Form versus Function:
A look at Coral Reefs and their Fish

An aquarium based program for high school students

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In conjunction with
The North Carolina Aquarium
At Fort Fisher
With special thanks to
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Dr. Dennis Kubasko
Ruth Schneider

Introduction to the Form versus Functions Project

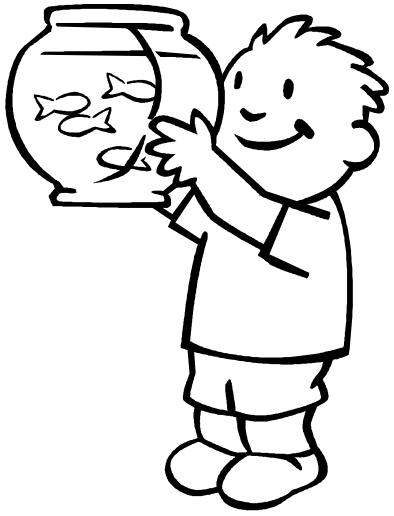
The following project is part of a Senior Honor's Thesis at the University of North Carolina at Wilmington. My thesis is based upon education in public aquariums. After researching education in informal settings, I noted that many students visit aquariums as a one day experience. Without some way for these students to reinforce information they learn on their visit, it is quickly lost.

Therefore, the basis of my thesis is in order to improve trips it is necessary to pave pre and post visit activities that tie the field experience into the classroom material. To test this hypothesis, I have written the following program for high school students and teachers to use in connection with a visit to the North Carolina Aquarium at Fort Fisher.

The North Carolina Aquarium at Fort Fisher opened in 1976 along with the North Carolina Aquarium at Roanoke Island and at Pine Knoll Shores. The aquariums were established to "promote awareness, understanding, appreciation, and conservation of the diverse natural and cultural resources associated with North Carolina's ocean, estuaries, rivers, streams, and other aquatic environments" (North Carolina Aquarium's Website).

The North Carolina Aquariums are a division of the North Carolina Department of Environment and Natural Resources. The Aquariums are accredited by the American Zoo and Aquarium Association.

The North Carolina Aquarium at Fort Fisher is dedicated to "Inspiring appreciation and conservation of North Carolina's aquatic habitats".



Before You Visit

In order to schedule a trip to the aquarium, please visit page for teachers and students: http://www.ncaquariums.com/newsite/ff/teachers.htm
The 2005-2006 Field Trip guide can be viewed at the following page:
http://www.ncaquariums.com/newsite/ff/schoolguide.pdf
The Field Trip guide contains the registration information for school groups.

April and May have close to 800 – 1000 students visiting a day. In order to ensure a quality experience for your students, we have established the following school guidelines:

Grades Pre-K – K are recommended to visit in the Fall and Winter months (up to late March).

Grades 7th – 12th are recommended to visit on Monday and Tuesday.

Grades 1st – 6th are recommended to visit on Wednesday through Friday.

Any school that wishes to schedule an afternoon visit (1 pm or later) can arrive on any day of the week. Schools who schedule a fee-based special activity program are encouraged to attend on days of program availability. Pre-registration is required for self-guided tours and special activity programs.

Expect to wait about 30 minutes before you begin your tour. This is for a short orientation by Aquarium Security and restroom time.

Schools must pre-register or admittance may be denied due to building capacity. Out-of-state school groups will be charged a discounted group rate.

At this time, NC School groups are defined as follows:

- Private registered and public pre-schools and kindergartens
- Public and private elementary and secondary schools
- Community and technical colleges
- Public and private colleges and universities
- Charter schools
- Home schools

Aquarium Rules and Parking Guidelines

- Aquarium staff reserves the right to ask a group to leave. If this should occur, your school's principal will be contacted.
- Upon arrival, school buses should pull up to the circular drive in front of the main building.
- Students should remain quietly on the bus until greeted by an aquarium staff member.
- Aquarium Security will direct buses to parking after everyone has safely disembarked.
- Bus engines must remain off while the bus is parked.
- Chaperones need to arrive with the school group.
- Children accompanying chaperones who are not part of the field trip class will need to pay full youth admission and full program fees. Youth (6-17) $6, children 5 & under are free.
- Teachers and chaperones must remain with their assigned students at all times.
- Picnic tables are available on a first come, first serve basis. They are not covered.

Activity Summary

I. Pre-Visit Activity

All About Coral

Before visiting the aquarium, the students will learn about coral reefs through student centered or teacher centered activities. By the time students are finished with this activity they will understand what a coral reef is, how it works, and the major vocabulary associated with coral reefs. The students will create a notebook containing the information presented in this activity. The teacher centered activity will take 30-90 minutes whereas the student centered activity will take two 90 minute class periods.

Major Concepts:

- Ecology of a coral reef
- Natural versus artificial reefs

Objectives:

- Define a coral reef
- Identify the major reef types
- Learn why reefs are threatened
- Learn the difference between natural and artificial reefs
- Become familiar with coral reef terminology

II. On-Site Activity

Heads and Tails

By the end of this activity, students will understand why fish have a variety of shapes. Students will learn the function of each different body shape. Students will practice using this information by building their own fish by choosing from the different body shapes that are discussed. By labeling the fish, form and function will be reinforced.

Major Concepts:

- Form versus Function
- Natural Selection
- Adaptations

Objectives:

- Be able to describe why fish have certain shapes
- Determine where a fish lives on a reef based on shape
- Determine how a fish moves based on shape
- Determine where and how a fish eats based on shape

Watch and Learn

Students will observe fish in coral reef tanks located in the aquarium. As they observe, they will collect data on how the fish move related to their body shape. These observations will be used in the post visit activity.

Major Concepts:

- Form versus Function
- Collecting data/observations

Objectives:

- Learn how to study animals in their natural habitat
- Learn how to collect observations from live animals

III. Post-Visit Activity

Option 1: Scientific Paper

Students will learn to write their own scientific paper using the observations they collected at the aquarium. Students will support or negate a given hypothesis based on the information that they bring back with them.

Major Concepts:

- How to write a scientific paper
- Organizing and analyzing data

Objectives:

- Learn the basic parts of a scientific paper
- Learn how to organize, display, and analyze data

Option 2: Student Presentations

Students will practice giving oral presentations using the information that they were given at the aquarium. Students will use PowerPoint or other visual aids to help with their presentation.

Major Concepts:

- How to give an oral presentation
- Organization

Objectives:

- Learn how to give a presentation in front of a class
- Learn how to organize information in order to present it

Pre-Visit Activity All About Coral

Curriculum Goals:

High School Biology:
- Goal 4: Unity and Diversity of Life
- Goal 5: Ecology

ISTE Goal:
7: Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity. (4, 5, 6)

Location: Classroom and/or Library

Estimated time: Two 90 minute class periods
Materials:
- Vocabulary list provided in packet
- Books or internet access to research coral reefs,
- Composition notebooks to help students organize their information.

Major Concepts:
- Ecology
- Natural versus Artificial Reefs

Objectives:
- Define a coral reef
- Identify the major reef types
- Learn why reefs are so threatened
- Learn the difference between natural and artificial reefs
- Become familiar with coral reef terminology

Before arriving at the aquarium, it is important to have some background information that will be useful to the study of reef fish and how they function in their environment. In order to properly study these animals, it is helpful to have an understanding of their surroundings. The pre-visit activities for this project are centered on coral reefs and their structure and function.

The first step to this portion involves important coral reef vocabulary. Included in this packet is a list of important coral reef vocabulary words.

Vocabulary (Teacher Centered): 2 minutes

Included in this packet is a coral reef vocabulary list. Give each student a copy to refer to as they learn about coral reefs.

Coral Reefs (Teacher Centered): 30-90 minutes

Also included in the packet is a coral reef information section. This section can help you to present information on coral reefs. There is also a coral reef PowerPoint included in this packet. This will help your students to pick out the important information on coral. Have them take notes in their student notebook as you go through the PowerPoint. Once your class has a basic understanding of coral reefs, you are ready to visit the aquarium.

Vocabulary (Student Centered): One 90 minute class period

Included in this packet is a blank copy of the coral reef vocabulary list. Give each student a copy of the list. Using what resources are available to you (library and/or computers) have the students work in teams to look up the definitions. Divide the list evenly among the groups. As the students work, have them take notes on their portion of the vocabulary. This will be presented to the class the next day.

