Charting Fish Behavior & Movement

Below are suggested additions to the Charting Fish Behavior & Movement "Beyond the Activity" in the It Takes All Kinds (Lawrence Hall of Science MARE 1994) to incorporate information learned from Dr. Jensen's presentation and subsequent discussion.

Lesson Overview

Students observe and keep daily logs of behaviors, patterns of movement, individual variations in feeding, growth, and breathing patterns.

Lesson Rationale

Learning observation skills will assist students in understanding fish behavior and interactions among individuals as well as individuals with their environment.

Materials

1. Classroom aquarium with fish
2. Clear plastic acetate or plastic wrap
3. Adhesive colored dots (multiple colors)
4. Stopwatches or timers
5. Computer and projector

Preparation

1. If possible, set-up a classroom aquarium with multiple fish species or organize a trip to an aquarium.
2. Explore the Tagging of Pacific Predators website (http://topp.org/) and the Interactive Fish Tag Display website (http://www.admb-foundation.org/FishTagDisplay/tagDisplay.html).
3. Cut multiple pieces of clear plastic wrap the size of the classroom aquarium.

Procedure

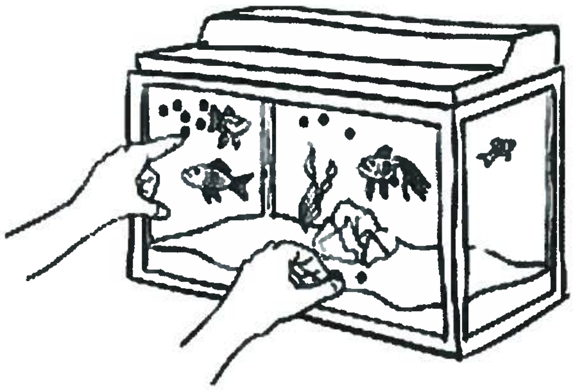
1. Explain that scientists use a range of different methods to track fish behavior that often involves tagging the fish. If possible, bring up the Tagging of Pacific Predators website (http://topp.org/) and have the students "tag" one of the creatures on the map and watch it move around the Pacific Ocean. Explain that the animals are real top predators (sharks, fish, turtles) that have had tags attached to their bodies that use a device like a GPS unit

to send information about the location of the fish to satellites. Have the students look for patterns in the movements of the animals.

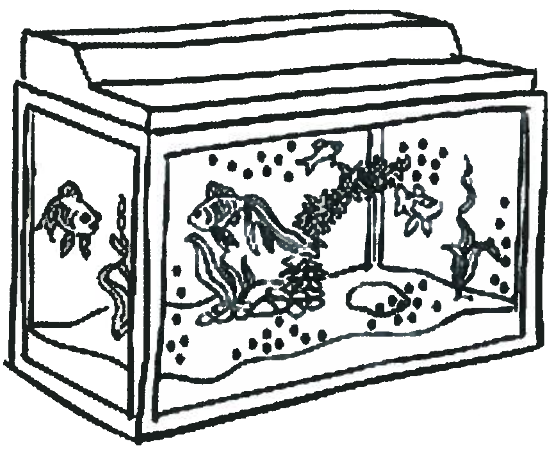
2. Then talk with the students about how scientists often use different types of tags to "observe" the movements of fish over time.
    a. Some tags are not active, meaning that they attach to the outside of the fish but a scientist only gets information about the location of the fish when a fisherman catches the fish and calls the scientist. Bring up the Interactive Fish Tag Display (http://www.admb-foundation.org/FishTagDisplay/tagDisplay.html) website of the Google Maps program. Show the students the Recapture Map. Click on an icon and information about the fish will appear. Select one of the icons in the top right corner and the students will be able to see a direct line from where the fish was first caught (Release) to where it was caught a second time (Recapture).
    b. Compare the time between the Release and Recapture. Ask the students if they think the fish swam in the direct line that is shown on the map between those two points. Explain that this is why some scientists use active tags to be able to get more information about how fish move. Click on an icon that has a black dot in the middle of it. Students will be able to see the actual movement pattern of the fish between the Release and Recapture. Then select the Animation page and play the animation to have students observe the movement of different fish in the project.
3. Tell the students that they are going to be scientists to observe patterns in the behavior and movement of the fish inside of the aquarium just like the two examples you just showed them. However, they have the advantage that they can actually see the fish!
4. Divide the class into small groups. First, have the students observe the fish to look for behaviors and movements. Have the students think about:
    a. Do certain fish tend to hang out in certain places?
    b. If so, why do you think they do?
    c. What might happen when you add food or other objects to the aquarium?
    d. What are some other ways you could keep track of the movements and habits of your fish?
5. The ask the groups of students to think of and write down different behavior and movement patterns they observed and ways to track the chosen behavior and movement patterns.
6. Bring the class back together and have the different groups share their observations and ideas about how they think the class should scientifically observe the fish behavior and movement patterns.
7. Brainstorm with your students which potential behavior patterns they might observe (feeding, growth, defending territory, etc.). Write down the students' ideas on the board. Repeat the brainstorming session for different movement patterns they might observe. Ask the students if they think the movement patterns would differ for different

behaviors? At different times of day? For different species? At the end of the brainstorming session decide as a class which behaviors and movements you are interested in observing.

