

# Robert E. Barrett Fishway: Teacher Materials



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**Robert E. Barrett Fishway: Teacher Materials**

Dear Teachers,

The Robert E. Barrett Fishway Teacher Materials are designed for mid-elementary school grades visiting the Fishway in Holyoke. Throughout this packet, you will find topics related to your visit and materials that will aid you as you prepare students. Please adapt the materials to fit your students' needs.

Thank you and think fish!

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## Outline of Events

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### **Teacher-led at school** (activities attached):

- Information about migratory fish
- Adaptations of fish
- Fish anatomy
- Life cycles of American shad and sea lamprey

*\* Note: These are possible topics to be covered by teachers prior to or after fishway programs.*

### **HG&E's In-school presentation** (Holyoke Public School 4<sup>th</sup> grades):

- What you will see at the fishway: river, dam, fish elevators and fish.
- The fish you will see at the fishway
- How the fish elevators work
- Tips for the field trip

### **At the fishway** (1-hour tour):

- Overview about the river, the dam and why the fish are migrating.
- Information about hydropower (brief).
- Review fishway operation; observation of the fishlift
- Observation of the fish that have been lifted and are in a holding area.
- Hands-on activity about how anadromous fish find their way back to their natal rivers
- If appropriate, an activity about sea lamprey

## Information on Connecticut River Migratory Fish Species

### **Diadromous Fish of the Connecticut River**

What is a diadromous fish? Most fish live their whole lives either in salt water or fresh water but diadromous fish spend part of their lives in both. There are two types of diadromous fish in the Connecticut River: anadromous (ah-**nad**-ro-mus) and catadromous (ca-**tad**-ro-mus).

Anadromous fish are born in fresh water and go to salt water for several years to feed and grow. They return to fresh water to spawn.

Catadromous fish are born in salt water and go to fresh water for several years to feed and grow. They return to the ocean to spawn.

### **Anadromous Fish of the Connecticut River**

#### **American shad (*Alosa sapidissima*)**

- American shad are the most abundant anadromous fish in the Connecticut River. They are silver in color and have a forked tail.
- They are the largest member of the herring family reaching up to 20 inches and 6 pounds.
- Males are usually younger and smaller than females. Females carry about 1/3 of their body weight in eggs.
- Spawning occurs in the main stem of the river in May and June when the water is between about 60° and 70° F.
- Eggs incubate in the water column for 4 to 9 days and juvenile shad stay in the river and feed until the fall when they go to the ocean and head south.
- American shad migrate between North Carolina and Nova Scotia every year for 3 to 6 years.
- When they reach sexual maturity, American shad return to their river of origin to spawn.

#### Fun Facts

- Every river has its own mineral and chemical 'scent.' Scientists think that one way shad find their way home is by using their sense of smell.
- The largest American shad on record, 11 lbs. 4 oz., was caught in the Connecticut River at Holyoke by Bob Thibodo in 1986.

**Atlantic salmon (*Salmo salar*)**

- A mature Connecticut River Atlantic salmon is usually 25 to 30 inches long and 10 to 20 pounds. It causes great excitement when viewed at the Robert Barrett Fishway windows. The size, spotted body, and straight tail are identifying traits.
- After two years of life in a fresh water stream, the young salmon migrate to the ocean and head for waters off of Greenland where they feed for two years before returning to the stream where they were born.
- Most Connecticut River salmon return in the spring and wait for six months before spawning. Anadromous fish do not eat while in fresh water, instead they live off of the fat reserves developed while feeding in the ocean.
- Unlike salmon from the west coast, Atlantic salmon can return to the ocean to feed and spawn again another year.

**Fun Facts**

- Salmon can jump up rapids and waterfalls about as high as a basketball hoop.
- Atlantic salmon are listed as endangered species in Maine. Pollution, dams and unfavorable conditions in the ocean threaten their survival.