Coral Reefs (Student Centered): One 90 minute class period

The groups will give a presentation to the class on the vocabulary words that they were assigned. They will define the words so that the other students can fill in their vocabulary sheet. Then the group will explain why those words are important so that students can fill in their activity notebook. At the end of each presentation, the teacher should fill in any missing information.

*These activities are just to help your students gain a basic understanding of coral reefs. They will not be expected to be experts when they get to the aquarium. Use as much or as little of this information you feel is needed to make this experience meaningful for your students.

On- Site Activity #1 Heads and Tails

Curriculum Objectives

High School Biology:

4.3: Assess, describe and explain adaptations affecting survival and reproductive success.

- Structural adaptations in plants and animals (form to function).
- Co-evolution

Location: Aquarium Classroom

Estimated time: 60 minutes

Materials:

- Student notebooks
- Form and function worksheets (2 sets per student)
- Glue
- Scissors
- Crayons or markers

Major Concepts:

- Form versus Function
- Natural Selection
- Adaptations

Objectives:

- Be able to describe why fish have certain shapes
- Determine where a fish lives on a reef based on shape
- Determine how a fish moves based on shape
- Determine where and how a fish eats based on shape

At the aquarium, students are introduced to coral reef fish, their structure, and their function. The class will look at body shape, mouth shape, fin shape, and other fish morphology in order to determine which shapes work best in different situations. There will be a PowerPoint presentation that will introduce the different body shapes and how they work. The students add the structure versus function information to their notebook that already includes coral reef vocabulary. Then, the students will create a fish using the different body shapes that they learned about during the program. They will choose the shapes based on the functions they want their fish to be able to perform.

On- Site Activity #2 Watch and Learn

Curriculum Objectives

High School Biology:

1.01 Identify biological questions and problems that can be answered through scientific investigations.

1.02 Design and conduct scientific investigations to answer biological questions.

- Collect and record data

Location: Aquarium:

- Cape Fear Shoals
- Cape Fear Ledge
- Pacific Reef Tank

Estimated time: 30 minutes

Materials:

- Student notebooks
- Pencils
- Fish Form Worksheet

Major Concepts:

- Form versus Function
- Collecting data/observations

Objectives:

- Learn how to study animals in their natural habitat
- Learn how to collect observations from live animals

After the structure and function class, the students will be taken down to the three coral reef tanks in the aquarium. The students will watch the fish to find information using the follow hypothesis: "Different fish shapes are better suited to different activities/functions". Students will take observations of the fish as they swim in their habitats.

The students will be given a worksheet so they know what they are being asked to accomplish during this activity. First they will choose three fish to sketch into their notebooks. Along side each drawing they will give the name of each fish. Below the name, the students will attempt to describe the fish using the terms they learned during the form versus function activity. The students will speculate on where the fish live on the reef, what they eat, and how they move based on their body shape. The students will be able to use the worksheets they completed in the last activity to help them describe their fishes.

The students will look for the characteristics that were studied as well as for ones were not. Students should make observations about how different fish morphology affects how fish move through the water. Look at different:

- Body shapes
- Tail shapes
- Fin shapes

- Mouth Shapes
- Schooling habits

As a class, be sure to include the following species:

- Tarpon
- Butterfly fish
- Stingray
- Sandbar Shark

How do different shapes affect the way fish move through the water? Students will write down how the fish move, where they spend most of their time on the reef, and how they interact. The students will be given a fish observation worksheet. They will use this information in the post-visit activities.

After the students have completed their observations, we will return to the classroom and talk about the fish they chose. The students will be asked to support their observations and explain why they made certain decisions about fish.

Post-Visit Activity, Option 1 Scientific Paper

Curriculum Objectives

High School Biology:
1.02 Design and conduct scientific investigations to answer biological questions.
- Organize data into charts and graphs.
- Analyze and interpret data.
- Communicate findings.

English I (Grade 9-12):
6.01 The learner will apply conventions of grammar and language usage

Location: Classroom or library computers

Estimated time: Two 90 minute class periods plus outside work

Materials:
- Computers
- scientific paper handouts
- student notebooks

Major Concepts:
- How to write a scientific paper
- Organizing and analyzing data

Objectives:
- Learn the basic parts of a scientific paper
- Learn how to organize, display, and analyze data

After the visit to the aquarium, the students will bring together all the information they gathered at the aquarium as well as the information they gathered before the visit. They will use this information to write a scientific paper on coral reef fish. The students should use their background information on coral reefs and structure and function to write the introduction.

The material and methods will involve the observations that they took while at the aquarium. Their results will be the information that they gather from the reef tanks. The discussion will bring all of this information together. They will talk about what problems they faced by using a captive habitat instead of a natural one. They will decide whether or not their hypothesis was supported by their observations.

Writing this paper will allow students to:
- Retain more information because it is being used again
- Practice writing skills
- Practice grammar skills
- Use the vocabulary collected at the beginning of the project
- Learn to write a scientific paper.

Post-Visit Activity, Option 2 Student Presentations

Curriculum Objectives

High School Biology:
1.02 Design and conduct scientific investigations to answer biological questions.
- Communicate findings.

ISTE Goal:
5: Use technology tools and resources for managing and communicating personal/professional information (3, 4)
7: Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity. (4, 5, 6)

Location: Classroom and Computer Lab

Estimated time: Two 90 minute class periods

Materials: Student notebooks, PowerPoint, and computer

Major Concepts:
- How to give an oral presentation
- Organization

Objectives:
- Learn how to give a presentation in front of a class
- Learn how to organize information in order to present it

If your class does not have time to put together scientific papers, oral presentations are another option. Divide your students into groups and assign each group one section of fish morphology (ex: mouth shape). Have the students put together a PowerPoint presentation on their area of morphology. They will include the function for each shape, why this shape is beneficial, where on the reef you would find this shape, and the fish(es) that they saw at the aquarium with that shape. The students will also include pictures and descriptions of the fishes they observed at the aquarium. Use the PowerPoint worksheet to help the groups design their project.

Use the first class period to allow the groups to prepare their presentation. The second class period will be used for the presentations themselves. This is another way to help reinforce the information that the students learned at the aquarium

Coral Reef Information

The following information is a basic overview of coral reefs, their structure, and function. All of the following information was taken from James W. Nybakken's Marine Biology: An Ecological Approach. Please feel free to go into as much depth with this information as you feel is appropriate for your class. The important thing is to cover the basics of a coral reef before your visit to the aquarium, as it will make your trip easier and more rewarding. There are many other resources available online as well as in books. This is the information that seemed to cover the basics but feel free to edit this to fit your class. All about coral: http://www.mbmp.org/corals.htm

Coral reefs are estimated to cover over 600,000 square miles of the earth's surface. Coral reefs are unique because they created entirely by biological activity. The living portion of a coral reef is called a polyp. These polyps absorb molecules out of the water that they then secrete in the form of calcium carbonate that they use to build up the reef. Other animals that also build up the reef include calcareous algae and any other animal that produces calcium carbonate.

Corals are found all over the world: polar, temperate, and tropical, but it is only in the tropical regions that corals build reefs. A reef building coral is called hermatypic and a non-reef building coral is called ahermatypic. Hermatypic corals are only found in tropical regions and are distinguished from ahermatypic corals because they live with a symbiotic algae called zooxanthellae.

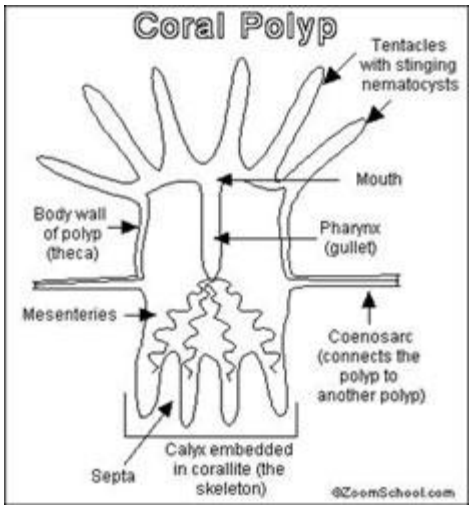
A symbiotic relationship is where one or both animals benefit from the interaction. If both benefit it is called mutualism, if one benefits and the other is not harmed, it is called commensilism, and if one benefits and the other is harmed it is called parasitism.

