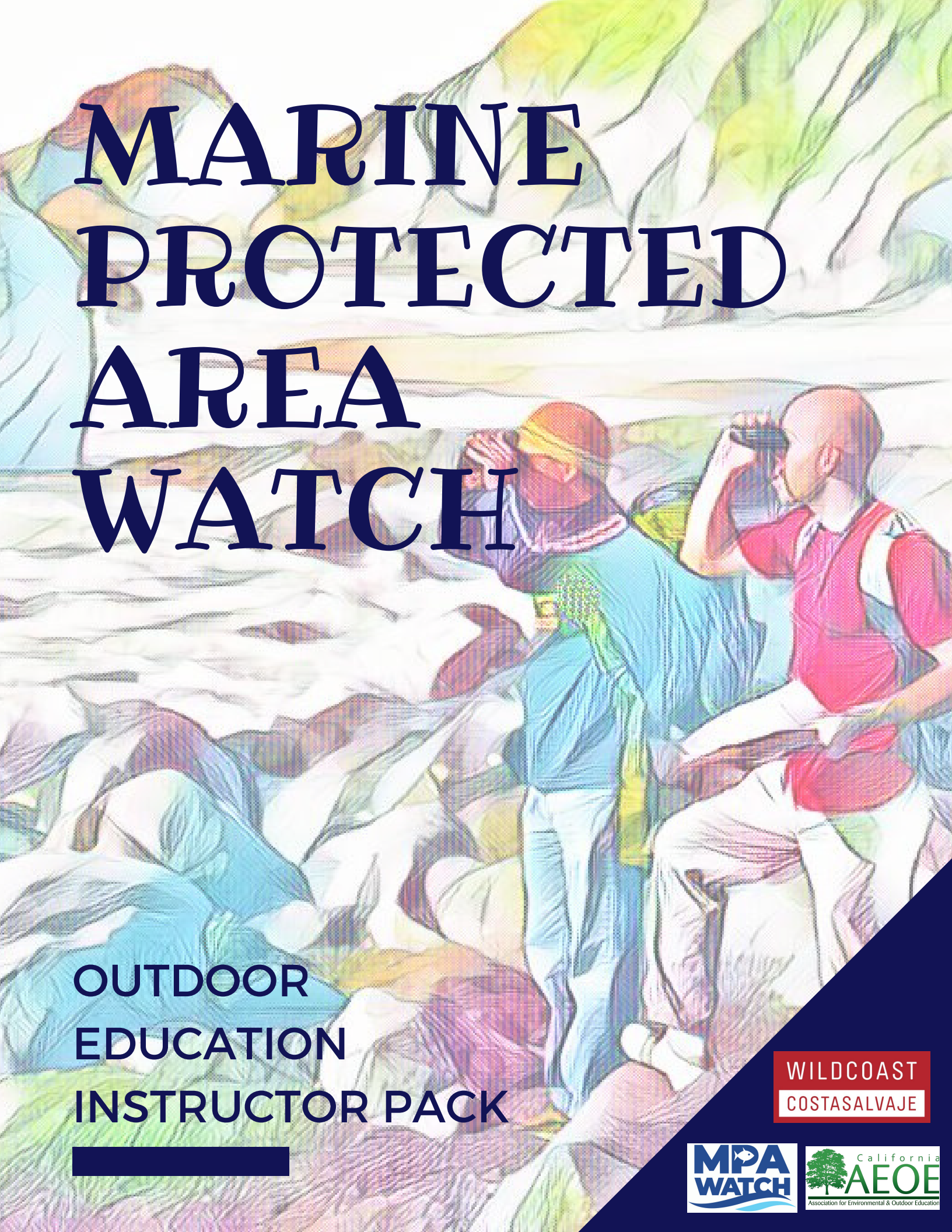


MARINE PROTECTED AREA WATCH

OUTDOOR EDUCATION INSTRUCTOR PACK

WILDCOAST
COSTASALVAJE

MPA WATCH

California AEOE
Association for Environmental & Outdoor Education

MPA WATCH

WILDCOAST
COSTASALVAJE

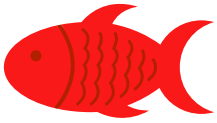
MPAs

Marine Protected Areas (MPAs)

California's coastal and marine ecosystems are some of the most iconic and treasured resources in the state and contribute greatly to the history, identity, and economy of the area. Unfortunately these same ecosystems are also some of the most exploited and without proper care the long-term health of these resources is in jeopardy. Recognizing the need to safeguard California's coastal and marine ecosystems the state legislature passed the Marine Life Protection Act in 1999. This act aimed to protect California's precious marine resources by creating a statewide network of marine protected areas (MPAs). Designed to protect the diversity and abundance of marine life while still maintaining recreational access for people, MPAs now protect over sixteen percent, or 850 miles, of the California coast.

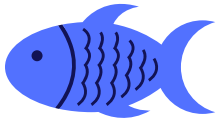
Just as state parks protect resources on land, MPAs protect resources in the ocean by managing human activities within biologically important areas. The Marine Life Protection Act recognizes that a combination of MPAs with varied amounts of allowed activities and protections (marine reserves, marine conservation areas, and marine parks) can help conserve biological diversity, provide a sanctuary for marine life, and enhance recreational and educational opportunities.

There are 124 MPAs in California that fall under six categories:



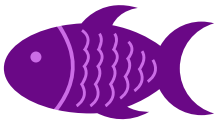
State Marine Reserve (SMR)

An MPA where no take, damage, injury, or possession of any kind of living, geologic, or cultural marine resource is allowed.



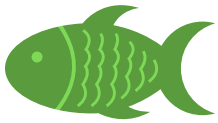
State Marine Conservation Area (SMCA)

An MPA where some recreational and/or commercial take of marine resources may be allowed (restrictions vary).



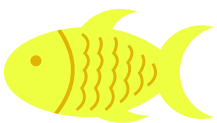
No-Take State Marine Conservation Area (No-Take SMCA)

An MPA where no take of any living, geologic, or cultural resource is allowed, EXCEPT for take incidental to specified activities permitted by other agencies (i.e. sand renourishment).



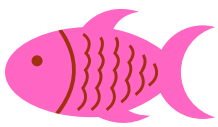
State Marine Recreational Management Area (SMRMA)

A marine managed area where some take of marine resources may be allowed and legal waterfowl hunting is allowed (restrictions vary)



State Marine Park (SMP)

An MPA that allows some recreational take but does not allow commercial take.



