

Monterey Bay Aquarium

Natural History Poster Learning Activities

Key Concepts

The habitat illustrated in the poster is a living system.
There are living and non-living parts to the system.
The living and non-living parts interact and impact each other.

Basic Skills

Observe, infer, identify, sort

Materials

Poster(s)

Six color printable posters and keys (Kelp Forest, Rocky Shore, Sandy Beach, Coastal Wetlands, Coral Reef, Deep Sea) are available on the aquarium's web site in the Teachers Section under Learning Resources

(http://www.montereybayaquarium.org/lc/activities/poster_ispy.asp)

Poster key(s) (see above note)

Crayons, colored pencils or markers

Teacher Preparation and Activity Procedures

The posters can be used as a starting point for student inquiry. Coupled with other activities, students can generate questions and design investigations to find answers to their own questions related to living systems.

We have included teacher sheets and student handouts for the Kelp Forest, Rocky Shore and Sandy Beach and Deep Sea posters. Coral Reef and Coastal Wetlands Poster Activities can be based on the inquiry questions and suggestions for the other posters.

Web Site Resources

About the Animals (http://www.mbayaq.org/efc/living_species/default.asp)

Photo, description, diet, habitat and conservation information for over 150 animals and plants.

Aquarium Exhibits Section (<http://www.mbayaq.org/efc/>)

Photos and natural history information about the habitats featured in the natural history posters.

- Four of the Monterey Bay habitats posters relate to permanent aquarium exhibits (Kelp Forest, Rocky Shore, Sandy Beach and Wetlands).
- The Deep Sea poster shows life in Monterey Canyon. We have no live Deep Sea exhibit but have extensive online materials about this habitat.
- Our Splash Zone exhibit features coral reef animals.

Video Library (http://www.mbayaq.org/efc/video_library/video_library.aspx)

Short video clips to watch online of some of the animals found in our exhibits. A good way to show students what the habitat or animals depicted in the posters look like.

Live Web Cams (http://www.mbayaq.org/efc/cam_menu.asp)

We offer live streaming images of many of our exhibits on our live web cams.

Kelp Forest Poster

Teacher Page

Activity Description

How does giant kelp obtain nutrients? Where do animals make their homes in the kelp forest? Using the kelp forest poster as an inquiry starter, students will observe the living and non-living parts of this ecosystem. They generate questions and design investigations to find answers to their own questions related to the kelp forest and other living systems.

Key Concepts

- The kelp forest is a living system.
- There are living and non-living parts to the system.
- The living and non-living parts of the kelp forest interact and impact each other.

Materials

- Kelp Forest poster (color printable version available on the aquarium's web site under Teachers and Kids, Learning Activities)
- Black line master of the poster
- Poster key
- Crayons, colored pencils or markers

Directions

For an **inquiry approach** to using the Kelp Forest poster, use the poster as an inquiry starter to generate student observations and questions.

Notice and Wonder

1. Tell the students that the kelp forest poster provides us with an underwater view of the kelp forest, much as a SCUBA diver would see it. Encourage them to look carefully at the poster.

2. Encourage your students to look for clues that would give them information about the interactions that might take place between the living and non-living parts of the kelp forest. Have them consider what kelp forest animals need to survive, what conditions they have to endure and how they manage in such a harsh environment. Discuss how those conditions would differ between the surface and sea floor.
3. Have them jot down what they notice about the kelp forest as it is portrayed in the poster and what they wonder about the kelp forest.

Generate Student Questions

1. Ask the students to generate some questions based on their notes and post those questions in a common area.
2. Use the student-generated questions as an opportunity to assess their current understanding of the kelp forest system, as well as providing some possible starting points for student inquiry activities and investigations.

For a **directed approach** to using the Kelp Forest poster, duplicate a blackline poster and species key for each student. A good source of species information for the students is the Living Species List on the Monterey Bay Aquarium web site.

1. Ask the students to use the key to identify the various living and non-living parts of the kelp forest system.

2. Have each student select one of the animals or plants to investigate and share with their classmates:
- How does it get its food?
 - How does it protect itself from predators?
 - How does it reproduce?
 - Does it spend its entire life at the kelp forest? If not, where else does it go?
 - How is it affected by the non-living aspects of the Kelp forest system?
 - How does it affect other living and non-living parts of the system?

(**Note:** Students may respond to these questions and the ones below using the Student Page.)