There are six major physical factors, or abiotic factors, that limit coral reef development: temperature, depth, salinity, light, sedimentation, and being exposed to air (desiccation). The best temperature for a reef building coral is between 73-75°F. The absence of coral reefs off the west coast of Central America and Africa is due to upwelling of cold water that prevents the reefs from growing there. The ideal depth for a reef is less than 80 feet deep although some can survive as deep as 230 feet. The zooxanthellae within their cells need light in order to photosynthesize and cannot survive below there. Light is the most significant limiting factor for coral reefs due to this reason. Since the coral polyps are true marine animals, they cannot tolerate salinities that range too far from the normal 35 ppt, or parts per thousand. A few species can tolerate a higher salinity due to evaporation and a few can tolerate lowered salinity due to an increase of freshwater.

Also an increase of freshwater is often accompanied by an increase in sedimentation as rivers bring in dissolved materials along with the freshwater that they carry. Some reef building corals are able to remove the sediments that fall on them, but this is only helpful for small quantities of sediments. The more sediment that is deposited the harder it is for the coral to cope. Sedimentation reduces the rate of photosynthesis and causes harm to the zooxanthellae. Corals do best in areas with strong wave action. Their structure is strong enough to withstand the force of the waves and at the same time, they receive a constant source of fresh water. The fresh water brings with it oxygen and food for the corals and also helps prevent sedimentation.

The last abiotic factor that affects coral reefs is desiccation. Every time a coral is exposed to air for long periods of time they begin to dry out and die. Corals can produce mucus to prevent some of the desiccation, but that only works for an hour or two. Due to this, a coral's upward growth is limited to the low tide line.

The structure of coral:

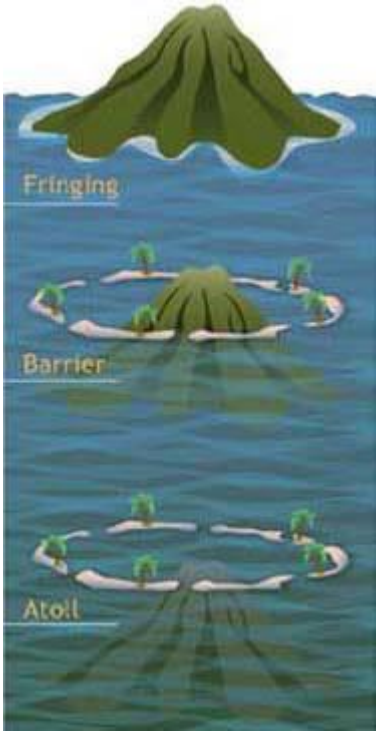


(http://www.mbmp.org/corals/polypdiagram.jpg)

Corals are closely related to sea anemones and jellyfish; the biggest difference is that corals secrete the chemicals that make up the reef and the others do not. Corals can be colonial or solitary but only colonial corals build reefs. The individual coral animals are called polyps. Each polyp lives in a cup called a corallite. You can distinguish different species of coral based on the cup shape. Rising from the bottom of the cup are small blades called sclerosepta in a pattern that is distinctive for each species. Each polyp has a mouth that is surrounded by tentacles. All tentacles have stinging cells called nematocysts that they use to capture food. The zooxanthellae are found within their skin tissue.

Corals can reproduce in a few different ways. They can bud or reproduce sexually. Budding is an asexual way to increase the colony but not to start new colonies. In order to start new colonies, the corals release their gametes into the water. This is called spawning. When the egg is fertilized, it becomes a planula, which is the free-swimming form of a coral. The planula then swims around until it finds a good place to land and start a new colony.

Corals can build three different types of reefs: atolls, barrier reefs, or fringing reefs.



(http://www.nos.noaa.gov/education/kits/corals/media/coral04a_240.jpg)

An atoll is a ring-shaped reef that is located far from land and encloses a lagoon. These are usually located in the Indo-Pacific. Barrier reefs and fringing reefs both occur close to land. Barrier reefs are usually farther from land and are usually a bit deeper than the fringing reef. The largest barrier reef is the Great Barrier Reef in Australia.

Natural vs. Artificial Reefs

Another angle that you can look at is the difference between natural and artificial reefs. There is a debate over the pros and cons of manmade reefs versus natural reefs. An artificial reef is anything that has been purposefully or accidentally placed on the ocean floor to help build or rebuild coral reefs. The hope is that animals will colonize these items in order to make a healthy reef system. At first glance, it appears that man-made reefs are doing their job but recent research brings up a few concerns. One concern is that these reefs are movable unlike natural reefs. The fear is that big storms such as hurricanes will move the "reef" and possibly damage the surrounding natural reefs by dropping the artificial reef on top of them. Another concern is that the artificial reefs release chemicals into the environment that may degrade the surrounding area. Items such as old tires, sunken ships, and others release chemicals such as oil into the water.

Although one of the original purposes for artificial reefs was to increase fish populations, it appears that artificial reefs are not doing their job. It seems that the fish populations are indeed increasing but research shows that the fish may not be using the reefs for reproduction. The fish leave their natural habitats on the natural reefs to populate the new reefs but the new reefs are not suited to their reproductive needs. This makes it easier for fisheries to collect fish because they all congregate in the same place. The artificial reef may, in the long term, actually hurt these fish populations instead of help. For a more in depth look

at artificial reefs the following two websites are very helpful:
http://www.oceanconservancy.org/site/PageServer?pagename=bpm_feature2_4
http://www.cdnn.info/article/artificial_reefs/artificial_reefs.html

Also interesting is the difference between North Carolina reefs and tropical reefs. The coral reefs in North Carolina are part of the South Atlantic Bight continental shelf. Generally, these reefs are fossiliferous limestone and sandstone outcrops. The live-bottom habitat (30-64 meter depth) consists of low rock ridges, outcroppings, coral patches, and ship wrecks. The North Carolina reefs are so similar to the tropical reefs that when tropical fish are swept up on the Gulf Stream they are able to survive until winter when the water temperature drops. The majority of the coral reefs off the North Carolina coasts are part of the shoals. Shoals were formed when the ocean levels were lower and the rivers carved paths to the sea. When the sea levels rose again the channels were then underwater and became a perfect hard bottom habitat. For more information on North Carolina Reefs go to the following pages:
http://oceanexplorer.noaa.gov/explorations/03edge/background/reef_systems/reef_systems.html
http://oceanexplorer.noaa.gov/explorations/04etta/background/plan/plan.html
http://oceanexplorer.noaa.gov/explorations/islands01/background/islands/sup9_capefear.html

Form versus Function Information

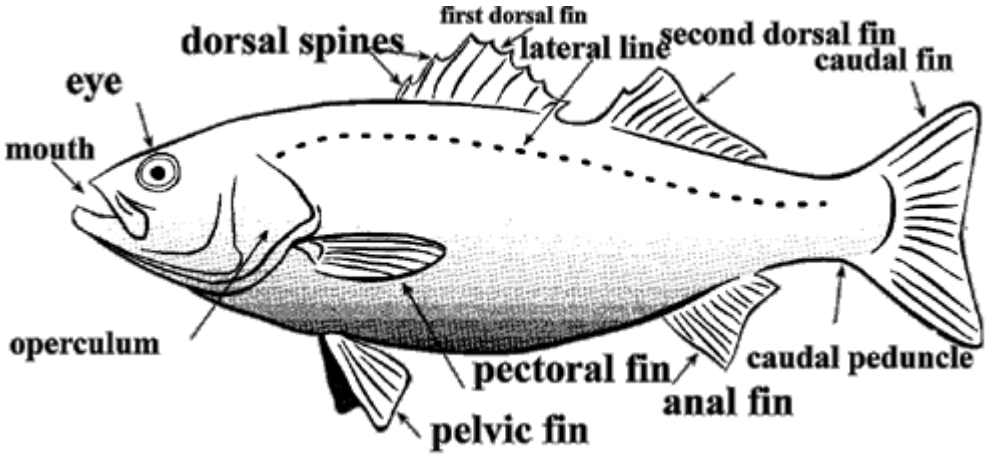
Aquarium Activities

Even on land we can see that form follows function. For example: carnivores have sharp teeth to help tear the meat they eat. Herbivores, instead, have flat teeth to help grind the plants that they eat. The same is true in the oceans. Today we will be looking at different fish shapes and how each shape is well suited to its function as well as its placement on the coral reef.