Special Closure

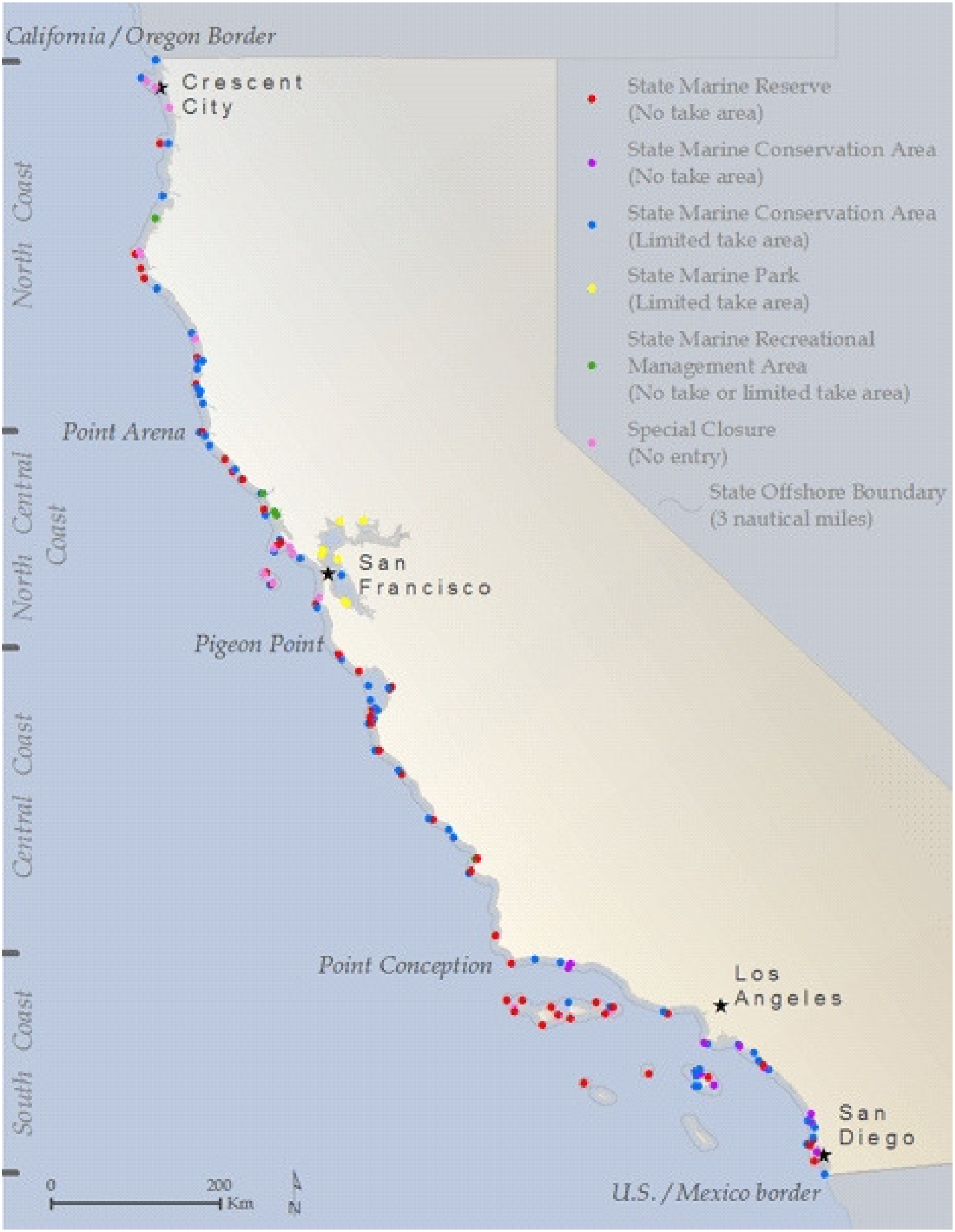
Prohibits or restricts access in waters adjacent to seabird rookeries or marine mammal haul-out sites.

Key Words

Marine Protected Area (MPA): MPAs are areas in or near the ocean made to protect or conserve marine life and habitat, safeguard cultural sites, and provide enhanced recreational opportunities

Natural Resource: Materials or substances such as minerals, forests, water, or animals that are found in nature and are valuable to humans.

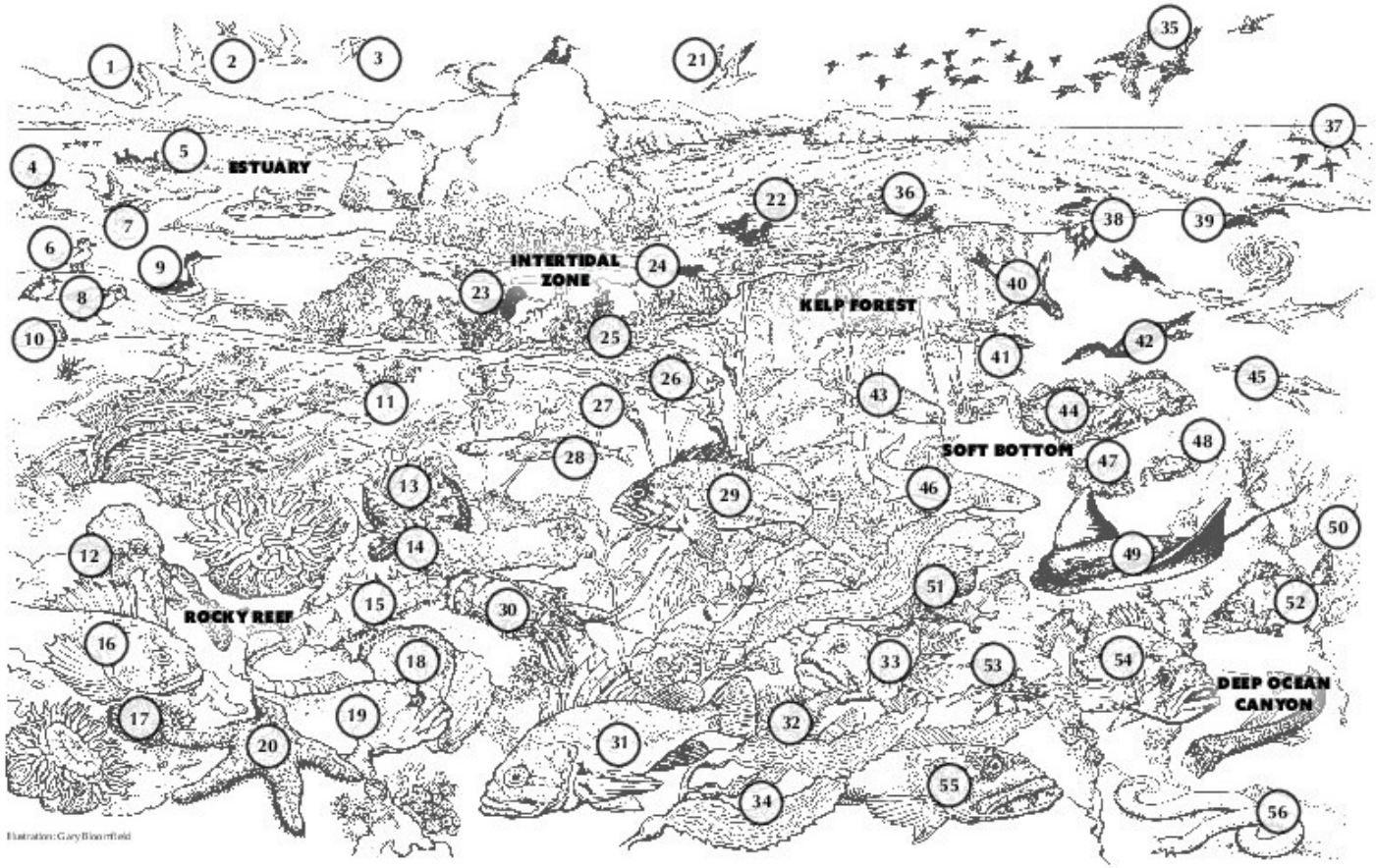
Take: To hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.


