

# Form and Function

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Grade Level(s): 3<sup>rd</sup>-5<sup>th</sup>

Time: 35-45 minutes

Group Size: 20-30

## NYS Learning Standards Core Curriculum MST

### Living Environment: Standard 4

Students will: understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

- *Key Idea 1:* Living things are both similar to and different from each other and nonliving things.
- *Key Idea 3:* Individual organisms and species change over time.

## Summary

Students will be introduced to freshwater or saltwater fish species of New York State. By the end of the program, students will learn that over time fish, as well as other animals, have adapted or changed to survive in their environment. Although different fish species have different appearances, the function of their outside body parts is similar. In addition, the outside body parts (external anatomy features) of fish can tell us a lot about a species such as where it lives in the water, how it finds food, and how it protects itself from predators.

## Materials

- *Fish Anatomy reference sheet*
- *Fish Parts reference sheet*
- *Fish Planets worksheet*
- Fish models/pictures

## Objectives

After this presentation, students will be able to

- Identify 1-3 local fish species
- Construct a fish using 3-5 external anatomy features of a fish
- Explain how body form influences body function
- Compare and contrast adaptations of different fish species

## Vocabulary

- **Anal Fin-** last bottom fin on a fish located near the anal opening; used in balance and steering
- **Caudal/Tail Fin-** fin on end of fish; used to propel the fish
- **Countershading-** color pattern on animals where pigmentation of the animal is darker on top and lighter on bottom.
- **Dorsal Fin-** backside fin on a fish; used for balance and protection
- **External Anatomy-** the outside body parts
- **Gills-** organ a fish uses to obtain oxygen from the water
- **Inferior Mouth-** a mouth that opens downward (usually bottom feeders)
- **Operculum-** flexible bony plate that covers the gills
- **Lateral Line-** organ a fish uses to “feel” low vibrations; tiny pores
- **Nares-** organ a fish uses to smell; similar to nostrils but not used for breathing
- **Pectoral Fin-** chest fins on a fish; used for balance
- **Pelvic Fin-** bottom or belly fins on a fish; used in balance and steering
- **Scales-** protective cover on a fish; similar to skin
- **Slime Layer-** covers scales; layer protects from bacteria, parasites, etc.
- **Superior Mouth-** a mouth that opens upward (usually surface feeders)
- **Terminal Mouth-** a mouth located at anterior end of fish’s body (mid water feeder)