First we should talk about the terminology used to describe directions on a body.

Ventral	Toward the front (belly) of the body or towards the **bottom** of the head
Dorsal	Toward the back of the body, or towards the **top** of the head
Rostral	Toward the nose
Caudal	Toward the feet (humans) or tail
Lateral	Away from the midline
Medial	Toward the midline
Bilateral	On both sides of the body or head
Ipsilateral	On the same side of the body or head
Contralateral	On the opposite side of the body or head

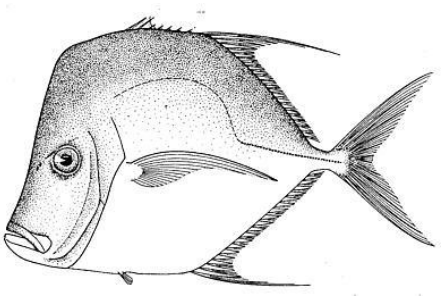
(http://salmon.psy.plym.ac.uk/year1/neurotr.htm)



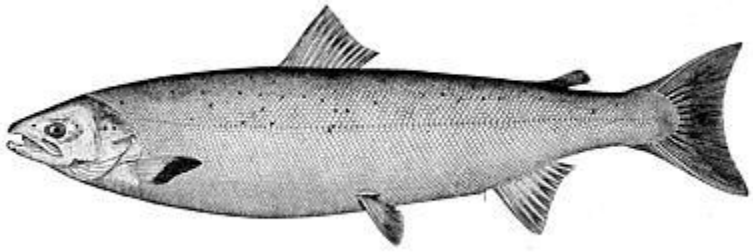
(http://www.seaworld.org/infobooks/BonyFish/physical.html)

Let's start with body shape. By looking at the overall shape of a fish, you can get an idea of where they live within the aquatic environment. Fish that live at the surface usually have a flattened back and an upturned mouth. One example is the Flat Needle Fish: (NOAA)

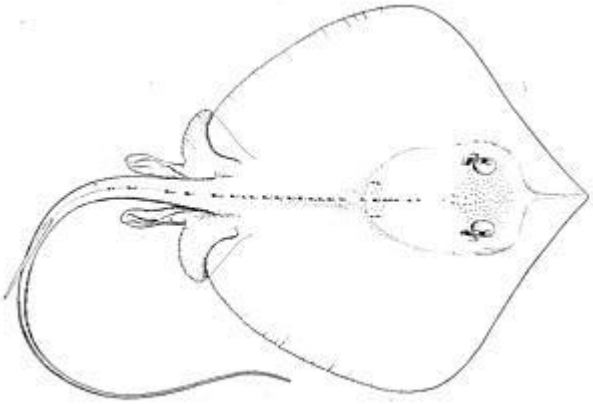
Fish that live in slow-moving waters usually have tall bodies and are laterally compressed. The lookdown in a good example: (NOAA)



Fish that live in fast-moving waters usually have torpedo shaped bodies. Salmon is one example (NOAA):

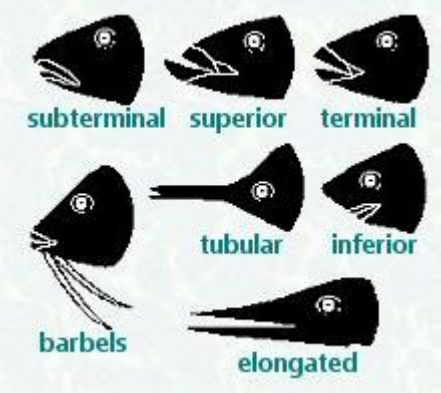


Bottom-dwelling fish have flattened bellies and inferior or down turned mouths. (NOAA):



Next we should look at mouth shape. There are three general locations of the mouth in fish which can help you decide where the fish eats. Surface feeding fish usually have an undershot, upturned (superior) mouth for feeding on organisms on the surface of the water. Fish that feed in mid water have a terminal mouth, which is usually considered the “normal” fish mouth. This helps them eat things that are straight in front of them. Predatory fish

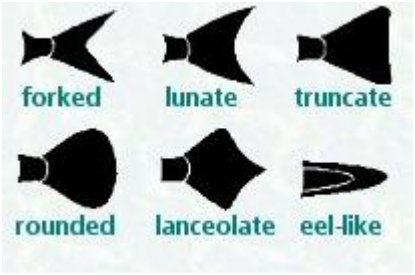
usually have a wide mouth, while omnivorous fish have smaller mouths. Bottom feeding fish generally have an inferior mouth. Often, bottom feeding species also have barbels, or whiskers, which are tactile and taste organs used for locating food in dark or muddy waters.



(Redang)

Next morphological characteristic to examine are the fins. The fins are used for movement, stability, nest-building, spawning, or as tactile organs. Fins can be single or paired. Many home aquarium fish seen in the hobby have long, drawn out fins, which have been developed through selective breeding. In nature, these fins are not found.

The caudal or tail fin is used for propulsion. Fish that have forked caudal fins are regular fast-swimmers. Fish that have rounded caudal fins are fish capable of quick action like predators. Large, elongated caudal fins are often used to attract mates. The single anal fin is located on the underside of the body just forward of the caudal fin. The anal fin serves to stabilize the fish while it is swimming. Long anal fins that are moved in an undulating manner are used for propulsion. The paired pelvic or ventral fins are located forward of the anal fin. Ventral fins are used to provide further stability in swimming. Sometimes these fins are modified as long, thread-like fins used as a tactile organ.



(Redang)

The paired pectoral fins are located near the gill cover and are used for maneuvering the fish. These fins have been adapted, in the case of some bottom-dwelling species, so fish can prop themselves up or even walk around above or below water. Sometimes the pectoral fins are equipped with spines for defense. The single dorsal fin is located on the back of the fish and serves to help balance the fish while swimming. The rays of this fin are often sharp,

and a spine is often present. The adipose fin is a tiny fin found between the dorsal and caudal fins on some fish.

Body covering: Most fish are covered with scales, which protect the body. Some fish such as catfish have bony plates which serve the same purpose. Other species have very small scales or no scales at all.

Body coloring: Many species of fish have distinctive patterns on their bodies. These stripes are used for camouflage and communication. Eye spots are used to confuse predators whereas "egg-spots" let other fish know when a female is pregnant. The different patterns also help the fish to blend into their background whether it is the reef or a school of fish. It is harder to pick out one fish when you can not tell where one ends and another begins.

(Redang)

Color is determined by the pigment of the fish and the light reflection. Fish with solid, dark coloration usually have pigmented skin, while species with silvery iridescence rely on light reflection. Some species are able to alter their coloration, while some fish assume different coloration at night. Healthy fish are almost always more colorful than unhealthy one. During territorial displays, during the spawning season, and at spawning, the color of most species is enhanced.

For more information visit Sea World's Education page on Bony Fish:
http://www.seaworld.org/infobooks/BonyFish/physical.html
This page includes pictures that may be helpful.

