival of the seahorses. They are helping to establish community-based conservation of seahorse fisheries, education of the communities and enforcement of legislation.

WOW! Seahorses possess many unique characteristics that help them survive. Observe the seahorses. How many of the following adaptations did you see? How do these adaptations help the seahorse survive?

- " A seahorse can move its **eyes** in different directions at the same time! They can rotate 360 degrees, so they can see nearly all the way around them in all directions.
- " The **coronet** is the "crown" of the seahorse head. Each seahorse's coronet is as unique as a human fingerprint.
- " The **bony plates** on seahorses provide protection from predators. Because of this, seahorses don't move their bodies in a wavelike fashion as most fish do. Instead, they glide gracefully by fanning their delicate fins.
- " Seahorses are the only fish with **prehensile tails**, which allow them to hold onto corals, seagrasses or each other.
- " Seahorses suck up food with their tube-like **snout** and swallow it whole because they do not have teeth. They have no true stomachs, so they must eat several times a day. Seahorses feed on plankton, microscopic organisms found in the water.
- " Did you have a hard time finding some seahorses? They are experts at camouflage. They come in a wide variety of colors and shapes. Seadragons and many seahorses can actually grow appendages to make them look more leaf-like.

Who's Who?

leafy seadragon, weedy seadragon, pipefish, potbelly seahorse, dwarf seahorse, Barbour's seahorse, coral shrimpfish, chocolate chip starfish, sea urchin, clown fish, coral shrimp

COVE FOREST GALLERY

The **Cove Forest** is an immersion exhibit, a recreation of a small, ancient forest found high in the Appalachian Mountains. Immersion exhibits are designed to make you feel as if you are actually walking through a habitat, such as a forest. The Cove Forest is one of the only indoor exhibits in the world that experiences the four seasons. Wildflowers bloom in the spring and the live trees lose their leaves in the winter. How do we accomplish this? Natural light shines in through the glass peaks. Very little artificial heating and cooling is used, resulting in a temperature that varies by about 10 degrees from the outside temperature. Chillers are used to cool the soil, providing the necessary cues for plants to become dormant.

The first animal exhibit in the Cove features **snakes** found in the southern Appalachians.

Q: How do these snakes protect themselves?

A: All snakes in this exhibit are camouflaged to help them blend in with their surroundings. Both the rattlesnake and copperhead are venomous; however, the main reason they use venom is to paralyze and help digest their prey. Defense is a secondary use of venom. **What is the difference between poison and venom?** Both are potentially dangerous toxins. However, venom is injected while poison must be eaten or absorbed.

Walk up the stairs to the Cove overlook. It is a great place to spot free-flying birds. Listen carefully to the calls of the songbirds to help pinpoint their locations.

Q: What is a songbird?

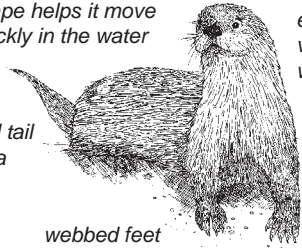
A: Any passerine or perching bird having a musical call.

Q: Why do birds sing?

A: Birds call for two basic reasons: to attract mates and to protect territory from intruders. Songbirds actually learn their songs, which range from very simple (one or two notes) to complex. In most species the males do most of the singing. However, northern cardinals are one of the exceptions.

River otters are well-suited to their life in the water. Observe an otter and **find at least two adaptations that help it survive.**

streamlined body
shape helps it move
quickly in the water



ear and nose
valves close
when underwater

strong tapered tail
that works as a
rudder

webbed feet
work like paddles

Q: Why do you see bubbles when the otter swims? A: They are air bubbles, but not from breathing.

Air is trapped between its two layers of fur. Dense underfur keeps the otter warm, while its longer oily fur keeps it dry.

Conservation Note: The **river otter** was once considered a pest that stole fish away from fishermen. The otter was trapped and killed both for its fur and to eliminate it from competing for fish. Habitat loss and pollution have also taken their toll, virtually eliminating the otter from east Tennessee. The animal has recently been reintroduced into this area with hopes that the population will increase.

