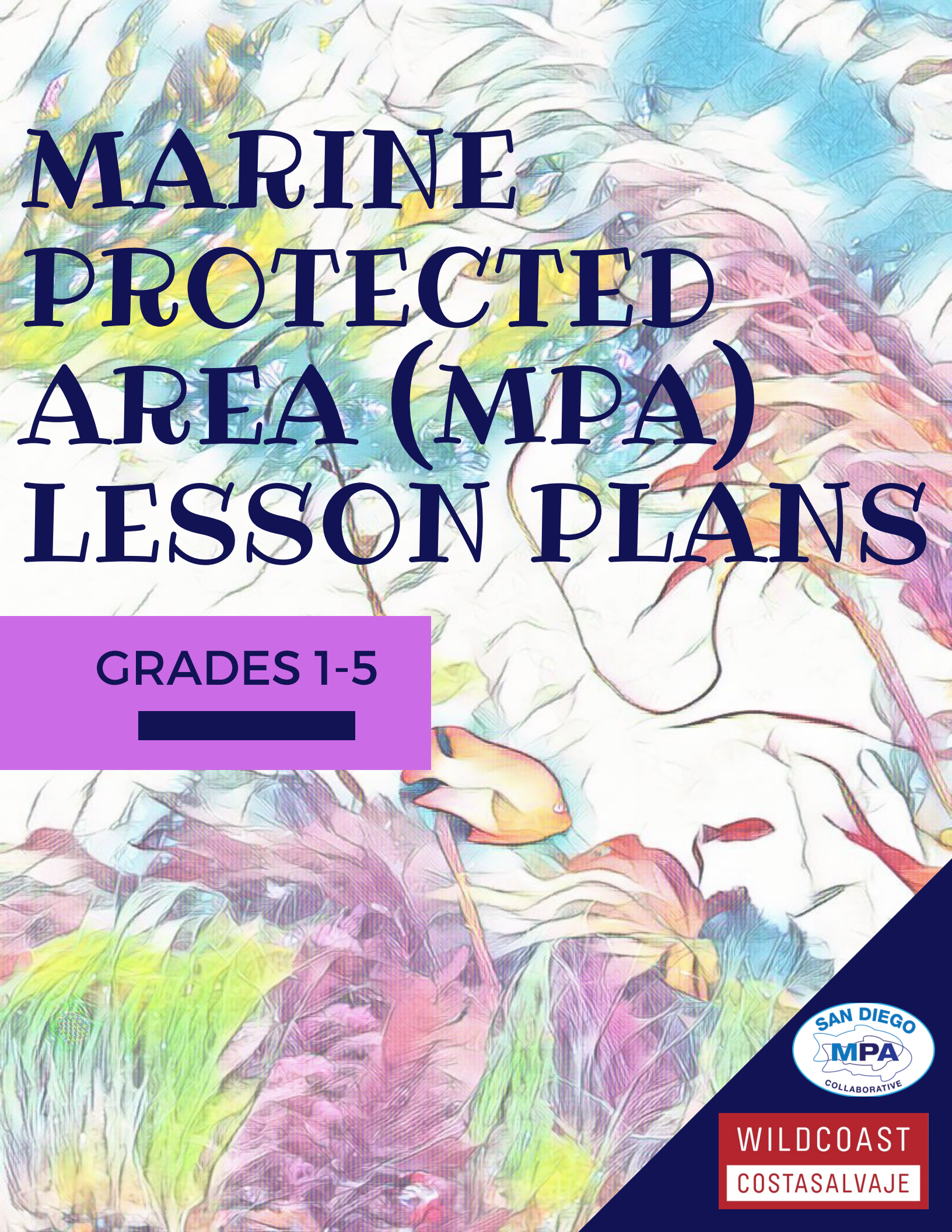


MARINE PROTECTED AREA (MPA) LESSON PLANS

GRADES 1-5

SAN DIEGO MPA COLLABORATIVE

WILDCOAST
COSTASALVAJE

Desiccation Lab

Rocky Intertidal - Grades 1-5

Learning Objectives

A) Students will explore a tidepool and record data on tidepool organisms, exposure to sun and desiccation of sea anemones, and human impacts on the rocky intertidal (Part 1).
B) Students will learn about taxonomy by sorting their tidepool organisms into categories (Part 2).
C) Students will use art to further explore taxonomy and adaptations and discuss threats to the rocky intertidal (Part 3).

