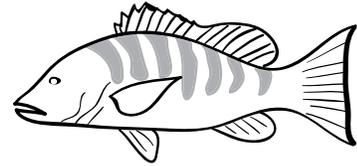


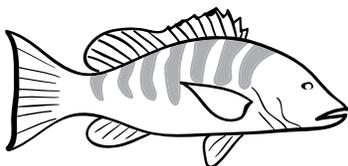
# Making a Big Splash with Louisiana Fishes



Written and Designed by  
Prosanta Chakrabarty, Ph.D., Sophie Warny, Ph.D., and Valerie Derouen  
LSU Museum of Natural Science



**To those young people  
still discovering their love of nature...**



## Note to parents, teachers, instructors, activity coordinators and to all the fishermen in us:

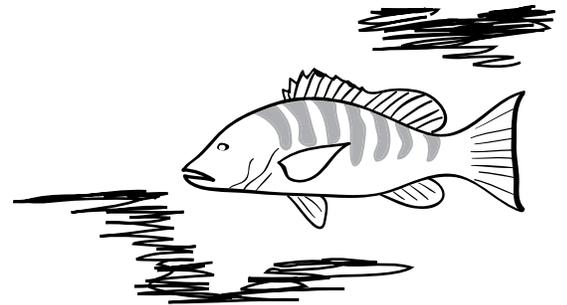
This book is a companion piece to Making a Big Splash with Louisiana Fishes, an exhibit at Louisiana State University's Museum of Natural Science (MNS). Located in Foster Hall on the main campus of LSU, this exhibit created in 2012 contains many of the elements discussed in this book. The MNS exhibit hall is open weekdays, from 8 am to 4 pm, when the LSU campus is open. The MNS visits are free of charge, but call our main office at 225-578-2855 to schedule a visit if your group includes 10 or more students. Of course the book can also be enjoyed on its own and we hope that you will enjoy it on your own or with your children or students.

The book and exhibit was funded by the Louisiana Board Of Regents, Traditional Enhancement Grant - Education: Making a Big Splash with Louisiana Fishes: A Three-tiered Education Program and Museum Exhibit. Funding was obtained by LSUMNS Curators' Sophie Warny and Prosanta Chakrabarty who designed the exhibit with Southwest Museum Services who built it in 2012. The oarfish in the exhibit was created by Carolyn Thome of the Smithsonian, and images exhibited here are from Curator Chakrabarty unless noted elsewhere (see Appendix II).

The Fish Section of the LSUMNS includes over 500,000 representative specimens of all major groups of living fishes in the world. The collections are rapidly expanding and include holdings from the Southeastern U.S., Hawaiian Islands, Mexico, Central and South America, the Greater Antilles and the Indo-West Pacific. Hundreds of research papers, theses, and dissertations have been based wholly, or in part, on this collection. The Fish Section is headed by Curator Chakrabarty who was hired in 2008; the ichthyology lab also includes postdocs, graduate students and undergraduates. Dr. J. Michael Fitzsimons founded the Fish Section in 1971 and built the foundation of the collections until his retirement in Aug, 2007.

If you have any comments or questions about this activity book, please send us your feedback and suggestions to help us improve the book and make it a better tool for teaching basic science principles to elementary school children.

This book was developed as a special publication of the **Occasional Papers of the Museum of Natural Science**  
Louisiana State University  
119 Foster Hall  
Baton Rouge, LA 70803  
Phone: 225-578-3080  
Fax: 225-578-3075



Also, please write and tell us about class projects you did when visiting us at the MNS.

For more information about the LSU Museum of Natural Science, please visit our website at [www.museum.lsu.edu](http://www.museum.lsu.edu) for general information or to learn about research being conducted at the MNS or [www.museum.lsu.edu/education](http://www.museum.lsu.edu/education) for information on our outreach programs and exhibit displays.

LSU is an equal access/opportunity institution.

Written and Designed by Prosanta Chakrabarty, Ph.D., Sophie Warny, Ph.D., and Valerie Derouen  
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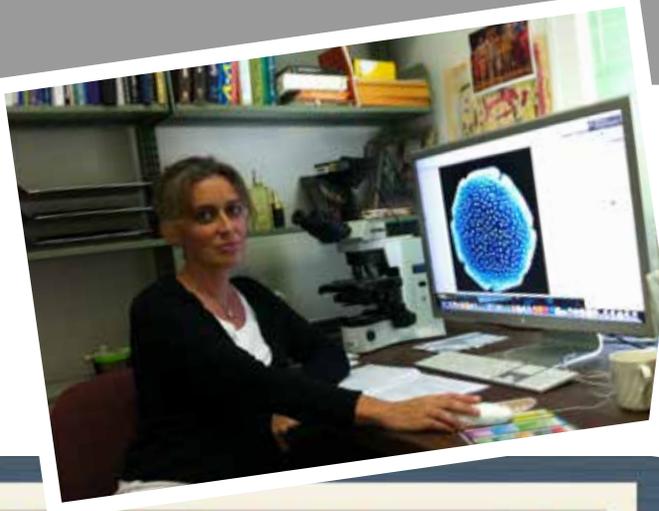
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To all young explorers... Enjoy!





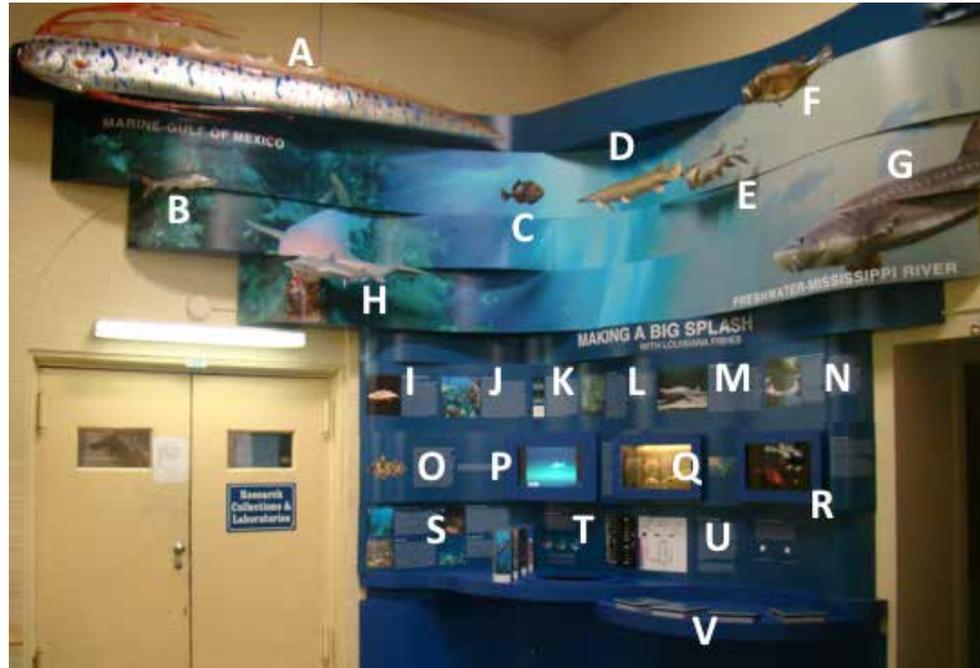
# Making a Big Splash

## The exhibit at LSU!



Come visit us in Foster Hall, on the LSU campus to discover our new exhibit!

- A Oarfish, *Regalecus russelii*, the longest bonyfish
- B Gafftopsail Catfish, *Bagre marinus*
- C Black Triggerfish, *Melichthys niger*
- D Alligator Gar, *Atractosteus spatula* (painted like a Spotted Gar, *Lepisosteus oculatus*..oops)
- E American Paddlefish, *Polyodon spathula*
- F Largemouth Bass, *Micropterus salmoides*
- G Atlantic Sturgeon, *Acipenser oxyrinchus*
- H Dogfish shark, *Squalus acanthias*
- I The Louisiana Pancake Batfish – *Halieutichthys intermedius*
- J Gulf of Mexico
- K Tripodfish
- L The Mississippi River
- M Sturgeon and Paddlefish
- N Freshwater Fishing in Louisiana
- O Overview text of the exhibit and Fish Section at LSU MNS
- P Video Display of LSU collecting trips, SERPENT videos, etc.,
- Q A Fragile Ecosystem – 2010 Gulf of Mexico Oil Spill
- R Bioluminescence in the Deep Sea – with light-up display
- S Fish Habitats – deep sea, Amazon River, caves, coral reefs
- T Gondwana Map with moving continents display
- U Historical Biogeography
- V Question and Answers, pop-up display





# Chapter I: The Toadfish and the Gar

This short story is meant for young children to help explain the two very different aquatic habitats we have in Louisiana: the freshwater Mississippi (where the gar is from) and the marine, saltwater, Gulf of Mexico (where the toadfish is usually found).

“Croak, croak,” said the toadfish, “Croak, croak.” No one understood him; no one seemed to care to understand.

He approached the banks of the Louisiana marsh, “Croak, croak, croak” he said loudly to no one in particular. No one understood, but an alligator gar approached him.

“Hey buddy, I’m a little lost, this water tastes a little salty. Do you know how I can get back into freshwater?”

“Croak, croak” said the toadfish, and nodded his head yes.

“Huh? Great, I guess. What’s your name pal? I’m Gaston the Garfish,” said Gaston the Garfish.

“Croak, croak, croak, croak,” said the toadfish

“That’s a weird name? And long. I’m just going to call you ‘Croaky,’” said the gar.

“Croak,” resigned the toadfish.

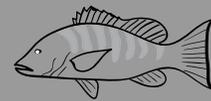
“Actually, I think I passed someone who speaks your language. Follow me” said the gar.

So the toadfish followed the garfish, even though it was the gar that said he was lost. The toadfish was a bit jealous of the gar’s beautiful cylindrical body that was covered in neat interlocking diamond-shaped scales. His own body was soft, short and plump. He was feeling a bit self-conscious but he wanted to help his new friend get home to the freshwaters of the Mississippi. The toadfish preferred the salty water of the Gulf but decided to head upstream anyway to help his friend - or maybe just to follow him, it was hard to tell who was following whom anymore.



**The Gulf Toadfish, *Opsanus beta***





First the toadfish and the gar passed a bird, "Tweet"

"Hey buddy you know how to get to the Mississippi River?" asked the gar.

"Tweet" said the bird, and flew off.

"Birds are dumb, Croaky," said the gar.

"Croak, croak" snorted the toadfish who was really starting to like his new friend.

As they moved upstream the two fish passed by boats and barges and soggy beignets, bottles and bananas. The toadfish wasn't use to so much stuff floating around, he lives in the Gulf of Mexico where he liked to lay quietly along the seagrass and rocks; the Mississippi River was a very different place. He wasn't very comfortable there compared to his ocean home.

Unexpectedly they came across an old cranky alligator that was resting on the riverbank.

"Hey Gator," said the gar, "Why the long face?"

"Ha Ha...Very funny fish brains, I could ask you the same thing. Wha'd'ya want?" asked the alligator.

"I can't understand what my friend Croaky here is trying to say. Can you see if you can understand him?"

The toadfish and the alligator looked at each other. The alligator didn't say anything: the toadfish didn't say anything either.

Suddenly the alligator slipped into the water and swallowed the toadfish.

The gar was shocked, he was frightened, he was... disgusted.

All of a sudden the alligator's mouth cracked open and kept getting wider and wider. Croaky was croaking and vibrating really loud and fast and he kept shaking faster and faster.

The alligator was shocked, he was scared, he was.....disgusted.

He spit out Croaky and slinked back on to land.

"Come on Croaky, I don't think this gator understands us" said the much relieved gar.

At the other end of the bank the gar saw a toad. But the toad didn't see the gar and just as he jumped into the water the gar grabbed the toad by his leg.

"Croak, croak" said the toad.

"Croak, croak" said the toadfish.

"Hey Croaky what is this guy your cousin or something?" as the garfish spoke the toad escaped.

"Nope, nope" said the toadfish.

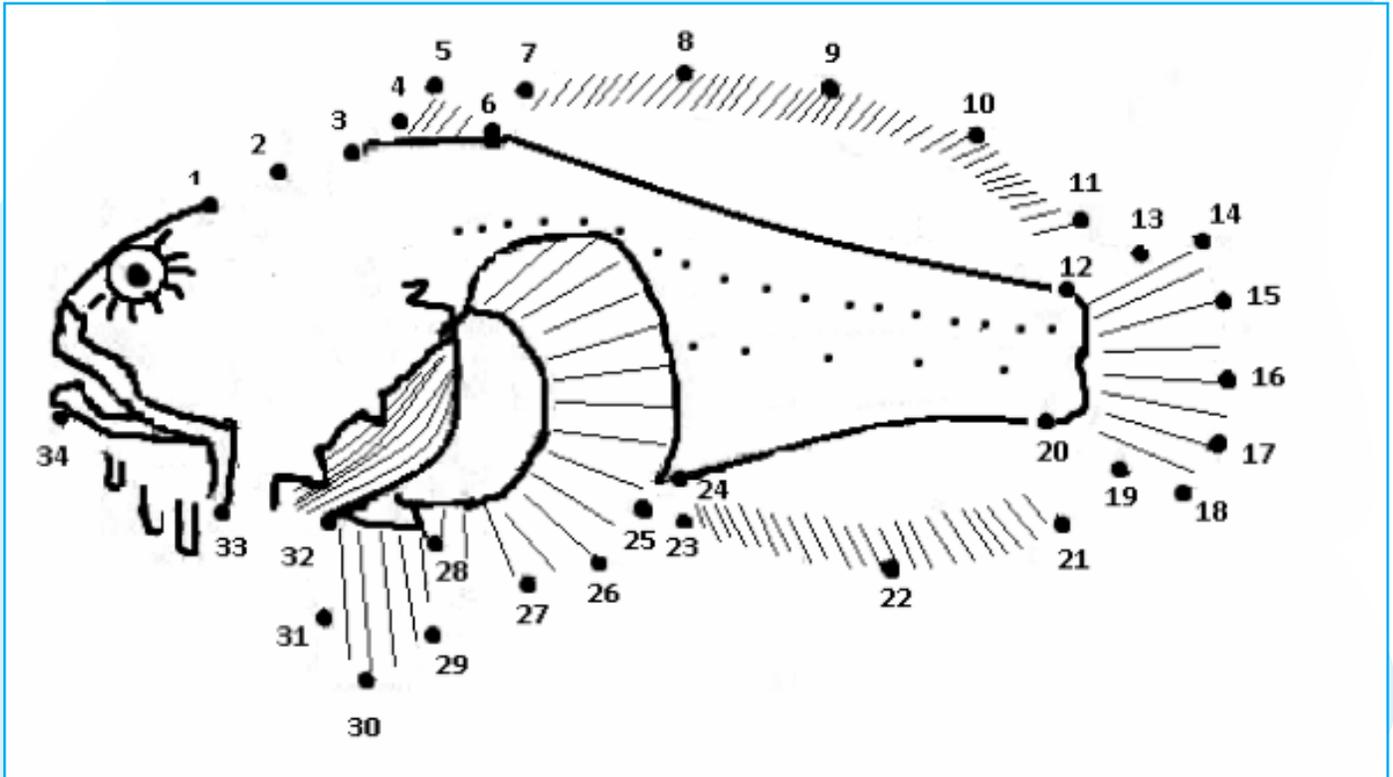


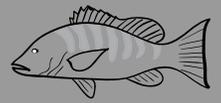
**Gaston the Garfish, check out those beautiful and primitive ganoid scales.**





Activity 1:  
Connect the dots - Who is this?  
Here is a hint: These fishes really do vibrate very rapidly when making sounds.





“Hey, I think you are starting to make sense” said the gar.

The toadfish was tired.

He wanted to head back down river to go home. He liked his new friend but he didn’t like how the water tasted up river, too sweet.

He winked at his new friend and said, “Croak, croak.”

The garfish didn’t understand, but he understood, “Nice meeting you Croaky. I guess I’ll catch you next time. Thanks for helping me get back upstream, maybe I’ll see you in the Gulf sometime.”

“Nope, nope...no sea-gar, nope.”

“Ha ha, no cigar, I’ll remember that one buddy”

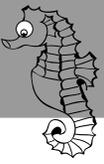
“Joke, joke” croaked the toadfish and went downstream back to his salty home in the Gulf of Mexico.

## Activity 2: The sea maze

Can you help the toadfish find his way home?

The maze is a square grid with a complex path. At the top left, there is an illustration of a toadfish. To its right, the word "START" is written above a downward-pointing arrow. At the bottom center, there is a signpost with a sign that says "To Ocean" above a rightward-pointing arrow. The maze is designed to be solved by tracing a path from the start to the ocean sign.





# Chapter II: Q & A for kids

---

## 1) What is ichthyology?

Ichthyology is the study of fish – all things fish, e.g., their evolution, ecology, behavior, life history and everything else!

## 2) What is a fish?

There are so many kinds of fish that they are hard to define. Fish are aquatic vertebrates with gills and with limbs in the shapes of fins (definition from Gene Helfman). Some have lost some or all fins (as in some swamp eels), and some live on land most of the time (like mudskippers) but this rough definition is pretty good. Under this definition animals like amphioxus, lamprey, hagfish, sharks, salmon, and coelacanths are fish but some things people call fish, like shellfish and jellyfish are not.

## 3) How many kinds of fishes are there?

Around 32,000 species are known! That's more than all the reptiles (including birds), mammals, and amphibians combined! There are about 200 new species of fish discovered each year and there may be more than 50,000 total species!

## 4) Where do fishes live?

Fishes are almost everywhere there is flowing water (as oppose to ice water, which doesn't flow); in the deepest ocean, in caves, swamps, and of course in rivers and lakes.

## 5) How do fishes move around in the water?

Most fishes have fins that they use to swim. They also have lateral lines that help them sense the environment around them.

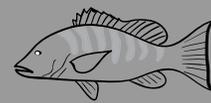
## 6) Can fish produce light?

Yes! Many marine fish do. They use the light to communicate, to avoid predators, or to attract prey.

## 7) Do fish sleep?

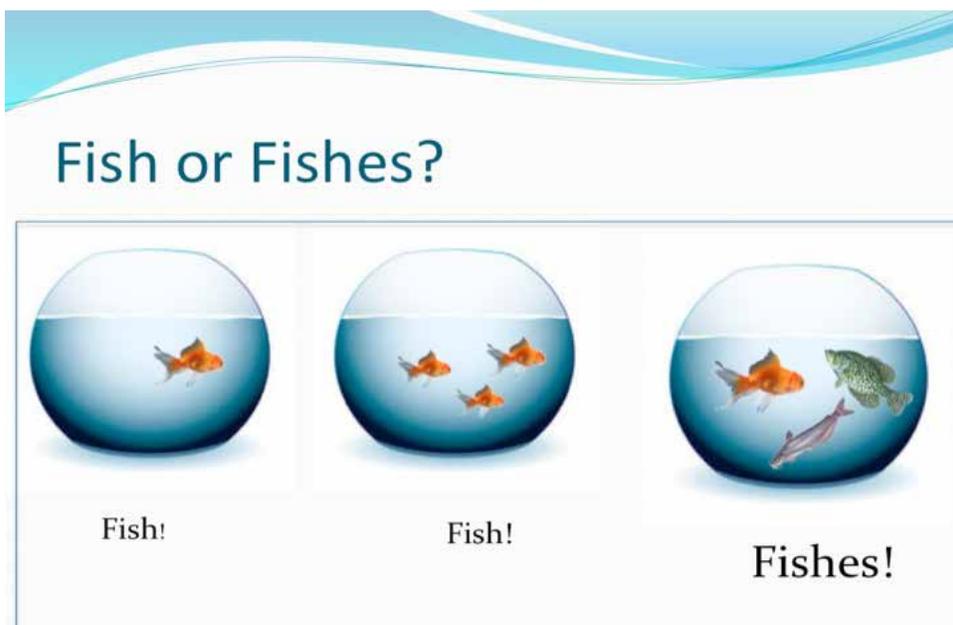
Yes, but not like you or I. They don't close their eyelids and lay down (most don't have eyelids and can't lay down). Fish sleep involves them being in a restful state and staying relatively still although some species of shark 'sleep' even while swimming.





