OUR UNDERSEA LEGACY:

A Curriculum Resource for Marine Protected Areas in Southern California

Birch Aquarium at Scripps Institution of Oceanography, UC San Diego

Legoland California Resort Sea Life Aquarium

Heal the Bay

COSEE West

Ocean Institute – Experience is the Teacher

Cabrillo Marine Aquarium

Aquarium of the Pacific – A non-profit institution

Heal the Bay Aquarium, Santa Monica Pier

Sea Grant, University of Southern California

Santa Barbara Museum of Natural History Ty Warner Sea Center

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I. Our Amazing California Ocean

Background Information

Stretching for a picturesque 1,110 miles along the Pacific Ocean, California has the third longest coastline in the United States. This coastline is a scenic and natural resource available for everyone to enjoy. Some of the habitats found along this diverse shoreline include rocky intertidal, kelp forests, sandy shores, beach dunes, wetlands, and unique islands. Our coastal resources support California's $43 billion coastal economy and are a rich source of inspiration. Commercial and recreational fisheries and tourism have long been economic drivers in communities along the Pacific coastline, in addition to shipping and local recreation, and many other coastal dependent businesses and activities.

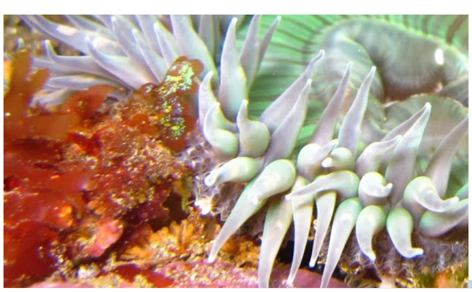
In 1999, California was the first state to pass a law requiring the establishment of science-based, statewide network of marine protected areas (MPAs). California recognized that it was important to provide holistic protection to our coastal resources (in addition to species-specific management practices that have been the norm). This led to the passage of the Marine Life Protection Act (MLPA) in 1999. Under this law, the state convened local ocean community members to work together to identify MPA locations using the best available science, which resulted in the inclusion of about 16% of California's coastline within MPAs. Now California has a network of over 120 MPAs where marine life is protected.

What is an MPA? It is a special place in the ocean, similar to a national or state park on land, where people are encouraged to visit and explore, but where harvest of wildlife is limited. Around the globe, from Hawaii to Australia, in the Pacific and the Indian Ocean, and elsewhere, thousands of MPAs representing 1.8% of the ocean, protect marine life from the pressures of human activities. These MPAs consistently have more marine life, greater diversity and larger animals than unprotected areas outside of these underwater parks. In California the animals and plants that live in MPAs are allowed to grow and thrive, and to reproduce safely in protected habitats with limited fishing pressure, allowing marine life and the habitats they depend upon to recover from human impacts and to maintain their ecosystem integrity for future generations. MPAs foster robust populations that can withstand current and future threats from climate change and other factors. With diverse habitats protected, organisms can move between and among habitats as necessary due to life cycles, seasonal cycles, and ecosystem changes.

In addition, many coastal areas have been important to native peoples, who have relied upon them for their livelihoods and spiritual values. Some MPAs protect this cultural heritage and site history; MPAs can protect these values and other sites of historical significance.

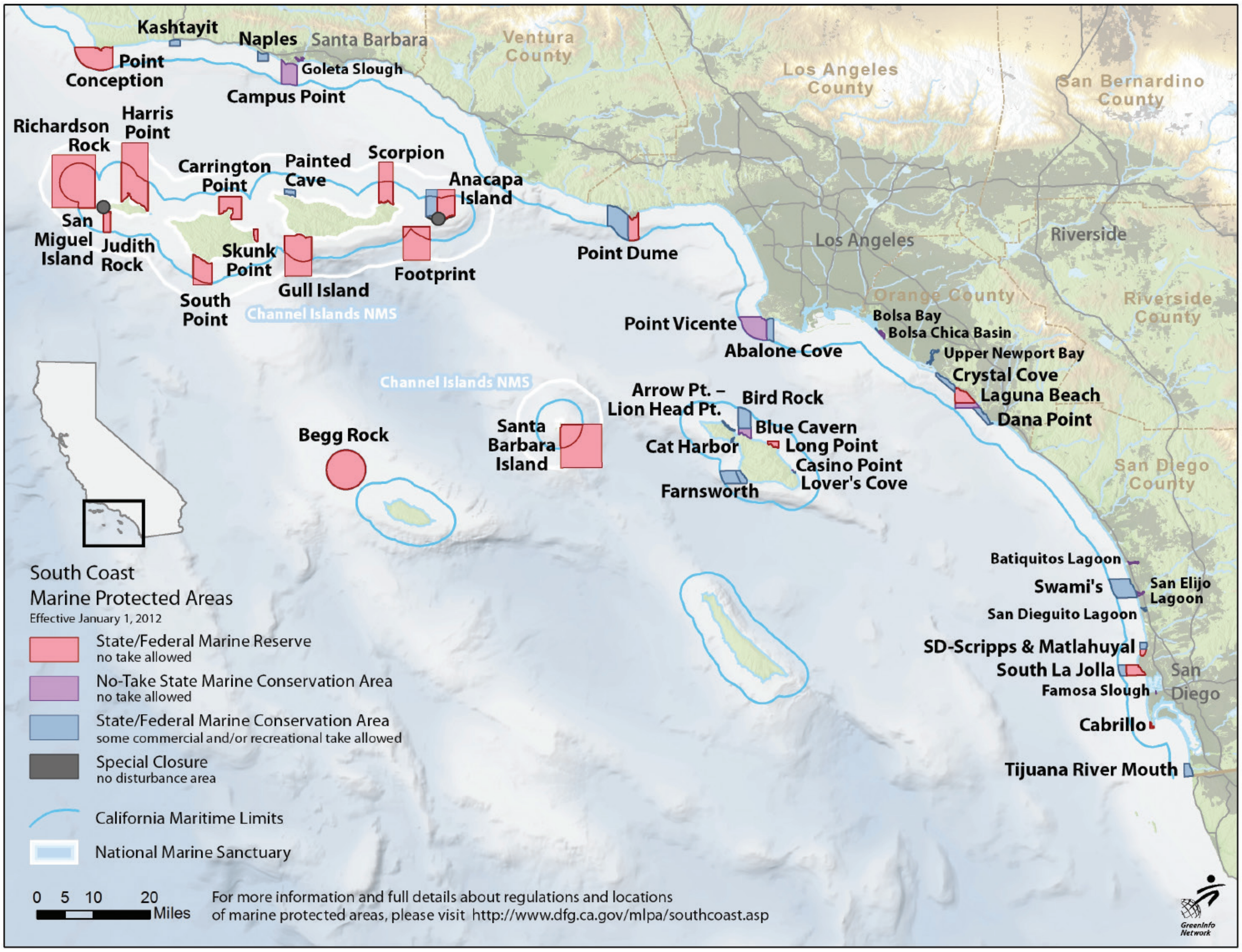
Protection of marine biodiversity was one of the key arguments in creating MPAs. What is marine biodiversity? Most of the Earth's water is salt water in the ocean, which covers 70% of the Earth. In these salty, wet habitats live diverse life forms that exchange energy and nutrients among themselves and the environment. Some of these life forms have completely disappeared while other still thrive. Marine biodiversity is the variety and abundance of life (microbes, algae, plants, and animals) found in the ocean.

Marine biodiversity is important because it is often used as a measure of the health of a biological system. Some environmental changes may be harmful while others may be beneficial. When the environment changes, some plants and animals survive and reproduce, while others die or move to new locations. Maintaining marine biodiversity is important for natural resources, natural ecosystem balances, aesthetic pleasure, and economics. You will often find biodiversity thriving in MPAs. These areas demonstrate both a variety and abundance of marine life.



In this section, your students will be introduced to some of the biodiversity found in our amazing California ocean waters through interactive lessons.

Map of Southern California's MPAs



Source: http://www.dfg.ca.gov/marine/mpa/scmpas_list.asp

State Marine Reserves are open to recreation and non-consumptive use (i.e. you can't take (fish) or hurt anything in the Reserve).

No Take State Marine Conservation Areas are similar to State Marine Reserves, except that they are open to specific restoration or research activities that might involve taking or altering the environment in a limited way by permit only.

State Marine Conservation Areas are open to limited recreational or commercial harvest of organisms.

Special Closures are areas that prohibit or restrict access and/or boating activities in areas adjacent to special sea bird or marine mammal sites.

Overview
Students will look at resources as an introduction to California's coastal resources

Learning Objectives
After completing this lesson, students will be able to:
• Describe a portion of the California coast
• Create a visual and written depiction of a California coastal organism and explain how it relates to other organisms

Time
45 minutes

Suggested Group Size
Individually for research, then in small groups to compare their research and creations, and as a class or in large groups to create the mural

Materials
Access to images or videos from the Resources Section
Notebook paper and pencils
Drawing materials

Engage
Ask students what do they know about our California coast and ocean.

Explore
Using images from the internet, the poster in this packet, and videos such as "Marine Protected Areas: Special Ocean Places Deserve Special Protection" (see Resources Section), have students explore California's underwater resources. Have students take notes on what they see and note how many different kinds of animals and algae there are. Note the interactions occurring among the organisms.

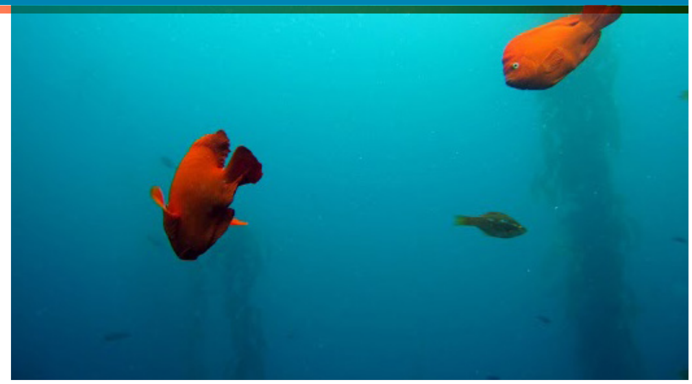
Explain
California's coastal waters are home to a rich array of habitats and species, many found nowhere else on Earth. Due to their uniqueness and the diversity (number of kinds or types) of animals that call them home, many people, including scientists, think our California coastal habitats (the rocky shores, kelp forests, sandy beaches, sea grass beds, and wetlands) are worth protecting for future generations.

Elaborate
Ask students what they saw or learned about animals and habitats that surprised them. Have them write a brief description about an animal, algae or aspect of a habitat that interested them.

Evaluate
Have students work together as a class or in smaller groups to create a mural of the California coast that depicts a healthy ecosystem or habitat relying upon their research and their images. Once students have added their piece, have them look at the overall mural and work together to make sure they have filled in any elements or habitats that may be missing. Assess students based on the degree of detail they were able to record and how their piece supports the creation of the entire mural.

Vocabulary
Coast - the edge of the land where it meets the sea
Ecosystem - the living community of organisms interacting with each other and their physical environment
Habitat - the natural environment of an organism that includes all it needs to stay alive, such as its home, food, shelter, and water
Healthy - functioning well and properly; in balance
Species - a group of similar organisms that can produce young together

I. Our Amazing California Ocean |
Lesson: Getting to Know Garibaldi



Overview
Students will look at the Marine Protected Area Poster to explore the life found in our California ocean with a special focus on some of the unique species that will benefit from the creation of a underwater parks.

Learning Objectives
At the end of this lesson, students will be able to:
• Describe an organism of the California coast in a non-fiction, descriptive essay

Time
20-30 minutes

Materials
"My Underwater Park" 8.5 x 11 B&W Coloring Sheet – (larger coloring surface)
A copy of the full My Underwater Park color poster
Photos of some of the brightly colored organisms – adult and juvenile garibaldi, California sheephead, nudibranch
Samples of nature writing for students – a selection of a few examples are available in the resources section.

Preparation
Copy Park B&W Coloring Sheet for each student and coloring utensils.

Procedure
Engage
After handing out the coloring sheets, ask students to look at the sheet and share some of the things they notice. Ask students if they think the coloring sheet is an accurate depiction of what it really what it looks like underwater in California's coast. Have them explain why or why not.

Explore
Obviously, one of the big differences between the sheet and our ocean, is our ocean is full of color. Explain to students that, while most people assume that coral reefs are the only colorful ocean habitats, our coastal habitats such as the rocky shore and kelp forest depicted on their sheets also have brightly colored and interestingly patterned animals. Project or hold up a copy of the full color poster to the class. Have them identify some of the brightly colored organisms. Specifically, have them find the adult garibaldi and juvenile garibaldi on their sheets and have them color them in using scientifically accurate colors.

Explain
While students are coloring, explain that the garibaldi is the state marine fish of California because it is so unique and a good representation of our local diversity. Other things to note about the garibaldi:

1. Adult garibaldis are brightly colored orange fish, the largest of the damselfish family, and are native to the Pacific Ocean ranging from Monterey Bay, California to Guadalupe Island, Baja California. The garibaldi is the official state marine fish of California, and because of this designation, it protected in California coastal waters. It gets its common name from its bright color: Followers of Italian historical figure Giuseppe Garibaldi wore bright reddish orange colored shirts. Its scientific name is *Hypsypops rubicundus*, translates as high appearance, very red (Hypsy = high, ops = appearance; rubi = reddish, cundus = very red).
2. While adult garibaldi are a bright and rich orange color, juvenile garibaldi are often found with numerous blue spots and a slightly paler version of their parents. Once they become adults, they lose the blue spots and become a much brighter shade of orange.
3. Adult garibaldi maintain a distinct home territory. The male clears a sheltered nest site within his territory and farms a mat of algae to shelter developing eggs. The female then deposits eggs within the nest of the male she feels has the best algal mat. The male subsequently guards the nest until the eggs hatch after 19–21 days. During this time

period, the male garibaldi aggressively tries to keep all other fish away from the very edible eggs. Like all male damselfish, the male garibaldi will boldly attack much larger swimming creatures, including humans, to the point of biting divers in order to try to drive them away from the area where the eggs are deposited.

4. In their territory, they pick small invertebrates off of the rocks and kelp, keeping them from their eggs and their territory while picking up a tasty snack along the way! By selectively farming particular species of algae and clearing their territory of surrounding invertebrates, they can play a significant role in determining the biodiversity. They are found in relatively shallow water (<30m/100ft deep), and can be found in dense populations of 40 individuals inhabiting an area the size of a basketball court!

After explaining these aspects of the garibaldi to students, have them guess at why it is such a bright color. If students have trouble coming to the conclusion that the garibaldi's color is a warning to would-be intruders, ask them to think of brightly colored animals on land such as bees or poisonous butterflies to recognize similarities.

Elaborate

Have students examine and color the other organisms on the sheet. Have them discuss those that are brightly colored and why they might be that way. The California sheephead and mantis shrimp who are both aggressive like the garibaldi, the small purple nudibranch is poisonous, and the bright purple urchin is covered in protective spines. If students do not come to it on their own, help them to conclude that animals can be brightly colored if they have ways other than their color to protect themselves. Have students look for those animals with less bold colors or camouflaging patterns and have them discuss why they are colored that way. The sharks may surprise the students with their camouflaging color, but have them guess as to why a small species of shark may want to hide.

Evaluate

Using what they have learned, have the students write up a descriptive paragraph about a unique organism that surprised them with their unique coloring. Have students circle their favorite animal on the sheet and ask them where they would need to go to see that organism and then have the students share any anecdotes or stories they have of seeing these organisms in person and to record these as a part of their descriptive sheet. Ask students to explain if they think the organisms they are studying should be protected and have them include that as well. Explain to students that this sort of writing is non-fiction science writing. Give students time to revise their paragraphs to ensure that they have written a brief but compelling piece about their organism and their experience with it and thoughts about it.