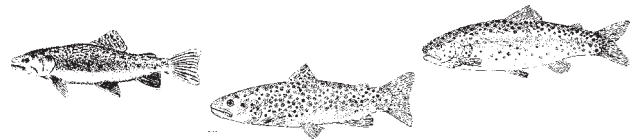
A Different Look

male brook trout



female brook trout

Many fish species change color or develop outward signs that make the male distinguishable from the female during spawning season. The spawning male brook trout develops a hooked lower jaw called a kype. The colors on his sides intensify and his belly changes to a bright red-orange. This difference in appearance between the male and female is known as sexual dimorphism.



Brook, rainbow and brown **trout** are found both inside and just outside the Cove. Brook trout are the only trout native to Tennessee.

Q: Which features can be used to distinguish between each of the three kinds of trout?

A: A white strip borders all but the dorsal fin of the brook trout. The brown trout does not have spots on its tail and paired fins. The rainbow trout has a prominent pink, red or silver band along its side.

Who's Who?

northern pine snake, copperhead, corn snake,
river otter, bluebird, brook trout,
northern cardinal

DISCOVERY HALL

Discovery Hall showcases a variety of aquatic habitats such as rivers, streams and wetlands. The exhibits bring you up close and personal to the often unnoticed creatures of our region. Although many are small, their roles in the ecosystem are large. Some warn us of disturbing conditions in our environment simply by their presence or absence. Others tell a story of time past when their populations were large and their habitats healthy.



Brightly colored **sunfish** play a vital role in the web of life in the aquatic community. They prey on insect larvae, crustaceans and other invertebrates and, in turn, are fed on by larger fish, birds and mammals.

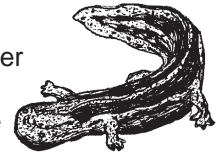
Q: If the sunfish were removed from its community, how would the community and its members be affected?

A: The ecosystem would be unbalanced. Populations of prey species such as insect larvae would increase. Predators like birds would be missing a food source and would be forced to rely on other sources to survive. Competition among predators would increase due to the lack of available food.

Amphibian Alert

Amphibians such as the **hellbender** and **treefrogs** are considered to be indicator species. A decline in their numbers can indicate a change in the quality of their habitat. Amphibians are very sensitive to water pollution because their skin is so permeable. Along with oxygen, pollutants may pass through their skin. These harmful substances can cause deformities and even death.

The **hellbender** is the largest salamander in North America. Observe its body shape.



Q: How might its shape help it survive in fast-moving streams?

A: The hellbender has a flattened body. Its thin, flat shape helps it stay put among the rocks in the rushing waters.

Like all amphibians, the hellbender respire through its skin.

Q: How does its loose, wrinkled skin help it absorb more oxygen?

A: Loose wrinkles provide more surface area for oxygen absorption. To demonstrate this concept, compare a smooth baseball and a koosh ball. The koosh ball has more surface area due to the spikes.

Animal Communication



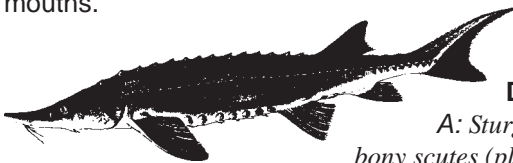
Animals can't talk, but they have other ways of communicating messages to one another.

Baby alligators chirp a distress call when in danger and the mom quickly arrives to protect them. Each type of **treefrog** also has its own distinct call to communicate messages of alarm, distress, feeding behavior or reproductive readiness. **Listen carefully at these exhibits to hear the recorded calls of the treefrogs and alligators.**

Sturgeon Encounter

Students can experience the thrill of touching a fish at the sturgeon encounter. Before arriving, please discuss the following guidelines with your class. Place your hand in the water and when a sturgeon swims by, run your hand gently along its back. Do not restrain the fish by grabbing, lifting or pulling on them. If you restrain them or splash, they will swim away.

The **lake sturgeon** is often called a living fossil. Their fossil record dates back to the age of the dinosaurs. It is one of the longest lived fishes; some may live up to 150 years. Sturgeon locate food on the bottom of lakes and rivers using their fleshy barbels, or whiskers. They suck up food such as crayfish, worms, mollusks, insect larvae and algae with their tube-like mouths.



Q: Observe the sturgeon carefully, then touch one. Describe its outer covering. Do sturgeon have scales? How do they protect themselves?

A: Sturgeon do not have scales. Instead, their bodies are covered in tough skin. Five rows of bony scutes (plates) under the skin protect the sturgeon much like a suit of armor.