Coral Reef Vocabulary

From James Nybakken's
Marie Biology: An Ecological Approach

Abiotic: Non-living
Ahermatypic: corals that do not build reefs
Atolls: a circular coral reef that forms when coral develops on a volcanic island
Barrier reefs: coral reef that lies at least 10 kilometers from land
Biotic: The living components of an ecosystem
Bleaching: when unusually warm water temperatures cause coral to lose their color. The discoloration or loss of symbiotic zooxanthellae
Budding: Budding is a type of asexual reproduction. A new organism is formed by the protrusion of part of another organism. When coral buds, one cell becomes two cells. This is an example of reproduction. This is very common in plants, but may be found in animal organisms, such as the hydra, as well. Usually, the protrusion stays attached to the primary organism for a while, before becoming free. The new organism is naturally genetically identical to the primary one (a clone).
Calcium carbonate: a molecule consisting of calcium, carbon and oxygen secreted by corals to their skeleton. It is also secreted by mollusks to form their protective shells
Calcareous: calcium-containing
Cilia: hair-like structures that are used for locomotion, and in some species, for feeding, short, motile, generally microscopic, hair like projections found on many protists and larvae of some invertebrates. Cilia are used for locomotion, the generation of a current, or filter feeding.
Colony: Term applied to organisms that occur in a fixed location, with one generation growing atop previous generations, as in coral reefs. A colony is also a group of plants or animals that are connected or living close together.
Coral Polyp: a small organism that is usually less than an inch in diameter but can be as large as a foot that form coral reefs
Desiccation: drying out due to exposure to air
Exoskeleton: an external skeleton or supportive covering of an animal formed from the ectoderm, as for example, the shell coverings of a crustacean, the calcium carbonate secretions of stony corals, or the bony plates of an armadillo
Fringing reefs: coral reefs that are close to the shore, separated by low waters
Hard coral: a coral in the anthozoan order Scleractinia. Also known as the stony corals, these organisms possess a hard external calcareous skeleton. A synonym of stony coral. A group of coral species known as stony coral that forms the hard, calcium carbonate skeleton in several shapes; other include the brain corals, fungus or mushroom corals, staghorn and table corals, flower pot corals, bubble corals and lettuce corals.
Herbivore: An animal that eats only plants.
Hermatypic: reef building corals with zooxanthellae.
Invertebrate: An animal that has no backbone.
Lagoon: A shallow sound, channel, or pond near or communicating with a larger body of water. A coral atoll surrounds a lagoon, which may contain its own water life.
Larva: The early form of an animal that at birth or hatching is fundamentally unlike its parent and must metamorphose before assuming the adult characteristics.

Limestone: a sedimentary rock consisting mainly of calcium that was deposited by the remains of marine animals
Marine: In seawater.
Mollusk: Invertebrate animals with soft, unsegmented bodies, such as clams and snails, usually enclosed in a calcium shell.
Nematocyst: The stinging cell in a coral polyp. A specialized cell in the tentacles of cnidarians (Phylum Cnidaria, jellyfish, corals, and anemones) and ctenophores (Phylum Ctenophora, comb jellies). Each nematocyst typically contains a barbed and/or venomous coiled thread that can be ejected in defense or to capture prey.
Photosynthesis: The process that plants use to change C02 and water into sugars using the energy from sunlight. These sugars are the food for the plants.
Phytoplankton: Microscopic floating plants, mainly algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current
Plankton: Microscopic plants and animals that drift with the currents near the surface of the ocean.
Planula: The tiny larval swimming stage of corals
Soft coral: In contrast to the hard or stony corals, most soft corals do not possess a massive external skeleton
Salinity: The concentration of dissolved salts, usually sodium chloride, in water.
Sedimentation: The process of subsidence and deposition of suspended matter from a wastewater by gravity.
Solitary: Corals that do not grow in colonies
Staghorn: Large branching coral resembling antlers
Symbiosis: To live together; a condition in which two animals, two plants, or a plant and an animal live in partnership. The relationship can be that of commensalism, where one organism benefits from activities of the other; parasitism, where one organism lives on another to the detriment of its host; or mutualism, where both organisms benefit from the association.
Turbidity: Cloudiness of water due to suspended material. Causes include soil erosion, waste discharge, urban runoff, and algal growth
Tropics: Technically, the area between the Tropic of Cancer (21-1/2 N latitude) and the Tropic of Capricorn (21-1/2 S latitude), characterized by the absence of a cold season. Often used to describe any area possessing what is considered to be a hot, humid climate.
Zooplankton: animal component of the plankton community
Zooxanthella: A type of algae that lives inside of coral polyps (and some other sea creatures).

Coral Reef Vocabulary

Abiotic:
Biotic:
Tropics:
Marine:
Limestone:
Hard coral:
Staghorn:
Soft coral:
Hermatypic:
Ahermatypic:
Colony:
Solitary:
Atolls:
Barrier reefs:
Fringing reefs:
Lagoon:
Bleaching:
Budding:
Coral Polyp:
Larva:
Planula:
Calcium carbonate:
Calcareous:
Cilia:
Nematocyst:
Desiccation:
Exoskeleton:
Invertebrate:
Mollusk:
Herbivore:
Plankton:
Zooplankton:
Phytoplankton:
Photosynthesis:
Zooxanthella:
Symbiosis:
Commensalism,
Parasitism
Mutualism
Turbidity:
Salinity:
Sedimentation:

Fish Observation Worksheet

Using the Cape Fear Shoals, Sharktooth ledge, and the Pacific Reef tanks, choose three fishes to sketch in your notebook. Once you have finished the sketches:
1. Find the name of your fish. If it is not listed, ask an aquarium employee to help you. If you still can not find it, what name would you give the fish?
2. Label each part of the fish using the fish shape worksheet. What type of mouth does it have? Fins? Body shape?

Now observe the fishes and answer the following questions.
1. Where do you think this fish lives on the reef? What about this fish leads you to that decision?
2. Where do you think the fish eats? What mouth shape does it have?
3. Is it a schooling fish or does it appear to be solitary?
4. Is your fish territorial? How can you tell?
5. How does your fish swim? Is it built for speed? Maneuverability? How can you tell?
6. Does your fish live close to the reef or far away? What body shape does it have?
7. Is your fish well adapted to its environment? Why or why not?

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How to Write a Scientific Paper

1. **Title:** The title should be concise and accurately describe the contents of the paper. Only the first word and proper names should be capitalized.
2. **Author and Affiliation:** This would be your name and your school.
3. **Abstract:** The abstract should briefly summarize the paper. It is usually 100-250 words. You should state the goals of the study. Summarize the main results and conclusions. Do not include any information that is not included in the paper.
4. **Introduction:** Introduce the material to your reader. Give the background information needed to understand the paper. Make sure you cite all literature that you use. State the objectives and the reason for the study. The objectives may be stated as a hypothesis or a question.
5. **Materials and Methods:** Describe the procedure and the design of the experiment in order so that someone else would be able to repeat your experiment if necessary. Describe the area where the study took place, include a map if available. Give the genus and species of each animal studied and include a brief description if necessary.
6. **Results:** State the results first without explaining them. Use graphs as well as text.
7. **Discussion:** Explain your data from the results section. Tell what conclusions you reached. Did you support your hypothesis? Address any questions that were unanswered. Compare your results to other studies.
8. **Literature Cited:** You must reference every item that you used to write your paper. If you take ideas from someone else and do not give them credit it is called plagiarism. This goes on its own page.

Citing Literature

Journals: Author's last name, initials, year of publication, title of paper, journal name, volume number, pagers.

Books: Author's last name, initials, year of publication, title, publisher, location, total pages.

Paper in a book: Author's last name, year of publication, title of paper, pages, *In:* editor's name (ed.), book title, publisher, location.

Other things to keep in mind: Always write your scientific paper in the past tense. Unless there is still work to be done, it is finished so it should be past tense. Also, make sure you avoid the first person (I, me, we). Always label the different sections of your paper (materials and methods). If necessary, look at examples on how to write a scientific paper, they will be your best guide.

PowerPoint Presentation

Things to include in your PowerPoint:

1. Introduction Slide: Who are you and what is your presentation about? Make sure each group member has their name on the slide.
2. Coral Reef Slide: Give three facts about coral reefs.
3. Form and Function Slide: Define form and function.
4. Fish Shape Slide: Explain why your body shape is important. List all the shapes that we talked about and explain why that shape is important.
5. Fish Slides: For each fish you described at the aquarium, make a slide and explain what you know about the fish by looking at its body shape.
6. Conclusion Slide: Tell us why this information is important.

Be sure to include at least three pictures off of the internet in your presentation.

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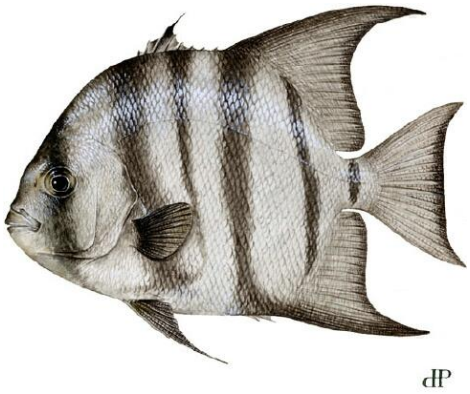
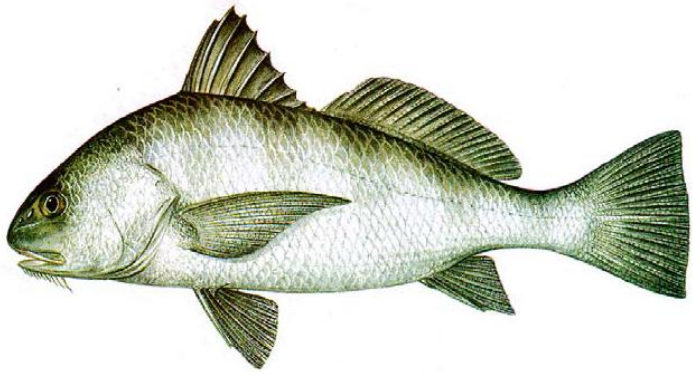
Fish Facts

The following pictures are from the National Oceanographic and Atmospheric Association's North East Fisheries Science Center's index of line art and are followed by (NOAA). The other pictures are from the Florida Fish and Wildlife Research Institute and are noted as (Florida). The fish facts were found on the Florida website.