Note: To build understanding of nonfiction science writing, you might share other examples of non-fiction descriptive science essays, such as David Quammen, Barbara King·solver, Rachel Carson, Stephen Jay Gould, Jack Prelutsky or Ogden Nash. A few samples are in the resources section.

Possible Lesson Extensions

• Have students add themselves to the blank areas on the coloring sheet using this as an opportunity to talk about the importance of people using MPAs too!
• Using the blank edges of the coloring sheet, have students take notes, label the zones or organisms that are identified on the poster, or add other organisms that they think are missing.
• Use the coloring sheet to facilitate a discussion about diversity versus abundance, a discussion of form and function looking at factors such as organism shape, color, mouth shape, etc.
• Use the coloring sheet or poster as a scavenger hunt tool during a trip to your local Southern California aquarium.

Vocabulary

Farming - caring for and growing organisms for use and food
Organism - a living species, can be a member of any kingdom of life
Sheltered - protected
Significant - worth noting or paying attention to
Territory - a range or area in which an organism can be found, often guarded or protected by the organism


Rockfish


Spanish shawl, nudibranch

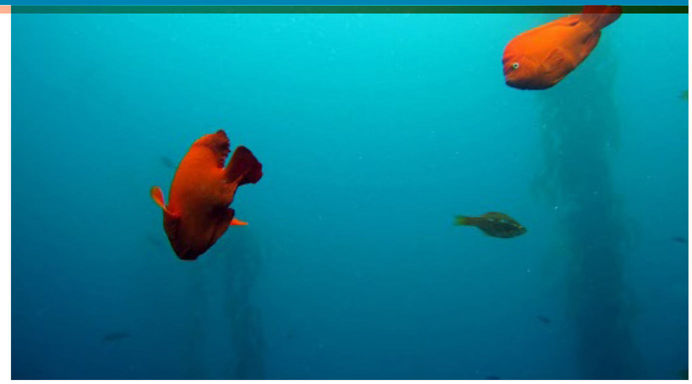

Juvenile garibaldi


Adult garibaldi

California sheephead

Treefish

I. Our Amazing California Ocean | Lesson: An Introduction



Overview
This lesson builds on the California's Coast and Getting to Know Garibaldi lessons and introduces students to the concept of MPAs

Learning Objectives
At the end of the lesson, students will be able to:
• Explain what Marine Protected Area, or MPA is and how it helps protect biodiversity and abundance of organisms in the ocean

Time
20-30 minutes

Suggested Group Size
Entire class, with some pair activities

Materials
"My Underwater Park" coloring sheets from "Getting to Know Garibaldi" lesson

Preparation
Read the background on MPAs and diversity and abundance

Procedure
Engage
Review students' learning from Getting to Know Garibaldi and California's Coast by asking them "What in the ocean do you think is the most important to protect? Do we all agree or do different people have different likes and dislikes? Is there a habitat or organism that they would be upset if it were to disappear from the area? Do they want to see our California coast protected?"

Explore
Have students spend two minutes doing a "Think-Pair-Share" on how they might protect our California coast. (Students spend 30 seconds thinking about ideas, one minute sharing their idea to a partner, then 30 seconds sharing with a larger group or the entire class). Then have students share ideas that they like with the class.
Ask students if they have heard of a MPA (Marine Protected Area).

Explain
Ask students to look at their coloring sheet and think of how an underwater park might protect the organisms shown on the sheet. Have students share their ideas. Clarify that a MPA is similar to a national park on land. It has animals and plants (or algae) that live in it. People are allowed to visit, explore and enjoy MPAs , but like parks on land these parks protect some organisms from being harvested or taken out of the habitat. MPAs allow seaweeds and animals to grow and thrive in habitats that will allow for a variety and abundance of marine life. These protected areas allow marine life to eat, grow, mate and reproduce without fishing pressures. MPAs are special places in the ocean where marine resources can be protected now and saved for future generations.

Have students think about and discuss some of the threats that could endanger a marine habitat?

Elaborate
Marine Protected Areas allow marine life to eat, grow, mate and reproduce without the pressure of harvest. Female fish can in fact grow older and larger within MPAs – this has been demonstrated in protected areas all over the world. Older and larger female fish have many more offspring than younger, smaller fish. Research shows that maintaining safe and protected habitats will allow for fish to grow older and larger.

For example, a Vermillion Rockfish
At 7 years old, is about 14.6 inches long and may produce 150,000 offspring
At 13 years old, is about 19.7 inches long and may produce 700,000 offspring
At 19 years old, is about 23. 6 inches long and may produce 1,700,000 offspring. Students will explore this phenomenon of Big, Old, Fat, Fecund, Female, Fish (BOFFFs) in another activity MPAs = More Fishes

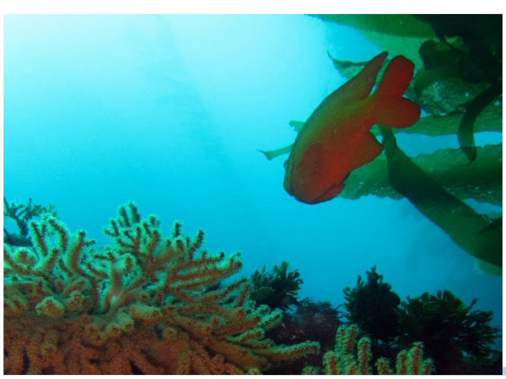
Have students look at their coloring sheet and count
1. how many different KINDS of organisms that they can find,
2. how many INDIVIDUALS they can find.

Ask students if they know another term for having many kinds of organisms in one place. Some students may know the term variety, but explain that biodiversity is the scientific term for variety. Ask them if they know the scientific term for the number of creatures – abundance. Have students do a "Think-Pair-Share" about the importance of biodiversity and abundance in a habitat, and how MPAs/underwater parks might aid in maintaining or encouraging biodiversity and abundance.

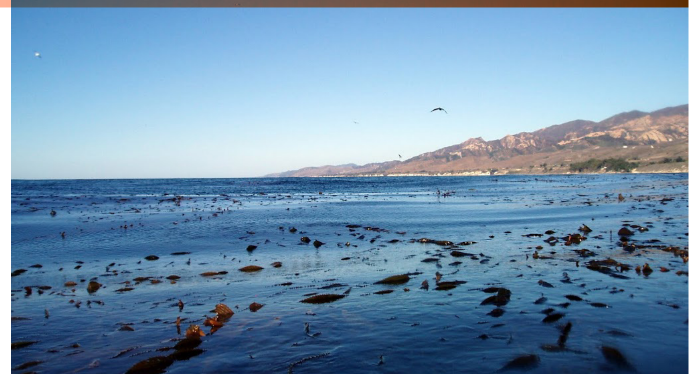
Evaluate:
Discuss how Marine Protected Areas can increase marine biodiversity, abundance and variety.

Vocabulary

Abundance - number of individuals in a habitat or ecosystem
Marine habitats - habitats found in the ocean, natural environments of organisms; in Southern California, our primary marine habitats are the sandy shore and corresponding sandy bottom, sea grass beds, rocky shore and corresponding rocky reef, kelp forest, and open ocean
Marine biodiversity - biodiversity is the variety of species in a region; marine biodiversity refers to this variety in the ocean
Marine Protected Area - MPA a special place in the ocean, similar to a national or state park on land, where people are encouraged to visit and explore, but where harvest of wildlife is limited
Underwater parks - areas underwater that are protected
Variety - number of species in a habitat or ecosystem
Organism- a living species, can be a member of any kingdom of life
Species - a group of similar organisms that can produce young together
Fecund - fertile, producing or capable of producing new growth or offspring
BOFFF - big, old, fat, female fish, sometimes known as Big, old, fat, fecund, female fish (BOFFFF); larger, sexually mature female fish who are capable of producing more offspring than smaller, younger female fish




Lesson: Understanding an Ecosystem Approach



Overview
Students will be introduced to the value of MPAs and the ecosystem approach to conservation versus management methods that just focus on individual species

Learning Objectives
After completing this lesson, students will be able to:
• Describe an ocean food web
• Describe the impact of losing specific species in a habitat
• Explain why MPAs use an ecosystem approach to conservation

Time
30 minutes

Suggested Group Size
Entire class, individually and in small groups

Materials
Underwater Park 8.5 x 11 B&W Coloring Sheet
A projected version of the sheet
Blank paper and writing/drawing materials
Food web examples – See Resources Section

Procedure
<u>Engage</u>
Teacher prompt: Ask a student what he or she ate for dinner last night. Use the information to create a quick food chain (or food web) on the board. Ask students to define the drawing as a food chain (or food web). If possible, also draw connections to show where there are food webs in the drawings.

<u>Explore</u>
Have students look over their coloring sheets and have students suggest organisms that might eat one another creating a food chain or food web. Have students draw lines making connections and then as a class share the students' suggestions on the projected coloring sheet.

<u>Explain</u>
Identify and discuss marine consumers and producers. Marine consumers are organisms that do not make their own food, instead they eat the producers, as well as other others types of consumers. Marine producers are organisms in the ocean like phytoplankton and seaweed that use photosynthesis to make their own food. Explain that the connections they make create a food web, which is just an illustration of the complex connections among what eats what in a particular habitat. This shows the flow of energy.

If the students haven't already, ask them to discuss the largest producer in the image and one of the largest producers in the ocean – giant kelp. Ask students if they know who eats the giant kelp. If they do not know, lead them to the purple sea urchins. Ask them if they know who eats the ever so tempting spiny urchins. The not-depicted answer is sea otter, in addition to the depicted California sheephead and lobster. Scientists often refer to California sheephead and these others as keepers of the kelp due to their role in protecting kelp forests and keeping the kelp forest habitat in balance by eating the urchins which eat the kelp. Yet these predatory populations are reduced from historical numbers and the urchins' populations are growing.

Discuss the consequences of California sheephead, lobsters, or sea otters going extinct. What would happen to the abundance of urchins? (It would increase.) What would happen to the abundance of kelp and kelp forests? (It would decrease.) Explain that this is what has happened in some parts of Southern California – sea otters were hunted to virtual extinction for their thick, warm fur coats while the large California sheephead and lobsters have become less abundant due to overfishing.

Elaborate

Have students take their blank papers and fold them in half – on one half, have them draw a healthy food web, and an imbalanced food web on the other half. In small groups, have students discuss how their healthy food web would be impacted if only one organism in their food web was protected. Have students then discuss if the entire habitat where their food web was found could be protected, how that might impact the food webs? Students will realize that a holistic ecosystem protection is a better way to keep habitats and all of the life within them healthy. While some species need additional protection or management (e.g. endangered species) an ecosystem approach ensures all of the components necessary for that species to survive are kept in balance or sustainable. MPAs help buffer against ocean threats and restore marine life and habitats.

Evaluate

Have students identify and discuss ideal ways to protect overall ecosystem health. Have students identify some of the challenges in deciding to protect areas. If students bring up that sometimes it just isn't reasonable or fair to protect a habitat to the exclusion of all else, acknowledge that point and tell them you will be returning to it in the next section.

Possible Lesson Extensions

• Have students create marine food web models by creating sculptures and connecting their creations with string or rope – creating a literal web.
• Have students research an organism and use that research to complete the "Why Should I Be Saved" worksheet from the Resources section.
• Have students research their favorite seafood and try to find connections to MPAs or even just to other species and their habitats necessary for that species' continued survival.

Vocabulary

Consumer - organisms that must ingest or eat others to get their energy
Ecosystem based management - a conservation approach that looks at an entire ecosystem, its living (biotic) and non-living (abiotic) factors and how they interact to ensure that all aspects of the habitat or ecosystem vital to its continued health are protected or is sustainable
Food chain - the pattern of energy moving through a habitat from a producer through a series of consumers
Food web - the transfer of energy among producers and consumers within a habitat, composed of many varying food chains
Marine animals - animals that live in the ocean
Marine habitats - habitats found in the ocean, natural environments of organisms; in Southern California, our primary marine habitats are the sandy shore and corresponding sandy bottom, sea grass beds, rocky shore and corresponding rocky reef, kelp forest, and open ocean
Marine biodiversity - biodiversity is the variety of species in a region; marine biodiversity refers to this variety in the ocean
Producers - organisms that use photosynthesis or chemosynthesis to produce food/sugar for energy

II. Swimming into the Science of MPAs

Background Information

There are many ocean stakeholders - people who have a stake or interest in marine resources and other ocean issues from an economic, recreational, scientific, environmental, emotional, legal, or other perspectives. Stakeholders' connections with the ocean vary from person to person. One of the unique features of the MLPA process in California and the establishment of MPAs is that public stakeholders were instrumental in determining the recommended locations for MPAs along the coastline. Because there are so many different perspectives and values, compromise was necessary. Some stakeholders were recreational divers and fishermen, while others, such as commercial lobster fishermen and whale watching operations rely upon ocean resources for their income. Other stakeholders included those whose jobs include managing and monitoring the resources of the marine protected areas, such as marine scientists, and those who represent ocean conservationists and aim to protect marine life for future generations. California's MPAs were designed with input and compromise from all of these stakeholders, which leads to a more robust and informed system of underwater parks.

Another reason MPAs were created was to help mitigate or avoid an issue known in conservation as the "*Tragedy of the Commons*". Fisheries can provide the classic example of tragedy of the commons. This can happen when fish are in areas that are open to fishing and many fishermen act in their own self-interest and catch as many fish as possible until all the fish are caught, rather than looking to preserve the environment for the future and create a sustainable fishery for years to come by limiting each person's individual catch. "The Tragedy of the Commons" was initially proposed as a hypothetical model to illustrate a much larger societal problem. In early English history, there was often a common pasture (the commons) where all members of a community could take their livestock for grazing. Each individual farmer was motivated to use this pastureland for his animals to get the maximum benefit possible. However, as more animals used the resource, the pasture became trampled and overgrazed until there was no grass left for anyone. Therefore, if each farmer was motivated simply to maximize personal benefit, and thus used the pasture as much as possible, the pasture or commons soon became of no use to anyone.

Similarly, the ocean's supply of fish is a common resource that is rapidly being depleted. The basic issue is that since 1950, the fishing industry has quadrupled its catch. According to the United Nations, 15 out of 17 world fisheries are overfished or depleted. Ninety percent of the large fish species in the oceans have been fished out, or fished to the point that the fishery can no longer sustain their populations in the last 50 years. In short, fish are being taken from the oceans faster than they can reproduce and grow. Many fisheries have already seen collapses. This results in over-exploitation. When areas like MPAs are set aside there is less damage to the overall fish stocks and the community is able to obtain continued ocean resources, and certain areas (MPAs) act like an insurance policy ensuring that there are areas which still provide safe habitats for marine life. Historically, the fishing industry looked for the most effective and efficient ways to catch as many fish as possible. With technological advancements, fishing pressure in many areas has become stronger than the resource can support. Only recently, have we realized that part of natural resources management needs to include taking responsibility to protect the fish stock for future generations. Marine Protected Areas are an important tool in that protection.

Marine Protected Areas also help to protect many species whose life cycle is diverse and uses a variety of habitats during its life. One example of this is the boccacio. Even though boccacio have been an abundant and adaptive rockfish, they have suffered from overfishing and their population has benefited from fishing regulations. Boccacio occur in coastal waters from Baja California, Mexico, to Alaska. An area of scarcity off northern California and southern Oregon separates the northern and southern segments of the population. Genetic analyses indicate that bocaccio from southern California and central California (Monterey) are a well-mixed population, but do not mix extensively with fish sampled from Washington waters (Russ Vetter, NMFS, SWFSC, personal communication).

