DEFENDING THE DEEP

This lesson plan developed by:

Overview:

Deep-sea mining is the extraction of minerals from the ocean floor at depths below 1,000 meters. Deep-sea mining activities can destroy the physical structures of the seafloor and the ecosystems they house, kick up sediment plumes that smother organisms, alter ocean chemistry, and create noise pollution in an otherwise quiet deep ocean. In this game, students will learn about some of these environmental impacts and the importance of protecting these important ecosystems from destructive deep-sea mining activities.

Materials:

For instructor (for demonstration purposes):

- Clear container
- Tap water
- Cup of sand

Per group of students:

- Deep-sea mining game board
- Deep-sea mining cards and animals
- Scissors
- Tape and glue

Set-up Prior to Activity:

1. Print and cut out the deep-sea mining game board. Tape the two halves together.
2. Print out the deep-sea mining cards. Glue the location cards sheet (ex. A1, B3) to the sheet that has cards that say "LOCATION". Glue the activity cards sheet (ex. Deep-Sea Mining, Sediment Plume) to the sheet that has the cards that say "ACTIVITY." Cut out all the cards and place them in two piles for location and activity. Cut out the deep-sea animals.

Defending the Deep (cont.)

3. If possible, laminate the board, cards, and animals to use again in the future.

Duration:
30-45 minutes

Physical Activity:
Low

Background:
The deep sea, which is generally defined as a depth below 200 meters, is the largest habitat on our blue planet. As you travel from the surface of the ocean down toward the seafloor, light disappears, water pressure increases, temperature decreases, and food becomes scarce. Despite the harsh conditions, there is an astounding variety of habitats and life found in the deep sea. Some of the unique habitats include:

- **Seamounts** are underwater mountains that rise from the ocean floor but do not reach the water's surface. Seamounts are typically formed through volcanic activity and play an important role in ocean ecosystems. These underwater mountains affect ocean circulation and mixing, resulting in nutrient upwellings that stimulate phytoplankton growth, which supports a wide array of marine life. They also create habitats for deep-sea corals, sponges, fish, and other organisms.


Photo credit: Oceana

- **Hydrothermal vents** are fissures found on the seafloor from which geothermally heated water emerges. They are located along the mid-ocean ridge, where tectonic activity can be found. The fluids emitted are extremely high temperatures, and are rich in dissolved minerals, including sulfides. The hydrothermal vent ecosystems are known for unique forms of life, including chemosynthetic bacteria, tube worms, giant clams, and various fish species that have adapted to the harsh conditions.

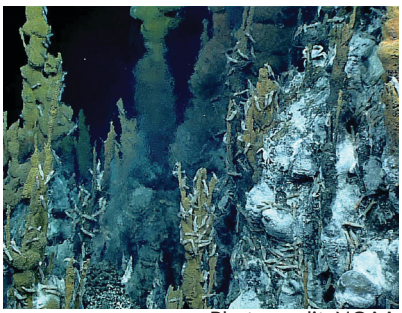
Photo credit: NOAA

- **Abyssal plains** are vast, flat areas of ocean floor that lie at depths typically ranging from 3,000 to 6,000 meters. These plains are formed primarily by the deposition of fine sediment. Along their surface, potato-sized polymetallic nodules can be found. They are formed from metals such as iron, copper, cobalt, manganese, and nickel precipitating from seawater. Despite their seemingly barren appearance, abyssal plains support diverse marine life, including deep-sea fish, squid, sea cucumbers, and microorganisms.


Photo credit: Philweb CC

Defending the Deep (cont.)

As we continue to explore the deep sea, we make new discoveries that help increase our knowledge of one of the least understood places on our planet.

What is deep-sea mining?
Deep-sea mining is a new industry focused on collecting minerals and metals from the deep seafloor below 1,000 meters. Companies are interested in mining metals found in the deep sea, such as cobalt and nickel, to be used for batteries of electric cars and other machines as we transition to renewable energy.

Deep-sea mining refers to three distinct, but related, industries defined by the types of ore targeted for exploitation: the cobalt-rich crusts of seamounts, the hydrothermal vents' massive sulfide deposits that are rich in gold, nickel, copper and other metals, and the polymetallic nodules found on abyssal plains.