## 8) Is it 'fish' or 'fishes'?

'Fish' is the singular (i.e., one fish), but can also be used as a plural if discussing one type of fish, but 'fishes' is correct when discussing different species. Either, 'fish' or 'fishes' can also be used when discussing these organisms in general terms (e.g., Can fish produce light?)

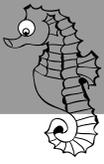


## 9) What is the biggest - and the smallest - fish?

The largest fish overall is the whale shark, *Rhincodon typus*, which can get over 15 meters (50ft). The longest bonyfish are the oarfishes like the one in the LSU MNS fish exhibit (see pg. 2 letter A) which can get to around 7.5 meters (about 25ft). The smallest fish are less than a 2½ cm (half inch), in the cyprinid genus *Paedocypris*.

## 10) Why should we care about Louisiana's fishes?

Louisiana is surrounded by habitat for fishes from the Gulf of Mexico to the mighty Mississippi and all the other rivers and lakes in the region. We rely on fish for food, sport and they are a major part of our natural history and culture. We hope this book will help you better understand the importance of fish in general.

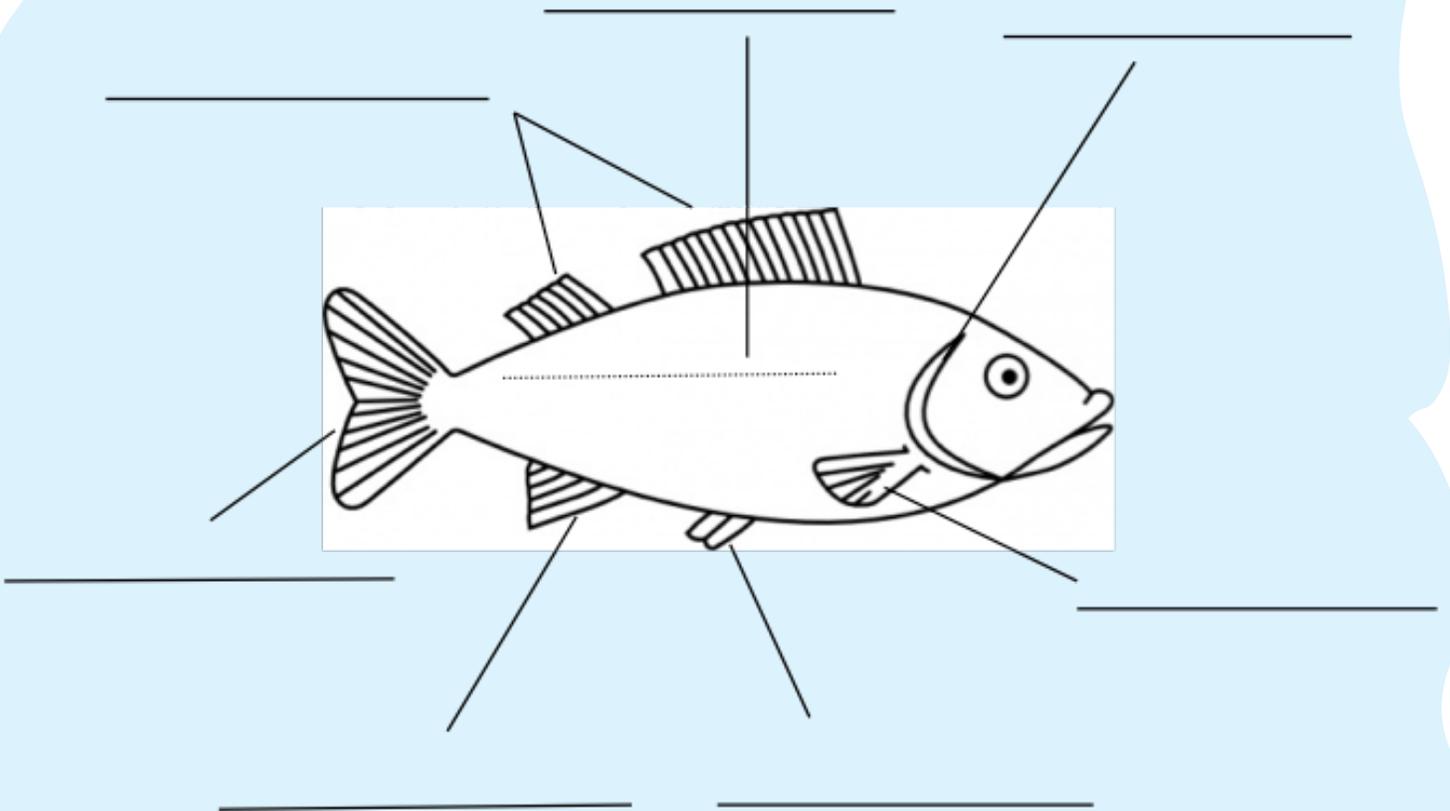


### Activity 3: The Outer Parts of a fish

Use the words below to label the parts of the fish.

Anal Fin  
Caudal Fin  
Dorsal Fins  
Gill Cover

Lateral Line  
Pectoral Fin  
Pelvic Fin





# Chapter III: The ABCs of Louisiana

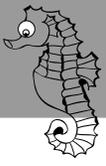
# A

## THE ATCHAFALAYA BASIN



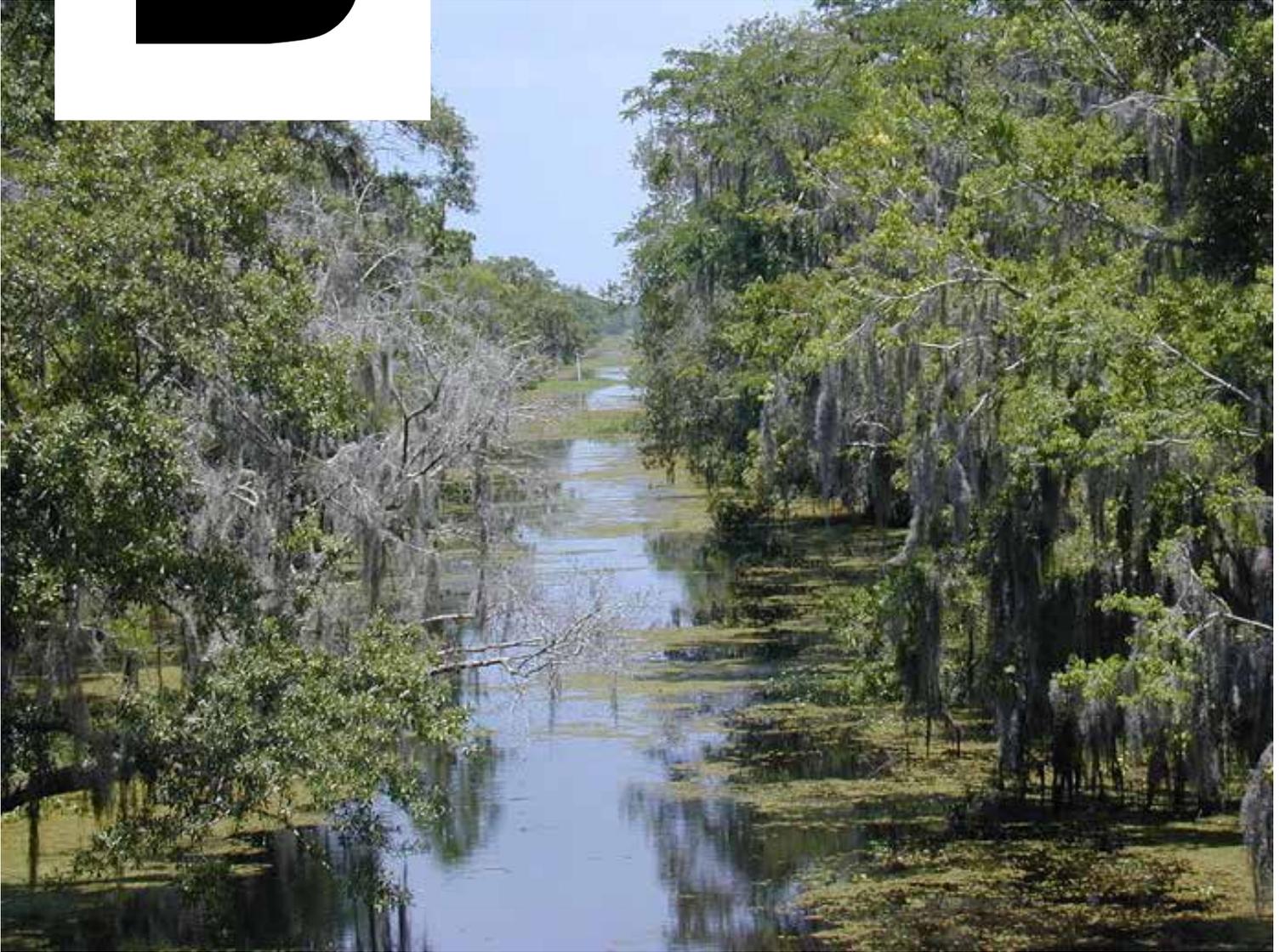
The largest swamp in the United States of America!





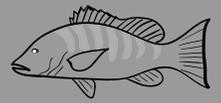
# B

## BAYOUS



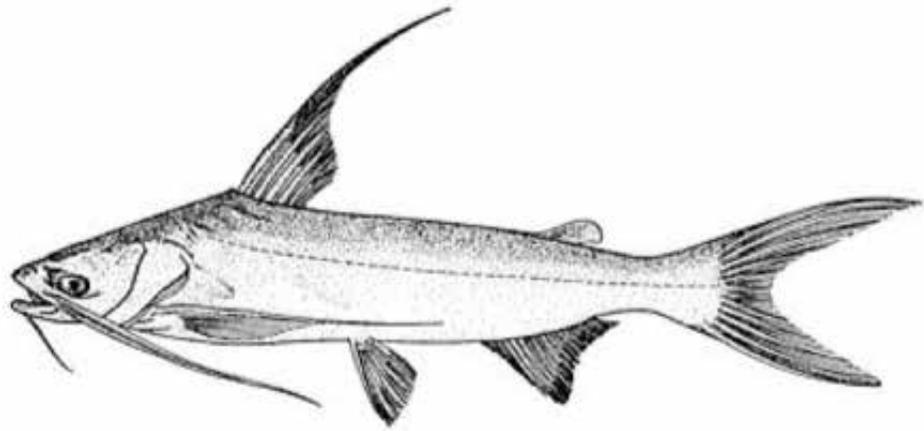
Bayous are very slow moving rivers. They are common in Louisiana.





# C

## CATFISHES



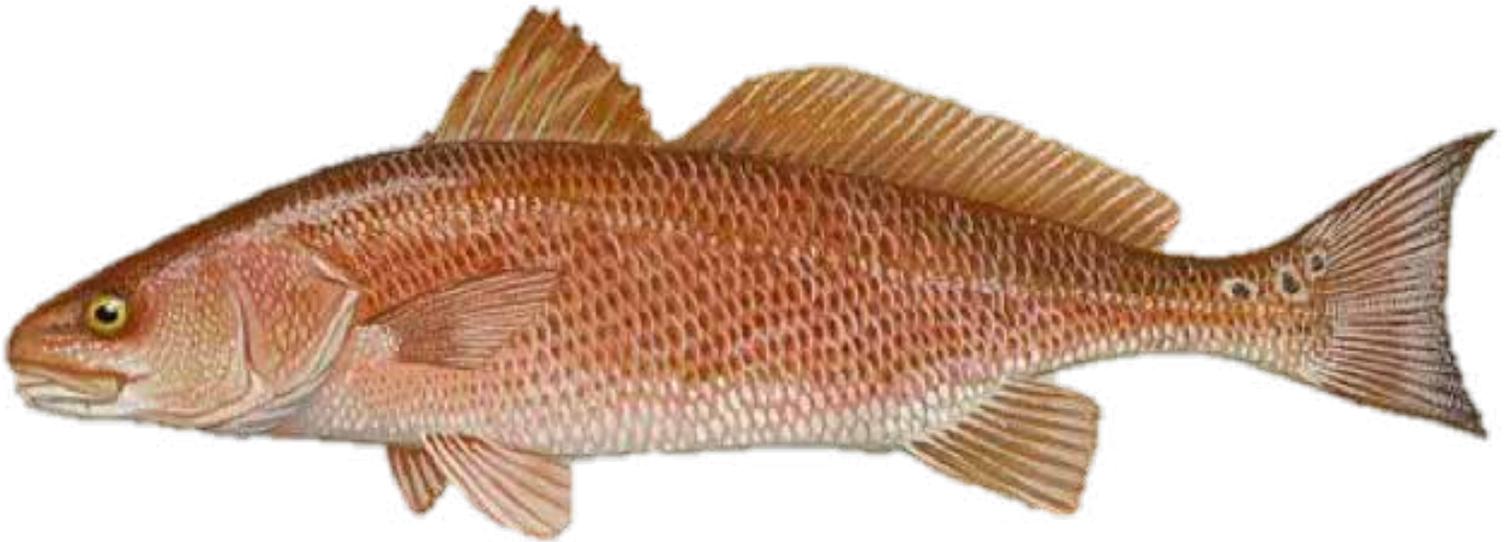
Catfish have barbels that look like cat whiskers and a few species live in the ocean, but most are strictly freshwater. The ventral side of the skull of the Gafftopsail Catfish, *Bagre marinus*, is said to look like a cross, so it is also called the “crucifix fish.”



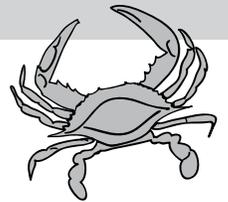


# D

## DRUMS



Did you know some fish can make noises? Drums (Family Sciaenidae) make a drumming sound, surprisingly enough. Our famous Redfish, *Sciaenops ocellatus*, is a kind of drum.





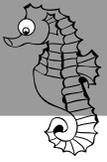
# E

## EELS



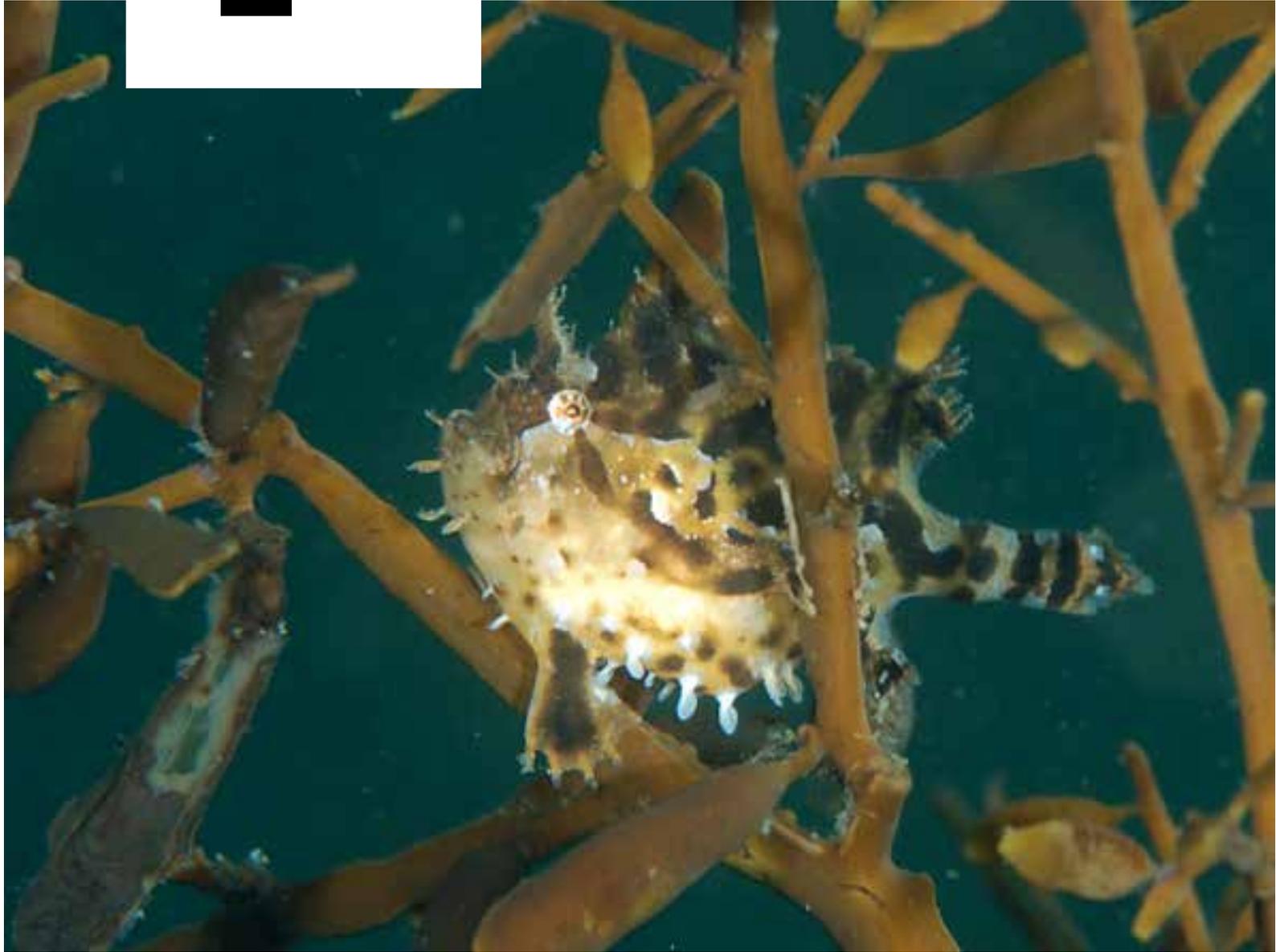
Eels belong to the order Anguilliformes.  
The one pictured above is *Anguilla rostrata*, which can be found in Louisiana.  
Individuals of this species live most of their life in freshwater but spawn in the Atlantic Ocean.





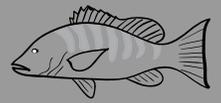
# F

## FROGFISHES



Frogfish are a type of anglerfish. They are great at hiding and use a lure to catch their prey. This is *Histrio histrio*, the Sargassumfish that can be found in the Gulf of Mexico.