Bocaccio do not show strong habitat specificity. Adults (both in schools and singly) are most frequently found in association with rocky areas, from near-surface to depths exceeding 100 fathoms. Offspring (larvae and early juveniles) are pelagic until early June, when they move toward the shore and settle to the bottom where they develop as juveniles. They grow rapidly, but typically take five years to mature. Juvenile bocaccio (age three to six months) sometimes form dense schools in the nearshore area. Bocaccio are one of most mobile rockfish species and are capable of moving freely throughout the range of the southern stock.

They serve as prey to larger organisms, including marine mammals, and juvenile bocaccio can at times provide a significant component of seabird diets. Bocaccio are predatory fish and consume a wide variety of smaller fishes, including adults and juveniles of many species of rockfish including bocaccio. Due to this long and varied life cycle, bocaccio are subject to pressures from habitat degradation and overfishing throughout their life. Because of their vulnerability to pressures, Marine Protected Areas are an important tool in protecting species like the bocaccio.

Science plays an instrumental role in identifying areas for protection by synthesizing decades of peer reviewed scientific studies. Science, through research and monitoring of MPAs, will continue to ensure that the size, spacing between, and habitat protected in MPAs of California's network are sufficient to promote recovery of key species and habitats.

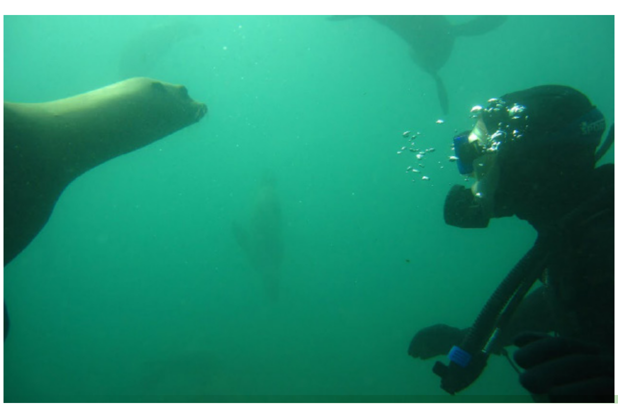
The scientific understanding of marine reserves and other protected areas is growing rapidly. Worldwide, science has shown that by protecting sensitive and important ocean and coastal habitats through ecosystem-based management, marine life flourishes and in turn, creates a healthier system overall. These healthy ecosystems can then provide both environmental and economic benefits for everyone. As indicated in the Marine Life Protection Act (MLPA):

> *Fish and other sea life are a sustainable resource, and fishing is an important community asset. MPAs and sound fishery management are complementary components of a comprehensive effort to sustain marine habitats and fisheries.*

Marine life reserves are an essential element of an MPA system because they protect habitats and ecosystems, conserve biological diversity, provide a sanctuary for fish and other sealife, enhance recreational and educational opportunities, provide a reference point against which scientists can measure changes elsewhere in the marine environment, and may help rebuild depleted fisheries.

Conducting ecological and social research will be critical in determining the effectiveness of California's marine protected areas. The MPA Monitoring Enterprise leads the development and implementation of impartial, scientifically rigorous research and monitoring plans. Find out what research is being conducted and where at http://oceanspaces. org/explore

Collaborative stewardship including monitoring and citizen science by regional organizations is a key strategy to secure enduring protection. Heal the Bay and other groups such as Orange County Coastkeeper, WILDCOAST in San Diego, and Santa Barbara Channelkeeper have established MPA Watch programs to monitor and gather observational data on human activities in and around MPAs through trained volunteer scientists. This data helps inform MPA managers about how California's MPAs are being used and where targeted education and enforcement might be needed to help facilitate compliance with these underwater parks.



Lesson: MPAs – What's at Stake?

Adapted from National Geographic Education's Marine Protected Area: Stakeholder Debate

Overview
This lesson looks at the process of creating MPAs using the input of multiple stakeholders via student participation in a mock stakeholder meeting and debate.

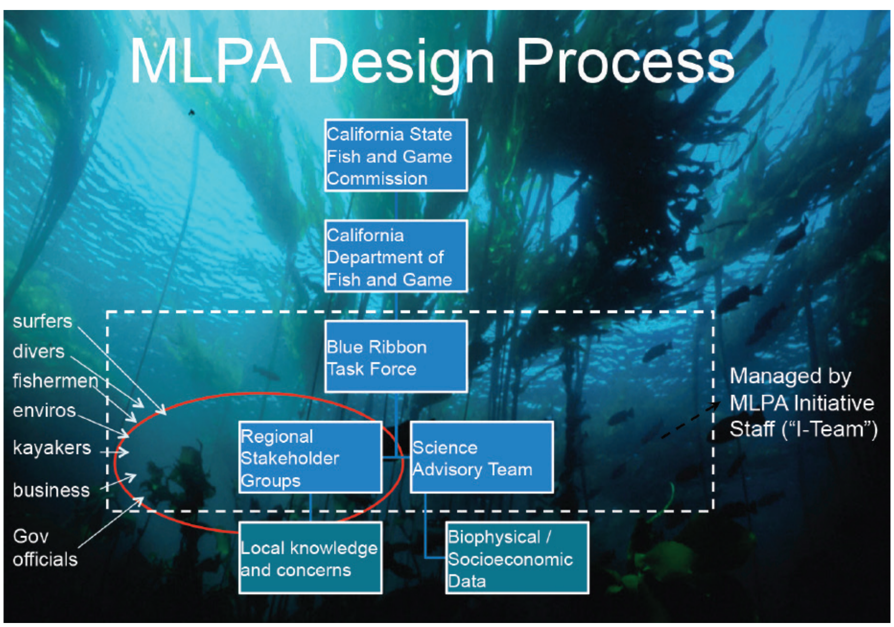
Learning Objectives
After completing this lesson, students will be able to:
• Describe the process of creating or establishing guidelines engaging multiple stakeholders

Time
2 class periods – one for research & one for mock stakeholder process

Suggested Group Size
Individual students will each serve a specific role within the class

Materials
Access to the internet queued to a video or podcast from our resources section
Video projector
1 copy of "Which Stakeholder am I?" worksheet per student

Preparation or prior knowledge
A discussion of how laws are made and implemented can be helpful to this lesson.



Graphic provided by Dana Roeber Murray

Procedure
Engage
As a class, view one of the videos or podcasts found at the end of the lesson. After the video, have the students discuss why it matters to them. Ask them if they think they should have a say in laws related to ocean protection. Why or why not?

Explore
Identify that stakeholders are individuals who will be impacted by a decision or have a stake in the decision. Select

one of the video segments and create a summary or graphic organizer of who the stakeholders are and why MPAs are important to those stakeholders. Do any two or more of those stakeholders express similar values for MPAs? Have students create individual cards for each of the identified stakeholders.

Explain

Look at the stakeholder cards created by the class and determine which should be categorized together via similar backgrounds, interests, or concerns (for example boaters, anglers, commercial fishermen, etc.). Ask students how to explain how they organized or classified the stakeholders and why they would classify them the way that they did?

Have students develop a summary statement that represents one or more of the stakeholder groups that they have sorted. Make sure the summary statement includes why MPAs are important to that group.

Have students discuss which stakeholder group they most relate to and why. Have students complete the "Which Stakeholder am I?" worksheet page 36.

Elaborate

Have students research the position of the stakeholder that they most identified with and have your class host a mock stakeholder process meeting by having students taking on the roles of individual stakeholders. For those students who didn't strongly identify with one group or another, have them run the meetings (they will need to research this process as well).

1. As part of preparing for their roles have the students contact the person they are representing, or someone in that type of role and ask them about the role they served as a stakeholder.
2. Identify a portion of the coast and the issue to be discussed, that will effect the establishment of a MPA.
3. Use one class period to allow students to share their recommendations and collaborate to establish the boundaries for an MPA using each of their unique viewpoints. Remind students that unlike a mock trial, there are no winners or losers in this process, except the ocean. At the end of the class period the students must make a recommendation of one area for the MPA. It is up for debate as to where, how large, what habitats are protected and what exactly is allowed in the MPA (such as different types of fishing or research).

In the actual stakeholder process, participants were given science guidelines to help them develop their MPA recommendations. You may want to present some similar ones to your students. For example, you might want to give them size range requirements minimum 3 square miles, maximum 18 square miles, for the South Coast Stakeholder Group. The environment performs better with larger boundaries, but the compromise may have a negative economic impact. Another guideline used might be minimum number of habitats protected or a minimum area of a specific type of habitat. Establishing science guidelines can help frame the discussion and clarify tradeoffs. Providing a goal will help to guide the students.

Evaluate

Have students assess how successful they felt they were in representing their stakeholders' viewpoints and getting them incorporated into the creation of the MPAs. If they were meeting facilitators have them assess how successful they thought they were in that process. Have students discuss as a class the pros and cons of involving so many stakeholder opinions and voices in the creation of MPAs.

Extension

• Have students research the list of stakeholders that took part in the South Coast MLPA Process using the Stakeholder List from the South Coast MLPA Process list in the Resources section before performing the stakeholder debate.
• Have students interview members of their community to see how they feel about ocean protection and use those viewpoints to inform their stakeholder role.
• Invite the stakeholders represented to your mock meeting and ask for their evaluation of the effort.

Vocabulary

Stakeholder - an individual or category of individuals that will be impacted by a decision and have a "stake" in the issue or resource

Facilitator/facilitation - A facilitator is someone who helps to make something happen by guiding a process, facilitation is the act of helping and guiding the process

Lesson: Fishing for Solutions

Overview
Through a variety of activities, games, and discussions, students will explore the impact of fishing on the ocean and the role MPAs can play in alleviating this pressure.

NOTE: For Learning Objectives, Time, Suggested Group Size, Materials, and Preparation see individual lesson components.

Procedure
Engage
MPAs = More Fishes Activity
Explore
Avoiding a Tragedy of the Commons Activity
Explain
Ensuring the Life Cycle is Unbroken – Bocaccio Activity
Elaborate
Estimating Fish Populations Activity
Evaluate
Visualizing Knowledge Activity

Engage
Activity: MPAs = More Fishes

Learning Objective
At the end of the activity, students will be able to:
• Explain how Marine Protected Areas provide habitat for fish to grow larger, older, produce more eggs and have more offspring.

Background Information
One very important impact marine reserves have is that fishes have the opportunity to grow bigger than in unprotected areas because they are not targeted by fishermen. This is important because larger animals produce more eggs resulting in substantially more babies than smaller animals produce. Marine reserves typically have larger abundance and diversity of fish. To be successful, MPAs should provide habitat for the different life stages of a fish.

Time
5 - 20 minutes

Materials
Prepared in advance stuffed fish with strings of "babies" (not included) to represent number of eggs laid/year and images using the directions in the resource section

Procedure
Ask the students "How many of you like to eat fish?
Do any of you catch your own fish?
How do you decide when to keep a fish or to throw the fish back?"

Hold up smallest fish.
Ask the students if you or someone caught this fish would you keep it to eat? How many eggs do you think this fish will produce in a year? If a group, get them to each guess. Show the string with number of babies produced and explain each "baby fish" represents 10,000 eggs.

What would happen if you threw the fish back and let it grow larger for a few years, and when you caught it again it was this size?

Hold up medium sized fish.

Repeat the question: If you or someone caught this fish would you keep it to eat? How many eggs do you think this fish will produce in a year? If a group, get them to each guess. Show the string with number of babies produced and explain each "baby fish" represents 10,000 eggs. Compare the length of "baby fish" strings.
What would happen if you threw the fish back again and let it grow larger for a few more years, and when you caught it again it was this size?

Hold up large sized fish.

Repeat the question: If you or someone caught this fish would you keep it to eat? How many eggs do you think this fish will produce in a year? Show the string with number of babies produced and explain each "baby fish" represents 10,000 eggs. Compare the three fish and the strings of "baby fish" that they would produce in a year. Ask the participants what can they tell about fish productivity when compared with size of fish.

Vermillion Rockfish	Size of fish	# of offspring per year
19 years old	23. 6 inches	1,700,000 offspring
13 years old	19.7 inches	700,000 offspring
7 years old	14.6 inches	150,000 offspring

Discuss with the students whether they think there should be areas for fish to grow bigger and have more babies? Identify that these are Marine Protected Areas. When the fish produce more offspring then fill the protected area, some end up outside of the MPA where fishermen can catch them. When this happens the fishermen benefit from the MPA as well.

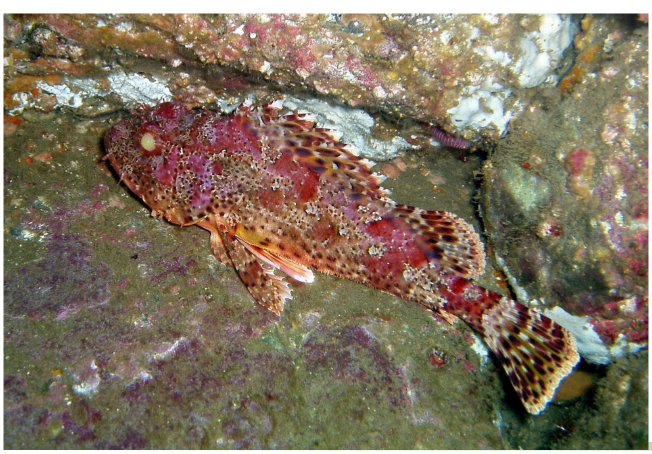
Note: This correlation isn't true for all fish, but it is true for many fish, including the kelp bass and rockfish that are important for healthy food webs in our coastal waters.

Extension

• Have students draw a representation or model of what they learned how marine protected areas can help fish and fishermen.
• Have students interpret the graph and then use it to create their own fish models for sheephead or kelpbass.
• Have students develop a graph of size vs. productivity of sheephead and kelpbass from "Using GIS Mapping of the Extent of Nearshore Rocky Reefs to Estimate the Abundance and Reproductive Output of Important Fishery Species" (see Resources section). Keep in mind that in preparing their work they will want to be effective in communicating the science with their audience. Brainstorm in advance strategies that they can use to be more effective including color, wording, images, etc.

Evaluate

Have students share their graphs with partners and discuss what they used to be effective communicators.



Explore
Activity: Avoiding a Tragedy of the Commons

Learning Objective
At the end of this activity, students will be able to:
• Explain why sharing natural resources between two or more parties is complicated and how through planning and management fish stocks can recover from overfishing and other human caused impacts.

Time
1 – 2 class periods

Materials
Fishery facts information sheet:
http://www.pbs.org/emptyoceans/educators/activities/docs/Fishing-fishery-facts.pdf
Science Daily: Ending the Ocean's Tragedy of the Commons:
http://www.sciencedaily.com/releases/2010/09/100914095930.htm
Science Daily: One Solution to Global Overfishing
http://www.sciencedaily.com/releases/2012/03/120319163807.htm
Empty Oceans, Empty Nets:
http://www.pbs.org/emptyoceans/eoen/index.html
A fun PSA that drives home the importance of thinking beyond our own action:
http://www.shiftingbaselines.org/mpas/psa.php

• Tragedy of the Commons Activity Sheet
• 16 crackers or cut out fish for each group of four, plus additional fish for reproduction at the end of each fishing season
• Four spoons
• One pencil or crayon
• One bowl for each group

Procedure
Have students read Tragedy of the Commons: A Brief Overview before they play the Let's Go Fishing! A "Tragedy of the Commons" Simulation. Using the questions on Tragedy of the Commons Activity Sheet, have a clas s discussion about tragedy of the commons and the role MPAs might play in protecting against this phenomenon.

