MPA Toolkit
Unit 1

Grades K-2

Produced by the Humboldt, Del Norte, and Mendocino Collaboratives in partnership with the California Department of Fish and Wildlife

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Dear Educator,

Welcome to the MPA Toolkit - a collaborative project designed for practical use by both formal and informal educators. This Toolkit has many different components including two units of study, equipment necessary to conduct activities, examples of marine specimens, and other objects meant to enrich the learning experience while teaching about Marine Protected Areas (MPAs). The two units of study (Units 1 & 2) are aligned with the Next Generation Science Standards (NGSS) and have a wide range of activities easily modified to various age groups. Materials can be easily adapted to a range of audiences including those out in the field, in the classroom, or at a workshop. Each activity is designed for students to learn about a particular concept or goal in order to more fully understand how California's MPAs work. In addition, every lesson applies the 5E Instructional model and has links to online information. I hope you find the Toolkit interesting, informative, and fun. We'd love to hear from you.

Sincerely,

Melinda Bailey
Lead Author

Submit all comments and suggestions to: calla@mpacollaborative.org
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Preface

Why this Toolkit was created

The MPA Toolkit is to inform youth about the California Network of Marine Protected Areas and to provide informed stewardship and enjoyment of these marine "parks". It is intended for use either in the classroom or on-site (e.g., beach, estuary, etc.). The Core MPA Messages found below steered the direction and content of each lesson as education and engagement are key components to the overall success of the MPA Network.

How to use the Toolkit

When you use this MPA Toolkit you will find a wide spectrum of tools. Each Unit of study can be found in a hard-copy format within the accompanying MPA Toolkit "chest" or on a flash drive found on a lanyard in the upper section of the Toolkit. Each lesson is connected to NGSS core ideas, MPA goals, and includes a plethora of extension activities and additional information. Within each lesson you will find important background information to get you started and a recommended procedure to make it easy to use. Integration of the 5E instructional model is applied at the end of every lesson. Most of the materials necessary to conduct activities are present and others are easily available in local stores or classrooms. Many lesson make a connection to Traditional Ecological Knowledge (TEK) also referred to as Indigenous Knowledge and refers to the accumulating body of knowledge passed down through generations. Examples include a Yurok doll adorned with shells and other regalia and the Yurok language as it relates to the ocean. Additional items related to TEK can be found in a separate pocket folder located in the Toolkit. A poster tube is another part of this Toolkit and within it are bamboo poles for activities, a large Northern California MPA map, and several posters to make learning relevant and fun. A good place to start is the gray binder, which is easy to thumb through to give you a first glance at some of the important messaging and visual aids to get you started.

Core MPA Messages

1. MPAs can protect natural diversity and ecosystem functions.
2. MPAs can sustain and restore marine life populations
3. MPAs can improve recreational, educational, and study opportunities
4. MPAs can protect representative and unique habitats
5. The MPA Network has clear objectives, effective management, adequate enforcement, and uses sound science.
6. California's MPAs are designed and managed as a network.

What is an MPA

Marine Protected Areas or MPAs are special places set aside 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 (and other resources such as rocks, sand, oil, archeological artifacts, etc.) is limited or prohibited. MPAs are not only found along the California Coast, they exist all

around the globe including the Indian Ocean, across the Pacific from Hawaii to Australia, and elsewhere.

Why We Need MPAs

The world's oceans and coasts are increasingly threatened by development, pollution, overfishing, and natural events, which strain the health of our marine ecosystems. MPAs are a tool to help reduce those stresses and restore marine ecosystems. They can also act as an "insurance policy" by conserving biological diversity, protecting spawning and nursery areas, and protecting habitats such as wetlands that can shield communities from coastal storms and flooding. These benefits, along with other economic benefits from recreation, tourism, and fishing, help sustain coastal communities.

Protecting Biodiversity

Marine biodiversity is the variety or abundance (the number of different microbes, algae, plants, and animals) of life found in the ocean. Because California's MPAs are protected areas, they may foster robust populations that are better equipped to withstand current and future threats such as climate change, seasonal cycles, and ecosystem changes. Maintaining biodiversity is important because it is often used as a measure of the health of a particular habitat or biological system, however, this concept has its limitations. For instance, invasive species can add to the overall diversity of a system but have detrimental effects on an ecosystem. When the environment changes, some plants and animals survive and reproduce, while others die or move to new locations. When you have many species instead of only a few, there is a much better chance that the important roles or niches, critical for survival and keeping the balance of life, will be maintained. Therefore, encouraging marine biodiversity is important for keeping natural ecosystem balances, protecting coastal resources, maintaining beauty or aesthetic pleasure, and economics. If you are lucky enough to visit a MPA, you will often see a diverse web of life thriving there.

California's MPAs

Stretching for a picturesque 1,110 miles along the Pacific Ocean, California has the third longest coastline in the United States. The California coast is a fascinating place both biologically and geologically and is full of abundant natural resources. Upon visiting one will find pristine beaches, rugged sea stacks, rocky shorelines, and a wealth of sea life, from sea lions to bull kelp. Economically, California's coast resources support a $43 billion coastal economy. Commercial and recreational fisheries and tourism continued to be important economic drivers for those living along the coast and proper management of these resources is essential.

In 1999, California passed the Marine Life Protection Act (MLPA), requiring the establishment of a statewide network of Marine Protected Areas (MPAs). Under the MLPA, the state brought together scientists and groups of ocean community members to work together to identify MPA locations. Recommended placement of MPAs were weighed by the California Fish and Wildlife Commission, who finalized the MPA Network in stages between 2007 and 2012, using the best science to direct them.

In California, MPAs were set aside to act as a **network** protecting the animals and plants (i.e., algae) that live in them as well as various habitats found along the coast. Similar to state or national parks, MPAs have clear boundaries that are regulated in the hopes of promoting greater diversity and larger animals compared to unprotected areas. When marine life and the habitats in which they live are left alone, they are allowed to recover from human impacts (such as over fishing) or natural ones (such as La Nina events which are warming trends).

California has 124 MPAs, which results in protection for 16% of California's coastal waters. Some of the habitats you can find in these MPAs include kelp forests, estuaries, sandy bottoms, rocky intertidal zones, rocky reefs, and subterranean canyons. In addition, many coastal areas have been important to native peoples who have relied upon them for their livelihoods and spiritual values for generations. In addition, MPAs can help protect this cultural heritage by limiting extraction while managing for future generations to enjoy.

MPA Toolkit Unit 1 Outline (grades K-2)		
Lessons	**Objective(s)**	**Connections to NGSS**
This unit introduces marine habitats – especially intertidal zones (tide pools) and kelp forests and encourages students to understand we live on an ocean planet worth protecting. Marine Protected Areas (MPAs) are introduced through vocabulary and games. Lessons integrate animal and plant (i.e. algae) characteristics as well as some of their adaptations to living in the ocean. In addition, this unit introduces some MPA goals by learning about marine life abundance as well as BOFFF (Big, Old, Fecund, Female, Fish) that can help promote and rebuild healthy marine populations.		
Lesson 1: A Watery World Worth Protecting Phenomenon: 70% of the Earth's surface is covered by the ocean.	**Lesson 1:** Introduces students to the idea that Earth is a watery world by seeing Earth from space. They learn reasons why our oceans are worth protecting and the Karuk word for ocean. Introduces students to the concept of an MPA through roleplay along with the meaning of the words: Marine, Protected, and Area. At the end of this lesson, they brainstorm and discuss human uses of the ocean and human impacts on the ocean. **Learning Objectives:** A) Students will understand that the majority of Earth's surface is covered by one big ocean. B) Marine Protected Areas (MPAs) are places that are set aside to protect different habitats found in the ocean.	Lesson 1: KESS3.A, KESS.C, 2LS4.D, 2ESS2.C
Lesson 2: Tuning Into the Intertidal Zone Phenomenon: Tide pools are exposed during low tides and can be a part of a	**Lesson 2:** This lesson introduces students to the concept of a "habitat as a home". It shows a variety of organisms that live in a tide pools through a fun storybook. Tide pools are part of the intertidal zone, a key habitat type protected by Marine Protected Areas (MPAs). Students observe various organisms that live in a tide pool and review some of them by matching the	

habitat called the intertidal zone.	ocean critters to their silhouettes. Older students try and identify 20 tide pool organisms and look at some of the adaptations they have that allow them to live there. **Learning Objectives:** A) Students will understand that a place where something lives is called a habitat. B) They will understand that a unique community of sea life has adaptations that make them well suited to live in an intertidal zone.	Lesson 2: KLS1.C, KESS2.E, KESS3.A, KESS3.C, 1LS1.A, 1LS1.B, 1LS1.D, 1LS3.B 2LS4.D
Lesson 3: The Kelp Forest -- Giants of the Sea Phenomenon: Some types of brown algae or kelp are ecosystem engineers and produce kelp "forests".	**Lesson 3:** Students learn the role of kelp as a producer and compare similar features between kelp (or algae) and land plants. Additionally, they learn that MPAs protect kelp forests, which are referred to "giants of the sea". They look at pictures of kelp and are introduced to the importance of kelp as food, and as nurseries and homes for a myriad of animals. To wrap up the lesson, they model a giant kelp by stretching a rope out 150 ft. and lay end to end to see how many kids it takes to reach this length. **Learning Objectives:** A) Students will compare similarities and differences between kelp and land plants to understand their important role as producers in a marine environment and as important habitat. B) Students will understand that MPAs protect kelp forests by restricting people from harvesting them.	Lesson 3: KLS1.C, KESS2.E, KESS3.A, 1LS1.A, 1LS1.B, 1LS1.D, 2LS2.A, 2LS4.D
Lesson 4: Through the Eyes of Harlee the Harbor Seal Phenomenon: Harbor seals have the greatest range of any pinniped in the world (Pinnipeds are the	Lesson 4: This lesson uses a charismatic species (the harbor seal) to introduce students to all six key habitat types protected by MPAs including sandy bottoms, rocky intertidal, rocky reefs, and submarine canyons. In addition, they will observe the types of marine life found in each habitat type by looking at pictures from the Internet or ones in books and other sources. An optional extension is for the students to be able to tell the	

group of fin-footed carnivorous sea mammals that include sea lions, fur seals, true seals, and walrus).	difference between harbor seals and sea lions (their cousins). **Learning Objectives:** A) Students will be introduced to all six types of marine habitats protected by Northern California MPAs by performing a dramatization where they act as a harbor seal that travels to all of them.	Lesson 4: KESS2.E, KESS3.A, 1LS1.A, 1LS1.D, 1LS3.B, 2LS4.D
Lesson 5: Benefits of Big, Old, Fecund, Female, Fish! Phenomenon: A mature female fish can produce a million more babies in a year compared to younger fish.	Lesson 5: This lesson utilizes fish puppets of varying size and maturity to introduce the idea that by protecting BOFFFs (BIG, OLD, FECUND or FERTILE, FEMALE, FISH) more babies will be reproduced, which can help regenerate populations. Using a paper spinner, they will also be able to predict the sequence of the different stages in a fish's life cycle using the Vermilion Rockfish as an example. **Learning Objectives:** Students will learn about the benefits of protecting BOFFF (Big, Old, Fecund, Female, Fish) fish using puppets in regards to reproductive potential. In addition they will learn the stages of a fish's life cycle.	Lesson 5: KLS1.C, KESS3.C, 1LS1.A, 1LS1.B, 1LS1.D, 2LS4.D

MPA Toolkit

For Humboldt and Mendocino Counties

UNIT 1

Grades K-2

Lesson 1: A Watery World Worth Protecting

NGSS -- DCI (Disciplinary Core Ideas):
KESS3.A Natural Resources
KESS3.C Human Impacts
2LS4.D Biodiversity and Humans
2ESS2.C The Roles of Water in Earth's Surface Processes

Time:
30 – 60 mins.

Toolkit Materials for the Teacher

- ✓ Blue marble
- ✓ Blow up Earth globe
- ✓ M-P-A signs
- ✓ Cones, rope, and sticks for setting up the MPA game.
- ✓ Books in the Toolkit (optional)
- ✓ Online resources (see links)

Connections:
Physical geography, mathematics, biology, engineering, language arts

MPA Core Ideas:

MPAs can protect representative and unique habitats.

Learning Objectives: A) Students will understand that the majority of Earth's surface is covered by one big ocean. B) Marine Protected Areas (MPAs) are places that are set aside to protect different habitats found in the ocean.

Phenomena: 70% of Earth's surface is covered by the ocean.

Background information:
Earth is truly a water planet and is the only planet in our solar system with large quantities of liquid water. The fact that our planet has liquid water allows life to flourish here. Life began in the oceans over 2 billion years ago and today humans and all other life depends on the ocean for survival. It is an integral part of the water cycle and is responsible for shaping our planet. Compared to all other solid planets in our Solar System (i.e., Mercury, Venus, and Mars) Earth is a blue planet, which is why it is sometimes referred to or symbolized as a "blue marble." In this lesson, students should make the connection that we live on an ocean planet and that some places in our ocean are protected. Because humans live on land there is much we don't know about the ocean.

California's Marine Protected Areas (MPAs) extend from Mexico to the Oregon coast. They have been designed to protect, maintain, enhance and restore marine ecosystems for their ecological values and their enjoyment by the public through good science and effective communication. There are several different types of MPAs. In this lesson students should focus on the idea that MPAs are like underwater parks. They include a full range of marine habitats including: sandy bottoms, submarine canyons, rocky reefs, intertidal zones, kelp forests, and estuaries. To assist in their understanding of the general purpose of an MPA, this lesson has them play a game of tag after learning the meaning of CMPA (California Marine Protected Areas).

Vocabulary
Area
Habitat
Marine
Prediction
Protect

Suggested extensions:

- Read the Yurok Creation Story below.
- Color the Earth. Use brown for land and blue for the ocean (see page below)
- Compare the density of salt water to fresh water by seeing what floats and sinks (see properties of sea water)
- Model how most surface water will eventually makes it to the sea by conducting a simple activity regarding watersheds.
- Using a big blue plastic tarp, model the types of things that might end up in the ocean based on human activities such as agricultural run off, oil spills, and garbage.
- Make a class collection of things that come from the ocean such as sand, kelp, shells, agates, sand dollars, etc.

Before you begin this lesson, you will want to set up an area ahead of time to play a game of tag using the cones, ropes, and sticks found in the Toolkit (see procedure below). Several books about the ocean, along with many other posters and pamphlets about MPAs are in the Toolkit for further application and discussion. Additionally, there is a Yurok story at the end of this lesson that explains how *Ocean* was created. It might be a fun way to let students know that an additional benefit of MPAs is that they help protect places of cultural and historical significance.

Suggested procedure:
Before you begin, make sure the items you need from the Toolkit are out and set up. If you want the students to play the game of tag described below, this should be set up ahead of time or done the next day. This lesson introduces students to what an MPA is beginning with the meaning of: Marine, Protection (or protected), and Area. To start, hold up a blue marble and say, "Pretend this is a planet in outer space. If you were flying in a space ship looking back at Earth, our planet would look similar to this blue marble. Because of this we can use a blue marble as a model of planet Earth". Ask Q**1)** What color is our planet? (Answer: blue) Q**2)** Why is Earth blue? (Answer: most of the surface is covered by water) Q**3)** What sorts of things live in the ocean? (Answers will vary) Q**4)** Is the ocean salty or fresh? (Answer: salty) Q**5)** How do humans use the ocean? (Answers will vary including recreation, transportation, for food, exploration, and disposal).

Next, have them look closer at our "watery world". Hold up the blow-up Earth globe and say, "Can you see the ocean?" "Look how big it is." "We live near the Pacific Ocean." Point to where you live. Ask as many questions as you would like to maintain their interest such as what sorts of things live in the ocean and how humans depend on the ocean.

Explain to the students that just like on land, some places are put aside as "parks".You may want to use a local park as an example. Just like a park on land, parks in the ocean are places that have boundaries and rules. These ocean parks are called Marine Protected Areas (MPAs). Introduce the words: *Marine*, *Protected*, and *Area*. There are many ways to do this. One alternative is to write the three words: Marine, Protected, and Area on a board. Another is to use the large laminated cards in the Toolkit.

