What is an Ecosystem?

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Santa Barbara Coastal Long Term Ecological Research Project

The National Science Foundation

California Department of Education Science Standards

6th Grade

- Shaping Earth's Surface

  2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.

  d. Students know earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

- Ecology (Life Science)

  5. Organisms in ecosystems exchange energy and nutrients among themselves and with the environment.

  a. Students know energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs.

  b. Students know matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.

  c. Students know populations of organisms can be categorized by the functions they serve in an ecosystem.

  d. Students know different kinds of organisms may play similar ecological roles in similar biomes.

  e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

- Investigation and Experimentation

  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.

  a. Develop a hypothesis.

7th Grade

- Earth and Life History (Earth Science)

  4. Evidence from rocks allows us to understand the evolution of life on Earth.

  b. Students know the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.

- Investigation and Experimentation

  7. Scientific progress is made by asking meaningful questions and conducting careful investigations.

  b. Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.

  c. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

Watershed Ecosystem Lessons

In this lesson students will be introduced to, or reminded of, the concept of an ecosystem. Students will learn 10 important principles of ecology through an overhead guided lecture and fill-in notes and will have the chance to review the newly learned principles with an active matching game. Students will discuss the idea of a disturbance and think about how disturbances (both human caused and natural) affect an ecosystem. In addition the students will more closely examine the marine food web of the Santa Barbara Channel and will have to predict what would happen to this ecosystem when faced with a disturbance.

A. What is an Ecosystem?

Objectives:

* The students will understand the concept and definition of an ecosystem.
* The students will become familiar with basic ecological principles including: succession, pioneer communities, climax communities, abiotic factors, biotic factors, levels of biological organization (organism⟶ biosphere), limiting factors, habitat, niche and food chains/webs.
* The students will understand what the role of an ecosystem is and the effects of a disturbance on an ecosystem.

Specification: At the end of this lesson, the students should be able to:

a. Write a definition for an ecosystem.
b. Explain the ecological principles covered in the lesson.
c. Explain the role of an ecosystem and describe how an ecosystem may change if disturbed using evidence or explanations to back up their thinking.

Introduction:

An Ecosystem is "a functioning natural unit with interacting biotic (living or once living organisms) and abiotic (non-living, physical features) components in a system whose boundaries are determined by the cycle and flux of energy, materials and organisms" (http://www.epa.gov/owowwtr1/watershed/academy/acad2000/ecology/ecology2.html).

OR….

An Ecosystem is "all the interacting parts of the physical and biological worlds" (Ricklefs, R.E. *The Economy of Nature 5th Edition*. 2001. W.H. Freeman and Co., New York, NY, p. 523).

Ecology is "the study of the interactions that take place among organisms and between organisms and the physical features of the environment" (Glencoe Science Voyages: Life and Physical Science, p. 823). The word ecology comes from the Greek word *oikos*, meaning household, therefore ecology is the study of the earth household or ecosystems

(Capra, F. The Center for Ecological Literacy: Guide to Ecoliteracy: A new context for school restructuring).

10 important Ecological Principles: (Glencoe Science Voyages: Life and Physical Sciences)

1. Biotic Factors: "Living or once-living organisms in the environment" (p.825).

2. Abiotic Factors: "Nonliving, physical features of the environment such as soil, sunlight, water, temperature, and air" (p.823).

3. Limiting Factors: "Any biotic or abiotic factor that restricts the number of individuals in a population. They may also indirectly affect other populations in the community" (p. 829).

4. Habitat: "The physical location where an organism lives" (p. 833).

5. Niche: "The role of an organism in the ecosystem" (p. 833).

6. Food Chain/Web: "A food chain is a simple way of showing how energy in the form of food passes from one organism to another- usually have 3-4 links, no more than 5 because energy is lost at each transfer. A food web is a series of overlapping food chains, which provides a more complete model for the way energy moves through a community, also more accurate because they show that many organisms feed on more than one level of an ecosystem" (p. 838).