**Atlantic Salmon Restoration History**

- In the early 1800's the Atlantic salmon became extinct in the Connecticut River due to prevalence of small dams on tributaries and the large dam at Turners Falls that blocked migration to spawning habitat.
- In the 1860's salmon were stocked into the river with limited success.
- In 1967 a combined federal and state restoration effort began. This was met with moderate success which declined as time passed. It is believed that changes in the ocean were major contributors to the low numbers of returning adult salmon. Due to low returns and severe hurricane damage to a hatchery in Vermont, US Fish and Wildlife withdrew support of the program in July 2012. However, salmon fry were last stocked in 2013 and adults should continue to return to the Robert Barrett Fishway through 2017.

**Blueback Herring (*Alosa aestivalis*)**

- This small herring, about 8 to 12 inches long, was once abundant in the river but now is rarely seen at the Robert Barrett Fishway. It has been designated a Species of Concern by the federal government due to drastic declines along the Eastern seaboard.

- The Blueback herring used to be a popular bait fish but now there is a moratorium on harvesting by recreational and commercial fishermen.
- Male bluebacks mature in 3 to 4 years, and females in five years. They live up to eight years
- Blueback herring are found in ocean waters from Florida to Nova Scotia. They not only return to their river of origin to spawn, they return to their natal area of the river.
- Their migration into the Connecticut River begins in April and peaks mid-May to early June. After spawning, adults return to the ocean.

#### Fun Facts

- Blueback herring are highly migratory at sea and swim in large schools, eating zooplankton such as copepods or small shrimp, as well as small fish.
- One way anglers tell the difference between blueback herring and their 'sister' river herring, alewives, is the dark color of the lining of their body cavities.

#### **Gizzard Shad (*Doromosa cepedianum*)**

- The gizzard shad is the new kid on the block in the Connecticut River. The species was first observed at the Holyoke dam in 1986.
- The gizzard shad is a member of the herring family (Clupeidae) like the American shad, but they are of a different genus. They look much like an American shad that ran into a wall. They have a blunt head and are more football-shaped.
- Gizzard shad are truly anadromous along southern regions of the East coast, but in the Connecticut River it is unclear whether or not they migrate to the ocean. Many might live in the river year-round.
- Sexual maturation takes approximately 3 to 5 years and gizzard shad can live 6 to 7 years.
- Gizzard shad spawn in shallow areas when water temperatures are between 56 and 70 degrees Fahrenheit.
- Juveniles filter feed on plant material in the water while adults also eat small animal organisms.

#### Fun Facts

- Gizzard shad tolerate muddy and polluted waters better than many other fish.
- Gizzard shad are named for the strong, muscular 'gizzard-like' stomach similar to the gizzard in chickens. It helps process plant food strained from mud and water.

**Sea Lamprey (*Petromyzon marinus*)**

- The snake-like sea lamprey is one of the most popular and amazing species seen at the Robert Barrett Fishway. It is often mistaken for an eel, but it is a completely different fish.
- The sea lamprey has been on the earth since the time of dinosaurs—260 million years. It is one of the most ancient fish on earth.
- The sea lamprey is a study in persistence. It is a slow swimmer, losing its eyesight, digestive system and teeth when it enters fresh water, yet intent on finding spawning grounds by using its sense of smell and touch.
- When a male and female locate a cobble-bottomed tributary with a sandy stretch nearby, they work together moving rocks with their sucking mouths to build a nest called a redd, in which they spawn. Until hatched, the eggs rest against the little dam created by the wall of the redd.
- Spawning marks the end of the adults' lives and the nutrients from their decaying bodies enrich the stream environment, feeding their young and many other organisms.
- The juvenile sea lamprey, called ammocoetes, bury into the sandy bottom and filter feed for 5 to 7 years before floating downstream to the ocean.
- While in the ocean, sea lampreys are parasitic, using their disk-like mouths to attach to fish and withdraw fluids and blood. They grow from the size of a pencil to 30 inches long in 18 months at which time they begin the long, strenuous journey to fresh water.
- While traveling upstream they rest by holding on with their mouths to rocks, anglers boots, the windows of the fishway or any hard surface. However, they are not feeding while on their migration upstream.