3. With your classmates, create a kelp forest food web that includes the species in the poster.
4. Additional focus questions and investigation topics might include:
- What are the living things in this picture of the kelp forest?
 - What are the non-living things in this picture of the kelp forest?
 - Which animals at the kelp forest do you think eat other animals? Which animals do they eat? What makes you think so?
 - Which animals at the kelp forest do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the kelp forest?
 - Which animals in the poster are residents?
 - What do you notice about where the plants are growing in the kelp forest?
 - What parts of the poster could you see if you were walking on

the beach and looking at the ocean? What wouldn't you be able to see?

- How does this picture compare to your idea of how the kelp forest looks?
- Do you think tides would affect the kelp forest in this poster? In what way(s) might it be affected?
- How would sunlight affect the living things at the kelp forest?
- Do you think the waves would affect the kelp forest? In what way(s)?
- In what way(s) might color be important to the living things at the kelp forest?
- How would wind affect the living things at the kelp forest?
- How would the kelp forest look at night?
- Do you think the kelp moves? What would cause it to move?
- How would this kelp forest be different in the winter? How would storms affect it? What would happen to the animals?
- How would it be different if there were sand instead of rocks?
- What do you think might be harmful to the things at the kelp forest? Why?
- How can we study the kelp forest without harming it or its inhabitants?
- How could what happens in your town or city affect the kelp forest?
- How could what happens at the kelp forest affect you?
- If you had to live in the kelp forest in the poster, what would you need to survive?

Activity Links

www.mbayaq.org/efc/kelp.asp

Visit the Monterey Bay Aquarium's web site for a diver's eye view of the towering kelp forest exhibit using the kelp cam! This live cam shows just a small portion of the 28 feet high exhibit and its many inhabitants. For information about the kelp forest habitat and its inhabitants, visit the "About the Animals" link in the upper navigation on the web site. Have students read along with the interactive book, *Pup's Supper*, on the aquarium's web site to learn more about sea otters in the kelp forest.

Background

In the study of the kelp forest, as with all systems, it is important to think about the whole system in terms of its living and non-living parts and the parts in terms of how they relate to one another and to the whole. As with non-living systems, such as engines, sewage systems and political systems, a living ecosystem is a collection of things and processes that interact to perform some function. There are inputs and outputs, interactions among the system components and with other systems. Often systems include subsystems.

The main goal of having students learn about systems is not to have them talk about systems in abstract terms but to enhance their ability to attend to various aspects of particular systems in attempting to understand or deal with the whole system.

California Science Standards Science

Grade K: 1a, 1c, 2a, 2c, 3a, 3b, 4a, 4b, 4e

Grade 1: 2a, 2b, 2c, 2d, 2e, 3c, 4a, 4b, 4d, 4e

Grade 2: 1a, 1b, 2a, 2c, 2d, 4a, 4c, 4d, 4g

Grade 3: 1a, 1d, 2a, 2b, 2c, 3a, 3b, 3c, 3d, 5a, 5b, 5e

Grade 4: 2a, 2b, 2c, 3a, 3b, 3c, 6a, 6c, 6f

Grade 5: 2a, 2e, 2f, 2g, 3a, 4a, 4b, 4c, 6a, 6b, 6c, 6g, 6h, 6i

Grade 6: 3a, 4d, 5a, 5b, 5c, 5d, 5e, 7a, 7d

Grade 7: 3a, 4f, 5a, 5b, 5c, 6b, 6c, 7b, 7e

Grade 8: 1a, 8a, 8b, 8c, 8d, 9a, 9b

Grades 9-12:

Physics: 3d, 3e, 4a

Biology/Life Sciences: 6a, 6b, 6c, 6d, 6e, 6f, 7d, 8b

Earth Sciences: 3a, 5a, 5d

Investigation and Experimentation:
1a, 1g

Benchmarks for Science Literacy from American Association for the Advancement of Science (AAAS) recommends that students have a wide variety of experiences with systems and systems thinking.

Primary students should practice identifying parts of things and how one part connects to and affects another. By the end of 2nd grade, students should know:

- most things are made of parts,
- some things may not work if some of its parts are missing and
- when parts are put together, they can do things that the parts can't do by themselves.

Students in grades 3-5 should have experience taking mechanical systems apart and perhaps putting them back together. By the end of 5th grade, students should know:

- if something consists of many parts, the parts usually influence one another and
- something may not work as well (or not at all) if a part of it is missing, broken, worn out, mismatched or misconnected.