7. Levels of Biological Organization: "organism (a single individual from a population) _ population (all of the individuals of one species that live and reproduce in the same area at the same time) _ community (made up of populations of different species that interact in some way) _ ecosystem (consists of communities and the abiotic factors that affect them) _biosphere (highest level of biological organization, it is made up of all of the ecosystems on earth)" (p. 825).

8. Succession: "The process of gradual change from one community of organisms to another" (p. 850).

9. Pioneer Communities: "The first community of organisms to move into a new environment" (p. 851).

10. Climax Communities: "When a community has reached the final stage of ecological succession" (p. 853).

What is a Disturbance?

A disturbance is "a process or event that results in changes to the physical and biological characteristics of the environment" (http://www.epa.gov/watertrain/agents/agents2.html).

Not all disturbances are bad… think about the weather, if it has been raining for a long time (maybe not in Santa Barbara!), and then the sun comes out; the physical environment changes, but not necessarily in a negative way.

There are natural disturbances all the time: floods, droughts, fires, windstorms, erosion, and earthquakes just to name a few.

There are also a lot of disturbances that humans can cause such as: changing the way a river flows, agriculture, cutting down trees, building, stopping fires, mining, hunting and fishing, and introducing exotic species. These are often tied to the natural disturbances but may happen at a faster pace or on a larger scale.
(http://www.epa.gov/watertrain/agents/agents2.html).

Activity: (approximate time: 45-60 minutes)

Materials: Ecological principles overheads, student fill-in notes, ecosystem/ disturbance/ food web handout, disturbance overhead, ecological principles matching pieces (10 words/10 definitions, 20 pieces total), blank food web handout, food web cut-outs, scissors and tape or glue.

- Start off by asking the students if they know the term ecosystem. If they do know it, ask them what their idea or definition of an ecosystem is.
- Have a class discussion where the students brainstorm ideas about the meaning of "ecosystem" and write these ideas up on the board. This can also be done as a journal activity.
- Present the 10 basic ecological principles outlined in the discussion in a mini-lecture using the overheads as visuals to help the students grasp the concepts. Have the students fill in the student notes on the ecological principles while they listen to the lecture.
- After the lecture, give each student 1 piece of the ecological principles matching game. Each student should either have a word/term or a definition. Tell the students that they need to walk around the room, talking to the other students to find the other half of their piece. They should figure it out based on the information on their card, but as a double check, the pieces should fit together when the students are right.
- Ask the students what they think of when they hear the word disturbance. This could be a journal question as well.
- Explain to them that there are always disturbances in the environment, both natural and human caused. Ask the students if they can think of any natural or human caused disturbances; make a list on the board.
- Ask them if they see any connections between the natural and human caused disturbances (*it will depend on which ones they list, but try and highlight the connection between human disturbances being very similar to natural disturbances but often faster and larger. Use the lists in the introduction to help guide the discussion if necessary*).
- At this point, you can use the disturbance overhead to help them with their list. For each disturbance on the overhead, ask the students if it is natural, human caused or both.

- Tell the students that you are going to play a food web game. (*Give each student a copy of the hand-out with the blank food web and a copy of the pieces of the food web that they need to cut out and place on the food web).*
- Explain the instructions to the students: 1. First, they need to cut out the pieces with the organisms on them. 2. Next they need to think about what each organism will eat, keeping in mind that each one may eat or be eaten by more than one organism. 3. The students need to arrange the cut outs on the blank foodweb to complete the ecosystem. Once they have all of the pieces in the proper place (and have checked their answer with you) they can glue or tape the pieces in place. (*If you have the students do this as homework; have them write in their answers and then the next day in class everyone can correct their food web together and glue the pieces down).*
- The arrows should be pointing from the prey to the predator. For example:

  Sandwich → Human.
- After all of the students have finished their foodweb, tell them that a disturbance has occurred. Suddenly, the Northern Anchovy became extremely popular (maybe people decided anchovies on pizza were great!), and local fishermen went on a fishing frenzy and caught almost all of the anchovy! The students need to figure out how removing all of the anchovy would affect the rest of the foodweb and the ecosystem. Have them write responses to the following questions on the ecosystem/disturbance/food web handout:
  1. Would removing the anchovies affect any other organisms? If yes, which other organisms would it affect and how (would their populations increase or decrease?) Explain.
  2. Are there any organisms that wouldn't be affected by the removal of the anchovies? Why or why not?