California / Oregon Border
Crescent City
North Coast
North Central Coast
Central Coast
South Coast
Point Arena
San Francisco
Pigeon Point
Point Conception
Los Angeles
San Diego
U.S. / Mexico border
State Marine Reserve
(No take area)
State Marine Conservation Area
(No take area)
State Marine Conservation Area
(Limited take area)
State Marine Park
(Limited take area)
State Marine Recreational
Management Area
(No take or limited take area)
Special Closure
(No entry)
State Offshore Boundary
(3 nautical miles)
0
200
Km
N

SAFEGUARDING AN UNDERWATER WILDERNESS

HABITATS & SPECIES LIKELY TO BENEFIT FROM CALIFORNIA'S MARINE PROTECTED AREAS

CALIFORNIA MARINE PROTECTED AREAS



The California Marine Protected Area (MPA) Network was established to help conserve marine life and restore the integrity of marine ecosystems.

The Network includes 124 protected areas covering 16 percent of state waters. There are several key habitat-types found within California's MPAs including estuaries, intertidal zones, rocky reefs, kelp forests, soft ocean bottoms, and submarine canyons. Over 100 species of fish, invertebrates, sea birds, marine mammals, algae and plants are likely to benefit from MPA protections. Those species include ones that spend all or significant portions of their lives within MPAs.

California's ecologically connected MPA Network is the largest of its kind in the world. The California Department of Fish and Wildlife manages the Network and works in collaboration with key partners and local communities to monitor, protect, and sustain California's unique coastal heritage.

How many species can you identify? Use the key below to check your work.

Note: this illustration is intended to convey species likely to benefit from MPAs along the entirety of California's coast. The six habitat-types and 56 species pictured are unlikely to occur within such close proximity to each other.

1. California Gull *Larus californicus*
2. Western Gull *Larus occidentalis*
3. Heermann's Gull *Larus heermanni*
4. Long-billed Curlew *Numenius americanus*
5. Brant *Branta bernicla*
6. Snowy Plover *Charadrius nivosus*
7. Dunlin *Calidris alpina*
8. Sanderling *Calidris alba*
9. Western Grebe *Aechmophorus occidentalis*
10. Pacific Littleneck Clam *Leukoma staminea*
11. Gooseneck Barnacle *Pollicipes polymerus*
12. Red Octopus *Octopus rubescens*
13. Red Abalone *Haliotis rufescens*
14. Turban Snail *Tegula funebralis*
15. California Sea Cucumber *Apostichopus californicus*
16. Cabezon *Scorpaenichthys marmoratus*
17. Purple Urchin *Strongylocentrotus purpuratus*
18. Rock Scallop *Crassadoma gigantea*
19. Monkeyface Prickleback *Cebidichthys violaceus*
20. Ochre Star *Pisaster ochraceus*
21. Caspian Tern *Hydroprogne caspia*
22. Pigeon Guillemot *Cepphus columba*
23. Black Oystercatcher *Haematopus bachmani*
24. Black Turnstone *Arenaria melanocephala*
25. California Mussel *Mytilus californianus*
26. Shiner Surfperch *Cymatogaster aggregata*
27. Bull Kelp *Nereocystis luetkeana*
28. Surf Smelt *Hypomesus pretiosus*
29. Copper Rockfish *Sebastes caurinus*
30. California Spiny Lobster *Panulirus interruptus*
31. Black-and-Yellow Rockfish *Sebastes chrysomelas*
32. Red Urchin *Mesocentrotus franciscanus*
33. Wolf-eel *Anarrhichthys ocellatus*
34. Giant Kelp *Macrocystis pyrifera*
35. Brown Pelican *Pelecanus occidentalis*
36. Rhinoceros Auklet *Cerorhinca monocerata*
37. Sooty Shearwater *Ardenna grisea*
38. Common Murre *Uria aalge*
39. Harbor Porpoise *Phocoena phocoena*
40. California Sea Lion *Zalophus californianus*
41. Olive Rockfish *Sebastes serranoides*
42. Brandt's Cormorant *Phalacrocorax penicillatus*
43. Harbor Seal *Phoca vitulina*
44. Blue Rockfish *Sebastes mystinus*
45. Market Squid *Doryteuthis (Amerigo) opalescens*
46. Leopard Shark *Triakis semifasciata*
47. C-O Turbot *Pleuronichthys coenosus*
48. Dungeness Crab *Metacarcinus magister*
49. Bat Ray *Myliobatis californica*
50. Purple Gorgonian *Eugorgia rubens*
51. California Sea Hare *Aplysia californica*
52. Flag Rockfish *Sebastes rubrivinctus*
53. Spot Prawn *Pandalus platyceros*
54. Vermilion Rockfish *Sebastes miniatus*
55. Lingcod *Ophiodon elongatus*
56. Pacific Hagfish *Eptatretus stoutii*

MPA Resources

WILDCOAST

Digital copies of all materials included in this teaching pack as well as any questions about MPA Watch may be obtained by e-mailing: angela@wildcoast.org

Ocean Institute

Free, online MPA unit including background information, MPA Watch lesson plan, games, and activities for students.

Available online at:
https://oceaninstitute.education/course/view.php?id=95
Use guest login- password: MPA

California Department of Fish and Wildlife

Resources including fact sheets, maps, posters, brochures, and videos.

Digital copies of all CDFW documents may be found at:
https://www.wildlife.ca.gov/Conservation/Marine/MPAs
Printed copies may be available by e-mailing: marnin.Robbins@wildlife.ca.gov

California Marine Sanctuary Foundation

Resources including fact sheets, maps, posters, brochures, and curricula.

Digital copies of all CMSF documents may be found at: http://californiampas.org/
Printed copies may be available by e-mailing: katelyn@californiamsf.org

Marine Protected Areas and MPA Watch

Lesson 1

Learning Objectives

A) Students will learn what an MPA is and why we create them.
B) Students will understand that everyone can be a scientist.
C) Students will collect data for the California MPA Watch program.

NGSS: DCI (Disciplinary Core Ideas):
MS-LS1-5
MS-LS2-4
MS-LS2-5
MS-ESS3-3.

Time: 60-90 mins.

Materials for the Teacher
- Whiteboard and marker
- Map of California and/or local MPAs
- Image of yellowtail
- Hula hoops

Materials for the Students
- Clipboard
- Pencil
- MPA Watch datasheet

Background information:

Marine Protected Areas (MPAs)

We can think of marine protected areas, or MPAs, as underwater parks. Just like we have national, state, and regional parks on land, there are many different types of MPAs. Different parks allow different activities - same with MPAs! In some of them you can fish, while in others you can't. Some MPAs allow all kinds of activities (fishing, swimming, boating, etc.) while others are much stricter. By restricting what people can do and take in these underwater parks, we can protect California's natural resources.