With middle school students, systems thinking can be made explicit, suggesting analysis of parts, subsystems, interactions and motion. But descriptions of parts and interactions are more important than calling everything a system. By the end of 8th grade, students should know:

- a system can include processes as well as things,
- thinking about things as systems means looking for how every part relates to others,
- the output from one part of a system can become the input to other parts,
- any system is usually connected to other systems, both internally and externally and
- a system may be thought of as containing subsystems and as being a subsystem of a larger system.

High school students should have the opportunity to reflect on the value of thinking in terms of systems and apply systems concepts to diverse situations.

By the end of 12th grade, students should know:

- a system usually has some properties that are different from those of its parts, but appear because of the interaction of those parts,
- understanding how things work and designing solutions to problems can be facilitated by system analysis,
- the successful operation of a designed system usually involves feedback and
- even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

Benchmarks for Science Literacy.
American Association for the
Advancement of Science Oxford
University Press, New York, 1993.

Kelp Forest Poster Activity

Student Page

1. Use the key to identify the various living and non-living parts of the kelp forest system.
2. Select one of the animals or plants and investigate and share with your classmates:
 - How does it get its food?
 - How does it protect itself from predators?
 - How does it reproduce?
 - Does it spend its entire life at the kelp forest? If not, where else does it go?
 - How is it affected by the non-living aspects of the kelp forest system?
 - How does it affect other living and non-living parts of the system?
3. With your classmates, create a kelp forest food web that includes the species in the poster.
4. Additional focus questions and investigation topics might include:
 - What are the living things in this picture of the kelp forest?
 - What are the non-living things in this picture of the kelp forest?
 - Which animals at the kelp forest do you think eat other animals? Which animals do they eat? What makes you think so?
 - Which animals at the kelp forest do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the kelp forest?
 - Which animals in the poster are residents?
 - What do you notice about where the plants are growing at the kelp forest?
 - What parts of the poster could you see if you were walking on the beach and looking at the ocean? What wouldn't you be able to see?
 - How does this picture compare to your idea of how the kelp forest looks?
 - Do you think tides would affect the kelp forest in this poster? In what way(s) might it be affected?
 - How would sunlight affect the living things at the kelp forest?
 - Do you think the waves would affect the kelp forest? In what way(s)?
 - In what way(s) might color be important to the living things at the kelp forest?
 - How would wind affect the living things at the kelp forest?
 - How would the kelp forest look at night?
 - Do you think the kelp moves? What would cause it to move?
 - How would this kelp forest be different in the winter? How would storms affect it? What would happen to the animals?
 - How would it be different if there were sand instead of rocks?
 - What do you think might be harmful to the things at the kelp forest? Why?
 - How can we study the kelp forest without harming it or its inhabitants?
 - How could what happens in your town or city affect the kelp forest?
 - How could what happens at the kelp forest affect you?
 - If you had to live at the kelp forest in the poster, what would you need to survive?

Rocky Shore Poster

Teacher Page

Activity Description

How do animals survive the force of crashing waves at the rocky shore? How do they avoid drying out at low tide?

Using the rocky shore poster, students will view the rocky shore as if looking through a window placed at the middle tide zone. They will identify the living and non-living parts of this ecosystem and share their findings.

Key Concepts

- The rocky shore is a living system.
- There are living and non-living parts to the system.
- The living and non-living parts of the rocky shore interact and impact each other.

Materials

- Rocky Shore poster
- Blackline master of the poster
- Poster key
- Crayons, colored pencils or markers

Directions

1. Duplicate blackline posters and keys for each student in your class.
2. Encourage your students to look at the poster. Explain that they are viewing the rocky shore at the middle tide zone and that they can see above and below the water. Ask them to make reasonable guesses as to the interactions that take place between the living and non-living parts of the rocky shore. Have them consider what rocky shore organisms need to survive, what conditions they have to endure and how they manage

in such a harsh environment.

Discuss how those conditions would differ between the different parts of the rocky shore.

2. Using the key, have your students identify the various living and non-living parts of the rocky shore system.
3. Have the students select one of the animals or plants that they see in the poster. Throughout the unit, have the students investigate:
 - How does it get its food?
 - How does it protect itself from predators?
 - How does it keep from drying out or getting crushed by the waves?
 - How does it reproduce?
 - Does it spend its entire life at the rocky shore? If not, where else does it go?
 - How is it affected by the non-living aspects of the rocky shore system?
 - How does it affect other living and non-living parts of the system?