Traditional Ecological Knowledge (TEK): Read the Yurok's creation story about how Kingfisher and Earthquake create the ocean with the help of abalone shells (story is below). After reading the story hold up an abalone shell so all can see. Karuk word for ocean: **vúras**	One side of the card has the letter and the other side the word. Explain the meaning of each of the words (see definitions). The word *marine* can be confusing since it is a word that "relates" to many aspects of the ocean, not just the ocean itself. The verb *protect* can be discussed by bringing up examples of ways we protect ourselves, our homes, our schools, etc. The word *area* might be better understood if you draw a square on the board and explain that area refers to a two dimensional space (length x width). Again you may want to use some examples, such as bedroom or the classroom space to explain that it can be described as a area. (Note: MPAs are actually are a three dimensional space but there is no need to confuse them). To emphasize these three words and their meanings ask for three volunteers to stand up in the correct order so as they hold up the signs, together they say *Marine, Protected, Area*. The person holding up the sign for Marine begins. Have the class repeat the word out loud as they clap the syllables. Continue with the other two words. Once everyone has said the words together, have the students with the signs flip their sign. Repeat - this time have the students say the meaning of each letter M. P. A in the proper sequence. Repeat as many times as necessary. Next, play a modified game of tag outside so they understand that MPAs are marine reserves or parks with boundaries. Set up two areas: a protected area (i.e., MPA) and a non-protected area outside of the defined boundary. To set up the protected area, feel free to use the cones, sticks, tape, and rope to make a "safe" area. Designate roles. Some students can be "enforcers" who do not let the "fisherman" into the MPA. Others can be fisherman. These will be the ones that try and catch (or tag) all of the others who are "fish". Keep in mind that some MPAs allow some sustainable fishing practices. The students are free to "swim" where they want, but they will only be safe in the area zoned as an MPA. Depending on the size of your group, decide how many fisherman, enforcers, and fish you want. Explain to the students that just like in a game of regular tag there is a "safe zone". The "safe zone" in this case is a Marine Protected Area. Give a signal to begin the game using a whistle or a different sign. At the signal the students begin to "swim" – in this case run around. Have most students

	who are fish begin well outside of the MPA boundary so they need to swim (run) to the "safe zone". If the "fish" get to the MPA, they are "safe". If they are caught outside the MPA zone, they should be removed from the game. Enforcers make sure everyone is acting by the rules. At some point have the roles switched. Those that were "fish" are now fishermen, etc. After the game of tag, settle the students down by asking: Q1: Why does Earth appear blue from outer space? (Answer: it is largely covered by water) Q2: What does M-P-A stand for" (Answer: Marine Protected Area). Q3: What is the purpose of a MPA? (Answer: To protect marine organisms and their homes) Q4: How do people use the ocean? (Answers will vary) At this point, feel free to turn the conversation to seafood. There is a seafood poster in the Toolkit. Many people like to eat food from the ocean but we need to do it so responsibly and sustainably. Q5: How have humans impacted our oceans? (Answers will vary). Have the group discuss some of the ways people use the ocean and what impacts they have seen or heard about when it comes to our oceans. Some responses might include fishing, garbage, oil spills, shipwrecks, fishing nets, plastic, etc. Q6: Why is the ocean worth protecting? (Answers will vary. They should mention that MPAs protect the animals and plants that live there, offer recreational and study opportunities, help protect places of cultural significance, etc.) Optional Extension: <u>Integrating Traditional Ecological Knowledge (TEK):</u> Explain that some MPAs have an added benefit because they help protect places that are culturally or historically important to people. Traditional Ecological Knowledge (TEK) refers to the body of knowledge about how resources have been used and or cared for through the ages. This knowledge is often passed down through an oral tradition or story telling. Native Americans have been using the ocean for thousands of years and many of their stories relate to the ocean. If you decide to do this extension, explain to the student that you will be telling them a fictional story (i.e., a fable) from the Yurok tribe that explains how the ocean was created (see story below: *How Thunder and Earthquake Made Ocean*). You may to get out an abalone shell and a picture of a kingfisher (a

	type of bird often seen fishing from rivers or lakes) before beginning. You may also want the students to role play Earthquake by drumming their feet or hands.

Connection to MLPA Goals:
Goal 1: To protect the natural diversity, and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

Links to online resources:
Monterey Bay Aquarium's site has a wide assortment of information and activities regarding ocean habitats and sea life. Here is the main link.
http://www.montereybayaquarium.org/visit/monterey-area/monterey-bay-national-marine-sanctuary
Ocean Literacy makes connections and gives a framework to broaden educational outreach regarding Earth.
Ch 4. Lesson1: Earth's Water Part of Lesson 1: *Earth the Blue Planet* by Brent Coley. This simple slide show explains how much of the ocean is covered by water and why the ocean is salty.
https://www.murrieta.k12.ca.us/cms/lib5/CA01000508/Centricity/Domain/851/Chapter_4_Lesson_1_Earth_The_Blue_Planet.pdf
EPA's All the Water in the World Curriculum adopted from Project Aquatic Wild
https://www.epa.gov/sites/production/files/2015-08/documents/mgwc-ww-intro.pdf

Engage: Hold up a blue marble and have the students pretend they are looking at a blue planet from their spaceship.
Explore: Hold up an Earth globe and have the students see how big our ocean is compared to the land.
Explain: Tell the students that just like parks on land that are set aside to help protect the animals and plants that live there, some places in the oceans have been set aside for protection as well. These places are called Marine Protected Areas or MPAs.
Elaborate: Ask the students to come up with ways humans use the ocean. Next, ask what sorts of human impacts have they heard about that affect the ocean.

Teacher Reference:

TEK CONNECTION: (Note: there is a colorful slideshow to go with this story if you want to show the students pictures as you go. This slideshow can be found on the Pen Drive in the TEK folder.)

Suggestion: As you read this story show pictures of a kingfisher and have the kids make an earthquake by pounding on their tables or the floor.

A NATIVE AMERICAN STORY

How Thunder and Earthquake Made Ocean

(Yurok California)

Thunder lived at Sumig.
One day he said, "How shall the people live there is just prairie there?
Let us place the ocean there." He said to Earthquake, "I want to have
water there, there so that the people may live. Otherwise they will have
nothing to live on." He said to Earthquake, "What do you think?"

Earthquake thought. "That is true," he said. "There should be water there.
Far off I see it. I see the water. It is at Opis.
There are salmon there and water."

"Go," said Thunder. "Go with Kingfisher, the one
who sits there by the water. Go and get water at Opis.
Get water that is to come here."

Then the two of them went. Kingfisher and Earthquake went
to see the water. They went to get the water at Opis. They had
two abalone shells that Thunder had given to them.
"Take these shells," Thunder had said.
"Collect the water in them."

First Kingfisher and Earthquake went to the north end of the world.
There Earthquake looked around. "This will be easy," he said.
"It will be easy for me to sink the land." Then Earthquake ran around.
He ran around and the ground sank.
It sank there at the north end of the world.

Then Kingfisher and Earthquake started for Opis.
They went to the place at the end of the water. They made the ground sink behind them as they went. At the Opis they saw all kinds of animals and fish that could be eaten there in the water at Opis.
Then they took water in the abalone shells.

"No we will go to the south end of the world," said Earthquake.
"We will go there and look for water. Thunder, who was at Sumig, will help us breaking down the trees. The water will extend all the way to the south end of the world. There will be salmon and fish of all kinds and seals in the water."

Now Kingfisher and Earthquake came back to Sumig.
They saw that Thunder had broken down the trees.
Together the three of them went north.
As they went together they kept sinking the ground.
The Earth quaked and quaked water flowed over it as Kingfisher and Earthquake poured it from their abalone shells. Kingfisher emptied his shell and it filled the ocean halfway to the north end of the world.
Earthquake emptied his shell and it filled the ocean the rest of the way.

As they filled in the ocean, the creatures, which would be food swarmed into the water. The seals came as if they were thrown in handfuls.
Into the water they came, swimming toward shore. Earthquake sank the land deeper to make gullies and the whales came swimming through the gullies where the water was deep enough for them to travel.
The salmon came running through the water.

Now all the land animals, the deer and elk, the foxes and minks, the bear and others had gone inland. Now the water creatures were there.
Now Thunder and Kingfisher and Earthquake looked at the ocean.
"This is enough," They said. "Now the people will have enough to live on.
Everything that is needed is in water."

So it is that the prairie became ocean. It is so because Thunder wished it so.
It is so because Earthquake wished it so. All kinds of creatures are in the ocean before us because Thunder and Earthquake wished the people to live.

MPA Toolkit

For Humboldt and Mendocino Counties

UNIT 1

Grades K-2

Lesson 2: Tuning Into the Intertidal Zone

NGSS -- DCI (Disciplinary Core Ideas):
KLS1.C Organization for Matter and Energy Flow in Organisms
KESS2.E Biogeology
KESS3.A Natural Resources
KESS3.C Human Impacts on Earth Systems
1LS1.A Structure and Function
1LS1.B Growth and Development of Organisms
1LS1.D Information Processing
1LS3.B Growth and Development of Organisms
2LS4.D Biodiversity and Humans

Time:
30 – 120 mins.

Toolkit Materials for the Teacher

- ✓ Book: In One Tidepool
- ✓ Animal pictures for the intertidal zone (see online information)
- ✓ Laminated CMPA brochures and poster
- ✓ Dried animal specimens (optional)
- ✓ Plastic sea life specimens (optional)
- ✓ CMPA Coloring Book (optional)

Learning Objectives: A) Students will understand that a place where something lives is called a habitat. B) They will understand that a unique community of sea life has adaptations that make them well suited to live in an intertidal zone.

Phenomena: Tide pools are exposed during low tides and can be a part of a habitat called the intertidal zone.

Background information:
Marine Protected Areas (MPAs) are designed to protect marine habitats and the species that live there. In this lesson, students will focus on one of those habitats – intertidal zones. Tide pools mostly occur along rocky shorelines within this zone, which encompasses the strip of land that is underwater during high tides but exposed during low tides. How low a low tide will be is dependent upon many factors including the moon phase. The lowest low tides (and highest high tides) are called spring tides and occur roughly every two weeks around the time of the full and new moon. These tides are also called king tides and have nothing to do with the spring season.

As one studies the intertidal zone certain patterns emerge. Generally, the intertidal can be divided into four different zones: low, mid, and high tide zones and a splash zone (refer to image 1 below). Many species tend to occupy one particular zone instead of being spread evenly. During low tide, animals and plants (e.g., seaweed) have adapted ways to prevent drying out, getting too hot, or being eaten by predators like birds. During high tide, they need to avoid being injured or washed away by waves, and avoid predators like crabs, sea stars, and fish otherwise they will perish. The zone where a species is found is where it is best adapted to survive the challenges it faces there (for more information refer to the links below).

This lesson will introduce students to tide pools through the book: *In One Tidepool: Crabs, Snails, and Salty Tails* by A. Fredericks. This story gives examples of several animals that live in a tide pool and uses poetry to explain how they are

Toolkit Materials for the Students

- ✓ A Pacific Tide Pool Worksheet (optional) Dried animal specimens (optional)
- ✓ Plastic sea life specimens
- ✓ Worksheet 1: Cut out cartoons of marine organisms that live in tide pools
- ✓ Student worksheet 2 (optional)
- ✓ Glue *
- ✓ Crayons (optional) *

* Not included in the Toolkit

Connections:
Art, physical geography, physical science, zoology, engineering, language arts

MPA Core Ideas:

MPAs protect representative and unique habitats.

Vocabulary:
habitat
intertidal zone
invertebrate
vertebrate
Marine Protected Area (MPA)
tide pool

adapted to their environment. The animals emphasized in this book are crabs, snails, sponges, anemones, fish, barnacles, limpets, and sea stars. Each has various adaptations that allow it to survive. The **intertidal zone** is an extreme place to live because of frequent exposure to sun (temperature and moisture changes), pounding waves, and other factors such as predation. By getting children to appreciate some of the challenges these organisms face, they will gain a better understanding of the concept of *adaptation*. Adaptations include physical and behavioral characteristics organisms possess that allow them to be suited to a particular environment – in this case tide pools. At the end of the book you can find *Field Notes* where more information is given about each animal including *Fantastic Facts*.

Older students may be able to group intertidal organisms by comparing characteristics such as whether they have a shell, stinging cells, or tube feet. Animals without a backbone are called **invertebrates**. A crab is a type of invertebrate with 5 pairs of legs including claws, and a hard shell or carapace. **Crabs** are **crustaceans** and are related to crayfish, shrimp, barnacles and other animals with an exoskeleton (usually a hard shell) and segmented bodies (they are all arthropods). Rock crabs have to shed their hard shell (called molting) in order to grow. They live among the rocks and can move up and down into different tidal zones. Hermit crabs need to find new shells every time they molt and grow. Although they can move from one tide pool to another, they generally don't move very far. A **sea anemone** is another type of predator and belongs to a group called **cnidarians**. It is another type of invertebrate that has a soft, round or radially symmetrical body with many tentacles. Among its tentacles it has stinging cells that paralyze its prey so that it can draw its meal into its mouth. There is one opening located on the top of the circular mass that serves as both a mouth and an anus. It is related to jellyfish and coral, which also have stinging cells. It feeds on crab, sea urchins, mussels and other small animals. **Sea stars** or starfish are commonly seen. They are important predators with five or more arms and are keystone species. They belong to a group called **echinoderms**. They move on tube feet and have reduced spines, a characteristic that defines this group. Urchins sea cucumbers and are also echinoderms. For more information about tide pool animals, refer to the links or materials in the Toolkit. There are several plastic ocean life toys (many are generic and not accurate enough to show specific species) as well as dried specimens in the Toolkit that can be used as props in this lesson as well.

Suggested extensions:

- Follow up this activity with coloring sheets from the Monterrey Bay Aquarium coloring book.
- Have students act out different species in a tide pool role model game.
- Model a tide pool using a paper plate, sand, rocks, plastic toys, and clear blue paper (see link below).
- Show a quick video on tide pooling including safety rules and importance of MPAs (see link below).
- Take a field trip and explore a tide pool using the proper etiquette set forth by the Ocean Institute.

TEK Connection:
Introduce the Yurok language by introducing the students to the following terms:

Kelp: paa-moh
Mussel: pee-'eeh
Seaweed: che-gel
Sea star: ko-yaakw'
Crab: ko'-ses
Barnacles: 'yerr-ner'

Visiting a Tidepool: In densely populated places, such as San Diego or Laguna Beach, one of the biggest threats tide pools face are from people. Tide pools are fragile and can be harmed by pollution, trampling, and collecting things from them. If students visit a tide pool, be sure to have them abide by the tide pool etiquette set forth by the Ocean Conservancy and other conservation groups (refer to online resources below). For further information about tide pools and the organisms that live there refer to additional reading.

Suggested procedure:
Ask if any one has been to the ocean during low tide. Have they ever climbed on the rocks and peered into a tide pool? (refer to image 1 below). Explain that **tide pools** are found in a place called the **intertidal zone.** For younger students break this word apart and explain its meaning (inter=within, tidal=refers to the tides, zone=a specific area). Explain that people can mostly explore these places during low tide because otherwise they are covered by water. There are usually two high tides and two low tides every day. Do they know what causes the tides? (Answer: the pull of the moon (2/3) and sun (1/3) on Earth's oceans). Next, write: habitat, intertidal, and tide pool on the board along with other vocabulary words you want the students to learn in this lesson (e.g., invertebrate, vertebrate, organism, etc).

Explain to the group that Marine Protected Areas or MPAs protect many types of habitats found in the ocean including one called the intertidal zone. Explain to them that an animal's home is called a **habitat**. Some species like humans can live in many different types of habitats. Others are restricted to a very specific type of habitat. You may want to refer to a habitat they are familiar with such as a forest or desert to better understand this idea of a habitat as a home. At this point, an option is to sing the song *Habitat, Habitat, Have to Have a Habitat* song by Bill Oliver (the lyrics and link can be found below). After the song, explain that they are going to learn about a very important type of habitat found in the ocean. This habitat is called a tide pool.

