Family Fun

Interdependence in the Farallones

Enduring Understanding: All organisms in an ecosystem are interdependent, and therefore a balanced ecosystem is important to their survival.

Materials

- "Farallon Islands Organism" cards
- Glue sticks
- Markers/pencils
- Chart paper (one sheet per group)
- Student handouts
- Google pictures of Farallon Islands organisms
  - Great White Shark
  - Copepod
  - California Sea Lion
  - Double-Crested Cormorant
  - Pacific Herring
  - Common Murre
  - Vermillion Rockfish
  - Humpback Whale
  - Market Squid
  - Warty Sea Cucumber
  - Dinoflagellate
  - Krill
  - Diatom
  - Brown Pelican
  - Northern Anchovy
  - Sun

Setup:

1. Print the student handouts.
2. Copy and cut out "Farallon Islands Organism" cards. (Another option is to give students a list and have them write the names of the organisms on the poster or a piece of paper.)
3. Look up pictures of the "Farallon Islands Organism" cards.

Program outline:

The organisms that live in an ecosystem are connected to each other.

- Work together to create a diagram showing how the organisms in the marine ecosystem near the Farallon Islands are related.
- Prepare:
  - 1 piece of chart paper
  - 1 marker
  - 1 set of "Farallon Islands Organism" cards
- Your challenge is to organize the organisms in this ecosystem in a way that makes sense to you, using the information provided on the cards. You may use the marker to draw arrows only.
- Complete the challenge and then compare the various diagrams. If you have multiple students with you, they may have slightly different arrows or their arrows might be pointing different directions. Ask them to discuss.
  - The arrows indicate the flow of energy through the ecosystem and should point from prey to predator, starting with the sun.

Program outline:

Interdependence

- Discuss how the food web diagram shows both biodiversity and interdependence.
- Biodiversity is the total number of species in an ecosystem, with a sufficient number of each species to fulfill their ecological roles and maintain a balanced, sustainable system. Biodiversity is important because balance is essential to a healthy ecosystem. Every species fills a particular role that is important to the functioning of the whole system. On the second page of the student handout, use the table to define and give examples of the following ecosystem roles and relationships:
  - Predator/Prey: Predators eat prey to gain energy.
  - Producer: Producers use photosynthesis to produce usable energy for the ecosystem.
  - Consumer: Consumers have to eat other organisms to gain energy.
  - Decomposer: Decomposers break down dead organic matter and animal waste.
  - Apex Predator: The great white sharks in this ecosystem are apex predators. They do not have natural predators and are at the top of the food web. They play an important role in the ecosystem because they maintain balance for all the organisms that live there, and help to sustain biodiversity. Apex predators keep their prey species healthy by eating animals that are less fit, and keeping the population of prey species low so they do not deplete their own food sources. (It is important to note that even though the seabirds do not have predators listed in this activity, they do have natural predators and so they are not apex predators.)
- Introduce a new organism and discuss its role in the ecosystem.
  - Harbor Seal
    Diet: crabs, squid, fish
    Predators: orca whales, great white sharks, bears
    Threats: marine plastics (entanglement and ingestion), pollution
- Interdependence is a key message of this diagram and an important principle in nature. All organisms in an ecosystem are interdependent—they depend on each other for their survival.

Natural disturbance of ecosystem balance

- Because balance is so important in an ecosystem, a disturbance to any of the species creates a disturbance in the entire system. These changes can be caused by natural or human activity. The graphs on the student handouts have example data representing a population of California sea lions and great white sharks.
- Have students study the balanced predator/prey relationship graph and discuss the questions. This graph is also an example of data representing a sudden decrease in predator species and the impact on prey species.
  - The predator/prey relationship causes the populations to change in cycles. As the predator population increases, the prey population decreases, then they reverse. The predator has a lower overall population because fewer individuals are supported at the top of the food web. Also, an increase in predators causes a slightly larger decrease in prey.
- Have students study the unbalanced predator/prey relationship graph and discuss the differences and possible reasons for this outcome.
  - Possible reasons for a large population increase and then dramatic collapse of prey species occurs when predators are removed from the ecosystem and the prey have a population boom and then

Program outline continued:

exhaust their resources and collapse.
- The removal of an apex predator from an ecosystem is harmful to an ecosystem because it throws it out of balance, changing the populations of all the organisms in the ecosystem.