California has 124 MPAs all along the coast. These MPAs protect many different habitats where many different animals live. MPAs give marine species a safe place to breed and grow. Animals inside of MPAs may be larger than those found outside of MPAs, allowing them to have more offspring than smaller animals. Offspring born within MPAs may also have access to more food, space, and other resources, allowing offspring to be healthier.

MPAs also provide opportunities for people to see beautiful, protected ocean spaces through snorkeling, scuba diving, swimming, kayaking etc. Sometimes, people don't know that they are in an MPA and accidentally do something they aren't supposed to do. That's why it is important to understand what MPAs are, why we have them, and where they are - so you know if you are in one!

Discussion:

Why do we make MPAs?

- Break students into small groups and have them discuss the following questions: What ocean animals can you think of? How might people affect those animals?
- Ask students to volunteer to share an idea from their group.

Vocabulary

- **Community (or citizen) Science:** The collection and/or analysis of scientific data by everyday people.
- **Marine Protected Area** (MPA): MPAs are areas in or near the ocean made to protect or conserve marine life and habitat, safeguard cultural sites, and provide enhanced recreational opportunities.
- **MPA Watch**: A network of programs that support healthy oceans through community science by collecting human use data in and around our protected areas.
- **Natural Resource:** Materials or substances such as minerals, forests, water, or animals that are found in nature and are valuable to humans.
- **Take**: To hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill any natural resources.
- **Transect**: A fixed path (with a start and end point) along which one counts and records scientific data.

Activity #1:

MPA Migration

In an open space, like a field or on the beach, denote a large rectangular playing area to represent the coast of California. Pick 3-4 students to play anglers and station themselves inside the playing field. Anglers are allowed to move throughout the game. The rest of the students will be fish, trying to migrate from one end of California to the other by running the length of the playing field without getting "caught" (tagged) by the anglers. Emphasize to the students that they are one population of fish, so they are not competing with each other. Rather, their goal is to have as many as possible successfully complete migration. Tagged students must go back to the start and wait for the next round.

For the first round play exactly as described above, expecting most of the fish to be caught. Ask students to think about what could be done to make their migration more successful. Place a hula hoop, or other marker, inside the playing field and explain to the students that this area denotes a marine protected area – a safe place where the anglers are not allowed to fish. Students standing in the MPA may not be tagged. Expect with only one MPA that migration will likely not be much more successful.

As you play continue to add more MPAs until you create a network of MPAs that spans the entire coast so students can jump from one MPA to the next without having to go in unprotected waters (students should not be tagged when jumping from MPA to MPA unless their feet touch the ground outside of the MPA). Discuss how this network approach led to the most success and why. The game ends when the entire fish population safely completes migration.

EXTENSIONS: 1) Include MPAs of different sizes. Include some so small that students may fall out and get tagged. Discuss how larger MPAs are more effective at saving populations. 2) Include different types of MPAs. For example, in state marine reserves there is no fishing, but in some state marine conservation areas there is limited fishing, so an angler could tag them (perhaps from a stationary point). Discuss how no take areas, such as state marine reserves, are the most effective at protecting populations.

California Department of Fish and Wildlife Key Messages

- MPAs protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
- MPAs help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.
- MPAs improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and manage these uses in a manner consistent with protecting biodiversity.
- MPAs protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic values.

Activity #2:

Draw a Scientist

- Ask students to draw *a* scientist either in the dirt/sand or in their journals.
- Ask students what their scientists looked like and draw a representation on a whiteboard. Typically, students draw a man with crazy hair and a lab coat.
- Ask students if this person could still be a scientist even if they were not wearing a lab coat. Erase the lab coat and draw regular clothes as you do this. Repeat for any other attributes until the person on your whiteboard looks like an everyday person.
- Ask students who this looks like now ("me!").
- Tell students that today they will be practicing a special type of science called "community science" (or citizen science) in which they get to be real scientists!

Background information:

Community Science

Community science (also known as citizen science) involves members of the general public (that's you and me!) collecting data that can then be used in scientific research. Anyone can participate in community science. It's a great way for people to help out professional scientists!

There are many different types of community science. Some involve using an app on your phone to take pictures or measurements that are then sent to professional scientists. Today, we are going to do a type of community science that involves taking notes about what you see. Your naturalist/instructor will then add your notes to an online database of information that professional scientists can access.

Background information:

MPA Watch

We already talked about why we create MPAs and how they can help protect ocean animals. Now that California has created these underwater parks, it's important for us to see how people are using them. Are people visiting MPAs? If they are, what kind of activities are they doing there? The answers to these questions will help us to figure out if the MPAs are working and help in creation of future MPAs. We are all going to be citizen scientists today and help collect some information about what people are doing in this MPA.

(Note: if you are at a control site, it is worth talking about why we have control sites. It is helpful to see how people are using non-MPA areas and then compare that to the data we get from MPAs.)

Connections:
Art, science

Ocean Literacy Connection:

- **6C**: The ocean is a source of inspiration, recreation, rejuvenation, and discovery. It is also an important element in the heritage of many cultures.
- **6D**: Humans affect the ocean in a variety of ways. Laws, regulations, and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution), changes to ocean chemistry (ocean acidification), and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- **6G**: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Activity #3:
MPA Watch

- Break students into pairs or small groups of 3-4.
- Each group should get a clipboard, pen/pencil, and MPA Watch data collection sheet.
- Explain the process: students will begin at one end of a predetermined transect and walk to the other end, recording human activity along the way. Different activities will need to be recorded in different columns.
- Before you begin, fill in the top part of the data sheet (the "metadata") together and make sure students understand each activity.
- Naturalists/instructors should "float" from group to group and be available for questions.
- At the end, come together and briefly discuss your findings as a group. Why might different small groups have gotten different answers? How might your answers have been different at a different time of day?

Debrief/Check for Understanding
Ask students to synthesize everything they have learned about MPAs and the implications of their data on MPA management and conservation.

Examples of this could be:

- What activity(ies) did you notice the most during your MPA Watch survey?
- Do you think these activities have a low or high impact on the environment?
- Which activities do you think have the lowest impact? The highest impact?
- What types of activities do you think should be encouraged in MPAs? Discouraged?
- Some MPAs allow limited take while some do not allow any take at all? Based on the evidence you collected and what you know about MPAs, do you think one would be more effective than the other at protecting coastal and marine resources?
- What are some things you can do to help protect coastal and marine ecosystems?

Alternatively, or in addition to, students can draw signs (geared toward the general public) that inform users about MPAs (see plover example in appendix).

Engage: Have students share activities they like to do and things they like to see at the beach.
Explore: Students will explore the beach and marine protected areas through games and communicyt science (MPA Watch).
Explain: Explain MPAs and how human use affects coastal and marine ecosystems.
Elaborate: Ask the students what types of activities were most prevalent. Explore possible impacts of those activities on coastal and marine ecosystems.
Evaluate: Ask the students to synthesize the information they learned and data they collected to make recommendations on how they and others can help protect coastal and marine resources.

NGSS Alignment

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
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.

