Fish and Shark: Background Information & Pre and Post Activities

BACKGROUND INFORMATION

BASIC ECOLOGICAL CONCEPTS

Ecology is the study of the relationships between organisms and their environments. An ecologist asks questions like: Where does this organism live and what characteristics make it particularly suited for that location? How does this organism get its food? What other organisms eat it? By asking questions such as these some basic principles have emerged. Understanding the following basic ecological concepts help us appreciate the complexity of life residing in and around the Bay.

Everything is related to everything else

Perhaps the easiest place to see interdependence in the environment is to look at food. All food on this planet is essentially made by plants through the process of *photosynthesis. Herbivores* are animals, which depend directly on plants for food. *Carnivores* eat herbivores. Take away all of the plants and there would be no animals. Can a plant, then, exist independently of all other organisms? No. Although it doesn't eat, a plant needs *nutrients* and is dependent on *decomposers* (bacteria and fungi) to break down dead organisms, thereby releasing these nutrients for use by the living plant.

Everything depends on something else

All organisms are also dependent on factors in the physical environment. They must have a source of water. Animals must have oxygen to breathe. Plants must have sunlight to perform photosynthesis. You can probably think of many more examples of how organisms are dependent on their environments.

Everything must go somewhere

No object ever disappears completely from the face of the earth. It may be broken down into atoms and be used to build something else, but those atoms are still there. In this way, nature deals with waste by recycling. Any plant or animal that does not become food for some animal becomes food for decomposers, which free the nutrients to be used again. Anything that cannot be decomposed must remain in the environment as it is. What are some examples of this kind of waste? The next time you throw something away, you might remember that there really is no "away" to throw it to.

Earth's resources are limited

How often do you run out of time to do what you want or need to do? Everyone knows that each day only has so much time in it, and that we have to be careful how we use it if we are going to

accomplish everything we need to. The earth's available resources are like time in that we have to be careful how we use them, or they might run out. There is only so much gold, so much petroleum, so much fresh water, so much food, and so much space. All organisms are limited by the availability of resources, but humans have a special opportunity and a special responsibility. Although plants cannot make a decision to conserve clean water, humans can. To do this intelligently we must find out how much of each resource is available and then we must budget our use. We must also think about recycling. The earth can recycle its components naturally but humans must make special efforts to preserve the natural resources.

ICHTHYOLOGY

Perhaps the most familiar of all the organisms that live in the Bay are the fish. If an animal lives in the water, has a backbone, breathes with gills, is cold-blooded (has the same temperature as its surroundings), and has fins, chances are the animal is a fish. The study of fish is called Ichthyology. Fish are nektonic animals, meaning they swim in the open water. This section focuses on the fish most likely to be seen in the Bay.

WHERE FISH ARE FOUND

The water column is divided into three zones; top, middle and bottom. Fish living in the top zone are usually long and torpedo-shaped. They eat plankton and exhibit counter-shading. Mid-water fish have football-shaped bodies and strong muscles to swim fast enough to catch smaller, slower fish. Bottom fish are usually flat, and are predators.

FISH ADAPTATIONS

An adaptation is a physical characteristic or behavior that an animal evolves to become better suited to their environment. Taking a look at the external form or structure of a fish can tell us a great deal about where it lives and how it makes its living. The shape of the fish's body, the size and shape of its fins, the size and placement of its mouth, and the coloration of the fish each has a story to tell.