Conservation Note: Today the **lake sturgeon** is listed by most states, including Tennessee, as threatened or endangered. Its decline is likely due to overfishing, habitat destruction and changes to spawning routes due to dam construction.

Q: What is the Tennessee Aquarium doing to help bring this fish back to our rivers?

A: The Tennessee Aquarium is involved with a variety of resource agencies and private conservation groups releasing sturgeon into the French Broad River near Douglas Dam. TVA has worked to improve the water quality of this river, and it is now considered to be suitable habitat for sturgeon. The Aquarium raises sturgeon until they have grown to a release size of about 12 inches, giving them a "head start." Currently, over 57,000 sturgeon have been released.

Who's Who?

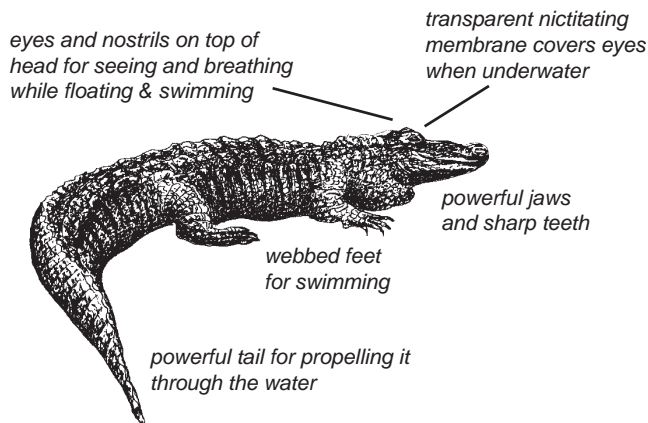
sunfish, baby alligator, hellbender, green treefrog, red-spotted newt, yellow-blotched map turtle, lake sturgeon

DELTA SWAMP GALLERY

A **delta cypress swamp** is a complex and beautiful ecosystem. A multitude of insects, reptiles, amphibians, mammals and birds all make their living here. The essential ingredient in this magnificent habitat is water. Rainfall, underground water tables, rivers and humidity all contribute to the lush conditions of the swamp.

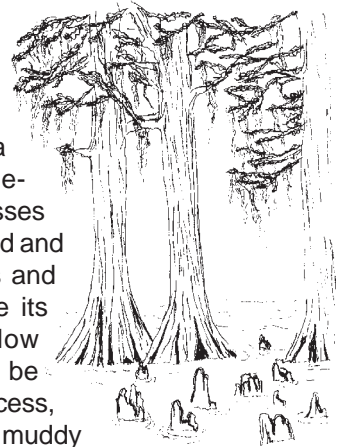
When we think of wetlands, we conjure up images of mosquito infested, dismal, muddy places. However, wetlands are an important ecosystem. They help improve overall water quality downstream by filtering sediment, toxic chemicals and other pollutants. Wetland plants stabilize shorelines, helping to decrease erosion. They provide habitat for thousands of life forms.

The **American alligator** is a well adapted predator. Observe the alligator and **find at least two adaptations that help it survive.**



Bald Cypress

The bald cypress tree is well-adapted to life in a wetland. It has a widespread root system and wide-spreading trunk bases called buttresses which serve to anchor it in the ground and provide support during high winds and heavy flooding. Most unusual are its bumpy knees arising from shallow roots. It is thought that they may be involved in the tree's respiration process, as well as helping to anchor it in the muddy soil.



The trees in the Delta Swamp exhibit have varied origins. Some are live trees; others are dead trees that were air lifted from the wreckage of Hurricane Hugo in South Carolina in 1988; and the remaining trees are fabricated specimens made of fiberglass, wire mesh, concrete and rubber.

As you wander through the Delta, keep your eyes open for turtles lying on logs.

Q: Why are the turtles “basking” on the logs?

A: Like all other reptiles, turtles are ectothermic, meaning their body temperature is determined by the temperature of the air or water. Turtles climb onto logs to bask in the sunlight to warm up. We use heat lamps in the Aquarium exhibits to create basking spots. Occasionally, turtles spend time in a special room under the glass peaks to be exposed to real sunlight.

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Q: How do the ducks in the Delta Swamp stay dry even when they dive underwater?