(**Note:** Students may respond to these questions and the ones below using the Student Page.)
4. Additional focus questions might include:
 - What are the living things in this picture of the rocky shore?
 - What are the non-living things in this picture of the rocky shore?
 - Which animals at the rocky shore do you think eat other animals? Which animals do they eat? What makes you think so?

- Which animals at the rocky shore do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the rocky shore?
 - Which animals in the poster are residents?
 - What do you notice about where the plants are growing at the rocky shore?
 - How does this picture compare to your idea of the rocky shore?
 - Do you think tides would affect the rocky shore in this poster? In what way(s) might it be affected?
 - How would sunlight affect the living things at the rocky shore?
 - Do you think the waves would affect the rocky shore? In what way(s)?
 - In what way(s) might color be important to the living things at the rocky shore?
 - How would wind affect the living things at the rocky shore?
 - How would the rocky shore look at night?
 - Do you think the rocks move? What would cause them to move?
 - How would this rocky shore be different in the winter? How would storms affect it? What would happen to the animals?
 - How would it be different if there was sand instead of rocks?
 - What do you think might be harmful to the things at the rocky shore? Why?
 - How can we study the rocky shore without harming it or its inhabitants?
- How could what happens in your town or city affect the rocky shore?
 - How could what happens at the rocky shore affect you?
 - If you had to live at the rocky shore in the poster, what would you need to survive?
5. Throughout the unit, have the students keep a running list of questions that develop as they conduct various activities. At the end of the unit, have students review the poster questions and those they generated. Ask what other things they would like to find out about the rocky shore.

Activity Links

www.mbayaq.org/efc/rocky.asp

Visit Monterey Bay Aquarium's web site to learn more about where the land meets the sea! Watch a living tidepool video, use the tidepool spotting guide to locate rocky shore animals and play the interactive *Make a Tidepool* game. Use the "About the Animals" list for rocky shore animal facts.

Background

In the study of the rocky shore, as with all systems, it is important to think about the whole system in terms of its living and non-living parts and the parts in terms of how they relate to one another and to the whole. As with non-living systems, such as engines, sewage systems and political systems, a living ecosystem is a collection of things and processes that interact to perform some function. There are inputs and outputs and interactions among the system components and with other systems. Often systems include subsystems.

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Rocky shore organisms live in specific parts of the intertidal zone. In general, predators and competitors set the lower limit of an organism's range. Physical factors, such as water, salinity and temperature, determine the upper limits of the range.

Competition for space is fierce in the rocky intertidal. Many animals and algae grow on one another. Rocky shore creatures must constantly deal with the drag and shock of waves.

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Grade 2: 1a, 2a, 2c, 2d, 3b, 4a, 4c, 4d, 4g

Grade 3: 1a, 1d, 3a, 3b, 3c, 3d, 5a, 5e

Grade 4: 2a, 2b, 2c, 3a, 3b, 3c, 5c, 6a, 6f

Grade 5: 2a, 2f, 2g, 3a, 3b, 4a, 6a, 6g, 6h, 6i

Grade 6: 1f, 2c, 3a, 4a, 4d, 5a, 5b, 4c, 5d, 5e, 7d

Grade 7: 3a, 4c, 4f, 5a, 5b, 7b, 7e

Grade 8: 1d, 1e, 2a, 2f, 9b

Grades 9-12:

Physics: 1d, 1f, 3a, 3d, 4a

Biology/Life Sciences: 6a, 5b, 5c, 6d, 6e, 6f, 7d, 8b

Earth Sciences: 3a, 5a, 5d, 6g

Investigation and Experimentation: 1a, 1g

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University Press, New York, 1993.