National Oceanic and Atmospheric Administration/Department of Commerce, photographer William B. Folsom, NMFS

Let's Go Fishing! A "Tragedy of the Commons" Simulation

As the head of your family, you need to fish for food. The nearest fishing spot is a small, pleasant cove that currently supports 16 fish. There are four families that rely on this cove for their food and living. They fish in the morning, after which time the remaining fish reproduce...one offspring per fish in the cove.

PART 1

Directions:

- Go to your lab table with your partners. However, you will work individually, as you represent your own family. Four families per table.
- On your table find 4 fishing poles (spoons), a crayon (for part 2), and a cove for fishing (bowl).
- The oldest person goes first. Each fisherperson may take as many or as few fish as he/she wants during their turn, but more than one fish is needed to feed each family. The morning of fishing will last no more than 10 seconds, but you don't have to use the full time.
- If you catch one or no fish your family will starve. Two or more fish feed your family.
- At the end of the morning's fishing, double the number of remaining fish to simulate reproduction. The oldest person will reproduce the fish.
- Fish for two more days.
- Rotate your fishing order so everyone has a chance to go first.
- No talking is allowed during fishing.
- Fill in the table below, as you fish.

Common Cove: Part One Table

Morning	# of fish at start	# of fish taken by 1st fisher	# of fish taken by 2nd fisher	# of fish taken by 3rd fisher	# of fish taken by 4th fisher	Total fish left at end of day
1						
2						
3						
Totals						

PART 2

For this second round, part of the cove is protected.

- Mark off the section where no fishing is allowed by placing a pencil or crayon in the bowl as the divide between the area of open fishing and the marine protected area (no fishing).
- Ensure there are fish in both the open fishing area and the marine protected area
- Students may continue to fish taking turns as in Part 1, fishing only within the cove open to fishing.
- At the end of each day of fishing remember to have the fish reproduce.
- When the marine protected area fish population reaches 16, it represents "carrying capacity" and the fish beyond 16 can "spillover" into the adjacent open fishing area of the cove.
- Once the population of fish in the cove exceeds 16 allow the extra fish "spillover" into the adjacent open fishing area of the cove.
- Fill in the table below as you fish.

Common Cove: Part Two Table

Morning	# of fish at start	# of fish taken by 1st fisher	# of fish taken by 2nd fisher	# of fish taken by 3rd fisher	# of fish taken by 4th fisher	Total fish left at end of day
1						
2						
3						
Totals						

(Adapted from Tori Haidinger; retrieved 6/05/10 apcentral.collegeboard.com)

ANALYSIS (Think about your data and discuss these questions at your table.)

1. Did this activity accurately portray what you think would happen in a fishing community? Why or why not?

2. Did all fisherfolk fulfill their needs? If not why not?

3. If people were fishing in their own cove would they have behaved any differently? Why or why not?

4. What happened the first time you went "fishing"?

   A. How does this relate to overfishing?

5. Why are there time limits and what does the time limit represent?

6. How did you plan your actions and strategies before each harvest?

7. Did anyone sacrifice the number of fish caught for the good of the community? Why or why not? Does society ever reward that type of person?

8. Mathematically, what is the best strategy for harvesting the natural resources?

9. What did you observe about the fish in the protected area?

10. How is this a model for sustainability?

11. Did the marine protected area benefit the fishing area? How? Did you think it was a good idea? Why?

12. Think of a local commons that you are familiar with (parking lot, park, school bathroom, etc.). Do similar situations arise? Explain how those problems might be solved.

13. What are some natural resources that are common resources?

14. Can you think of other examples of common resources that have been exploited by people?

15. Renewable resources are no longer renewable if we overuse the resource. What strategies can be used to prevent "the tragedy of the commons?"

16. Create a phrase or skit that communicates one of your strategies for preventing the tragedy of the commons.

EXTENSION: Play Voices of the Bay Fisheries Activity for more in depth learning about fishing impacts: http://sanctuaries.noaa.gov/education/voicesofthebay/pdfs/balanceactivity.pdf

Explain
Activity: Ensuring the Life Cycle is Unbroken – Bocaccio

Learning Objective
At the end of this activity, students will be able to:
• Explain why protecting a diversity of habitats and the organisms in those habitats is needed, in order to protect species throughout their lifetimes

Background
The bocaccio, a rockfish found along our coast, is an example of how a species uses more than one habitat through its life cycle. They settle in a new home during each stage of their life even though the adult fish are fairly stationary. As they hatch they are planktonic, then as a young fish most bocaccio live in shallower waters with algae or sea grass or under kelp paddies. As they age they move into deeper water with boulder fields and rocks. To protect the species, the different environments have to be available in close enough proximity to one another. The movements of animals among them connect the habitats to one another. All habitats used by fish and invertebrate species throughout their lives must be protected for a marine reserve to successfully protect the species living there.
(adapted from http://www.nmfs.noaa.gov/pr/pdfs/species/bocaccio_detailed.pdf)

Time
1 – 2 class periods

Materials
Prepare in advance:
1. Separate pieces of the bocaccio life cycle stages taken from drawings found in *The Science of Marine Reserves, PISCO* "Life Cycle of Bocaccio" - one per student or student pair
http://www.piscoweb.org/files/images/pdf/SMR_US_HighRes.pdf (Pg 12 – 15) - one per student or student pair

Bocaccio background information for each group:
2. Copy of fishbase information on bocaccio found at
http://www.fishbase.org/summary/Sebastes-paucispinis.html …..(through section "human uses" section)
3. NOAA Species of Concern: Bocaccio found at http://www.nmfs.noaa.gov/pr/pdfs/species/bocaccio_detailed.pdf
4. Bocaccio Species Overview summary
5. Table of reproduction lengths (add LM=length at first maturity)
http://fishbase.sinica.edu.tw/Reproduction/MaturityList.php?ID=3987&GenusName=Sebastes&SpeciesName=paucispinis&fc=573
6. Text only from PISCO bocaccio life cycle from "The Science of Marine Reserves"
http://www.piscoweb.org/files/images/pdf/SMR_US_HighRes.pdf
Bocaccio Life Cycle Data Sheet – one per student or student pair
Bocaccio Species Overview – one per student pair
Computer access to Marine Map MPA site descriptions

Procedure
1. Have students put the bocaccio life cycle images in sequential order and describe the sequence to their partner in one or two sentences. Have partner teams develop one (or more) key question they have about bocaccio.
2. Explain how fish, just like all animals, have a basic task — to reproduce. Add time elements to the life cycle and identify the changing needs of the fish at different stages of life.
3. Have students use the reference materials to read about the natural history of the bocaccio including its range (where it is normally found), complete the data chart.
4. Using their data sheet have students create a diagram or model that shows the habitat changes at different stages of the bocaccio's lifecycle.
5. Have students share their findings with the rest of the group and discuss which factors are important to consider when planning for all of the life cycle stages of the bocaccio.

Extension
Have students use Marine Map (http://southcoast.marinemap.org/marinemap/) and compare the resources found in specific marine protected areas with the habitat descriptions needed for the different stages of the bocaccio life cycle.

Elaborate

Activity: Estimating Fish Populations

Adapted from from Carolyn Newkirk Wildlife Sampling Activity

Activity Overview

Have students work in small groups of three or four to complete this lab. This lab will simulate the capture-recapture method of population sampling incorporating math and science benchmarks. It can be used as in introductory lesson to population sampling and to begin discussions of how scientists use data to make decisions regarding protected areas and wildlife management. The math expectations can be challenging so students will need prior knowledge of how to solve proportions.

Learning Objectives

At the end of the activity, students will be able to:

• Explain how scientists sample fish populations to estimate population size

Materials

Small bowl
Dried beans or two colors of M&Ms (not almond or peanut)
Paper cup
Markers for each group of 4
Estimating Fish Populations Worksheet -1 per student

Procedure

1. Ask students: How can you figure out how many animals are in an area or population? Can we just count them all? Why or why not?

2. Explain to students that every fish cannot be captured and counted in a large body such as the ocean so sample (subsets) are taken and used to estimate the total population of fish.

Ask them: How do you think scientists can tell us population numbers for different species? Often they sample the population. Explain that managing fish populations requires knowing how many fish are in an area and determining how the population changes over time. Demonstrate the more samples that are taken the more accurate the estimate can be. Tell your students they will simulate the sampling technique as they explore this process.
For this, they will work in small groups using a student recording sheet to collect data for the lab.

After students present their materials and data sheets to the rest of the class, ask the class to select components that together would create the ideal data sheet and materials supply list. Discuss how scientists gather data over time, and that often it can take years before determining a pattern or trend, showing how a species is doing.

1. Work as a group to create a modified data sheet you could use to sample the fish to determine not just numbers but ages (size) of the fish.
2. What other factors would you record to ensure your data can be compared with another scientist's data from the same location? What are the site indicators you might want to include?
3. List the materials you would use to sample fish populations in the natural environment.
4. For more samples, have students all start with the same "population" and then use all the data to calculate your average. Does it get closer to the true number?

Extension

How does precision versus accuracy apply in science?

Evaluate
Activity: Visualizing Knowledge

Activity Overview
Assess student understanding as students work in a team to create a visual (mural, infographic, cartoon or other method) showing the benefits of an MPA. Compare the current mural with those created in California's Coast to demonstrate knowledge gain.

Learning Objectives
Students will demonstrate an increase in knowledge of how Marine Protected Areas benefit the ecosystem

Procedures
1. Share example of how images can convey a message using the diagrams shown in Current, vol. 26, Number 2, 2010 "How Marine Reserves and Networks Protect Ocean Resources", Pg 24 – 25.
http://marineprotectedareas.noaa.gov/ pdf/helpful-resources/education/current/current_jun_2010.pdf

2. Have students discuss infographics that they have noticed and they feel are effective communication tools. Infographics have also become powerful tools in communicating complex topics easily and quickly (and are often great examples of STEAM – Science, Technology, Engineering, Art, and Math - in action!).

3. Have students look at some of the great MPA and ocean-related infographics and discuss what works and what doesn't. What are the most effective types of messages, what types of colors, font and use of space works well. Examples of ocean related graphics can be found at:
http://geodata.grid.unep.ch/images/Ecosystem%20Management%20-%20Protected%20Areas.png
http://wwf.panda.org/?201819/Infographic-Marine-Protected-Areas-in-the-Coral-Triangle#
http://wwf.panda.org/_core/general.cfc?method=getOriginalImage&uImgID=%26%2AR%2C%26%21NG1%0A
http://geodata.grid.unep.ch/extras/posters.php
http://www.oneworldoneocean.com/blog/entry/plastics-breakdown-an-infographic#.UidCoGRESbg
http://www.davidsuzuki.org/publications/downloads/2011/Finding_Solutions_Summer11_Two_Coasts_Infographic.pdf
http://www.pewenvironment.org/news-room/other-resources/osprey-reef-time-to-go-deeper-mr-burke-85899435539
http://www.cherishonline.co.za/wp-content/uploads/2012/07/infographic_large.jpg
http://thenaturalnumbers.org/sardines/

4. Tools to help create infographic using online include:
http://www.easel.ly/
http://visual.ly/
http://prezi.com/
http://piktochart.com/

5. Evaluate the visual presentation for important knowledge gain, demonstrating an understanding of the relation-ship between MPAs and increased biodiversity, species size and abundance, protection of the ocean for present and future generations.

Suggested Grading Rubric for Murals or Infographics

	Clarity of information	Biodiversity	Species size	Habitat protection	time
1	Student visual product is unclear and difficult to understand	Value of MPAs in protecting biodiversity is not expressed	Value of MPAs in allowing species to reach large sizes is not expressed	Value of MPAs in protecting habitats is not expressed	Value of MPAs in protecting ocean resources for the present and future is not expressed
2	Student visual product is clear and easy to understand	Value of MPAs in protecting biodiversity is expressed	Value of MPAs in allowing species to reach large sizes is expressed	Value of MPAs in protecting habitats is expressed	Value of MPAs in protecting ocean resources for the present and future is expressed
3	Student mural or infographic excells in its communication of information	Value of MPAs in protecting biodiversity is expressed very clearly and compellingly	Value of MPAs in allowing species to reach large sizes is expressed very clearly and compellingly	Value of MPAs in protecting habitats is expressed very clearly and compellingly	Value of MPAs in protecting ocean resources for the present and future is expressed clearly and compellingly

Vocabulary for Swimming into the Science of MPAs

Benthic - on the bottom or happening near the bottom
Capture/recapture - to collect, release and recollect at a later time
Carrying capacity: - the number of organisms that an ecosystem or habitat can support
Common resources - resources or items that everyone in a community shares
Commons - a shared resource or region
Dimorphic - existing or representing two distinct forms
Exploited - make full use of a resource to its or the environments detriment
Fecundity - number of babies able to reproduce
Fish stocks - population of a particular species or type of fish
Genetic analysis - researching the genes of the organism
Habitat - location where an organism or community normally lives
Harvesting - to gather a crop from where it's grown, usually a food item
Infographic - an image or group of images that depicts information, often in analytical form
Internal fertilization - fertilization that occurs within the female's body
Life cycle or Life stages - the life of an organism from birth to death; some organisms go through complex, many stage life cycles
Marine Protected Area - an area of ocean and/or ocean shoreline protected from human activities in order to conserve a natural resource or historically significant area; protections and restrictions on that area can vary, but almost all are still open to non-consumptive use, i.e. they can be visited but nothing can be taken or hurt in the area
Marine Reserve - a type of marine protected area that is protected from fishing
Metamorphose - transformation from larval to an adult organism in two or more stages
Model: - a representation or example of an item or situation
Natural history - an understanding of what an organism is, what it does and what it is connected to; understanding of its "story"
Natural resources - items that come from the environment
Over-exploitation - to work something too hard or use too much of something
Overfishing - fishing an organism beyond its capacity to replenish itself, leading to extreme reductions or even extinction of a species
Ovoviviparous - producing young by eggs that are hatched within the body of the parent
Planktonic: - free-floating organisms moved by the tide or currents
Population - the abundance of a particular species or group of species
Proportion - a portion of a number with respect to a greater whole, a percentage
Recapture - something that has been taken, let go, and recaught
Range - an organism's territory or environment where it finds its resources
Recover - populations return to historic levels
Renewable resources - items that can be harvested sustainably
Reproductive length - length at which a fish typically is able to produce young
Sampling - take a smaller portion of something, that represents the whole group often used in respect to research
Sampling population - the group of individuals you are taking, counting and/or studying
Simulate - to pretend to act in a way that copies a real action in the world, to imitate
Simulation - an imitation or representation of something, usually a process or an act
Spillover - overflow from one area to another
Sustainability - the act of being able to continue a behavior
Sustainable - a behavior that can be continued without having detrimental impacts
Tag - attach a device to identify the fish has been caught and released; some electronic tags are used to monitor movement of fish
Targeted - the sought after species
Tragedy of the Commons - a term describing a situation where everyone shares a resource, but no one bears the responsibility for caring for it
Visual media - methods of communication that can be seen

III. MPAs and YOU

The creation of a system of Marine Protected Areas in California was not undertaken lightly, nor was the selection of geographies random. The ocean is at risk from a variety of human actions from overfishing to global climate change. It is hoped that the creation of MPAs will help to buffer the ocean from these negative impacts or allow it to be more resilient to other stressors. After all, the ocean is important for all it provides food, oxygen, medicine, transportation, jobs, cultural connections and recreation for billions of people, as well as driving global weather patterns and the water cycle that brings us water to drink. The creation and enforcement of MPAs should help protect all of those ocean services for us and for generations to come.

