NOAA Gray's Reef National Marine Sanctuary
Acoustic Fish Tagging Project
Activity: Make and Implant a "tag" (transmitter) into a Snapper or Grouper Species – Then Dissect Fish – Grades 9-12

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Focus
Fish anatomy and acoustic technology

Focus Questions
What is the external anatomy of a large, pelagic fish?
How hard is it to perform surgery on a large, pelagic fish?
How big can the equipment be that is being implanted into a large, pelagic fish?

Learning Objectives
- Students will learn the basic external anatomy of large, pelagic fish.
- Students will discover some of the challenges scientist face when working with large fish.
- Students will learn some of the limitations of equipment used to study fish.

Materials Needed
- ✓ 1 package modeling clay
- ✓ A large, pelagic fish for each team. Many snapper and grouper species can be purchased at fish markets around the United States. The particular species of fish does not matter, as long as it is a part of the snapper-grouper complex. Also, remember to purchase the fish whole. Students will learn more with a completely intact fish and will be able to do a dissection activity later with the same fish.
- ✓ Toothpicks and labels or small pieces of paper to serve as labels – allow 30 of each item. The markers are to be placed next to a particular part of the anatomy for identification purposes.
- ✓ Dissecting kit or scalpel or kitchen knives (sharp, thin, flexible)
- ✓ Spoon
- ✓ Newspapers
- ✓ Paper towels
- ✓ Chromatic Gut Sutures. These can be purchased from veterinary supply stores or a thick sowing needle and thread will work.
- ✓ Forceps
- ✓ Microscope

- ✓ Plastic bags (for waste)
- ✓ Soap and water (for washing up)

Total Teaching Time
Three 45-minute periods

Seating Arrangement
Sufficient space for each student team to comfortably and safely work on a two to three foot long fish.

Maximum Number of Students: 30

Key Words

Abdominal cavity	Anal fin	Brain
Caudal (tail fin)	Dorsal fin (spiny and soft-rayed)	
Eyes	Gills	Gonads
Heart	Intestinal tract	Kidneys
Lateral Line	Liver	Muscle tissue
Operculum (gill cover)	Otoliths	Pectoral fins
Pelagic	Pelvic fin	Receiver
Scales	Spinal cord	Swim bladder
Stomach	Transmitter	Vent (on a fish)
Ventral		

Background Information
In this lesson, students will learn about the anatomy of snapper and grouper species. Also, students will begin to understand some of the obstacles that are entailed in an acoustic tagging project.

Purpose of Acoustic Tagging
To better manage marine resources, we need to understand the biology of fishes and what factors impact their behavior. The acoustic tagging project will help managers understand how much time red snapper and three grouper species (gag, red and scamp) spend in particular areas of Gray's Reef National Marine Sanctuary. Also, this project will allow tracking of their daily, seasonal, and annual movements to better understand the behavior of these fish. The movement patterns may vary between individual species being studied or between individual age groups.

There are several questions we hope to answer, such as:

- Do resident times differ between species?

- How does temperature or weather affect the amount of time the fish spends in the sanctuary?
- Does the time of day have an effect on the amount of time the fish spends in the sanctuary?
- Does the period of the lunar cycle have an effect on the amount of time the fish spends in the sanctuary?

Acoustic tracking offers many benefits as compared to direct observation or conventional tag and recapture. Direct observations of subjects may alter fish behavior. In contrast, acoustic tagging allows us to detect whether a fish is present in or absent from the target area, without having to be there. Also, conventional tag and recapture can have more impact on the fish since this process requires the fish to be handled multiple times. Acoustic tagging allows us to receive more present-absent data with relatively less stress to a fish.

Tags and Receivers

Sixteen fish are currently tagged with transmitters: seven scamp, *Mycteroperca phenax*, five gag, *Mycteroperca microlepis*, three red snapper *Lutjanus campechanus*, and one red grouper *Epinephelus morio*. These fish were caught using hook and line and vented (gas expelled from swim bladders) using an empty hypodermic needle. The tags were then surgically implanted into the fish's abdominal cavity. These tags emit a unique "ping" every 120 seconds at a given frequency, which the acoustic receivers can detect up to about 200 meters.