A: When a bird rubs its bill over its feathers or preens, it is not only smoothing out ruffled or damaged feathers, but also spreading oil. Many birds, including ducks, have an oil gland (also called the uropygial gland) located above the base of their tails. A bird collects this oil on its beak, then gently rubs it on its feathers while preening. This oil doesn't actually waterproof the bird, but it does act as a conditioner keeping the feathers strong and healthy which in turn makes the feathers water resistant.

A Fine Fisherman

The **alligator snapping turtle** is the largest of North America's freshwater turtles. It gets its name from its powerful bite and from the ridges along its shell that resemble those on an alligator's back. The alligator snapper is an impressive predator, mainly feeding on fish. It catches its food in a unique way!



The snapper lies on the bottom of the river with its mouth open. It lures fish by wiggling a pink worm-like growth on its tongue.



When a curious fish gets too close, the turtle quickly slams its strong jaws shut to capture the meal.

Who's Who?

American alligator, alligator snapping turtle, wood duck, hooded merganser, sora, bald cypress, chicken turtle, cardinal

GULF OF MEXICO

The Tennessee Aquarium tells the story of rivers and how they flow to the sea. Beginning as small streams in the Appalachian Cove Forest, the rivers that flow through our region wind through many habitats on a journey toward the ocean. The **Gulf of Mexico** represents the final destination of this path. As you look at the exhibit, notice the transition from the mangrove trees found near the shoreline (on the right side of the exhibit) to the open ocean (left side of the exhibit). The coastline of the Gulf is an area where salt and freshwater flow together to create an exceptionally nutrient-rich and fertile ecosystem. This area is home to a tremendous diversity of native and migratory wildlife.

Creative Camouflage

Body shape can help camouflage a fish.

Q: Find and observe a surgeonfish. Describe its shape. How do you think its shape helps the fish hide from predators?

A: Surgeonfish are flattened from side to side. Their extremely thin bodies seem to disappear when looking at them head-on.

Many fish utilize a type of camouflage called countershading. They have a dark back and a light belly.

Q: Which Gulf fish are countershaded? How does this type of camouflage help the animal survive?

A: Sea turtles, stingrays and sharks are countershaded. A dark back helps them blend in with the ocean bottom when looking down from above. A light belly helps them blend in with the surface when looking up from below.

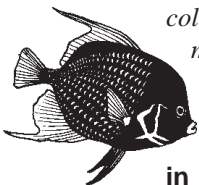
Many fish have stripes or bars to help them blend in with their surroundings. This is called **disruptive coloration**.

Q: Find a fish with disruptive coloration. What does it blend in with?

A: Spadefish, porkfish and sergeant majors exhibit disruptive coloration. Vertical stripes and bars help fish blend in with aquatic plants, corals and roots.

Q: Some fish spend most of their time near the bottom, while others prefer the top. Do their bodies look the same or different? How is their body shape an advantage in this area of the water column?

A: Bottom-dwelling fish, such as stingrays, have flattened bellies to allow for constant contact with the ocean floor for feeding, resting and swimming. Their mouths are located on the ventral (belly) side to allow for bottom-feeding. The tarpon is an example of a fish that spends its time at the top of the water column. It is long and slender with an upturned mouth for feeding at the surface.



Q: Do fish who spend most of their time in the mangroves look the same as those in the open areas? How does their body shape help them maneuver in these areas?

A: Open water fish are often larger and streamlined with powerful forked tails. They need to be able to swim with maximum speed over long distances. They are often silver in color, allowing them to blend in with the sparkling water and spend most of their time in open areas. Fish such as the blue tang, angelfish and grunts tend to remain in sheltered areas. Fish that spend time in the mangrove roots are generally smaller and flattened from side to side. Their thin bodies enable them to dart easily around and through the mangrove roots.

Mangrove Trees

Mangrove trees are uniquely adapted to life in saltwater. They are able to tolerate high salt concentrations, regular immersion in water and the low oxygen content of muddy silt. Arching roots provide support and plenty of surface area to obtain oxygen from the air. Mangrove habitats are important, trapping sediments and providing shelter for animals.

Q: Find one fish that hangs out in the mangrove roots. Why do you think it prefers this area?