In general, people tend to protect things that they love. It's hard to love those things with which you are not familiar, or things with which you have no experience. This section of the curriculum outlines some opportunities for students to experience MPAs and the ocean. It is hoped that once students have direct experiences with the ocean, they will want to play a greater role in its protection. This is why the final lesson of Protecting Our Undersea Legacy: MPAs in Southern California offers students opportunities to think about their experiences with MPAs and how they might play a role in ocean protection. Simple student activities outline ways to get students involved in ocean conservation. This section offers a small sampling of ways for students to get involved.

Please contact any of the organizations that partnered to create this curriculum for more opportunities to experience Southern California's coastal ocean and our local Marine Protected Areas, as well as opportunities to get involved in ocean stewardship!

III. MPAs and YOU |
Lesson: MPAs in Person

Overview
There are few things as compelling as first-hand experiences. In this lesson, students will learn ways that they can interact with MPAs themselves, and ways to share their experiences with others. In this lesson, teachers can assign as homework activities or work as a class to explore MPAs.

Learning Objectives
Students will describe a virtual or real experience in an MPA a virtural experience including providing a clarifying reason to protect our CA coast

Time
Variable

Suggested Group Size
These activities can be completed individually, in small learning groups, or as an entire class.

Materials and Preparation
Activity dependent

Preparation
Activity dependent

Procedure
Engage

Now that we have learned about the creation of MPAs and our amazing coastal California ocean, let's talk about how we can interact with these important areas. What would you like to see or learn more about?

One way to help protect our ocean resources and MPAs is to personally explore them and then to be able to share their wonder through first-hand storytelling of your experience.

Explore

Think, pair, share about a trip you have taken to a protected area in nature (maybe a state or national park, a marine reserve or other area). What was this area like? What was your favorite part of the experience?

Explain

Option 1 – Visit an MPA!
With your family, friends or class, visit a local Marine Protected Area or Marine Sanctuary. See the maps in this guide (pg 02) or visit http://www.californiampas.org/ or http://www.californiampas.org/ to find the area closest to you!

Option 2 – Virtually visit an MPA!
Another option is to use Google Earth to explore California's MPAs. Google Earth has created a layer to use to explore our MPAs: earth.google.com/gallery/kmz/ca_marine_protected_areas.kmz California State University – Monterey Bay has created some virtual tours of California Marine Protected areas further north. Visit their EcoViz website at http://ecoviz.csumb.edu/home/#CACoast to virtually tour them.

Option 3 – Scientific exploration of an MPA
Combine your visit to an MPA with a community science experience. Community science (also known as citizen science) uses the power of the public and the resources of the many to maximize the amount of information scientists can gather about a region, a species, or conditions. By participating in a community science project, you

can put your observation skills to good use and help scientists collect data while you visit an MPA. There are many opportunities, some locally based and some nationally based, to participate in community science. Some notables include:

• LimPETS – Long-term Monitoring Program and Experiential Training for Students is a program that trains teachers and students to monitor either a rocky intertidal or sandy beach along the California Coast. http://limpetsmonitoring.org/

• The Great Backyard Bird Count is a joint program organized by the Audubon Society and The Cornell Lab of Ornithology. The program asks volunteers to count birds for one weekend in their neighborhoods, schoolyards, local parks, beaches or anywhere else they might want to explore! One of the largest community science projects in the world, the Great Backyard Bird Count crosses borders and includes birders throughout North America. Web-based resources are offered to help increase your birding skills and help you add to the count. http://www.birdsource.org/gbbc

• Grunion Greeters is a southern California citizen science project coordinated by Pepperdine University researchers with a host of non-profit, government and community organizations partners. This long-term project involves hundreds of volunteers to study the spawning activity and habitat of the California grunion. Volunteer Grunion Greeters witness and record environmental conditions and grunion behaviors as they monitor sandy beaches along the Southern California coastline. This project has helped to spur community awareness and support for healthy and protected beaches. http://grunion.pepperdine.edu/

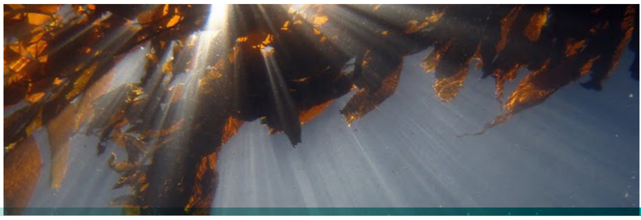
• MPA Watch is a citizen science program started in the LA-area by Heal the Bay, but has since expanded throughout Southern California. By walking along beaches and surveying ocean users, volunteers combine their love of the beach and ocean while collecting valuable scientific data. Collected data helps inform MPA management and supports the California Department of Fish and Wildlife. http://www.mpawatch.org/

To find more community science opportunities, check out:
http://www.scientificamerican.com/citizen-science/ and http://www.citsci.org/
www.usc.edu/org/cosee-west/resources2011"commscienceCommunity

Option 4 – Visit a local aquarium, zoo or nature center
Sometimes it's just not possible to visit an MPA, but there are other ways to experience the life and habitats they have to offer! Our local Southern California aquaria, as well as some of our local zoos, science and nature centers display the animals and habitats found in MPAs. These facilities can make marine life easily accessible, and they have people available right there to help answer any questions you might have. These sites can be a great way to explore Southern California's marine neighbors. The partnering aquaria that developed this resource are a great way to start!

Explain
Whether told by a friend, a family member or even a stranger, people tend to trust stories and anecdotes when they hear them in person over any other method of communication. When you explore a MPA and communicate your experience, you can use your voice as a tool in protecting these amazing places. Think about some of the things you know from talking to other people. Are there some stories that have changed your mind about a situation or a person that surprised you? Take a few moments in class to discuss with a neighbor a time when a story changed your viewpoint on a situation.

Elaborate
Using observations from your explorations, write about a memory or an experience that you found compelling or moving. Before putting pen to paper, discuss how you can use your story as a tool to protect our ocean resources. Who or how can you share it with as many people as possible? Who do you think needs to hear your story the most? As you write, make sure to use descriptive language, adjectives and adverbs, to bring your experience to life for your reader.



Vocabulary

Community science - science that uses members of the community to gather data or perform scientific analysis; sometimes called citizen science because it uses the residents or citizens of a particular area to perform the science instead of only scientists

Marine sanctuary - a specific type of marine protected area where certain behaviors like fishing or dredging are not allowed, the specific protections can vary among sanctuaries

Virtual - being similar or simulated, often used in reference to computer activities that simulate activities in the real world

Evaluate

Teachers: Look over student work and examine it for genuine anecdotes and first person experiences.

Suggested Grading Rubric for Persuasive Anecdotes

	PERSONAL PERSPECTIVE	DESCRIPTIVE LANGUAGE	PROTECTION MESSAGE
1	Student has not written about a personal experience	Student did not use adjectives, adverbs, and other descriptive terms	Student did not include a message about ocean protection tied to their experience
2	Student has written about a personal experience	Student did use adjectives, adverbs, and other descriptive terms	Student included a message about ocean protection tied to their experience
3	Student has written about a personal experience in a compelling way	Student used adjectives, adverbs, and other descriptive terms often and well	Student included a compelling message about ocean protection tied to their experience

Lesson: YOU Can Protect our Coast!

Overview
Students will discuss and identify ways that they can play an active roll in protecting our California coast and Marine Protected Areas.

Learning Objectives
At the end of this lesson, students will describe and explain behaviors that help to protect ocean and coastal health.

Time
Variable

Suggested Group Size
These activities can be completed individually, in small learning groups, or as an entire class.

Materials and Preparation
Activity dependent

Procedure
Engage

After their introduction and exploration of our local coastal waters and MPAs, ask students how do they feel about protecting these areas for future generations. Have students share their viewpoints, perspectives, and reasons actively listening and checking for clarification. Create a list of pros and cons that summarizes why they feel they way they do.

Explore

Have students research the ways they can help explore the ocean. How many of them are already doing things to help right now?

Explain

Some of the ways everyone can help the ocean include:

1. **Making sustainable seafood choices** - Choosing sustainable seafood can help the ocean in many ways. Sustainable seafood is seafood that is harvested in a way that doesn't damage the enviroment and ensures that species will continue to be here for future generations. Also, sustainable seafood must be harvested without harming too many other creatures. It can be easy to find out if that shrimp is safe or that ahi is okay, check out SeafoodWatch.org or NOAA's fishwatch for more information on sustainable seafood and to download free guides.

2. **Cleanup** - There are so many cleanup events throughout California. Visit the California Coastal Commission's page of locations and coordinators by county: http://www.coastal.ca.gov/publiced/aab/aab2.html. You can organize a schoolyard clean-up as well, preventing pollution from getting to the ocean by stopping it at its source. Make sure students use gloves and do not pick up harmful items to keep safe while cleaning up your campus.

3. **Reducing pollution** - Reduce, reuse & recycle – One of the easiest ways we can help the ocean is to use less, and reuse or recycle what we do use. This will keep unnecessary waste from polluting the ocean and poisoning, entangling or choking marine life like turtles and dolphins.

4. **Go Non-toxic and safe chemical disposal** - Don't flush those pills or pour those unknown chemicals down the drain, take them to a hazardous waste clean up site instead! Our storm drain system that moves water off our streets goes straight to the ocean without any filtering, so that's not a safe way to dispose of anything except rainwater. Additionally, the sewage system, the system of pipes that moves water from our homes and buildings to a treatment plant, is designed to handle water and human waste, not harsh chemicals and a mixture of medicines. Those chemicals can

go right through the sewage treatment center and flow out into the ocean. In California, you can safely dispose of other pharmaceuticals and other chemicals, by contacting your local department of public works.

In LA County – 1-888-CLEANLA or
http://dpw.lacounty.gov/epd/cleanla/
Outside of LA County, please check out
http://earth911.com/recycling/hazardous/ to find your local household hazardous waste disposal site!

LET'S ADD TO THIS LIST! Think of another way you can protect the ocean and pursue your own idea

Elaborate

Have students compete to see who adopts the most new ocean safe behaviors. Have students present to their families, other students, or community members all the ways they can be ocean-friendly.

Evaluate

Assess students abilities to explain their behaviors' impacts on the ocean in both negative and positive ways. Evaluations can include writing (descriptive prose, persuasive letters), making posters, using art to communicate their point, and creating ads or PSAs.

Video and Podcast resources

Video

South Coast Marine Protected Areas: Humans and Nature Together:
http://www.youtube.com/watch?v=3ynkWlZO1JE

Marine Protected Areas: Special Ocean Places Deserve Special Protection:
http://www.youtube.com/watch?v=8wmpBK65vw4

A Three-minute intro to MPAs:
http://vimeo.com/77523573

Podcasts

Enforcement of Marine Protected Areas
http://www.thankyouocean.org/2011/11/07/enforcement-of-marine-protected-areas/

Managing California's Network of Marine Protected Areas
http://www.thankyouocean.org/2011/10/24/managing-california%E2%80%99s-network-of-marine-protected-areas-mpas/

Monitoring Marine Protected Areas in the Channel Islands
http://www.thankyouocean.org/2009/01/26/monitoring-marine-protected-areas-in-the-channel-islands/

National Marine Protected Areas Center
http://marineprotectedareas.noaa.gov/

MPA video resources
http://www.californiampas.org/pages/resources/digitalmedia.html
Sustaining communities, connecting with nature share human connection

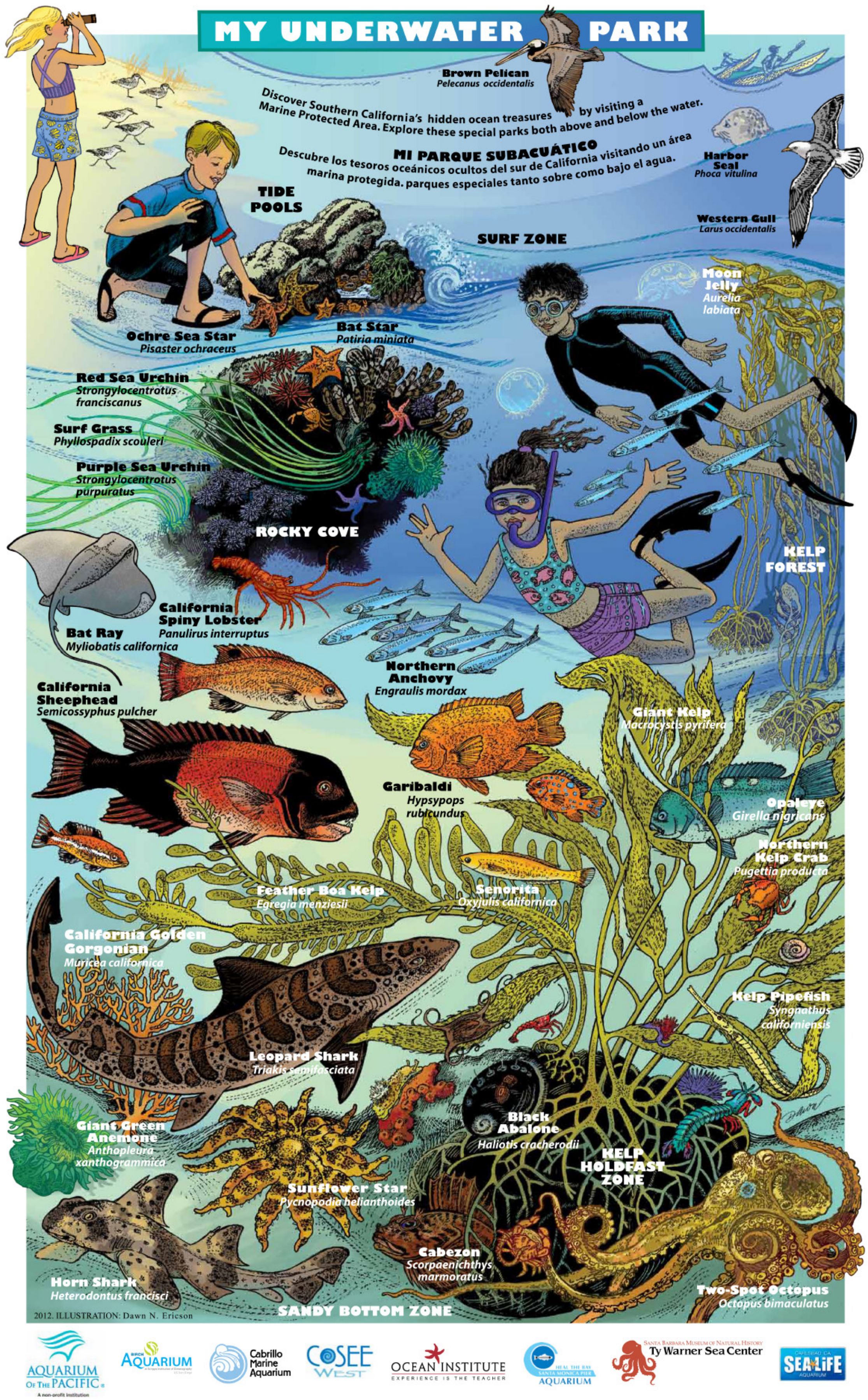
NOAA Ocean Media Center
http://www.youtube.com/user/NOAAOceanMediaCenter

California's Coast

Marine Protected Areas: Special Ocean Places Deserve Special Protection video
http://www.youtube.com/watch?v=8wmpBK65vw4

The Southern Passage: a video about why Californians need Marine Protected areas
http://vimeo.com/11667020

My Underwater Park Colored Poster – see below
Coloring Sheet – see below
Samples of Non-Fiction Nature Writing – see below