## External Anatomy

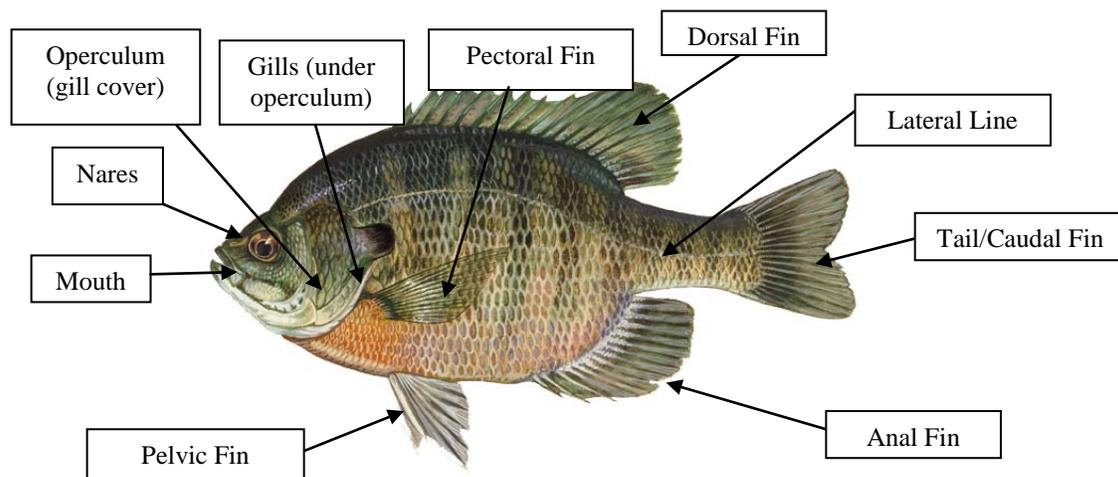


Illustration by Duane Raver

## Background

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Over time fish, as well as other animals, have adapted or changed to survive in their environment. Although different fish species have different appearances, the function of their outside body parts is similar. In addition, the outside body parts (**external anatomy** features) of fish can tell us a lot about a species such as where it lives in the water, how it finds food, and how it protects itself from predators.

### External Anatomy Features

Common external anatomy features of fish include: *dorsal fin*, *anal fin*, *caudal fin*, *pectoral fins*, *pelvic fins*, *gills*, *lateral line*, *nares*, *mouth*, *scales*, and *body shape*.

### Fins

All fish have external appendages called fins. Like human limbs, fins provide fish with balance, steering, and protection. Fins are either single along the centerline of the fish: the dorsal fin, anal fin, and tail fin; or paired fins: the pectoral fins and pelvic fins. **Pectoral fins** help fish balance. The back fin or **dorsal fin** is also used in balance and protection and in some fish families (pike and gar) it is used for propulsion. The **pelvic fin** and **anal fin** are located on the bottom or belly of fish and help with steering as well as balance. The tail fin, also called the **caudal fin**, helps propel fish forward.

There is an important difference in the placement of the pelvic fins between the spiny rayed fishes (perch, bass) and the non spiny rayed fishes (trout, pike, minnows). In non spiny rayed fishes (more primitive) the pelvic fins are in the pelvic region where they function primarily for balance. In the spiny rayed fishes (more advanced) the pelvic fins have moved up almost under the chin and in some cases in front of the pectoral fins (see Figure 1). This position of the pelvic fins allows the fish to use the four paired fins together for very fine movements such as pivoting and swimming backwards which non spiny rayed fishes cannot do.



Figure 1: A bluegill sunfish (spiny rayed fish) as compared to a brook trout (non spiny rayed fish). Note how the pelvic fin is located under the pectoral fin of the sunfish. The brook trout's pelvic fin is located farther back behind the pectoral fin. Illustrations by Duane Raver.

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## *Gills*

Located on either side of fish, **gills** provide oxygen to fish from the water. The gills are covered by a flexible bony plate called the **operculum**. Some fish have spines located on the operculum as a defense mechanism to protect them from predators.

## *Lateral Line*

Running down the length of a fish's body is the lateral line. The **lateral line** is a canal made up of a series of tiny holes containing sense organs located just under the scales of a fish. This organ is used to feel pressure changes in the water.

## *Nares*

All fish can smell. Located on a fish's snout are paired holes, or **nares** used for detecting odors in the water. Nares are similar to nostrils but are not used for breathing. Some fish, like catfish and eels, have a heightened sense of smell.

## *Scales and Slime*

Most fish have scales covering the length of their body. **Scales** protect fish from injury, much like skin on the human body. On top of these scales is a mucus covering known as the **slime layer**. Slime protects fish from bacteria and parasites in the water. Anglers should be careful not to remove the slime layer when handling a fish.

## *Body Shape*

A fish's body shape as well as the shape and size of certain external features can tell you a lot about that fish. For example, the body shape of a fish can indicate where that fish lives in the water and what type of swimmer it is.

## *Tail Shape*

A fish's tail shape can tell you about the fish's swimming abilities. For instance, a sharp forked tail like that of a tuna implies a fast swimmer, whereas a rounded tail means the fish is good at turning.

## *Mouth*

The mouth parts of a fish will vary in size. Some fish have very small mouths while some have large gaping mouths. Some fish have teeth, depending on what the fish eats. The location of the mouth on a fish's body can also give us a clue as to what the fish eats. A **superior mouth** (a mouth pointing upward) means the fish will usually eat food located above it, whereas a fish with an **inferior mouth** (a mouth pointing downward) will usually eat food located below it. Fish with a **terminal mouth** located at the anterior end of the body are usually mid water feeders.