NGSS: DCI (Disciplinary Core Ideas):
HS-LS2-2
HS-LS2-7
HS-ESS3-1

Time: Four to nine 50-minute class periods plus one and a half to two hour field trip

Materials for the Teacher
-Life in the Sand: Field Guide to Sandy Shores

Part 1: Data Collection

Background information:

(recommended one to six 50-minute class periods)

In this lesson students will explore the unique adaptations organisms in the rocky intertidal possess to help protect against drying out (known as desiccation). Students may complete a tidepool journal during an optional field trip to learn more.

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!

Rocky Intertidal

MPAs protect a wide range of ecosystems including kelp forests, sandy shores, and the rocky intertidal. This lesson will focus on the unique and fun rocky intertidal

The **intertidal zone**, the unique area between the high and low tide lines, is a harsh and unforgiving habitat. The highly conditioned species that live there are subject to the rigors of both the land and the sea, going from completely submerged to only occasionally wet within just a few feet of space. Organisms that inhabit the intertidal zone must endure extreme fluctuations in moisture level, temperature, salinity, and sunlight creating a robust assortment of biologically diverse organisms. These fascinating creatures boast an even more fascinating set of adaptations, creating an adventure for anyone who visits this space between the land and the sea.

MPAs limit or prohibit which intertidal organisms may be taken by humans, reducing the stress and safeguarding resources on species within this dynamic environment.

Materials for the Students

-Living on the Edge: Field Guide to the Rocky Intertidal
-Two pans, boxes lined with wax peper, or Tupperware per group
-Dry dirt or sand
-Rocks of assorted sized
-Two sponges per group
-Clumps of algae or leaves
-Desiccation lab data sheet
-One tidepool journal (see appendix) per student
-Pencils

Vocabulary

-*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.
-*Take*: To hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill any natural resources.

Activity: Desiccation Lab

In this lab students will explore the idea of **desiccation** – drying out due to exposure to the sun. **Tidepool** organisms have learned to live in extreme environments where they may be completely submerged in water for long periods of time or completely out of the water and exposed to the sun for long periods of time. Many tidepool animals, such as sea anemones, have learned to protect themselves from drying out by covering themselves with shells or algae during periods in which they will be out of the water (imagine that shells and algae are kind of like sunblock for tidepool animals!).

MPAs help protect these types of animals by limiting or prohibiting take of resources such as shells and algae, leaving more covering material available. In this lab students will create a model of two tidepools, one inside an MPA where there are ample materials to cover their tidepool animal and one outside of the MPA where humans have collected almost all the shells the animals would have used for protection. Students will use sponges to represent sea anemones and algae or leaves and shells to represent the protective coverings or "sunblock."

Students will form a hypothesis about whether or not there will be a difference in how long the sea anemones inside the MPA can survive in the sun vs. the sea anemones not in the MPA and collect scientific data to test their hypothesis.

1) Prep/Gather materials needed for lab:
   a.Mini tidepool models
      i. Two pans, boxes lined with wax paper, or Tupperware containers per group
      ii. Dry dirt or sand
      iii. Rocks of assorted sizes
b) Two sponges per group (could cut a sponge in half and use the halves instead)
c) Boxes of materials students may use to cover their sponges. Make two boxes of materials: one for use to cover the sponges in their MPA containers and one for their non-MPA containers. The box of materials for the MPA should be quite full and provide various items to use as cover.