Fourteen acoustic receivers are deployed in the sanctuary. An acoustic receiver array consists of the receiver attached to a buoy line that is suspended vertically in the water column using two subsurface floats and a steel bar as an anchor. The receiver is attached about 1.5 meters from the bottom so that when the bottom gets stirred up by fish or weather the receiver is not affected. Divers retrieve the receivers once every three months, download the data, and then return to the mooring.

Tagging the Fish

Tagging the fish is a difficult process. The first requirement is catching a fish without damaging it or causing it to die. This can be problematic since being caught can be very stressful to the animal. When fish are stressed, they are more prone to die. Also, snapper and grouper live at the bottom of the water column. This is usually 60 ft or more below the surface. When a fish is brought to the surface quickly, the pressure from the water is dramatically decreased very rapidly. This causes the air in their swim bladder to expand rapidly. The swim bladder can expand so much it ruptures, but more likely will push other organs out of the way and may damage them. So fish that

have been brought up from the deep frequently have their swim bladders protruding from their mouths, eyes bulging out, and stomachs expanded like a balloon. Trying to keep these fish alive is a hard process that requires a skilled fisherman to catch the fish and another person skilled in how to properly vent the air from the fish.

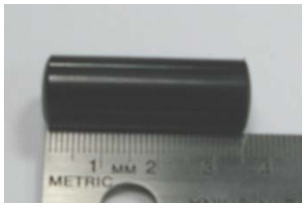
The next problem is how to hold the fish and conduct the surgery. Fish are really slimy and don't like be still. Also, there is no way to put the fish to sleep or "knock it out" to conduct any work on it. Scientists have to be able to get a very good grip on a fish to work on it. With smaller fish this really isn't a large problem. But snapper and grouper species can be 3 or 4 ft long. The larger the fish, the more powerful it is. This creates the need for scientists to figure out a way to hold the fish to work on it, which usually takes more than one person.

One more problem with trying to tag a fish with internal tags is not killing the fish during surgery. When making an incision in the fish, scientists have to be really careful not to cut any of the internal organs. When the incision is made in the belly of the fish, there is only a centimeter or two between the muscle layer and the intestines. If a scientist cuts the intestines, the fish will not be able to survive. This should be an easy fix by cutting "softly" into the fish, but sometimes that doesn't work. The skin and muscle a scientist needs to cut through is really thick and very tough. This requires that scientists know what they are doing and how to do it. Remember that while trying to do this, if the fish isn't held down well enough, it will move! There is also the added difficulty of the boat moving about in the waves, so scientists must be able to work in unstable conditions.

Period #1: 45 minutes

Seating Arrangement
Sufficient spaces for students to sit at their desks

Activity Instructions
Ask students about their knowledge of snapper and grouper species. Ask why they think understanding the anatomy is important. Ask why they think understanding the movements of the fish is important. Ask students to choose a fish type and do research on the internet to find out the answers to the questions. Ask students to report their findings back to the rest of the class.



The tags will be molded out of the modeling clay. Each team will make one tag and let it dry for at least 24 hours. Pinch off a piece of clay about the size of a half dollar. Roll the clay in your hand to make and ball. Then roll it side to side to make the ball into a cylinder. The end result should look about like the photo to the left and it should be smaller than an AA battery.

Period #2: 45 minutes

Seating Arrangement

Sufficient space for each student team to work comfortably and safely on a two to three foot long fish.

Activity Instructions

Lay out newspaper on the desk and hand students a snapper or grouper species. In groups of 2 or 3, have them label all of the external anatomy. They can view Figure 1 for information.