**Fun Facts**

- Sea lampreys have 3 eyes. The lateral eyes are going blind at they migrate upstream, but a light sensor, a white spot on top of their heads, keeps them oriented in the water column as they journey inland.
- The primitive breathing holes on each side open and close to pump water into their gill structures.
- Differences between Sea lamprey and American eels
  - Sea lamprey are cartilaginous fish, eels are bony fish.
  - Sea lamprey have a disk-like mouth, eels have a hinged jaw.
  - Sea lamprey have breathing holes, eels have gills and a gill cover.
  - Sea lamprey have no pectoral (side) fins, eels have one pair.



- Sea lamprey have two fins on their backs, eels have one fin extending from the back around the tail to the stomach.

### **Shortnose sturgeon (*Acipenser brevirostrum*)**

- Shortnose sturgeons were placed on the federal endangered species list in 1967 and if accidentally caught, must be released immediately.
- There are two populations of shortnose sturgeons in the Connecticut River, one landlocked near Turners Falls and a larger population below the Holyoke dam.
- It takes shortnose sturgeons a long time to sexually mature—about 7 years for males and 11 years for females. Even then, females spawn only every three years after that. This makes population recovery very slow.
- Shortnose sturgeons live a very long time compared to other fish—as long as 67 years in one known female—but generally up to about 30 years.
- They usually are 30 to 36 inches long and weigh 5 to 12 pounds although they can reach 48 inches and 50 pounds.
- The shortnose sturgeons are bottom dwellers and use their tube-like mouths and feelers to eat worms, insect larvae and crustaceans.

#### Fun Facts

- These ancient fish have rows of bony plates on their bodies called 'scutes' that give them a primitive appearance.
- Traveling in groups called 'clumps', shortnose sturgeons generally do not enter the fishlift area because it requires that they swim at the top of the water column, something they usually avoid.

### **Striped Bass (*Morone saxatilis*)**

- Striped bass draw many anglers to the waters of the Connecticut River each spring. They are a favorite recreational fish but only those 28 inches or longer can be kept.
- Unlike the other anadromous fish in the Connecticut River, the striped bass are not migrating to spawn. They are here to feed on the shad, salmon and herring.
- Although there may be a small population of striped bass that spawn in the Connecticut River, the primary spawning grounds are the Chesapeake, Delaware and Hudson Bays.
- When juvenile bass are about 2 to 3 years old they leave their nurseries in the spring and migrate north along the coast to the Gulf of Maine in search of food. When the water gets cold, they return south for the winter.

- The number of striped bass lifted at the Holyoke dam does not represent the population in the river. A few small 'schoolies' might tag along with a school of shad and enter the fishlift but there can be up to a million adult stripers in the river between Holyoke and the Long Island Sound.

#### Fun Facts

- Striped bass can live up to 40 years and weigh 100 pounds. The Massachusetts record is 73 pounds although individuals over 50 pounds are rare.
- Most feeding takes place at night and striped bass will eat most anything including shad, herring, salmon smolts, perch, smelt, lobsters, crabs, soft clams, and squid.