# G

## GULF OF MEXICO



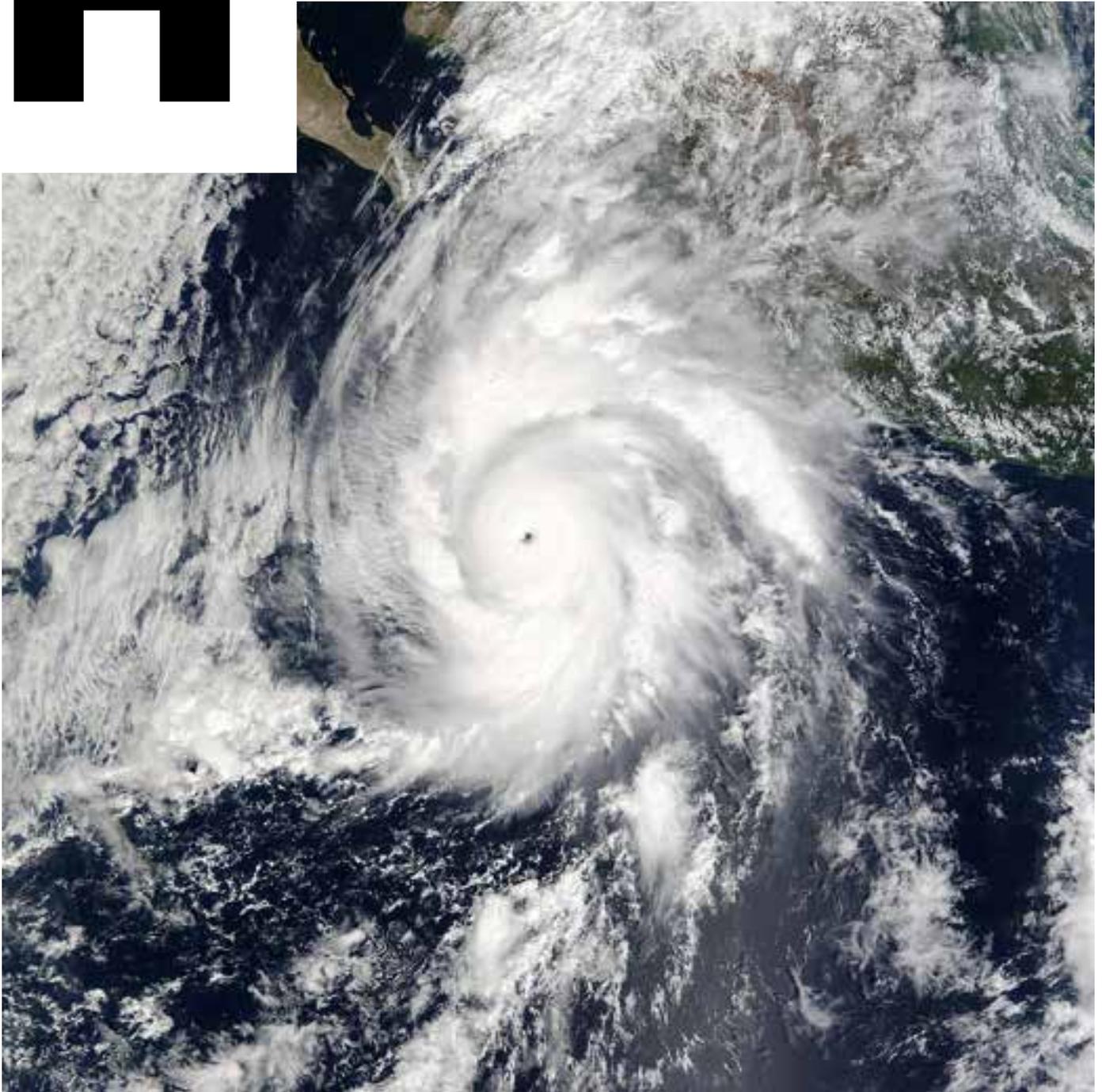
The Gulf of Mexico is the 9<sup>th</sup> largest body of water and is thought to have formed 300 million years ago!





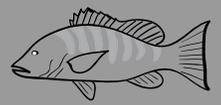
# H

## HURRICANES



Hurricanes are very powerful storms that usually form over warm water like the Gulf of Mexico.





# ICHTHYOLOGY



Ichthyology is the study of fish.  
The image above is from the LSU ichthyology collections showing the results of a Gulf of Mexico collecting trip by Dr. Chakrabarty who is an ichthyologist.





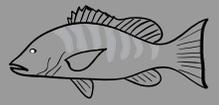
# J

## JACKS



Jacks are fast swimming predatory fishes in the family Carangidae.





# K

## KILLIFISHES



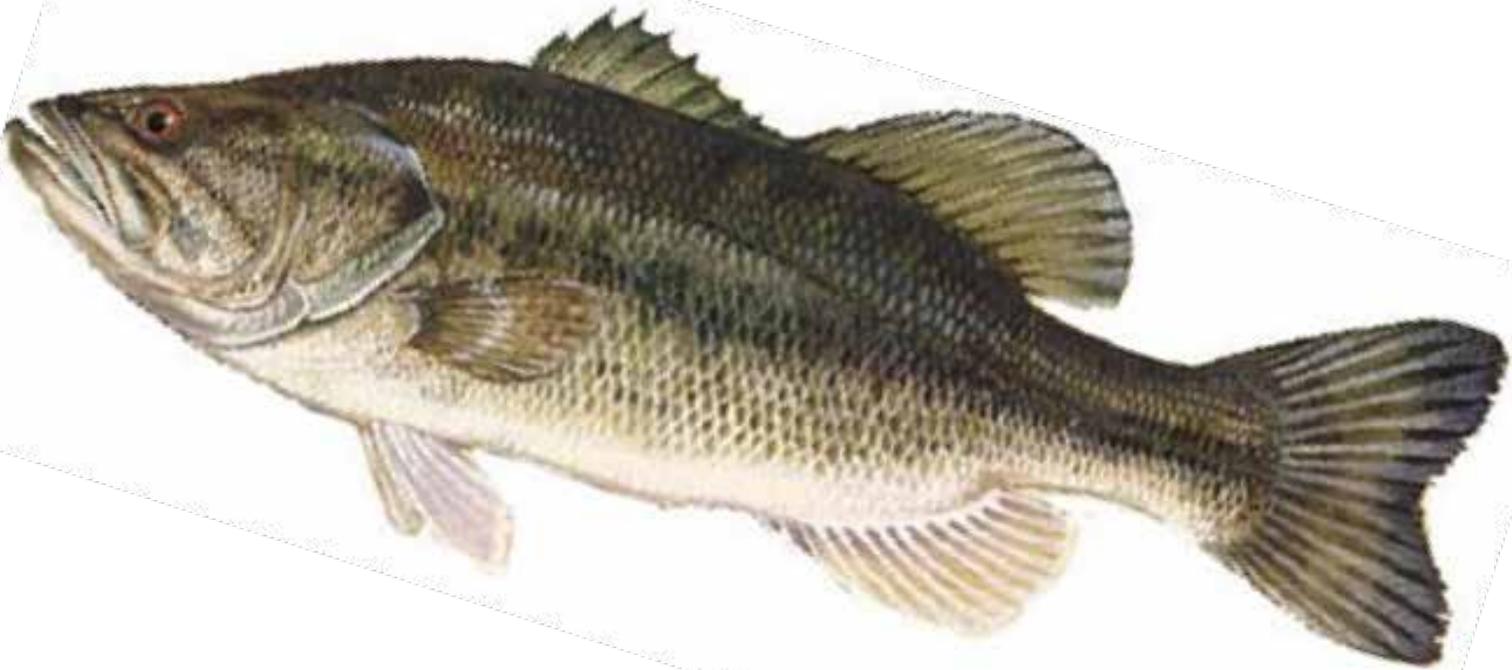
Killifish are commonly used as bait to catch larger fish. Ever heard of a cocahoe minnow?





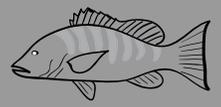
# L

## LARGEMOUTH BASS



Largemouth bass are actually a type of sunfish, like bluegills.  
The term “bass” is used for many unrelated species.





# M

## MISSISSIPPI RIVER



The Mississippi River is the largest watershed in North America and is one of the longest rivers in the world.





# N

## NEEDLEFISHES



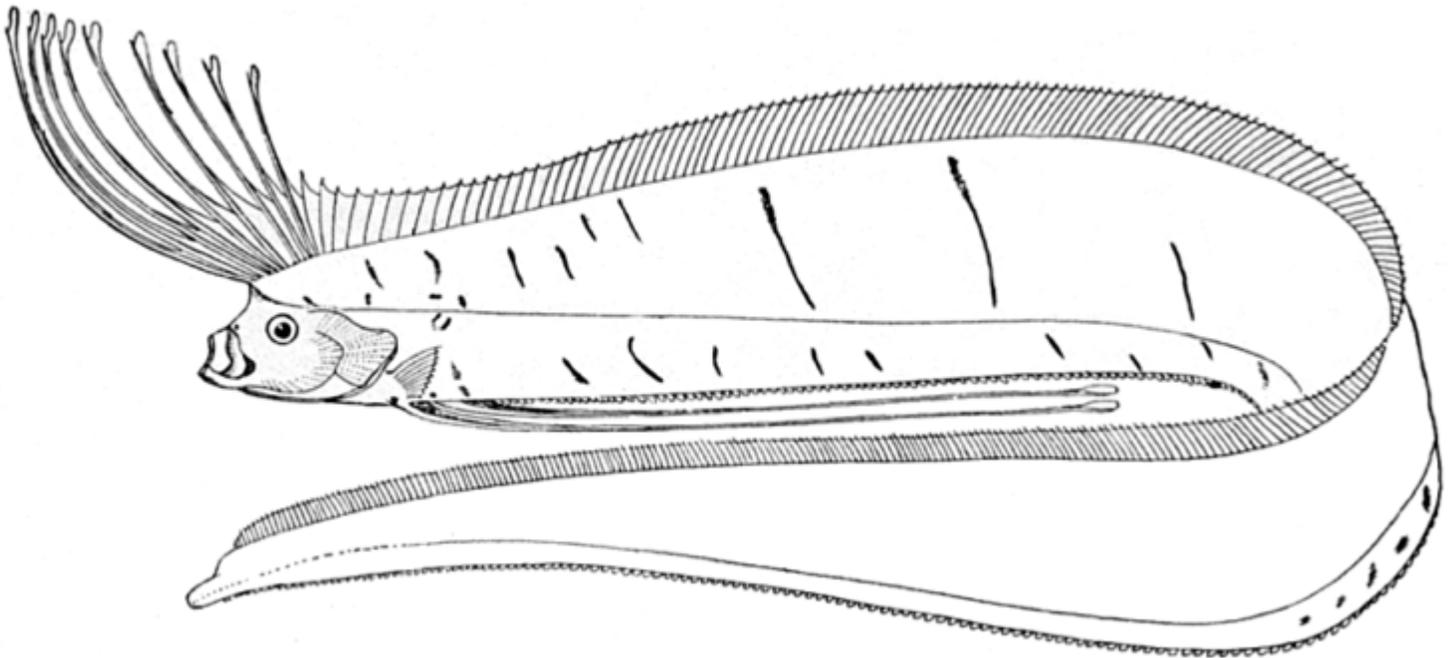
They are called needlefish because similar to a needle, they are long and slender. They also have sharp teeth that they use to capture prey.





# O

## OARFISHES



The oarfishes, also known as the 'King of Herrings', are the longest bonyfishes but they are not related to herrings. Come see the specimen on display at the LSU MNS.





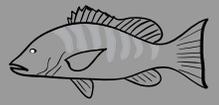
# P

## PARASITES



Parasites are in nearly every organism on Earth, including other parasites. Some are quite spectacular like this isopod that has eaten and replaced the tongue of this Atlantic Croaker.





# Q

## BAYOU QUEUE DE TORTUE



This bayou was first settled by the Attakapa Indian Tribe. Its name means turtle's tail in French.





# R

## RAYS



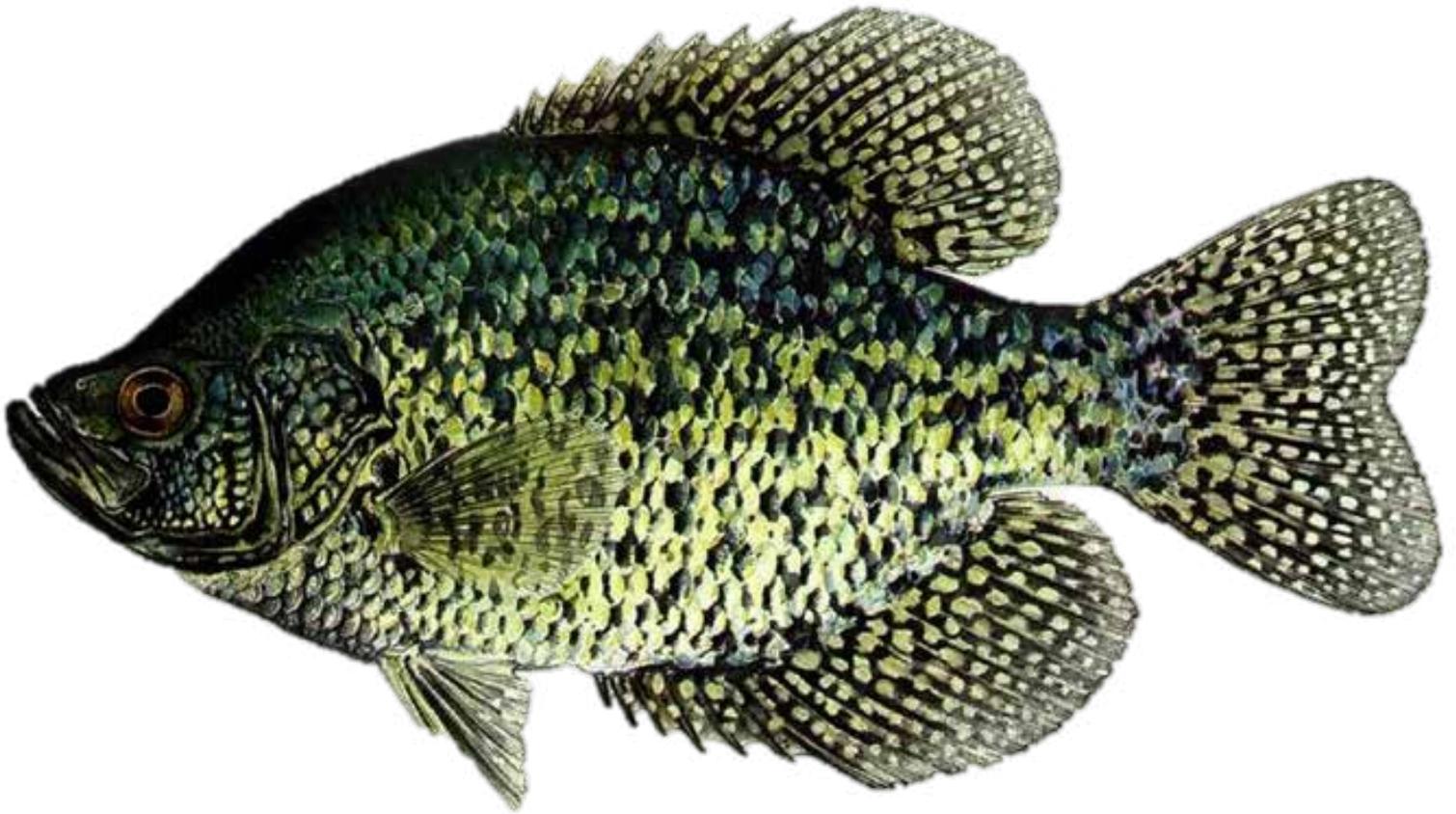
**Rays have flattened bodies and mostly live close to the sea floor. But you better watch out, some species have a venomous stinger.**





# S

## SAC-A-LAIT



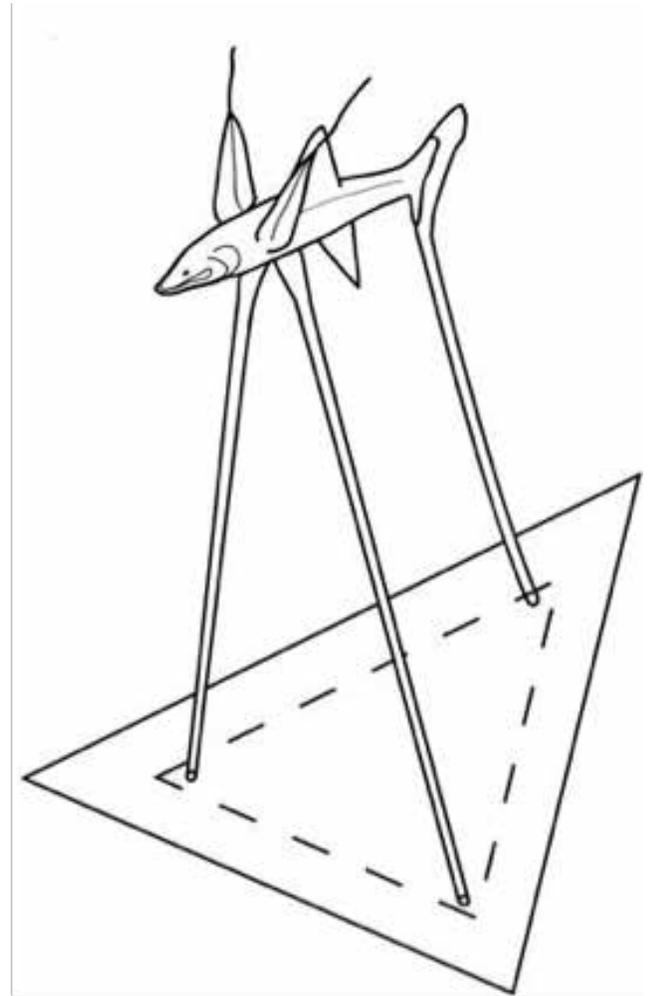
Down here in south Louisiana, sac-a-lait is the local name for a crappie. The name means "Sack of milk."  
Find out why on page 48!





# T

## TRIPOD FISHES



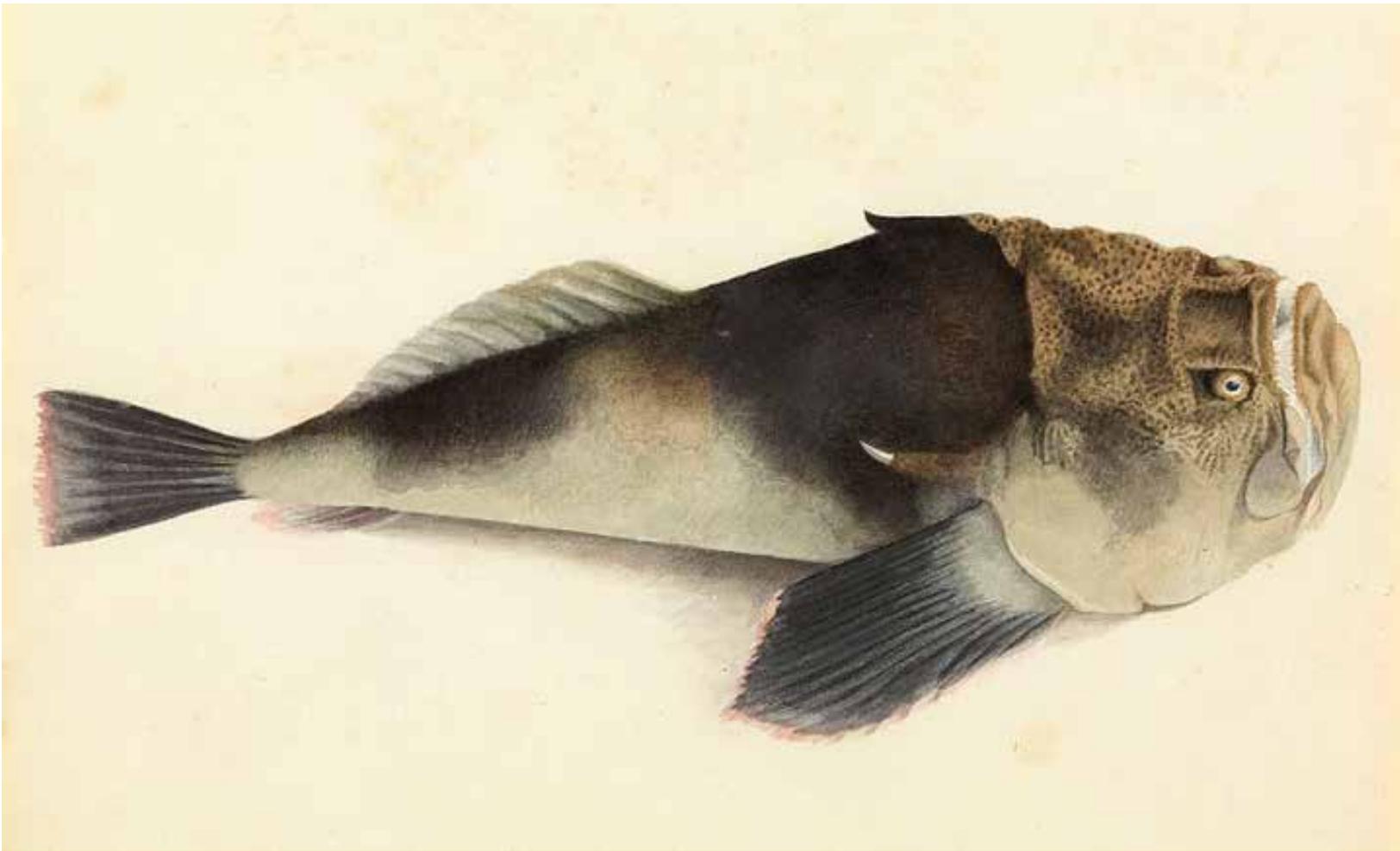
Because these fish can stand on their elongated fins, they look like camera tripods.  
Read more about them on page 38.