After the external anatomy is labeled, students can surgically implant their transmitters into the fish. Using a scalpel, students should make a 1 inch incision about 2 inches forward of the vent (Figure 2 a & b). Remember to make a very shallow cut; it is very easy to nick the intestines that are on the other side on the muscle. Once the incision is made all the way into the abdominal cavity, slide the transmitter into the abdominal cavity (Figure 2 c). Once the transmitter is in place, prepare to close the incision with sutures. With the needle, pick the scales around the incision off. Only one or two layers of scales around the incision will need to be removed. It is easier to handle using the needle if the needle is held in a pair of forceps. Slide the needle into one side of the incision, all the way through the skin and muscle, but be careful not to nick the intestines (Figure 2 d). Slide the needle back out of the other side of the incision through the muscle and skin (Figure 2 e). Pull thread through until there is enough on both sides to tie a knot. Tie a square knot in the thread (loop thread over-under one way, and then the other way) and cut the excess thread off (Figure 2 f). Repeat creating a suture two more times. The incision should take no more than 3 sutures to completely close the cut (Figure 2 g). Make sure to space the sutures out.

If time permits, clean one of the scales carefully with water and a paper towel. Look at the scale through a microscope. You should be able to see rings in the scale. Count how many rings there are on the scale. This tells you the age of that scale. The age of the scale could be the age of the fish, if they were never damaged in that area. The only way to be able to age a fish

is to age a lot of scales and determine the oldest, or you could extract the otoliths from the fish's head and count the rings on the otoliths. The otoliths can never be removed from the fish while the fish is still alive, so the rings on them are a more accurate age of the fish.

Period #3: 45 minutes

Seating Arrangement

Sufficient space for each student team to comfortably and safely work on a two to three foot long fish.

Activity Instructions

Students should group together in sets of 2 or 3 as before. If there are any students who are squeamish about the dissection, make sure they are grouped with some who are not.

Place the fish on its side with its belly towards you. Using the tip of a thin and flexible knife (or scalpel), cut from the vent towards the front of the body (Figure 3, path 1). Cut only as far as the pectoral fins, passing in between the pelvic fins. Move the fish so the belly is pointing away from you. Then start a second incision from the just behind the pectoral fin and go towards the belly until it crosses the end of the first incision (just below the pectoral fins) (Figure 3, path 2). Be careful of the ribs in this region. They are sharp and are pointing down at the belly. Also, remember to always cut away from you!
If students are having trouble seeing into the abdominal cavity, then a third cut similar to the second cut can be made on the opposite side of the fish. Also the excess muscle over the abdominal cavity, which is now hanging free, can be carefully cut off.

Once inside the abdominal cavity students can label the internal anatomy. If it is a reproductively mature adult, the gonads can be removed. If they are incased in a membrane, cut the connective tissue to the membrane. If they are not in a membrane, they can be removed using a spoon. They can view Figure 4 for information.

Extensions:

#1. Visit a public aquarium with your students and observe the various species of fish. Discuss the different types and sizes. Include ideas on whether fish are pelagic or benthic, the depths where they may be found and whether this acoustic tagging project would work for these species.

#2. Assign or ask the students to choose another tagging project and write a report on it. The students should be able to use the internet to research different projects and to download images.

#3. Ask students to design their own tag and receiver using modeling clay, pipe cleaners, toothpicks, etc. and then describe to the class how their system would work.