## Anadromous species

**American shad**



**Atlantic salmon**



**Blueback herring**



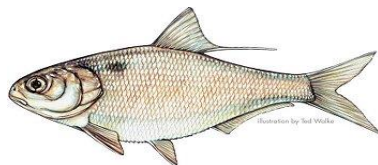
**Shortnose sturgeon**



**Sea lamprey**



**Gizzard shad**



**Striped bass**



## Catadromous Fish of the Connecticut River

### American eel (*Anguilla rostrata*)

- The wondrous American eel is the only catadromous fish in the Connecticut River. It begins life far away in the warm Sargasso Sea in the Atlantic Ocean. Although no one has ever witnessed eels spawning, millions of eggs are present in the Sargasso Sea.
- The eggs develop into transparent, leaf-like larvae that drift north in the Gulf Stream arriving at the coast in about a year. By this time they have formed an eel-shaped body and fins, but are still transparent and called 'glass eels.'
- When the eels have developed greenish-brown pigmentation they are called elvers and will remain in estuaries or swim upstream, even as far as hundreds of miles, where they slowly develop into adult yellow eels.
- American eels are nocturnal, swimming and feeding on insects, fish, crabs, worms, clams, frogs, and carrion at night.
- In as few as 3 but as many 40 years, eels sexually mature, turn silver color, develop large eyes and thick skin, and begin their long journey back to the Sargasso Sea.
- The number of American eels has dropped dramatically and the species is under review for endangered species status.
- At the Robert Barrett Fishway there are 5 eelways, ramps they can climb at night, that aid the Connecticut River population migrate upstream.

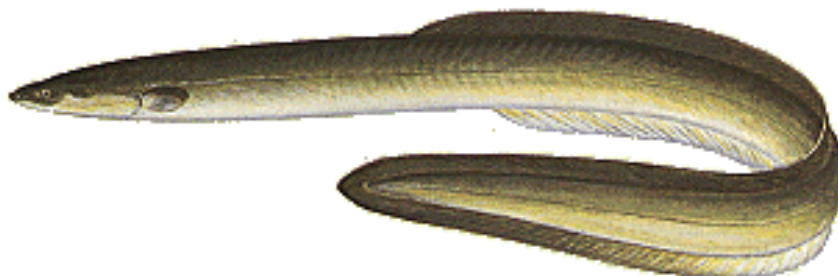
### Fun Facts

- Unlike other fish, eels can swim backwards and forwards and twist rapidly. To get a bite of a larger fish, they grab on with their teeth and spin their bodies 6 to 14 times per second. Fishermen who catch eels report that they spin wildly on the line.
- Eels can travel short distances over land, especially wet grass or rocks, because they can absorb oxygen through their skin as well as their gills.

## Catadromous species

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**American eel**



### Helpful Resources

[www.hged.com](http://www.hged.com)  
Holyoke Gas and Electric  
Go to Environment and Safety  
Go to Hadley Falls Fishlift  
You will see bar graphs when you click on historical fish counts of the various species.

[www.fws.gov/r5crc/index.html](http://www.fws.gov/r5crc/index.html)  
U.S. Fish & Wildlife Service  
Connecticut River Coordinator's Office  
Go to Recreational Fishing to find fish facts  
Go to Fisheries Management for more detailed information about efforts to restore Connecticut River fish

## American Shad Life Cycle Activity

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Teachers: Print enough copies for groups of 6 students. Cut apart the life-cycle stages. Give one complete life cycle set to each group of students. Have each group put the life cycle in the right order. A life cycle is a circle and can begin at any point. To simplify, one section says 'Start here.'



### START HERE:

From mid-April to mid-May adult American shad enter the Connecticut River. They come from the ocean and swim upstream in the river to lay their eggs. When fish lay eggs, it is called spawning.



When the water warms up to about 65 degrees, spawning begins. Each female releases about 100,000 to 200,000 eggs. Male shad circle the female and release milt which fertilizes the eggs.



Fertilized eggs drift in the water and hatch in 4 to 9 days. The larval shad have a yolk sac attached that provides nourishment for about 5 days. After about a month, the larvae develop scales and fins and become juveniles.



The juvenile shad live and feed in the river from June until October when they swim downstream to the ocean and head south for the warmer waters off of the coast of North Carolina.



American shad migrate north each spring from North Carolina to Canada, swimming and feeding. They return south in the fall. They do this each year for 3 to 6 years.



When they are fully developed adults and ready to spawn, the grown American shad swim back to the river where they were born and begin the journey upstream to continue the circle of life.

## Sea Lamprey Life Cycle Activity

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Teachers: Print enough copies for groups of 6 students. Cut apart the life-cycle stages. Give one complete life cycle set to each group of students. Have each group put the life cycle in the right order. A life cycle is a circle and can begin at any point. To simplify, one section says 'Start here.'