# U

## URANOSCOPIDAE



This is the family name for Stargazers.

Their eyes are located on top of their heads so that they can look up for food while buried in the sand.





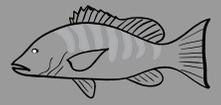
# V

## VERMILLION RIVER



Also known as Bayou Vermillion, it is an important 113km (70 mile river) in southern Louisiana.





# W

## WETLANDS



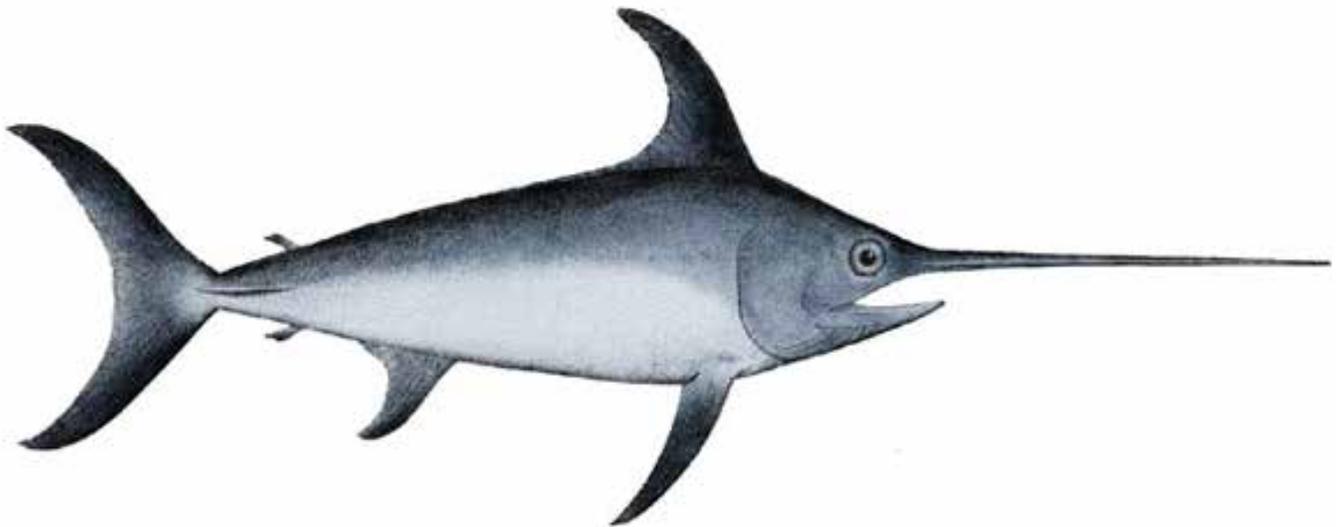
A Wetland is an area of land saturated with water such as marshes and swamps. Get it? “Wet” “Land.”





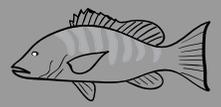
# X

*XIPHIAS GLADIUS*



Whoa that's a mouthful! This is the scientific name for swordfish.





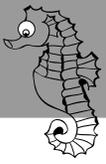
# Y

## YELLOWFIN TUNA



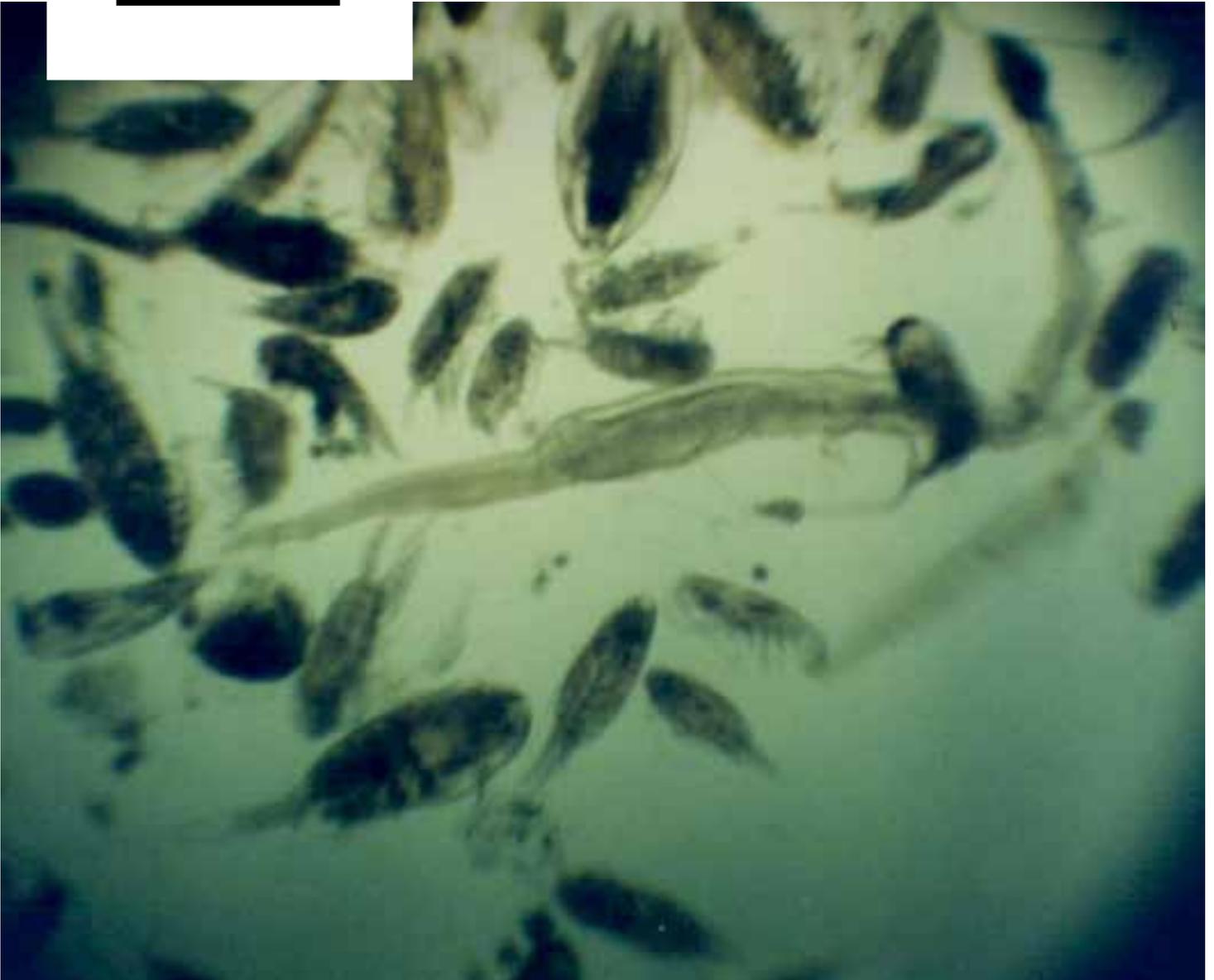
You may have eaten this fish from a can but they can reach 90 kilograms (about 200lbs) and over 2 meters (about 6.5ft). They are top ocean predators.





# Z

## ZOOPLANKTON



Zooplankton are a very important part of the aquatic food chain. They are a mix of small animal life (including eggs, larvae, and small individuals of different species) that float at the ocean surface.





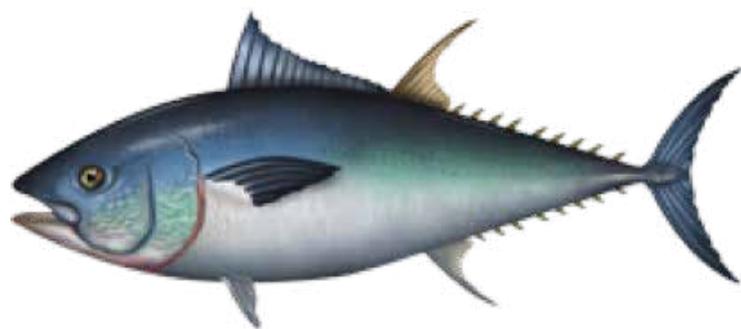
# Chapter IV: The Gulf of Mexico

Chapter IV to VIII are meant for older children and students. But the activities are for all ages and we encourage older readers to help younger readers with the information in the text.

The Gulf of Mexico is over 800,000 square kilometers (about 500,000 square miles) and one of the 10 largest bodies of water in the world. It formed over 300 million years ago and has a wide variety of habitats from intertidal shallow coastal waters to coral reefs to deep-sea habitats that reach more than 4000m (13,000 feet)!

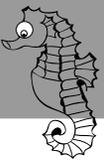
The Gulf of Mexico is a diverse and beautiful habitat for fishes that still remains remarkably unexplored. New species (like the Louisiana Pancake Batfish discovered by Dr. Chakrabarty and colleagues), new behaviors (like the tripod fish's locomotion), and new habitats (like deep coral, hot vents and cold seeps) are still being discovered on

a yearly basis in the Gulf. There are over 1500 fish species known from the Gulf of Mexico! Perhaps the most spectacular is the oarfish, (*Regalecus* spp.). These species are the longest known bonyfishes and are known to reach lengths up to 7.5m (25ft). Oarfish are very poorly known, and only a few specimens have ever been seen alive. The LSU MNS has a specimen that is 3m long (10ft) that was collected in the Gulf of Mexico. The Gulf of Mexico is the **spawning grounds** to many fish species including the Atlantic Bluefin Tuna (*Thunnus thynnus*), which is the most expensive fish in the world (see picture on left). A single individual can fetch more than \$100,000 at market: these fish are highly **endangered** due to fishing pressures and threats to their habitat.



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## Section IV.A: The Louisiana Pancake Batfish - *Halleutichthys intermedius*

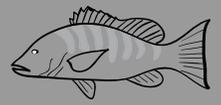
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The Louisiana Pancake Batfish was discovered and described by LSU MNS Curator Dr. Prosanta Chakrabarty and colleagues in Taiwan (Dr. Hans Ho) and the American Museum of Natural History (Dr. John Sparks). The pancake batfishes are shallow-dwelling forms of anglerfish that, like its deep-sea relatives, have a lure (called an esca) at the front of its head to attract prey. Unlike those deep-sea forms, batfishes emit a chemical instead of light from their esca. These fishes hop along the ocean floor and consume invertebrates. Their sandy coloration and spikey hard exterior are excellent for avoiding predators but tuna and marlin still often consume them.

*Halleutichthys intermedius* is one of only 77 species of fishes that are **endemic** (e.g. only found in) the Gulf of Mexico, another 1500 species are resident to the Gulf (but are also found outside of it). Nearly the entire known distribution of this species was in the region of the 2010 Gulf of Mexico Oil Spill. The discovery of this species was recognized by the International Institute for Species Exploration as one of the “Top 10 New Species” in 2011. It has been featured on CNN, the BBC, NPR and many other national and international news outlets.



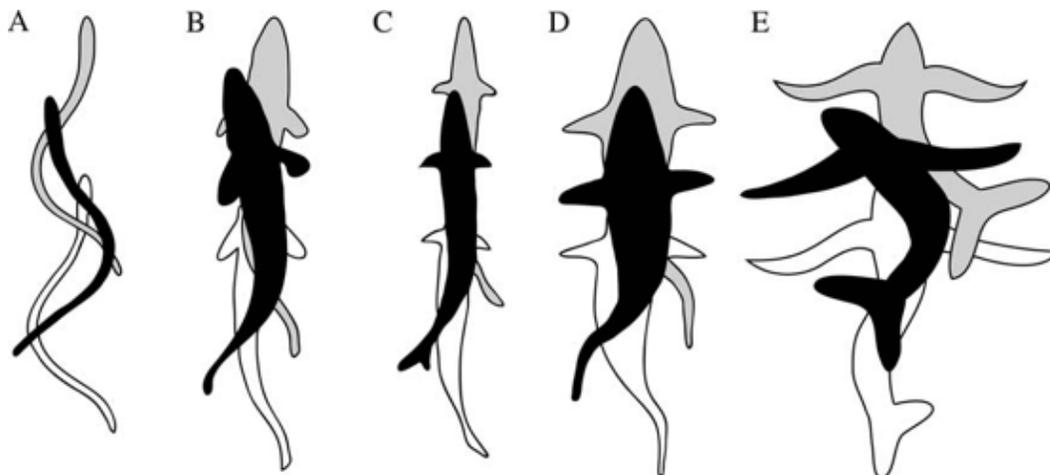


## Section IV.B: Tripod fish and the SERPENT project



Tripodfishes are nearly blind, benthic, deep-sea forms of lizardfishes (Aulopiformes). They are called tripodfish because of their elongated pectoral-, pelvic-, and caudal-fin elements that they use to land on the bottom of the ocean. A research initiative at LSU called SERPENT (Scientific and Environmental ROV Partnership using Existing Industrial Technology) took the only known video of an individual using its fins to land. The still images above show *Bathypterois grallator* swimming and landing on the ocean floor 1443m (4734 feet) below the surface. The swimming motion is unique to this family and is only the fifth known **locomotory** style of swimming in fishes (Image above and below from Davis & Chakrabarty, Marine Biology Research, 2011; 7: 297-303).

This “**bathypteroiform**” locomotion (E in figure below) entails the body and caudal fin providing the propulsive force but the **undulatory** (wave-like) motion of the body is restricted to the anterior half. The pectoral fins, which are outstretched, also do not provide any **propulsion** (unlike in most other fishes that do use these fins). Although never observed feeding, the contents of the stomach reveal a diet composed mostly of plankton. These elongate elements of the pectoral fins are **innervated** by enlarged spinal nerves, and may aid in prey capture or detection. It is also not known why tripodfishes land on the ocean floor with their stilt-like appendages. These fishes are known from the Gulf of Mexico as well as the Pacific, Atlantic, and Indian oceans.



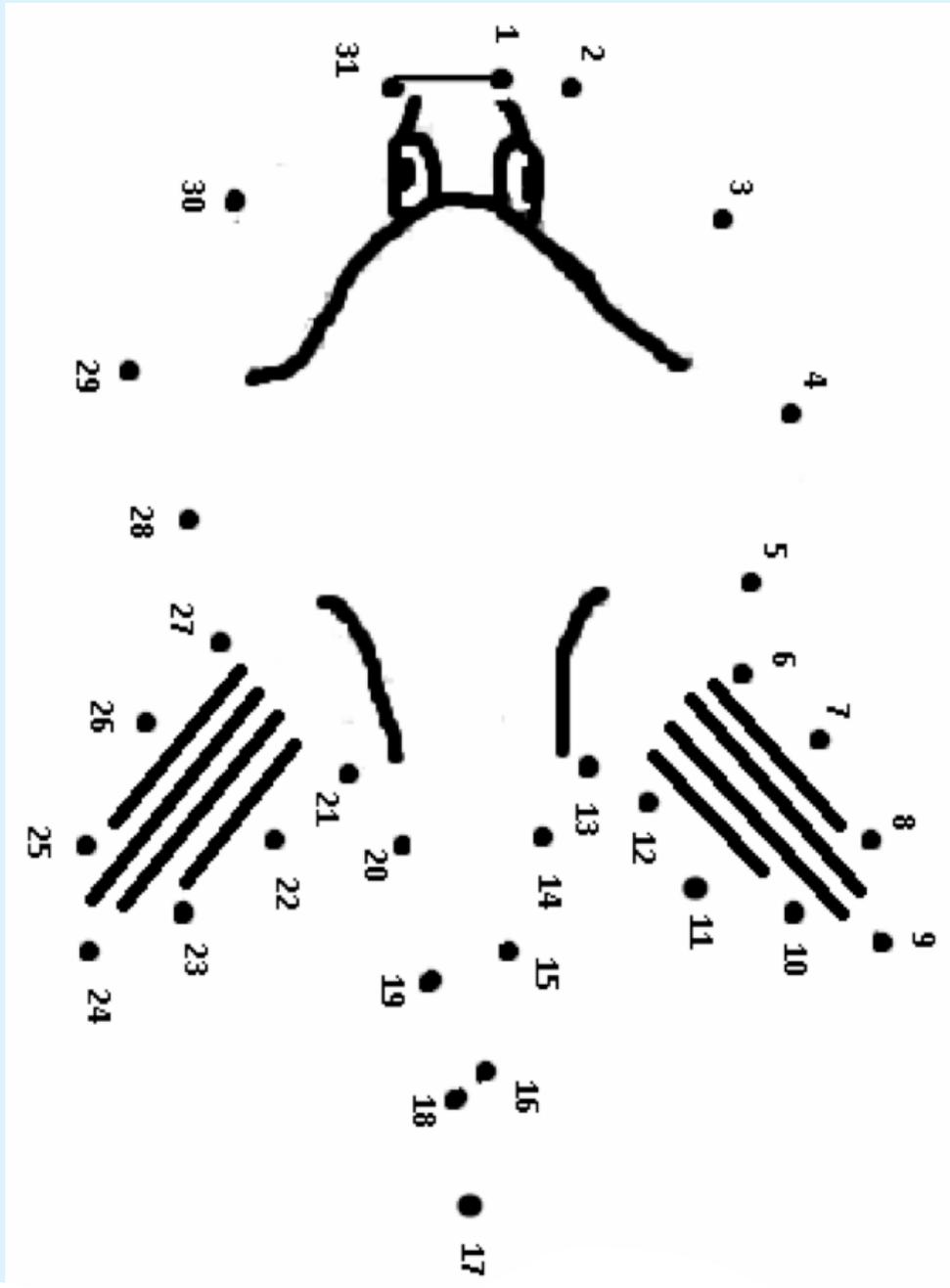
Body and/or caudal fin locomotion including:  
(A) anguilliform,  
(B) subcarangiform,  
(C) carangiform,  
(D) thunniform, and  
(E) subcarangiform or ('bathypteroiform'). Illustrations A to D are redrawn by Matt Davis and modified from Lindsey (1978).





### Activity 4: Connect the Dots

This fish's body is "dorsoventrally flattened" or "depressed." This means it is flattened from top to bottom. Connect the dots to reveal the fish described above!