The box for the non-MPA should be fairly empty, representing a lack of shells and algae due to people collecting them in the unprotected area.

i. MPA

- Assorted shells (seashells or rinsed egg shells)
- Clumps of algae, large, flexible leaves (not dry), or cloth torn into strips to simulate clumps of algae

ii. Non MPA

- Just a few random bits of similar items as above

2) Introduce Lesson

a. Discuss the importance of tidepool organisms remaining damp.

b. Ask the students how long a tidepool animal might remain damp if it is uncovered by the tide going out or someone moving a rock or clump of algae.

a. Describe the experiment to the students, including the materials they will be using, and ask them how they might use the materials to design an experiment. When introducing the materials do not mention that the non-MPA bin of materials will have less than the MPA bin. Let them discover this and ask questions about it during set up.

3) Prepare Tidepool Models

a. Pass out two containers and two sponges to every group.

b. Have students label one container "MPA/Protected" and one container "Unprotected."

c. Have students fill their containers approximately 2" full with dry soil or sand. Create a "tidepool" by placing rocks on top of the sand.

d. Have students soak both sponges in water and then place one sponge on top of the sand and rocks in each of their containers.

e. Start by having students choose items out of the MPA bin to cover the sponge in their MPA model. Have them think about whether their animals would want to be completely covered or only partially covered and cover them accordingly.

f. Repeat the process for the non-MPA model with the items from the non-MPA bin. Most of the sponges in their non-MPA will be uncovered.

g. If possible place containers outside in the sun or under a sunny window.

4) Collecting Data

a. Either provide the students with a data table or have them create their own.

	Unprotected Our Guess	Unprotected Real Data	MPA/Protected Our Guess	MPA/Protected Real Data
Start (0 min)				
+ 15 min				
+30 min				
+ 45 min				
Etc.				

Descriptors: wet, very damp, damp, slightly damp, dry

Vocabulary

-*Intertidal Zone :* The area between the high and low tide lines.

-*Desiccation* - Drying out because of being left out of the water at low tide.

Tidepool - Small pools of water left behind when the tide goes out.

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.

b. Have students make predictions about how long they think it will take each sponge to dry out by guessing whether each sponge will be wet, very damp, damp, slightly damp, or dry for each time interval. Fill this in under the "Our Guess" categories.

c. Check the sponges every 15 minutes (or any other regular interval that works with your class schedule) and record whether the sponges are wet, very damp, damp, slightly damp, or dry in the appropriate cell on their data sheet.

d. Continue until the sponges are dry or you reach the end of your allotted time during class.

5) Class Discussion

a. How close were your predictions?

b. Did animals stay damp longer in the MPA or outside of the MPA? Why?

c. What other tidepool animals have you heard of? Could any of them be affected by the things that people do in the tidepool?

Field Trip *(optional, recommended 1 hour in the field)*

During this field trip students will have the opportunity to explore a local tidepool and complete several activities related to tidepool organisms and conservation.

Teacher Prep:

1) Determine which tidepool your class will visit. The following website has good suggestions: https://lajollamom.com/best-san-diego-tide-pools/

2) Note if your tidepools are within an MPA or outside of an MPA. From the above website all of the tidepools are within an MPA except Shell Beach.

3) Check the tide to determine which day and time will have an acceptable low tide for this project. Negative, outgoing tides are best, although tides under ~1 foot often work as well. The best tides are in the winter and early spring.

Tides may be found here:
https://tidesandcurrents.noaa.gov/tide_predictions.html?gid=1393

1) Print a tidepool journal for each student (see appendix). In class go over each of the activities students will be doing in the field. The journal is also designed as a coloring book, so you may give students time to color the pages. Distribute to chaperones to hand out to students in the field.

In the Field:

1) Go over good tidepooling practices with the students:

-Watch where you step, that might not be a rock!

-Leave things how you found them. If you turn over a rock put it back exactly how you found it.

-Take only pictures. Leave all rocks, plants, animals, and other tidepool creatures exactly how you found them.

-Leave animals be. Tidepool organisms have a hard enough life as it is without being touched by a bunch of sticky fingers.

-Be careful where you put your fingers. Many animals like sea urchins and crabs have defenses against predators.

-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.