MY UNDERWATER PARK
Brown Pelican
Pelecanus occidentalis
Discover Southern California's hidden ocean treasures by visiting a Marine Protected Area. Explore these special parks both above and below the water.
MI PARQUE SUBACUÁTICO
Descubre los tesoros oceánicos ocultos del sur de California visitando un área marina protegida. parques especiales tanto sobre como bajo el agua.
Harbor Seal
Phoca vitulina
Western Gull
Larus occidentalis
TIDE POOLS
SURF ZONE
Moon Jelly
Aurelia labiata
Ochre Sea Star
Pisaster ochraceus
Bat Star
Patiria miniata
Red Sea Urchin
Strongylocentrotus franciscanus
Surf Grass
Phyllospadix scouleri
Purple Sea Urchin
Strongylocentrotus purpuratus
ROCKY COVE
KELP FOREST
California Spiny Lobster
Panulirus interruptus
Bat Ray
Myliobatis californica
Northern Anchovy
Engraulis mordax
California Sheephead
Semicossyphus pulcher
Giant Kelp
Macrocystis pyrifera
Garibaldi
Hypsypops rubicundus
Opaleye
Girella nigricans
Northern Kelp Crab
Pugettia producta
Feather Boa Kelp
Egregia menziesii
Senorita
Oxyjulis californica
California Golden Gorgonian
Muricea californica
Kelp Pipefish
Syngnathus californiensis
Leopard Shark
Triakis semifasciata
Black Abalone
Haliotis cracherodii
Giant Green Anemone
Anthopleura xanthogrammica
KELP HOLDFAST ZONE
Sunflower Star
Pycnopodia helianthoides
Cabezon
Scorpaenichthys marmoratus
Horn Shark
Heterodontus francisci
Two-Spot Octopus
Octopus bimaculatus
SANDY BOTTOM ZONE
2012. ILLUSTRATION: Dawn N. Ericson
AQUARIUM OF THE PACIFIC
A non-profit institution
BIRCH AQUARIUM
Cabrillo Marine Aquarium
COSEE WEST
OCEAN INSTITUTE
EXPERIENCE IS THE TEACHER
HEAL THE BAY SANTA MONICA PIER AQUARIUM
SANTA BARBARA MUSEUM OF NATURAL HISTORY
Ty Warner Sea Center
SEA LIFE AQUARIUM

NAME:

Non-Fiction Nature Writing Examples

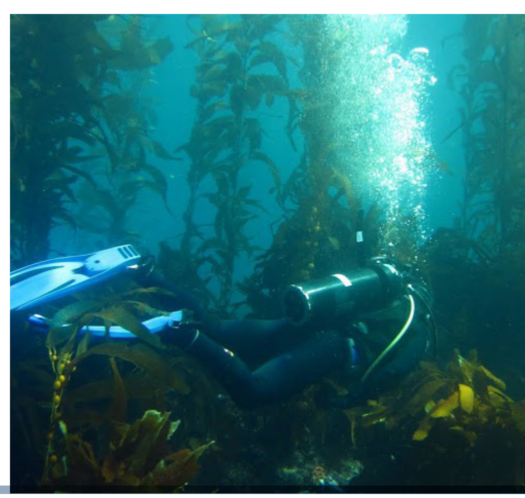
"There is one marine production, which from its importance is worthy of a particular history. It is the kelp, *Macrocystis pyrifera*. This plant grows on every rock, from low-water mark to a great depth, both on the outer coast and within the channels... The number of living creatures of all Orders, whose existence intimately depends on the kelp is wonderful."

"A great volume might be written, describing the inhabitants of one of these beds of seaweed... I can only compare these great aquatic forests of the southern hemisphere, with the terrestrial ones in the inter-tropical regions. Yet, if in any other country a forest was destroyed, I do not believe so many species of animals would perish as would here, from the destruction of kelp."
- Charles Darwin

"The ocean is a place of paradoxes. It is the home of the great white shark, two-thousand-pound killer of the seas, and of the hundred-foot blue whale, the largest animal that ever lived. It is also the home of living things so small that your two hands might scoop up as many of them as there are stars in the Milky Way. And it is because of the flowering of astronomical numbers of these diminutive plants, known as diatoms, that the surface of waters of the ocean are in reality boundless pastures. Every marine animal, from the smallest to the sharks and whales, is ultimately dependent for its food upon these microscopic entities of the vegetable life of the ocean. Within their fragile walls, the sea performs a vital alchemy that utilizes the sterile chemical elements dissolved in the water and welds them with the torch of sunlight into the stuff of life. Only through this little-understood synthesis of proteins, fats, and carbohydrates by myriad plant "producers" is the mineral wealth of the sea made available to the animal "consumers" that browse as they float with the currents. Drifting endlessly, midway between the sea of air above and the depths of the abyss below, these strange creatures and the marine inflorescence that sustains them are called "plankton" – the wanderers."
-Rachel Carson, Undersea

"Through this sepia landscape walks a sepia animal, ghostly, along the side of a forest road. It's an improbable creature – a lion in a country famed for tigers. If someone were watching, it might seem translucent and incorporeal, holographic, projected here into western India by laser gimmickry. But no one is watching and the animal is real. It has substance and heft. It's a native deizen of a place known as Gir, the last natural refuge of Panthera leo persica, the Asiatic lion."
-David Quammen, Monster of God

"June is the cruelest month in Tucson, especially when it lasts till the end of July. This is the season when every living thing in the desert swoons south toward some faint salt dream of the Gulf of Mexico: tasting the horizon, waiting for the summer storms. This year they are late. The birds are pacing the ground stiff-legged, panting, and so am I. Waiting. In this blind, bright still-June weather the shrill of the cicadas hurts your eyes. Every plant looks pitiful and, when you walk past it, moans a little, envious because you can walk yourself to a drink and it can't."
-Barbara Kingsolver, High Tide in Tucson



An Introduction to Marine Protected Areas

Animation on why reserves are important:
http://newswatch.nationalgeographic.com/2012/09/25/you-can-have-your-fish-and-eat-them-too/

Why the ocean matters video:
http://video.nationalgeographic.com/video/environment/habitats-environment/habitats-oceans-env/why-ocean-matters/

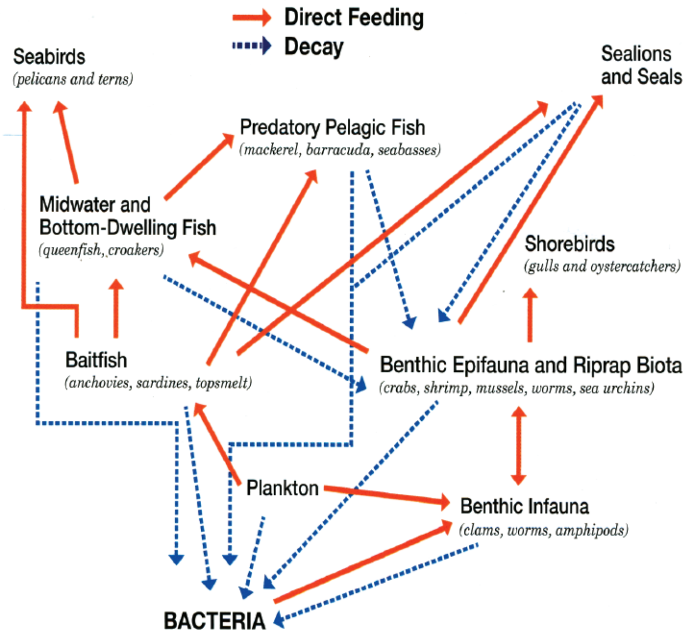
An overview on the value and importance of MPAs:
http://www.thankyouocean.org/threats/marine-life-decline/mpas/

Turning the Tide video on helping to protect the ocean for future generations:
http://vimeo.com/10287462

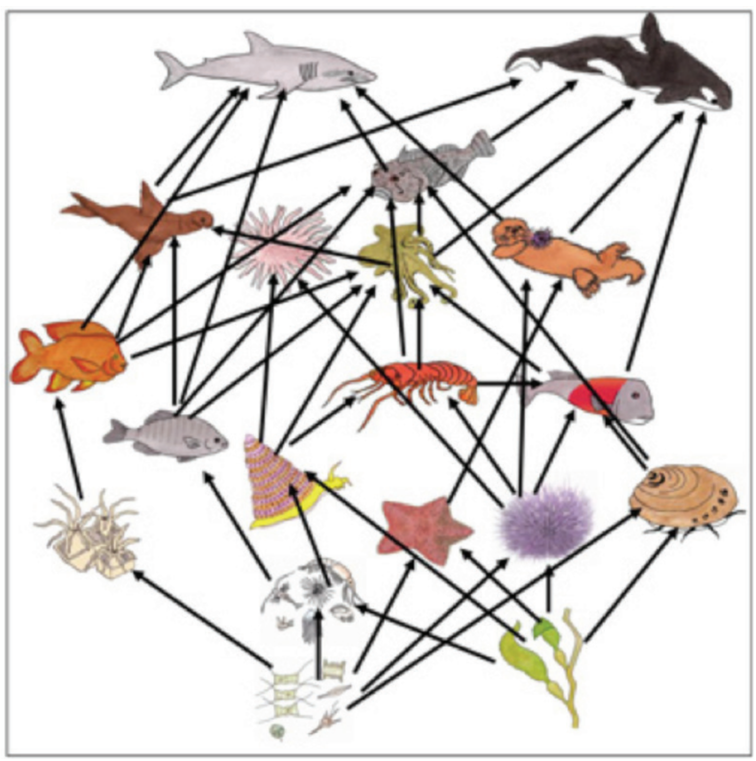
Trailer for A Sheltered Sea, a video about ocean protection:
http://vimeo.com/1051943

Understanding an Ecosystem Approach

Food Web Examples



Dawn N. Ericson,
Los Angeles and Long Beach Harbor Habitat; Our Biological Treasures



www.speakeasies.biz/deskKits.html

Additional marine food webs can be found at:
http://www.usc.edu/org/seagrant/Education/IELessons/Unit3/Lesson5/Example01.html
http://kelpforestwebsite.weebly.com/food-chain.html
https://www.montereybayaquarium.org/PDF_files/activities/seasearchers/aquarium_ss_foodwebs.pdf
http://w3.shorecrest.org/~Lisa_Peck/MarineBio/syllabus/ch11_ecosystems/ecosystem_wp/sandybeaches_ashleyj_jessica/foodweb.html
Additional Kelp Resource guide by Dawn Navarro
http://www.usc.edu/org/seagrant/Education/curriculum/SC_KELP_BOOKsm2.pdf

MPAs – What's at Stake?

Inside the Lines: 16 min video done before the establishment of the MPA network – shows stakeholders who use areas and their opinions:
http://vimeo.com/10632305

The Southern Passage: a video about why Californians need Marine Protected areas: http://vimeo.com/11667020

Trailer for A Sheltered Sea, a video about ocean protection:
http://vimeo.com/1051943

Interviews clarifying MPA areas in the process of establishing MPAs:
www.vanessakaneshiro.com/?portfolio=kpcc-npr-radio-marine-protected-areas

Stakeholder List from the South Coast MLPA Process – see below

Which Stakeholder am I? Worksheet – see page 38

Stakeholder List from the South Coast MLPA Process

This is a listing of the members of the South Coast MLPA Stakeholder Group. To find out more about their connection to the ocean you can review their nominations/applications at the link on the bottom of the page.

- Calla Allison, Marine Protection Officer, City of Laguna Beach (alternate for Ken Kearsley)
- John F. Ballotti, Member, Los Angeles Rod and Reel
- Benjamin Beede, General Manager, The Cultured Abalone
- Philip Beguhl, commercial fishing representative, Santa Barbara County Fish and Game Commission
- Steve Benavides, Co-founder, Kelp Forest Coalition
- Bob Bertelli, President, California Sea Urchin Commission
- Julie Bursek, Education and Outreach Coordinator, Channel Islands National Marine Sanctuary (alternate for Brent Scheiwe)
- Roberta R. Cordero, Co-Founder and President, Chumash Maritime Association
- Lauren Czarnecki, Lab Manager, Information Technology Manager and Research Coordinator, Wrigley Institute for Environmental Studies (alternate for Wayne G. Griffin)
- Jim Dahl, Council Member, City of San Clemente (alternate for Leslie Daigle)
- Leslie Daigle, Mayor Pro Tem, City of Newport Beach and Regional Council Member, Southern California Association of Governments
- W. Scott Dunn, non-consumptive recreational user, naturalist and kayak guide
- Dr. Jonna Engel, Staff Ecologist, California Coastal Commission
- Dr. John M. "Jack" Engle, Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara (alternate for Phyllis Grifman)
- Roy "Buck" Everingham, Owner, Everingham Brothers Bait Company (alternate for Ciro Ferrigno)
- Jenn Feinberg, Ocean Policy Consultant, Natural Resources Defense Council (alternate for Greg Helms)
- Ciro Ferrigno, Member of the Board, California Wetfish Producer's Association
- Ray Fields, President, The Abalone Farm, Inc. (alternate for Benjamin Beede)
- Josh Fisher, commercial lobster fisherman (alternate for Phil Beguhl)
- Robert C. Fletcher, President, Sportfishing Association of California (alternate for Mike Gauger)
- Mary Jane Forster-Foley, President, MJF Consulting Inc. (alternate for David Weeshoff)
- Russell E. Galipeau, Superintendent, Channel Islands National Park
- Michael Gauger, Seaforth Sportfishing, Inc.
- Tommy Gomes, Owner, Uni Goop Bait (alternate for Bruce Steele)

- **Joel Greenberg**, Southern California Chapter Chairman, Recreational Fishing Alliance (alternate for John Ballotti)
- **Wayne G. Griffin**, President, Catalina Island Chamber of Commerce
- **Phyllis Grifman**, Associate Director, University of Southern California Sea Grant Program
- **Mervin "Louie" Guassac**, Executive Director, Kumeyaay Diegueno Land Conservancy
- **Marcela Gutiérrez,** Wildlife Conservation Program Manager, WiLDCOAST (alternate for Sarah (Abramson) Sikich)
- **Kate Hanley,** Director of Operations and Marine Conservation, San Diego Coastkeeper
- **Gregory Helms**, Southern California Program Manager, The Ocean Conservancy
- **Ray Hiemstra**, Associate Director, Orange County Coastkeeper (alternate for Kate Hanley)
- **Mike Huber**, Regional Environmental Coordinator Program Manager, U.S. Department of Defense Region IX
- **Ken Kearsley,** former Mayor, City of Malibu
- **M.J. Kennedy**, Deputy Director, Kayak Fishing Association of California (alternate for Paul Lebowitz)
- **R. Kevin Ketchum**, General Manager, California Yacht Marina
- **Eric Kett**, Owner, Sea Zen Marine Consulting (alternate for Dr. Terry Maas)
- **Mick Kronman**, Harbor Operations Manager, City of Santa Barbara
- **Paul Lebowitz**, Director, Kayak Fishing Association of California
- **Dr. Terry Maas,** Director, Underwater Society of America and Founding Member, Sea Watch
- **Jeff Maassen**, Vice President, Commercial Fishermen of Santa Barbara, Inc. (alternate for Bob Bertelli)
- **Jenny Marshall**, Consultant, U.S. Navy (alternate for Mike Huber)
- **Carl Mayhugh**, President, Pacific Oceanworks, Inc. (alternate for Steve Benavides)
- **Mike McCorkle**, President, Southern California Trawlers Association (alternate for Gerry Richter)
- **Dr. Michael McCoy**, Member, Tijuana River National Estuarine Research Reserve Management Authority (alternate for Dr. Vinod Sasidharan)
- **Merit McCrea**, Captain, Condor Cruises and Research Technician, Marine Science Institute (alternate for Norris Tapp)
- **Marc Mills** (alternate for Dr. Chugey Sepulveda)
- **Garth Murphy**, Founder, Surf Research (alternate for W. Scott Dunn)
- **Bob Osborn**, Member, United Anglers of Southern California (alternate for Wendy Tochihara)
- **Jack Peveler**, President, California Association of Port Captains and Harbormasters (alternate for Mick Kronman)
- **Dr. Benjamin Pister,** Marine Ecologist, Cabrillo National Monument (alternate for Russell E. Galipeau)
- **Lia Protopapadakis**, Marine Policy Specialist, Santa Monica Bay Restoration Foundation (alternate for Dr. Anne Spacie)
- **Gerry D. Richter**, Vice President, Point Conception Groundfishermen's Association
- **Dave Rudie**, Owner, Catalina Offshore Products (alternate for R. Kevin Ketchum)
- **Dr. Vinod Sasidharan**, Associate Professor and Program Coordinator, Recreation and Tourism Management Program, San Diego State University
- **Brent Scheiwe**, Director, SEA Lab
- **Dr. Chugey Sepulveda**, Laboratory Director, Pfleger Institute of Environmental Research
- **Sarah (Abramson) Sikich**, Coastal Resources Director, Heal the Bay
- **Dr. Anne Spacie**, Science Director and Member of the Board, Batiquitos Lagoon Foundation and Professor Emerita, Purdue University
- **Bruce Steele**, Captain, F/V Halcyon
- **Norris Tapp**, Captain, F/V Freelance
- **Cassidy Teufel**, Coastal Program Analyst, California Coastal Commission (alternate for Dr. Jonna Engel)
- **Wendy Tochihara**, National Sales Manager, Izorline International
- **David Weeshoff**, Member of the Board, International Bird Rescue Research Center

Nominations for South Coast Stakeholder group - http://www.dfg.ca.gov/marine/mpa/sc_nominations.asp

Worksheet: Which Stakeholder Am I?