## Section IV.C: The 2010 Oil Spill

The 2010 Gulf of Mexico Oil Spill was the largest oil spill in history (outside of warfare) and the only one to ever occur in the deep-sea. The spilling of nearly 200 million gallons of oil and the use of more than two million gallons of **dispersant** in the deep-sea make this a unique event and one whose consequences are still not clearly understood. Potential impacts of the oil spill on native fish **fauna** include: diverted spawning grounds, concentrated **bioaccumulation** of **pollutants**, altered migration routes, depleted populations, and local and global extinctions.



Fishes beneath the surface swimming in oil during the 2010 spill. Left: *Nomeus gronovii* (the Man-of War fish) with a Portuguese man-o-war above it. Right: A Porkfish, *Anisotremus virginicus*.

LSU MNS Curator Chakrabarty created a program with University of North Carolina and Ohio State colleagues called SpeciesMap that help better understand the effects of the spill on the local ichthyofauna. (See Chakrabarty et al., *Biodiversity and Conservation* [2012] 21:1865–1876)

The researchers used museum records of collections from 124 Gulf of Mexico species including all 77 endemic species and combined this with data about the **Macondo blowout** made available from NOAA to create SpeciesMap. By overlaying the entire distribution of the spill over its 16-week spread with the known localities of fishes, researchers were able to identify which species were possibly threatened by having their habitat in the region of the spill. More than half of the endemic species were shown to have habitat in this spill zone, with 20 species having more than 35% of the distribution overlapping with the

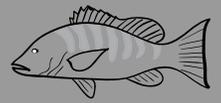


spill zone. These included the Leafnose Leg Skate, *Ancanthobatis folirostris*, with (80% of habitat in spill zone) that was rare even before the spill. The Gold Brotula, *Gunterichthys longipenis*, (88% of habitat in spill zone) is very rare and is a fossorial creature that buries itself in the shoreline sand; this species may have been more affected by clean-up efforts and dredging than by the spill itself.



View from the SpeciesMap program showing the distribution of museum specimens of *Halieutichthys intermedius* relative to a single days view of the location of the spill at the surface of the Gulf of Mexico.





LSU researchers (Whitehead et al. Proceedings of the National Academy of Science 2012 [109] 20298-20302), found that even years after the spill that some species were still affected by residual oil in the sand. Specimens of the Gulf Killifish, *Fundulus grandis*, from areas that had low exposure to hydrocarbons due to the spill, showed developmental and reproductive impairment. Clearly more research needs to be done on other species but the remaining oil from the spill is still doing damage.

Images from Dr. Benjamin Dubansky and the studies of Whitehead et al. mentioned above.





SECRET CODE



Activity 5: SECRET CODE

Use the code to figure out the answer to the question:

“What are the two biggest threats to fish populations?”

\_\_\_\_\_ - \_\_\_\_\_ &

\_\_\_\_\_

\_\_\_\_\_ !





# Chapter V: The Mississippi River

## Section V.A: Background on the River

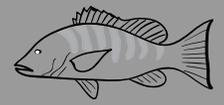
The Mississippi River is one of the largest and oldest rivers in the world. Because it has been around for so long it has provided a stable habitat for many animals and is home to some of the most ancient lineages of fishes alive today including sturgeon, paddlefish, gar and bowfin (all groups that evolved in the Mesozoic). While smaller river systems and lakes appear and disappear over the course of thousands of years, the Mississippi River has been around for tens of millions of years. Flowing over 4,000km (2,500 miles) from the Great Lakes to the Gulf of Mexico, the Mississippi River is one of the most important habitats for fishes in North America. The Mississippi discharges around 7,000 to 20,000 cubic meters of water per second into the Gulf of Mexico. Carried with the water is sediment, nutrients, and agricultural runoff. This influx of nutrients and runoff creates a large “dead zone” [Hypoxic Zone] around the outflow into the Gulf of Mexico where there is little oxygen for huge stretches of water (thousands of square km). Louisiana is the only state besides Minnesota that has political boundaries on both sides of the Mississippi.





The Mississippi is home to catfishes, shad, minnows, shiners, suckers, sunfish and a variety of other fishes. Ancient lineages from the age of the dinosaurs such as gar, sturgeon, paddlefish and bowfin still survive in the Mississippi today! Bowfin (*Amia calva*) are the only surviving member of the order Amiiformes that once had dozens of species dating back to the Triassic (250 million years ago). This group is now limited to one species only found in North America in the Mississippi basin. The local name, Choupique, for this species is derived from the Choctaw word “shupik” which means mudfish.





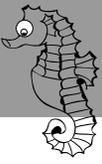
## Section V.B: Sturgeon and Paddlefishes (Acipenseriformes)

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Sturgeon and paddlefishes are one of the most ancient lineages of fishes with modern representatives (these kinds of animals are sometimes called 'living fossils'). They are also among the most **endangered**. The Pallid Sturgeon (*Scaphirhynchus albus*), like the one shown on the top left, is one of the rarest fishes in North America. These long-lived species also mature at a late age and produce few young. Long **migrations** and an **anadromous** life style (spawn in freshwaters but live in the marine realm) are typical for many sturgeon species. River damming and overfishing for their eggs (the famously highly prized and priced caviar) has led to most of the 27 species of Acipenseriformes to be declared endangered. Acipenseriformes also includes two **extant** species of paddlefish, the American (*Polyodon spathula*; see image top right) and Chinese (*Psephurus gladius*). The Chinese paddlefish was once purported to reach lengths greater than 6m (20 feet) and weigh more than 453kg (1000 pounds). The Chinese paddlefish is extremely rare and may already be extinct. The American paddlefish (sometimes called the spoonbill catfish) is more common and shown in the image at the top right. This species has a broad paddle like rostrum that is covered in **neuromasts** (nerve endings) that make the rostrum an efficient **electrosensory** antenna used to capture prey. The skeletons of sturgeon and paddlefish are mostly **cartilaginous**. Fossil members of Acipenseriformes are known from 200 million years ago. The American Paddlefish, the Pallid Sturgeon and the Atlantic Sturgeon (*Acipenser oxyrhynchus*) are all native to Louisiana. The Atlantic Sturgeon can grow to more than 2.4m (8ft) and is the largest freshwater fish in the state after the Alligator Gar (*Lepisosteus spatula*).





## Section V.C: Freshwater Fishing in Louisiana



Nearly 200 species of freshwater fish are found in our state belonging to over 20 families. Major rivers include the Atchafalaya, Black, Mississippi, Ouachita, Pearl, Red, and Sabine; minor, but important, drainages include the Amite, Boeuf, Bogue Chitto, Calcasieu, Comite, Little, Tangipahoa, Tchefuncte, Tensas and Tickfaw. Perhaps the most important area for freshwater endemism in the state are the Florida Parishes in the east. They have the most unique **ichthyofauna** in the state, with 25 species not found

anywhere else in Louisiana, probably due to the rolling **topography** with clear sandy-bottomed streams and rivers that are bounded by the Mississippi to the west and Pearl River to the east. (For more on this topic read the classic, “Freshwater Fishes of Louisiana” by Neil Douglas.)

Along with the scientific names of common fishes from our state, students of ichthyology should also be familiar with the Cajun names. “Gaspergoo” are freshwater drum (*Aplodinotus*





*grunniens*), Sac-a-lait are crappies (*Pomoxis* spp.), and bowfin (*Amia calva*) are Choupique. Some of the origins of the Cajun names are a bit unclear. For instance, the literal translation of *Sac-a-lait*, is “bag of milk”; however, this may be actually derived from the sinking of a cork when a crappie is hooked when fishing. “It sinks” or “C’est callé” sounds a lot like ‘*Sac-a-lait*,’ but makes more sense than bag-of-milk.

Some species that are commonly sought after in Louisiana are the Largemouth Bass (*Micropterus salmoides*), and the Alligator Gar (*Lepisosteus spatula*). Four of the seven living gar species are native to Louisiana. All living gar

species are members of the family Lepisosteidae, but there are many more extinct gar species known. The oldest fossil gars are known from 120 million years ago and were distributed in Greenland, Africa, India and Madagascar while all the living forms are found in North and Central America and Cuba. The largest living gars are the Alligator Gars. The maximum size is somewhat disputed, but specimens close to 3m (10 feet) are known. Louisiana is one of the few states where gars are eaten as food (most people find them unpalatable). However, one should be wary of their eggs: the green eggs of gars are highly toxic to humans.





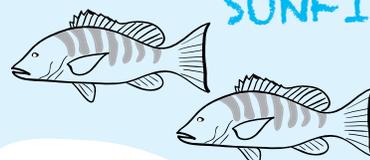
## Activity 6: Word Search. Fishes in Louisiana & Gulf of Mexico

H	C	E	M	S	W	E	Z	S	W	R	P	T	D	T
N	S	A	I	K	U	W	H	O	A	B	D	A	H	S
I	B	I	T	P	G	C	N	G	A	B	P	V	M	K
F	M	S	F	F	P	N	K	S	Q	X	R	O	B	P
W	C	U	X	E	I	A	S	E	U	T	A	Z	A	Y
O	T	Q	R	M	L	S	R	U	R	R	C	U	T	D
B	I	O	A	D	E	D	H	C	F	O	H	Q	F	A
H	S	I	F	N	U	S	D	I	G	U	O	N	I	E
G	V	Y	V	N	T	X	S	A	Y	T	O	N	S	H
I	Z	R	R	U	Y	H	A	J	P	E	A	T	H	S
H	M	Z	B	A	S	O	V	P	G	S	N	G	Q	P
H	S	I	F	D	O	P	I	R	T	U	U	C	H	E
R	A	A	U	P	I	J	U	L	Q	E	B	V	I	E
W	W	A	L	Y	S	T	I	N	G	R	A	Y	S	H
H	A	Y	Q	E	S	S	H	I	N	E	R	W	K	S

BASS  
CARP  
DRUM  
OARFISH  
SHEEPSHEAD  
STURGEON  
TRIPODFISH

BATFISH  
CATFISH  
GAR  
PADDLEFISH  
SHINER  
SUCKER  
TROUT

BOWFIN  
CRAPPIE  
MINNOW  
SHAD  
STINGRAY  
SUNFISH





# Chapter VI: Bioluminescence in the Deep Sea

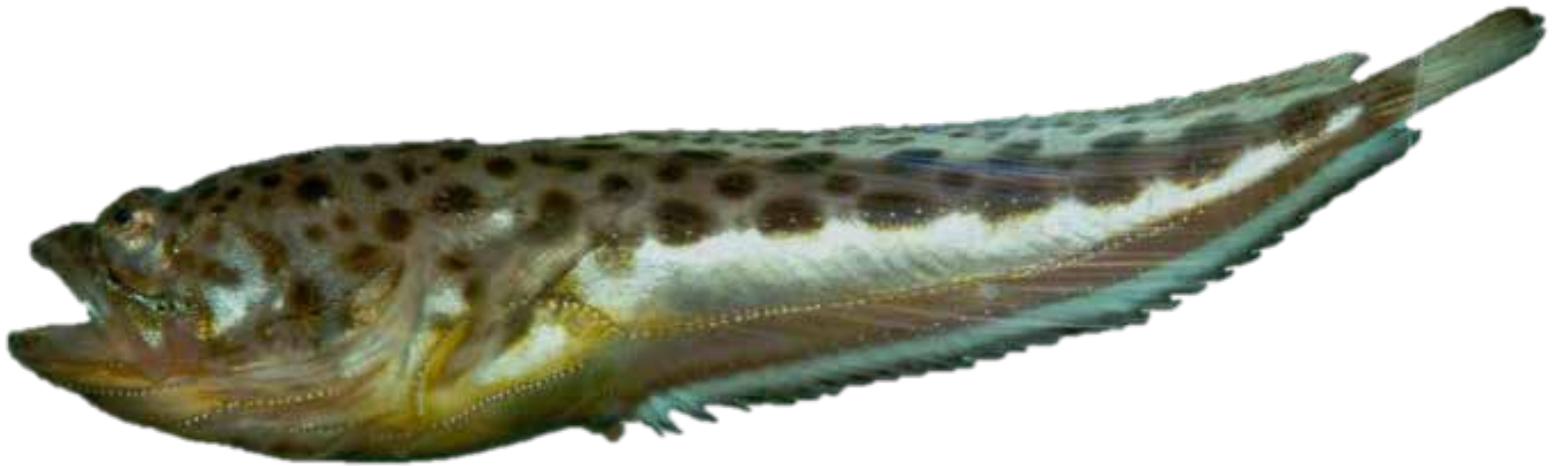


Image of ponyfishes (*Leignathidae*) and a wolftrap angler (*Lasiognathus amphirhamphus*) image of that fish from Dr. Ted Pietsch.

**Bioluminescence** is the emission of light by a living organism. Many creatures in the deep sea use bioluminescence because little to no sunlight reaches beneath 1000 meters under the ocean surface. Some fishes use light generated by colonies of bacteria they store in special light organs, others generate light on their own via a chemical reaction very similar to respiration that emits a photon. Light is used to attract mates and prey but can also attract unwanted predators. Be careful how you use your light!

The deep sea of the Gulf of Mexico and other parts of the world are extremely poorly studied. This environment is perpetually dark, extremely cold (just a few degrees above freezing) and vast. The deep-sea environment is the largest habitat on Earth but we know much more about space than we do about life below 1000 meters in the ocean. Although this region lacks sunlight, the flashing bioluminescence





of many deep-sea creatures keeps it from being completely dark. Fishes are known from some of the deepest parts of the oceans. Snailfishes, *Pseudoliparis amblystomopsis*, are known from a depth of 7,700 meters (25,300 ft). Pressures at this depth are many hundreds of pounds per inch. How exactly fishes have adapted to survive at this depth is not known.

Some bioluminescent forms are found in rather shallow water. The ponyfishes (Leiognathidae) are found near the ocean surface to about a depth of 400m. Ponyfishes use the light produced by a colony of luminescent bacteria (*Photobacterium* spp.) housed in a circumesophageal light organ. Male ponyfishes co-opt this bacterial light to make photic displays to attract females. Huge schools of males will display together, making beautiful synchronous displays

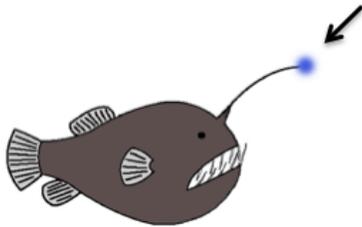
that light up large areas of open ocean. Male and female ponyfishes also use light for predator avoidance. Ponyfishes can light up the ventral (bottom) half of their body to match the ambient light from above; this makes them nearly invisible to predators viewing them from below. The ponyfishes are only found in the Indo-West Pacific Oceans but local Louisiana fishes like the Atlantic Midshipman (*Porichthys plectrodon*, a kind of toadfish) flash in shallow waters of the Gulf of Mexico in a similar fashion. The Atlantic Midshipman is one of the most beautiful fishes in our local waters with very elaborate gold coloration around the body that are accentuated by the light they produce. (The image above doesn't do them justice.)





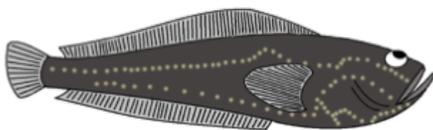
## Activity 7: Matching Different Ways Fish Use Light

Bioluminescence is the emission of light by a living organism. Fish use bioluminescence in different ways. Match the fishes below with the way they use light. (Arrows indicate where the light is produced.)



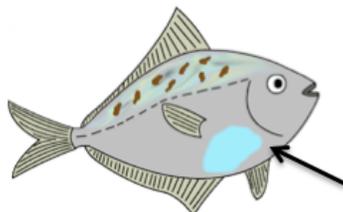
Deep Sea Angler Fish

This fish uses light to attract its mates.



Midshipman

This fish uses light to attract its prey.



Ponyfish

This fish uses light for camouflage by counter-illumination.



# Chapter VII: The Ecosystems of Fishes

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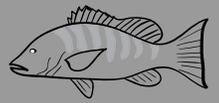
As we've mentioned before fishes live almost everywhere there is water.

Let's explore some of these habitats!

## Section VII.A: Freshwater and Subterranean Cave Habitats

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Of all the world's water only 2% is freshwater and most of that is preserved as ice in Greenland and in the polar ice caps (the rest is marine saltwater). In fact, only about .01% of the world's water is flowing freshwater. This provides all of our drinking water and all of the habitat for freshwater life. A great deal of this freshwater is **subterranean**. There are roughly 150 species of cavefishes known around the world (but there are probably many, more). These cavefishes are typically blind (even eyeless) and lack pigment.

These blind **troglobitic** species have a very limited ability to **disperse**; therefore, their relationships can tell us a great deal about how landmasses have moved. Because these animals cannot survive outside of these caves, the relationships among closely related disjunctly-distributed species likely means the areas where they live were once connected. The fish specimen shown below is a new species of cavefish described by LSU MNS and American Museum of Natural History researchers from Madagascar, *Typhleotris mararybe* (from Sparks and Chakrabarty, 2012), those displayed in the exhibit are blind members of the genus *Astyanax*, from Mexico (see page VI, Section S). Unfortunately, despite cave habitat being available in Louisiana, there are no cavefishes known from our state.





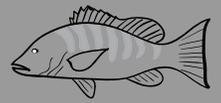
## Section VII.B: Coral Reefs and Marine Ichthyofauna

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Coral reefs are the rainforests of the oceans. These areas are incredibly diverse habitat and home to some of the most spectacular life on the planet. Corals are themselves living organisms despite their appearance as rocky substrate. Coral bleaching, caused by temperature change and other stresses cause corals to lose their endosymbionts (zooxanthellae) and die. **Bleaching** is a major threat to these spectacular and important habitats. Corals account for only 0.1% of the world's ocean surface but are the home to 25% of all marine life (including fishes, mollusks, echinoderms, etc.). About 60% of all species of fish are marine, the remaining 40% are freshwater (despite 98% of the water on Earth being marine).





## Section VII.C: The Amazon



The Amazon River of South America is the largest river system in the world. In parts it is 10km wide (6.2 miles) and is about 6400km (4000 miles) long. The majority of the river travels through tropical rain forest and it is the center of Neotropical fish diversity. It is home to about 5,600 species of freshwater fish, more than any other area in the world. This represents more than 1/5 of the total number of fish species known and about 10% of all vertebrate species. (That means 1 out of every ten vertebrate species known today is an Amazonian fish!) These fish include many species of cichlid, piranha, catfish, electric eels and freshwater stingrays. It also includes huge species such as the Pirarucu (*Arapaima gigas*) that can reach 4.5 meters (15 ft) and weight up to 200 kilograms (440 pounds). It is also home to the infamous parasitic catfish the Candiru (*Vandellia* spp.), which has been known to lodge itself in the nether regions of unsuspecting (and unlucky) human bathers. A few specimens of this species are on display in the exhibit (see page VI, Section S).



VANDELLIA CIRRHOSA. Cuv. Val.





# A Note About the Coelacanth – and Our Place in the Tree of Life of Fishes

One of the greatest science triumphs in the last century was the discovery of a living species of Coelacanth (*Latimeria chalumnae*). These fishes are more closely related to humans and other tetrapods (all members of Sarcopterygii – or lobbed-finned fishes) than they are to Actinopterygii (the ray-finned fishes) like bass, perch or almost any other fish you can think of. Coelacanths have limb and wrist bones that are homologous (similar due to common ancestry) to ours and they are part of the lineage that gave rise to the first vertebrates to invade land. These first land invaders gave rise to all the land vertebrates (tetrapods) on Earth today. There are two species of extant Coelacanth, from opposite ends of the Indian Ocean, but there are many more in the fossil record dating back to the end of the Devonian (360 mya). The living forms are found in deep water (100-250m) caves and swim using a “doggy-paddle” motion like tetrapods.