SHAPE

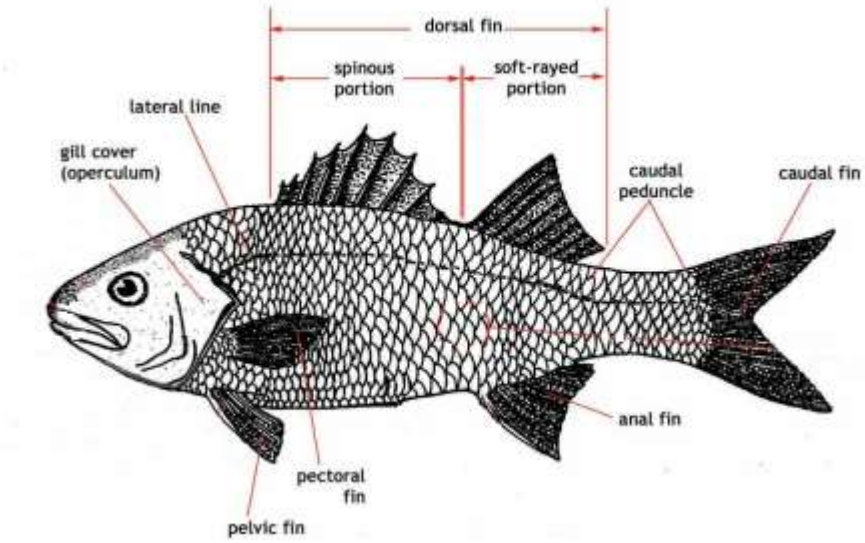
Fish that live on the bottom are often flat (or depressed), in order to conform to the surface on which they live. Mid-water fish are often laterally compressed for ease of movement through the grasses and crevices where they forage. Fish that live near the top of the water often have a long, slender, torpedo-shaped form in order to move quickly.

FOOD

Much can be learned about a fish's place in the food web by looking at its mouth. Fish like the California halibut, which are carnivorous and eat other fish, have big mouths and sharp teeth. Some fish, including anchovies, have sieve-like gill rakers (projections inside the gill openings that support the rakers) that filter plankton from the water. Bat rays, which feed on clams and other

invertebrates, have a mouth positioned underneath their body, which is equipped with hard plates for crushing the shells of their prey.

EXTERNAL FISH ANATOMY



FINS

Fish have fins to help them move through the water. Each of the fins on their body has a different job. The tail fin, or caudal fin, gives the fish power and helps it move forward. The pectoral and pelvic fins help steer the fish, and in some fish help it move forwards and backwards. The anal and dorsal fins aid in stability, and in some cases they help propel the fish forward.

CAMOUFLAGE

Another external adaptation is the coloration fish have developed to avoid detection by their predators. The black bars of the leopard shark, for example, help disrupt the outline of its body. Many flatfish can change the color of their body to match that of the surface where they are living. Most fish display counter-shading, being dark on the top and light on the bottom. This helps them to blend in with the water and the bottom when seen from above and the sky when seen from below.

GILLS

Fish breathe by absorbing dissolved oxygen with their gills. Water taken in through the mouth moves over the gill filaments and passes out under the gill covers. Since less oxygen is present in water than in air, a fish's gills must be more efficient than lungs. Numerous filaments on the gill rakers (support for the filaments) are intended to increase the surface area of the gill, thus allowing greater intake of oxygen.

SENSORY ORGANS

Fish are able to perceive color. They do not have eyelids or tear producing glands. Nasal openings, or nares, can "smell" substances in the water. This is an especially important sense in salmon, which are thought to use nares to find their home spawning stream. Fish also have a sense of taste. Taste receptors are located in the mouth, head, and on other body surfaces. Feelers called barbels are located near the mouth. Fish can both hear and make sounds. The ear is entirely internal, and serves as a balance organ as well as an organ for hearing. Fish also sense their environment through the lateral lines which run the length of both sides of their body. The lateral line detects pressure changes in the water and enables the fish to register movement and distance.

Following is some information on specific Bay fish to help your students prepare for their program.

BOTTOM DWELLERS:

FLATFISH California Halibut, Diamond Turbot, Starry Flounder

Camouflage: Flatfish have an amazing ability to change color depending on the type of ground cover in the area. Thus, if a brown-colored flatfish living on a muddy bottom suddenly found itself in an area covered with white and brown rocks, its color would quickly change to a mottled white/brown appearance to blend in with its new surroundings!

Food: Eat mainly worms, tiny crabs, clams, or small fish.