Next, gather the students into a circle in a comfortable place and have them sit down. Remind them that they need to be quiet and listen so everyone can enjoy and understand the book. Read the book to them, making sure they can see the pictures. Once you finish the story, explain that a tide pool is just one type of habitat Marine Protected Areas (MPAs) help protect. Do they remember what a Marine Protected Area is? Tide pools are often found in a habitat called the intertidal zone (as

	previously mentioned). Others include estuaries, kelp forests, rocky reefs, and sandy bottoms. Reviewing the importance of MPAs is a good review from Lesson 1 in Unit 1. Check for understanding: Q1: Who can tell me the name of the habitat we have been studying? (Answer: intertidal zone or tide pool) Q2: When can we best see the organisms that live in the intertidal zone? (Answer: during low tide) Q3: How might a human impact a tide pool? (Answers will vary. They might include humans take things, trample, fish there, pollute, etc.) Optional extension: Next, explain that they are going to look more closely at some of the animals that live in a tide pool. Tide pools are found in the intertidal zone - one of the key habitat types MPAs protect. Follow up and evaluate what the students have learned through independent practice. Refer to student worksheets 1 and 2 below and pick which one is appropriate for your grade level. Have younger students glue marine organisms onto the tide page of silhouettes. They can also draw their own tide pool and paste the animals to it. For older students you may want to have them try and identify as many of the 20 labeled organisms as they can found on the Pacific Tide Pool worksheet below. There is an enlarged laminated picture in the Toolkit. Further Extension: Next, hold up a dried marine specimen or plastic toy and ask what they think each one is. Examples include sea star, urchin, abalone, and mussel. Next, point out some of the features each has that enables it to live in an intertidal zone. If your group is already knowledgeable about tide pools, ask them in what particular zone the organisms might live. For instance, a crab might visit all of the zones, whereas barnacles and mussels are sedentary (sessile). Barnacles can be found anywhere from the splash zone down into the low tide zone depending on the species. Most fish need water all of the time and will generally move out with the tides or be found in tide pools that remain even when the tide goes out. Mussels, sea anemones and sea stars prefer to live near water and are most commonly found in the mid to low tide zones. Mussels survive in the intertidal by attaching themselves to rocks using strong fibers; these strong fibers along with their hard shells help protect them from wave forces, predators, and allow them to hold in water that keep their bodies moist and cool when the tide is out.

	To connect to Traditional Ecological Knowledge (TEK), some Yurok words for various sea life are listed in the left hand column. These words are a good way to introduce the idea that the ocean has been used by local Native Americans, such as the Wiyot, Sinkyone, Yurok, and Coast Yuki and other tribes, for generations (refer to map below). A great way to round out this lesson is to have students color one or more pages relating to tide pools. Extension for older students: Before independent practice using worksheet 2, you may want to introduce the term *vertebrate* and *invertebrate*. Most of the animals that live in a tide pool are invertebrates. Hold up a few examples of various animals that live in the intertidal zone so they can identify them better. Point out some of the adaptations each organism has such as tube feet or a hard shell. Refer back to the book for more information. Ask where a selected animal or plant (seaweed) might live within an intertidal zone (e.g., pool in a low tide zone, wet rock in a mid tide zone, rocky shore within the splash zone).
Connection to MLPA Goals: Goal 4: To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.	
Links to online resources: Sing the Habitat, Habitat, Have to Have a Habitat Song with Bill Oliver. The lyrics are found below. https://www.youtube.com/watch?v=VVPyjukPxFA Monterrey Bay aquarium "A Habitat is Home" activities which offers several additional activities related to ocean life and their habitats: http://www.montereybayaquarium.org/-/m/pdf/education/activities/aquarium-ss-habitats.pdf?la=en A great resource to learn about habitats and the ecology of tide pools in California. http://californiatidepools.com/ Good 4 minute video on tide pooling along the Sonoma Coast. https://www.youtube.com/watch?v=OAZK_eOLI6s Wildcoast Tidepooling Guide: A student guide to the Interdial Zone (note: it can also be found on the pen drive as a pdf) or by going to the California MPA "Teaching Materials" link. https://drive.google.com/file/d/1xrd2l1U1fGoQIntMFNpUHbeRPe1OpjLZ/view	
Engage: Connect to what students already know. Ask the students if they have ever visited a beach or rocky intertidal habitat during low tide. What have they seen there? **Explore:** Use a story that describes the various organisms that live in a tide pool; a place found within the intertidal zone. **Explain:** After reading the story, explain that a habitat is a type of home. MPAs protect different habitats. Some animals live in a home or habitat called the intertidal zone. Animals that live there have features that enable them to survive in this harsh environment. Animals need to have ways to avoid drying out during low tide or being eaten by predators. **Elaborate:** Animals have adaptations that allow them to live in different places. For instance, an abalone has a strong muscular foot that allows it to cling to rocks. **Evaluate:** Ask the students questions relating to what they have learned. Q1: Who can tell me the name of the habitat we have been studying? (answer: intertidal zone)	

Q2: When can we best see the organisms that live in the intertidal zone? (during low tide)
Q3: Hold up a few examples of the animals that live in tide pools and have the students tell you what they know about it. They can say where they live or identify a type of adaptation it has.
Q4: How might a human impact a tide pool? (take things, trample the marine life, pollute, etc.)
Q5: How can a Marine Protected Area help protect the various animals that live in an intertidal habitat? (Answers will vary. MPAs have rules of what you can take from a place. Some allow certain types of "take" others are "no-take" zones. By monitoring and enforcing these places with certain rules, we can make them healthier.)

Teacher References: Image 1

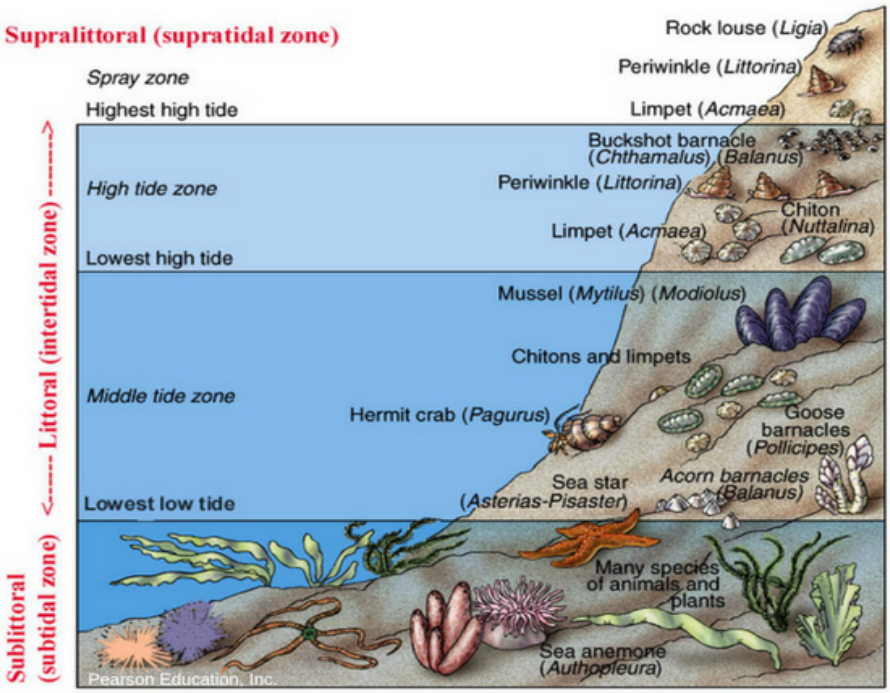
WILDCOAST
COSTASALVAJE

SAN DIEGO MPA COLLABORATIVE

intro

The Intertidal Zone

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.



1

Have to Have a Habitat[1]

Habitat habitat, have to have a habitat
Habitat habitat, have to have a habitat
Habitat habitat, have to have a habitat
Have to have a habitat to carry on

The Forest is a habitat, a very special habitat
It's where the biggest trees are at
It's where a bear can scratch her back
Keeps the ground from rolling back
Renews the oxygen in fact
The forest is a habitat that we depend on

The stream is a habitat, a very special habitat
It's where the freshest water's at
Where people fish and muskrat
When the people dump their trash
The streams take the biggest rap
A stream is a habitat that we depend on

The meadow is a habitat, a very special habitat
It's where the tallest grass is at
It's where a rabbit takes a nap
In a meadow we relax, play a game with ball and bat
The meadow is a habitat that we depend on.

People are different from foxes and rabbits
Affect the world with our bad habits
Better to love it while we still have it
Rat-i-tat-tat our habitat's gone.

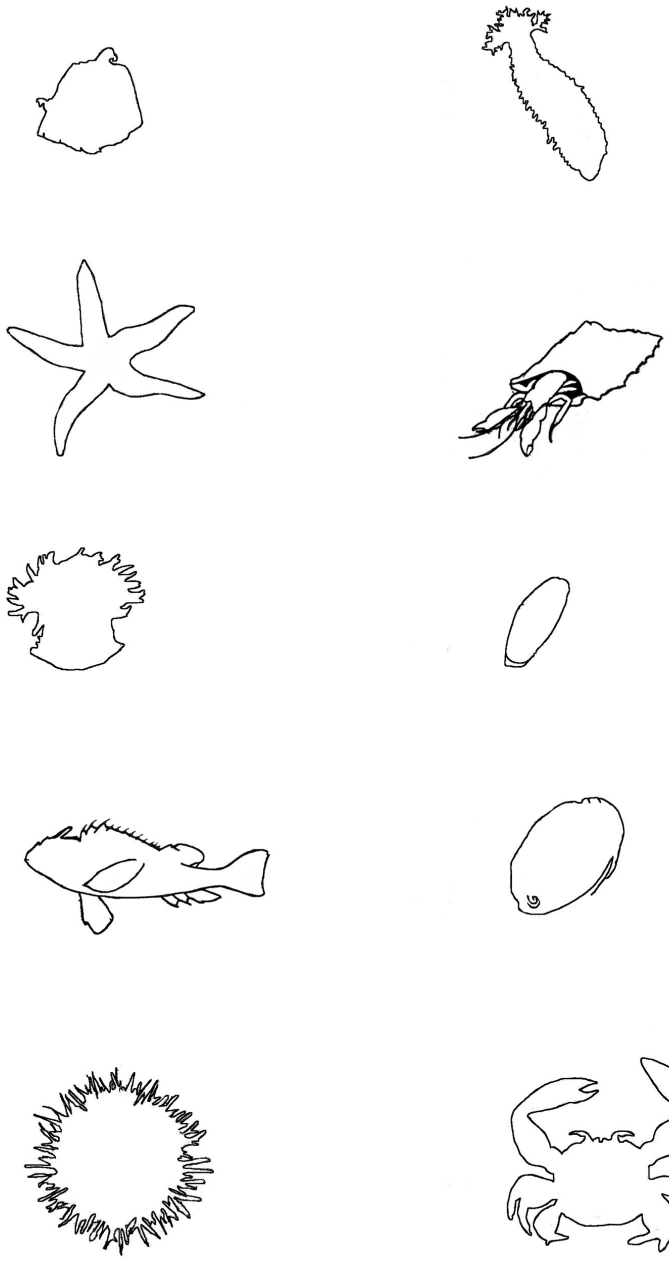
Chords: C Am F G
C Am F G
C Am F G
G F C

Song by Bill Oliver, *additional lyrics by David Weiss*

Note: The You Tube video starts with the verse on the oceans.

http://kstrom.net/isk/maps/ca/calprecontact.gif 1/28/2018

Student Worksheet 1 Directions: students match the animal on page 2 to their silhouette below.



Note: You will need to make copies and cut out images below prior.

1 

BARNACLE

2 

SEA CUCUMBER

3 

SEA STAR

4 

HERMIT CRAB

5 

SEA ANEMONE

6 

OLIVE SHELL

7 

SULPIN

8 

ABALONE

9 

SEA URCHIN

10 

KELP CRAB

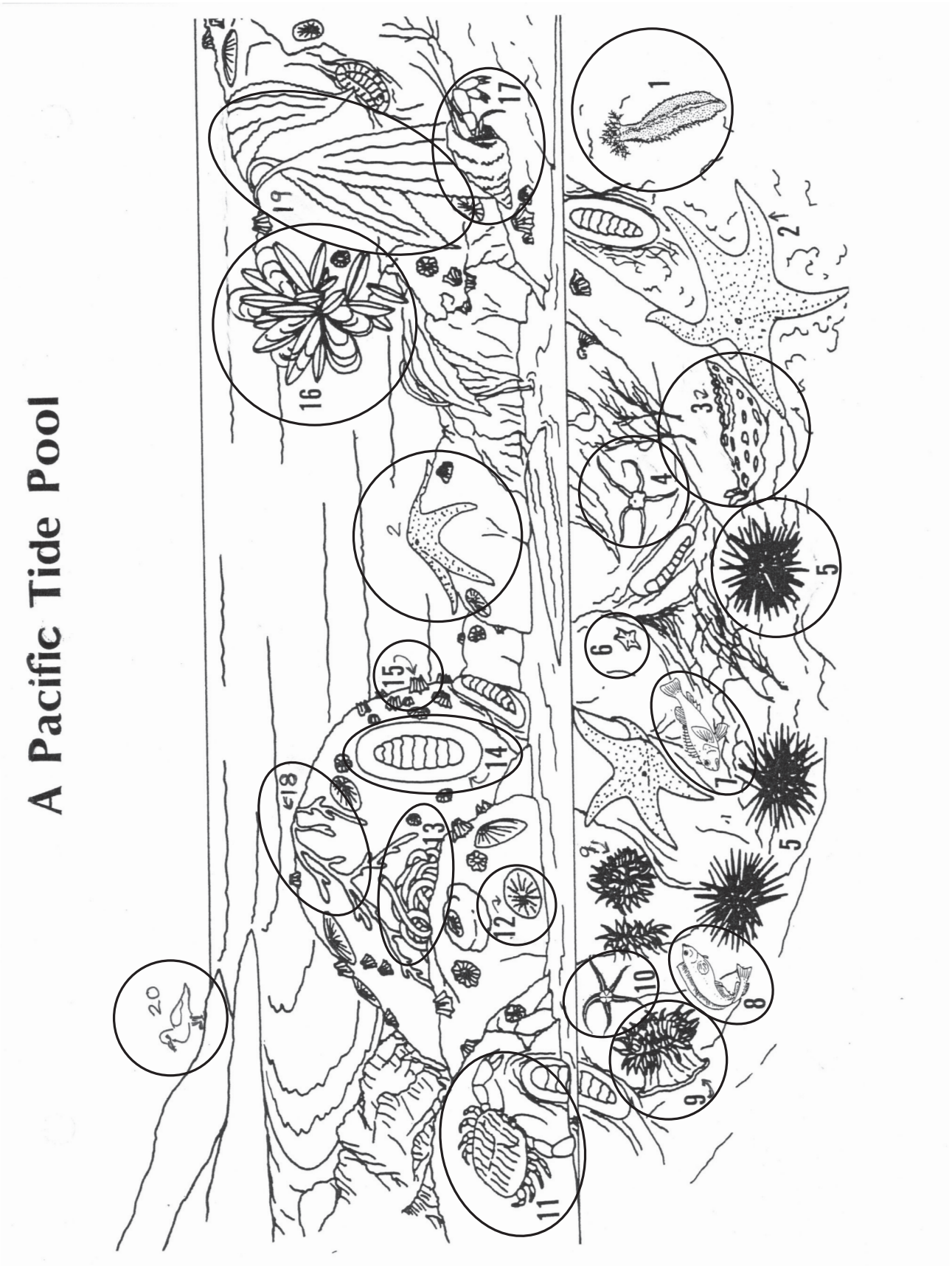
Extension: Student Worksheet 2 (answer sheet) Pacific Tide pool picture (designed to be cut in two)

Student Name		Student Name
1		**1**
2		**2**
3		**3**
4		**4**
5		**5**
6		**6**
7		**7**
8		**8**
9		**9**
10		**10**
11		**11**
12		**12**
13		**13**
14		**14**
15		**15**
16		**16**
17		**17**
18		**18**
19		**19**
20		**20**

Extension: Worksheet 2: Make copies of the second page below. Have students identify as many organisms as they can.