### START HERE:

Adult sea lampreys slowly make their way up the Connecticut River to find the perfect place to lay eggs (spawn) in streams that flow into the river. They build nests, called redds, by picking up and moving rocks with their sucker mouths. The walls of the redds create underwater dams.



When the redds are ready the sea lampreys spawn for 2 days and then they die. When they die, nutrients from their bodies go into the water and help feed the young lampreys.



The eggs rest against the wall of the redds for 2 weeks. Then the young lampreys bury into the sand and feed on tiny pieces of plants that float in the water. They have no eyes or mouths. They only have filters for gathering food.



After about 5 years, when sea lampreys grow to be about the size of a pencil, they develop eyes and a circular, sucker mouth with several rows of teeth. In the late fall they swim to the ocean.

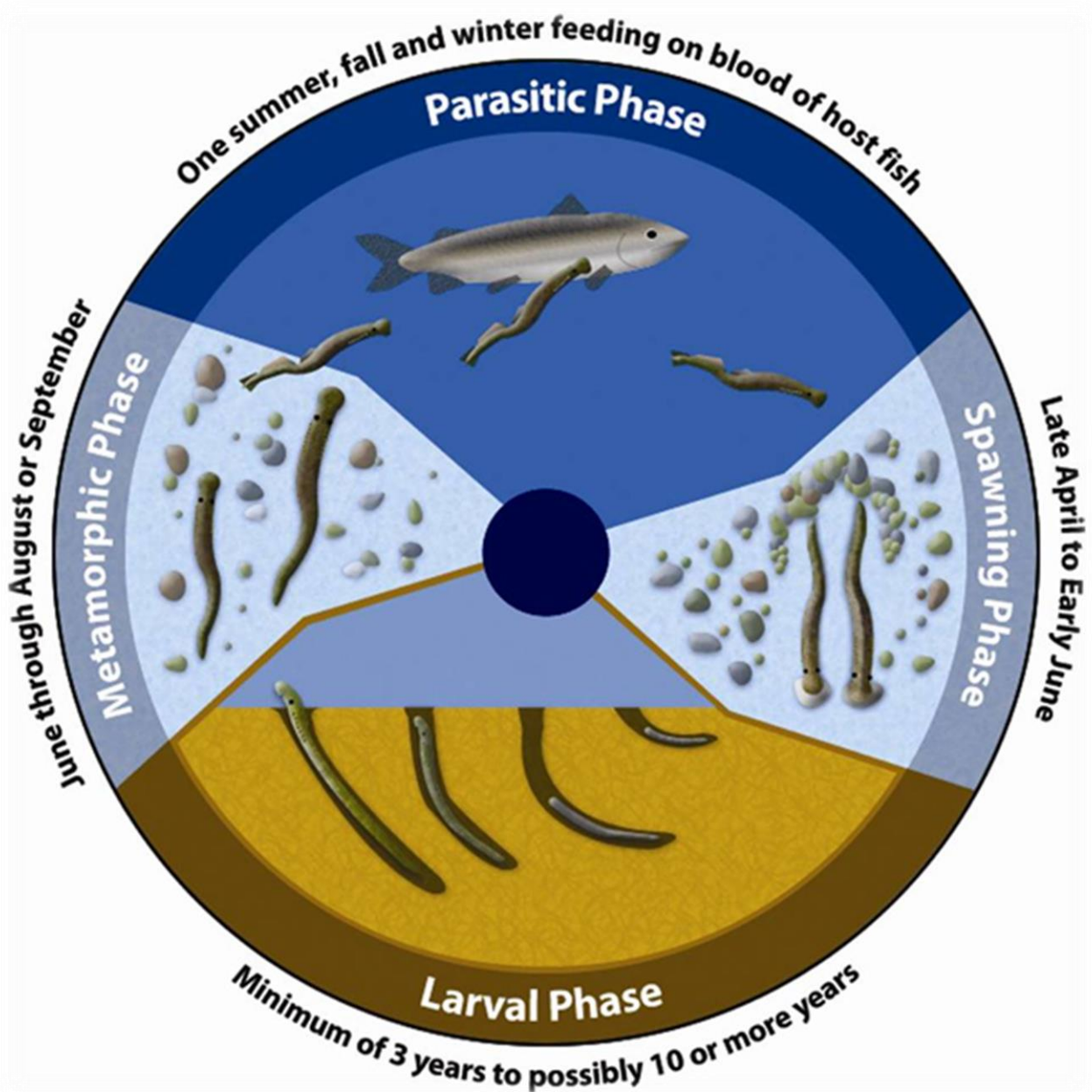


In the ocean, sea lampreys use their sharp teeth to grab onto passing fish. With its sharp tongue, it makes a hole in the fish and sucks blood for its food.



When the sea lampreys have grown to about 2 ½ feet long they are big enough to spawn and they begin the long and difficult journey from the ocean to a river. When they enter fresh water, they become blind, their teeth start falling out and they can't eat any more. But, they swim hard to find the right place for their young to grow.

## Life Cycle of Sea Lamprey



## Fish Anatomy

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### Fins:

- Mid-line dorsal and anal fins keep the fish from rolling to the side.
- Paired pectoral and pelvic fins are used for steering, stopping and hovering.