## Form, Function, and Adaptations

Although fish species may look very different from one another due to adaptations, their body parts serve similar functions. Here are a few examples:

### *Largemouth Bass*

Largemouth bass live towards the bottom of freshwater bodies and are therefore darker in color. Their greenish brown tint helps them to camouflage with the surrounding aquatic vegetation protecting them from predators swimming above. When swimming through the water, their white bellies help to camouflage them with the sky above. This color pattern, called **countershading**, is a common type of camouflage for many animals. The teeth of a largemouth bass are brush like with a texture of sandpaper, used for gripping in order to swallow prey whole. Adult largemouth can easily consume smaller fish, frogs, and even baby ducks. Although the mouth parts of largemouth bass are different than many other freshwater predators, they serve the same function: to consume food.



Illustration by Duane Raver

### *Flounder*

Flounder are a group of flat-lying saltwater fish that live on the sea floor. When hatched, flounder resemble most other fish by swimming upright. About a week to a month into its life, one eye rotates to the other side of the head to join the other eye (right or left side of the fish depending on the species of flounder). This adaptation allows flounder to lie flat on the ocean floor and wait for their food; thus they are called a lie-and-wait predator. Flounder show an extreme form of countershading with the bottom side of the fish totally white and the top side colored. Flounder also have many sharp teeth which allow them to eat smaller fish swimming above. Although this group of fish looks different than most fish, the fins still have the same functions.

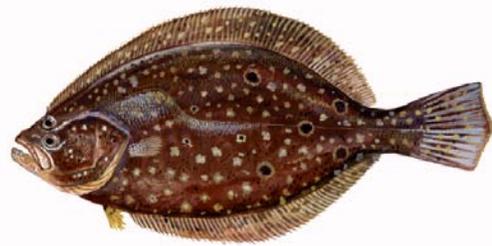


Illustration by Duane Raver

### *Chain Pickerel*

There is another important function of the dorsal fin (usually paired with the anal fin) in some families of fishes (notably the pike family and also gars) and that is propulsion. Chain pickerel are a member of the pike family. These fish are the drag racers of the fish world. Their dorsal and anal fins have moved all the way back near the tail and basically double the size of the caudal fin providing the fish with very fast starts so that they can ambush prey. Fish like this have torpedo shaped bodies which allow them to move quickly through the water and usually have sharp teeth



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which allow them to grab and hold onto the prey which they catch at high speed. A saltwater example of this is the needlefish.

## *Sea Robin*

Having several adaptations to protect it against predators, the sea robin is an interesting looking fish. Sea robins are a bottom dwelling fish with very large pectoral fins. The large pectoral fins make the fish look larger to predators swimming through the water. As additional defense against predators, sea robins have a very sharp dorsal fin and spines on their gill covers. Sea robins can also make a barking sound to scare off predators. Although the sea robin physically looks different than other species, its fins still help to balance its body, steer through the water, and protect it against predators. Because of its odd external characteristics, many humans consider the sea robin to be a trash fish, when in fact it is fine for human consumption.

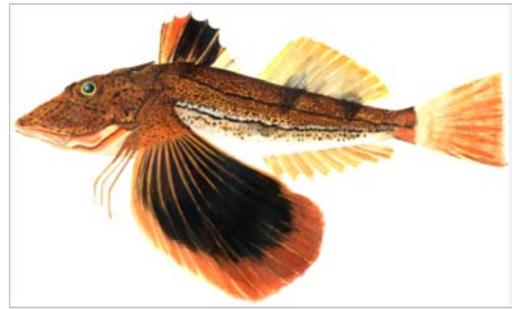


Illustration by Nim Lee

## **Relationship to Fishing**

Knowing what a fish eats, where it lives, and how it defends itself against predators can help us when fishing to target that species or to handle our catch. Depending on where a fish lives in the water changes how and where anglers fish for that species. For example, black sea bass prefer to live in and around structure, meaning rocks, dock pilings, etc. Therefore, anglers targeting sea bass fish in these areas and in many cases go offshore to find reefs or wrecks to fish on. Similarly, catfish have a heightened sense of smell and lack superior vision. Therefore by knowing what the catfish eats, anglers can better target them by using baits with a strong odor, called stink baits.

