



Cabrillo Marine Aquarium Lesson Plan

Grade Level: Fourth Grade, Sixth Grade

Title: Ocean Food Chain Game

Objective: Students will be able to define a food chain and recognize the difference between an herbivore, carnivore and omnivore.

California Science Standards: 4th: 2b 6th: 5a, 5b

Time to Complete: 50 Minutes (It is recommended to have at least twelve students for this activity. Plan on 30 minutes of “play” time.)

Materials Provided by CMA Ocean Discovery Kits: *Worksheet: Observation and Analysis of the Ocean Food Chain*, Animal Buttons; Pictures of Phytoplankton, Pacific Sardine, Pacific Mackerel, Yellowtail; Preserved Specimens of Pacific Sardine, Pacific Mackerel

Materials Provided by Teacher: Masking tape, sandwich bag (or other container) per student, 4-5 liters of popped popcorn, pencils, stopwatch or clock

Vocabulary: Carnivore, decomposer, food chain, food web, herbivore, omnivore, phytoplankton, plankton, primary consumer, producer, secondary consumer, tertiary consumer, trophic level

Teacher Preparation:

1. Make a “stomach” bag for each student by placing strips of masking tape across each plastic sandwich bag so that the bottom edge of the tape is 4cm from the bottom of the bag. The top of the tape, then, will be 6.5 cm from the bottom of the bag.
2. Make sufficient copies of the “Observation and Analysis” worksheet for the class.
3. You will want to select a large area or other open space that is suitable for a game of tag.

Background Information:

The transfer of food from its source, algae and phytoplankton, to one or more organisms is called a food chain. (To go deeper, the chain actually starts with photosynthesis) This transfer occurs when one organism consumes another. In this game, there are four links to the food chain: phytoplankton, sardine, mackerel, and yellowtail. Popcorn represents the phytoplankton, and students play the parts of sardine (phytoplankton eaters), mackerel (which eat sardine), and yellowtail (which eat mackerel). During each round of the game, the “animals” must get enough to eat and avoid being eaten. In this game, the populations (one kind of organism living in a given area) are so small that the survival of two sardine,

two mackerel, and one yellowtail (a highly migratory fish that frequently is found in schools so it can find a mate and thus reproduce) represents a "balanced" food chain.

Phytoplankton: Derived from the Greek words “*phyto*” (plant) and “*plankton*” (made to wander or drift), these microscopic plant-like organisms are the base of the marine food web, and they play a key role in removing carbon dioxide from the air. Like land plants, phytoplankton have chlorophyll to capture sunlight, and they use photosynthesis to turn it into chemical energy as they consume carbon dioxide and release oxygen. Phytoplankton (producers) serve as food for fish and other larger organisms.

Sardine (*Sardinops sagax*): Reaching an average length of up to 16 inches, the Pacific sardine (omnivores) are a schooling fish that feed on zooplankton (copepods, arrow worms, and krill) and phytoplankton.

Mackerel (*Scomber japonicas*): The Pacific mackerel reaches a length of 25 inches, and similar to Pacific sardine, they are a schooling fish. Mackerel (carnivores) will feed on small fishes, squids, and large plankton such as krill and copepods.

Yellowtail (*Seriola lalandi*): Yellowtail are a type of jack and can reach a length of 5 feet. Swimming usually in schools, they (carnivores) feed on mackerels, squid and pelagic red crabs.

	Pacific Sardine	Pacific Mackerel	Yellowtail
Length	Up to 16 inches; average 9 inches	Up to 25 inches; average 16 inches	5 feet
Lifespan	16-25 years	11 years	12 years
Age of maturity	2 nd -3 rd year	Males – age 1 Females – age 2	2 years; all spawn by 3 years
Breeding Season	All year; peaks February-August in Southern California; spawn every 6-8 days during peak season	January – October; peak April to August; spawn 8 or more times per season	Off warmer waters May – October; peaks July and August off central Baja California
Number of eggs produced per spawn	9,000 – 101,000	68,000	458,000-3,900,000 per season

Lesson Outline:

1. Observe the fish specimens, focusing on overall size and mouth size. Have students draw and label mouths on the handout.
2. Define a food chain: the transfer of energy from the primary producers (typically green plants) through a series of organisms that eat and are eaten, assuming that each organism feeds on only one other type of organism.
3. Students record definition on the worksheet.