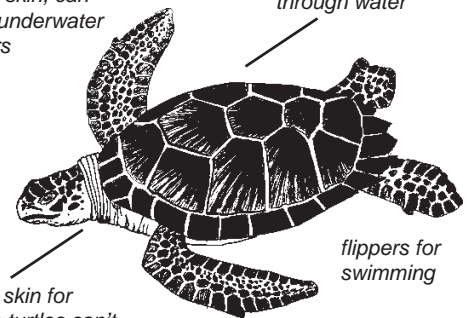
A: Many fish can be found in the mangroves, including squirrelfish, blue tangs, angelfish and grunts. Mangrove roots provide shelter for the smaller fish, keeping them safe from larger predators who cannot negotiate the tight spaces between the roots.

How is a sea turtle different from turtles that live on land?

Observe the sea turtle and find at least two adaptations that help it survive in the water.

breathe using lungs; also respire through skin; can remain resting underwater for up to 2 hours

streamlined (flattened) shell for moving quickly through water



tough leathery skin for protection; sea turtles can't tuck head & flippers into shell

flippers for swimming

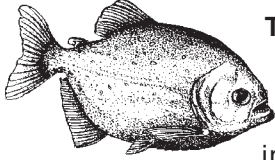
Conservation Note: Sea turtle populations have declined dramatically due to habitat loss, drownings in fishing gear and poaching of eggs and adults. Illegal trade of products such as tortoise shell jewelry and leather items, combined with the continual development of beachfront property, has kept the turtle on the endangered or threatened list. All sea turtles are now protected by federal laws and international agreements. These laws protect the sea turtles in the water and work towards preserving their nesting beaches.

Who's Who?

green sea turtle, bonnethead shark, southern stingray, barracuda, tarpon, blue tang, porkfish, mangrove trees, cownose ray, southern flounder

RIVERS OF THE WORLD GALLERY

As evident throughout this gallery, where there are rivers, there is life. Out of all the water on earth, less than three percent is freshwater and most of that is trapped in glaciers and ice caps. What remains, and upon which all life depends, is mostly found in rivers. Rivers are very important to the people, plants and animals that live in and around them. All rivers carry freshwater; however, that's where the similarity ends. Cold water rivers, such as the Volga in Europe, contrast sharply with warm water rivers, like the Zaire in Africa. Both the habitats and the species that live within the waters are vastly different. The **Rivers of the World** gallery showcases rivers that sustain life on five continents.



The **red-bellied piranha** have been portrayed as vicious fish by Hollywood. Their razor-sharp teeth are capable of slicing one-inch chunks from their prey.

However, unlike the behavior portrayed in movies, piranha behavior follows seasonal changes in the Amazon. During the rainy season, food is plentiful. During the dry season, food is scarce.

Q: During which season do you think the piranha will become aggressive? Why?

A: Piranha will feed on any available food source when they are starving during the dry season.

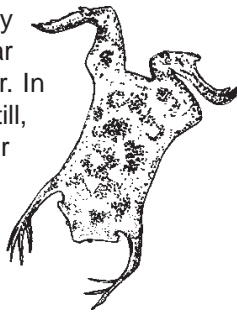
You're My Main Squeeze

Snakes such as the boa and the anaconda are constrictors. These snakes grasp their prey with curved teeth and immediately wrap around the potential meal in tight coils. The snake does not "crush" its prey, but squeezes tighter each time the prey animal exhales. Such constriction prevents the animal's heart and lungs from functioning, thus suffocating the animal. The meal is then consumed head-first and whole.

The **surinam toads** are not dead! They are masters of camouflage. They appear to be dead leaves floating in the water. In order to detect prey, they remain very still, using tiny star-like projections on their toes that sense movements in the water.

Q: How does remaining very still in the water help the toads detect prey?

A: When the toads are perfectly still, they can pick up even the smallest waves in the water made by moving animals. If the toad was moving, it wouldn't be able to tell the difference between waves it created and those from prey.

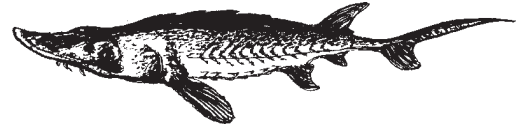


Who's Who?

Beluga sturgeon, red piranha, koi, African dwarf crocodile, boa constrictor, yellow anaconda, pignose turtle, surinam toads, caiman lizard

Big Belugas

The **Beluga sturgeon** is the largest species of sturgeon in the world with a record length of 28 feet and weighing 1.5 tons. Another claim to fame for this fish is its production of eggs that command the highest price of all caviar. Sturgeon populations are in danger world-wide due to the demand for caviar.