Review the enduring understandings from the lesson.

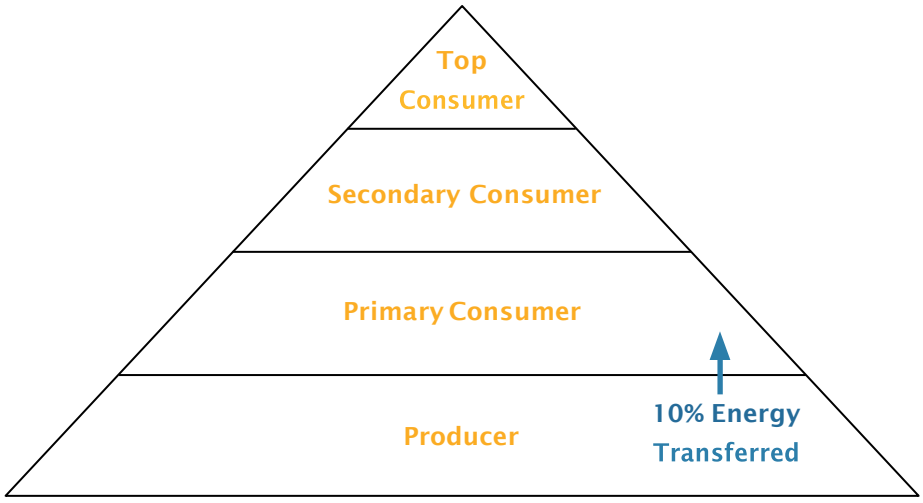
- How are organisms in an ecosystem connected to each other?
  - Each organism in an ecosystem is dependent on every other organism. They each play a role in the balance of the ecosystem. For example, predators, prey, producers, and consumers are important in sustaining a healthy ecosystem.
- What is biodiversity and why is it important?
  - Biodiversity is the total number of species in an ecosystem, with a sufficient number of each species to fulfill their ecological roles and maintain a balanced, sustainable system.
  - Biodiversity is important because many different organisms in various roles are essential to keeping a balanced and healthy ecosystem.
- Predators have an important role because they keep their prey populations healthy and at lower numbers so they do not deplete their food resources.

Background information:

An **ecosystem** is an interdependent community of organisms in their non-living physical environment. All the living organisms in an ecosystem are dependent on one another for their survival, and therefore it is critical for ecosystems to remain in balance. The **biodiversity** of the ecosystem is the number of species in an ecosystem with a sufficient number of each species to fulfill their ecological roles and maintain a balanced, sustainable system. Biodiversity is important because different species depend on each other in addition to their own species and the non-living environment around them.

Organisms depend on each other for energy. In an ecosystem energy begins with sunlight. The energy from the sun is then used by **producers**, such as plants or algae, along with water and carbon dioxide to undergo photosynthesis and generate food energy. Photosynthesis is essential to an ecosystem because it takes unusable energy from the sun and changes it into energy that is accessible to other living organisms. Producers, at the bottom of the food web, make up the greatest biomass in an ecosystem. The producers are then eaten by **consumers**, that have to eat other organisms to gain energy. There are several layers of consumers (primary consumers eat producers, secondary consumers eat primary consumers, etc.), and several types of consumers (herbivores only eat producers, carnivores only eat animals, and omnivores eat both).

The relationships between organisms in the food web of an ecosystem can be modeled with a trophic pyramid made up of several trophic levels. Trophic levels are hierarchical levels of an ecosystem that indicate the transfer of energy through an ecosystem from producers to top consumers. Organisms in the same level fulfill a similar ecological role. The energy moves from one organism to the next in the ecosystem, but some energy is lost as heat each time it is transferred. Only about 10 percent of the total energy is transferred from one trophic level to the next. Because of this, the ecosystem supports fewer individuals at each successive trophic level.