Predators: Sharks, marine mammals, and humans.

Fun Fact: Flatfish actually begin life with one eye in the traditional position on each side of the head. Immediately after birth, however, one eye begins migrating across the head to lie next to the other eye on the opposite side. Because the fish lays flat on one side, having two eyes on one side is a distinct advantage in sighting both predators and prey!

SHARKS Leopard Shark, Brown Smoothhound

Descriptions: Leopard sharks are grey with heavy black bars and spots. Brown smoothhounds are a solid, coppery-brown color.

Food: Eat mainly small fish, shrimp, crabs, and clams.

Predators: Humans are the main predators of adult sharks.

Fun Facts: Sharks have no bones; their skeletons are made up of cartilage, like our noses. They can hear prey up to 1 mile away! Although they have generally poor eyesight, they have a great sense of contrast. Their eyes have a special layer that intensifies light so they can see their prey in near darkness.

Sharks have ancestors older than the dinosaurs by 200 million years! Although they have bad reputation, only 7 out of 365 species of sharks are truly dangerous

to humans. Most are small, timid creatures more likely to flee from a swimmer than attack.

MIDDLE DWELLERS:

SURFPERCH Shiner Surfperch, Barred Surfperch

Description: Perch are normal fish shape (laterally compressed) and dwell in the mid-water zone. The barred surfperch has 6-10 dark vertical stripes on each side; the shiner surfperch has 2-3 faint yellow vertical stripes on each side.
Food: Worms, plankton, and sand crabs.
Predators: Birds, fish, and marine mammals.
Fun Facts: Their front-positioned mouth and small teeth allows them to eat smaller fish and other invertebrates. The lateral line is visible as a dark, thin strip running the length of sides. Used as "ears," these lines sense vibrations in the water.

TOP DWELLERS:

SMELT Topsmelt, Northern Anchovies

Description: Smelt are long, silvery and torpedo shape, with small mouths located at the front of their body. Anchovies are also long and silver, but have long lower jaws.
Food: Plankton and small crustaceans.
Predators: Many different birds and fishes. Also fished commercially and as sport.
Fun Fact: Top-dwelling fish school or group together when threatened by predators. This behavior possibly confuses the predator into believing that the school is one big fish!

GLOSSARY

ADAPTATION	Modification of an organism in order to survive within its habitat.
BENTHOS	The substrate at the bottom of a body of water; the adjectival form of benthos is benthic.
BIODEGRADABLE	Something capable of being broken down to simple compounds, especially into harmless products, by the action of microorganisms.
BIODIVERSITY	The richness, abundance and variety of life across all trophic levels of which all ecological systems, including the planet earth, are comprised.
BRACKISH	Water that has more salt than fresh water but not as much as seawater.

CAMOUFLAGE	Method of hiding in which organisms blend in with their surroundings.
CARNIVORE	An animal that consumes other living animals.
COMMUNITY	A group of plants or animals living in the same area and depending on one another for survival.
CONSUMER	An organism that gets its nutrients by eating other organisms.
DECOMPOSER	An organism that breaks down organic material and releases simple substances usable by other living things. Examples of decomposers are bacteria and fungi.
DECOMPOSITION	The breakdown of substances into inorganic forms.
DEPOSIT FEEDER	An animal that feeds by ingesting substrate and filtering out the small organic particles on the substrate.
DETRITIVORE	An animal that eats detritus.
DETRITUS	Dead plant and animal material.
DIATOM	A type of microscopic, one-celled photosynthetic organism. All diatoms are surrounded by a silica shell and most are a golden brown in color.
DICHOTOMOUS KEY	A tool used to identify organisms based on their physical features.
DISSOLVED OXYGEN	Oxygen that has dissolved in water and can be used for respiration.
ECOLOGY	The study of relationships between organisms and their environment.
EDGE COMMUNITY	A productive area where land and sea interface. This community, because of its proximity to land, receives huge inputs of sediment, nutrients and freshwater, which in turn supports a diversity of plants and animals.
ENDANGERED	An organism that is threatened with extinction.
ENVIRONMENT	The sum of all physical and biological factors that affect an organism.
ESTUARY	A semi-enclosed body of water where salt water and fresh water meet and mix.
FILTER FEEDER	An animal which extracts food particles by straining the water. Examples of filter feeders are clams, oysters, sponges and some fish.
FOOD CHAIN	A sequence of living organisms in an ecosystem in which members of one level feed on those in the level below and in turn are eaten by those in the level above them.
FOOD WEB	An assemblage of organisms in an ecosystem, including plants, herbivores and carnivores, which shows the relationship of "who eats whom."
GILL	An organ used for underwater breathing or respiration by fishes and some invertebrates.
HABITAT	The particular area in which an organism normally lives.
HERBIVORE	An animal that eats plants.