(Florida)

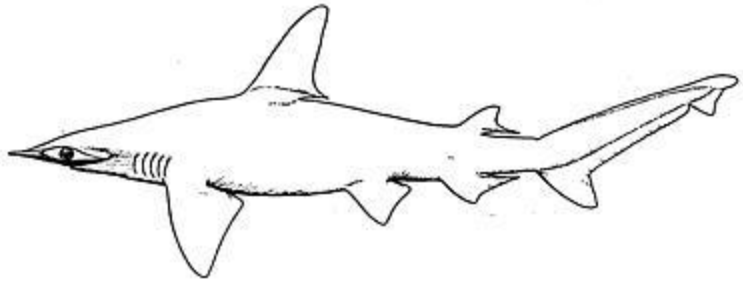
ATLANTIC SPADEFISH - Chaetodipterus faber
Family Ephippidae, Spadefishes
Description: silvery with 4 to 6 black vertical bands on each side which sometimes become obscure in larger fish; deep, flattened body; separated first and second dorsal fins; concave caudal fin; anterior rays of second dorsal fin and anal fin elongated.
Similar fish: no close resemblance, but frequently and mistakenly called angelfish.
Where found: Inshore and nearshore, around natural and artificial reefs, and especially near navigation markers in 15 to 20 feet of water.
Size: most catches less than 2 pounds, known to reach 15 pounds.
Remarks: spawns in spring and summer; travels in large schools; small juveniles almost totally black, known to drift on their sides and mimic floating debris; feeds on crustaceans, small encrusting invertebrates, and may nibble on tentacles of jellyfish.



(Florida)

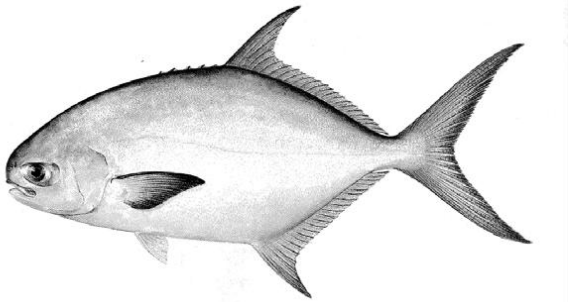
BLACK DRUM - Pogonias cromis
Family Sciaenidae, Drums
Description: high arched back; 10 to 14 pairs of chin barbels; gray or black colored body in adults; young have 4 to 6 vertical bars; has cobblestone-like teeth capable of crushing oysters; scales large.

Similar fish: red drum, Sciaenops ocellatus; the vertical bars on juvenile black drum are somewhat similar to those on sheepshead, Archosargus probatocephalus; and spadefish, Chaetodipterus faber.
Where found: Inshore fish common to bays and lagoons; bottom dweller often found around oyster beds; also offshore.
Size: common to 30 pounds.
Remarks: largest member of the drum family; spawns nearshore in winter and early spring; feeds on oysters, mussels, oysters, crabs, shrimp, and occasionally fish; longevity to 35 or more years.
Florida record: 93 lbs.



(NOAA)

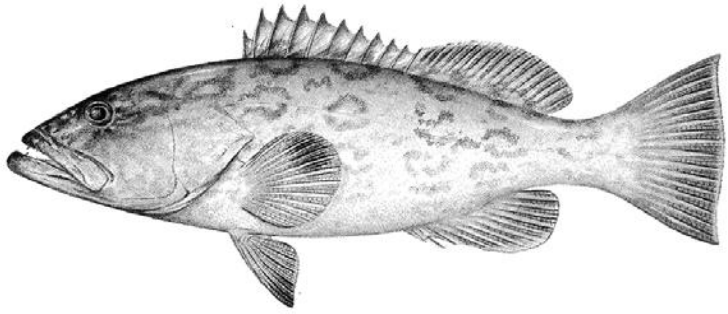
BONNETHEAD SHARK - Sphyrna tiburo
Family Sphyrnidae, Hammerhead sharks
Description: broadly widened head in the shape of a shovel; only slight indentation of anal fin; front of head not notched at midline; gray or grayish-brown in color.
Similar fish: Other hammerhead sharks.
Where found: Inshore species found in bays and estuaries.
Size: commonly 3 to 4 feet.
Remarks: matures at about 3 feet in length and bears 6 to 12 young at a time; feeds chiefly on crabs and other crustaceans.



(Florida)

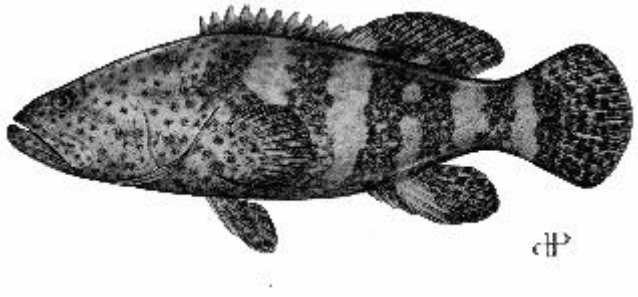
FLORIDA POMPANO - Trachinotus carolinus
Family Carangidae, Jacks and Pompanos
Description: greenish gray on back, shading to silvery sides; fish in dark waters showing yellow on throat, pelvic, and anal fins; deep flattened body with small mouth; no scutes; 22 to 27 soft dorsal rays; 20 to 23 soft anal rays; origin of anal fin slightly behind origin of second dorsal.
Similar fish: permit, T. falcatus; palometa, T. goodei; the permit is deeper bodied; dorsal body profile not strongly angled at insertion of second dorsal fin; pompano rarely grow larger than 6 pounds, permit common to 40 pounds.

Where found: Inshore and nearshore waters, especially along sandy beaches, along oyster bars, and over grassbeds, often in turbid water; may be found in water as deep as 130 feet.
Size: usually less than 3 pounds.
Remarks: Spawns offshore between March and September; feeds on mollusks and crustaceans, especially sand fleas; local movements are influenced by the tide, and seasonal movements are influenced by temperature.
Florida record: 8 lbs., 1 oz.



(Florida)

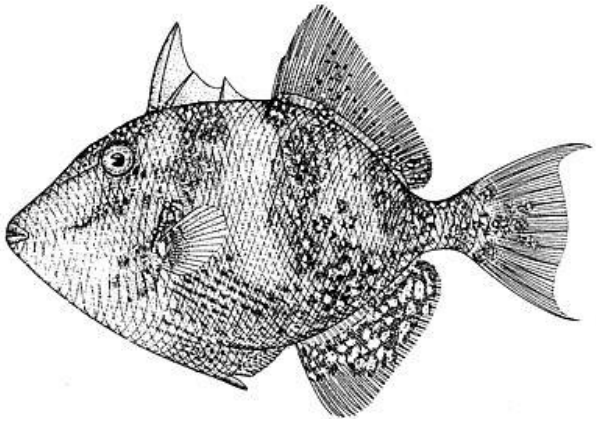
GAG - Mycteroperca microlepis
Family Serranidae, Sea Basses and Grouper
Description: Brownish gray in color with dark worm-like markings on sides; strong serrated spur at bottom margin of preopercle, less noticeable in large specimens; fins dark, with anal and caudal having white margin; often confused with black grouper; most noticeable differences are brassy spots on black grouper; tail of gag is slightly concave, black grouper's tail is square; gag has white margin on anal and caudal fins, black does not; under 10 pounds, gag's spur on preopercle is distinctive, where black is gently rounded.
Similar fish: black grouper, M. bonaci.
Where found: Adults offshore over rocks and reefs; juveniles occur in seagrass beds (inshore).
Size: Common to 25 pounds.
Remarks: Forms spawning aggregations in water no shallower than 120 feet in Middle Grounds area, January through March; current research to identify similar aggregations off the Atlantic coast is ongoing; young gags are predominantly female, transforming into males as they grow larger; feeds on fish and squid.
Florida record: 71 lbs., 3 oz.