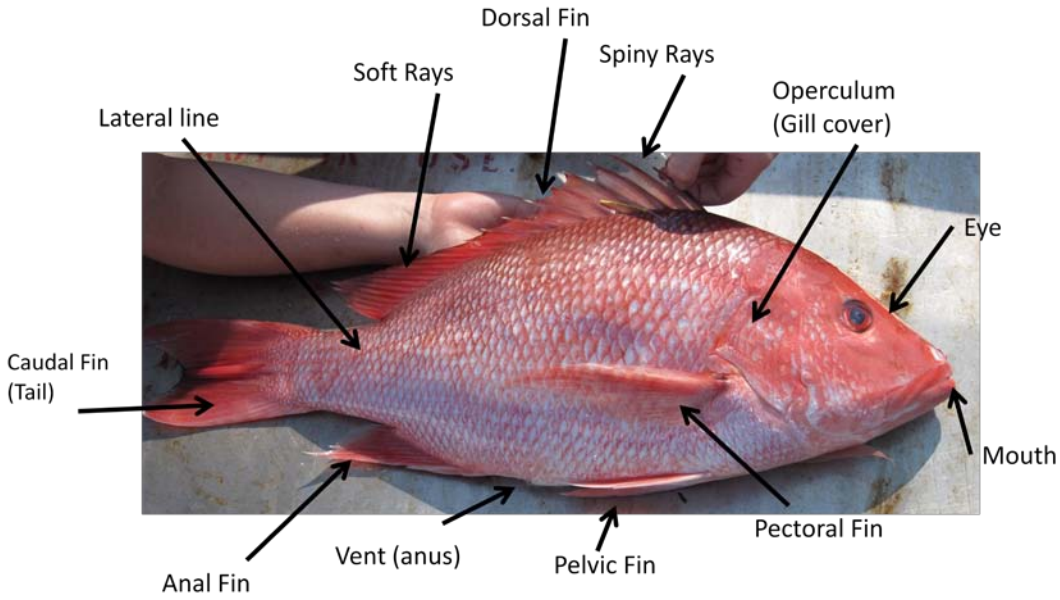
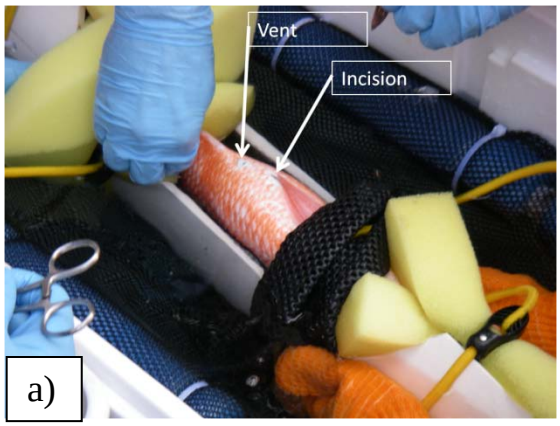
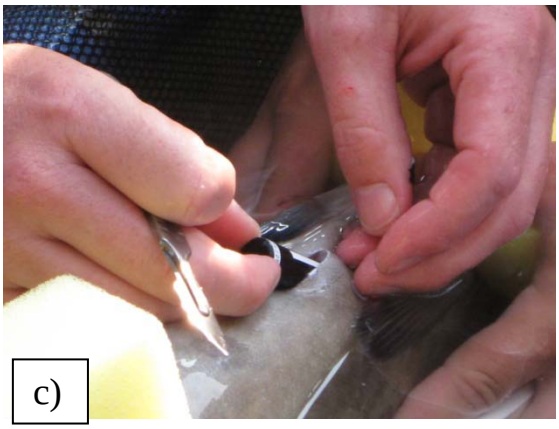


Figure 1: The external anatomy of a red snapper (*Lutjanus campechanus*).





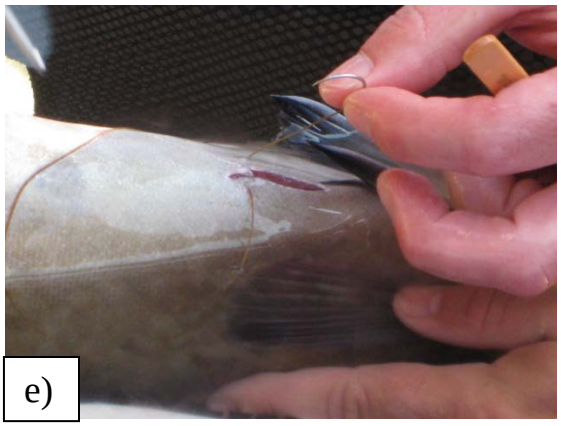


Figure 2: a) Fish about to undergo surgery with the vent and incision area labeled. b) Using a scalpel to start incision. c) Inserting the acoustic tag. d) Inserting the needle to start the closing suture. e) Pulling the needle through the opposite side of the incision. f) Tying the suture closed. g) Closed incision with 3 sutures.