What are the impacts of deep-sea mining?
Since deep-sea mining is a new industry, the environmental impacts remain poorly understood and vary significantly depending on the type of mineral being mined. Some of the environmental impacts include:

- **Destruction of the Immediate Ecosystem:** On both cobalt-rich crusts and hydrothermal vents, the ore is the habitat, so mining these deposits will also destroy the ecosystem. To mine these substrates, seafloor production tools grind down the ore body, reducing the deposit to a slurry of sediment and small nodules which can be pumped to the surface for processing. Polymetallic nodule mining along the abyssal sea floor with tank-like benthic crawlers will be destructive to any organisms that live directly on the nodules or in the surrounding sediment.
- **Sediment Plumes:** Activity from deep-sea mining will produce sediment plumes at the mining site as well as in the water column from discharge as the ore is cleaned aboard a surface ship. The mining plume has the potential to smother the organisms around the mining site and spread out several kilometers. The deep sea ordinarily has slow-moving currents and naturally still, clear water so its organisms have evolved without the need or ability to "cough" up or clear sediment from their gills and feeding appendages. The cloud of dust can cause large scale disruption of the seafloor ecosystem.
- **Noise Pollution:** The natural deep abyssal soundscape is consistent and quiet. Deep-sea mining activities are noisy, which can cause stress and interfere with communication and feeding, and cause emigration of marine animals, destabilizing ecosystems.

To prevent irreparable damage to these ecosystems that are almost entirely unexplored we need to protect these areas from deep-sea mining activities. Additionally, governments and companies should prioritize reducing the demand for virgin supply (with enhanced recycling, for example) rather than expanding the supply.

Defending the Deep (cont.)

Activity:

Part 1: Introduction

1. Ask the whole group the following questions:
   - What types of habitat and animals are found in the deep sea?
   - What is mining? What is deep-sea mining?
   - Why do we need minerals?
   - What type of environmental impacts do you think deep-sea mining may cause?
2. Demonstrate a sediment plume with a clear container filled with water and sand. One of the impacts of deep-sea mining is the creation of sediment plumes either through the mining itself or through the discharge from the surface ship as the ore (minerals) are cleaned. Pour the sand into the clear water and discuss how the deep sea ordinarily has slow-moving currents and naturally still, clear water. Deep-sea organisms have evolved without the need or ability to "cough" up or clear sediment from their gills and feeding appendages.

Part 2: Play the Game

1. Have the students break into groups of 4-5 people. Let the students know that there are two piles of cards (LOCATION and ACTIVITY). For each turn, they will pick up a card from each pile. The LOCATION card tells the student where the ACTIVITY card should be placed on the game board. There are three main types of activities:
   - Deep-Sea Mining (dark gray)
   - Sediment Plume (tan)
   - Protected Area (green)
2. Place all the deep-sea animals on top of squares that have habitat, such as deep-sea corals, sponges, or anemones. During the game, the deep-sea animals must be on a square that has habitat or is a protected area (green card). If there is no place for the animal to go, they will need to be removed from the game.
3. Pick one person to go first. The person will pick up a LOCATION card and an ACTIVITY card. Read the ACTIVITY card aloud and place the card down where the LOCATION card says to go.
4. If the ACTIVITY card says, "Deep-Sea Mining" or "Sediment Plume" and it is placed on top of a deep-sea animal, you must move that animal to a new habitat or on a protected area (green card). If there is no place for the animal to go, they will need to be removed from the game.
5. Continue playing until all the deep-sea animals have been displaced or the board is completed.

Discussion:

As a group, discuss the following questions:

- What happened to the deep-sea animals when deep-sea mining activities occurred?
- What are ways we can protect deep-sea habitats and wildlife?

Defending the Deep (cont.)

Ocean Literacy Principles:

Ocean literacy is an understanding of the ocean's influence on us, and our impact on the ocean. There are seven Ocean Literacy Essential Principles that all people of our blue planet should have an opportunity to learn and understand. This activity touches upon the following Essential Principles:

1. The Earth has one big ocean with many features
2. The ocean and life in the ocean shape the features of Earth
4. The ocean makes Earth habitable
5. The ocean supports a great diversity of life and ecosystems
6. The ocean and humans are inextricably interconnected
7. The ocean largely unexplored

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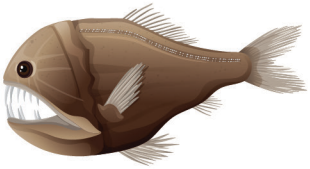
As sailors and water-lovers, you are among the first to notice changes to our seas such as fewer marine animals, more pollution and damaged marine habitat. Through our Green Boating initiative, Sailors for the Sea Powered by Oceana provides opportunities for you and your community to address pressing ocean health issues. As a Green Boater, you will be provided with the information, resources, and access to combat marine plastic pollution, prevent habitat destruction, source responsible seafood, and protect marine animals. From demanding plastic-free alternatives to choosing sustainable seafood, your voice and actions are an important part of restoring the abundance of our oceans and protecting marine habitats. Join our growing Green Boating Community today.