Wrap up the activity by asking the students to share their ideas about how the disturbance would affect the rest of the foodweb and ecosystem. Make sure that the students understand that all of the pieces of the foodweb are connected.

Teacher Lecture Notes- 10 Important Ecological Principles

** These are just meant to give you a little extra information about these principles and some examples that may help you better explain them to the students by relating the ideas to their lives. The references are also provided so that if you want further information you may go straight to the source.

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1. Biotic Factors: "Living or once-living organisms in the environment" (p.825).

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3. Limiting Factors: "Any biotic or abiotic factor that restricts the number of individuals in a population. They may also indirectly affect other populations in the community" (p. 829).
Example: A biotic factor that could restrict the number of individuals in a population would be something like food- if you don't have enough food to feed yourself, there is no way you are going to increase your population, you would die. An abiotic factor would be something like space, if there aren't any more empty lots of land to build houses on in Santa Barbara it will prevent any more people from moving here and the population won't increase.

4. Habitat: "The physical location where an organism lives" (p. 833).
Example: What is your habitat? It could be your room, your house, your neighborhood or even Santa Barbara.

5. Niche: "The role of an organism in the ecosystem" (p. 833).

Example: Instead of just the physical location where you live, a niche is your role, so your niche is student or brother, sister, son, or daughter. Maybe you have certain chores around the house such as taking out the trash or doing the dishes; that is your role in your home environment.

6. Food Chain/Web: "A food chain is a simple way of showing how energy in the form of food passes from one organism to another- usually have 3-4 links, no more than 5 because energy is lost at each transfer. A food web is a series of overlapping food chains, which provides a more complete model for the way energy moves through a community, also more accurate because they show that many organisms feed on more than one level of an ecosystem" (p. 838)
Example: A simple human food chain might consist of plants at the bottom which feed cows, which feed you hamburgers. The idea of a food web is that there are more complicated links- you don't only eat hamburgers, you probably (hopefully) also eat plants (fruits, veggies and grains). That would mean that you are eating at different levels of the food chain. Other animals do this too and when you connect all of the different animals and plants in all of the possible combinations of who eats who or what, it gets complicated and looks like a big spider web.

7. Levels of Biological Organization: "organism (a single individual from a population) _ population (all of the individuals of one species that live and reproduce in the same area at the same time) _ community (made up of populations of different species that interact in some way) _ ecosystem (consists of communities and the abiotic factors that affect them) _biosphere (highest level of biological organization, it is made up of all of the ecosystems on earth)" (p. 825).
Example: If we look at how you fit into the levels of biological organization- you would be an organism, one individual, you would live in a population of other people who live nearby (maybe your neighborhood or school), Santa Barbara would be a community of these smaller populations, our ecosystem would include our community, nearby communities (Ventura, Goleta, Oxnard) and would also include the abiotic factors (waters, soil, air, etc) that make up the physical environment where we live and the animals and plants that live in that environment along with us. Finally, our biosphere would be all of the different ecosystems that you would find all over the world.

8. Succession: "The process of gradual change from one community of organisms to another" (p. 850).
Example: After something disturbs the environment (for example a forest fire), there may not be anything left except dirt. When species do start to grow back there is usually an order that they come back in, this is called succession. The first species to come back will be quick growing, usually weedy species. They are usually small. These are generally followed by slightly larger, slower growing plants like shrubs, which are followed by even slower growing larger things like trees. Eventually the community will return to the composition that it began with before the fire; or a similar one at least.

9. Pioneer Communities: "The first community of organisms to move into a new environment" (p. 851).

Example: Have you ever noticed that your garden or lawn always seems to have weeds in it? Weeds seem to be able to grow anywhere in any conditions and even when you keep pulling them out, they always seem to grow back. When something disturbs the environment, or even wipes it out completely, usually when plants start growing again you see weedy species first. The quick growing species that can grow in a wide variety of conditions usually grow first.