- Caudal fin is used for propulsion.
- Adipose fin found in some fish such as trout and salmon may have use as a sensory organ to aid swimming in turbulent water.
- Most fins have internal rays or spines that provide structure. The adipose fin is fleshy and has no rays or spines.

### Scales:

- Scales are derived from the same substance that makes skin.
- They form a protective surface for the fish. Most fish also form a mucous layer over their scales for added protection.
- They overlap in a head-to-tail direction that allows for a smooth flow of water over the body and flexibility of motion.
- As scales grow they add concentric layers and form rings as do trees. Counting the rings on a fish scale is one way to determine its age.
- Some fish such as catfish and sea lamprey do not have scales.

### Gills:

- Under the gill cover (operculum) are the feathery, red gills that allow fish to breathe underwater.
- Water enters the fish's mouth and is forced over the gills and exits from the gill slit at the posterior edge of the gill cover.
- Gills extract oxygen from the water and blood vessels in the gills carry oxygen to the fish's body.
- Gills function like lungs do in land animals and marine mammals.

### Lateral line:

- The lateral line is a protective mechanism in fish.
- The line is made of tiny pores, or openings, in the scales along the sides of the fish.
- In each pore a hair-like structure senses changes in water pressure.
- When a predator approaches, water movement will be sensed by these hairs in the lateral line pores.
- Nerves attached to the hairs send the information to the fish's brain and the fish can speed up or turn quickly to get away.