Connections:
Art, science, engineering

Ocean Literacy Connection:

-The ocean supports a great diversity of life and ecosystems.

-The ocean and humans are inextricably interconnected.

-Never turn your back on the ocean....it needs you too much! But seriously, watch out for waves and the incoming tide.

2) Break students into small groups, each accompanied by a chaperone.

3) Give boundaries, an emergency meeting spot, a final meeting place, and end time.

4) Release student groups, led by chaperones, to explore the tidepools and complete their tidepool journals. Journals include:

a. Cover page: Have students fill in their name, date, tidepool location, and whether or not the tidepools are located within an MPA. Students may color the cover as an optional activity (note: students will be cutting up this page for a later activity)

b. Tidepool organism classification: Instruct students to find and draw six different tidepool organisms. Each should be a different species (i.e. only draw one anemone, one shore crab, etc).

c. Sea anemone activity: As a follow up to the desiccation lab done in class, have each group find a clump of anemones out of the water in the field and record how many of them are completely covered, partially covered, and not covered by shells or algae.

d. Human activity monitoring: Have students take a look around them at the other people in or near the tidepools. Have them record how many people are: looking in tidepools, walking or running, collecting shells, sitting/relaxing/napping, fishing, or playing in the water. Ask them to make a special note of any activities that may impact the tidepools.

5) At the end of the field trip collect student journals to use for follow up in class.

Suggested extensions:
-Omit the field trip portion and distribute "creature cards" (see appendix) for sorting in Part 2.

Part 2: Data Analysis

1) Back in the classroom distribute the students' tidepool journals (or make copies of the page where they drew the tidepool organisms).

2) Have students cut the journal in half (hamburger style) so that the page with their organism drawings is separate.

3) Have students cut out the square for each of their tidepool organism drawings.

4) In their research groups have students combine all their organism drawings.

5) Instruct students to work together with their research groups to sort their organisms into different categories. For instance, students may choose to sort them by shape, color, size, presence of a certain adaptation, etc. How they actually end up sorting them is not as important as them thinking through ways to sort organisms.

6) Once all groups have sorted their organisms have them present their sorting method to the class.

7) Present the idea of taxonomy to the students, including the classification system. Explain that intertidal invertebrates, tidepool animals without a backbone, are so diverse that we classify them by phylum, one of the most general categories.

8) Present the five phyla of intertidal invertebrates (for more information refer to Living of the Edge: Field Guide to the Rocky Intertidal:

a. Porifera (sponges) – “pore bearing”
b. Cnidaria (Cnidarians) – “stinging cells”
c. Echinodermata (Echinoderms) – “spiny skin”
d. Arthropoda (arthropods) “jointed appendages”
e. Mollusca (Mollusks) – “muscular foot”

9) Present the one vertebrate phylum, chordata (chordates, aka vertebrates), and explain that any animal with a backbone falls into this category.
10) Have students rearrange their cards, if necessary, into the six phyla mentioned above.

PART 3: Conclusions

Activity:
In this activity students will create an organism that fits into one of the six phyla presented in Part 2. This activity can be used as a check for understanding.
1) In their research groups or individually instruct students to create an organism. The organism must:
a. Not exist in real life
b. Live in the rocky intertidal
c. Fit into one of the six phyla presented in Part 2
2) Students should:
a. Draw their organism
b. Name their organism
c. State in which phylum it belongs
d. State its diet
e. State its predators
f. Name three adaptations their organism has to help it survive in the rocky intertidal
g. Describe how MPAs might help protect their organism
3) Allow students to share their organisms with the class.

Discussion:
1) Discuss the diversity, or different types of species, you found in the tidepools.
2) Did you collect your data inside an MPA or outside of an MPA? Do you think that made a difference in the diversity of species you found? Do you think diversity is higher inside or outside of an MPA? Why?
3) What types of human activity did you record at the tidepool? Did any human activity hurt wildlife? Help wildlife? Do you think being in an MPA/not being in an MPA affected human activity?