ICHTHYOLOGY	The study of fish.
INVERTEBRATE	An animal without a backbone.
NUTRIENTS	The raw materials necessary for continuing life processes.
OCEANIC ZONE	The area that encompasses the open water that lies beyond the continental shelf.
OMNIVORE	An organism that eats both plant and animal material.
OVOVIVIPAROUS	Reproductive strategy where mother bear young that develop internally but are unattached to a placenta inside the mother (born live from an egg).
PELAGIC	Living or occurring in the open ocean.
PHOTIC ZONE	Upper sunlight portion of the water column. The depth of the photic zone in the ocean ranges from 30 to 200 meters.
PHOTOSYNTHESIS	The process used by plants to make food; in this process light energy is used to combine carbon dioxide and water to make carbohydrates (sugar and starch); oxygen gas is given off as a by-product.
PHYTOPLANKTON	Algae, usually microscopic, which freely drift in the sunlit portions of the water column.
PLANKTON	Drifting aquatic plants and animals; the adjectival form of plankton is planktonic, and a planktonic organism is called a plankter.
POLLUTION	Harmful impact on the environment resulting from human activities.
PREDATOR	An animal that captures other animals for food.
PREY	An animal caught for food.
PRODUCER	An organism that makes its own food; an example of a producer is a green plant.
RESPIRATION	Process used by animals and plants to release energy from food; this process requires oxygen and releases carbon dioxide and water.
SALINITY	The amount of salt in the water. Measured in parts per thousand.
SCAVENGER	An organism that is an opportunistic feeder; scavengers usually include dead and decaying animal flesh in their diets.
SPECIES	A population of plants or animals that are able to produce viable of with each other and not with other species.
TIDES	The daily rise and fall of the sea level along a shore, occurs twice a day on our local shores.
TUBE FEET	In echinoderms, hollow appendages filled with water and operated by the water-vascular system. Used for attachment, movement and the capture of water.
VERTEBRATE	An animal with a backbone. The back bone can be made of bone or of cartilage like in some fish (sharks and rays).
VIVIPAROUS	Reproductive strategy where mothers bear young that are nourished through a placental attachment (live birth).

WATER-VASCULAR	A system of canals, bulbs and appendages filled with sea water. This system is involved in locomotion in echinoderms.
ZOOPLANKTON	Animal plankton.

PRE-VISIT ACTIVITIES

You may want to ask your librarian to set aside ecology or marine science books for your class, or ask students to bring books and magazines from home to share.

ANIMAL ADAPTATIONS

Have your class research and discuss how marine animals protect themselves from their predators or what adaptations they have to become better predators. Have the class team up in small groups and be responsible for researching one phylum. Within each group, each student can choose one animal from this phylum. They can use books or any other resources to put together a report.

SCIENTIFIC CLASSIFICATION

Demonstrate the meaning of scientific classification by having students categorize inanimate objects according to their own framework. You could use fruit, or something ordinary such as different kinds of nails (wood, standard, aluminum, galvanized, ringed, headless), to each small group. Have them categorize and then share their results with each other to start a general discussion on classification. Do we need it? Is any one type of classification better than another? Is there a benefit to sticking to one standardized system of classification?