Knowing the body shape and fin locations of a fish can tell us a lot about the movements fish will make when attacking bait. For example, a chain pickerel's long torpedo shaped body allows it to make quick darting movements forward. While these fish are fast, they are not very maneuverable (like an arrow shot from a bow, they go fast and straight, but cannot turn if the target moves). As a result they often miss their target. An astute angler, knowing this fact, will cast his lure back to the same spot after a missed strike and prepare for another strike.

## *Main Activity*

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### **Introduction**

1. Introduce yourself
2. Introduce day's activities:
  - a. Prep for upcoming fishing trip
  - b. Fish identification
  - c. External anatomy
  - d. Form equates function

## Local Fish Species and External Anatomy

1. Introduce external anatomy features while introducing fish species. Focus on mouth, body, and tail fin shapes.
  - Start with one fish and go over all of the features.
  - Introduce 2-3 other species; review features.
2. Discuss how the forms are different on some of the fish but the function is similar. Be sure to address adaptations over time; adaptation vs. adjustment.
3. Discuss proper handling techniques, safety for students and safety for fish, and how knowing external anatomy features can help with fishing.
  - Slime layer=protection=wet hand, no rag or shirt
  - Dorsal fin=protection=slide hand over fin
  - Gills=breathing=do not hold by gills
  - Teeth=eating/protection=do not hold by mouth
  - Body shape=where lives=where to fish
  - What fish eats=what to use as bait

Introduce next activity: fish creation.

- a. Say: Once students have learned features, now they are going to apply these skills to create their own fish.
2. Hand out *Fish Planet worksheet*. Read directions aloud. Have students read different environments to choose from.
3. After reading, point out area to create fish and questions to be answered.
  - a. Students must answer questions thoroughly.
  - b. Worksheets will be collected after class and possibly posted on website or used as display materials.
4. Hand out *Fish Parts worksheet*. Students must use the mouth, body, and tail shapes from the worksheet. All other fins and protection mechanisms are left to the student to decide. All fins must be included.
  - a. Be creative!
  - b. Remind the students that this activity is not a judge of artistic skills, but a chance to apply what they learned about external features and form/function.
5. Give students 10-12 minutes to create their fish.
  - a. Walk around and assist students.
  - b. Helpful tips:
    - Start with selecting planet
    - Decide what your fish will eat=mouth
    - Decide where your fish will live=body
    - Decide how your fish will move=tail fin
    - Decide how your fish will protect itself
    - Sometimes it is easier to start with answering the questions and then drawing the fish

If time allows, after students have created their fish, the instructor will have a few students share their creations and tell why the fish has certain adaptations.

## Wrap up

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### Relation to Fishing

Explain that by simply knowing the external anatomy features of a fish, it can help us with fishing. Give a few examples of certain species and ask the students where they would fish or what type of bait they might use.

*Examples:*

- Flounder- lives on bottom, use sinkers to get bait down to bottom
- Bluefish- lives in top-middle of the water column, use bobber to keep bait afloat
- Chain pickerel- long torpedo body shape helps fish make quick darting movements but it will often miss its target. Cast to the same spot again to give this fish an opportunity to catch the bait.



### Review

- Ask the students to name 3-5 external anatomy features of a fish
- Ask the students to explain how the body form of a fish influences function
- Ask the students which adaptations they found interesting

### Questions for Discussion

Q: What unique adaptation do flounder/fluke have that allows them to lie flat on the ocean floor?