Defending the Deep (cont.)

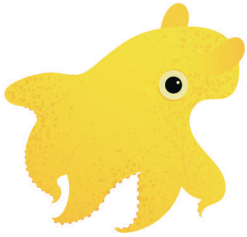
Deep-sea animals:

Giant Sea Spider



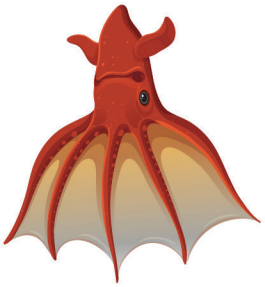
Anglerfish

Nautilus

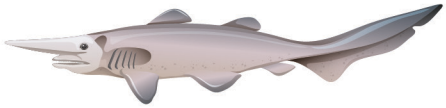


Dumbo Octopus

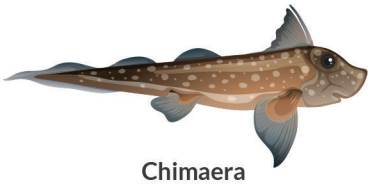
Viperfish



Vampire Squid



Goblin Shark



Chimaera

A1	A2	A3
B1	B2	B3
C1	C2	C3
D1	D2	D3
E1	E2	E3
F1	F2	F3

A4	A5	A6
B4	B5	B6
C4	C5	C6
D4	D5	D6
E4	E5	E6
F4	F5	F6

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Sediment Plume created while mining the seafloor with a tank-like benthic crawler.	**Sediment Plume** created while mining the seafloor with a tank-like benthic crawler.	**Sediment Plume** created while mining the seafloor with a tank-like benthic crawler.
Sediment Plume created while mining a hydrothermal vent which contains sulfides.	**Sediment Plume** created while mining a hydrothermal vent which contains sulfides.	**Sediment Plume** created while mining a hydrothermal vent which contains sulfides.
Sediment Plume created while mining cobalt-rich crusts of a seamount.	**Sediment Plume** created while mining cobalt-rich crusts of a seamount.	**Sediment Plume** created while mining cobalt-rich crusts of a seamount.
Deep-Sea Mining for minerals on the cobalt-rich crusts of a seamount.	**Deep-Sea Mining** for minerals on the cobalt-rich crusts of a seamount.	**Deep-Sea Mining** for metals in sulfide deposits on a hydrothermal vent.
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Deep-Sea Mining Banned in the area to protect deep-sea habitat and wildlife.	**Deep-Sea Mining Banned** in the area to protect deep-sea habitat and wildlife.	**Deep-Sea Mining Banned** in the area to protect deep-sea habitat and wildlife.

Sediment Plume created while mining the seafloor with a tank-like benthic crawler.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.
Sediment Plume created while mining a hydrothermal vent which contains sulfides.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.
Sediment Plume created while mining cobalt-rich crusts of a seamount.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.	**Sediment Plume** caused by pumping sediment back into the ocean from surface ship.
Deep-Sea Mining for metals in sulfide deposits on a hydrothermal vent.	**Deep-Sea Mining** for polymetallic nodules that are found on abyssal plains.	**Deep-Sea Mining** for polymetallic nodules that are found on abyssal plains.
Deep-Sea Mining for metals in sulfide deposits on a hydrothermal vent.	**Deep-Sea Mining** for polymetallic nodules that are found on abyssal plains.	**Deep-Sea Mining** for polymetallic nodules that are found on abyssal plains.
Marine Protected Area designated which does not allow deep-sea mining.	**Marine Protected Area** designated which does not allow deep-sea mining.	**Marine Protected Area** designated which does not allow deep-sea mining.