## **Fish Senses**

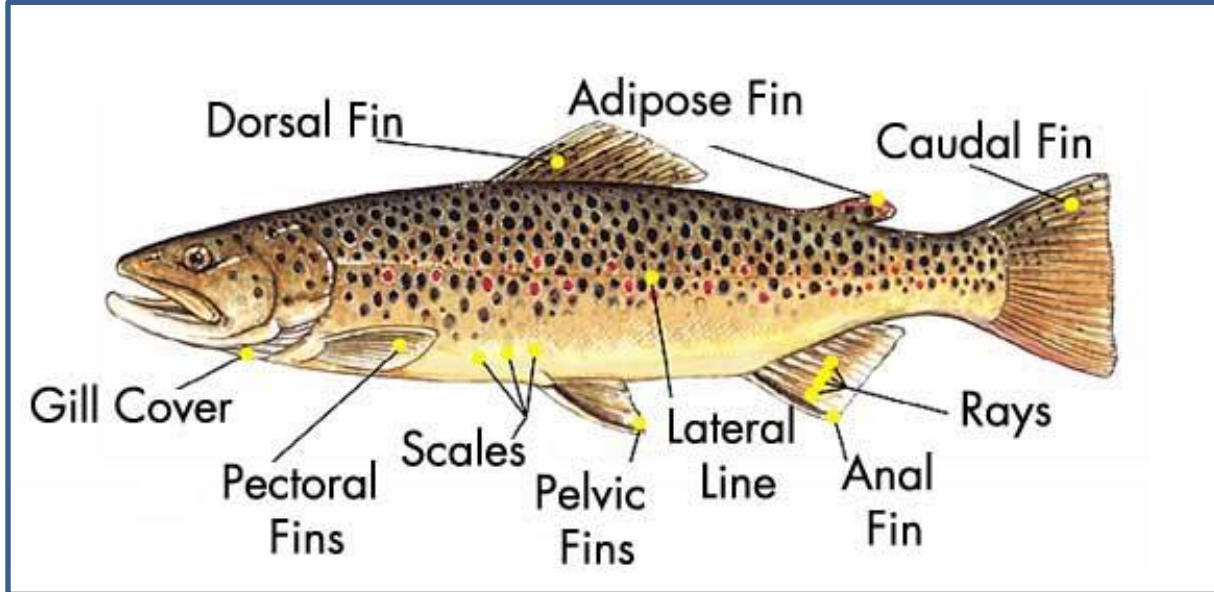
Can fish hear? Yes, fish have internal ears and can hear well.

Can fish smell? Fish rely heavily on their sense of smell. Their nostrils are very close to their brains and the information from the nostrils is immediately detected by the fish.

How do fish see underwater? Fish focus by moving the eye lens in and out. Land animals change the shape of lens. Fish have a stationary iris to allow in as much light as possible. The iris in land animals opens and closes to adjust to light. Most fish can see color.

Do fish sleep? Fish do not have eyelids and cannot close their eyes, but they do have periods of reduced activity and metabolism. Some fish rest on the bottom but others, such as some sharks, continue swimming while 'asleep.'

## Fish Anatomy Activity



*Draw your own fish below and label the body parts.*



## From Humans to Fish

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In order for humans to go underwater and swim like fish we have to use certain kinds of gear. We wear our adaptations! Turn this over and draw a line from the 'human adaptation' to the corresponding fish part. Then draw your own fish and a human swimming underwater.

Draw your own fish and diver here:

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Draw a line from the gear to the corresponding part of the fish!

Diving Gear

SCUBA



Buoyancy compensator



Swim fins



Wet suit



Mask

Fish Part

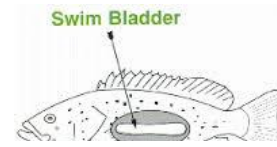
Scales



Caudal (tail) fin



Swim bladder



Eyes for underwater



Gills



### Tips for the 'Human to Fish' Activity

Human gear:

- SCUBA stands for Self-Contained Underwater Breathing Apparatus
- A buoyancy compensator is a vest that holds air and aids the diver in achieving neutral buoyancy by adjusting air in the vest.
- Swim fins are used to propel the diver forward. Divers use their arms to help them turn or tread water.
- The wet suit protects the diver's skin from scrapes and because humans are warm blooded (unlike fish) and get cold when diving, it helps keep divers warm.
- A diving mask creates a layer of air in front of the diver's eyes. Humans cannot see well under water. The layer of air allows for clear vision underwater.

Fish parts

- Fish scales are made of material similar to, but harder than skin and overlap from front to back. They protect the fish and allow for movement.
- The caudal fin is used to propel the fish forward.
- The swim bladder in the fish is a hollow gas-filled organ that allows the fish to conserve energy by maintaining neutral buoyancy (suspending) in water. Fish can increase or decrease the air in the bladder as needed. Fish that do not have a swim bladder sink if they stop swimming.
- Fish eyes are different from ours. They are designed to see through water.
- Gills extract oxygen from the water and blood vessels in the gills carry oxygen to the fish's body.

**Thank you for your interest in  
HG&E's Robert E. Barrett Fishway!**