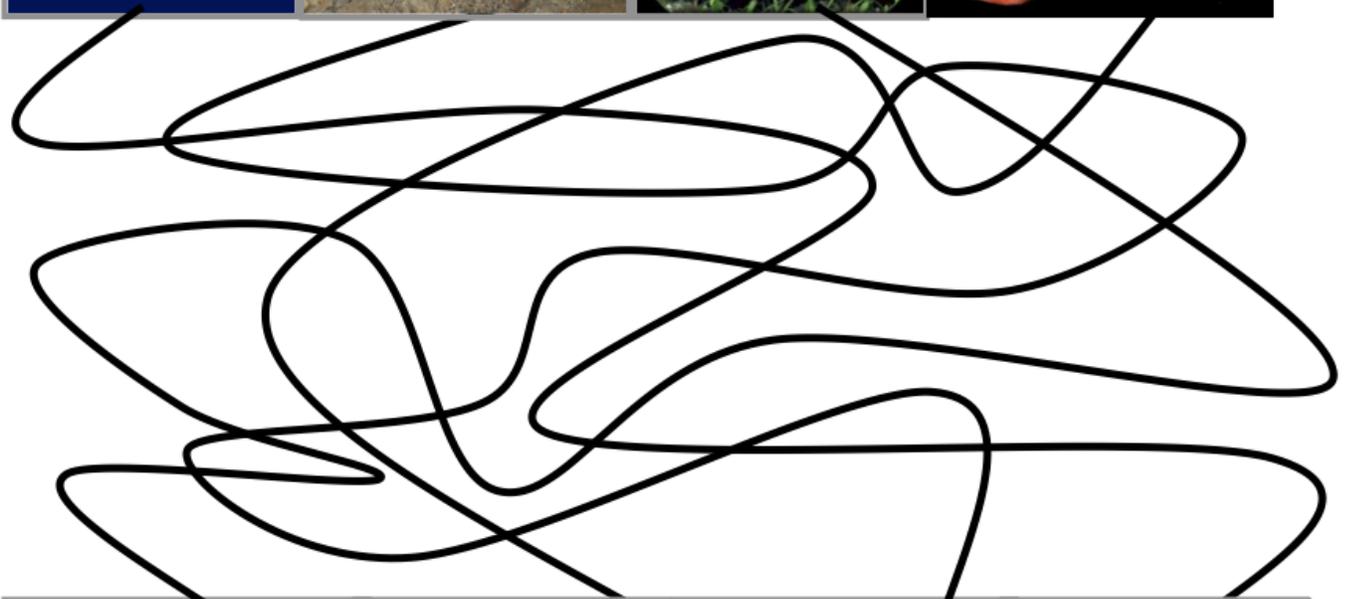
Activity 8: Follow the lines starting at each fish to find out which habitat these fishes call home.

Clown Fish

Blind Cave Fish

Piranha

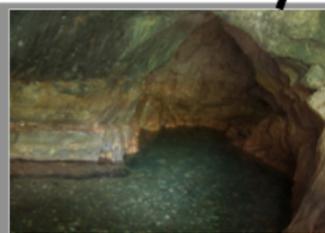
Deep Sea Anglerfish



Amazon River



Deep Sea



Freshwater Cave

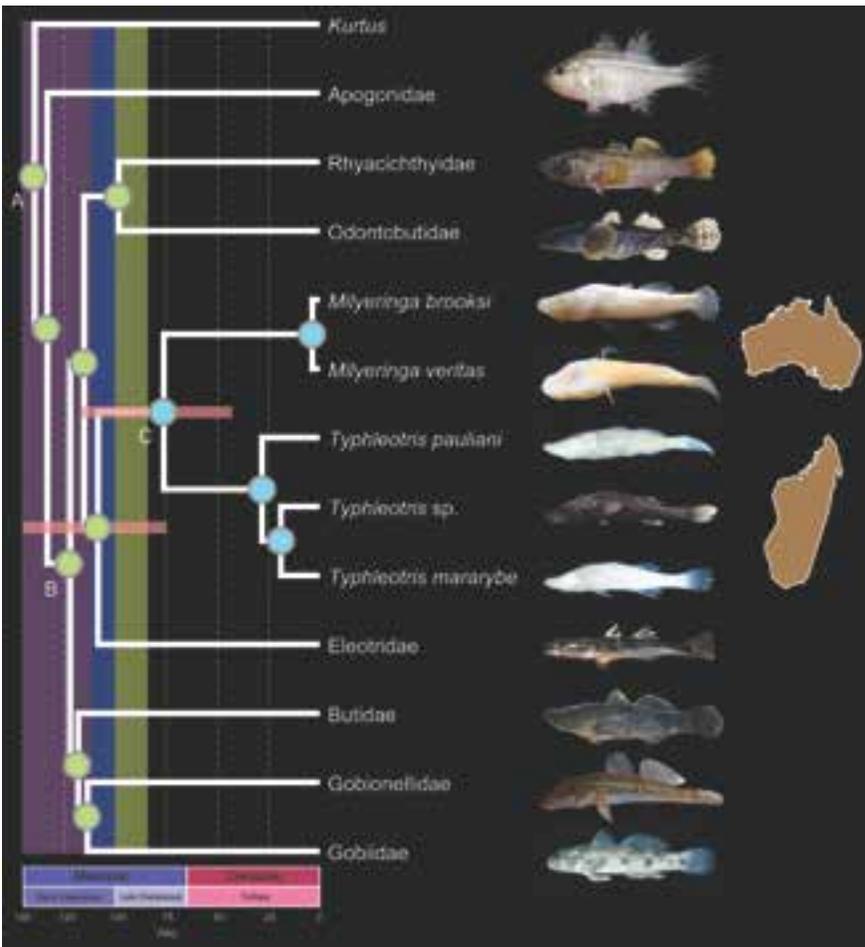


Coral Reef



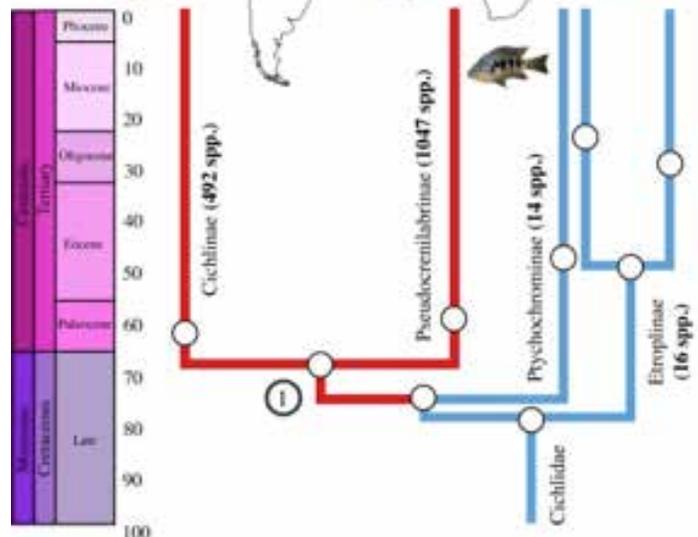


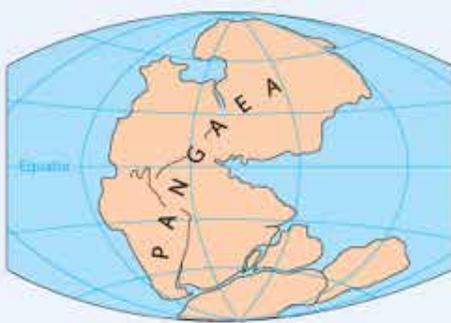
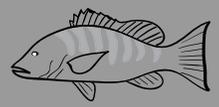
# Chapter VIII: Studying Systematics and Biogeography of Fishes



The two **phylogenies** (tree diagrams showing evolutionary relationships) to the left show two distinct groups of freshwater fishes that have a Gondwanan distribution, both are from studies done at LSU (see Appendix II). Gondwana was the supercontinent formed by Madagascar, India, Africa, South America, Australia and Antarctica in the Mesozoic. This supercontinent broke apart and separated many closely related groups of organisms that are now on opposite ends of oceans. On the top left is a phylogeny of gobioid fishes, including blind forms from Australia and Madagascar. These blind species are not able to leave their cave habitats and are hypothesized to have separated when Australia and Madagascar broke apart. This phylogeny based on DNA shows that

the age of all gobioid fishes (A-B) traces back to the Early Cretaceous, and that the separation of the Australian blind fishes, *Milyeringa*, and the Malagasy blind fishes, *Typhleotris*, goes back to the (C) Mid to Late Cretaceous. This period of separation of these lineages based on the divergence of DNA fits with the geological timing of the break-up of these landmasses.





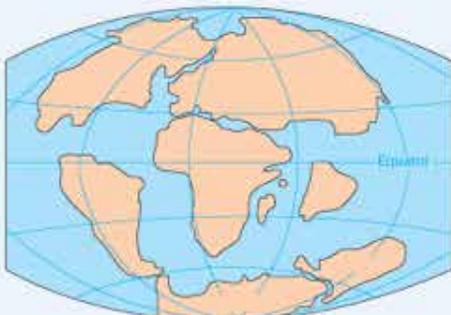
PERMIAN  
250 million years ago



TRIASSIC  
200 million years ago



JURASSIC  
145 million years ago



CRETACEOUS  
65 million years ago

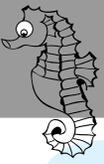


PRESENT DAY

The same is true for the case of the cichlid fishes depicted in the phylogeny on the bottom of the previous page. Cichlid fishes found in Madagascar, India, South America and Africa also show DNA sequence divergence that suggests they **diverged** at the same time as those Gondwanan landmasses separated. Freshwater fishes are particularly useful in helping us better understand Earth history because they typically are tied to the freshwater habitats they are found on and do not cross the marine environment because of physiological constraints.

The supercontinent of Pangea existed over 200 million years ago and included Laurasia in the North, and Gondwana in the South. All of these pieces formed a single landmass near the equator more than 100 million years ago. These pieces began to separate slowly over the course of millions of years and drifted to their present locations thousands of kilometers apart at a rate of just a few centimeters a year. Can you find Louisiana in the maps to the left?





## Activity 9: Phylogenetic Trees. Use the information below to complete the phylogenetic trees below.

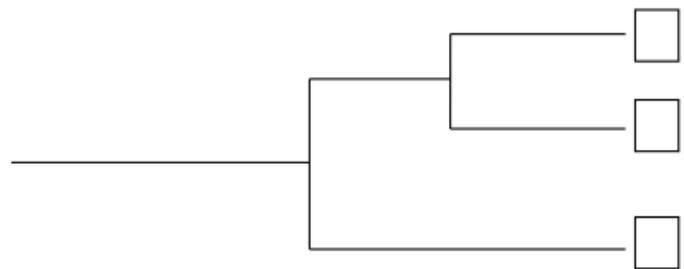
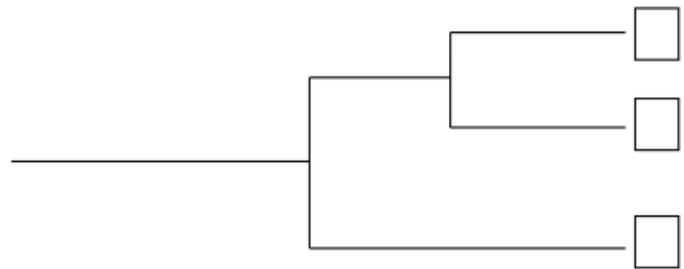
Phylogenetic trees are useful tools for showing evolutionary relationships. When organisms are grouped together on a tree, they are thought to be more closely related to each other than to other organisms. If two groups are joined together by a single node, they are called sister taxa.

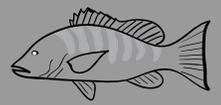
1. Organism A, B, and C are all closely related to one another. Organism "A" is the sister group of organism "C."

2. Organism D, E, and F are all closely related to one another. Lineage "E+F" is the sister group of organism "D."

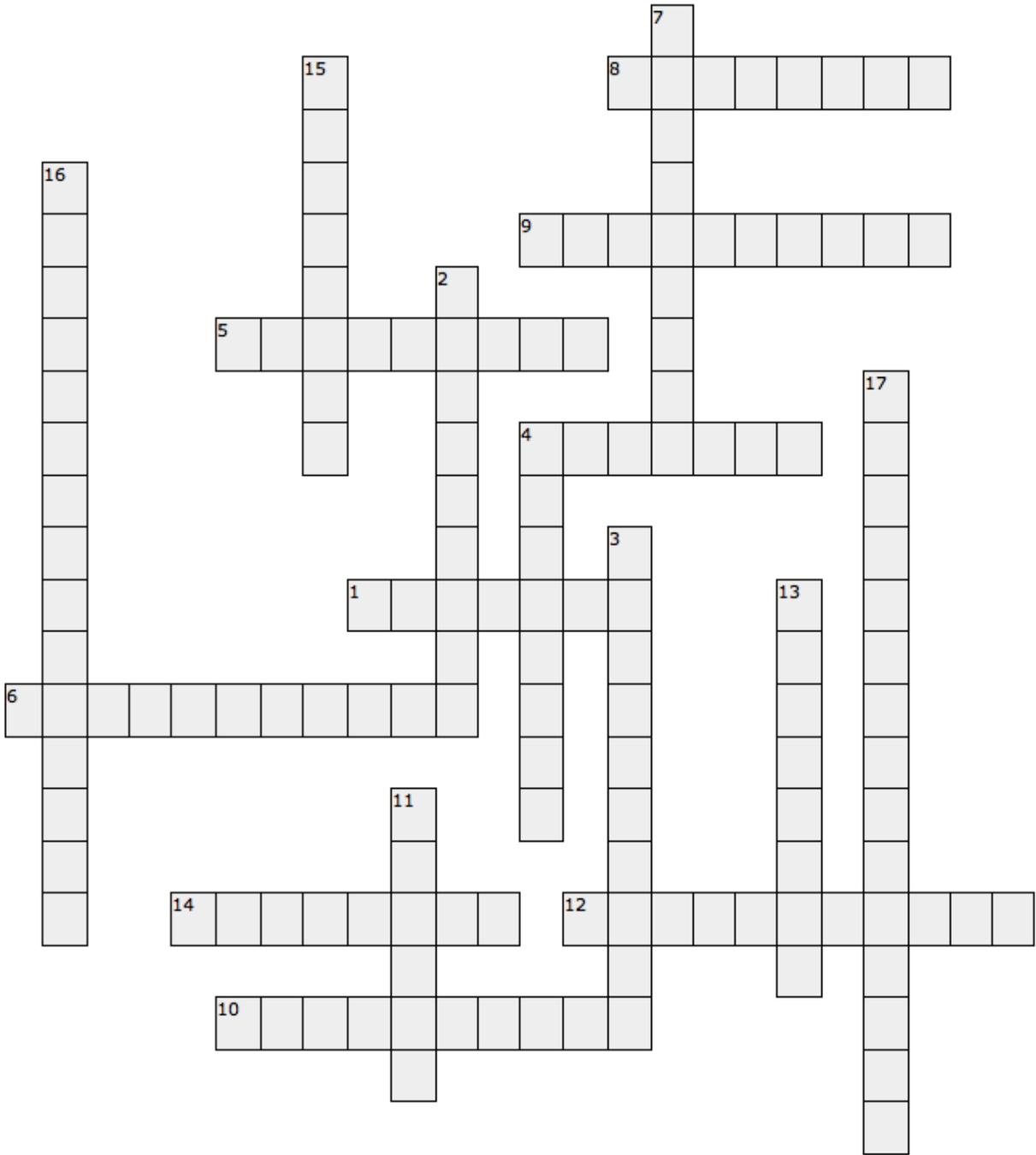
\*A lineage is a group of organisms that have evolved from a common ancestor (grouped together from the same node)

Example:





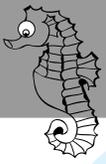
# Activity 10: Crossword Puzzle... Let's see what you learned!



### Word Bank

- |            |                  |                 |             |             |
|------------|------------------|-----------------|-------------|-------------|
| Amazon     | Bathypteroiiform | Bioluminescence | Bleaching   | Coelacanth  |
| Coral Reef | Deep Sea         | Gondwana        | Ichthyology | Mississippi |
| Oarfish    | Oil Spill        | Paddlefish      | Phylogeny   | Ponyfish    |
| Sac-a-lait | Sturgeon         | Tripod Fish     |             |             |





## Definitions for Activity 10

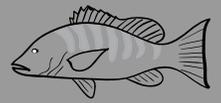
### Across:

1. Located 1000m below sea level, it is the largest habitat on earth. It lacks sunlight so it is always cold and dark.
4. Longest bony fish.
5. Major threat to the coral reef habitat.
6. The study of fish.
8. Southern supercontinent formed by India, Madagascar, Africa, South America, Antarctica, and Australia in the Mesozoic Era.
9. Lobed finned fish with limb and wrist bones similar to a human's. They are found in deep water and use a doggy-paddle motion to swim.
10. Nearly blind, benthic, deep sea form of lizard fish. It has elongated pelvic and caudal fins.
12. One of the largest and oldest rivers flowing from the Great Lakes to the Gulf of Mexico in North America.
14. Cajun name for Crappie.

### Down:

2. Tree diagram showing evolutionary relationships.
3. One of the oldest fishes in North America. Its skeleton is made of mostly cartilage and it has a nose (rostrum) shaped like a paddle.
4. The 2010 Gulf of Mexico \_\_\_ was the largest in history and the only one to occur in the deep sea. The severity of its consequences are still not known.
7. Rainforests of the ocean. They are incredibly diverse habitats characterized by coral organisms.
11. Largest river system in the world. It is located in South America and is home to fishes like cichlids, piranhas, and catfishes.
13. Bioluminescent fish found near the ocean surface. They house bioluminescent bacteria in a light organ
15. One of the rarest fishes in North America. It is covered in bony scutes. It matures at a late age and produces few young.
16. Emission of light by a living organism.
17. 5th locomotory style of swimming in fishes. It uses the body and caudal fin to propel itself but the wave motion only occurs towards the front of the fish.





# Chapter IX: Common Fishes of Louisiana

This chapter showcases some of the most common fishes you may encounter in the waters of Louisiana. It is by no means exhaustive but it does represent the most common fishes from the collecting efforts of the LSU Ichthyology class from 2009-2013. Most fishes are found in Big Branch Marsh on the North Shore of Lake Pontchartrain (marine), or freshwater sites including Thompson Creek in St. Francisville, or in sites near Ramah and Hammond.