Name: ______________________________

Organization or Agency: ______________________________

Job Title: ______________________________

Job Duties: ______________________________

I want MPAs to be created because: (logic) ______________________________

____

I am not in favor of MPA creation because: ______________________________

____

MPAs are important to me because: (emotion) ______________________________

____

I belong to the following stakeholder group(s) (ex: fisherman, boaters, beach users, etc.): ______________________________

____

I work with the following MPA experts and other stakeholders on a regular basis: ______________________________

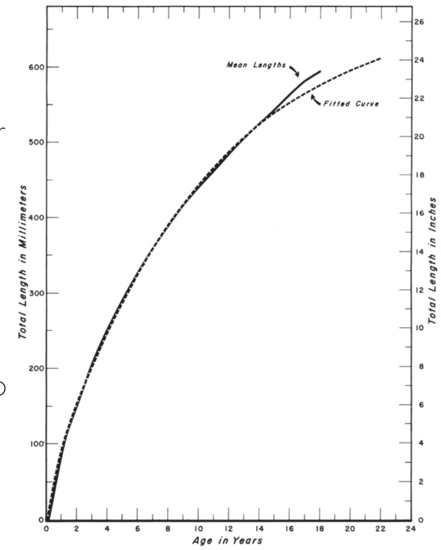
____

My favorite MPA that was created is: ______________________________

____

MPAs = More Fishes

Create your own models to teach that fish size and age effect productivity. First print the fish image on page 46 onto fabric or paper at the correct sizes for age. The actual size representation for Vermillion Rock fish are 7 years old: 14.6 inches, 13 years old: 19.7 inches, 19 years old: 23.6 inches. Attach the two sides together with stuffing in the middle using stapler or tape for paper or sewing the fabric.
Background article for extension activity:
Using GIS Mapping of the Extent of Nearshore Rocky Reefs to Estimate the Abundance and Reproductive Output of Important Fishery Species"
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0030290



Vermilion rockfish age-length relationship, sexes combined, 1,022 items.

Phillips, Julius B., 1964. The life history on ten species of rockfish (Genus *Sebastodes*). Fish Bulletin (216). 70p.

String beads or link paperclips to represent the number of eggs produced at each size/age classification.
7 YEARS OLD: 150,000 offspring (you will need 15 beads or clips)
13 YEARS OLD: 700,000 offspring (you will need 70 beads or clips)
19 YEARS OLD: 1,700,000 offspring (you will need 170 beads or clips)
Fill a jar with 10,000 orange beads to represent 10,000 eggs

Avoiding a Tragedy of the Commons

End of the Line – a video about overfishing in the ocean:
http://www.filmeducation.org/theendoftheline/index.html

Fishery facts information sheet:
http://www.pbs.org/emptyoceans/educators/activities/docs/Fishing-fishery-facts.pdf

Science Daily: Ending the Ocean's Tragedy of the Commons:
http://www.sciencedaily.com/releases/2010/09/100914095930.htm

Science Daily: One Solution to Global Overfishing:
http://www.sciencedaily.com/releases/2012/03/120319163807.htm

Empty Oceans, Empty Nets:
http://www.pbs.org/emptyoceans/eoen/index.html

A fun PSA that drives home the importance of thinking beyond our own action:
http://www.shiftingbaselines.org/mpas/psa.php

Tragedy of the Commons: A Brief Overview

The tragedy of the commons was initially proposed as a hypothetical model to illustrate a much larger societal problem. In early British history, there was often a common pasture (the commons) where all members of a community could take their livestock for grazing. Each individual farmer was motivated to use this pastureland for his animals to get the maximum benefit possible. However, as more animals use the resource, the pasture became trampled and over-grazed until there was no grass left for anyone. Therefore, if each farmer was motivated simply to maximize personal benefit, and thus used the pasture as much as possible, the pasture or commons soon became of no use to anyone.

Fisheries can provide the classic example of tragedy of the commons. This can happen when fish are in areas that are open to fishing, and many fishermen act in their own self-interest and catch as many fish as possible until all the fish are caught, rather than looking to preserve the environment for the future and create a sustainable fishery for years to come by limiting each person's individual catch. In other words, the ocean's supply of fish is a common resource that is rapidly being depleted. The basic issue is that since 1950, the fishing industry has quadrupled its catch. According to the United Nations, 15 out of 17 world fisheries are overfished or depleted. 90% of the large fish species in the oceans have been fished out, or fished to the point that the fishery can no longer sustain their populations, in the last 50 years. In short, fish are being taken from the oceans faster than they can reproduce and grow. Many fisheries have already seen collapses.

Final Resources for Ensuring the Life Cycle is Unbroken – bocaccio

Detailed information on the bocaccio (this was adapted for their background information):
http://www.nmfs.noaa.gov/pr/pdfs/species/bocaccio_detailed.pdf

PISCO "Life Cycle of Bocaccio":
http://www.piscoweb.org/files/images/pdf/SMR_US_HighRes.pdf (Pg 12 – 15) - one per student or student pair

FishBase information on bocaccio:
http://www.fishbase.org/summary/Sebastes-paucispinis.html (through section "human uses" section)

Table of reproduction lengths (add LM=length at first maturity):
http://fishbase.sinica.edu.tw/Reproduction/MaturityList.php?ID=3987&GenusName=Sebastes&SpeciesName=paucispinis&fc=573

Text only from PISCO bocaccio life cycle from "The Science of Marine Reserves":
http://www.piscoweb.org/files/images/pdf/SMR_US_HighRes.pdf

Bocaccio Life Cycle Data Sheet – see below

Bocaccio Species Overview – see below

Bocaccio Life Cycle Data Sheet

Name of Fish: ______________________________

Eggs

Location:____________________ Incubation time:____________________

Comments:______________________________

Reproduction

Age at reproduction:____________________ season:____________________

Average number of young produced:______________________________

Comments:______________________________

Larval Fish (first hatched)

Month hatch:______________ month released:______________ Habitat:______________

Comments:______________________________

Fry (juvenile fish)

Habitat:______________________________

Comments:______________________________

Adult

Habitat:______________ Diet:______________ Average lifespan:______________

Comments:______________________________

Take your data and create a model of the lifecycle of the bocaccio showing the use of different habitats on the reverse of this sheet

Bocaccio Species Overview

Life History

In most respects bocaccio is typical of other rockfishes. They have internal fertilization and the eggs grow and hatch internally (Wourms, 1991). Fifty percent of females are mature, ready to reproduce, at 48 cm FL, full length (Gunderson et al., 1980). Fish begin reproduction early in the fall. The embryos develop for at least a month before the larvae hatch internally (Moser, 1967). Bocaccio can produce from 250,000-2,500,000 larvae (Phillips, 1964). The young are released during the winter months (Wyllie Echeverria, 1987) and larvae eventually metamorphose into pelagic juveniles (Moser and Boehlert, 1991), a stage that takes months to complete (Woodbury and Ralston, 1991). The young settle from intertidal to deep benthic habitats begins in late spring and extends throughout the summer months. Even though the young grow very rapidly, adults grow slowly (Wilkins, 1980). Moreover, growth is sexually dimorphic, with females reaching larger sizes than males (ca. 90 versus 75 cm). The diet of bocaccio is primarily fish. (from STATUS OF BOCACCIO OFF CALIFORNIA IN 2002 by Alec D. MacCall)

Species info below from FishBase (http://www.fishbase.org/summary/Sebastes-paucispinis.html)

Sebastes paucispinis Ayres, 1854

Bocaccio

Add your observation in Fish Watcher: http://www.fishbase.us/fishwatcher/menu.php

Activity: Estimating Fish Populations

Estimating Fish Populations Worksheet – see below

Investigating Fish Populations

1. Work in small groups of four to complete the lab below. Make sure to record your data in the table below.

2. Put all of the beans in the bowl. Using the spoon cup, "capture" a sample of the beans.

3. Mark each of these beans with a small X. This is the original captured amount. Record this number here: (If using M&Ms, start with one color and replace the recaptured fish with a different color... feel free to eat your original colored captures.)

4. Put these beans back into the bowl. "Capture" another sample of beans. Record this total in the sample column. Record the number of beans that have "recaptured" or are marked with an X.

5. Repeat step three four more times, recording your data in the table below.

Trial	# caught	# recaptured
1		
2		
3		
4		
5		
Total		

To calculate the estimated population take the total number captured, multiply that by the number of times you repeated the process (don't include your first capture, only the repeats; in this case it's 5 times); divide that number by the total number recaptured.

Population Estimate = [(total # captured) x (# of recapture events)] · (total # recaptured)

My population estimate is:

1. Do you think that this is a good way to estimate of the number of beans in the bowl? Explain your reasoning.

2. Count the actual number of beans in the bowl. How does this number compare to your estimate in #1? Explain your answer.

3. Can you think of a better method for calculating the overall population of an organism in the wild?

Goals of the Marine Life Protection Act

From the California Department of Fish & Wildlife

The Marine Life Protection Act (MLPA) of 1999 directs the state to redesign California's system of marine protected areas (MPAs) to function as a network in order to: increase coherence and effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage, as well as to improve recreational, educational and study opportunities provided by marine ecosystems subject to minimal human disturbance.

The six goals of the MLPA are:

Goal 1
To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

Goal 2
To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.

Goal 3
To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.

Goal 4
To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.

Goal 5
To ensure that California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.

Goal 6
To ensure that the MPAs are designed and managed, to the extent possible, as a component of a statewide network.

Official Categories of the Different Kinds of MPAs in California

There are different marine managed areas classifications used in California's MPA network. This includes three MPA designations (State Marine Reserve, State Marine Conservation Area, State Marine Park), a marine recreational management area (State Marine Recreational Management Area), and special closures:

• In a State Marine Reserve, it is unlawful to injure, damage, take, or possess any living geological, or cultural marine resource, except under a permit or specific authorization from the managing agency for research, restoration, or monitoring purposes. While, to the extent feasible, the area shall be open to the public for managed enjoyment and study, the area shall be maintained to the extent practicable in an undisturbed and unpolluted state. Access and use for activities including, but not limited to, walking, swimming, boating, and diving may be restricted to protect marine resources. Research, restoration, and monitoring may be permitted by the managing agency. Educational activities and other forms of nonconsumptive human use may be permitted by the designating entity or managing agency in a manner consistent with the protection of all marine resources. (PRC Section 36710(a))

• In a State Marine Park, it is unlawful to injure, damage, take, or possess any living or nonliving marine resource for commercial exploitation purposes. Any human use that would compromise protection of the species of interest, natural community or habitat, or geological, cultural, or recreational features, may be restricted by the designating entity or managing agency. All other uses are allowed, including scientific collection with a permit, research, monitoring, and public recreation, including recreational harvest, unless otherwise restricted. Public use, enjoyment, and education are encouraged, in a manner consistent with protecting resource values. (PRC Section 36710(b))

• In a State Marine Conservation area, it is unlawful to injure, damage, take, or possess any living, geological, or cultural marine resource for commercial or recreational purposes, or a combination of commercial and recreational purposes, that the designating entity or managing agency determines would compromise protection of the species of interest, natural community, habitat, or geological features. The designating entity or managing agency may permit research, education, and recreational activities, and certain commercial and recreational harvest of marine resources. (PRC Section 36710(c))

• In a State Marine Recreational Management area, it is unlawful to perform any activity that, as determined by the designating entity or managing agency, would compromise the recreational values for which the area may be designated. Recreational opportunities may be protected, enhanced, or restricted, while preserving basic resource values of the area. No other use is restricted. (PRC Section 36710(e)). The Fish and Game Commission may designate, delete, or modify state marine recreational management areas for hunting purposes. (PRC Section 36725(a))

• A Special Closure is a geographically specific area that prohibits human entry. Special closures are smaller in size than MPAs and are designed to protect breeding seabird and marine mammal populations from human disturbance.

FAQ's

What is the Marine Life Protection Act or MLPA?

This ground-breaking law was passed by the California legislature in 1999. The goal of the MLPA is to create a network of marine protected areas based on science and according to clear, conservation-based goals. The MLPA is protecting the ocean in a similar way our national and state parks protect land.

Just like past visionaries who saw the need for setting aside pristine pieces of land for future preservation, California is now working to set aside beautiful ocean habitat and resources for a healthy tomorrow.

How is the California coast divided into areas?

To plan a statewide network of MPAs, California's coast was divided into four distinct geographic regions (along with a fifth region - San Francisco Bay). Each region has different regional stakeholders and scientists involved who are familiar with and know the local ocean and coastal habitat. The four geographic regions are the north coast (from the Oregon Border to Alder Creek, north of Point Arena), the north central coast (from Alder Creek to Ano Nuevo), the central coast (Ano Nuevo to Point Conception) and the south coast (Point Conception to the Mexican border).

What is a marine protected area?

Marine protected areas (MPAs) are protected spaces set aside in the ocean, just like parks are set aside on land. MPAs come in all shapes and sizes, but are most effective when protecting areas rich in habitat.

What is a marine reserve?

A marine reserve is a marine protected area that provides the highest level of protection for marine life. Marine reserves are the "look, pass through, but don't touch or take anything" Marine Protected Areas. Marine Reserves still allow scientific surveys of the area, as well as surfing, swimming, "just look" diving and boating.

What does scientific research say about marine reserves?

Scientists have studied the performance of 124 Marine Reserves of many different sizes in a variety of habitats. A comprehensive review of Marine Reserves reveals that most well-regulated Marine Reserves result in large, rapid and long-lasting increases in population, number of species, and reproductive output of marine animals and plants. The review found that the average weight of all animals and plants studied is more than four times larger in reserves than in unprotected areas.

Why do marine reserves work?

Protection from fishing allows animals in reserves to survive longer and grow larger. Also, habitats are protected from anchors and fishing gear, so they can sustain the plants and animals that rely on them. Fully protected marine reserves are currently the only marine management tool that promotes the recovery of entire ecosystems, not just specific species.