A: one eye migrates, so that both eyes are on the same side

Q: Where do sea robins live in the water column (top, middle, or bottom)?

A: bottom

Q: What does a bluefish eat?

A: smaller fish

Q: If a fish has a forked tail, is it a fast or slow swimmer?

A: fast swimmer

Q: Why do some fish have a spiny dorsal fin?

A: for protection against predators

Q: What are the large pectoral fins of a sea robin used for?

A: makes the fish look larger to predators

Q: If a fish has an inferior mouth, where does it get its food?

A: bottom feeder

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Q: What type of habitat does a largemouth bass prefer?

A: near shelter (logs, weeds, under plants)

Q: What does a bluegill sunfish eat?

A: smaller fish, zooplankton, insects

## Related Materials

Freshwater Sportfish of New York Brochure available on the NYSDEC website:

<[http://www.dec.ny.gov/docs/administration\\_pdf/commonfish.pdf](http://www.dec.ny.gov/docs/administration_pdf/commonfish.pdf)>.

*Printable brochure with photos and descriptions of common freshwater sportfish of NY State*

Nearshore Saltwater Sportfish of New York Brochure available on the NYSDEC website:

<[http://www.dec.ny.gov/docs/wildlife\\_pdf/nearshorefish.pdf](http://www.dec.ny.gov/docs/wildlife_pdf/nearshorefish.pdf)>.

*Printable brochure with photos and descriptions of common saltwater sportfish of NY State*

## Web Resources

“Fisheries Biology and Management,” Maryland Department of Natural Resources (MD DNR).

<<http://www.dnr.state.md.us/education/envirothon/FISH%20ANATOMY.pdf>>.

*Background information on external and internal fish anatomy with diagrams*

“Freshwater Fishes,” NYSDEC. 2012.

<<http://www.dec.ny.gov/animals/269.html>>

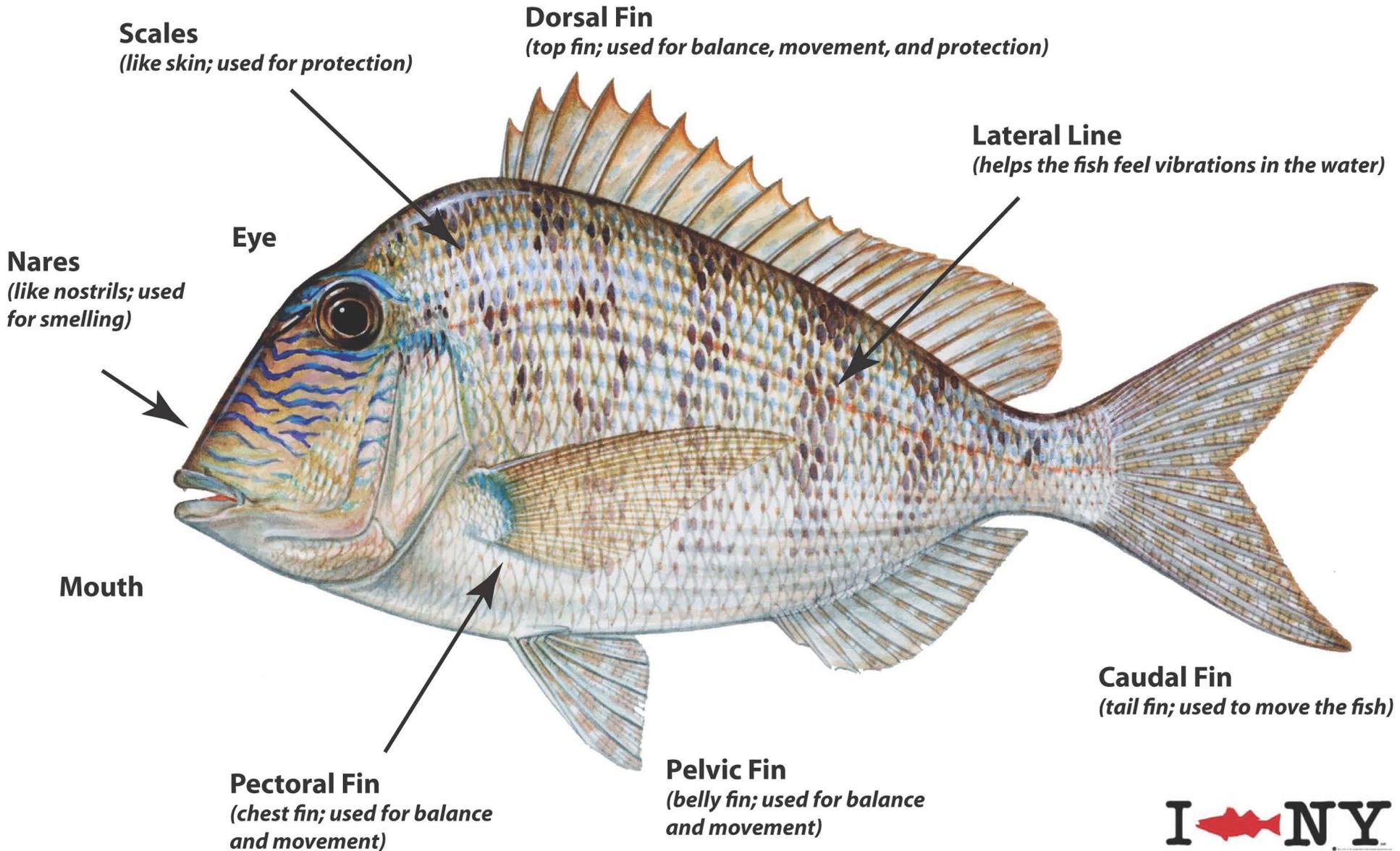
*NYSDEC site providing information on a variety of species, with over ten series on fish including: true bass, common minnows, common prey fish, sunfish, and trout.*