Rocky Shore Poster Activity

Student Page

1. Use the key to identify the various living and non-living parts of the rocky shore system.
2. Select one of the animals or plants and investigate and share with your classmates:
 - How does it get its food?
 - How does it protect itself from predators?
 - How does it reproduce?
 - Does it spend its entire life at the rocky shore? If not, where else does it go?
 - How is it affected by the non-living aspects of the rocky shore system?
 - How does it affect other living and non-living parts of the system?
3. With your classmates, create a rocky shore food web that includes the species in the poster.
4. Additional focus questions and investigation topics might include:
 - What are the living things in this picture of the rocky shore?
 - What are the non-living things in this picture of the rocky shore?
 - Which animals at the rocky shore do you think eat other animals? Which animals do they eat? What makes you think so?
 - Which animals at the rocky shore do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the rocky shore?
 - Which animals in the poster are residents?
 - What do you notice about where the plants are growing at the rocky shore?
 - How does this picture compare to your idea of the rocky shore?
 - Do you think tides would affect the rocky shore in this poster? In what way(s) might it be affected?
 - How would sunlight affect the living things at the rocky shore?
 - Do you think the waves would affect the rocky shore? In what way(s)?
 - In what way(s) might color be important to the living things at the rocky shore?
 - How would wind affect the living things at the rocky shore?
 - How would the rocky shore look at night?
 - Do you think the rocks move? What would cause them to move?
 - How would this rocky shore be different in the winter? How would storms affect it? What would happen to the animals?
 - How would it be different if there were sand instead of rocks?
 - What do you think might be harmful to the things at the rocky shore? Why?
 - How can we study the rocky shore without harming it or its inhabitants?
 - How could what happens in your town or city affect the rocky shore?
 - How could what happens at the rocky shore affect you?
 - If you had to live at the rocky shore in the poster, what would you need to survive?

Sandy Beach and Dunes Poster

Teacher Page

Activity Description

What lives deep in the sand? How do animals get their food at the sandy beach? Using the Sandy Beach and Dunes poster, students will view the sandy beach as if they are looking through a window placed at the surf line. Students will identify the living and non-living parts of this ecosystem and share their findings.

Key Concepts

- The sandy beach and dunes are a living system.
- There are living and non-living parts to the system.
- The living and non-living parts of the sandy beach and dunes interact and impact each other.

Materials

- Sandy Beach and Dunes poster
- Blackline master of the poster
- Poster key
- Crayons, colored pencils or markers

Directions

1. Duplicate blackline posters and keys for each student in your class.
2. Encourage your students to look at the poster. Explain that they can see above and below the water and above and below the sand. Ask them to make reasonable guesses as to the interactions that take place between the living and non-living parts of the sandy beach and dunes. Have them consider what sandy beach and dune animals need to survive, what conditions they have to endure and how they manage in such a harsh environment. Discuss how those

conditions would differ between the beach and the dunes.

3. Using the key, have your students identify the various living and non-living parts of the sandy beach and dunes system.
4. Have the students select one of the animals or plants that they see in the poster. Throughout the unit, have the students investigate:
 - How does it get its food?
 - How does it protect itself from predators?
 - How does it keep from drying out or getting crushed by the waves?
 - How does it reproduce?
 - Does it spend its entire life at the sandy beach and dunes? If not, where else might it go?
 - How do the non-living aspects of the sandy beach and dunes system affect it?
 - How does it affect other living and non-living parts of the system?
 - (**Note:** Students may respond to these questions and the ones below using the Student Page.)
5. Additional discussion questions might include:
 - What are the living things in this picture of the sandy beach and dunes?
 - What are the non-living things in this picture of the sandy beach and dunes?
 - Which animals at the sandy beach and dunes do you think eat other animals? Which animals do they eat? What makes you think so?

- Which animals at the sandy beach and dunes do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the sandy beach and dunes?
 - Which animals in the poster are residents?
 - What do you notice about where the plants are growing at the sandy beach and dunes?
 - What parts of the poster could you not see if you were walking on the sandy beach?
 - How does this picture compare to your idea of how the sandy beach looks?
 - Do you think tides would affect the sandy beach and dunes in this poster? In what way(s) might it be affected?
 - How would sunlight affect the living things at the sandy beach and dunes?
 - Do you think the waves would affect the sandy beach and dunes? In what way(s)?
 - In what way(s) might color be important to the living things at the sandy beach and dunes?
 - How would wind affect the living things at the sandy beach and dunes?
 - How would the sandy beach and dunes look at night?
 - Do you think the sand moves? What would cause it to move?
 - How would this sandy beach and dunes be different in the winter? How would storms affect it? What would happen to the animals?
 - How would it be different if there were rocks instead of sand?
 - What do you think might be harmful to the things at the sandy beach and dunes? Why?
 - How can we study the sandy beach and dunes without harming the ecosystem or its inhabitants?
 - How could what happens in your town or city affect the sandy beach and dunes?
 - How could what happens at the sandy beach and dunes affect you?
 - If you had to live at the sandy beach and dunes in the poster, what would you need to survive?
6. Throughout the unit, have the students keep a running list of questions that develop as they conduct various activities. At the end of the unit, have them review the poster questions and those they generated. What more would they like to find out about the sandy beach and dunes?