Most male ducks are brightly colored. Female ducks are usually dull in comparison.

Q: Find a duck in the Nishikigoi exhibit. Is it male or female? What purpose do the bright and dull colors serve for male and female ducks?

A: Male mandarin ducks are brightly colored to attract a mate. Female mandarin ducks are dull to help them blend in with the grasses along the shoreline where they raise their babies.

Hide and Seek

The colors and patterns of animals are incredibly beautiful, and they are often an important element in defense, reproduction, and survival.

Q: Can you find an animal in the Rivers gallery that exhibits the following colorations?

Camouflage helps an animal blend in with its surroundings in order to hide from predators or stalk prey.

A: Examples of camouflaged animals are the, surinam toad, mossy frog and cichlid fish.

Some animals **warn** other animals using bright colors or special patterns. Other species recognize the warning coloration as a message to stay away. Such animals are often poisonous or distasteful.

A: Mandarin newts have bright orange or red spots on their backs. Fire-belly toads seem camouflaged until they raise up and expose their bright red bellies. All three animals warn others that they will taste bad if eaten.

Some animals have black spots or "**false eyes.**" A confused predator may attack these spots instead of the real eyes, protecting the important head region from attack.

A: The four-eyed turtle has four eyespots on its neck, helping to confuse predators.

TURTLE GALLERY

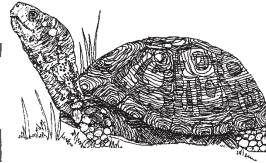
For thousands of years **turtles** have fascinated people all over the world. Turtles are amazingly adaptable. There are turtles that live in freshwater and in oceans, primarily on land or mostly in the water, in deserts or the tropics. Their shells can be high and domed, flat and smooth or ridged. Turtles' necks can retract straight back within their shells or curve to the side in an "S" shape. The Tennessee Aquarium exhibits more freshwater turtle species than any other public facility.

Turtles are classified as reptiles along with snakes and alligators.

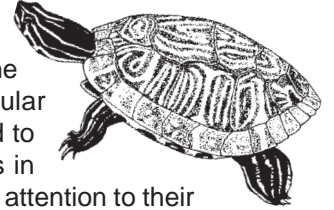
Q: What characteristics do all reptiles share? What makes a turtle different from the other reptiles?

A: All reptiles are ectothermic, meaning their body temperature is regulated by their surroundings. Reptiles have dry, scaly skin and/or scales. They reproduce by laying shelled eggs on land or by live birth. Turtles have four legs and a hard shell. They do not have teeth, only sharp bony plates in their jaws for biting and tearing food. Turtles lay clusters of eggs in the soil or sand.

Meet the Tennessee State Reptile, the Eastern box turtle. This turtle has a built-in advantage when it comes to protection from predators. The shell has been modified so that the turtle can completely withdraw its head and legs inside when there is danger. Hinges found on the shell enable it to close up tightly.



The word turtle is an inclusive word that refers to all species of aquatic turtles and land turtles. The word tortoise refers to a particular type of turtle that is well adapted to life on land. Observe the turtles in the Turtle Gallery, paying special attention to their habitats.



Q: What are the differences between aquatic turtles (live in water) and land turtles? How do their body shapes give them an advantage for survival in water or on land?

A: Land turtles, or tortoises, tend to have domed shells which provide stability and help minimize temperature changes. Predators often cannot open their mouths wide enough to crack a high, rounded shell. Aquatic turtles tend to have flatter, smoother shells. Streamlined shells allow them to move through the water with ease. Tortoises have short, stubby legs to help maneuver on land, while aquatic turtles have webbed feet for swimming.

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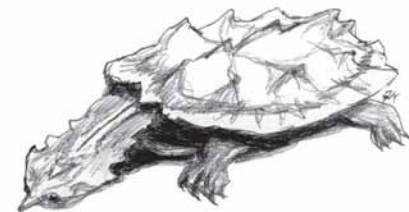
Conservation Note: Turtle populations are declining. Many turtles are collected from the wild and sold as pets, used as medicines and eaten for food. Habitats are being fragmented and infringed on as humans need more and more space. The Tennessee Aquarium is active in breeding and conservation efforts to protect threatened turtles around the world.