## Section IX.A: Visual Key to Major Families

1a - Ganoid (diamond shaped) scales present \_\_\_\_\_ Lepisosteidae (GARS)



1b - Ganoid scales absent \_\_\_\_\_ 2

2a - Scales absent, barbels present \_\_\_\_\_ Siluriformes Ictaluridae (CATFISH)



2b - Scales (non-ganoid type) present \_\_\_\_\_ 3

3a - Gular plate (large bone on bottom of head) present \_\_\_\_\_ Amiidae (BOWFIN)



3b - Gular plate absent \_\_\_\_\_ 4

4a - Large mouth extending behind eye, colorless, laterally compressed body \_\_\_\_\_ Engraulidae (Anchovies)



4b - Characters not as in 4a \_\_\_\_\_ 5

5a - Silvery stripe, flathead \_\_\_\_\_ Atherinopsidae (Siversides)





5b - no silvery stripe \_\_\_\_\_ 6

6a - Head flat, scaled and broad \_\_\_\_\_ Fundulidae (Killifish)



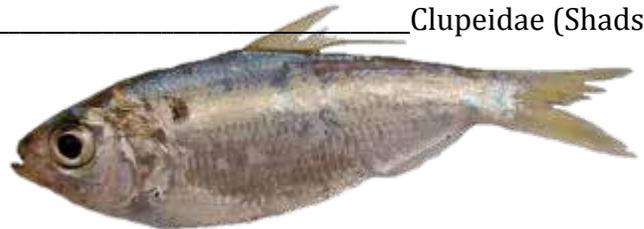
6b - head characters not as above \_\_\_\_\_ 7

7a - Males have gonopodium (elongated modified anal fin), black suborbital bar \_\_\_\_\_  
\_\_\_\_\_ Poeciliidae (Guppies)



7b - characters not as above \_\_\_\_\_ 8

8a - Silvery with postorbital spot \_\_\_\_\_ Clupeidae (Shads)



8b - characters not as above \_\_\_\_\_ 9

9a - Fleshy lips \_\_\_\_\_ Catostomidae (Suckers)



9b - Lips thin, not fleshy \_\_\_\_\_ 10

10a - Short gap between dorsal-fins \_\_\_\_\_ Percidae (Darters)



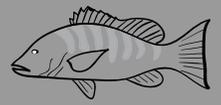
10b - no gap between dorsal fins or only single fin \_\_\_\_\_ 11

11a - Elongated single dorsal-fin \_\_\_\_\_ Centrarchidae (Sunfishes)



11b - short single dorsal fin \_\_\_\_\_ Cyprinidae (Minnows)





## Section IX.B: Highlight on The Most Common Sunfish

### Sunfish- Centrarchidae

- *Lepomis macrochirus* – spot at posterior end of dorsal fin



- *Lepomis gulosus* – lines radiate from eye



- *Lepomis megalotis* – elongated opercular flap "ear"



- *Lepomis cyanellus* – spot at posterior base of dorsal and anal fins





## Section IX.C: Highlight on The Most Common Minnows

# Minnow (Cyprinidae) Genera

- *Cyprinella*-diamond shaped scales



- *Luxilus*-tall lateral scales



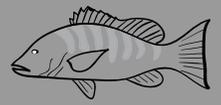
- *Pimephales* – small scales, dorsal/anterior, get larger posteriorly



- *Nocomis* –silvery scales, no stripes



The following Louisiana fishes are grouped by Order:Family, with the scientific name underlined followed by the common name and some identifying characters.



## Section IX.D: Highlight on Common Freshwater Fishes of Louisiana

### Amiiformes:Amiidae



### AMIA CALVA (BOWFIN)

LONG DORSAL FIN EXTENDING FROM MID-BACK TO THE CAUDAL FIN; ANTERIOR BARBELS IN FRONT OF NOSTRILS; MALES POSSESS A DARK SPOT AT THE BASE OF THE CAUDAL FIN

### Lepisosteiformes:Lepisosteidae



### LEPISOSTEUS OCULATUS (SPOTTED GAR)

53-60 LATERAL LINE SCALES; PROMINENT DARK, ROUND SPOTS ON HEAD AND BACK; LONG, SLENDER SNOUT WITH SHARP TEETH IN MOUTH



## Perciformes:Percidae



### AMMOCRYPTA BEANI (NAKED SAND DARTER)

TWO SEPARATE DORSALS, WHITE BODY



### PERCINA SCIERA (DUSKY DARTER)

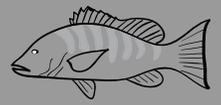
OLIVE COLORED WITH DARK ROUNDISH SPLOTCHES, ELONGATE AND COMPLETE LATERAL LINE, NAKED (SCALELESS) BREAST (UNDERSIDE)



### ETHEOSTOMA CAERULEUM (RAINBOW DARTER)

ORANGE BODY, BLUE VERTICAL STRIPES, INCOMPLETE LATERAL LINE





Perciformes:Centrarchidae



**POMOXIS ANNULARIS (WHITE CRAPPIE)**

6 DORSAL-FIN SPINES, VERSUS 7-8 IN BLACK



**MICROPTERUS SALMOIDES (LARGEMOUTH BASS)**

MOUTH GOES PAST EYE, OLIVE GREEN ABOVE, LIGHTER BELOW; ORANGE/YELLOW & DARK GREEN CAUDAL FIN



**MICROPTERUS PUNCTULATUS (SPOTTED BASS)**

TRICOLORED TAIL IN JUVENILES, LOTS OF SPOTS ON LATERAL SIDE, MOUTH DOESN'T GO BEHIND EYE WHEN CLOSED





**LEPOMIS MACROCHIRUS (BLUEGILL)**

ONE SPOT ON BASE OF DORSAL, SMALL MOUTH (DOESN'T REACH EYE), 6-7 WAVY VERTICAL BARS IN JUVENILES



**LEPOMIS CYANELLUS (GREEN SUNFISH)**

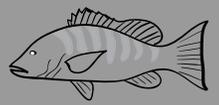
SPOT ON BACK OF DORSAL AND ANAL FINS



**LEPOMIS MEGALOTIS (LONGEAR SUNFISH)**

EXTREMELY LONG OPERCULAR FLAP, WAVY BLUE BARS/STREAKS RADIATING BACKWARDS, COLORFUL OVERALL, OPERCULAR FLAP BORDERED THINLY BY WHITE LINE





**LEPOMIS GULOSUS (WARMOUTH SUNFISH)**

**4 RADIATING STRIPES FROM EYE (“WARPAINT”); TEETH  
ON TONGUE; 3 ANAL-FIN SPINES**



**LEPOMIS MICROLOPHUS (REDEAR SUNFISH)**

**MOTTLED PATTERN, RED EAR**





## Cyprinodontiformes: Cyprinodon



### *CYPRINODON VARIEGATUS* (SHEEPSHEAD MINNOW)

ONLY SPECIES OF PUFFISH IN AREA, FEMALE HAS SPOT ON DORSAL FIN,  
MALES HAVE DARK EDGE ON DISTAL END OF CAUDAL FIN





**Cyprinodontiformes:Poeciliidae**



**GAMBUSIA AFFINIS (MOSQUITOFISH)**

VERY SMALL, ORIGIN OF DORSAL FIN BEHIND ANAL FIN, DARK SUBORBITAL BAR PRESENT



**POECILIA LATIPINNA (SAILFIN MOLLY)**

DORSAL FIN ANTERIOR TO ANAL FIN, 13-16 DORSAL RAYS, BLACK SPOTS ALONG BODY.





## Cyprinodontiformes: Fundulidae



### FUNDULUS GRANDIS (GULF KILLIFISH)

No dark spot on caudal fin, short snout, very faint vertical bars (females w/no bars).



### FUNDULUS OLIVACEUS (BLACKSPOTTED TOPMINNOW)

TOP PROFILE (DORSAL) FLAT, MOUTH POSITIONED TURNED UP, BLACK LINE DOWN MIDDLE, COUNTERSHADING, DARKER TOP & LIGHTER BOTTOM





## Cypriniformes: Cyprinidae



### CYPRINELLA CAMURA (BLUNTFACE SHINER)

BLUNT, ROUNDED SNOUT, CREAM STRIPE ALONG BACK  
OF CAUDAL FIN, ELONGATE SPOTTING ALONG RAYS OF  
DORSAL FIN



### CYPRINELLA VENUSTA (BLACKTAIL SHINER)

DIAMOND SHAPED SCALES, BLACK MARK ON CAUDAL FIN  
PERHAPS MOST COMMON FISH IN THE STATE



### HYBOGNATHUS NUCHALIS (MISSISSIPPI SILVERY MINNOW)

LATERAL LINE DIPS DOWN HALFWAY DOWN BODY;  
LATERAL LINE HAS 34-41 SCALES; 8 ANAL FIN RAYS



### LUXILUS CHRYSOCEPHALUS (STRIPED SHINER)

SCALES ARE TALL DOWN CENTER OF THE BODY, BIG HEAD,  
IRIDESCENT RED COLOR, COLOR BLEACH OUT WHEN STRESSED





**NOCOMIS LEPTOCEPHALUS (BLUEHEAD CHUB)**

MODERATE SIZED SCALES, DARK LINE THAT GOES THROUGH EYE  
ALL THE WAY DOWN THE BODY, FOLLOWS LATERAL LINE



**MACRHYBOPSIS STORERIANA (SILVERY CHUB)**

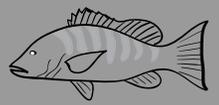
DOWNWARD TURNED MOUTH, BIG EYES



**PIMEPHALES NOTATUS (BLUNTNOSE MINNOW)**

SCALES GET SMALLER TOWARDS HEAD, MALES GET  
TUBERCLES ON HEAD





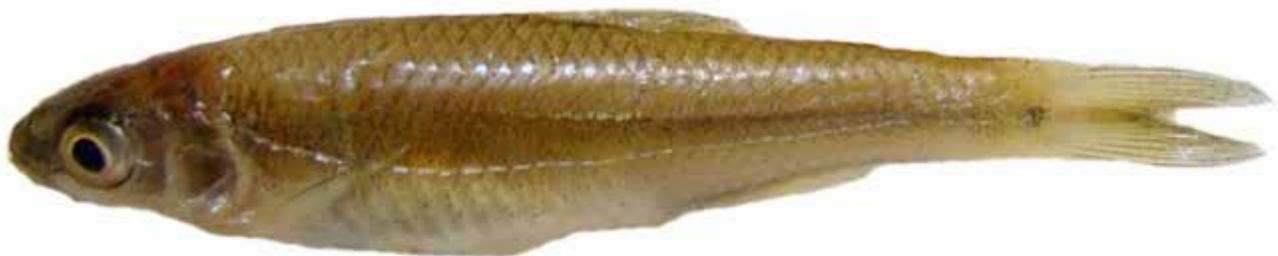
**NOTROPIS ATHERINOIDES (EMERALD SHINER)**

DORSAL OLIVE (“EMERALD”) COLOR; SILVER LATERAL STRIPE; ELONGATE, SLENDER BODY



**NOTROPIS LONGIROSTRIS (LONGLNOSE SHINER)**

DOWNTURNED MOUTH, LONG NOSE, FINS ARE YELLOWISH, BENTHIC SPECIES 2013 TICKFAW



**NOTROPIS VOLUCELLUS (MIMIC SHINER)**

DUSKY COLORED, RATHER NON-DESCRIPT





**Siluriformes:Ictaluridae**



**AMEIURUS NATALIS (YELLOW BULLHEAD CATFISH)**

**NO PIGMENTED SPOTS OR BARS, WHITE OR CREAM BARBELS ON CHIN;  
ANAL FIN HAS 24-27 RAYS**



**NOTURUS LEPTACANTHUS (SPECKLED MADTOM)**

**SMALL DOTS ALL OVER BODY**





## Section IX.E: Highlight on Common Marine & Brackish Fishes of Louisiana

### Atheriniformes:Atherinopsidae

Silversides have small dorsal fins, especially first dorsal, flattened dorsally especially caudal peduncle.



### MENIDIA AUDENS (MISSISSIPPI SILVERSIDE)

ROUNDED SNOUT



### MENIDIA BERYLLINA (INLAND SILVERSIDE)

WIDE AND HORIZONTALLY POSITIONED MOUTH



### LABIDESTHES SICCULUS (BROOK SILVERSIDE)

TWO DORSAL FINS, ONE W/SPINES AND ONE WITH RAYS, DORSAL PROFILE IS FLAT, UPTURNED MOUTH





## Clupeiformes:Engraulidae



### **ANCHOA MITCHILLI (BAY ANCHOVY)**

SILVER HEAD AND GILL COVER, REST OF BODY IS CLEAR; VERY LARGE, WIDE MOUTH; ONLY SPECIES OF COMMONLY FRESHWATER-DWELLING ANCHOVY

## Perciformes:Sciaenidae



### **CYNOSCIION NEBULOSUS (SPECKLED TROUT)**

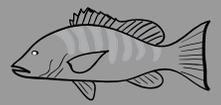
SPOTTED (MORE THAN JUVENILE REDFISH)



### **SCIAENOPS OCELLATUS (REDFISH)**

DARK SPOT ABOVE LATERAL LINE IN FRONT OF CAUDAL FIN

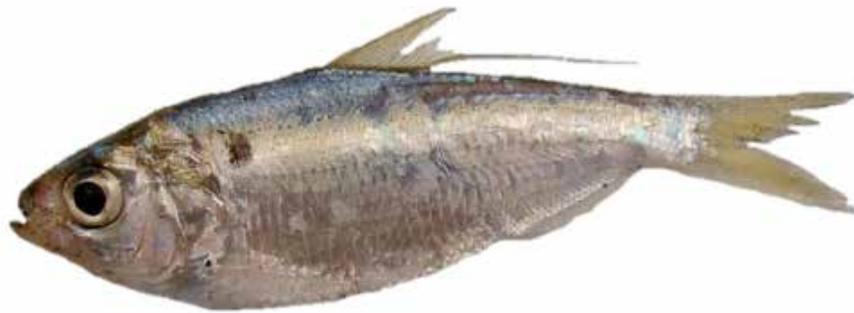




**POGONIAS CROMIS (BLACK DRUM)**

MANY BARBELS ON UNDERSIDE OF LOWER JAW

**Clupeiformes:Clupeidae**



**DOROSOMA PETENENSE (THREADFIN SHAD)**

SILVERY COLOR WITH YELLOWISH FINNS; SMOOTH, SLOPING SNOUT WITH NO BUMP AND NO PROJECTING UPPER JAW; LESS THAN 28 ANAL FIN RAYS; PROMINENT DARK SPOT BEHIND GILLS\* (ALSO PRESENT IN *D. CEPEDIANUM*, BUT IS MORE PROMINENT IN THIS SPECIES)



**DOROSOMA CEPEDIANUM (GIZZARD SHAD)**

GOLDEN COLOR AND GOLD EYES; SLOPING SNOUT WITH A BUMP ON THE END; LARGER THAN THREADFIN; MORE THAN 28 ANAL FIN RAYS





## Mugiliformes: Mugilidae



### MUGIL CEPHALUS (STRIPED MULLET)

8 ANAL-FIN RAYS; ADIPOSE (FATTY) EYELID; MORE SALTWATER OF LOCAL MULLET SPECIES



### MUGIL CUREMA (FLATHEAD MULLET)

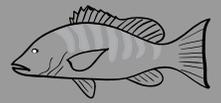
9 ANAL-FIN RAYS

## Syngnathiformes: Syngnathidae



### SYNGNATHUS SCOVELLI (GULF PIPEFISH)





**Beloniformes: Belonidae**



**STRONGYLURA MARINA (ATLANTIC NEEDLEFISH)**

ONLY NEEDLEFISH FOUND IN AREA

**Pleuronectiformes: Achiridae**



**TRINECTES MACULATUS (HOGCHOAKER)**

BROWN WITH BLACK LINES, FLAT





# ACKNOWLEDGMENTS

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We must thank foremost the funding source for both this book and for the exhibit. The Louisiana Board of Regents has helped tremendously in turning our Museum of Natural Science into a wonderful learning environment for families, teachers and students, not only undergraduates, but also children in K-12 classes. We also thank former LSUMNS Director Fred Sheldon and current Director Robb Brumfield for being helpful and encouraging throughout this process. Southwest Museum Services brought the wonderful exhibit to life and it was a pleasure working with them.

Special thanks to Caleb McMahan whose knowledge of Louisiana fishes is tremendous and was very helpful in reviewing this text.

Funding for this book came from an endowment of the Occasional Papers of the Museum of Natural Science, which allowed us to distribute this text for free.





# APPENDIX 1: Glossary

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(Words in the glossary are bolded in the text)

**Anadromous** – an aquatic animal that lives in salt water but travels to fresh water to produce young

**Anterior** – near the front

**Bathypteroform** – style of movement in fishes where the body and caudal fin move the fish forward (rather than the pectoral fins) while the front of the fish moves in a wave like motion.

**Bioaccumulation** – the building up of toxic substances in an organism

**Bioluminescence** – release of light by a living organism

**Bleaching (Coral)** – when corals lose their ability to support the organisms (zooxanthellae) that give the corals their color. This results in a white appearance.

**Cartilaginous** – a skeleton composed of cartilage as opposed to bone

**Counter-illumination** – a form of camouflage in which an organism produces light to blend in with a lighter background, such as the ocean surface.

**Disperse** – to spread out

**Dispersant** – a soap-like liquid or gas used to break apart mixtures into smaller particles or droplets

**Diverge** – separate and go in different directions

**Ecology** – the study of how organisms interact with their environment

**Electrosensory** – able to detect electrical impulses

**Endangered** – species that are at risk of becoming extinct

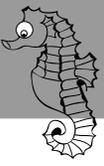
**Endemic** – an organism that is only found in a certain area (ex. Louisiana Pancake Batfish are only found in the Gulf of Mexico)

**Evolution** – change in traits of living organisms over time

**Extant** – species that still exist today

**Fauna** – the animal life in an area





**Habitat Degradation** – damaging or destroying a natural area where organisms live

**Ichthyofauna** – the fish diversity of a given area

**Ichthyology** – the study of fishes

**Innervate** – supply a body part with nerves

**Lateral Line** – group of sensory organs found in aquatic animals, such as fish, that sense vibrations and movement in water

**Locomotion** – how an animal moves

**Migration** – travelling long distances to move to a new habitat temporarily

**Mocondo blowout** – the explosion of this deep-sea oil pipeline caused the massive 2010 Gulf of Mexico Oil Spill

**Neuromast** – the sensory organ located in lateral lines that allow some aquatic organisms to detect movement in the water

**Phylogeny** – tree diagram showing evolutionary relationships

**Pollutant** – a substance that has a negative effect on the environment

**Propulsion** – the force needed for movement

**Spawning Ground** – the area an animal goes to mate and produce young

**Subterranean** - underground

**Tetrapod** – four-limbed animal with a backbone (ex. Frog, bird, dog)

**Troglobitic** – describes an animal that lives only in the dark part of caves

**Topography** – description of the physical surface features of an area

**Undulatory** – wave-like motion





# APPENDIX 2:

## References and image credits

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Cover Image - Created by Nathan Coussou

Exhibit Image – Prosanta Chakrabarty

### **Chapter I**

Story by Prosanta Chakrabarty

Gulf Toadfish – image by Prosanta Chakrabarty

Gar - [http://commons.wikimedia.org/wiki/File:Spotted\\_Gar\\_%28Lepisosteus\\_oculatus%29\\_%283148927599%29.jpg](http://commons.wikimedia.org/wiki/File:Spotted_Gar_%28Lepisosteus_oculatus%29_%283148927599%29.jpg)

Activities by Valerie Derouen, image by Stacy Peterson

### **Chapter II**

'Fish, Fishes' - image by Prosanta Chakrabarty, using Wikicommons stock fish and fish bowl images

Activity by Valerie Derouen

See more question/answer style writing on fishes in:

**Fishes: The Animal Answer Guide** – <http://www.amazon.com/Fishes-Animal-Answer-Curious-Naturalist/dp/1421402238>

**Do Fish Sleep? Fascinating Answers to Questions About Fishes:** <http://www.amazon.com/Do-Fish-Sleep-Fascinating-Questions/dp/0813549418>

### **Chapter III**

**A** [http://commons.wikimedia.org/wiki/File:Atchafalaya\\_Basin.jpg](http://commons.wikimedia.org/wiki/File:Atchafalaya_Basin.jpg)