Science and Engineering Practices

1. Asking questions
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

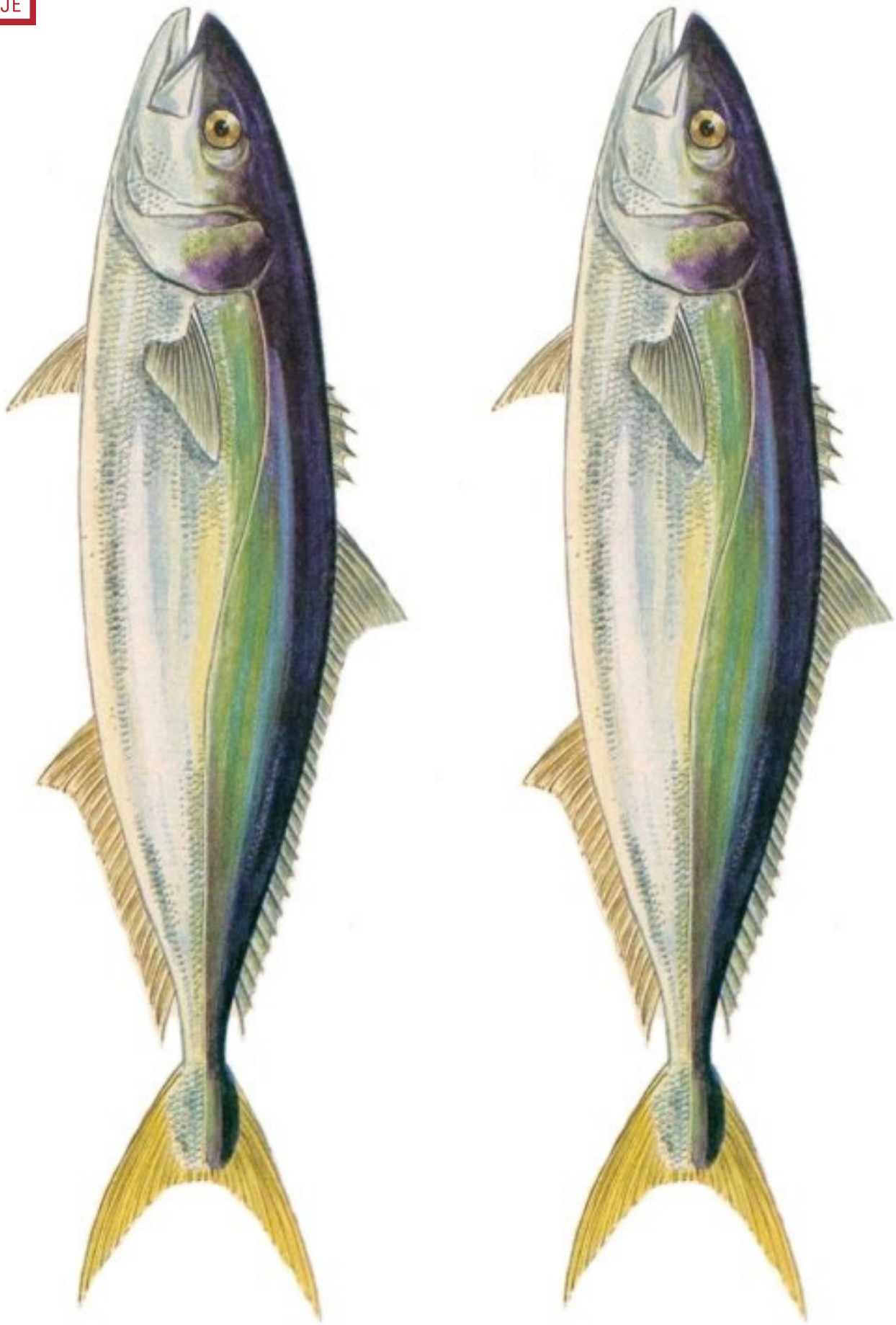
Crosscutting Concepts

1. **Patterns**. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
2. **Cause and effect:** Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Online Resources

California Marine Protected Areas video: https://youtu.be/xB_yqcfN7DE
Maps of California MPAs by region: http://californiampas.org/outreach-toolkit/printed-materials/maps
MPA Overview Sheets: https://www.wildlife.ca.gov/Conservation/Marine/MPAs/Outreach-Materials#26716428-mpa-overview-sheets

Appendix



Appendix


Please Respect the Fences
Please Beware of Nesting Plovers
Por Favor Respete los Cercos


Please Respect the Fences
We are living things too just like you! Share the Beach!
Por Favor Respete los Cercos

MPA Watch Data Sheet

Name(s):		Date: ___/___/_____	Transect ID:
Start Time:	End Time:	Clouds: clear (0%)/ partly cloudy (1-50%)/ cloudy (>50%cover)	Rain: yes / no
Air Temperature: cold / cool / mild / warm / hot		Wind: calm / breezy / windy	Tide Level: low / med / high
Visibility: perfect / limited / shore only		Beach Status: open / posted / closed / unknown	Sea State: Calm / 2-4ft / 4-6ft / 6ft<

On-Shore Activities	
Recreation (walking, resting, playing, etc. NOT tidepooling)	
Wildlife Watching	
Domestic animals on-leash	
Domestic animals off-leash	
Driving on the Beach	
Tide-pooling (not collecting)	
Hand collection of biota	
Shore-based fishing	

Off-Shore Activities (Non-Boating)	
Surfing/Boogie Boarding	
Offshore Recreation	
Stand Up Paddle Boarding	
SCUBA and snorkeling	

Boating	
Boat Fishing	
Kayak/Canoe/Dinghy	
Other Boating (please specify in comments	

Comments

Did you observe: ☐ scientific research; ☐ education; ☐ beach closure; ☐ large gatherings (e.g., beach cleanup); ☐ enforcement activity

Describe below and provide counts of individuals involved where possible, and whether it took place on rocky or sandy or sandy substrate.

Did you report a violation: ☐ yes ☐ no If yes, how many violations did you report _____

MPA Biodiversity

Lesson 2

Learning Objectives

A) Students will learn the concept of biodiversity.
B) Students will learn the idea that everything in nature is connected.
C) Students will learn why it is important to maintain biodiversity in our oceans.
D) Students will make observations about connections among organisms in an ecosystem.

NGSS: DCI (Disciplinary Core Ideas):
MS-LS2-1
MS-LS2-4

Time: 60-90 mins.

Materials for the Teacher

- Whiteboard with marker
  Yarn or string
- Pictures of coastal and marine ecosystems (i.e. kelp forest, sandy shore, rocky intertidal, sea grass)

Materials for the Students

- Organism cards (see Online Resources in appendix for example)
- Optional – Ecosystem Exploration worksheet

Background Info:

Biodiversity

The Greek root "bio" means life. That means that "biodiversity" is the diversity of life.

We live on a planet full of many different kinds of life - animals, plants, fungi, bacteria, and some things that are so weird, we hardly know what to call them. Scientists classify living things into different groups, with the smallest unit of classification being the species. Nobody really knows how many species exist on Earth because we haven't found them all - not even close! Some scientists think there could be a million species living just in the ocean.

Living organisms (biotic factors) interact with the non-living things (abiotic factors) around them - examples would be water, sunlight, wind, etc. We call a community of living organisms and their nonliving physical environment an ecosystem. Examples of ocean ecosystems here in California are kelp forests, sandy beaches, rocky shores (and tidepools), and the open ocean.