Why does fish size matter?

Large fish and invertebrates can produce enormous numbers of offspring ensuring future generations. Take for example the vermillion rockfish, a very sleek orange colored fish. A vermillion rockfish that weighs close to two pounds produces about 150,000 baby fishes while a vermillion rockfish weighing 7.5 pounds produces 1.7 MILLION baby fishes. That's a huge difference! Big fish are key to making sure marine life populations remain healthy and stable.

What are the benefits of marine reserves in California?

Marine reserves protect California's priceless coastal habitats by providing the highest level of protection leading to proven results.

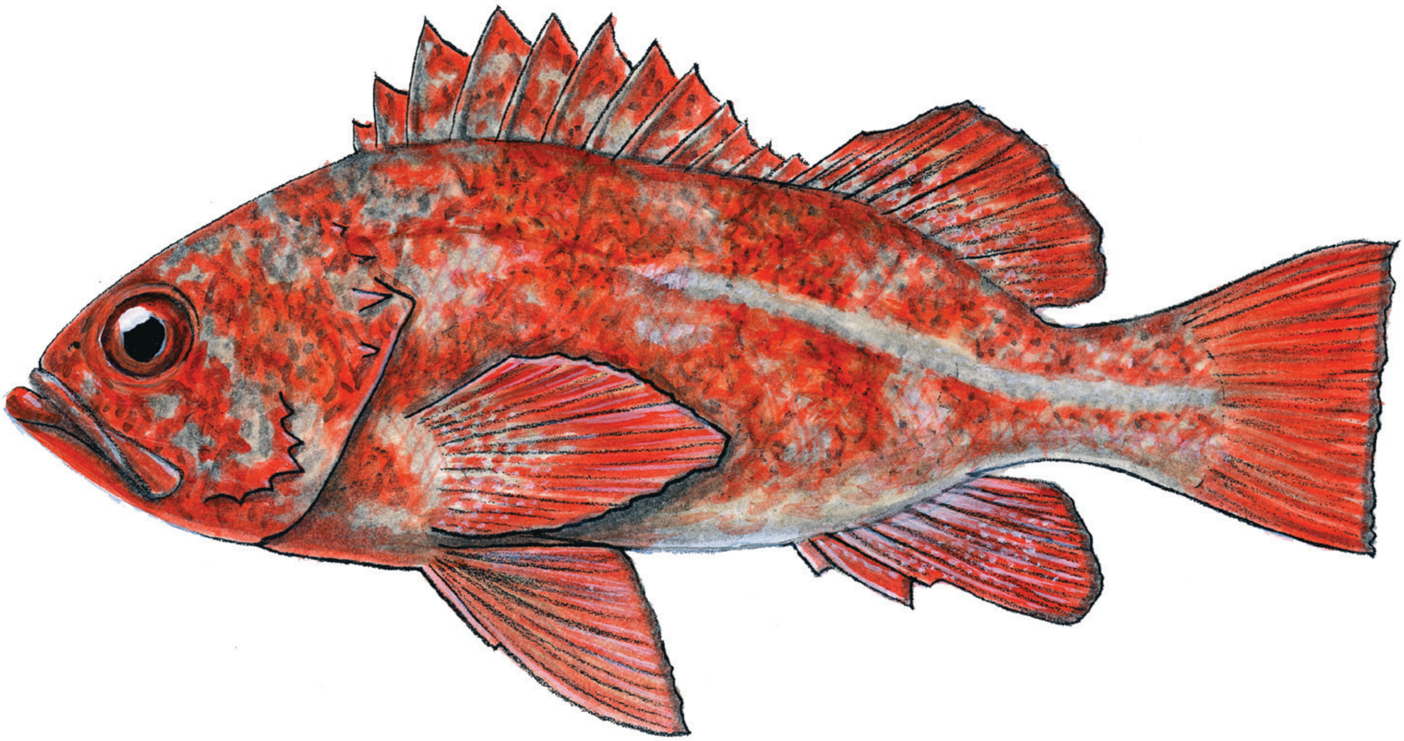
In a scientific survey of 124 reserves worldwide, scientists found that fish are larger, more abundant, and more diverse within marine reserves. Marine reserves allow fish, mammals, and other marine life to breed, feed, and succeed without human interference, providing refuges where ocean life recovers and flourishes for us and future generations to enjoy.

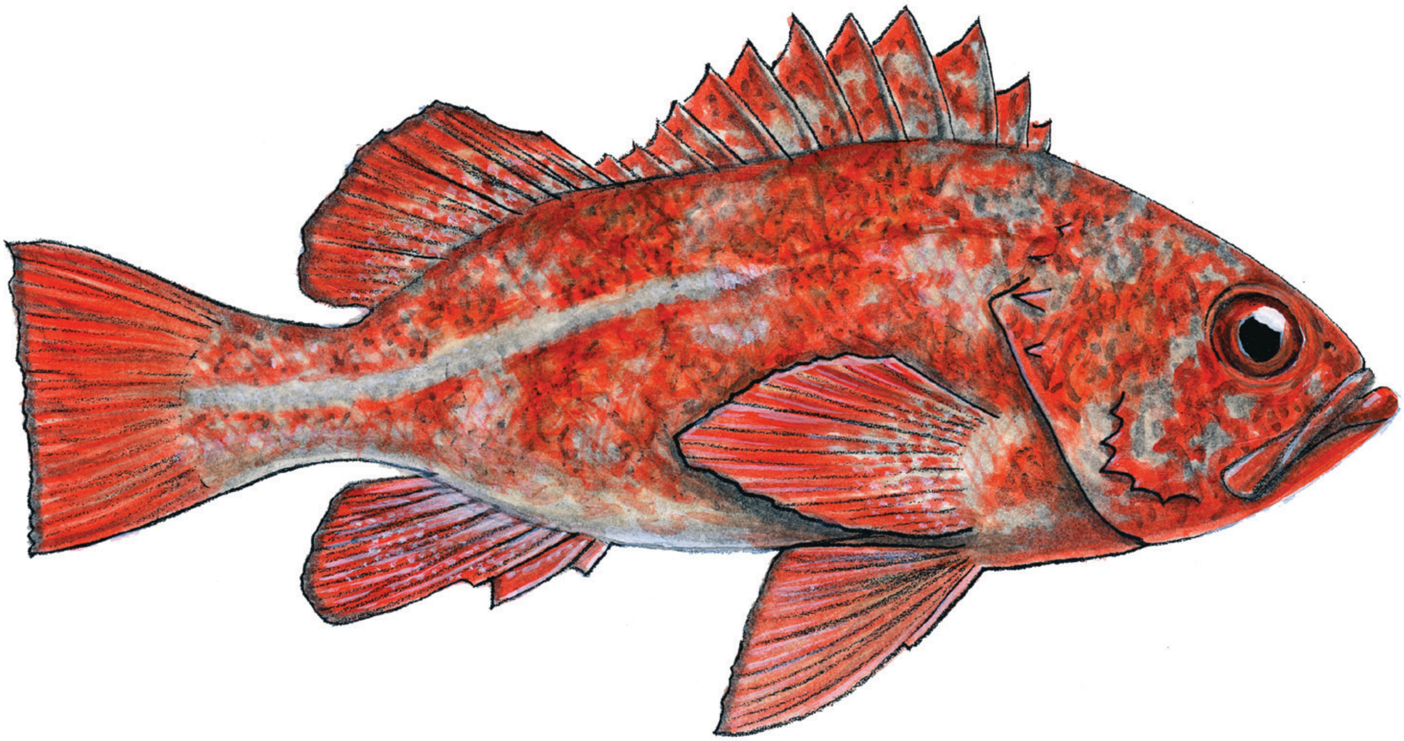
Why aren't current fisheries regulations sufficient for ocean protection?

Previously, if a species was in decline, protections were placed on that particular species, but not the food and habitat needed for that species' survival. Marine protected areas and especially marine reserves consider the bigger picture and ensure that all levels of the food chain receive protection by protecting the entire ecosystem.

How can marine reserves help fisheries if fishermen can't fish in these areas?

Animals living inside marine reserves help replenish fish populations outside their borders because larvae disperse in ocean currents in juvenile stages, spilling over into unprotected areas. It's no coincidence that the majority of record-breaking game fish in Florida are caught just outside the marine reserve at Merritt Island.





Vocabulary

Abundance - number of individuals in a habitat or ecosystem

Benthic - on the bottom or happening near the bottom

BOFFF - big, old, fat, female fish, sometimes known as Big, old, fat, fecund, female fish (BOFFFF); larger, sexually mature female fish who are capable of producing more offspring than smaller, younger female fish

Capture/recapture - to take an organism, count it and then release it to later resample the same location; used to determine population size

Carrying capacity - the number of organisms that an ecosystem or habitat can support

Coast - the edge of the land where it meets the sea

Common resources - resources or items that everyone in a community shares

Commons - a shared resource or region

Community science - science that uses members of the community to gather data or perform scientific analysis; sometimes called citizen science because it uses the residents or citizens of a particular area to perform the science instead of only scientists

Consumer - organisms that must ingest or eat others to get their energy

Dimorphic - existing or representing two distinct forms

Ecosystem - the living community of organisms interacting with each other and their physical environment

Ecosystem based management - a conservation approach that looks at an entire ecosystem, its living (biotic) and non-living (abiotic) factors and how they interact to ensure that all aspects of the habitat or ecosystem vital to its continued health are protected

Facilitator/facilitation - a facilitator is someone who helps to make something happen by guiding a process, facilitation is the act of helping and guiding the process

Farming - caring for and growing organisms for use and food

Fecund - fertile, producing or capable of producing new growth or offspring

Fecundity - number of babies able to reproduce

Fish Stocks - population of a particular species or type of fish

Food chain - the pattern of energy moving through a habitat from a producer through a series of consumers

Food web - the transfer of energy among producers and consumers within a habitat, composed of many varying food chains

Genetic analysis - researching the genes of the organism

Habitat - the natural environment of an organism that includes all it needs to stay alive, such as its home, food, shelter, and water

Harvesting - to gather a crop from where it's grown, usually a food item

Healthy - functioning well & properly; in balance

Infographic - an image or group of images that depicts information, often in analytical form

Internal fertilization - fertilization that occurs within the female's body

Life Cycle - the life an organism from birth to death; some organisms go through complex, many stage life cycles

Marine animals - animals that live in the ocean

Marine biodiversity - biodiversity is the variety of species in a region; marine biodiversity refers to this variety in the ocean

Marine habitats - habitats found in the ocean, natural environments of organisms; in Southern California, our primary marine habitats are the sandy shore and corresponding sandy bottom, sea grass beds, rocky shore and corresponding rocky reef, kelp forest, and open ocean

Marine Protected Area - an area of ocean and/or ocean shoreline protected from human activities in order to conserve a natural resource or historically significant area; protections and restrictions on that area can vary, but almost all are still open to non-consumptive use, i.e. they can be visited but nothing can be taken or hurt in the area; also known as an MPA

Marine reserve - a type of marine protected area that is protected from fishing

Marine sanctuary - a specific type of marine protected area where certain behaviors like fishing or dredging are not allowed, the specific protections can vary among sanctuaries

Metamorphose - transformation from larval to an adult organism in two or more stages

Model - a representation or example of an item or situation

Natural resources - items that come from the environment

Organism - a living species, can be a member of any kingdom of life

Over-exploitation - to work something too hard or use too much of something

Overfishing - fishing an organism beyond its capacity to replenish itself, leading to extreme reductions or even extinction of a species

Ovoviviparous - producing young by eggs that are hatched within the body of the parent

Planktonic - free-floating organisms moved by the tide or currents

Population - the abundance of a particular species or group of species

Producers - organisms that use photosynthesis or chemosynthesis to produce food/sugar for energy

Proportion - a portion of a number with respect to a greater whole, a percentage

Recapture - something that has been taken, let go, and recaught

Range - an organism's territory or environment where it finds its resources

Renewable resources - items that can be harvested sustainably

Sampling - taking a few of something, often used in respect to research

Sampling population - the group of individuals you are taking, counting and/or studying

Sheltered - protected

Significant - worth noting or paying attention to

Simulate - to pretend to act in a way that copies a real action in the world, to imitate

Simulation - an imitation or representation of something, usually a process or an act

Species - a group of similar organisms that can produce young together

Spillover - overflow from one area to another

Stakeholder - an individual or category of individuals that will be impacted by a decision and have a "stake" in the issue or resource

Sustainability - the act of being able to continue a behavior

Sustainable - a behavior that can be continued without having detrimental impacts

Territory - a range or area in which an organism can be found, often guarded or protected by the organism

Tragedy of the Commons - a term describing a situation where everyone shares a resource, but no one bears the responsibility for caring for it

Underwater parks - areas underwater that are protected from harvest to safeguard habitat and the associated marine life

Variety - number of species in a habitat or ecosystem

Virtual - being similar or simulated, often used in reference to computer activities that simulate activities in the real world

MPA Standards Grid

	California's Coast	Getting to Know Garibaldi	An Introduction to MPAs	MPAs – What's at Stake	Fishing for Solutions	MPAs in Person	YOU Can Protect our Coast!
6TH - 8TH GRADES							
Speaking Listening							
1. Engage effectively in a range of collaborative discussions	■	■	■	■	■	■	■
a. Come to discussions prepared and reflect on ideas under discussion.	■	■	■	■	■	■	■
b. Follow rules for collegial discussions	■	■	■	■	■	■	■
c. Pose and respond to specific questions with elaboration and detail	■	■	■	■	■	■	■
d. Review the key ideas expressed and demonstrate understanding of multiple perspectives	■		■	■	■	■	■
2. Interpret information presented in diverse media and formats and explain how it contributes to a topic, text, or issue under study.	■	■	■	■	■	■	■
Writing Standards							
2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.				■	■	■	
3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences		■					
5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.		■			■	■	
7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate				■		■	■
Reading Standards for Literacy in History/Social Studies							
3. Identify key steps in a text's description of a process related to history/social studies				■	■		
6. Identify aspects of a text that reveal an author's point of view or purpose		■		■		■	
7. Integrate visual information with other information in print and digital texts.	■						
Reading Standards for Literacy in Science and Technical Subjects							
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.					■		
7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually				■			

	California's Coast	Getting to Know Garibaldi	An Introduction to MPAs	MPAs – What's at Stake	Fishing for Solutions	MPAs in Person	YOU Can Protect our Coast!
Mathematics							
6th grade Statistics							
5. Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.					■		
7th grade Statistics							
1. Use random sampling to draw inferences about a population. 1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.					■		
Science							
6th grade							
2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.						■	
c. Students know beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.						■	
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.	■	■			■		
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.	■	■	■		■		■
7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.					■	■	■
Students will: **a.** Develop a hypothesis.					■	■	
e. Recognize whether evidence is consistent with a proposed explanation.				■			

	California's Coast	Getting to Know Garibaldi	An Introduction to MPAs	MPAs – What's at Stake	Fishing for Solutions	MPAs in Person	YOU Can Protect our Coast!
F. Read a topographic map and a geologic map for evidence provided on the maps and construct and interpret a simple scale map.						■	
h. Identify changes in natural phenomena over time without manipulating the phenomena					■		
7th Grade							
3. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. As a basis for understanding this concept:					■		
E. Students know that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient for its survival.					■		
Ocean Literacy	1,5,7	5,6	4,5,6	1,5,6,7	5,6,7	2,5,6,7	6,7
NGSS - if adopted as they are now:							
MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem			■		■		
MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems			■	■	■		
MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services				■	■		■
MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment						■	