10. Climax Communities: "When a community has reached the final stage of ecological succession" (p. 853).
Example: This is the end of succession when the largest, slowest growing plants and trees have re-established themselves in the environment. Generally people think that when a community reaches the climax community at the end of succession it is somewhat stable, but of course, there are always changes in the environment so it is never going to stay exactly the same.

10 Important Principles of Ecology

1. Biotic Factors: are the *living* or once-living organisms in the *environment*.

2. Abiotic Factors: are nonliving, *physical* features of the environment such as *soil*, sunlight, *water*, temperature, and *air*.

3. Limiting Factors: Any *biotic* or abiotic factor that *restricts* the number of *individuals* in a population.

4. Habitat: The *physical* location where an organism *lives.*

5. Niche: The *role* of an organism in the *ecosystem.*

6. Food Chain/Web: A food chain is a *simple* way of showing how *energy* in the form of food passes from one organism to another. They usually have *3-4* links, no more than 5 because energy is lost at each transfer. A food web is a series of *overlapping* food chains, which provides a more *complete* model for the way energy moves through a community, also more accurate because they show that many organisms feed on *more than one* level of an ecosystem.

7. Levels of Biological Organization:
An *organism* is a single individual from a population →
A *population* is all of the individuals of one species that live and reproduce in the same area at the same time →
A *community* is made up of populations of different species that interact in some way →
An *ecosystem* consists of communities and the abiotic factors that affect them →
A *biosphere* is the highest level of biological organization; it is made up of all of the ecosystems on earth.

8. Succession: The process of *gradual* change from one community of organisms to another.

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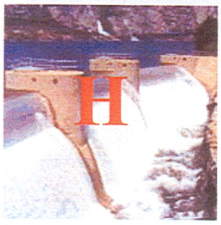
Disturbances:
Which are Natural? Which are Human Caused? Which are both?

Erosion



Changing Water Flow

Drought

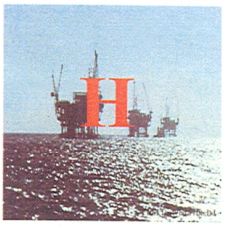
Fishing

Earthquake

Fire

Flood

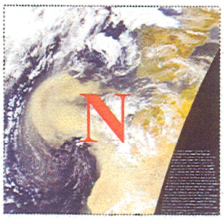
Cutting Lumber



Mining (oil)

Hurricane

Farming

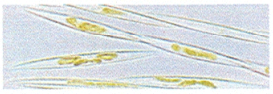


Sand Storm

Cut out the following pieces and arrange them into the proper order on the food web chart

Marine Mammal
Ex: Sea Lion

Algae
Ex: *Psuedo-nitzschia*



Fish
Ex: Northern Anchovy

Crabs
Ex: Sheep Crab

Birds
Ex: Brown Pelican

Bivalves
Ex: California Mussel

Fish Larvae

Zooplankton

Humans

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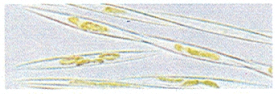

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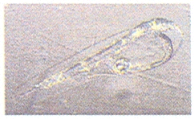
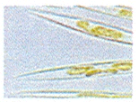
Fish Larvae