When scientists talk about biodiversity, they usually are referring to the diversity of both species and ecosystems.

Discussion:

California's Coastal and Marine Ecosystems

- Break students up into pairs or small groups. Challenge each group to come up with as many coastal and marine ecosystems as they can.
- Ask for volunteers to share their answers until you have a good list. From your list, choose one coastal or marine ecosystem to focus on (ideally, one that is close to your site and/or one that will visit with the students.)
- Now, challenge each group to make a list of the living and nonliving things that make up their ecosystem.

Vocabulary

- **Biodiversity**: The variety of life on Earth.
- **Species**: A group of similar individuals that are able to reproduce.
- **Biotic Factor**: The living things in an ecosystem.
- **Abiotic Factor**: The non-living things in an ecosystem.
- **Ecosystem**: A biological community of interacting organisms and their physical environment.
- **Kelp Forest:** underwater ecosystems formed in shallow water by the dense growth of several different species known as kelps. Known as the one of the most productive and dynamic ecosystems on Earth.
- **Sandy Shore**: Sandy shores or beaches are loose deposits of sand, including some gravel or shells, that cover the shoreline in many places. They make up a large portion of the world's ice-free coastlines. Beaches serve as buffer zones or shock absorbers that protect the coastline, sea cliffs or dunes from direct wave attack.
- **Intertidal Zone**: The area of land in between the high and low tidelines.

Activity:

Organism Game

- Hand out organism cards and make sure each student gets one. They cannot look at their cards!
- Each student should place their card on their forehead.
- Next, students need to mingle around the room and ask their classmates questions about their card. They are only allowed to ask one question at a time and questions must have a yes/no answer. After they ask a question, regardless of the answer, they have to move on to three more students before they return to that student. The idea is to narrow down the organism on their card by asking questions like "Am I a type of fish?"
- Have students hold on to their card for the next activity.

Background Info:

Everything is Connected

Each ecosystem is made up of a series of connections. Some organisms eat each other, some create homes that others live in, some have special relationships where they help each other, etc. Scientists understand some of these connections but there are a lot that we don't understand and certainly a lot that we don't even know about.

Sometimes, organisms can impact their ecosystems in big ways. We have found that changes in the number of one species can sometime impact many other species around them. For example, in California, people used to hunt sea otters. In some places, sea otters eat purple sea urchins. As the sea otter population dropped due to hunting, we started to see more and more purple urchins. The urchins like to eat the bottom of kelp, so as the urchin population increased, we saw kelp forests start to disappear. This is just one of many examples of how different organisms are connected.

Activity:

Web Game

- Have students hold onto their organism cards from the previous activity. You should hold a card that says "Human" and a ball of yarn.
- Begin by tossing the ball of yarn to a student (you hold the end so that a string now stretches between you.) That student needs to say what organism is listed on their card and one way that organism is connected to humans. That student should then hold onto a piece of yarn and toss the ball of yarn to another student, who will repeat the process.
- Some connections may be tougher than others - you may need to help students with these.
- At the end of the activity, you will have a web of yarn connecting the students/different organisms.
- End by discussing what this means. What would happen if one of our organisms started to take over the ecosystem? How would it affect others? Do we think this web exists in every ecosystem? How should this affect what we do?

- **Rocky Shore:** An intertidal area of coast covered predominantly in rock.
- **Tidepool**: Shallow pools of water left behind on the rocky shore during low tide. Many intertidal organisms take refuge here during low tide.
- **Open Ocean**: The largest ecosystem on Earth, comprised of everything in the ocean outside of coastal areas.
- **Take**: To hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill any natural resources.
- **Limiting Factor:** An environmental resource that restricts population growth, often because of limited supply.

Connections:
Art, science, engineering

Ocean Literacy Standards:
1A, 1H, 5E, 5F, 6G

Suggested extensions:
- For a more in-depth ecosystem exploration, use the Bioblitz lesson plan from the San Diego MPA Toolkit Field Guide to the Intertidal.

Background Info:

MPAs Protect Ecosystems

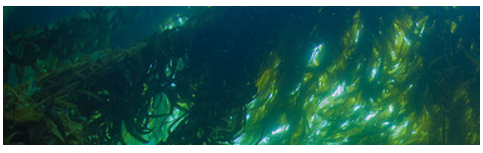
Marine protected areas in California are designed to strategically protect important ecosystems along our coast. Some may protect diverse kelp forests that fish may use as breeding areas. Some MPAs may protect rocky reefs where the California spiny lobster likes to hide. Whatever they are protecting, MPAs work by limiting or eliminating take. Since take is restricted in MPAs, MPAs allow safe places for all the biotic and abiotic factors that make up an ecosystem to thrive and interact in a more natural way without having to adjust their behavior (for biotic factors) to human influence as much as if all take were allowed. It is important to note that MPAs do not directly protect against all human impact. For example, MPAs do not directly protect ecosystems from the effects of climate change, but by creating more healthy and natural ecosystems, MPAs may increase resiliency to climate change.

As an example, think back to the game you just played where you used yarn to create connections among species within an ecosystem. In a non-protected area one or more of those species may be removed from the ecosystem. Imagine it is lobster season and fisherpeople catch most of the lobster. What would happen to the rest of the ecosystem you created? In MPAs species are protected from this type of take, allowing the ecosystem to remain more intact.

Activity:

Ecosystem Exploration

- Take the students to explore a marine/coastal ecosystem. Tidepools (especially those in MPAs!) work best if available.
- As they explore, ask students to identify five species they find and figure out at least one connection between each of the other organisms. *Optional worksheet provided in appendix.
- While exploring have students look for and record signs of human impact (i.e. trash, trampling, collecting, etc.)
- At the end of your exploration, ask students to share connections that they came up with and look for patterns.
- For a more in-depth ecosystem exploration, use the Bioblitz lesson plan from the San Diego MPA Toolkit Field Guide to the Intertidal.



Debrief/Check for Understanding
Have students synthesize the information they learned about intertidal organisms and the data they collected during the ecosystem exploration.

Ask questions such as:

- What organisms were the most prevalent?
- Were there any organisms you expected to find but did not? Why might this be?
- Did you see patterns of where you found certain species?
- Did any of the species seem to be directly interacting with one another? Indirectly?
- Based on what you observed during your ecosystem exploration, what seem to be the limiting factors in that ecosystem?
- What evidence of human impact did you find?
- How might marine protected areas be designed to help protect this ecosystem?
- What can you do to help protect this ecosystem?

Engage: Ask students to identify coastal and marine ecosystems they have visited or learned about.
Explore: Have students explore some of the organisms found in a local coastal or marine ecosystem.
Explain: Explain how biotic and abiotic factors interact in an ecosystem, how human activity can disrupt those connections, and how MPAs were made to protect coastal and marine biodiversity.
Elaborate: Allow students to explore connections between species in an ecosystem in the field.
Evaluate: Have students synthesize the information they learned about intertidal organisms and the data they collected during the ecosystem exploration.