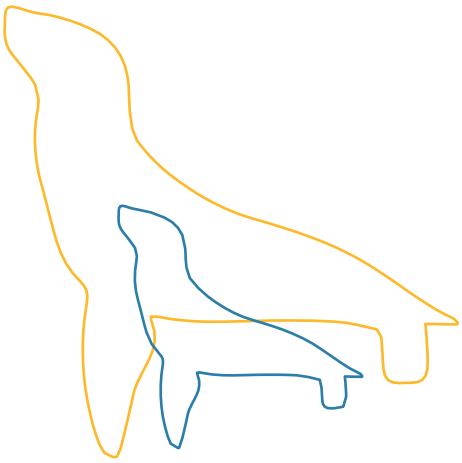
Balance in an ecosystem is important to all the organisms that live there. This is why predator/prey relationships play such an essential role in nature. Predators are able to keep their prey populations at a sustainable level. If there are too many prey individuals, they will eat up their resources and their numbers will collapse because they will be forced to look for food elsewhere. This has a ripple effect throughout the entire ecosystem, causing other species to have more or less food, and changing their

Background information continued:

population sizes. Ecosystems are resilient and resistant to some minor changes, but dramatic changes, whether caused by natural or human activities, will create a different ecosystem with a new balance.

The example ecosystem used in this lesson is the Farallon Islands. The Farallones are located about 30 miles off the coast of Northern California. The area supports a high level of biodiversity, including threatened and endangered species. One of the reasons this spot is so productive and diverse is because it is a major area of upwelling. Upwelling occurs where cold, deep, nutrient-rich ocean water is brought to the surface. This happens when winds blow across the ocean surface and push surface water away, making space that the deeper water moves up to fill. This water has more nutrients, and its presence creates a highly productive area.

The Farallon Islands are also an important nesting area for many species of seabird, and feeding grounds for the **apex predator**, the great white shark. Apex predators have no natural predators. They are essential to the health of their ecosystem. The balance of organisms within an ecosystem relies largely on its top predators. Great white sharks are found globally in temperate and subtropical waters in both open ocean and coastal areas. They travel to the Farallon Islands in the fall to feed on the abundance of sea lions and elephant seals in the area.



glossary:

Apex Predator: Top predator in an ecosystem; an organism with no natural predators

Biodiversity: Total number of species in an ecosystem, with a sufficient number of each species to fulfill their ecological roles and maintain a balanced, sustainable system

Consumer: Organism that gets energy by eating other organisms

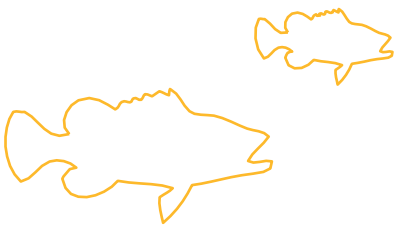
Decomposer: Organism that gets energy by breaking down dead organic matter or other organic waste

Ecosystem: Interdependent community of organisms in their non-living physical environment

Producer: Organism that uses sunlight, water, and carbon dioxide to generate usable energy

Predator: Organism that eats other organisms to survive

Prey: Organism that is eaten by another organism



Name: _____

Date: _____

Farallon Islands Organism Cards

Great White Shark Diet: sea lions, seals, whale carcasses Threats: overfishing prey, climate change, habitat destruction, hunting by humans outside the Farallon Islands	**Copepod (Zooplankton)** Diet: phytoplankton, other zooplankton, organic waste Predators: zooplankton, anemones, mussels, clams, whales, crabs, small fish Threats: pollution, climate change
California Sea Lion Diet: herring, squid, anchovies, rockfish, mackerel Predators: great white sharks, orca whales Threats: pesticides, marine plastics (entanglement and ingestion), hunting by humans	**Double-Crested Cormorant** Diet: anchovies, sardines, herring, crabs, crayfish, insects, shrimp Predators: gulls, crows, raccoons, coyotes, great horned owl Threats: pollution, habitat destruction
Pacific Herring Diet: crab, shrimp, small fish, plankton Predators: humpback whales, sea lions, seals Threats: habitat destruction, climate change, overfishing	**Common Murre** Diet: herring, squid, capelin, small crustaceans, marine worms Predators: western gulls, brown pelicans Threats: overfishing, climate change, oil spills
Vermillion Rockfish Diet: plankton, small crabs, shrimp, fish, squid, octopus Predators: other rockfish, salmon, sea lions, seals, seabirds Threats: overfishing, habitat destruction	**Humpback Whale** Diet: krill, anchovies, cod, sardines, mackerel, capelin Predators: orca whales Threats: pollution, entanglement in fishing gear