4) How many of the sea anemones you observed were completely covered? Partially covered? Not covered at all? Did you notice any human activity that could have affected how many shells and algae were available for the sea anemones to use as covering? Is this the result you expected? What roles do MPAs play in protecting organisms?
5) What are some things you can do to help protect tidepool creatures?

Engage: Have students learn about the challenges of living in the rocky intertidal through the desiccation lab activity.
Explore: Visit a tidepool and use the included tidepool journal to guide observations.
Explain: Explain that scientists categorize organisms based on the way they look.
Elaborate: Have students sort the organisms they observed in the tidepool before explaining the system scientists use. Discuss impacts of human activity on some of these organisms.
Evaluate: Ask the students questions relating to what they have learned (more questions may be found in Part 3 of this lesson plan).
Q1: Did you see high diversity (a lot of different creatures) or low diversity (not as many creatures) in the tidepool?
Q2: What types of human activity did you observe? Did any human activity seem to be helping or hurting the wildlife?
Q3: What roles do MPAs play in protecting organisms?

NGSS Alignment

3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

Science and Engineering Practices

Developing and Using Models: Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
Asking Questions: Ask questions that arise from examining models or a theory to clarify and/or seek additional information to determine relationships, including quantitative relationships between independent and dependent variables, and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the sustainability of a design.
Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution, apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data, and evaluate the impact of new data on a working explanation and/or model.
Constructing Explanations and Designing Solutions: Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Engaging in Argument from Evidence: Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence and make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge.

Crosscutting Concepts

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.
Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Online Resources

Scripps Institution of Oceanography Guide to San Diego Tidepools:
https://scripps.ucsd.edu/sites/scripps.ucsd.edu/files/communications-content/field_attachment/2014/Voyager_V11_n4.pdf

Cabrillo National Monument Tidepool Guide:
https://www.nps.gov/cabr/learn/nature/upload/CABRI_Intertidal-GuideCNMC_reduced.pdf

Southern California Tidepool Guide:
https://dornsife.usc.edu/assets/sites/291/docs/Southern_California_Tidepool_Organisms_ID_sheet.pdf