DICHOTOMOUS KEYS

To demonstrate how a dichotomous key works, play a "20 Questions" style game. Pick one student without disclosing his/her identity, then have the rest of the class discover who you've picked by asking yes-or-no questions. During this process, you can construct a key based on their questions. Tell them to go from the most general to the most specific. For example:

1a. Is the student male……..Go to question 2
1b. Is the student female……Go to question 7
2a. Does the student have blond hair…….Go to question 3
2b. Does the student have dark hair…….Go to question 9
3a. Does the student have blue eyes…….Go to question 4
3b. Does the student have brown eyes……..Go to question 11

FISH PRINTING

Fish printing, or gyotaku (gyo=fish, taku=rubbing), was invented by the Japanese in the 1800's and has since evolved into an art form. Prints can be made on paper, cloth, or t-shirts.

- Obtain whole fish, octopus, or squid from market. It should be thawed out.

- Wipe the outside of the fish to remove moistness and mucous. Be careful not to damage the scales.
- Lay fish on a newspaper covered table.
- Using a wide stiff brush, paint the side of the fish with fabric paint or water-based printers' ink of any color. Don't use too much paint as it will smear.
- Paint the fins and the tail last.
- Slowly lower the paper or cloth onto the painted fish and gently pat the material all over the fish. Make sure you get the tail and fins. Lift the print straight up from the fish.
- Place print in a safe place to dry and admire!

CAMOUFLAGE CRITTERS

Discuss the concept of camouflage, its usefulness to an animal, and perhaps how it evolved through natural selection. Have students draw an animal camouflaged for a particular environment (forest, meadow, stream bottom, etc.) Or, choose environments on the school grounds and create a critter (from paper, clay, pipe-cleaners, even raw vegetables!) that is camouflaged in those surroundings.

MEASURING

Using the metric system, we measure plankton in micrometers. Have the students make measuring sticks and send them out on a measuring hike. Tell them to find things of certain lengths. Let them figure out how many microns are in the items they measure.

Activities/Curriculum links:

https://coast.noaa.gov/estuaries/curriculum/
http://www.waquoitbayreserve.org/research-monitoring/salt-marsh-carbon-project/teachers/

POST-VISIT ACTIVITIES

AQUARIUMS

Set up an aquarium in your classroom. All you need is a small aquarium, an undergravel filter system, an air pump connected to a bubbler, and fish or invertebrates. Most aquarium stores can direct you, or ask us at MSI. Students can watch the fish as they move their gill openings. How many times do they "breathe" per minute? Have your class figure out what the animals need to survive: food, water changes, oxygen, etc.

TURN YOUR CLASSROOM INTO A BAY

Put blue paper around the classroom and have the students draw in various plants and fish, or have them cut out pictures of marine creatures to put on the blue paper. Let them put some benthic invertebrates on the bottom and plankton on the top!

MOBILES

Let the kids make mobiles of the fish they saw. Take a hanger, some string, some cut-out drawings or pictures of fish and have fun! Attach the fish to the string. Then attach the string at varying lengths to the hanger. Be creative, use pictures of plankton and benthic critters. Possibly take two copies of the fish, glue the edges together, and stuff with some already used paper (recycle it!) and have a 3-D mobile. Older groups can make mobiles in the form of a food chain.

WRITING THANK YOU LETTERS

Write letters to the instructors and/or your class sponsor to tell them about the trip. When we receive letters and pictures back from the kids our instructors remember what a thrill it is to be teachers. The sponsors also enjoy getting direct feedback from the class and teacher to reinforce that they are making a difference for kids learning science. Please include the day, date and time of your trip so we can try to remember your group a little better.

Activities/Curriculum links:

https://coast.noaa.gov/estuaries/curriculum/
http://www.waquoitbayreserve.org/research-monitoring/salt-marsh-carbon-project/teachers/