Answer Sheet: A Pacific Tide Pool List of Organisms

1. sea cucumber	11. crab
2. sea star	12. limpet
3. sea hare	13. tube worms
4. brittle star	14. chiton
5. sea urchin	15. acorn barnacle
6. bat star	16. California mussel
7. sculpin	17. hermit crab
8. kelpfish	18. bladderwrack
9. sea anemone	19. laminaria
10. dwarf brittle star	20. Western gull


A Pacific Tide Pool

MPA Toolkit

For Humboldt and Mendocino Counties

UNIT 1

Grades K-2

Lesson 3: The Kelp Forest– Giants of the Sea

NGSS -- DCI (Disciplinary Core Ideas):
KLS1.C Matter & Energy Flow in Organisms
KESS2.E Biogeology
KESS3.A Natural Resources
1LS1.A Structure and Function
1LS1.B Growth and Development of Organisms
1LS1.D Information Processing
2LS2.A Interdependent Relationships in Ecosystems
2LS4.D Biodiversity and Humans

Time:
Part I: *Kelp are Plants of the Sea*. 30 – 40 mins.
Part II: *Giant kelp is giant*! 10-15 mins.

Toolkit Materials for the Teacher

- ✓ Northern California Tidepool laminated guides.
- ✓ Poster or pamphlet showing MPA habitats.
- ✓ Worksheet "Is it an Alga"?
- ✓ 150 foot rope
- ✓ Online resources (see links)

Learning Objectives: A) Students will compare similarities and differences between kelp and land plants to understand their important role as producers in a marine environment and as important habitat.
B) Students will understand that MPAs protect kelp forests by restricting people from harvesting them.

Phenomena: Some types of brown algae or kelp are ecosystem engineers and produce kelp forests.

Background information:
Strolling along the sandy beach or exploring a rocky intertidal zone can be both fun and fascinating. Many of the animals and "plants" (e.g. algae) found in these places can captivate the imagination and may elicit a cry of surprise such as "What is that?!" Finding kelp and other seaweeds can be a great example of this wonderment. Kelp is a form of brown algae and is the largest and fastest growing of all seaweeds. Bull kelp has a long "rope-like" structure called a stipe and is sometimes referred to as bullwhip kelp. Piles of kelp and other seaweed debris (referred to as beach wrack) often get washed up on the beach after a storm. Digging through these piles, one can find a host of abundant, tiny critters that are worth a closer look. If something from the sea looks plant-like and is green or brown, there is a good chance it's a type of seaweed. Seaweed is a general term for algae (plant-like organisms) that live in the ocean.

Seaweeds can be divided into three groups: brown, green, and red algae. Similar to true plants (or vascular plants), seaweeds are *producers* and manufacture food through the process of photosynthesis. They need sunshine and salty water to survive. They pick up most of the nutrients they need directly from the seawater as it moves over their stem-like *stipes* and leaf-like *blades*. Because of this, water quality is an important factor for the survival of seaweed. Poor water circulation, warm temperatures, lack of nutrients, and excess sediment and runoff can inhibit growth.

Certain seaweeds have been harvested by humans for centuries as

Materials for the Students

- ✓ Student worksheets 1 & 2
- ✓ Pencils or crayons *
- ✓ Glue or tape *

*Not in the Toolkit

Connections:
Art, physical geography, biology, botany, math, language arts, engineering.

MPA Core Ideas:

MPAs can protect natural diversity and ecosystem function.

MPAs protect representative and unique habitats.

Vocabulary
blade
bladder
habitat
holdfast
kelp
producer
seaweed
stipe

Suggested extensions:

- Connect the concept of BOFFF from lesson 5 using abalone puppets to make the connection that abalone eat kelp.

food and fertilizer. Many produce a carbohydrate called algin, which is used in many foods as a thickening agent including pudding, yogurt, and ice cream. Wakame is a type of seaweed often found in seaweed salad (a Japanese dish) and nori is the type of seaweed sushi is wrapped in. For a list of products that you might find in your home that incorporate seaweed refer to the *There Are Algae in Your House!* link in the online references below.

In this lesson, students will learn about kelp forests. These are very important habitats and are critical for supporting certain species such as abalone. Kelp forests, just like forests on land, are ecosystem engineers; they create whole ecosystems. Because bull kelp and giant kelp (the two species emphasized in this lesson) grow very tall they are the types of seaweed that can form "forests". These kelp forests form canopies, which have several layers below. Kelp forests provide ample places for food and shelter and support a rich diversity of life living within their leaf-like blades and root-like holdfasts.

Students will first become familiar with kelp by comparing the structures they posses to those of land plants. After that, they will be introduced to a type of habitat called the "kelp forest". As mentioned in the previous lesson, a habitat is a home. Kelp forests are another type of habitat protected by Marine Protected Areas (MPAs) (The first type introduced in this unit is the intertidal zone – Lesson 2). Protecting kelp forests and other key habitats for their natural diversity and integrity are important goals of MPAs (for more information, please refer to the links below). MPAs help protect kelp forests by placing restrictions where needed from human harvesting and by protecting a variety of habitats (MPAs use an ecosystem approach).

Two types of kelp that form "kelp forests" are giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis leutkeana*) (refer to images below). The coastlines of Humboldt and Mendocino Counties mostly have bull kelp living there, which you can often see floating in large rafts by the single large "bulb" or air bladder. Giant kelp is used in the second part of this lesson because it is the "record holder" for height (refer to the images below). Giant kelp is perennial and can grow over 150 feet long throughout its lifetime! It is one of the fastest growing things on the planet. In California, it mostly grows along the central and southern coasts.

Kelp differs from true plants several ways (see comparative pictures below). Instead of leaves they have **blades** of various sizes and shapes and instead of stems they have **stipes**. Blades

- Look at footage of a kelp forest from a MPA live web cam or the one at Monterey Bay Aquarium (see link below).
- Grow plants from seed such as beans and see what conditions are most favorable.
- Collect seaweeds on the beach or among the rocks (outside of an MPA) and make a classroom picture book from them.
- Have students paint, draw, or press seaweed as an art project (see link below).
- Sing and dance along to the kelp song by Birdsong https://www.youtube.com/watch?v=buh7LPk62Lw
- Have the students eat algae by making a seaweed salad (see link below).
- Build a kelp forest model out of paper, pipe cleaners, or other materials.

TEK Connection

English and Yurok translation:

Kelp = paa-moh
Kelp = werhl-keehl
Along the seashore = Laa-peesh-kah

often have air filled sacs called **bladders** that help them float and reach toward the surface to gather more sunlight. Instead of roots they use a **holdfast** to attach to surfaces. At least 20 different species of kelp grow along the coast of California. Some of the larger more common types of kelp are: sea palm, giant kelp, bull kelp, and the feather boa kelp (refer to identification guides in the toolkit).

As mentioned above, kelp forests are one of the key habitats California Marine Protected Areas (MPAs) aim to protect. They supply food and hiding places for hundreds of organisms including juvenile and adult rockfish, lingcod, urchins, abalone, shrimp, snails, hydroids, brittle stars, and crabs. Snails attach themselves to blades while they scrape off algae. Sea otters tie themselves up in kelp to keep from floating away while they sleep or during storms. Seals, sea lions, and sea otters eat the fish that hide in the kelp forest.

There are many great ways to expand learning about kelp forests. A fun and informative six-minute long video is available on the kelp forests of Monterey as well as a live web cam of the Kelp Forest exhibit at the Monterey Bay Aquarium (see links below). Kelp forests are important habitats for abalone and abalone puppets can be found in the toolkit to enhance this lesson. Additionally, there is a Native American doll adorned with shells, including abalone beads, which can be used to show that abalone and other shellfish were important to Native American tribes (the doll is located in a separate container. See Unit 2, Lesson 4 for more information). Some of the Yurok names for kelp are found in the TEK Connection in the left hand column.

Suggested procedure:
Hold up a picture or a sample of kelp and ask the students what they think it is (see books or teacher references below). Next, hold up the poster (or pamphlet) showing the *Key Habitats in California MPAs.* (A set of pamphlets is in the Toolkit and can be used for students to work in groups). Ask them to identify which area on the pamphlet shows a kelp forest. Have them all point to it and look at the types of animals they see there. Next, have them take a closer look at a few examples of kelp. Explain that kelp forests are very important to the health of our ocean and provide important habitat for many different species. Remind them that a habitat refers to a "home". It is where plants (or algae), animals, and other organisms live. MPAs are like underwater parks and help protect important habitats for marine animals.

Next, help them to identify some of the features and roles kelp

	have through questioning: Q1**:** Do you think kelp is a type of plant? (Answer: yes, but not a true plant. Kelp is similar to a land plant because it gets its energy from the sun. It is a type of producer. It differs from land plants (or vascular plants) because it doesn't have true roots, stems or leaves. Kelp is a type of algae and can also be called seaweed) Q2**:** Where does kelp grow? (Kelp grows in the ocean and can be found in different places, including intertidal zones, rocky reefs, and shorelines. They are "plants" of the sea) Q3**:** Do you think anything eats kelp? (Answer: yes. Many types of animals eat kelp including a variety of invertebrates, fish, and humans) Q4: If so, what types of animals might eat kelp? (Answers will vary. Some animals include snails, sea urchins, and abalone) Q5**:** Besides food, how else do you think kelp can help (or benefit) animals? (Answer: kelp forests can act as a nursery, a place to hide, as well as supplying oxygen for animals). Be sure to include the fact that people eat seaweed and use it for other things, including making ice cream with it! In addition, kelp and other types of seaweed are very important to local Native American tribes. (Note: Talking about kelp and its uses in food and ceremonies can be a good connection to Traditional Ecological Knowledge (TEK)). Next, discuss how kelp is similar to land plants by comparing similarities and differences (see student worksheet 1 below). Using images or samples, point out the various features kelp has such as a holdfast instead of roots. As you point to these specific features, have the students say out loud or identify which ones they are (see graphic below). Using the worksheet, have the students identify the highlighted features through independent practice. Once, they are done with the worksheet, finish up by asking, "Why is this type of habitat important?" "Is it worth protecting?" "What sorts of animals live in this kind of habitat?" Conclude this lesson by having the students draw some of the animals they just mentioned using the bull kelp forest coloring page below (refer to student worksheet 2). Once they are done, post their coloring pages around the classroom. <u>Optional Extension</u>: ***Giant kelp is Giant!*** Switch the focus to the giant kelp forests found in Monterey Bay and other places because it is the "record" kelp based on height. Explain that giant kelp can grow over a foot a day and grow to be150 long! Under good conditions, it is one of the fastest growing things on the planet! Show them some pictures of the kelp forest (another option is to have them look at live video footage on the Monterey Bay webcam) and explain that this type

	of habitat is important for a lot of different fish and invertebrates. In order to show them how tall giant kelp can be, have them model the height. Find an area where you can stretch out 150 feet of rope (the rope in the Toolkit is already 150 ft). Next, instruct the students to lie down next to the rope and stretch themselves tall, lining up head to toe. Count the number of students and continue to have them move around until 150 ft is reached. Act amazed! How many students did it take to reach the length of the giant kelp? Review with the students that MPAs aim to protect this important type of habitat.

MPA Goal Connections:
#1 To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
#4 To protect marine natural heritage, including protection of representative and unique marine habitats in California waters for their intrinsic value.

Online resources:
Look at a live web cam of the kelp forest at Monterrey Bay Aquarium
http://www.montereybayaquarium.org/animals-and-exhibits/live-web-cams/kelp-forest-cam
National Geographic KIDS/Nature Boom Time: A great 6 minute video on Kelp Forests
https://www.youtube.com/watch?v=GDbHoF6loa8
California Academy of Sciences: Seaweed salad recipe
https://www.calacademy.org/educators/lesson-plans/sensational-seaweed
Ocean Planet, Smithsonian: There are Algae in Your House (nasa.gov)
https://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/education_lesson1.html
A lesson for Oregon University where kids learn how to press kelp
https://oimb.uoregon.edu/Documents/GK12/GK12-Fourth-AlgalPressing.pdf
A dichotomous key for identifying local kelp species; useful in grades 2 – 8.
https://oimb.uoregon.edu/Documents/GK12/GK12-Fourth-AlgalKey.pdf
National Geographic: Kelp forest ecosystem pdf, include a coloring page of the kelp forest
https://media.nationalgeographic.org/assets/file/Kelp_Forest_Ecosystem.pdf
Information and pictures of the Giant Kelp
https://www.montereybayaquarium.org/animals-and-exhibits/animal-guide/plants-and-algae/giant-kelp
Information regarding commonly harvested species of kelp in California
https://www.wildlife.ca.gov/Conservation/Marine/Kelp/Commonly-harvested-marine-algae
National Marine Sanctuaries, Kelp Forests: A Description
https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html

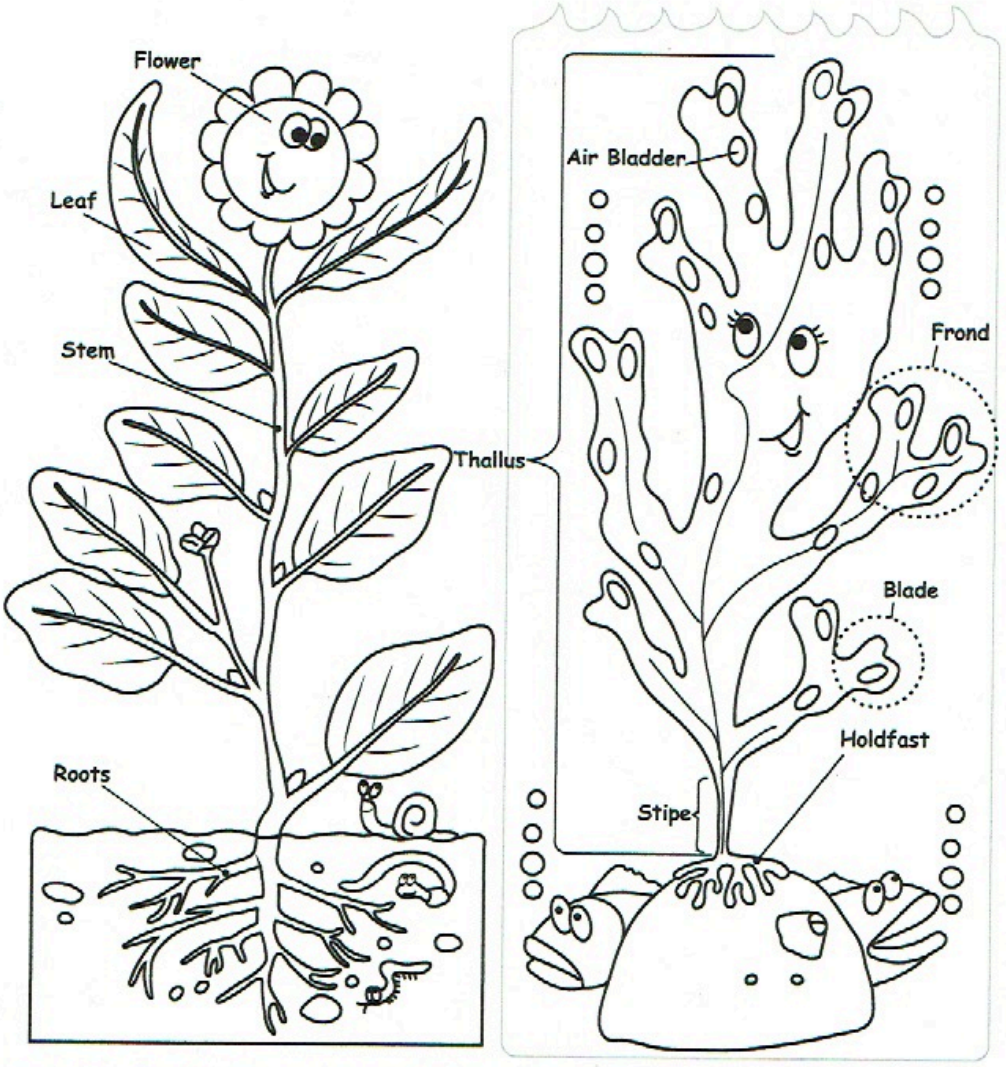
Engage: Connect students to what they already know. Show them a poster of the key habitat types protected by MPAs. Ask them to point to the habitat called the kelp forests. Discuss what types of animals they see in the picture.
Explore: Hold up more than one type of kelp and have them compare and contrast differences and similarities between kelp and land plants.
Explain: Explain that kelp is not a *true* plant, but because both use sunlight for food, they can easily be compared to land plants (or vascular plants). For instance kelp have a blade instead of a leaf and a holdfast instead of roots. Just like land plants, kelp and other seaweeds can be the basis of a ocean based food web because they make their own food using the sun. Just as a forest supports abundant forms of life, a host of organisms use kelp for shelter, food, and as a sort of nursery for their young.
Elaborate: Explain that a kelp forest is another very important type of habitat or home (Lesson 2 introduced students to an intertidal zone – a different type of habitat). Ask the students why kelp beds are important and why they may be worth protecting.
Evaluate: Ask the students how an Marine Protected Area (MPA) can help protect kelp forests by reviewing the fact that MPAs are protected areas and kelp cannot be harvested in most of these places. Use the MPA poster to review what they have learned.