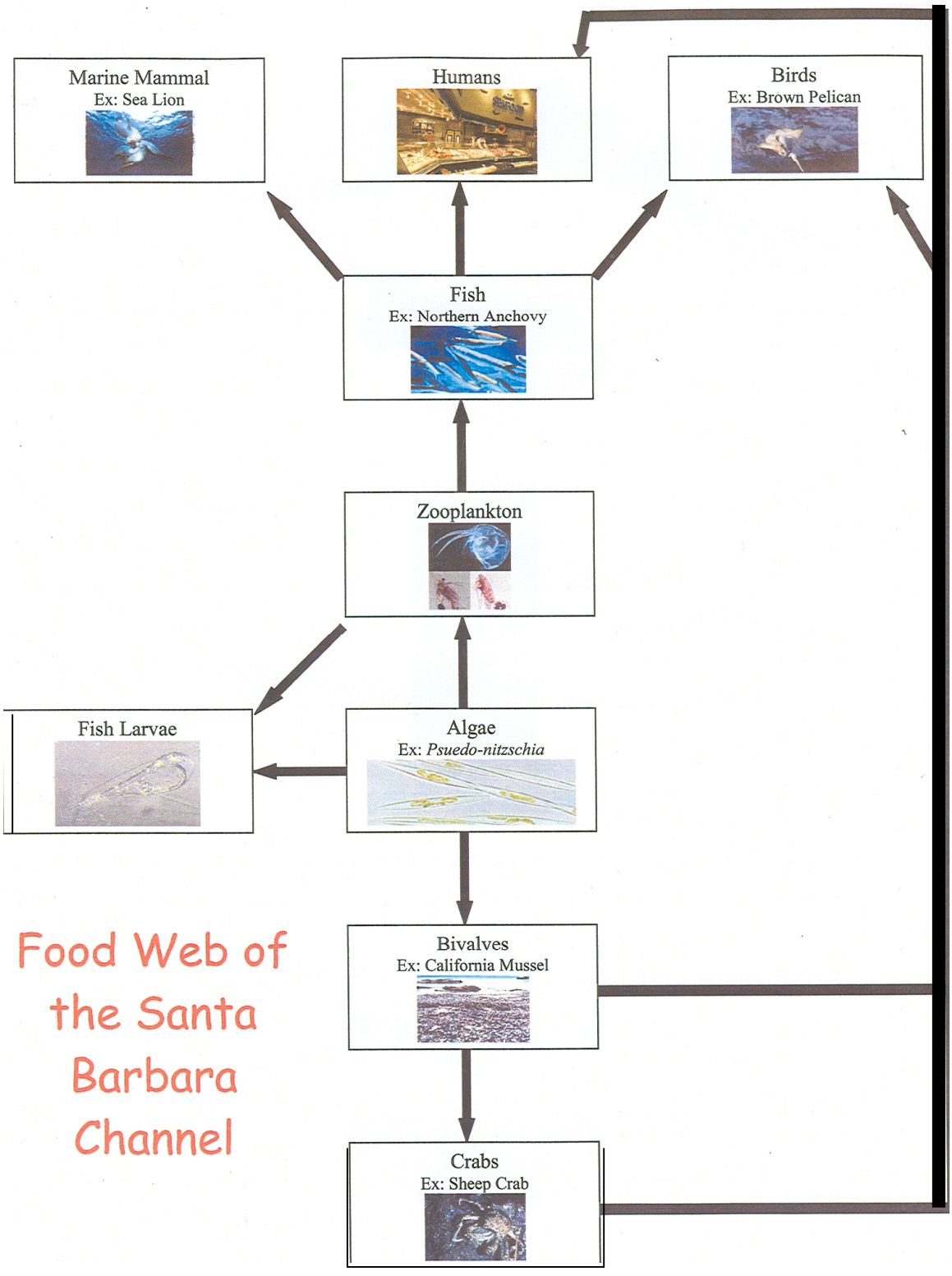


Zooplankton

Humans

Name	Distribution	Habitat	Diet	Fact	Picture
Algae/ Phytoplankton Example: *Psuedo-nitzschia*	World wide	Water (fresh and salt) as long as there is some sunlight.	Primary producers: Light, CO_2, Micro and Macro Nutrients	They are the base of the marine food web.	
Birds Example: Brown Pelican	Farallon Islands to Mexico.	Mostly coastal, occasionally found inland or over open ocean.	Fish and sometimes shrimp.	Almost went extinct in 1970's because of pesticide poisoning from DDT.	
Bivalves Example: California Mussel	Coastal areas from Alaska to Mexico.	Intertidal zone to 150 feet deep.	Filter feed plankton.	To collect enough food, mussels filter 2-3 liters of water per hour.	
Crabs Example: Sheep Crab	Northern California to Baja California.	Rocky reef and sand.	Invertebrates, fish and scavenged food.	Commonly called spider crabs because of their long spindly legs.	
Fish Example: Northern Anchovy	Temperate and subtropical Pacific waters.	Surface to 1000 feet deep. Coast to 300 miles offshore.	Zooplankton, phytoplankton and small fish.	They often times eat their own eggs!	
Fish Larvae	Worldwide.	Marine and Freshwater.	Phytoplankton and small zooplankton.	They are actually considered to be zooplankton since they are floating animals.	
Humans	Worldwide.	All types!	Animals and Plants.	Based on yearly seafood catches and world population, the average person eats 26 lbs of seafood a year!	
Marine Mammal Example: Sea Lion	Canada to Mexico.	Open water, kelp beds, offshore rocks and sandy beaches.	Fish, squid and octopus.	Stomachs often contain 100's of pieces of gravel, which are possibly used to reduce hunger pains.	
Zooplankton	Worldwide.	Marine and Freshwater.	Phytoplankton	Zooplankton means floating animal- they usually just drift, however some are weak swimmers.	

Food Web of the Santa Barbara Channel



Food Web of the Santa Barbara Channel

Marine Mammal
Ex: Sea Lion

According to this food web, they would decrease because their only food source is gone. In reality they would probably eat other fish as well and might not decrease as much.

Humans

Birds
Ex: Brown Pelican

Fish
Ex: Northern Anchovy

Removed by foodweb by over fishing

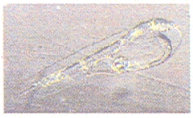