Activity Links

www.montereybayaquarium.org

Visit the Monterey Bay Aquarium web site and travel over beaches and wave-swept shores. View the “About the Animals” list for information about sandy beach and dune habitats and their inhabitants. Play Bird Bingo and watch sandy beach exhibit birds using the Aviary cam.

Background

In the study of the sandy beach and dunes, as with all systems, it is important to think about the whole system in terms of its living and non-living parts and the parts in terms of how they relate to one another and to the whole. As with non-living systems, such as engines, sewage systems and political systems, a living ecosystem is a collection of things and

processes that interact to perform some function. There are inputs and outputs and interactions among the system components and with other systems. Often systems include subsystems.

The main goal of having students learn about systems is not to have them talk about systems in abstract terms but to enhance their ability to attend to various aspects of particular systems in attempting to understand or deal with the whole system.

Beaches in the Monterey Bay exhibit the classic beach structure of being backed either by dunes or cliffs, followed seaward by the back beach, berm, beach face, intertidal zones and sand bar. The active coastal dune community continues landward on loose sands followed by the central dune scrub community.

The beach (back beach, berm and beach face) extends from the furthest reach of storm waves to the average high tide level.

The intertidal zone is the part of the beach that is affected by the change of tides.

- The upper intertidal is the most terrestrial of the beach environments. It exhibits the widest range of heat and cold. Thus, desiccation (drying out) is a significant problem for marine organisms in the summer and freezing is a problem in the winter. Fresh water, both surface water from rainfall and subsurface flow, can impact animals in this zone. Because of the limited inundation time, marine food resources are limited. The high intertidal fauna consists mostly of scavengers, which

rely on beach wrack material for sustenance. The wrack communities go through successional stages, being colonized first by highly motile beach hoppers and flies with later colonization by terrestrial isopods and beetles.

- The mid-littoral zone is characterized by a moderate inundation time, but is subject to many of the same rigors as the upper zone (temperature extremes, fresh water). The mid zone is more subject to rapid sediment removal during winter storms, requiring extreme mobility of its fauna.
- The swash zone, where wave breaking and runup often occurs, is characterized by the highest water movement. Consequently, it has a high degree of mechanical stress and the possibility of rapid sediment removal. It remains inundated over half the time, and so it is less subject to extremes of temperature and salinity.
- The low intertidal zone extends into the shallow subtidal. It is almost fully marine, being exposed to the air only on the lowest tides. The low intertidal is subject to almost constant wave action, requiring that the inhabitants be either rapid burrowers or protected against mechanical damage. It houses the most diverse faunal assemblage of the beach zones.

Ten shorebird species are common along the beaches of Monterey Bay. Among the small species are the Least and Western sandpipers, Dunlins, Sanderlings and both Short- and Long-billed dowitchers. Larger shorebird species include Black-bellied plover, Willet, American avocet, Marbled

godwit and Long-billed curlew. Most of these species also occur on outer sand beaches. Sanderlings, Willets and Marbled godwits are the species most commonly observed feeding along these beaches. Primary prey include sand crabs (*Emerita analoga*). Some birds, such as the Sanderling, also rely heavily on the beach isopod *Excirolana* sp.

There is a seasonal onshore-offshore movement of sand, with steeper beach slopes and offshore bars in the winter and gradual consistent slope in the summer. The seasonal erosion of the winter beach is due to the increased frequency and size of the waves. Smaller and less frequent summer waves redeposit much of the beach sand that was moved offshore by winter storms.

Sand in Monterey Bay is derived from several sources: 27% from cliff erosion, 54% from river discharge and 19% from long shore drift.

In addition to moving onshore and offshore, most of the beach sand in Monterey Bay moves toward the south along the coastline due to long shore transport. Long shore transport is caused by the angle at which most of the waves hit the beach. Long shore transport in the Bay is generally from north to south, but there are several small cells with northward transport, particularly in the southern half of the bay.