Student Worksheet (Teacher key): (Source: Anne Marie Sherry from www.biomara.org/schools)

BioMara

Answer sheet -Lesson 1 – What is Algae?

Activity 1 - Label the different parts of macroalgae (seaweeds) and a flower.



Lesson One. Page 15

Student Worksheet (source: www.biomara.org/schools)

Unit 1 K-2 Name _____

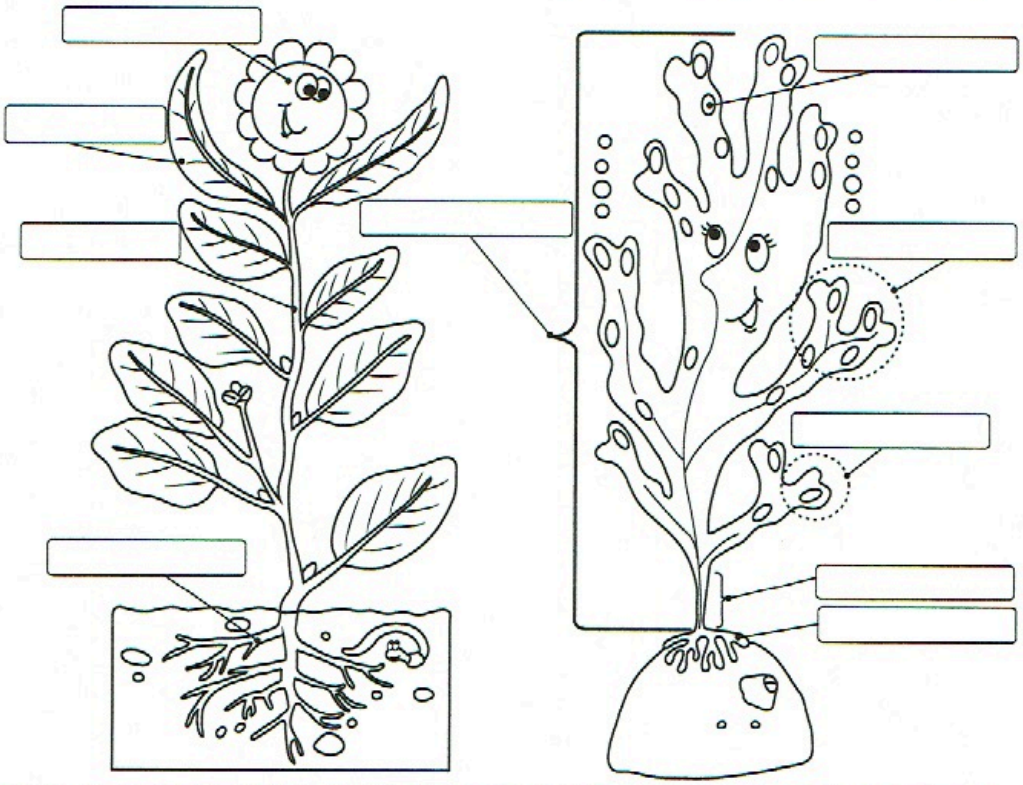
BioMara

Activity 1. Name _____

Label the different parts of macroalgae (seaweeds) and a flower.

Ask the pupils to label the appropriate parts of the macroalgae and flower by using the key words in the table.

THALLUS	FLOWER
FROND	STEM
BLADE	ROOTS
AIR BLADDER	LEAF
STIPE	HOLDFAST



Lesson One. Page 8

Student worksheet 2: Bull Kelp Coloring Page.

Bull kelp (Nereocystis leutkeana)

Bull kelp, like giant kelp (not pictured here), often grow in dense stands forming "underwater forests". They can grow as fast as 1 ft. and 8 inches a day and can reach 100 to 260 ft. Or they can grow half the length of a kid each day, and by the time they are fully grown, can be 30-80 kids high! Kelp offers shelter for young fish and many invertebrates. Draw in some of your favorite fish and invertebrates hiding among the kelp. You could draw in rockfish, sea urchins, sea stars, and crabs.

Quelpo del toro (Nereocystis leutkeana)

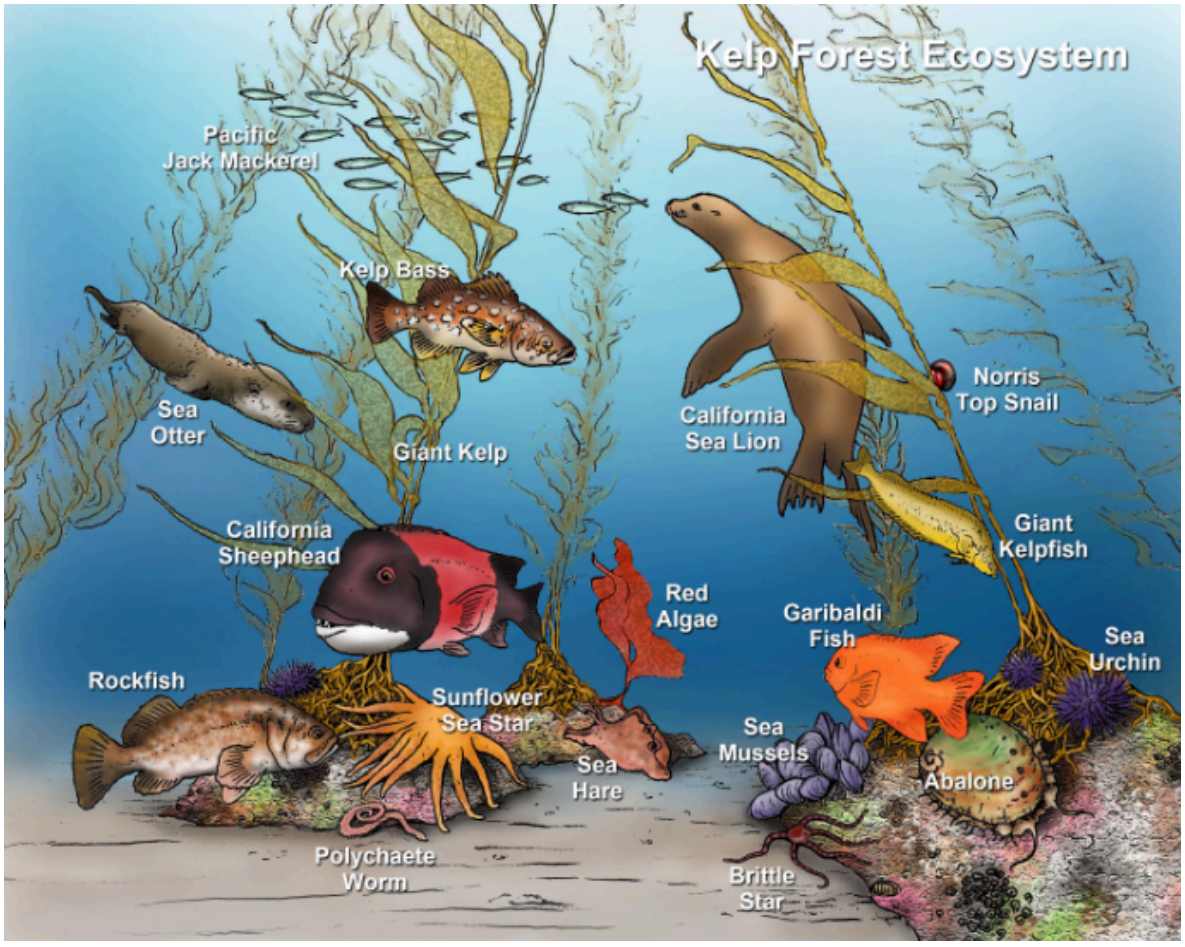
El quelpo del toro, como el quelpo gigante (no figura en esta ilustración), crece con frecuencia en densas columnas formando "bosques submarinos". Pueden crecer hasta un pie y ocho pulgadas al día, y pueden alcanzar de 100 a 260 pies. O bien, pueden crecer la mitad de la estatura de un niño todos los días, y ya cuando han alcanzado su madurez, pueden medir de 30 a 80 niños de altura. El quelpo ofrece albergue a peces jóvenes y a muchos invertebrados. Dibuja algunos de tus peces e invertebrados favoritos ocultos entre el quelpo. Podrías dibujar peces roca, erizos de mar, estrellas de mar y cangrejos.

Teacher references:

Bull Kelp

Laminaria

Giant Kelp



Source: National Geographic Education

Optional Coloring Page (a link to this image can also be found in the Online Resources)

Kelp Forest Ecosystem

NATIONAL GEOGRAPHIC education
natgeoed.org

MPA Toolkit

For Humboldt and Mendocino Counties

UNIT 1

Grades K-2

Lesson 4: Habitats Through the Eyes of Harlee the Harbor Seal

NGSS -- DCI (Disciplinary Core Ideas):
KESS2.E Biogeography
KESS3.A Natural Resources
1LS1.A Structure and Function
1LS1.D Information Processing
1LS3.B Variation of Traits
2LS4.D Biodiversity and Humans

Time:
30 – 60 mins.

Toolkit Materials for the Teacher

- ✓ Harbor seal puppet.
- ✓ Book: *See What a Seal Can Do* (optional).
- ✓ California Network of MPAs poster.
- ✓ CMPA Safeguarding an Underwater Wilderness poster.
- ✓ Picture of a harbor seal.
- ✓ Set of laminated pictures of each California MPA habitat along with a list of some organisms that can be found in each.
- ✓ Cones, sticks, and signs to set up each habitat type.
- ✓ Video introducing the difference between sea lions and harbor seals (optional).

Learning Objectives: Students will be introduced to all six key habitat types protected by Northern California MPAs by performing a dramatization where they act as a harbor seal that travels to all of them.

Phenomena: Harbor seals have the greatest range of any pinniped in the world (Pinnipeds are the group of fin-footed carnivorous sea mammals that include sea lions, fur seals, true seals, and walrus)**.**

Background information:
California is naturally diverse with a wide variety of plants and animals living there. All plants and animals have features or characteristics that allow them to adapt to their surroundings. Humans tend to be more familiar with the plants and animals that occur on land because that is where we live. The oceans off our coast also have a wide assortment of plants (i.e. algae or kelp) and animals living there. Some animals especially are difficult to study because they have huge migratory ranges, live in deep waters, or are highly cryptic. Others that we do know about may seem weird or bazaar, such as the giant octopus, sunflower star, or bat ray and can be a great way to introduce young students to ocean life. Some ocean life is highlighted in the *Ultimate Oceanpedia* book found in the Toolkit (which can be useful as a visual aid in this lesson). There are also several small sea life toys in the Toolkit that can be used for discussion purposes towards the end of this lesson.

Our ocean is vast and is separated into several zones based on depth and distance from shore. There are two general zones as you head out from shore: the **coastal zone** and the **pelagic zone**. The pelagic zone is open water and is where some of the largest animals such as whales and dolphins live. California MPAs are located in the coastal zone extending out from the shore three nautical miles. Additionally, they have been placed in close proximity to each other in order to help preserve the connections and flow of life between different marine ecosystems (refer to Lessons 1 in Unit 2). The concept of a network might be difficult for young kids to grasp, but it is worth mentioning as they learn about these important places.

Tookit Materials for the Students

- ✓ Harbor Seal coloring page (optional)

Connections:
Art, drama, physical geography, language arts, biology, zoology

MPA Core Ideas:

MPAs can protect natural diversity and ecosystem function.

MPAs can protect representative and unique habitats.

Vocabulary
habitat
harbor seal
estuary
sandy beach
kelp forest
rocky reef
intertidal zone
submarine canyon
seal
sea lion

Suggested extensions:

- Take the students to one of the marine habitat types (sandy beach, rocky reef, or intertidal zone) for further observations and to learn more about it.

A Marine Protected Area (MPA) is a clearly defined geographical space, recognized, dedicated, and managed to achieve goals associated with but not limited to preserving ecosystem services and protecting unique habitats. There is a map in the Toolkit showing where Northern California MPAs are located. Each one falls within one of six different marine habitats (see list below). Furthermore, a representative labeled laminated picture of each habitat type can be found in the Toolkit and are intended to be used in this lesson. Some of the habitats have already been introduced in this unit (i.e., Lesson 1- Intertidal Zones and Lesson 3 - Kelp Forests).
The six habitat types for California Marine Protected Areas are:

1) intertidal zones
2) kelp forests
3) rocky reefs
4) estuaries
5) sandy beaches
6) submarine canyons

One of the goals of the California Marine Protected Areas (MPAs) is to protect marine habitats for their intrinsic value and to preserve the structure, function, and integrity of these systems. In this lesson you can reinforce the idea that MPAs protect different places for different reasons. As mentioned in previosu lessons, some MPAs prohibit the disturbance of any marine resource while others allow the take of particular species. Regardless of specific regulations for each, California MPAs are places where human disturbance is limited.

A fun way for young students to be introduced to all six different habitat types is for them to pretend to be a harbor seal traveling from one to another. Harbor seals have the largest natural range of any pinniped. (Pinnipeds are the group of fin-footed marine mammals comprised of sea lions, fur seals, true seals, and the walrus). One way to expand this lesson is for students to compare seals to their cousin, the sea lion (see online resources below) as they are sometimes easily confused. Both sea lions and harbor seals can be found lying on the local rocks and beaches and swimming where people can easily see them such as near docks, boats, and shorelines.

Here is a quick comparison of these two common pinnipeds: **Harbor seals** belong to a group of seals called *earless* seals or true seals. They have holes on either side of their head instead of an earflap that covers the ear hole. They are clumsy on land compared to their *eared* seal counterpart, the sea lion. **Sea lions** are bigger, make more noise, and can walk on their flippers.