NGSS Alignment

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-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Science and Engineering Practices

1. Asking questions
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Online Resources

Organism Cards from Monterey Bay Aquarium: https://www.montereybayaquarium.org/-/m/pdf/education/activities/aquarium-ss-crittercards.pdf?la=en

California Marine Protected Areas video: https://youtu.be/xB_yqcfN7DE

Take a Virtual Dive in a Kelp Forest: https://youtu.be/HGMvPqfcDOk

Live Kelp Forest Cam: https://youtu.be/7mdv9Vb2tjU

Ecosystems of California: Threats and Responses: http://calnat.ucanr.edu/files/263126.pdf

Ecosystems of California videos: https://www.youtube.com/playlist?list=PLBEIahTDJmdkf-eL6ZQZtvxXFHQUKl0cF

Appendix

Appendix

Ecosystem Exploration

1. Write the common name of 5 organisms your group identified while tidepooling:

a.

b.

c.

d.

e.

2. Explain how your 5 identified organisms are similar. What characterizations/ adaptations do they share?

3. What are some potential threats to the everyday life of your observed organisms?

4. What ecological services does this ecosystem provide?

5. Is your ecosystem located in an marine protected area (MPA)? If so, how do you think your results might be different from an unprotected area? If you are not in an MPA, do you think this ecosystem would benefit by becomng an MPA?

6. What can you do to enhance the conservation of our coastal and marine ecosystems and wildlife?

Marine Debris and MPAs

Lesson 3

Learning Objectives

A) Students will learn what kinds of human trash end up in the ocean.
B) Students will understand how long it takes these items to break down.
C) Students will collect data on marine debris.
D) Students will participate in a stewardship project.

NGSS: DCI (Disciplinary Core Ideas):
MS-ESS3-3
MS-ESS3-4
MS-LS2-5

Time: 60-90 mins.

Materials for the Teacher
- Whiteboard with marker
- Picture of Great Pacific Garbage Patch
- Gloves
- Ocean Conservancy datasheet or Clean Swell app

Materials for the Students
- Whiteboard with marker or pencil and paper
- Marine debris kit (see description)
- Trash bags or buckets
- Trash pickers

Background Info:
Trash in the Ocean

Have you ever seen trash on the beach? Unfortunately, a lot of trash finds its way into our oceans. Most trash reaches the ocean by floating down rivers - it can also be left by people on beaches, thrown/dumped from boats, or blown by the wind. We call human-created trash in our oceans "marine debris."

Most marine debris is plastic. There is so much plastic in our oceans that it swirls together on giant "plastic islands" like the Great Pacific Garbage Patch. This is an area of the ocean filled with plastic - some that floats and a lot that is sinking throughout the entire ocean - and it has grown to twice the size of Texas. There are 5 plastic islands around the world.

Every year, an organization called the Ocean Conservancy runs an International Coastal Cleanup Day. People all around the world volunteer to collect trash on beaches and coastlines and the Ocean Conservancy counts what people find. In 2017, **800,000 people** volunteered and picked up over **20 million pieces of trash.** That's a lot of trash!

Discussion:
What kind of trash is in the ocean?
- Break students into pairs or small groups and have them discuss what types of trash they think may end up in the ocean.
- Bring the students back together and ask for volunteers to share one item their group suggested. Write up a list on a whiteboard. Keep going until you have a sizable list.

Vocabulary

- **Marine Debris:** Human-created waste that has deliberately or accidentally been released in a lake, sea, ocean, or waterway.
- **Great Pacific Garbage Patch:** A trash island between California and Hawaii representing the largest accumulation of ocean plastic in the world. It is currently larger than the state of Texas and has approximately 80,000 tons of plastic, the equivalent of 500 jumbo jets.
- **Biodegrade**: The breakdown of a material by bacteria, fungi, or other biological means.

Connections:
Art, science, engineering

Ocean Literacy Connection:
6G: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Suggested extensions:
Sterilize trash collected during beach cleanup and have students make art work with it.

Activity:
Coastal Stewardship Community Science Project

- Have your students walk along a section of beach, rocky shore, coastline, etc (in an MPA if possible!). and look for trash. Collect all of the trash that the students find in one bag or bucket. If available give students trash pickers so they may aid with picking up trash.
- Record trash found either on Coastal Conservancy datasheet (see appendix) or in their Clean Swell app.
- At the end of your walk, circle up and review the items that you found. Ask the students - what surprised you? What was our most common item? How did this trash get here (i.e. do we think it washed up or was dropped here)?
- If you don't find any trash, discuss why that may be (and remind students that not finding anything is still data!). What kind of coastlines have lots of trash vs. which ones are relatively clean? Why?

Activity:
Common Marine Debris

- Break students up into small groups.
- Give each group a piece of scrap paper and a pen/pencil or a small whiteboard and whiteboard marker.
- Have each small group discuss which trash items they think are most commonly found on beaches. Each group should make a list of 10 items.
- Once the groups have made their lists, share the 2017 Ocean Conservancy ranking with the students.
- Ask them - did you have any of these on your own lists? What surprised you? Why do you think these items are so common?

Background Info:
Trash Takes a Long Time to Decompose

People sometimes think that it's ok if trash ends up in the ocean because after a few years, it will break down and decompose, just like compost in a garden. Unfortunately, most marine debris takes a very long time to break down in this way and some never will. Research has shown that plastics are not able to biodegrade (be broken down by bacteria and other animals) but actually break down into smaller and smaller pieces until they become microscopic particles called microplastics – these can stay in the food chain forever.

The following list of marine debris is ranked from most to least commonly found on beaches from the 2017 Ocean Conservancy report. The time to biodegrade (or, in the case of plastics, to break down into microplastics) was added by 4Ocean:

1. **Cigarettes/Cigarette Filters** - 1-5 years
2. **Plastic Food Wrapper/Containers** - 20-30 years
3. **Plastic water bottles** - 450 years
4. **Plastic bags** - 10-20 years
5. **Plastic caps and lids** - 450-1,000 years
6. **Plastic utensils** - 450 years
7. **Plastic straws and stirrers** - up to 200 years
8. **Glass bottles** - 1 million years (estimated, exact time unknown)
9. **Aluminum cans** - 80-200 years
10. **Paper bags** - 1 month

Activity:

Trash Timeline

- Break students into small groups (you may choose to keep them in their same groups from the previous activity) and hand out a marine debris kit to each group. The kit contains 10 pieces of trash (one of each listed above.) Tell the students the ranking and have them order their items from most to least common.
- Ask the students to discuss which items they think will break down the quickest and which ones may take longer.
- Challenge the students to rearrange their marine debris items - this time ranking them from quickest to break down to slowest to break down. (Optional: you may choose to hand out 10 cards, each of which has one of the time scales listed above, and have the students label each item with a number of months/years. Consider the age of your students and whether this will enhance their learning or impede it.)
- Share the actual ranking.
- Ask the students - which one surprised you? What does this tell us about marine debris?

Discussion:

What can we do?

- Break students into pairs or small groups. (This may also be done as a full group discussion.)
- Ask the students - Why is it important to keep trash out of the ocean? What can we do to help address the problem of marine debris? What kinds of marine debris will be in our oceans the longest and how can we prevent them from getting there? What happens to this problem as the human population grows?