“Marine Fish,” NYSDEC, 2012.

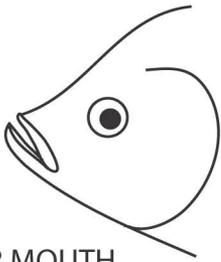
<<http://www.dec.ny.gov/animals/69149.html>>.

*NYSDEC site providing additional information on common marine species in NY waters*

# External Anatomy of a Bony Fish

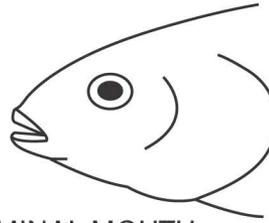


## MOUTH SHAPES



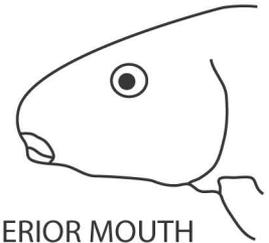
### SUPERIOR MOUTH

- Eats food above it
- May eat at the water's surface



### TERMINAL MOUTH

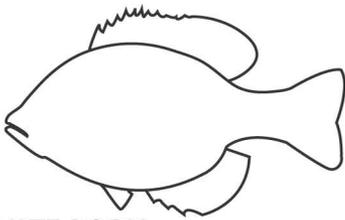
- Eats food in front of it



### INFERIOR MOUTH

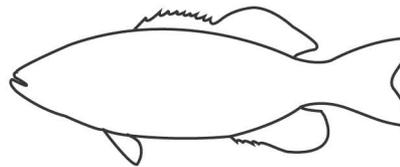
- Eats food below it
- May eat off of the bottom