• Find a book about one of the marine habitats and read it to the class. • Select a California MPA and make a mural or diorama including some of the life forms that live there. • Learn about an amazing cousin of the harbor seal – the elephant seal. Many videos can be seen including a live video cam in central California: http://www.elephantseal.org/photos.htm	Harbor seals have to crawl around like a worm on land. They do not migrate and can live in a variety of habitats. Their bodies are built for fast swimming and they can dive to nearly 1,200 feet and can hold their breath for over 25 minutes! They eat mostly fish but will also hunt mollusks (e.g., snails, squid, octopus, etc.) and crustaceans (e.g., crabs, shrimp). They are hunted by larger species such as sharks and killer whales. On land, their pups are susceptible to predation by coyotes and bobcats. The biggest threat to harbor seals is human caused pollution and other dangers posed by humans such as getting tangled in fishing nets. Because harbor seals have such varied homes, one can use this species to introduce students to a variety of marine habitats – the main focus of this lesson. They prefer to live in coastal areas, rocky islets, estuaries, and can even live in freshwater lakes. Although you don't think of seals living in deep submarine canyons, (one of the six habitat types in this lesson), they can dive very deep and may use this habitat for hunting fish and other organisms. For additional information about seals, there is a cute book titled *See What a Seal Can Do,* by Chris Butterworth in the Toolkit. Although it is mostly about the gray seal (an Atlantic ocean species), gray seals are very similar to harbor seals. Feel free to read it before you begin the described procedure below to introduce students to these sea mammals. Before you begin make sure you have all of the materials you need including the laminated pictures of each habitat type. You may also want to use the cones and sticks and place the pictures of each habitat type at each station for better comprehension. **Suggested procedure:** Begin by asking the students if they remember what M-P-A stands for (refer to Lesson 1). Have them say, "An MPA is a Marine Protected Area." Next, have them look at some pictures of sea life (refer to books or online information). Explain to the students that every animal (or plant) has different structures that help them survive and thrive in the habitat where they are found. Next, Ask them if they remember what the word *habitat* means (refer to Lesson 2). Remind them that a habitat is a home. Some types of animals will inhabit only one sort of place or ecosystem, but others can swim far and wide like whales, dolphins, and seals. California Marine Protected Areas are designed to protect the animals that live along the coast and not those that have huge ranges such as dolphin, whales, and sharks. At some point you may want to hold up the large California MPA network poster (or use a digital format) and show the students where they live. Remind them that they live next to the Pacific Ocean, the largest of all the oceans. Point out the red and blue

	places on the map and explain that these are MPAs. They are like underwater parks. Once they find where they live, ask them to give an example of a habitat (e.g., responses might include a forest, a sandy beach, a kelp forest, or a tide pool). Explain that many marine habitats are difficult for us to see because they are underwater and can be far away. It takes a boat or the ability to swim in order to see them. Even then, some are so deep that it is difficult for people to see them. Review the six different key habitats with them by holding up each laminated picture or using the Underwater Wilderness poster (listed above). Explain that in this lesson you want them to learn about all six types of habitats found in Marine Protected Areas including those that extend really far down like submarine canyons. Find the 6 pictures that coincide with each habitat type or show pictures of these habitat types. One at a time, hold the appropriate picture and say what kind it is (refer to the list above). Next, hold up a picture of a harbor seal (see pictures in the toolkit binder or refer to the images below). Ask the students if they know what kind of animal it is. Hold up the harbor seal puppet and point out various features they have such as flippers, spots, relatively slender bodies, whiskers, and large eyes. Explain that harbor seals eat fish and other things using their sharp teeth and flexible bodies. They are great swimmers and can dive to nearly 1,500 feet deep! They can hold their breath for over 25 minutes. Their whiskers are important features for finding food. Surfers see them frequently and sometimes they will interact with them. In this lesson, the harbor seal they will pretend to be is named Harlee. At this point you may want to read *See What a Seal Can Do* or jump to the next step, which is the dramatization. Be sure to have each MPA "station" set up ahead of time. Explain that just like humans who can travel far and wide and live in a variety of habitats (i.e., tundra, deserts, mountains, or jungles), the harbor seal can also live in a variety of places. It has the widest distribution of any animal called a pinniped. It is not unusual to see these curious critters looking at you in the shallow waters near the sea, such as in a harbor or bay. To get started, come up with a game plan. Tell the students that in this activity, they will pretend to be Harlee the harbor seal. Harlee travels to six different habitat types protected by MPAs. Decide how you want them to navigate through the habitat types (in two groups or all together with you as the leader). If you have an additional leader, one group can start in an estuary eventually swimming out to a kelp forest and a submarine canyon while the other group starts sunning

	themselves on a sunny beach before visiting a rocky reef and intertidal zone. Feel free to adjust the arrangement as you see fit. The order of the skit is only a suggestion (refer to skit below). After they completed the dramatization, give them some time to share their experience. Finish this lesson by having the students review the six different types of habitats as you hold up the each sign. If time allows, discuss what types of things might be found there. There is an assortment of sea life toys in the Toolkit to assist story telling. Remind them that Marine Protected Areas are like underwater parks. They help protect our ocean and the types of places they just visited. To round out the lesson, you may want the students to color the harbor seal coloring page below and add elements from one of the types of habitats they just learned about.

MPA Goal Connections:
#1 To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
#4 To protect marine natural heritage, including protection of representative and unique marine habitats in California waters for their intrinsic value.

Online resources:
Blue World Academy Video to introduce kids to seals and sea lions.
https://www.youtube.com/watch?v=fcgPpOhv9OM
Another short video (4 minutes) filmed at Pt. Reyes National Seashore showing the behavior and differences between the pinnipeds. Elephants, Seals, and Lions, Oh My!
https://www.nps.gov/media/video/view.htm?id=FA107D87-C249-5510-3A1DD3D13B6B62B7
Animal Diversity Web: *Phoca vitulia,* Harbor Seal, Natural History information.
https://animaldiversity.org/accounts/Phoca_vitulina/
National Marine Sanctuaries: For more information on seals and sea lions and how they differ
https://marinesanctuary.org/blog/the-difference-between-seals-and-sea-lions/

Engage: Show a map of Northern California MPAs and point to the location where the students live. Ask them what sorts of animals live in the ocean and show them pictures or toy models of sea life.
Explore: Show them the poster of the *CMPA Safeguarding an Underwater Wilderness* poster. Using dramatization, explore the six marine habitat types MPAs protect.
Explain: Explain that MPAs are special places that help protect different habitats. Habitats are "homes" for animals and other sea life. MPAs are similar to a park on land whereby certain human activities are regulated.
Elaborate: Watch a film to learn about harbor seal (or other seals) behavior and characteristics so they have a to better idea of how to mimic this species or read the book *Sea What a Seal Can Do*.
Evaluate: After the students "swim" to all of the six different marine habitats, review what they have learned by asking them to identify by name each habitat type. Ask them what sorts of living things they might find in each place. Ask them why it might be important to protect some of these places.

Teacher Reference:
SKIT: DRAMATIZATION OF A HARBOR SEAL

Before you begin, review some of the movements that the students will be using as they travel - acting as Harlee the harbor seal.
Diving (hands pointed as if diving into a pool)
Eating (chomp with their mouths)
Swimming (use their hands as if they were doing the breast stroke)

Explain that harbor seals may be a little awkward on land but they are great swimmers when in water. When they are on land they cannot walk on their flippers like sea lions can. They can only wiggle around, sort of like a caterpillar or worm. Have the students lie down on the sand or in the grass and practice moving their bodies a few feet without using their hands. Next, explain that they will need to listen to the clues. For instance sometimes the will eat a fish. How are they going to act this out? Sometimes they might dive down to a deep place. How might they act this out? Model these movements beforehand.

Next, explain the path that they will take (sandy beach to estuary to rocky reef to submarine canyon to kelp forest, ending at the rocky intertidal zone). This is variable depending on the size of your group(s) and how you have the skit arranged.
It is suggest that you use cones and attached labels to the poles that fit inside each cone.

SKIT:
Feel free to use the Harbor Seal Puppet and be the leader.
Everyone starts by laying down and listening.
Marker 1 (Sandy Beach):
Announcer:
"*Harlee has been sunning on the beach and is just waking up.*"
Kids stretch, yawn, and act lazy. They should try and move with no arms to assist them.

Announcer:
"*Harlee's stomach is growling and he/she pushes off to explore an estuary looking for fish.*"

Kids wiggle on the beach to get into the water (kids stand). They move their arms as if they were swimming moving to the next marker. They enter an estuary (they can pretend to peek up through eelgrass and other vegetation here). Now they should be at Marker 2 (Estuary)

Announcer:
"*A human comes by to bird watch at the estuary and Harlee decides to move out to a rock reef where she will hunt for fish, squid, or other tasty food.*" Kids swim to Marker 3 (Rocky Reef) this time diving down looking for fish (hands point forward – eyes are searching).

Announcer:
"*Harlee is now at the rocky reef and has caught a fish. He/she has been holding her breath for over 15 minutes and he/she needs to go back up to the surface for air.*"

Kids pretend to eat a fish (chomp). Once they are done they can pause at the surface and get some air (they can take a deep breath).

Announcer:
"*Now that Harlee has had a meal he/she decides to use his/her strong tail and dive down really far. Harlee dives way down deep and can spot a very deep canyon below.*"
At this point you may want them to close their eyes and either listen (make a *glub glub* sound) or have them put out their hands (or *whiskers*) to sense what is around them. "*It is very dark in the canyon and he/she can't stay long as she has been holding her breath for a very long time and needs to surface for air.*"

Kids move as if they are swimming to Marker 4 (Submarine Canyon). Kids swim a lot and dive deep where they can spot the canyon.

Announcer:
"*Tired, Harlee decides to head back to shore. She/he is getting cold. Before he/she does she would like to have another meal, so he/she decides to heads to a kelp forest where lots of animals hide.*"

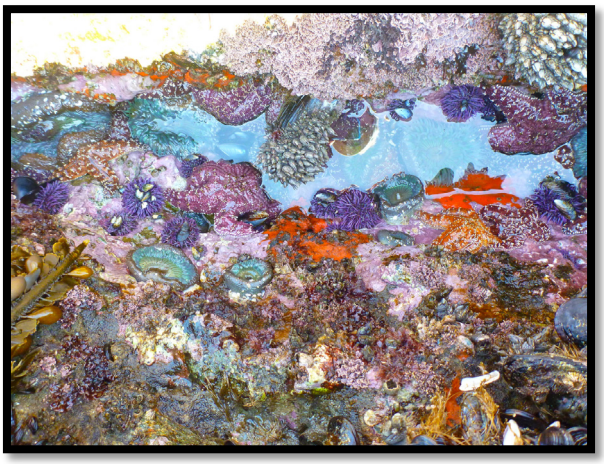
Kids act tired and cold as they swim to Marker 5 (Kelp Forest).
Announcer: "*In the kelp forest Harlee feels right at home. He/she hunts through the "forest" looking for fish and crab. He/she spots something and decides to get another meal.*"

Announcer:
"*Finally, with a warm belly full of food, Harlee swims back towards the shore. The tide has gone out and the currents have moved his/her to a rocky intertidal zone where she finds him/herself having to haul out onto low flat rocks.*"

Kids move to Marker 6 – Rocky Intertidal. They need to lie down again as they come to shore. They should wiggle not using their hands to lie down and warm up. They can put on a big smile since they have a belly full of food. It is now time for a nap.

After they completed the dramatization, give them some time to share their experience. Show them again the pictures of each ecosystem (habitat type) and discuss what sorts of organisms might live in each. For instance an eel needs rocks to hide in. A sand dollar needs a soft bottom to burrow into. Remind them that marine protected areas are like underwater parks. They protect these different places and the sea life that depends on them. Ask them why it is important to protect our oceans and these different habitat types.

Option for older students:
Extend their learning by asking: "*What might happen to a harbor seal if it doesn't have adequate space to hunt, raise young, or feel protected?"* Answers will vary. It could move to a new habitat. It might not be able to feed its young.



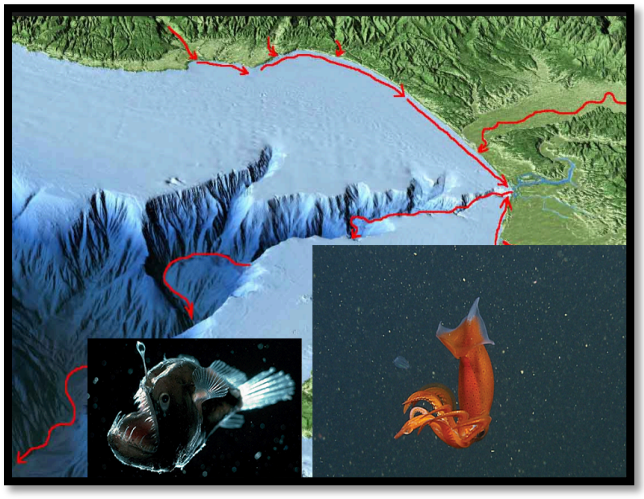
Rocky Intertidal

Estuary

Rocky Reef

Kelp Forest

Sandy Bottom



Submarine Canyon

Note: Large laminated cards of these habitats are in the Toolkit

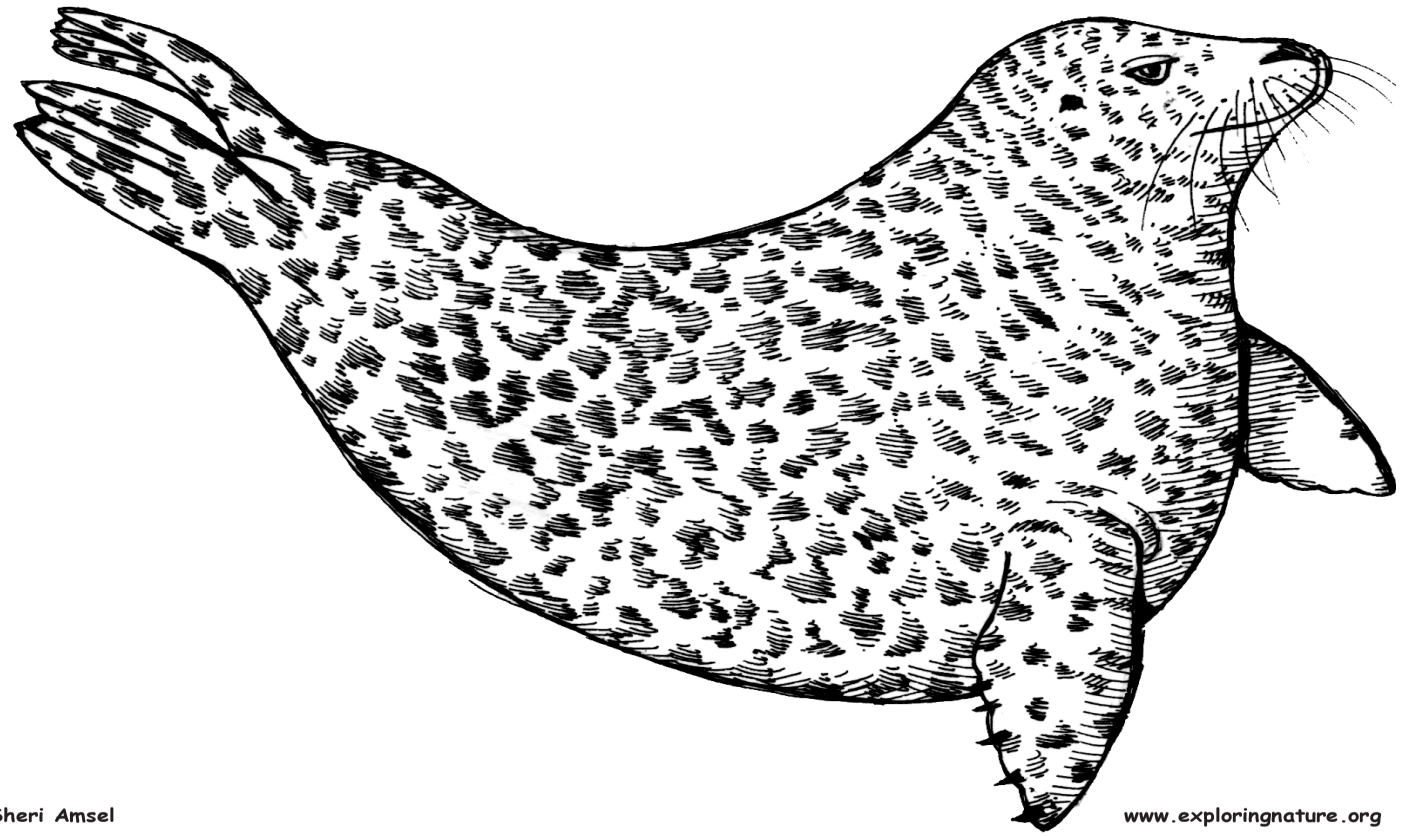
Teacher Reference (Lesson 4) Harbor Seal:

Features include thick, short, coarse hair, a strong tail and flippers. A layer of thick blubber keeps it warm. They usually have a spotted coat, big eyes, long whiskers, short arms, and no ear flaps.