4. Inform students the three fish they are observing are part of the same food chain. Based on their observations, have students infer the food chain for these fish. Complete a think-pair-share.
5. Diagram the
 phytoplankton → sardine → mackerel → yellowtail
 food chain on the board, and display it to the group.
6. Define and identify the *producer*, *consumer* as well as *omnivore* and *carnivore*. (There are no herbivores in this activity.)
7. Explain to students that they are going to become sardine, mackerel and yellowtail in a food chain game.
8. Scatter the popped popcorn over the area and explain that popcorn represents the phytoplankton eaten by the sardines.
9. Place students in three groups and attach the animal identification card. (A specific colored sash or bandana for each type of animal can replace the card and be tied around each student's waist or arm). Be sure each student knows which animal s/he is portraying.
10. Each student should also attach one stomach. Explain that when the game starts, the sardine will only try to eat the phytoplankton (popcorn) by placing it in their "stomachs." The mackerel will only try to eat the sardine (by tagging them) while the yellowtail will only try and eat the mackerel (by tagging them). When a mackerel tags a sardine, the mackerel takes the sardine's "stomach" and the sardine leaves the game. When a yellowtail takes a mackerel, it takes the mackerel's "stomach" and the mackerel leaves the game.
 - a. Emphasize that sardine can only feed on the phytoplankton, and that the mackerel can only eat the sardines, while the yellowtail can only eat the mackerel. All animals that are eaten must wait on the sidelines.
 - b. Mackerel can eat more than one sardine, and yellowtail can eat more than one mackerel.
 - c. Announce that the round will last 3 minutes or until all of one kind of organism are eaten.
11. Play the game by recording the starting population numbers on the data board. State the challenge, and start the stopwatch, then yell, "GO!" The first round lasts a short time because all of the sardine or mackerels are quickly eaten.
12. Count survivors. After the first round, record on the data board the number of each kind of animal that obtained enough food to survive. (Record on handout)
 - a. A sardine's stomach must be filled to the bottom of the tape (4cm), and a mackerel's stomach must be filled up to the top of the tape (6.5 cm from the bottom of the bag).
 - b. Yellowtail need the equivalent of one mackerel with a full stomach to survive.
 - c. Animals with less than a full stomach at the end of round "starve to death."
13. Balance the food chain. Explain that at least two sardine, two mackerel, and one yellowtail must survive at the end of the round to have a balanced food chain.

- a. Ask students how they can change the game to produce a balanced food chain. Typical suggestions are: change the number of sardine, mackerel, and yellowtail; provide more phytoplankton (popcorn); set up a safety zone for the sardine and mackerel where they are protected from attack; time releases, sardine feed for thirty seconds before mackerel look for food.
14. Play again. Record the students' suggestions and rank them in order of what the group wants to try first. Make the necessary adjustments: adding or removing identification cards/sashes/bandanas, redistribute "stomachs," and return popcorn to the activity area.
 - a. Record the starting populations and reset the timer and play a second round.
15. Allow players to keep changing the rules and repeating the game until they end up with a balanced food chain. At the end of each round, record the number of survivors. Encourage students to compare the results after each round to help them figure out how to balance their food chain. (Record on worksheet.)

Lesson Extensions:

- Yellowtail are highly migratory so more are present in a round.
- As seasons (round) change, Pacific sardine tend to move offshore and spread out in smaller, more numerous groups. Reduce the number of sardine in a round.
- Increased nutrients from human activity has caused a harmful phytoplankton bloom (red tide) to appear on shore. This has reduced the amount of oxygen present in the surrounding waters and many fish move out of the area.
- Introduce a new predator to a round: sea lions, birds, sharks, whales and dolphins all feed on all fish. (Be sure this fish is identified, has a "stomach" and knows what it needs to survive.)
- Introduce humans and their fishing techniques (e.g. purse seine).
- Introduce a population explosion due to breeding.
- Introduce pesticides (colored popcorn) to represent food contaminated with pesticides. Identify how many an organism can eat before it can become fatal (i.e. three for sardine, five for mackerel, ten for yellowtail).
- Increase the competition for food. Both mackerel and yellowtail eat sardine.
- Take a field trip to the Cabrillo Marine Aquarium. Contact (310) 548-7562 for more information and booking dates. Information can also be accessed at: <http://www.cabrillomarineaquarium.org/education/programs-school-group.asp> .

References:

- <http://www.anapsid.org/pdf/foodchaingame.pdf>
- Love, M. S. *Certainly More than You Want to Know about the Fishes of the Pacific Coast*
- California Department of Fish and Game. Resources Agency. *California's Living Marine Resources: A Status Report*