## BODY SHAPES



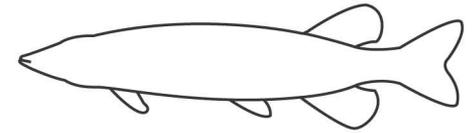
### OVATE BODY

- Slow swimmer
- Difficult for predators to swallow



### FUSIFORM BODY

- High speed swimmers



### ELONGATE

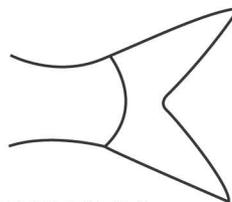
- Hides in rocks and weeds

## CAUDAL / TAIL FIN SHAPES



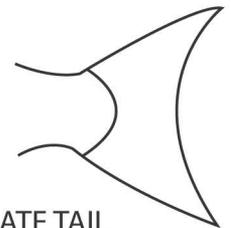
### HETEROCERCAL TAIL

- Fast swimmer
- Constantly moving



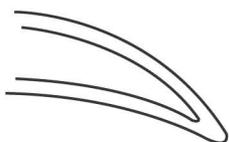
### FORKED TAIL

- Fast swimmer



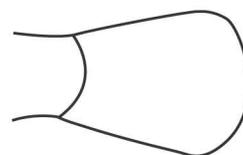
### LUNATE TAIL

- Long distance swimmer



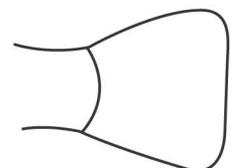
### POINTED TAIL

- Slow swimmer
- Bottom wriggler



### ROUNDED TAIL

- Good at turning
- Fast for short distances



### TRUNCATE TAIL

- Good at turning
- Slower swimmer



# FISH FOR THE FUTURE

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## **Background:**

It is the year 3000, and it is now possible for humans to build planets, and genetically engineer plants and animals to live on that planet. You are one of the scientists working on the animals, and it is your job to create a fish which will be perfectly suited to its environment on this new planet.

## **Task:**

You need to pick one of the following environments of already created planets, and design a fish which is going to be strong and resilient enough to survive in that environment. You need to consider **WHAT** the fish is going to eat, **HOW** it is going to move to get its food, and **WHAT** parts it has to defend itself. Your fish must include at least five external anatomy structures covered in class.

## **Environments:**

*Please select 1 of the following:*

1. This planet is dark and cold. The ocean floor is very mountainous. It rains almost all day. Because of the wet, dark conditions, only a few plants grow at the water's surface. Other marine animals on this planet include a swimming crab, a large nocturnal shark, a giant squid, and a variety of insects.
2. This planet is dry and hot. Most of the ocean floor is flat and covered in sand; although there are four patches of large rocks and coral. Each rock structure is about 50 miles apart. Marine animals on this planet include bottom clams, crabs that dig holes around the rocks, a school of red fish, and a type of dolphin.
3. This planet is tropical: wet and hot. Most of the ocean is covered by large kelp forests. A species of spiny algae grows thickly on the floor. The spines of this plant are poisonous, and any animal which touches one is sure to die. Marine animals include sea snakes, varieties of insects, and a school of 100+ silver-blue fish.
4. This planet has a moderate climate. The ocean bottom is partly mountainous and partly flat. Vegetation includes tall fans of coral with branched arms, and smaller seaweed red in color which bears ten fingerlike arms. Marine animals include insects, slow moving mammals, and a pod of nocturnal killer whales.