Student Worksheet: Harbor Seal Coloring Page

Name _____

Color the Harbor Seal



MPA Toolkit

For Humboldt and Mendocino Counties

UNIT 1

Grades K-2

Lesson 5: Benefits of Big, Old, Fecund, Female, Fish!

NGSS -- DCI (Disciplinary Core Ideas):
KLS1.C Matter & Energy Flow in Organisms
KESS3.C Human Impacts on Earth Systems
1LS1.A Structure and Function
1LS1.B Growth and Development of Organisms
1LS1.D Information Processing
2LS4.D Biodiversity and Humans

Time: 30 – 45 mins.

Materials for the Teacher in the Toolkit

- ✓ Platy fish spinner to show fish life cycle stages
- ✓ 3 Vermillion rockfish puppets with strings of eggs in pockets.
- ✓ Poster of local seafood (optional)
- ✓ MPA Poster: *Habitats & Species of California's MPAs*
- ✓ Copies of the vermilion rockfish coloring page (found below or in the coloring book in the Toolkit) (optional)

Learning Objectives: Students will learn about the benefits of protecting BOFFF (Big, Old, Fecund, Female Fish) fish using puppets in regards to reproductive potential. In addition they will learn the stages of a fish's life cycle.

Phenomenon: A mature female fish can produce a million more eggs or babies in a year compared to a younger fish.

Background information:
An important benefit of California's Marine Protected Areas (MPAs) is the fact that many older fish and invertebrates are protected. Humans prefer to catch and eat big old fish and looking back throughout history confirms this. Some species have been overfished for either sport or consumption or both. There are several disadvantages to taking or eating the larger, older fish. Some fish species live a long time (over 70 years) so it can take decades for them to reach reproductive maturity and help replenish fish stocks. In addition, large, fertile (or fecund), female fish can produce far more offspring than smaller, younger fish; therefore, older fish have a higher reproductive value.

One of the benefits of MPAs is that they can help replenish populations of fish and other species. Thus, MPAs can act as a "source" for young fish and invertebrates and no-take zones restrict fishing and other forms of extraction. By restricting the take of certain fish species, populations can potentially rebound over time. Because of the higher reproductive value of more mature fish, an acronym is used: BOFFF (Big, Old, Fat, Fecund, Female) fish. The difference between the terms fecund and fertile is **fecund** describes things that are highly fertile and that easily produce offspring, whereas **fertile** only implies the ability to reproduce. In this lesson, fecund is a more accurate description, as more mature fish are much more fecund because they produce many more offspring. What term you introduce to the students is up to you. It can be fun to learn a new scientific term. For instance, in this lesson a 13 year old female vermilion rockfish, approximately 20 inches long, produces 700,000 offspring per year compared to a 19 year old, 24 inch long, female that will produce one million more (1,700,000) offspring per year – more

Materials for the Students

- ✓ Vermilion rockfish coloring sheet (optional)
- ✓ Paper and crayons (options)*

* Not in Toolkit

Connections:
Art, economics, biology, math, zoology, language arts.

MPA Core Ideas:

MPAs can sustain and restore marine life populations.

MPAs can improve recreational, educational, and study opportunities.

Vocabulary
Fecund
Fertile
Fry
Juvenile
Egg
BOFFF
life cycle

Suggested extensions:

- Have students make their own life cycle spinners for fish or other sea creatures (template is found below).

than double the smaller fish! Data have shown that by preserving large, fecund or fertile female fish (i.e., BOFFF), the potential for population growth increases. The importance of preserving BOFFF is the main idea behind this lesson.

In this lesson, students will become familiar with a fish's life cycle, especially that of the **vermilion rockfish** – the same fish as the fish puppets found in the Toolkit. Some students may already be familiar with the salmon cycle since it has been stressed throughout the Humboldt/Mendocino areas. The salmon life cycle is more complicated than a rockfish, however. Salmon are considered anadromous, which means they divide their lives between the sea and a river. Conversely rockfish, cabezon, lingcod, and many other important commercial and recreational fisheries, spend their entire lives in the ocean. Unlike many fish species, **rockfish** reproduction occurs via internal fertilization; the embryos develop inside the female until they are released as small, larval fish. In contrast to juvenile fish, which look like small versions of adults, larval fish look very different from the adult. (refer to Image 2 below). They are transparent with a long body, a caudal (tail) fin for swimming, and large eyes and mouth for locating and eating prey. They are basically tiny eating machines whose main goal is to find and eat as much zooplankton as possible in order to grow quickly – while avoiding being eaten themselves. In two other popular sport fish, the **lingcod** and the **cabezon**, females lay eggs, which are then fertilized and guarded by the males until they hatch. Cabezon eggs have another defense – they are toxic! Image 3 below shows the reduction in size of lingcod over the last eighty years or so.

In Humboldt and Mendocino Counties, commercial, recreational, and subfishing (i.e., mixed species fishing) is economically and culturally important. You will find a nice colorful poster showing commercially harvested fish in the Toolkit. Showing students pictures of seafood that many people like to eat can be a great way of rounding out this lesson (refer to the posters in the Toolkit).

Suggested procedure:
Gather all the students together in a big circle. Before holding up the female fish puppets, explain to the students that they will be learning about fish that live in the ocean. Fish are important for a variety of reasons. In order for them to prosper, people need to set some limits and manage them so that there can be plenty of fish in the future. First, review a simple fish life cycle with the students. Depending on the students' prior knowledge, you may first want to introduce the concept of life cycles in a more general way using something more familiar to them such as an insect's

• Have students model how eggs are carried by currents by blowing bubbles in the wind (refer to Lesson 1 in Unit 2). • Have students make fish prints using rubber fish. • Plant seeds and count the population of seedlings the class produced after they have sprouted.	life cycle (i.e., egg, caterpillar, pupa, butterfly). Many fish including rockfish have a larval stage that, like the caterpillar, looks very different from the adult. (Note: The cartoon fish used on the spinner doesn't show the true form of a larval rockfish or fry). For an accurate picture of a larval fish, please refer to the Online References or image 2 below. Next, hold up the Platy fish life cycle spinner with the adult fish visible in the opening. Tell them that the fish is a female and she is pregnant. Have them predict what stage they will see next. Move the spinner to show "fry" (fry in this case represent larval fish). *Note: this particular fish (i.e., Vermilion rockfish) bears live young although, many other fish lay eggs as mentioned above*. It is fine if students predict that the female adult fish will lay eggs, but please correct them and explain that rockfish are different - the embryos develop inside the female, so this particular type of fish bears live young. Move the wheel to the stage that shows "juvenile". Explain that **juvenile** is the word given to a fish that is not yet able to have babies or is not yet mature. Just like us there are a few stages or steps that happen before they reach maturity. You might think of fry being in elementary school and juveniles in middle school. Ask, "What do you think will be the next stage (after juvenile)"? After getting their responses show the **young adult** stage. Explain that some fish can live a long time. Vermilion rockfish become old enough to bear young when they are three to four years old. After that return to the large adult stage again. Review the life cycle with them one more time, this time having the four words regarding the fish life cycle visible: fry (or larval fish), juvenile, young, and adult. Next, hold up the poster *Habitats & Species of California's MPAs*. Ask them to guess which one is the Vermilion rockfish (answer #54). Explain that one of the benefits of having Marine Protected Areas (MPAs) is that many fish species are protected so that they can grow into BIG, OLD, FECUND (or fertile), FEMALE, FISH. You may also want to "wow" them by showing them some pictures of really big ocean fish (refer to online resources below). Next, show the students the puppets, beginning with the smallest one. As noted earlier, the fish puppets in this lesson are modeled after the Vermilion rockfish, *Sebastes miniatus*. They can live for over 50 years and weigh up to 15 pounds. They mostly live along rocky bottoms. Explain that they will see how many more babies an old female fish produces compared to younger fish. Hold up the smallest fish puppet and explain how old it is and how much

	it weighs (note: the information is given on the outside of the puppet) and let the eggs fall out. Say, "Look how many babies this fish produces in one year". If you have older students, count them together "1, 2, 3, 4, etc.". Explain that each bead represents 10,000 larval fish. If they do the math, the young fish puppet can lay 150,000 eggs (15 fish beads) in one year. Repeat for the next puppet that is 13 years old. Again tell them the age and size of the fish and then let the eggs fall out. Tell them that a fish this old can have 70,000 babies (70 beads) in one year. Lastly, pull out the biggest, fecund, female, fish and explain how old she is and how much she weighs. Say, "Look how many babies the older fish can have". Let the beads fall and with enthusiasm, explain that the older 19-year-old fish can have over one million *more* babies compared to the 13-year-old fish. She can have 1,700,000 babies in a year! Reiterate that by protecting older fish many more fish are produced. Older fish have many more offspring and can be a source for replenishing or increasing populations. This is one of the overarching concepts of Marine Protected Areas (MPAs). To conclude, write B. O. F. F. F. on the board. Underneath each letter write the corresponding word. Next, have them say the meaning of each letter together: B= BIG, O=OLD, F=FECUND, F=FEMALE, F=FISH). If fecund is too complex of a word, use fertile in its place. By having some places set aside as sanctuaries, MPAs can help build populations of fish so that there will be plenty for everyone in the future. In other words - it is important to protect Big, Old, Fecund, Female, Fish! To evaluate what students have learned in this lesson, have students share verbally what they have learned or have them draw a fish life cycle. Another option is to have them color a vermilion rockfish found in the MPA coloring book (refer to the student page below).

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

Online resources:
Picture of larval fish in Gulf of Alaska
https://www.afsc.noaa.gov/Science_blog/larvalfish_main.htm
Kelp Kindergarten: Information on the survival of juvenile rockfish and the utilization of kelp beds.
https://fishbio.com/field-notes/ocean-bay-delta/kelp-kindergarten
Ocean Conservancy page on Canary Rockfish (similar to vermilion Rockfish)
https://oceanconservancy.org/wildlife-factsheet/canary-rockfish/
Washing Department of Fish and Wildlife: Vermilion Rockfish page.

https://wdfw.wa.gov/fishing/bottomfish/identification/rockfish/s_miniatus.html
Big fishes of the World: images of some of the record large fish
http://bigfishesoftheworld.blogspot.com/2011/11/pacific-halibut-hippoglossus-stenolepis.html
North Coast CA Sea Grant. Relevant information about fisheries of Northern California including main ports, seasons for fish, seafood posters, and more.
https://caseagrant.ucsd.edu/project/discover-california-commercial-fisheries/regions/north-coast
If you have a tablet or computer, flip through the life expectancy of different fish at
http://www.worldlifeexpectancy.com/fish-life-expectancy-vermilion-rockfish

Engage: Have students predict and explore the 4 main steps in a female fishes' life cycle by having them look at the stages using a "spinner". Begin with the adult and have them predict what will happen next. Continue through the cycle until the end.
Explore: Show the MPA poster showing the vermilion rockfish and/or pictures of economically valuable fish such as cabezon, lingcod, and rockfish to the students and tell them how big and old some of the species can get.
Explain: Using puppets, explain the importance of protecting old fecund female fish (BOFFF) because they can produce a lot more babies. Compare the fish puppets by looking at fecundity (the ability to produce abundant offspring).
Elaborate: Explain that the protection of old, female, fecund fish is one of the benefits of MPAs. MPAs can increase populations of fish by restricting the take of BOFFF because they have a lot more offspring compared to younger fish.
Evaluate: Have the students share verbally or in writing what they have learned by comparing the different ages and productivity of the vermilion fish puppets.

Teacher References:
Image 1: Vermilion rockfish (source: WA fws)

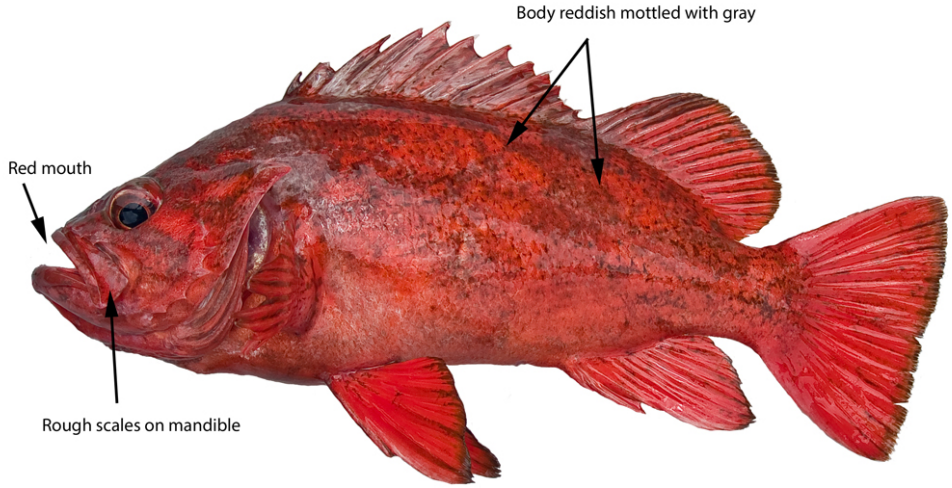


Image 2: Developmental stages of black rockfish (source: Aquaculture Research Journal, 2017)
Note: The life cycle fish spinner used in this lesson shows a cartoon version.

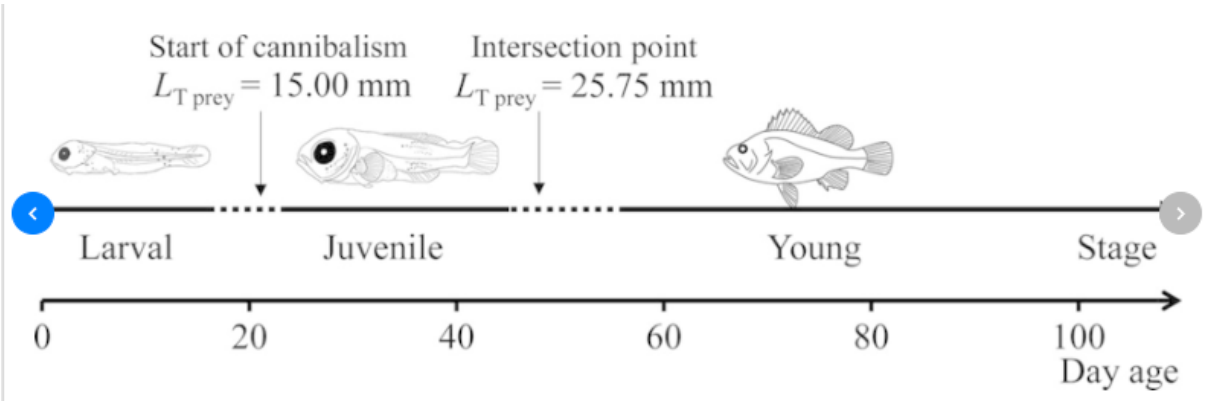
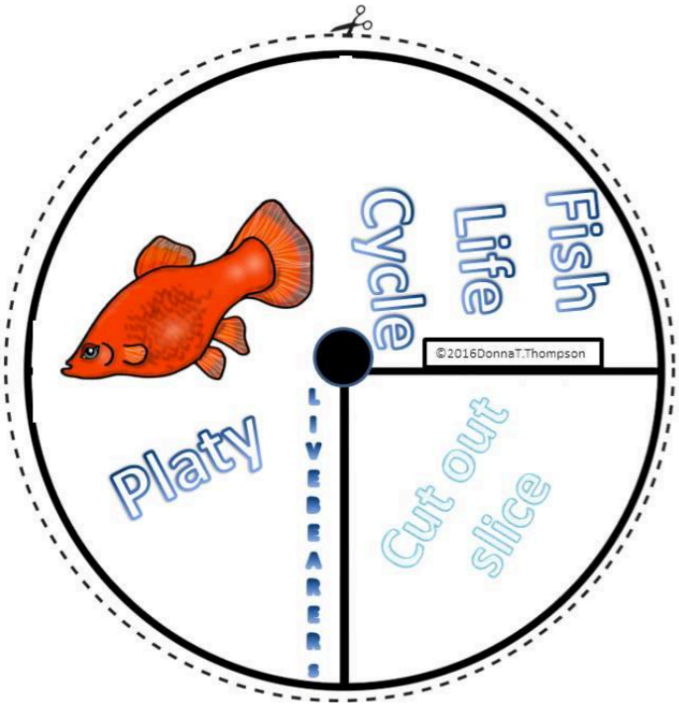