8. Explain that the students are going to create their own maps of how the fish move. They will use color dot stickers to mark the location of a fish.



9. They will then continue to place a colored dot where the fish is every 30 seconds for five minutes.



10. Pull off the clear plastic wrap and replace with a new piece of clear plastic wrap. Have a different student group repeat the observations. This can be done over multiple times during the day or during a week.
11. At the end of the investigation, display all of the clear plastic pieces with colored dots from the different groups. Have the students compare across the pieces to see how the paths of the fish differ over time.
12. Possible extensions for the activity include discussing with your students how patterns in behavior and movement may change across different habitats (would fish act the same over sand vs. coral reefs vs. in the open water column?) and in different life stages of a fish (many species along New Jersey spend their juvenile stage in bays and estuaries before moving to the ocean as an adult).

115
NEW TOOLS TO STUDY MARINE ANIMALS

The previous plate introduced manned and unmanned vehicles to explore the ocean. Equally impressive is the new generation of instruments used to study marine animals. Traditionally, scientists studying salmon and marine mammals took advantage of the animals' reproductive behaviors that brought them back to specific spawning streams and rookeries. Here, animals could be tagged during one reproductive season and then monitored for their return the following season. These methods provided information on mortality and growth, but told the scientists nothing about where the animals had been and what they were doing during the intervening period. Gathering accurate information for free-ranging animals like swordfish and tunas was virtually impossible. With modern tracking technology, scientists can monitor more marine animal populations and can also track the behavior and physiology of individuals.

Color the animals and the modern data gathering devices as they are discussed in the text.

Scientists studying *great white sharks* entice the shark to swallow a small transmitting instrument package, which houses a temperature (*thermistor*) and depth recorder, by wrapping it in a hunk of elephant seal or horse meat. Once ingested, the cigar sized (22 cm long by 3.5 cm diameter, 8.5 in by 1.5 in) transmitter sends out a signal that can be monitored using hydrophones, allowing the scientists to follow the shark in a small boat. The information sent includes the shark's depth and internal temperature. Data gathered by these instruments have provided scientists with their first insights into great white shark foraging and territorial behavior. The internal body temperate data allowed the researchers to verify the hypothesis that the great white shark maintains an internal core temperature considerably above that of the ambient sea water.

Scientists from the Tuna Research and Conservation Center in Monterey, California (a joint program of Stanford University's Hopkins Marine Station and Monterey Bay Aquarium) have worked with engineers to develop a pair of ingenious tags to study large pelagic fishes. The "*pop-up*" tag is an external device, weighing only 70 grams (2.5 ounces), anchored by a dart in the muscle below the fish's second dorsal fin. It contains a tiny microprocessor and satellite transmitter that can store and transmit data. The buoyant device is designed to pop off the fish by producing an electric current at a preprogrammed time that accelerates corrosion of the metal clasp fastening the tag to the fish. The tag floats (pops up) to the surface where it then transmits its location via satellite to the shore-based researchers. These data provide the scientists with their first look at large scale movement patterns of these economically important and severely threatened species. One of the pop-up tags recorded a Pacific *blue marlin* that traveled from Hawaii to the Galapagos Islands, a distance of more than 4500 km (2800 miles), in 90 days. Pop-up tags can be programmed to release at any time interval and have been deployed for up to a year. In an initial tagging experiment mounted with the cooperation of the fishing community of Cape Hatteras, North Carolina, 35 of 37 pop-up tags attached to bluefin tuna successfully transmitted data.

The second instrument used by the tuna researchers is the *archival tag*. Initially developed for marine mammals, the tag has been made smaller and is now used to study fish ranging in size from large pelagic fish like *bluefin tuna* to smaller tunas and plaice. The archival tag has a 10 cm (4 in) long piece that is implanted into the body cavity of the fish with a 15–20 cm (6–8 in) external stalk. It gathers and records data on the fish's swimming depth, its body temperature, the temperature of the surrounding water, and light intensity. The light data provide information on sunrise and sunset from which the scientists can calculate the fish's latitude and longitude (geoposition). The tags can be set to sample over a range of intervals for up to one year. Unlike the data-transmitting pop-up tag, the archival tag data can only be retrieved if the fish is caught and the tag recovered. Despite this liability, data obtained from archival tags have already provided initial crucial evidence concerning the movement and stock structure of Atlantic bluefin tuna. Ultimately, with continued tagging and data recovery, more enlightened and effective management of these magnificent fish can be achieved.

Marine mammal biologists have known for years that many large pinnipeds such as elephant seals and fur seals forage far at sea for extended periods, but could only speculate on the hunting regimen employed by these animals. Long-term *time* and *depth recorders*, slightly smaller than a soft drink can, are now employed with wondrous results. The recorders are attached with epoxy to the heads of *elephant seals* and recovered when they return to shore. Data provided by these instruments reveal that an individual elephant seal will dive to depths up to 900 meters (3000 ft), remain submerged for periods up to 45 minutes, surface for an interval of only a few minutes, and immediately repeat the dive profile. This exhausting feeding behavior has been recorded for female elephant seals to last continuously for several weeks, interrupted only by sporadic, half-hour naps at the surface.

NEW TOOLS TO STUDY MARINE ANIMALS

DATA RECORDERS*
- THERMISTOR a
- POP-UP TAG b
- ARCHIVAL TAG c
- TIME-DEPTH RECORDER d