Population will probably decrease; they eat anchovies which are gone, mussels which decreased and crabs which decreased.

Population will stay the same, eats zooplankton which is increasing, but also eats algae which are decreasing, so it may not be affected if it eats both food sources equally. If it eats more zooplankton, it may increase, and if it eats more algae, it may decrease.

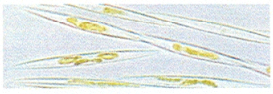
Zooplankton

Population will probably increase without grazing pressure.

Fish Larvae



Algae
Ex: *Psuedo-nitzschia*



Population will probably decrease because there are more zooplankton and therefore, more grazing pressure.

Bivalves
Ex: California Mussel

Population will probably decrease because there are fewer algae, and therefore, less food.

Crabs
Ex: Sheep Crab

Population will probably decrease because there are fewer mussels, and therefore, less food

What is an Ecosystem? References

Images:
All images without a reference are from Microsoft Clipart.
Disturbances:

1. Erosion: www.northern.org/artman/publish/slide3.shtml
2. Changing Water Flow: www.awwa.org/.../nov_dec/ Lead01_HetchHetchy.cfm
3. Drought: www.pep-c.org/droughts/
4. Fishing: www.epa.gov/waterscience/cs/manage/str11-12.html
5. Earthquake: cse.ssl.berkeley.edu/img/earthquakes/Railroad.gif
6. Fire: www.trolocsis.com/pic/NASA-CA-Fires.jpg
7. Flood: www.webshot.co.uk/floods.jpg
8. Cutting Lumber: http://coursesa.matrix.msu.edu/~hst203/images/lumber.gif
9. Mining (oil): http://www.tidalflatsphoto.com/ocean_tech/ocean_tech_1/pages/OI42935D.htm
10. Hurricane: http://photo.weather.com/interact/photogallery/details.html?pid=40352&activitiesCategory=4471&weatherCategory=&where=&locid=&submitter=&dateOfPhoto=&page=2
11. Farming: www.farmland.org/california/
12. Sand Storm: news.bbc.co.uk/.../ tech/newsid_661000/661091.stm

Food Web:

1. Anchovy, brown pelican, mussels, sea lion, and sheep crab: http://www.ocean.com/Library/Encyclopedia/NMS/ChannelIslands/
2. Algae: http://sbnature.org/research/vertebrates/imf/psuedonitzschia563.jpg
3. Fish larvae: http://www.scieng.flinders.edu.au/biology/people/qin_j/research.html
4. Humans: http://www.wholefoods.com/products/list_seafood.html
5. Zooplankton: http://darwin.wcupa.edu:16080/ponds/Biological%20control.htm

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