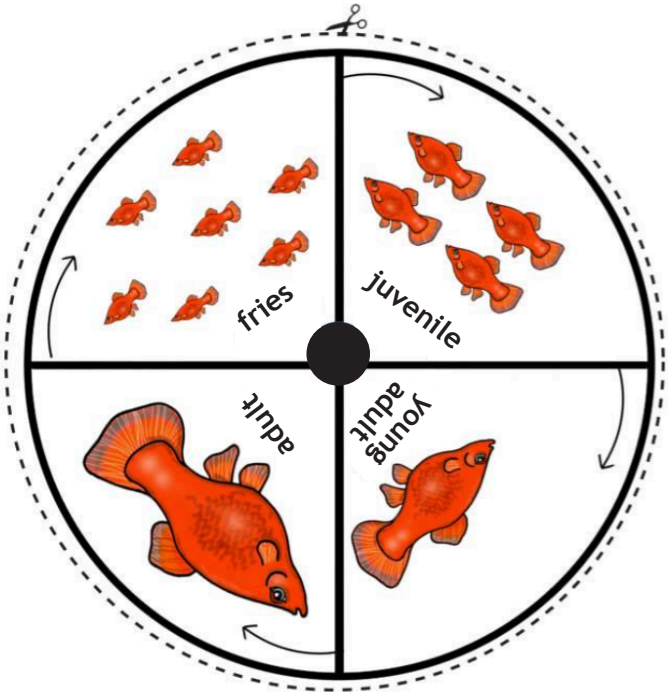
Image 3:

Above: Large lingcod
(Source "How To Catch a Lingcod" riptidefish.net)

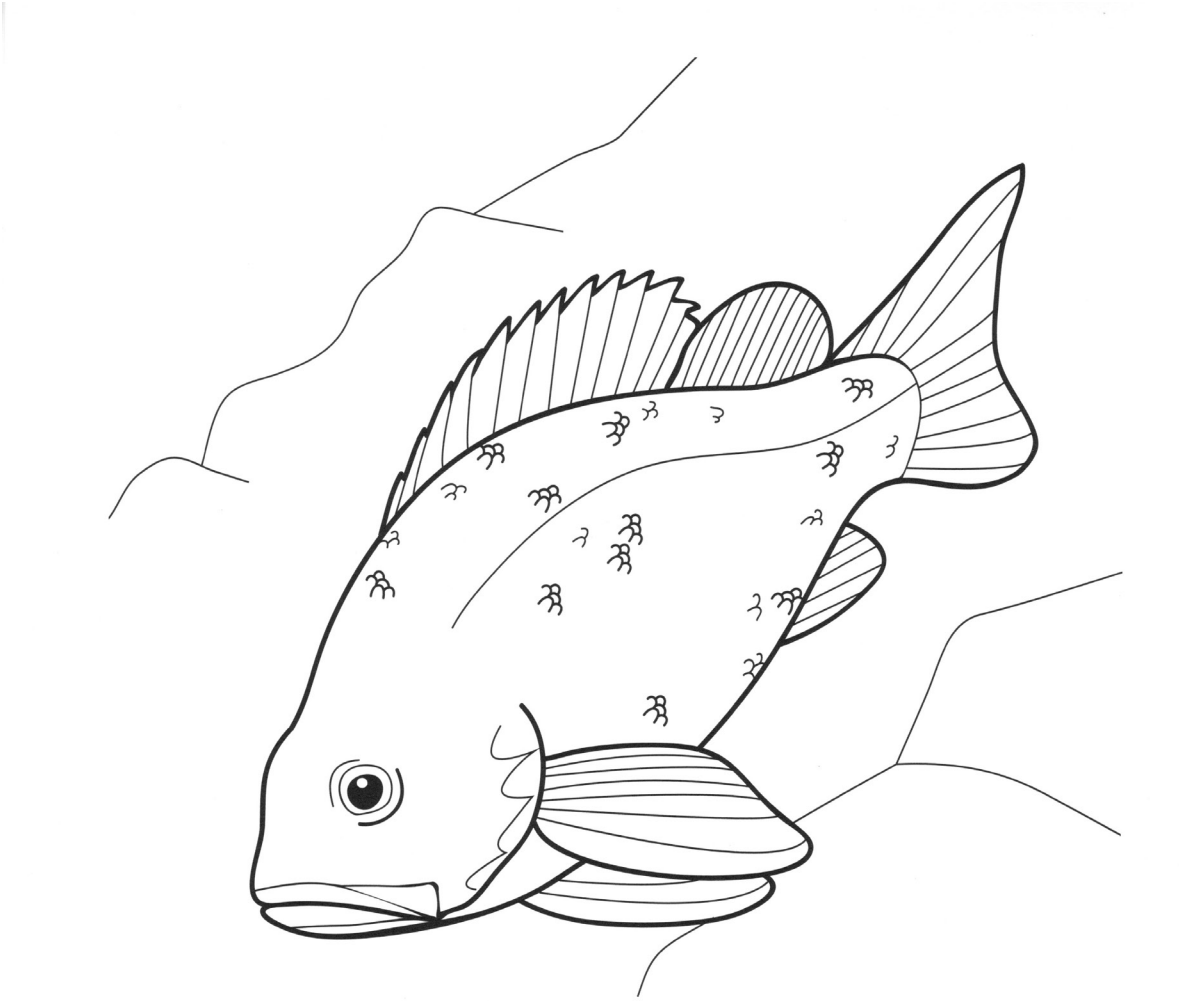
Source: Peabody Museum (Atlantic cod evolving to be smaller over time)

PLATY FISH SPINNER (in the Toolkit)
Note: It is optional to have students make their own spinners.





Student page – Vermilion rockfish coloring page NAME_____



Vermillion rockfish (Sebastes miniatus)

The vermillion rockfish live in deeper water, up to 1000 feet. They have bright red bodies with black and gray on their back and sides and can live to be 60 years old! Did you know that a fish could live that long? Animals can grow bigger in marine protected areas than in unprotected areas. Having bigger, older fish is important because they can have many more babies than the smaller ones. More babies mean more fish!

Pez de roca bermellón (Sebastes miniatus)

El pez de roca bermellón vive en aguas de hasta 1000 pies de profundidad. Tiene el cuerpo de color rojo chillante con negro y gris en el dorso y los costados, y puede vivir hasta los 60 años. ¿Sabías que hay peces que pueden vivir tanto tiempo? Muchos animales pueden crecer más tiempo y agrandarse más en las zonas marinas protegidas porque no se permite que se les pesque o se les haga daño. Tener peces mayores y más grandes es importante porque pueden tener más crías. Mientras más crías tengan, más peces habrá en el futuro.

Appendix A

MPA Glossary of Terms Unit 1 and Unit 2

Abalone: a mollusk with a flattened slightly spiral shell that has holes along the edge and is lined with mother-of-pearl.

Adorn: to enhance the appearance of especially with beautiful objects.

Area: a particular piece of ground or extent of space often set aside for special use.

Biodiversity: refers to the variety of species in a region; marine biodiversity refers to the variety in the ocean.

Biological: of or relating to biology or to life and living processes.

Blade (as it applies to kelp): a flat, leaf-like structure that grows out of a kelp's stipe.

Bladder (as it applies to kelp): a cavity found in various algae that contains gases and serves to keep the algae afloat.

BOFFF: Big, old, fat, fecund, female fish; larger, sexually mature female fish who are capable of producing more offspring than smaller, younger, female fish.

Carnivore: an animal that eats only other animals.

Characteristic (as it applies to biology): ways to describe organisms with things like multiple legs, stinging cells, tube feet, or having a hard shell.

Clam: a shellfish that lives in sand or mud and has a soft body surrounded by a hinged shell with two parts and that is often eaten as food. (Meriam)

Competition: the struggle between organisms of the same or different species for limited resources, such as food, light, or territory.

Consumer: an organism that must ingest or eat others to get their energy.

Crustacean: mostly aquatic invertebrates that includes crabs, lobsters, and shrimp.

Culturally: of or relating to culture.

Decomposer: an organism in a food chain that breaks down organic matter.

Dentalium: any of a genus (Dentalium) of widely distributed tooth shells.

Disperse: to cause to become spread widely.

Ecosystem: a biological community of organisms interacting with each other and with their physical environment.

Egg: a reproductive body produced by an animal and consisting of an ovum with its food-containing and protecting envelopes and being capable of development into a new individual.

Estuary: a passage where the tide meets a river current.

Fecund: fertile, producing or capable of producing new growth or offspring.

Fecundity: number of babies able to reproduce.

Fertile: capable of reproducing or of producing reproductive cells.

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

Food web: the interconnected feeding relationships within an ecosystem; composed of many food chains.

Fry (as it applies to fish): recently hatched or young fish.

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

Harbor seal: a seal with a mottled gray-brown coat and a concave profile, found along North Atlantic and North Pacific coasts.

Herbivore: an animal that eats only plants.

Heritage: something acquired from the past.

Holdfast: a part by which a plant (as a seaweed) or animal (as a tapeworm) clings (as to a flat surface or the body of a host).

Intertidal zone: of, relating to, or being the area that is above low-tide mark but exposed to flooding by the tide.

Invasive species a species that moves into an ecosystem and does harm to the other species living there.

Invertebrate: Animals that lack a backbone.

Juvenile: A young person, animal, or plant.

Kelp: Any of various large brown seaweeds.

Kelp Forest: Underwater ecosystems formed in shallow water by the dense growth of several different species known as kelps.

Keystone species: a species of plant or animal that produces a major impact (as by predation) on its ecosystem and is considered essential to maintaining optimum ecosystem function or structure.

Larva a developmental stage of an animal (after hatching from an egg) that appears different than the adult.

Life cycle: the life of an organism from birth to death; some organisms go through complex, many stage life cycles.

Management: the conducting or supervising of something.

Marine: of or relating to the sea.

Marine habitats: habitats found in the ocean, natural environments of organisms; in California primary habitats are sandy bottoms, rocky reefs, intertidal zones, kelp forest, and submarine canyons.

Marine Protected Area (MPA): an area of ocean/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.

Meroplankton: temporary plankton; zooplankton in the egg or larva stage, that will live on the sea floor or become a powerful swimmer as an adult.

Model: a representation or example of an item or situation.

Mollusk a type of animal with a soft body and no backbone, such as an oyster, clam, mussel, snail, slug, or octopus.

Mussel: any of various edible saltwater mollusks with a long dark hinged double shell.

Network: an interconnected or interrelated chain, group, or system.

Ocean current: a tidal or non-tidal movement of lake or ocean water.

Omnivore: an animal that eats both plants and animals.

Organism: a living thing.

Parasite a species that moves into an ecosystem and does harm to the other species living there.

Photosynthesis: the process by which plants and algae convert energy from the sun into food.

Phytoplankton microscopic photosynthetic organisms that drift in the surface waters of the ocean. The beginning of most food chains in the ocean.

Plankton: Living organisms that cannot swim strongly and are carried around inside the ocean currents.

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

Population: the abundance of a particular species or group of species.

Prediction: an act of predicting.

Predator: an animal that hunts and eats other animals to survive.

Prey: an animal that is hunted and eaten by a predator.

Primary consumer an organism in a food chain that eats a producer.

Producer: an organism in a food chain that is able to make its own food using sunlight and chlorophyll.

Population all the members of one species in a particular area.

Recreation: a way of refreshing mind or body.

Regalia: the emblems and symbols (as the crown) of royalty.

Remotely Operated Vehicle (ROV): are robotic submarines that are tethered to a ship,

where "pilots" control their movement and actions.

Replenish: to fill or build up again.

Rocky Reef: a chain of rocks or coral or a ridge of sand at or near the surface of water.

Sandy Beach: a sandy or gravelly part of the shore of a body of water.

Scavenger an animal that eats animals that are already dead.

Seal: any of numerous marine mammals that live mostly in cold regions, feed especially on fish, mate and give birth to young on land, and use short webbed flippers to swim and dive.

Sea lion: any of several large Pacific seals that have small ears on the outside of the body.

Secondary consumer an organism in a food chain that eats herbivores.

Seaweed: a plant-like organism growing in the sea.

Species a group of organisms that are physically similar and can produce offspring.

Spillover effect: overflow from one area to another; the spillover effect as it applies to MPAs is the ability for fish and other sea life to be replenished as populations move out of protected areas into adjacent areas.

Stipe: a stalk or stem, especially the stem of a seaweed or fungus.

Submarine Canyon: any of a class of narrow steep-sided valleys that cut into continental slopes and continental rises of the oceans.

Sustainable: a behavior that can be continued without having detrimental impacts.

Tertiary consumer an organism in a food chain that eats carnivores.

Tide pool: a pool of salt water left (as in a rock basin) when the tide recedes.

Top predator a predator in a food chain that no other consumer eats.

Transect: a sample area (as of vegetation) usually in the form of a long continuous strip.

Vertebrate: Species with a backbone.

Zooplankton: animals that drift in the ocean currents; different types are found at all depths from the surface down to the deepest depths.
Sources: www.merriam-webster.com/ **kids.britannica.com** **oceana.org** hwww.mesa.edu.au **www.mbari.org**

Appendix B

UNIT 2: GRADES 3-5
NGSS CURRICULUM ALIGNMENT:

Disciplinary Core Ideas:

3-LS1.1 From Molecules to Organisms: Structures and Processes: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. (LESSON 3)

3-LS1.B Growth and Development of Organisms: Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (LESSONS 1, 3)

3-LS2.C Ecosystem Dynamics, Functioning, and Resilience: When the environment changes in ways that affect a places' physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into transformed environment, and some die. (LESSONS 1, 2, 4, 5, 6)

3-LS 3.A Inheritance of Traits: Many characteristics of organisms are inherited from their parents. Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (LESSON 3)

3-LS3.B Variation of Traits: Different organisms vary in how they look and function because they have different inherited information. The environment also affects the traits that an organism develops. (LESSONS 3, 4, 6)

3-LS4.B. Natural Selection: Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (LESSON 4)

3-LS4.C Adaptation: For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (LESSONS 3, 4)

3-LS4.D: Biodiversity and Humans: Populations live in a variety of habitats, and changes in those habitats affects the organisms living there (LESSONS 1, 2, 4, 5, 6)

4-LS1.A Structure and Function: Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (LESSON 1, 2, 3, 4, 6)

4-ESS2.E Biogeology: Living things affect the physical characteristics of their region (LESSON 4)

5-PS3.D Energy in Chemical Processes and Everyday Life: The energy released from food was once energy from the sun that was captured by plants (or algae) in the chemical process that forms plant matter (from air and water). (LESSON 2)

5-LS1.C Organization for Matter and Energy Flow in Organisms: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. Plants acquire their materials for growth chiefly from air and water. (LESSONS 2, 3, 5)

5-LS2.A Interdependent Relationships in Ecosystems: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as decomposers. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (LESSONS 1, 2, 3, 4, 5)

5-ESS3.C Human Impacts on Earth Systems: Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

(LESSON 1, 2, 3, 4, 5, 6)

Science And Engineering Practices:

Analyzing and Interpreting Data: Use observations to describe patterns in the natural world in order to answer scientific questions.
Developing and Using Models: Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
Planning and Carrying Out Investigations: Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
Obtaining, Evaluating, and Communicating Information: Read grade-appropriate texts and/or media to obtain scientific information to describe patterns in the natural world.
Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.

Crosscutting Concepts:

Cause and Effect: Cause and effect relationships are routinely identified and used to explain change.
Patterns: Similarities and differences in patterns can be used to sort and classify, communicate, and analyze simple rates of change for natural phenomena.
Structure and Function: The shape and stability of structures of natural and designed objects are related to their functions.
Scale, Proportion, and Quantity: Natural objects exist from very small to the immensely large.
Systems and System Models: A system can be described in terms of its components and their interactions.