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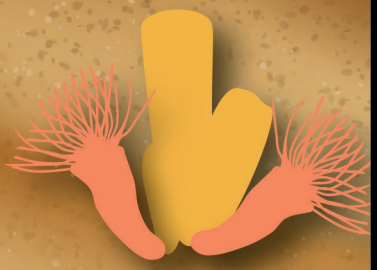
4			
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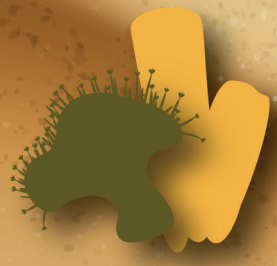
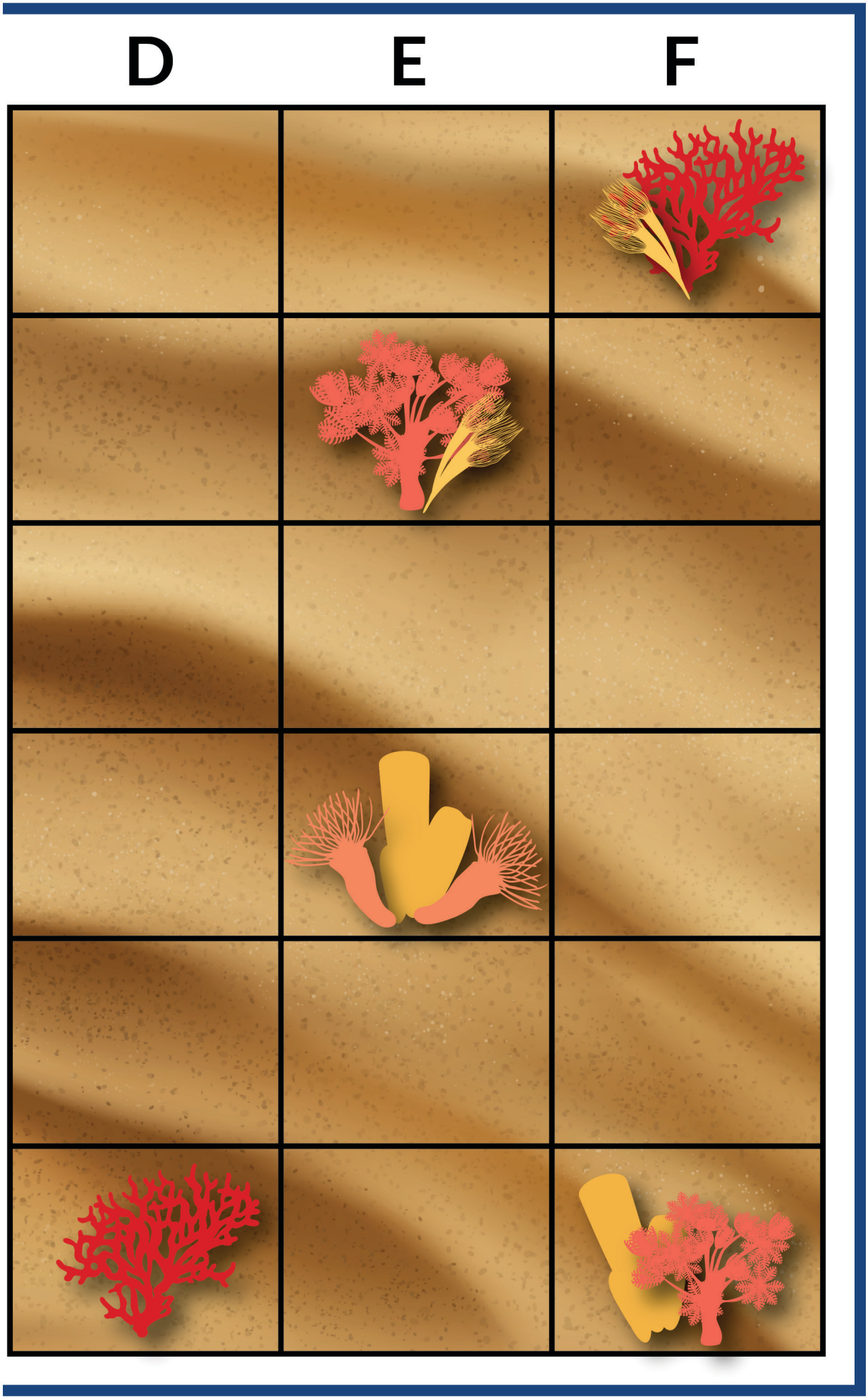
6			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