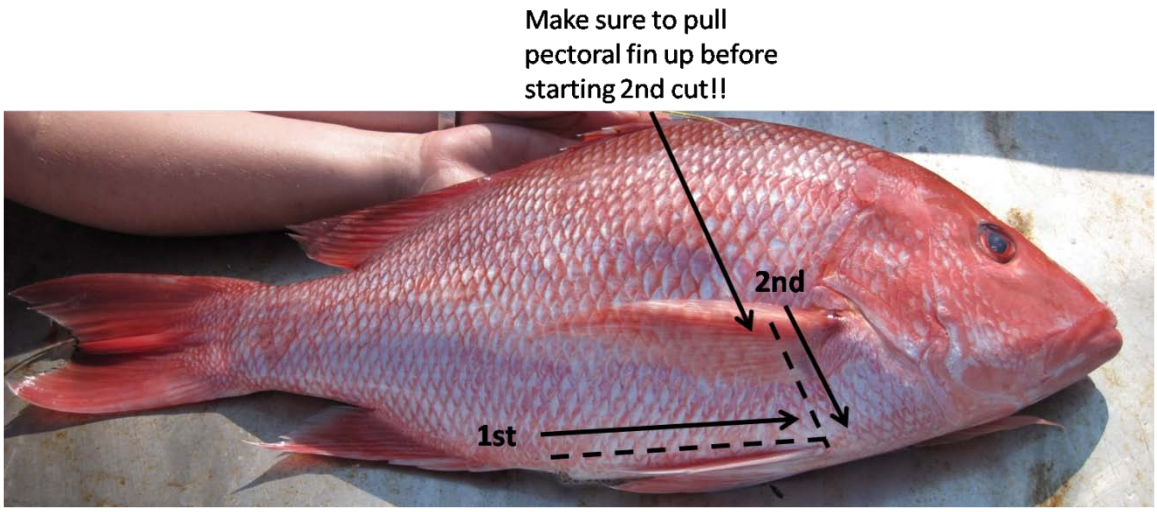


Figure 3: Cut lines along a red snapper to illustrate the location and direction that dissection cuts need to be made.

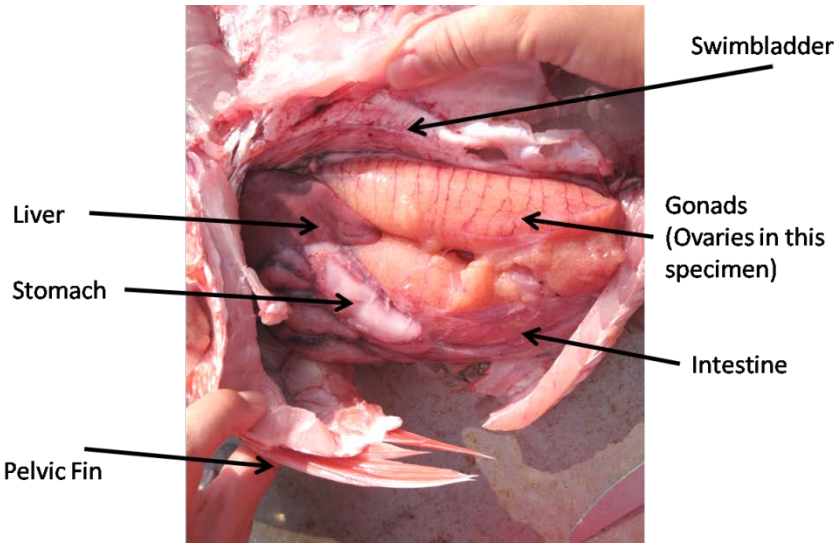


Figure 4: The internal anatomy of a red snapper (*Lutjanus campechanus*).