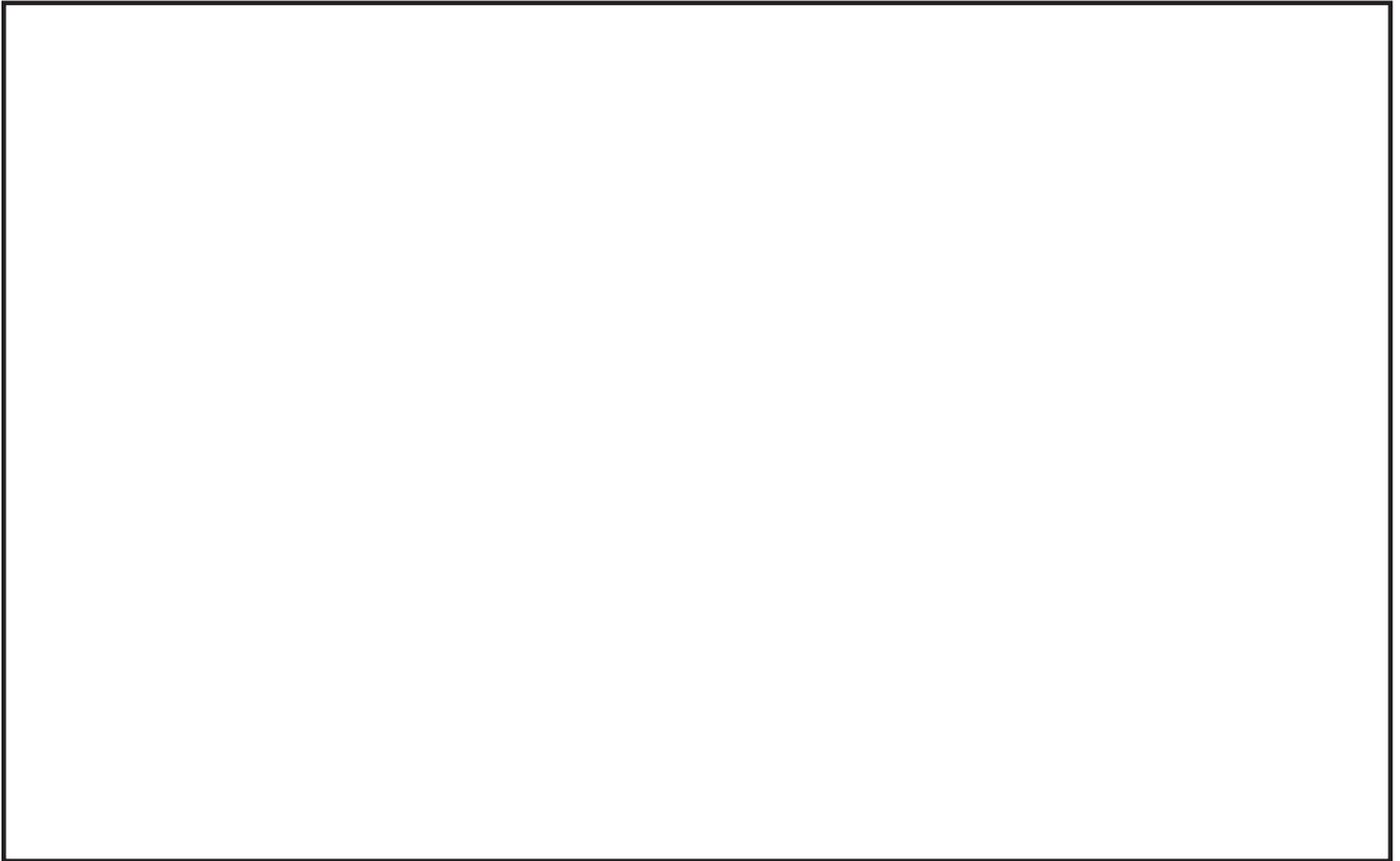
## **Completion:**

You will have about 10 minutes to complete your task. Please be sure to thoroughly answer the questions on the worksheet about your new fish.

# WANTED: A New Species of Fish

*As the head scientist, what can you tell us about your fish?*

**Scientist Name:** \_\_\_\_\_ **Planet Chosen:** \_\_\_\_\_



*In the box above, draw a picture of your fish in its habitat. Think about your fish's shape, fins, and color.*

**Swimming Habits:** *(how your fish swims; based on its tail and body shape)*

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**Eating Habits:** *(how and what your fish eats; based on its mouth shape)*

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**Defense Adaptations:** *(how does your fish defend itself from predators)*

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**Habitat:** *(where does your fish live in the water)*

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**Species Name:** *(create a name that tells something about your fish)*

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