The Monterey Submarine Canyon acts as a sediment sink, with sand accumulating at the canyon head. The sediment is then flushed down the canyon as a result of storms or earthquakes.

California State Content Standards Science

Grade K: 1a, 1c, 2a, 2c, 3a, 3b, 4a, 4b, 4c, 4d, 4e

Grade 1: 2a, 2b, 2c, 2d, 2e, 3b, 3c, 4a, 4b

Grade 2: 1a, 1b, 1c, 2a, 2b, 2c, 2d, 2e, 3b, 3c, 4a, 4c, 4d

Grade 3: 1a, 1d, 1f, 2a, 2c, 3a, 3b, 3c, 3d, 4e, 5b, 5e

Grade 4: 2a, 2b, 2c, 3a, 3b, 3c, 5a, 5c, 6a, 6c

Grade 5: 2a, 2b, 2e, 2f, 2g, 3a, 3b, 3c, 4a, 4b, 6a, 6g, 6h

Grade 6: 2c, 3a, 3c, 4a, 4b, 4d, 4e, 5a, 5b, 5c, 5d, 5e, 7d

Grade 7: 2a, 3a, 3d, 4f, 5a, 5f, 7b, 7e

Grade 8: 8c, 8d

Grades 9-12:

Physics: 3d, 4a, 4b, 4c

Chemistry: 7c

Biology/Life Sciences: 6a, 6c, 6c, 6d, 6e, 6f, 8a, 8b

Earth Sciences: 5d, 5f, 6b

Investigation and Experimentation: 1g

Benchmarks for Science Literacy from American Association for the Advancement of Science (AAAS) recommends that students have a wide variety of experiences with systems and systems thinking.

Primary students should practice identifying parts of things and how one part connects to and affects another. By the end of 2nd grade, students should know:

- most things are made of parts,
- some things may not work if some of its parts are missing and
- when parts are put together, they can do things that the parts can't do by themselves.

Students in grades 3-5 should have experience taking mechanical systems apart and perhaps putting them back together. By the end of 5th grade, students should know:

- if something consists of many parts, the parts usually influence one another and
- something may not work as well (or not at all) if a part of it is missing, broken, worn out, mismatched or misconnected.

With middle school students, systems thinking can be made explicit, suggesting analysis of parts, subsystems, interactions and motion. But descriptions of parts and interactions are more important than calling everything a system. By the end of 8th grade, students should know:

- a system can include processes as well as things,
- thinking about things as systems means looking for how every part relates to others,
- the output from one part of a system can become the input to other parts,
- any system is usually connected to other systems, both internally and externally and
- a system may be thought of as containing subsystems and as being a subsystem of a larger system.

High school students should have the opportunity to reflect on the value of thinking in terms of systems and apply systems concepts to diverse situations. By the end of 12th grade, students should know:

- a system usually has some properties that are different from those of its parts, but appear because of the interaction of those parts,

- an understanding of how things work and designing solutions to problems can be facilitated by system analysis,
- the successful operation of a designed system usually involves feedback and
- even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

Benchmarks for Science Literacy. American Association for the Advancement of Science
Oxford University Press, New York, 1993.

Deep Sea Poster

Teacher Page

Activity Description

How do animals survive in an ecosystem that has only faint light or is dark? What adaptations do they have for finding a mate? Using the Deep Sea poster, students will identify the living and non-living parts of this ecosystem and share their findings.

Key Concepts

- The deep sea is a living system.
- There are living and non-living parts to the system.
- The living and non-living parts of the deep sea interact and impact each other.

Materials

- Deep Sea poster
- Blackline master of the poster
- Poster key
- Crayons, colored pencils or markers

Directions

1. Duplicate blackline posters and keys for each student in your class.
2. Encourage your students to look at the poster. Explain that they can see deep below the ocean's sunlit zone into the deepest zone of darkness. Ask them to make reasonable guesses as to the interactions that take place between the living and non-living parts of the deep sea. Have them consider what deep sea organisms need to survive, what conditions they have to endure and how they manage in such a harsh environment. Discuss how those conditions would differ between the different parts of the deep sea.
3. Using the key, have your students identify the various living and non-living parts of the deep sea system.
4. Have the students select one of the animals that they see in the poster.