Turtles protect themselves in many ways; most obvious is the turtle's shell. Observe the variety of turtles in the Turtle gallery, paying special attention to the ways they keep safe.

Q: How many unusual methods of protection can you find? How might they help keep the turtle safe?

A: The following are examples of just some of the more unusual methods of protection used by the turtles exhibited in the gallery.

- " The **pancake tortoise** has a flattened, flexible shell, allowing it to find safety in the crevices of rocky outcroppings.*
- " **Sideneck turtles** have long S-shaped necks that bend and can be held tightly against the side of the body, making it difficult for predators to attack.*
- " The **mata mata** is a master of camouflage. Its shell is dark and is covered with algae, mosses and warty tubercles. The tubercles not only camouflage but also attract prey that the mata mata then sucks up.*
- " The **Indian star tortoise** gets its name from the star pattern on its shell. While it may not look camouflaged, it blends in perfectly with the grasses in which it lives.*
- " Young **spiny turtles** are like living pin-cushions, bearing sharp points around the shell, as well as small spines on the top. These points and spines deter many would-be predators. When the turtle grows too large for most predators to bite, it loses the spines.*



Who's Who?

mata mata, snake-necked turtles, pig-nosed turtle, spiny turtle, pancake turtle, star tortoise, Chinese big-head turtle,

TENNESSEE RIVER GALLERY

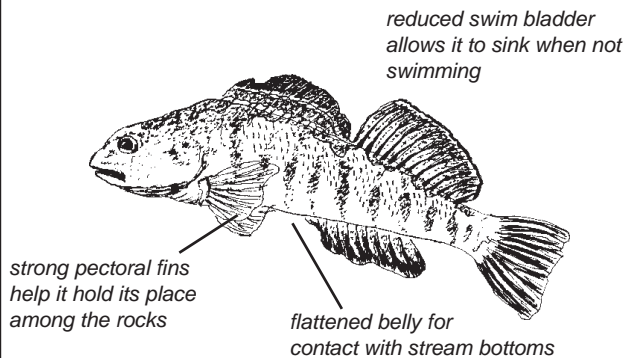
No matter their length, width or depth, all rivers share a common destination. They are all flowing to the ocean. The Tennessee River is unique in that it begins its journey southward but then turns northward away from the ocean. It continues its northerly journey until it reaches Paducah, Kentucky where it empties into the Ohio River. The **Nickajack Lake** exhibit depicts the section of the Tennessee River that extends from the Chickamauga Dam to the Nickajack Dam and flows right past the Aquarium. It is one of the largest freshwater exhibits in the world, containing approximately 138,000 gallons of freshwater.

Tennessee has more freshwater fauna (animals) of any state in the U.S. Boasting nearly 300 species of native fish, the Tennessee drainage is ahead of the Mississippi River with only 136 species. As you wander through the **Tennessee River** gallery, you'll get a closer look at some of the lesser known plants and animals found in and around our eastern Tennessee lakes and rivers.



Look near the surface of the water to find the webbed feet of our **diving ducks**. The ducks each have two legs, but sometimes you'll see just one. No, the duck is not injured. Ducks often tuck one leg up into their downy feathers to help conserve body heat.

Darters are well suited to their life in swift flowing, rocky waters. Observe a darter and **find an adaptation that helps it survive in its habitat.**



How do you distinguish between a male and female turtle? For most turtles, an internal probe is necessary to determine sex. However, many male aquatic turtles have long front claws while females have shorter front claws. During courtship, the male will wave his long claws in a female's face, hoping to attract her as a mate. Tail length is another means for distinguishing males from females. Males tend to have longer tails while females have shorter thick tails. **Observe the turtles in the Nickajack Lake exhibit. Can you find a male turtle?**

Feeding Strategies

Fish feed in a variety of ways. Find the following fish in the Nickajack Lake exhibit that demonstrate unusual feeding methods.



Paddlefish are named for their long, paddle-shaped snouts. They swim through the water with their mouths wide open. Their gills work like a strainer to filter plankton from the water.

The long cigar-shaped fish are called **gar**. They are lie-in-wait predators, hanging suspended just below the surface of the water. When a smaller fish swims near, they quickly strike in a sideways motion impaling the fish with sharp teeth.