**B** <http://commons.wikimedia.org/wiki/File:Bayou.jpg>

**C** [http://commons.wikimedia.org/wiki/Bagre\\_marinus](http://commons.wikimedia.org/wiki/Bagre_marinus) - Illustration by Prosanta Chakrabarty





- D** [http://commons.wikimedia.org/wiki/File:Red\\_drum\\_sciaenops\\_ocellata.jpg](http://commons.wikimedia.org/wiki/File:Red_drum_sciaenops_ocellata.jpg)
- E** [http://commons.wikimedia.org/wiki/Anguilla\\_rostrata#mediaviewer/File:Anguillarostratakils.jpg](http://commons.wikimedia.org/wiki/Anguilla_rostrata#mediaviewer/File:Anguillarostratakils.jpg)
- F** [http://commons.wikimedia.org/wiki/Category:Histrio\\_histrio](http://commons.wikimedia.org/wiki/Category:Histrio_histrio)
- G** [http://commons.wikimedia.org/wiki/Gulf\\_of\\_Mexico#mediaviewer/File:Gulf\\_of\\_Mexico\\_with\\_ship.jpg](http://commons.wikimedia.org/wiki/Gulf_of_Mexico#mediaviewer/File:Gulf_of_Mexico_with_ship.jpg)
- H** <http://commons.wikimedia.org/wiki/Hurricane#mediaviewer/File:HurricaneKenna2002.jpg>
- I** image from Prosanta Chakrabarty
- J** [http://commons.wikimedia.org/wiki/File:Caranx\\_hippos.jpg](http://commons.wikimedia.org/wiki/File:Caranx_hippos.jpg)
- K** [http://commons.wikimedia.org/wiki/File:Fundulus\\_grandis.jpg](http://commons.wikimedia.org/wiki/File:Fundulus_grandis.jpg)
- L** <http://commons.wikimedia.org/wiki/File:Largemouth-bass.jpg>
- M** [http://commons.wikimedia.org/wiki/File:Mississippi\\_River\\_Bridge\\_at\\_Baton\\_Rouge,\\_Louisiana\\_at\\_Sundown\\_Tranquility\\_Water\\_Peace\\_High\\_Resolution.JPG](http://commons.wikimedia.org/wiki/File:Mississippi_River_Bridge_at_Baton_Rouge,_Louisiana_at_Sundown_Tranquility_Water_Peace_High_Resolution.JPG)
- N** [http://commons.wikimedia.org/wiki/File:Cleaning\\_station\\_kona\\_hawaii\\_4.JPG](http://commons.wikimedia.org/wiki/File:Cleaning_station_kona_hawaii_4.JPG)
- O** [http://commons.wikimedia.org/wiki/File:King\\_of\\_herrings.png](http://commons.wikimedia.org/wiki/File:King_of_herrings.png)
- P** image from Prosanta Chakrabarty
- Q** <http://commons.wikimedia.org/wiki/File:Mermentaurivermap.png>
- R** [http://commons.wikimedia.org/wiki/File:Southern\\_stingrays\\_at\\_stingray\\_city.jpg](http://commons.wikimedia.org/wiki/File:Southern_stingrays_at_stingray_city.jpg)
- S** [http://commons.wikimedia.org/wiki/File:Black\\_Crappie.jpg](http://commons.wikimedia.org/wiki/File:Black_Crappie.jpg)
- T** images from Davis and Chakrabarty, 2011. From SERPENT and Dr. Matt Davis
- U** [http://commons.wikimedia.org/wiki/File:Sketchbook\\_of\\_fishes\\_-\\_26.\\_Stargazer\\_-\\_William\\_Buelow\\_Gould,\\_c1832.jpg](http://commons.wikimedia.org/wiki/File:Sketchbook_of_fishes_-_26._Stargazer_-_William_Buelow_Gould,_c1832.jpg)
- V** [http://commons.wikimedia.org/wiki/File:Vermilion\\_River\\_Abbeville\\_Louisiana.jpg](http://commons.wikimedia.org/wiki/File:Vermilion_River_Abbeville_Louisiana.jpg)
- W** [http://commons.wikimedia.org/wiki/Category:Swamps#mediaviewer/File:City\\_Swamp\\_%282232045171%29.jpg](http://commons.wikimedia.org/wiki/Category:Swamps#mediaviewer/File:City_Swamp_%282232045171%29.jpg)
- X** [http://commons.wikimedia.org/wiki/Swordfish#mediaviewer/File:Swordfish\\_skeleton.jpg](http://commons.wikimedia.org/wiki/Swordfish#mediaviewer/File:Swordfish_skeleton.jpg)
- Y** [http://commons.wikimedia.org/wiki/File:Yellowfin\\_tuna\\_nurp.jpg](http://commons.wikimedia.org/wiki/File:Yellowfin_tuna_nurp.jpg)
- Z** <http://commons.wikimedia.org/wiki/Category:Zooplankton#mediaviewer/File:Zooplankton.jpg>





## Chapter IV

Read more about the Gulf of Mexico and its ichthyofauna in:

**Gulf of Mexico Origin, Waters, and Biota** edited by **Darryl L. Felder and David K. Camp** -

<http://www.tamupress.com/product/Gulf-of-Mexico-Origin-Waters-and-Biota,5338.aspx>

**Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters, Second Edition** by Dickson Hoese and Richard Moore - <http://www.amazon.com/Fishes-Gulf-Mexico-Louisiana-Adjacent/dp/0890967679>

Gulf of Mexico image – redrawn and altered by Prosanta Chakrabarty from <http://commons.wikimedia.org/wiki/File:GulfofMexico3D.jpg>

Bluefin tuna - [http://commons.wikimedia.org/wiki/File:Thunnus\\_thynnus.png](http://commons.wikimedia.org/wiki/File:Thunnus_thynnus.png)

Pancake batfish image from Prosanta Chakrabarty

Ho, H.C., Chakrabarty, P., Sparks, J.S.(2010) Review of the *Halieutichthys aculeatus* species complex (Lophiiformes: Ogcocephalidae), with descriptions of two new species. *Journal of Fish Biology* 77:841-869.

Activity by Valerie Derouen

Tripodfish images from SERPENT (<http://www.serpentproject.com/>) used in Davis and Chakrabarty 2011.

Fish locomotion image created by Matt Davis also from Davis and Chakrabarty 2011

Davis, M.P., Chakrabarty, P. (2011) Video Observation of a Tripodfish (Aulopiformes: *Bathypterois*) from Bathypelagic Depths in the Campos Basin of Brazil. *Marine Biology Research* 7, 297-303.

SpeciesMap image from Dan Janies, University of North Carolina.

Chakrabarty, P., Lam, C., Hardman, J., Aaronson, J., House, P.H., Janies, D. (2012) SpeciesMap: A web-based application for visualizing the overlap of distributions and pollution events, with a list of fishes put at risk 2010 Gulf of Mexico Oil Spill. *Biodiversity and Conservation* 21: 1865-1876.

Deformed and normal type fish images, and fish in oil, from Dr. Benjamin Dubansky

Whitehead, A., B. Dubansky, C. Bodinier, T. Garcia, S. Miles, C. Pilley, V. Raghunathan, J. Roach, N. Walker, R.B. Walter, C.D. Rice, and F. Galvez (2012). **Genomic and physiological footprint of the Deepwater Horizon oil spill on resident marsh fishes.** PNAS, 109(50): 20298-20302

Activity by Valerie Derouen





## Chapter V

Read more about the Louisiana section of the Mississippi River and about Louisiana's freshwater fishes in:

**Freshwater Fishes of Louisiana** by Neil H. Douglas - <http://www.amazon.com/Freshwater-Fishes-Louisiana-Neil-Douglas/dp/0875110282>

Mississippi Image - <http://commons.wikimedia.org/wiki/File:Mississippi-map.gif>

Bowfin - <http://commons.wikimedia.org/wiki/File:Bowfin.jpg>

Pallid sturgeon - <http://commons.wikimedia.org/wiki/File:Pallid.jpg>

Paddlefish - [http://commons.wikimedia.org/wiki/File:Paddlefish\\_USFWS.jpg](http://commons.wikimedia.org/wiki/File:Paddlefish_USFWS.jpg)

Freshwater fishing in Louisiana – from Prosanta Chakrabarty, with his LSU Ichthyology Class Activity by Valerie Derouen

## Chapter VI

Read more about the deep sea and its fishes in:

**The Biology of the Deep Ocean** by Peter Herring <http://www.amazon.com/The-Biology-Deep-Ocean-Habitats/dp/0198549555>

Bioluminescence image created by Prosanta Chakrabarty, ponyfish images his, wolfttrap angler courtesy of Dr. Ted Pietsch

Midshipman image from NOAA [http://commons.wikimedia.org/wiki/File:Fish4399\\_-\\_Flickr\\_-\\_NOAA\\_Photo\\_Library.jpg](http://commons.wikimedia.org/wiki/File:Fish4399_-_Flickr_-_NOAA_Photo_Library.jpg)

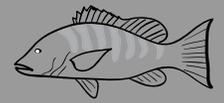
Activity by Valerie Derouen

## Chapter VII

Cave and cavefish images from Prosanta Chakrabarty, fieldtrip to Madagascar.

Coral Reef – [http://commons.wikimedia.org/wiki/File:Timor\\_Coral\\_Reef.jpg](http://commons.wikimedia.org/wiki/File:Timor_Coral_Reef.jpg)





Amazon –

Candiru (*Vandellia*) - [http://commons.wikimedia.org/wiki/File:Vandellia\\_cirrrosa\\_-\\_1856\\_drawing.png](http://commons.wikimedia.org/wiki/File:Vandellia_cirrrosa_-_1856_drawing.png)

Image of Coelacanth - [http://commons.wikimedia.org/wiki/File:Latimeria\\_Paris.jpg](http://commons.wikimedia.org/wiki/File:Latimeria_Paris.jpg)

Activity by Valerie Derouen – images from Ted Pietsch (anglerfish)and: DeepSea: [http://oceanexplorer.noaa.gov/explorations/02sab/logs/aug23/media/myctophid\\_bl.html](http://oceanexplorer.noaa.gov/explorations/02sab/logs/aug23/media/myctophid_bl.html)

Coral Reef: Author: Toby Hudson [http://en.wikipedia.org/wiki/Coral\\_reef#mediaviewer/File:Coral\\_Outcrop\\_Flynn\\_Reef.jpg](http://en.wikipedia.org/wiki/Coral_reef#mediaviewer/File:Coral_Outcrop_Flynn_Reef.jpg)

Cave Fish: Author: Frank Vassen

[http://commons.wikimedia.org/wiki/File:Typhleotris\\_madagascarensis.jpg](http://commons.wikimedia.org/wiki/File:Typhleotris_madagascarensis.jpg)

## Chapter VIII

Phylogenies from:

Chakrabarty, P., Davis, M.P., Sparks, J.S. (2012) First reported case of a trans-oceanic sister-group relationship between vertebrate troglobites. *PLoS One* 7:e44083 (pg.1-8).

McMahan, C., Chakrabarty, P., Smith, W.L.M., Sparks, J.S., Davis, M.P. (2013) Temporal Patterns of Diversification across Global Cichlid Biodiversity (Acanthomorpha: Cichlidae). *PLoS One* 8(8): e71162 (pg. 1-9).

Gondwana/Pangea image from the USGS - United States Geological Survey

Activity by Valerie Derouen

## Chapter IX

All images from Prosanta Chakrabarty except

Redfish [http://commons.wikimedia.org/wiki/Category:Sciaenops\\_ocellatus#mediaviewer/File:Red\\_Drum\\_%28Sciaenops\\_ocellatus%29.jpg](http://commons.wikimedia.org/wiki/Category:Sciaenops_ocellatus#mediaviewer/File:Red_Drum_%28Sciaenops_ocellatus%29.jpg)

Black drum

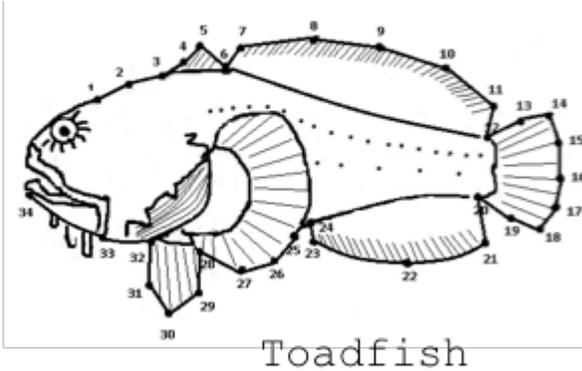
[http://commons.wikimedia.org/wiki/Category:Pogonias\\_cromis](http://commons.wikimedia.org/wiki/Category:Pogonias_cromis)





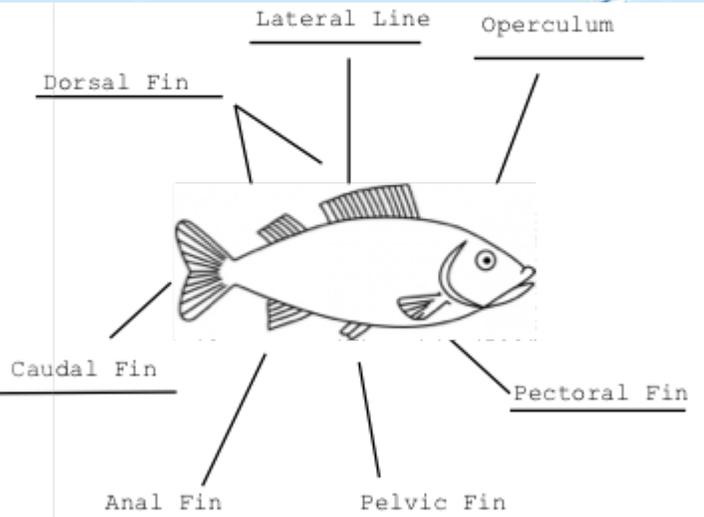
# APPENDIX 3: Answers to Activities

Activity 1: Connect the Dots

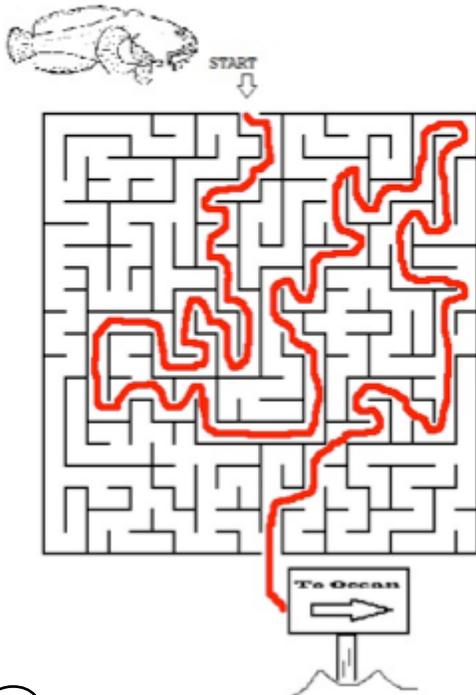


Toadfish

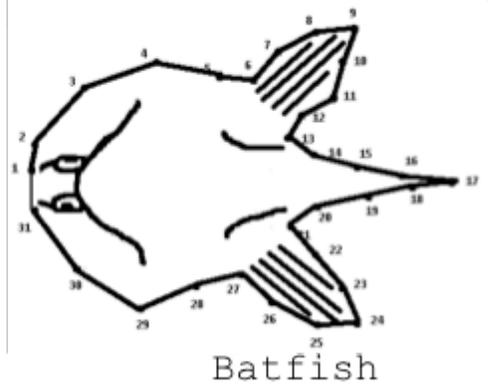
Activity 3: The Outer Parts of a Fish



Activity 2: The Maze

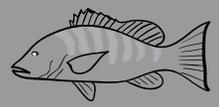


Activity 4: Connect the Dots



Batfish

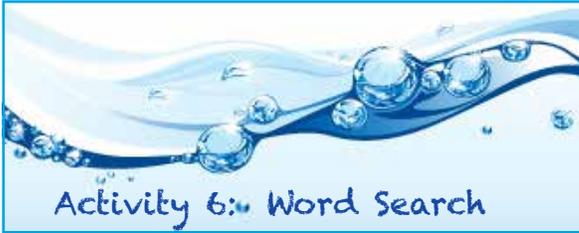




Activity 5: Secret code

Question: What are the two biggest threats to fish populations?

Answer: Over-Fishing & Habitat Degradation



Activity 6: Word Search

A 15x15 word search grid with the following letters:

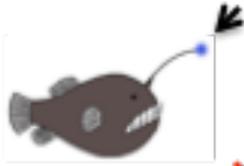
H	G	E	M	S	W	E	Z	S	W	R	P	T	D	T
N	S	A	L	K	U	W	H	O	R	B	B	A	H	S
I	B	I	T	E	G	U	N	G	A	B	P	V	M	K
F	M	S	F	E	P	N	A	S	Q	X	R	O	B	P
W	C	U	X	E	I	A	S	E	U	T	A	Z	A	Y
O	T	Q	R	M	L	E	A	U	R	R	C	U	T	D
B	I	O	A	O	E	D	H	C	F	O	H	Q	F	A
H	S	I	E	N	U	S	D	I	G	U	O	M	I	E
G	V	Y	V	N	T	X	S	A	Y	T	O	N	S	H
I	Z	R	R	U	Y	H	A	J	P	E	A	T	H	S
H	M	Z	B	A	S	O	V	P	E	S	N	G	Q	E
H	S	I	E	D	O	P	I	K	T	U	U	C	H	E
R	A	A	U	P	I	J	U	L	Q	E	B	V	I	E
W	W	A	L	Y	S	T	I	N	G	R	A	Y	S	E
H	A	Y	Q	E	S	S	H	I	N	E	R	W	K	S

Diagonal lines are drawn across the grid, indicating a secret code.





### Activity 7: Matching



Deep Sea Anglerfish



Midshipman



This fish uses light to attract its mates.

This fish uses light to attract its prey.

This fish uses light for camouflage by counter-illumination.

### Activity 8: Habitat

Piranha - Amazon River

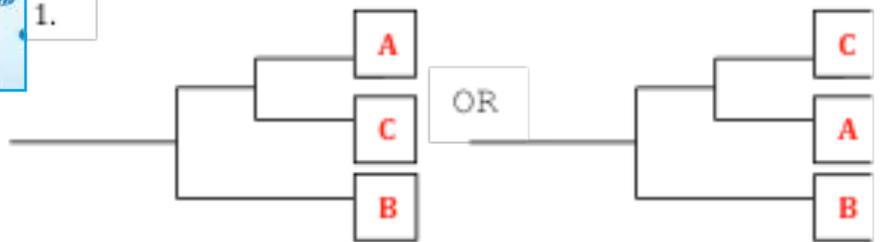
Clown Fish - Coral Reef

Blind Fish - Cave

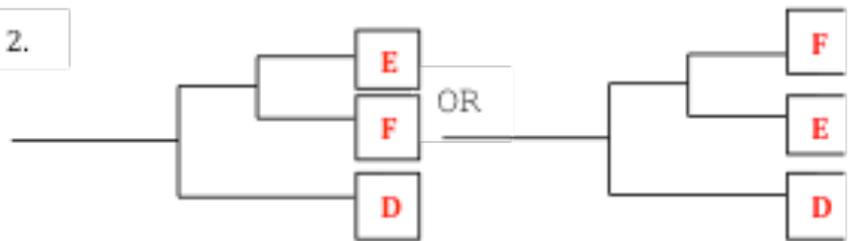
Anglerfish - Deep Sea

### Activity 9: Phylogeny

1.



2.





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