Name: _____

Date: _____

Farallon Islands Organism Cards continued

Market Squid Diet: worms, shrimp, small fish Predators: salmon, rockfish, seabirds, sea lions, seals Threats: pollution, climate change	**Warty Sea Cucumber** Diet: detritus (dead organic matter and animal waste) Predators: sea stars, fish Threats: overfishing, pollution
Dinoflagellate (Phytoplankton) Diet: Dinoflagellates are producers. They use photosynthesis generate usable energy. Predators: copepods, anemones, mussels, clams, whales Threats: pollution, climate change	**Krill** Diet: phytoplankton Predators: whales, mussels, clams, anemones, small fish Threats: overfishing, pollution, climate change
Diatom (Phytoplankton) Diet: Diatoms are producers. They use sunlight, water, and carbon dioxide to generate usable energy. Predators: zooplankton, anemones, mussels, clams, whales Threats: pollution, climate change	**Brown Pelicans** Diet: anchovies, sardines, mackerel Predators: raccoons, cats, dogs (main threats to eggs) Threats: pesticides (such as DDT) that cause eggshells to be thin and chicks to die, disturbance by fishermen, oil spills, overfishing of prey species
Northern Anchovy Diet: phytoplankton, zooplankton, larval fishes Predators: sea lions, seals, seabirds, rockfish Threats: overfishing, climate change	**Sun**

Name: _____

Date: _____

Interdependence in the Farallones

Interdependence Diagram

Name: _____

Date: _____

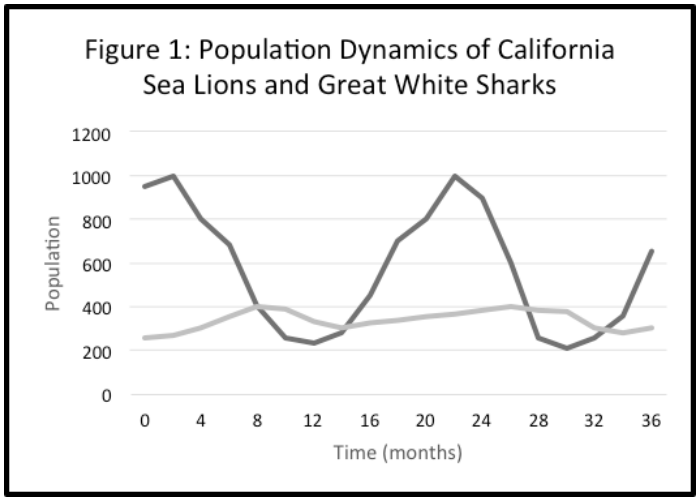
Interdependence in the Farallones continued

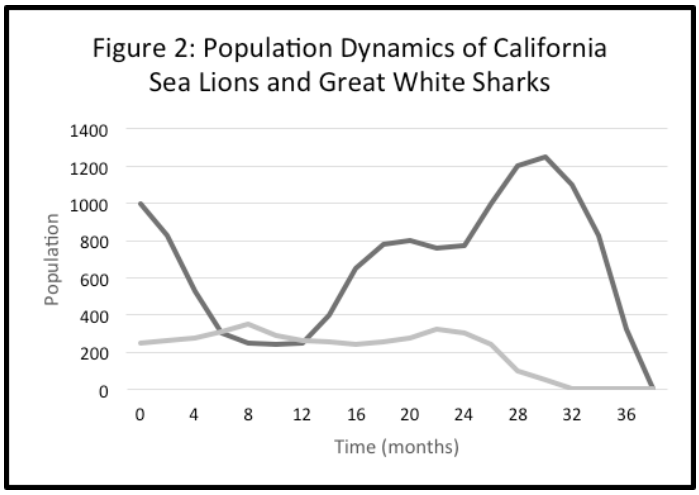
Term	Definition	Example
Predator/Prey		
Producer		
Consumer		
Decomposer		
Apex Predator		

Name: _____

Date: _____

Interdependence in the Farallones continued





California Sea Lion

Great White Shark

1. What happens to the California sea lion population as the great white shark population increases in Figure 1? Why?

2. What happens to the California sea lion population as the great white shark population decreases? Why?

3. Which animal is the prey and which is the predator? Give two reasons using evidence from the graph.

4. In Figure 2, what happens to both populations around 28 months?

5. What might have caused this to happen?

6. Is this good or bad for the rest of the ecosystem? Why?

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