BACK BAY SCIENCE CENTER

Fish Adaptations and Biogeography

ACTIVITY: There's Something Fishy

TIME: 40-50 minutes
GRADE LEVEL: 7th-12th
GROUP SIZE: 8-10 students

Activity at a Glance: Students will help to deploy scientific equipment, collect bottom-dwelling fish, then identify and measure the specimens.

NEXT GENERATION SCIENCE STANDARDS:

PERFORMANCE EXPECTATIONS

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.
HS-LS2-8. Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem (MS-LS1-4) • Evaluate the evidence behind currently accepted explanations to determine the merits of arguments (HS-LS2-8) **Constructing Explanations and Designing Solutions** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources […] (HS-LS4-4) **Scientific Knowledge is Open to Revision in Light of New Evidence** • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation (HS-LS2-8)	**LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction (MS-LS1-4) • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction (MS-LS1-4) **LS2.D: Social Interactions and Group Behavior** • Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives (HS-LS2-8) **LS4.C: Adaptation** • Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-4)	**Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability (MS-LS1-4) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects (HS-LS2-8, HS-LS4-4). ---------- Connections to Nature of Science **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future (HS-LS4-4)

Ocean Literacy Principle 5: The ocean supports a great diversity of life and ecosystems
I- Estuaries provide important and productive nursery areas for many marine and aquatic species.
F- Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life

BACKGROUND INFORMATION

Fish can be found in the wide array of waters on the planet. Marine fish have evolved mechanisms for handling salt, without losing cellular water through naturally occurring osmosis. Fresh water fish do not have this need. These adaptations usually select for life in either salt or fresh water. If an estuary is deep enough, it can actually maintain species within the different zones of its water column that are adapted to three habitats: salt water, the densest, on the bottom; fresh water, the least dense, on the top; and the brackish mix of the two in the middle. Besides adaptations for salinity, fish have evolved morphological and other traits that help them survive in their particular habitat. The gentler waters of an estuary provide an ideal environment for spawning and developing young of many species.

There are some species that can live in both fresh and saltwater. Perhaps the most well-known are the salmon, living for part of their life cycle in fresh water and then thriving in the open ocean as adults. In Upper Newport Bay, the Killifish, Longjaw Mudsucker and Arrow Goby can all live in fresh and saltwater. There are also some species, like the Topsmelt, that are able to live in the brackish waters, where the salinity levels fluctuate.

Because there is zonation, fish have also evolved morphological adaptations to help them survive. Survival depends on the ability to find food without becoming prey in the process. It's important to accomplish this without losing tremendous energy, so there's enough for the animal's growth and reproduction. Many species, such as the Shiner Surfperch, have evolved torpedo-shaped bodies that allow sleeker and more energy-efficient movement through the water and the resisting force of drag. Benthic, or bottom dwellers, such as the Diamond Turbot, California Halibut, and the Rays, commonly have flat bodies with both eyes on the side facing the water. The reed-like body of the Bay Pipefish mimics the eelgrass where it is commonly found. The pectoral fins of Rays have evolved into wing-like extensions of body tissue, allowing sleek movement. The powerful caudal fin allows efficient movement of the predatory sharks.

There are other morphological adaptations besides overall body shape. Thrusting underbites can be found in a number of species that hunt

at the top of the water column. Overbites characterize many fish that hunt along the sandy bottoms. Dentition is also an indicator of lifestyle. The Pacific Barracuda has teeth that are meant to bite and rip, while the forked teeth of the Topsmelt are adapted to foraging amongst plants. Because body tissue is denser than water, sinking is an issue for fish. Many boney fish have evolved an internal gas-filled swimbladder, just below their spine. By compressing or expanding the sac, buoyancy and vertical movement is regulated.