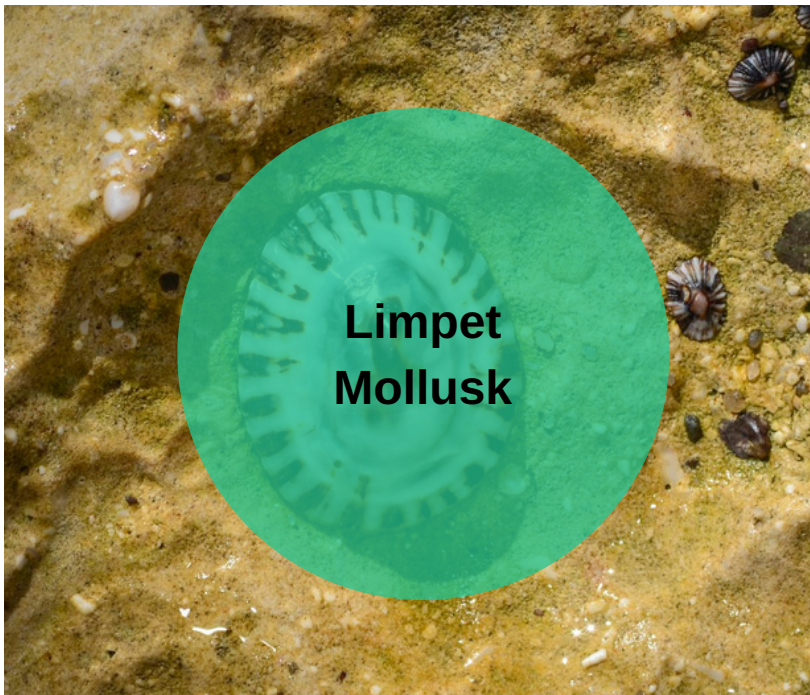

Red Algae
Red Algae

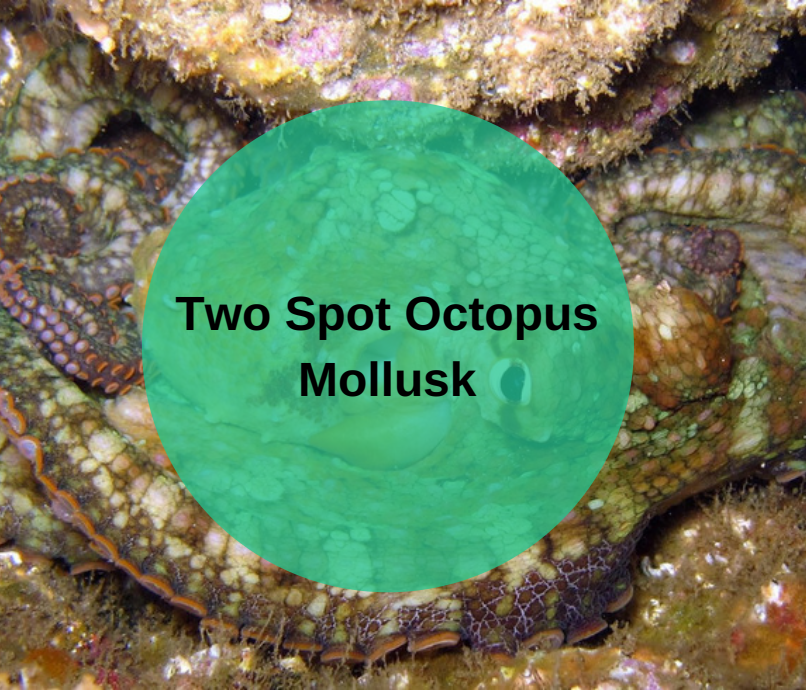

Sea Lettuce
Green Algae


Wavy Turbin Snail
Mollusk


Black Turbin Snail
Mollusk

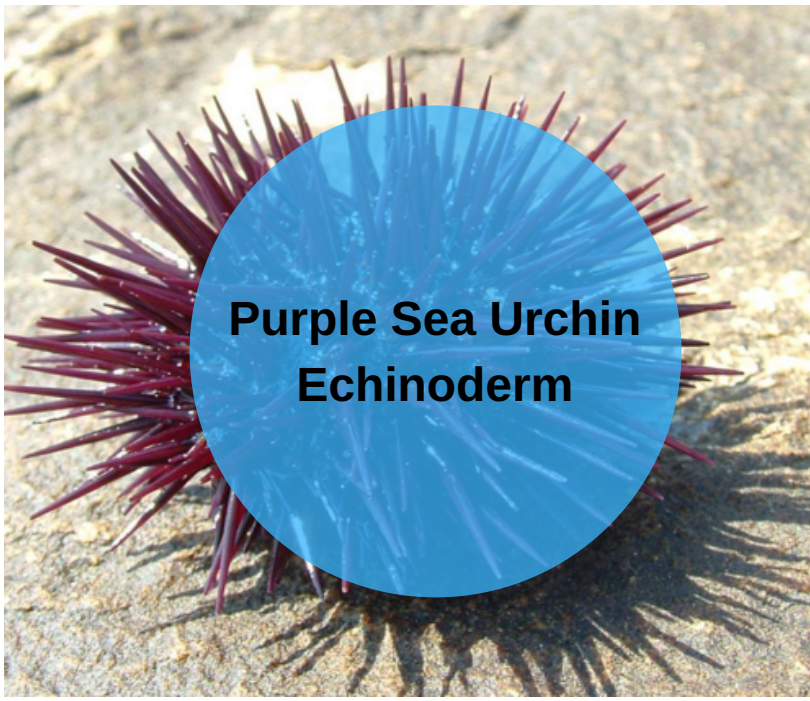

Keyhole Limpet
Mollusk

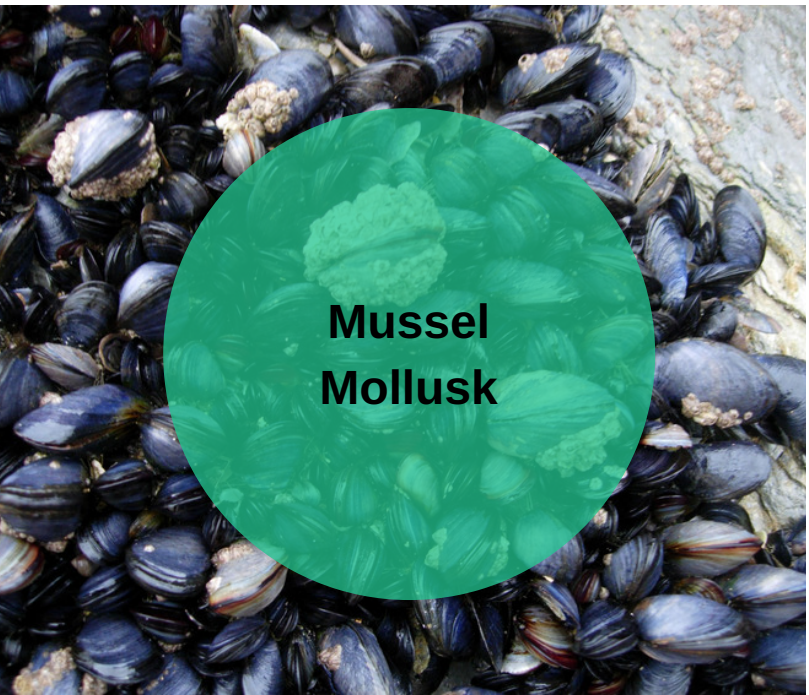

Limpet
Mollusk

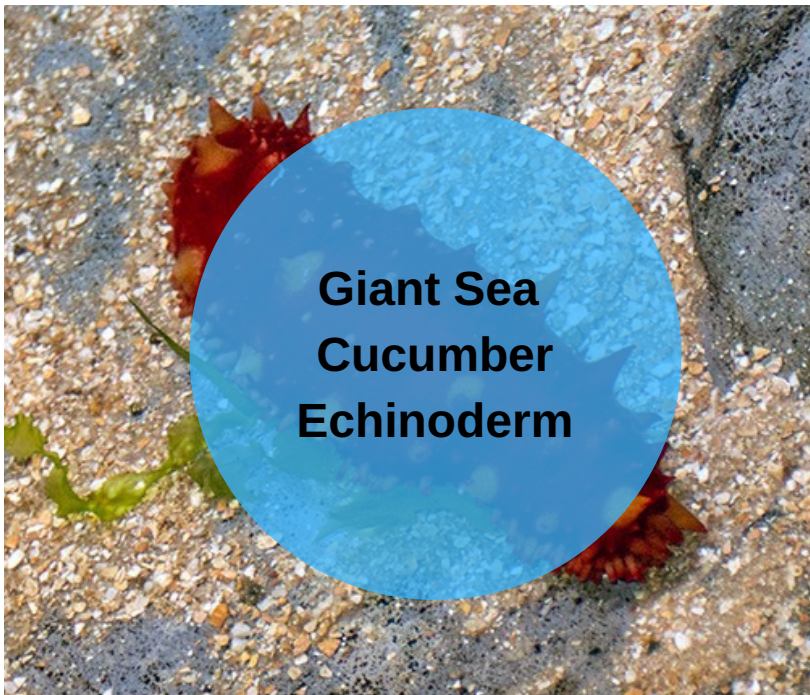

Two Spot Octopus
Mollusk


California Spiny
Lobster
Arthropod


Purple Sea Star
Echinoderm


Purple Sea Urchin
Echinoderm


Mussel
Mollusk


Giant Sea
Cucumber
Echinoderm


Shore Crab
Arthropod


Hermit Crab
Arthropod


Barnacle
Arthropod


Chiton
Arthropod


Giant Green
Anemone
Cnidarian


California Sea
Hare
Mollusk