Throughout the unit, have the students investigate:

- How does it get its food?
- How does it protect itself from predators?
- How does it reproduce?
- Does it spend its entire life at the deep sea? If not, where else does it go?
- How is it affected by the non-living aspects of the deep sea system?
- How does it affect other living and non-living parts of the system?

(**Note:** Students may respond to these questions and the ones below using the Student Page.)

5. Additional discussion questions might include:

- What are the living things in this picture of the deep sea?
- What are the non-living things in this picture of the deep sea?
- Which animals in the deep sea do you think eat other animals? Which animals do they eat? What makes you think so?
- Which animals at the deep sea do you think eat something besides other animals? What do you think they eat? What makes you think so?
- Which animals in the poster are visitors to the deep sea?
- What other visitors might come to the deep sea?
- Which animals in the poster are residents?
- Do you think there are some living things at the deep sea that you can't see? What might they be? What might they look like? Where might they live?
- Why do you think it is so crowded at the deep sea?

- Do you think tides would affect the deep sea in this poster? In what way(s) might it be affected?
 - How would sunlight affect the living things at the deep sea?
 - Do you think the waves would affect the deep sea? In what way(s)?
 - In what way(s) might color be important to the living things at the deep sea?
 - How would wind affect the living things at the deep sea?
 - How would the deep sea look at night?
 - How would this deep sea be different in the winter? How would storms affect it? What would happen to the animals?
 - How it would be different if there was only sand instead of rocks?
 - What do you think might be harmful to the things at the deep sea? Why?
 - How can we study the deep sea without harming it or its inhabitants?
 - How could what happens in your town or city affect the deep sea?
 - How could what happens at the deep sea affect you?
 - If you had to live at the deep sea in the poster, what would you need to survive?
6. Throughout the unit, have the students keep a running list of questions that develop as they conduct various activities. At the end of the unit, have students review the poster questions and those they generated. Ask what other things they would like to find out about the deep sea.

Activity Links

Visit Monterey Bay Aquarium's web site and take a virtual dive into the Monterey Canyon to see some of the strange creatures that live there. Learn how scientists explore the deep sea and discover some of the skills

that animals need to survive there, such as slime balls and glowing spit!

(http://www.mbayaq.org/efc/efc_mbh/dsc.asp)

Background

In the study of the deep sea, as with all systems, it is important to think about the whole system in terms of its living and non-living parts and the parts in terms of how they relate to one another and to the whole. As with non-living systems, such as engines, sewage systems and political systems, a living ecosystem is a collection of things and processes that interact to perform some function. There are inputs and outputs and interactions among the system components and with other systems. Often systems include subsystems.

The main goal of having students learn about systems is not to have them talk about systems in abstract terms but to enhance their ability to attend to various aspects of particular systems in attempting to understand or deal with the whole system.

California State Content Standards Science

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Grade 3: 1d, 2c, 3a, 3b, 3c, 3d, 4e

Grade 4: 2a, 2b, 2c, 3a, 3b, 6f

Grade 5: 2a, 3a, 6a, 6i

Grade 6: 5a, 5b, 5c, 5d, 5e, 7d

Grade 7: 3a, 3e, 5a, 5b, 5c, 6a, 6b, 7b, 7e

Grade 8: 8c, 8d

Grades 9-12:

Biology/Life Sciences: 6a, 6b, 6c, 6e, 6f, 6g, 7d, 8a, 8b

Earth Sciences: 5d, 5f

Investigation and Experimentation: 1a, 1g

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Benchmarks for Science Literacy. American Association for the Advancement of Science Oxford University Press, New York, 1993.

Deep Sea Poster Activity

Student Page

1. Use the key to identify the various living and non-living parts of the deep sea system.
2. Select one of the animals and investigate and share with your classmates:
 - How does it get its food?
 - How does it protect itself from predators?
 - How does it reproduce?
 - Does it spend its entire life at the deep sea? If not, where else does it go?
 - How is it affected by the non-living aspects of the deep sea system?
 - How does it affect other living and non-living parts of the system?
3. With your classmates, create a deep sea food web that includes the species in the poster.
4. Additional focus questions and investigation topics might include:
 - What are the living things in this picture of the deep sea?
 - What are the non-living things in this picture of the deep sea?
 - Which animals at the deep sea do you think eat other animals? Which animals do they eat? What makes you think so?
 - Which animals at the deep sea do you think eat something besides other animals? What do you think they eat? What makes you think so?
 - Which animals in the poster are visitors to the deep sea?
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