Carp, buffalo and **catfish** are bottom-feeders. Their sucker-like mouths are found on the underside of their bodies. They swim along "vacuuming" up food from the bottom.

Conservation Note: Before human intervention, the Tennessee River was perilous and unnavigable in many stretches and periodically flooded its banks. After World War I, the Tennessee Valley Authority constructed a series of dams and reservoirs along the river to help control flooding to make the river more navigable and to provide electricity. For all the good the dam system has done, it has also had adverse effects on wildlife, natural habitats and fisheries.

Q: As a class, research and discuss (or debate) the positive and negative effects of dams.

A: Dams slow the river system, causing an increased amount of sediments to settle out of the water. Sediments can clog fish gills, interfering with oxygen exchange as well as filter feeding. Particles also settle to the bottom and smother fish eggs and aquatic insect larvae. Dams are barriers which block the spawning routes of fish who normally swim upstream to lay eggs. The sudden release of water from a dam changes the water depth and temperature quickly, killing some fish. Sudden swift flowing water can sweep fish into the dam or away from vital habitat. Depth changes can also affect the breeding grounds of fish; depth is an important determining factor in a spawning location. Many of the positive effects can be found in the above conservation note.

Who's Who?

blue catfish, flathead catfish, paddlefish, longnose gar, largemouth bass, bluegill, sunfish, carp, barrens topminnow

LAKE NICARAGUA

What was once a saltwater bay of the Pacific Ocean is now the largest lake in Central America. Lake Nicaragua was formed over thousands of years as the volcanic land along the Pacific coast of the country rose up and cut off this body of water from the ocean. Over time, the salt content was diluted so drastically that the lake is now freshwater. Many species of fish traditionally found in the ocean have adapted to this new environment. Tuna, swordfish, tarpon and even one species of shark are present in this lake, along with many freshwater species.

What's In a Name?

The names of many cichlids tell something about the fish's appearance or behavior.

The **red devil** is named for its red coloration and its attitude. It is aggressive and overcrowding in its habitat may lead to cannibalism.

The **guapote tigre** or jaguar cichlid shows off spectacular color patterns during breeding season. The patterns resemble the markings of a jaguar or tiger.

The **blackbelt cichlid** is named for the black colored "belt" around its body.



A **convict cichlid** is named for the black stripes on its body that resemble prison attire.



Most fish do not protect their fertilized eggs or fry; however, many cichlids exhibit some form of parental care for their young. The Midas cichlid female fans their eggs to prevent debris from covering them, while the male guards the perimeter around the nest keeping intruders at bay.

Q: How does parental care give the eggs a better chance for survival?

A: Fish lay hundreds or thousands of eggs, hoping that some survive. Eggs are an easy source of food for predators because they can't protect themselves or swim away. However, parents can chase away predators, keeping their eggs and babies safe. Some cichlids also ensure the survival of their young by keeping debris from covering and smothering the eggs.

Who's Who?

midas cichlid, rainbow cichlid,
red devil, Nicaragua cichlid

FLOODED AMAZON

Here in the temperate United States, we experience four seasons. Tropical areas experience only two seasons: rainy and dry. During the rainy season in the Amazon, between 80 - 120 inches of rain can fall. This causes rivers to flood out of their banks and into the forests. When the water is high, food is plentiful. Some fish species are even adapted to feed on the seeds and fruits from the trees when the water is high.

The **pirapatinga** is related to the piranha. However, unlike its carnivorous relative, the pirapatinga is an herbivore, feeding on fruits and seeds. Aiding in seed dispersal, the pirapatinga play an important role in the ecosystem. After ingesting the fruit, the seeds will be carried down the river and excreted along with nutrient-rich urea.



One of the largest freshwater fishes, the **arapaima** averages 8 feet in length, but can reach 15 feet and weigh over 400 pounds. These fish are covered with tough rows of scales; native people dry these scales and use them as fingernail files and graters.

Q: The arapaima is a powerful predator. After studying its mouth placement, do you think it feeds from the surface or the bottom?

A: Notice its slightly upturned mouth. This allows it to feed from the surface, exploding from the water to swallow smaller fish. It sucks in its prey by suddenly opening its mouth, creating a current of rushing water that forces the prey into its mouth.

Who's Who?

arapaima, pirapatinga, rip saw catfish,
giant South American river turtle,
spiny palm tree