(Florida)

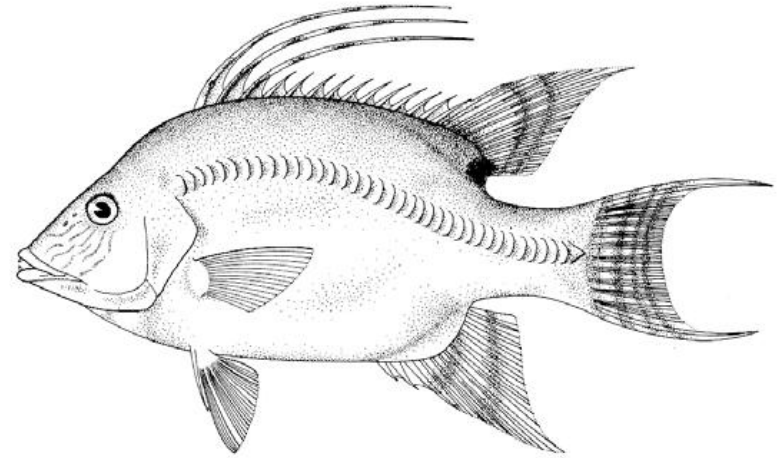
Goliath Grouper - Epinephelus itajara
Family Serranidae, Sea Basses and Grouper

Description: Head and fins covered with small black spots; irregular dark vertical bars present on the sides of body; pectoral and caudal fin rounded; first dorsal fin shorter than and not separated from second dorsal; adults huge, up to 800 pounds; eyes small.
Similar fish: other grouper.
Where found: Nearshore around docks, in deep holes, and on ledges; young often occur in estuaries, especially around oyster bars; more abundant in southern Florida than in northern waters.
Size: Largest of the groupers.
Remarks: Spawns over summer months; lifespan of 30 to 50 years; feeds on crustaceans and fish.
NOTE: Also known as jewfish which are protected from harvest in Florida waters.
Florida record: 680 lbs.



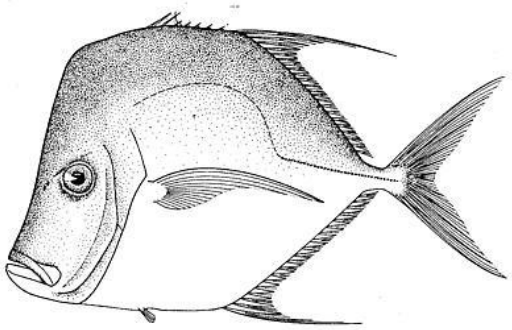
(NOAA)

GRAY TRIGGERFISH - Balistes capriscus
Family Balistidae, Leatherjackets
Description: Entirely olive-gray; dorsal and anal fins marbled; caudal fin lobes elongate in large adults; one or more enlarged scales behind gill opening; 26 to 29 dorsal fin rays; 23 to 26 anal fin rays.
Young: Large darker saddles on back (these saddles sometimes persist in adults); blue spots and short blue lines in dorsal fin and on upper half of body, becoming white below and in anal fin; upper rim of eye blue.
Where found: Hardbottom, reefs, and ledges.



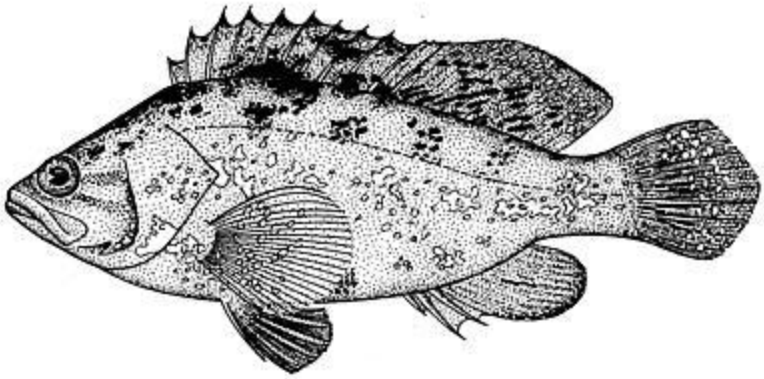
(Florida)

HOGFISH - Lachnolaimus maximus
Family Labridae, Wrasses
Description: Body deep, strongly compressed; color varies, but never bicolored; usually reddish, sometimes bright brick red; soft dorsal fin with a large dark spot at base; entire top of head nape purplish brown in large males; this patch of color continuous with blackish area that extends along entire base of dorsal fin; large blackish crescent through base of caudal fin; pelvic fin with dusky tip; 14 spines in dorsal fin - first 3 elongate, bladelike; rays at front of soft dorsal and anal fins and lower lobes of caudal fin elongate; mouth very protrusible.
Young: Greenish or brownish, mottled with dark.
Size: Up to 91 cm (3ft.).
Remarks: Esteemed as a food fish in some areas, but has been implicated in ciguatera; usually marketed as Hog Snapper.



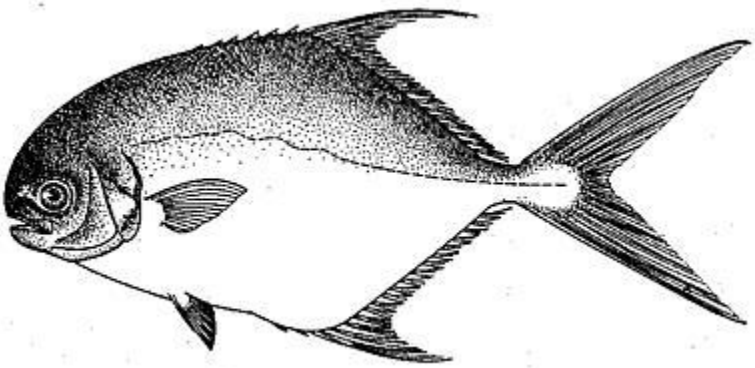
(NOAA)

LOOKDOWN - Selene vomer
Family Carangidae, Jacks and Pompanos
Description: Silvery, iridescent, sometimes with brassy highlights; body extremely compressed and deep, platelike; front of head very steep; lobes at front of soft dorsal and anal fins very long; pelvic fins small; lateral line arched toward front.
Young: Spines at front of dorsal fin and rays in pelvic fin streamerlike.
Size: Up to 30 cm (1ft.).



(NOAA)

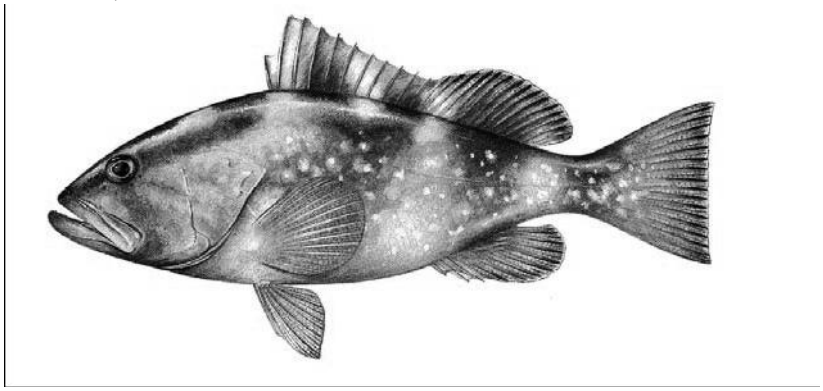
MUTTON SNAPPER - Lutjanus analis
Family Lutjanidae, Snappers
Descriptions: Color olive green on back and upper sides, all fins below the lateral line having reddish tinge; bright blue line below eye, following contour of operculum; anal fin pointed; small black spot below dorsal fin; V-shaped tooth patch on roof of mouth.
Similar fish: Lane snapper, L. synagris (anal fin pointed in mutton snapper, rounded in lane).
Where found: Inshore associated with grassbeds, mangroves, and canals; larger adults found on offshore reefs.
Size: Common to 15 pounds.
Remarks: Spawns in July and August; feeds on fish, crustaceans, and snails.
Florida record: 27 lbs., 6 oz.