Fish have other adaptations that help them survive. Countershading is another adaptation commonly seen in fish. Many species have pale undersides and darker topsides. When seen by a predator from below, they will blend more with the sunlight filtering into the water. When seen by a predator from above, they will blend more with the sand, rocks and vegetation. This type of camouflage is also seen in silvery fish such as the

Deepbody Anchovy, when incoming sunlight bounces off their bodies. Lateral lines are common to many fish species. Running along the length of its body, these receptors allow a fish to detect

vibrations in the surrounding water. Large vibrations denote a potential predator, small ones a potential prey. The Longjaw Mudsucker can actually breathe air, helpful for survival during low tides. Behavioral adaptations such as schooling makes any one individual less susceptible to predation, and the group projects a larger image.

The calmer waters of an estuary support ideal conditions for spawning and developing fish. This rich supply of fish contributes to a thriving and strong ecosystem. Aquatic ecosystems, however, are being threatened by introduced species. Often hitch-hiking on the hulls of boats or released by aquarium owners these invasive species can out-compete the native species for food. With no local predators, they can grow larger, hunt more successfully, and reproduce more. This seriously threatens the balance of the food web, and is an issue of concern for all who enjoy the beauty and resources of the estuary.

Abnormal weather patterns such as El Nino or La Nina set off a chain of events that can severely affect local fish populations. *El Nino* is a band of

unusually warm water that periodically develops off the western coast of South America and can cause climate changes across the Pacific Ocean. *La* Nina is the opposite, when a band of anomalously cold water develops and spreads across the Pacific Basin. The 'El Niño–Southern Oscillation' (ENSO) refers to variations in the temperature of the surface of the tropical eastern Pacific Ocean (*El Niño* and *La Niña*) and in air surface pressure in the tropical western Pacific. The two variations are coupled: the warm oceanic phase, *El Niño*, accompanies high air surface pressure in the western Pacific, while the cold phase, *La Niña*, accompanies low air surface pressure in the western Pacific. The mechanisms that cause the oscillation remain under study.

The extreme changes caused by these events create cataclysmic events, such as droughts and flooding, around the world. Typically, these anomalies happen at irregular intervals of two to seven years, and last nine months to two years. El Niño's warm rush of nutrient-poor water heated by its eastward passage in the Equatorial Current, replaces the cold, nutrient-rich surface water of the Humboldt Current. When El Niño conditions last for many months, extensive ocean warming and the reduction in easterly trade winds limits upwelling of cold nutrient-rich deep water, and its economic impact to local fishing for an international market can be serious. While ENSO is a natural occurrence it is believed that human impacts aggravate the effects, prolonging them and making them more marked.

These events also change the migration patterns and presence of marine species. Fish species that are found out of their typical range can be considered biological indicators of these weather conditions. The study of how species move and interact in different geographic areas is called *biogeography.* Along with chemical and physical studies, it is an important aspect of climate change research.

RESOURCES:

www.coastal.ca.gov/publiced/UNBweb/owow.html - Our Wetlands, Our World, Newport Beach
www.coastal.ca.gov/publiced/waves/waves1.html - Waves, Wetlands, and Watersheds
http://oceanservice.noaa.gov/education/tutorial_estuaries/welcome.html - background
http://www.era.noaa.gov/ - Estuary Restoration information
http://www.montereybayaquarium.org/animals/

TEACHER GUIDE – Fish Adaptations

ACTIVITY: One Fish, Two Fish, Flat Fish, Schooling Fish

OBJECTIVES:

Students will be able to:

1. Use argument based on empirical evidence and scientific reasoning to support an explanation for fish behaviors and the effect on the probability to successfully reproduce.
2. Evaluate evidence for the role of group behavior in fish species and how it impacts their chance of survival.
3. Construct an explanation based on evidence for how natural selection leads to adaptation in fish populations

MATERIALS:

Bottom Trawl Data Sheet
Pen
Ruler
Life Jackets (PFDs)
Fish Identification Sheets or “Picture Fish” app on smart devices
Clipboard
Bottom Trawl Net

KEY TERMS:

adaptation benthic countershading dentition dorsal invasive lateral line morphology osmosis pectoral salinity water column zonation