Debrief/Check for Understanding:

Have students synthesize what they have learned about marine debris and the data they collected by asking the following:

In previous lessons we learned that marine protected areas are great for protecting coastal and marine ecosystems from selective pressures such as fishing, collecting, and other forms of take. Do you think MPAs protect ecosystems against marine debris?

Unfortunately, MPAs are still susceptible to certain types of human impact such as climate change, ocean acidification, and marine debris so other types of management are necessary.

Challenge students to use what they have learned over the previous three lessons to create a plan to help protect MPAs from marine debris. Instructor note: many students will come up with the solution of making littering illegal inside of MPAs. Gently remind them that not everyone listens to the rules and even if they do, litter from other areas will still blow or float in from other areas, so a more comprehensive plan is needed.

Have each group create a poster or some other kind of written artwork depicting their plan and share.

Engage: Take students for a walk on the beach!
Explore: Allow students to explore the beach while picking up trash for subsequent activities and discussions.
Explain: Explain what marine debris is and discuss how it affects our oceans.
Elaborate: Have students participate in marine debris timeline activity to explore lasting effects of marine debris.
Evaluate: Evaluate students understanding by having them synthesize what they have learned to extrapolate this problem to marine protected areas and come up with a potential conservation plan.

NGSS Alignment

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Science and Engineering Practices

1. Asking questions
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Online Resources

Ocean Conservancy Datasheet: https://oceanconservancy.org/wp-content/uploads/2017/04/OC-DataCards_volunteerFINAL_ENG.pdf

Optional video: "The Majestic Plastic Bag": https://www.youtube.com/watch?v=GLgh9h2ePYw

Appendix


Ocean Conservancy
Top 10
ITEMS COLLECTED
1. CIGARETTE BUTTS
2,412,151
2. FOOD WRAPPERS
1,739,743
3. PLASTIC BEVERAGE BOTTLES
1,569,135
4. PLASTIC BOTTLE CAPS
1,091,107
5. PLASTIC GROCERY BAGS
757,523
6. OTHER PLASTIC BAGS
746,211
7. STRAWS, STIRRERS
643,562
8. PLASTIC TAKE OUT/ AWAY CONTAINERS
632,874
9. PLASTIC LIDS
624,878
10. FOAM TAKE OUT/ AWAY CONTAINERS
580,570
2017 INTERNATIONAL COASTAL CLEANUP


Ocean Conservancy
Top 10
ITEMS COLLECTED
1. CIGARETTE BUTTS
2,412,151
2. FOOD WRAPPERS
1,739,743
3. PLASTIC BEVERAGE BOTTLES
1,569,135
4. PLASTIC BOTTLE CAPS
1,091,107
5. PLASTIC GROCERY BAGS
757,523
6. OTHER PLASTIC BAGS
746,211
7. STRAWS, STIRRERS
643,562
8. PLASTIC TAKE OUT/ AWAY CONTAINERS
632,874
9. PLASTIC LIDS
624,878
10. FOAM TAKE OUT/ AWAY CONTAINERS
580,570
2017 INTERNATIONAL COASTAL CLEANUP

VOLUNTEER
OCEAN TRASH DATA FORM

Ocean Conservancy

Ocean and waterway trash ranks as one of the most serious pollution problems choking our planet. Far more than an eyesore, a rising tide of marine debris threatens human health, wildlife, communities and economies around the world. The ocean faces many challenges, but trash should not be one of them. Ocean trash is entirely preventable, and data you collect are part of the solution. The International Coastal Cleanup is the world's largest volunteer effort on behalf of ocean and waterway health.

HERE IS HOW IT WORKS:

1 CLEAN UP TRASH & COLLECT DATA

2 ORGANIZE & ANALYZE DATA

3 PUBLISH RESULTS

4 REDUCE OUR IMPACT

SITE INFORMATION:

Cleanup Site Name:

State or Province:

Zone or County:

Country:

Nearest Crossroad or Landmark:

NUMBER OF VOLUNTEERS WORKING ON THIS CARD:

adults

children (under 12)

MOST UNUSUAL ITEM COLLECTED:

TYPE OF CLEANUP:

Land: ☐ Underwater: ☐ Watercraft: ☐

Please return this form to your area coordinator.
If you are unable to do so, please mail or email it to:

Ocean Conservancy
Attn: International Coastal Cleanup
1300 19th Street, NW, 8th Floor
Washington, DC 20036
cleanup@oceanconservancy.org

Trash Free Seas: www.oceanconservancy.org/cleanup
Be a Green Boater: www.oceanconservancy.org/do-your-part/green-boating
Sponsors: www.oceanconservancy.org/cleanupsponsors

International COASTAL Cleanup

TRASH COLLECTED

Citizen scientist: Pick up all trash and record all items you find below. No matter how small the items, the data you collect are important for Trash Free Seas®.

EXAMPLE: TOTAL #

Plastic Bags: 𝍸 III = 8

Please DO NOT use words or check marks. Only **numbers** are useful data.

MOST LIKELY TO FIND ITEMS:

TOTAL #

Cigarette Butts: =
Food Wrappers (candy, chips, etc.): =
Take Out/Away Containers (Plastic): =
Take Out/Away Containers (Foam): =
Bottle Caps (Plastic) =
Bottle Caps (Metal) =
Lids (Plastic) : =
Straws/Stirrers: =
Forks, Knives, Spoons: =

Beverage Bottles (Plastic): =
Beverage Bottles (Glass): =
Beverage Cans: =
Grocery Bags (Plastic): =
Other Plastic Bags: =
Paper Bags: =
Cups & Plates (Paper): =
Cups & Plates (Plastic): =
Cups & Plates (Foam): =

FISHING GEAR:

TOTAL #

Fishing Buoys, Pots & Traps: =
Fishing Net & Pieces: =
Fishing Line (1 yard/meter = 1 piece): =
Rope (1 yard/meter = 1 piece): =

PACKAGING MATERIALS:

TOTAL #

6-Pack Holders =
Other Plastic/Foam Packaging: =
Other Plastic Bottles (oil, bleach, etc.): =
Strapping Bands: =
Tobacco Packaging/Wrap: =

OTHER TRASH:

TOTAL #

Appliances (refrigerators, washers, etc.): =
Balloons: =
Cigar Tips: =
Cigarette Lighters: =
Construction Materials: =
Fireworks: =
Tires: =

PERSONAL HYGIENE:

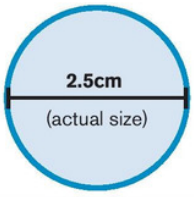
TOTAL #

Condoms: =
Diapers: =
Syringes: =
Tampons/Tampon Applicators: =

TINY TRASH LESS THAN 2.5CM:

TOTAL #

Foam Pieces =
Glass Pieces =
Plastic Pieces =



DEAD/INJURED ANIMAL	STATUS	ENTANGLED	TYPE OF ENTANGLEMENT ITEM
	Dead or Injured	Yes or No	

ITEMS OF LOCAL CONCERN:

1. 2. 3.

CLEANUP SUMMARY (circle units)

Number of Trash Bags Filled: Weight of Trash Collected: lbs/kgs Distance Cleaned: miles/km