(NOAA)

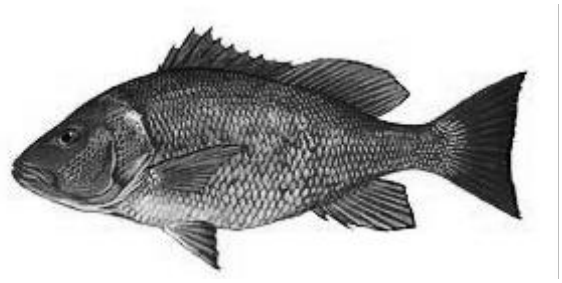
PERMIT - Trachinotus falcatus
Family Carangidae, Jacks and Pompanos
Description: Color gray, dark or iridescent blue above, shading to silvery sides, in dark waters showing golden tints around breast; small permit have teeth on tongue (none on pompano); no scutes; dorsal fin insertion directly above that of the anal fin; 17 to 21 soft dorsal rays; 16 to 19 soft anal rays.
Similar fish: Florida pompano, T. carolinus; the permit is deeper bodied; dorsal body profile forms angle at insertion of second dorsal fin; pompano rarely grow larger than 6 pounds, permit common to 40 pounds.
Where found: Offshore on wrecks and debris, inshore on grass flats, sand flats, and in channels; most abundant in south Florida, with smaller specimens from every coastal county.

Size: Common to 25 pounds.
Remarks: Reeds mainly on bottom-dwelling crabs, shrimp, small clams, and small fish.
Florida record: 51 lbs., 8 oz.



(Florida)

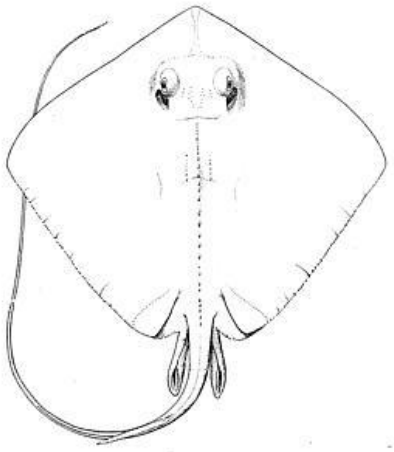
RED GROUPER - Epinephelus morio
Family Serranidae, Sea Basses and Grouper
Description: Color brownish red; lining of mouth scarletorange; blotches on sides in unorganized pattern; second spine of dorsal fin longer than others; pectoral fins longer than pelvic fins; squaredoff tail; margin of soft dorsal black with white at midfin; black dots around the eyes.
Similar fish: Nassau grouper, E. striatus.
Where found: Bottom dwelling fish associated with hard bottom; juveniles offshore along with adults greater than 6 years old; nearshore reefs.
Size: Common to 15 pounds.
Remarks: Spawns in April and May; prefer water temperatures between 66 and 77 degrees F; undergoes sex change, young individuals female, becoming male as they age, lifespan of at least 25 years; feeds on squid, crustaceans, and fish.
Florida record: 39 lbs., 8 ozs.



(Florida)

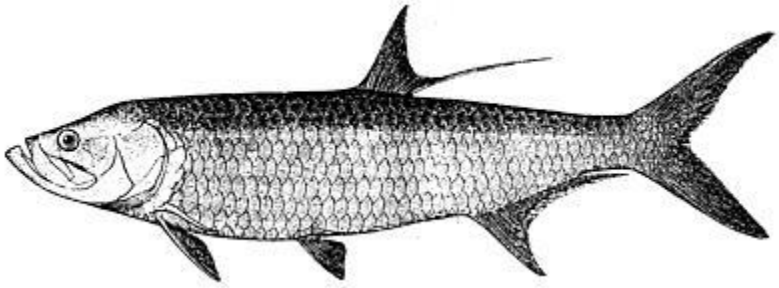
RED SNAPPER - Lutjanus campechanus
Family Lutjanidae, Snappers
Descriptions: Color pinkish red over entire body, whitish below; long triangular snout; anal fin sharply pointed; no dark lateral spot; red eye.
Similar fish: Silk snapper, L. vivanus.
Where found: Offshore on the continental shelf, more plentiful off the Panhandle than in south or middle Florida.
Size: Up to 20 pounds

Remarks: Juveniles occur over sandy or mud bottoms and are often taken in shrimp trawls; adults may live more than 20 years, and attain 35 pounds or more; sexual maturity attained at age 2; spawns June to October; feeds on crustaceans and fish.
Florida record: 46 lbs., 8 oz.



(NOAA)

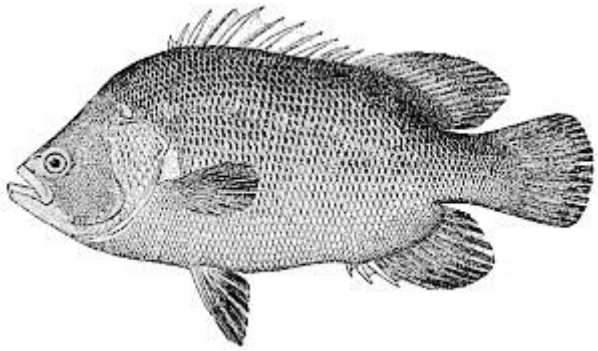
SOUTHERN STINGRAY - Dasyatis americana
Family Dasyatidae, Stingrays
Identification: Disk almost a perfect rhombus, with pointed corners; ventral finfold on tail long and relatively high, dorsal finfold rows near shoulder; disk usually uniform dark brown above, grayer in young.
Size: Up to 1.8 m (6 ft.) across disk.
Where found: Common in bays and estuaries.
Remarks: It is the largest stingray along the southeastern and Gulf shores.



(NOAA)

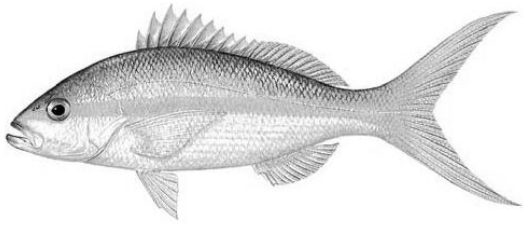
TARPON - Megalops atlanticus
Family Elopidae, Tarpons
Description: Last ray of dorsal fin extended into long filament; one dorsal fin; back dark blue to green or greenish black, shading into bright silver on the sides; may be brownish gold in estuarine waters; huge scales; mouth large and points upward.
Similar species: (As juveniles) ladyfish, Elops saurus.
Where found: Primarily inshore fish, although adult fish spawn offshore where the ribbon-like larval stage of the fish can be found.
Size: Most angler catches 40 to 150 pounds.
Remarks: Slow grow rate, matures at 7 to 13 years of age; spawning occurs between May and September; female may lay more than 12 million eggs; can tolerate wide range of

salinity; juveniles commonly found in fresh water; can breathe air at the surface; feeds mainly on fish and large crustaceans.
Florida record: 243 lbs.



(NOAA)

TRIPLETAIL - Lobotes surinamensis
Family Lobotidae, Tripletails
Description: Head and body variously mottled, tan to dark brown; fins (except spinous dorsal and pectoral fins) almost black; pale olive band across base of caudal fin; broad, dark brown bar from eye across cheek below corner of preopercle, and another from upper corner of eye to beginning of dorsal fin; two dark streaks on top of head, behind nostrils; upper profile concave at nape; edge of preopercle strongly serrated.
Size: Up to 1.1 m (42 in.)



(Florida)

YELLOWTAIL SNAPPER - Ocyurus chrysurus
Family Lutjanidae, Snappers
Description: Back and upper sides olive to bluish with yellow spots; lower sides and belly with alternating narrow, longitudinal pink and yellow stripes; prominent mid lateral yellow stripe begins at mouth and runs to tail, broadening as it passes the dorsal fins; caudal fin yellow and deeply forked; no dark lateral spots.
Where found: Juveniles are found inshore on grassbeds and back reefs; adults are found nearshore or offshore over sandy areas near reefs.
Size: Common to 3 pounds.
Remarks: Found mainly in tropical waters; spawns in mid summer; rarely exceeds 30 inches and 5 pounds in size; feeds on small fish and invertebrates.
Florida record: 7 lbs., 5 oz.

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