REMOTE SENSING | EDUCATOR

Links to Next Generations Science Standards |

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process
such that an optimal design can be achieved.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

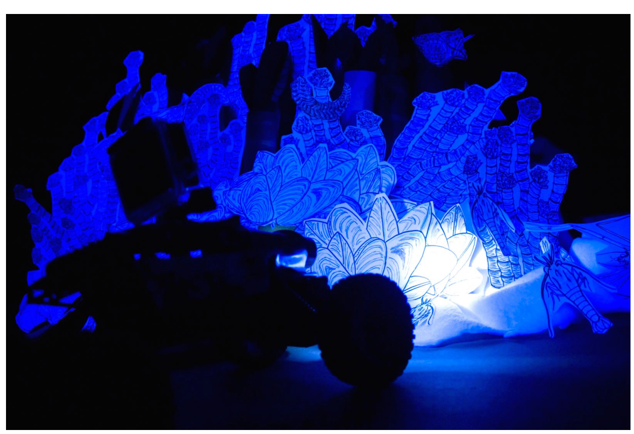
S T E M

Contributing Author | Dieuwertje Kast, Science Communication Fellow
Contributing Illustrator | Christina Machinski, christinamachinski.com
Pacing | 1-3 class periods
Background Needed | Basic understanding of exploration team dynamics and tools.
Assessment | Rubric provided
Materials/Resources |

- Each group (5-10 + students) will need the following:
    - 1 cleared area for habitat set-up and easy remote-controlled maneuvering of a toy car or truck
    - 1 Remote Controlled Monster Truck (https://www.amazon.com/Cheerwing-Crawler-2-4Ghz-Control-Monster/dp/B01LVXZ8R7)
    - 1 GoPro or similar type of camera
    - 1 tablet, cell phone or other device that can bluetooth with the camera.
    - 1 set of walkie talkies
    - 1 habitat scene to explore (see teacher's instructions for set-up)
    - 1 set of student data sheets
    - Clock or watch
    - Pencils
- Optional:
    - Blacklights
    - UV Safety Glasses (if black light is being used)
    - Small LED enabled flashlight to attach to RC truck

Overview

This lesson will introduce students to the dynamics of working together as an exploration team in a simulated deep sea habitat. Students will work closely together to discover geological structures and biological fauna of an unexplored area of the seafloor. They will learn about remote sensing, careers in exploration, data collection, and the technologies involved.



Links to Common Core Standards | CCSS.ELA-LITERACY.RST.6-8.9: Compare and contrast information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

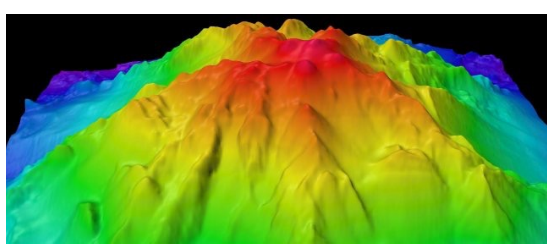
Set The Stage! To introduce the simulation activity, have students line up outside the classroom or area where it will be set up with all views blocked. Explain to students they will work in teams to explore an unknown area without any light, and very dangerous conditions for humans. Prompt conversation and inquiry to see if students can guess the type of habitat they will be exploring. To gauge student familiarity with the topic, see if they can come up with some of the tools or methods used in ocean exploration on their own, before explaining the simulation.

Objectives & Learning Outcomes

- Students will learn about remote sensing and its applications to ROV piloting and deep sea exploration.
- Students will model a deep sea remote sensing ROV team using remote controlled trucks and a bluetoothed camera system.
- Students will learn about the process of collecting and analyzing data from a deep sea habitat.

Guiding Questions

- 1. What are some challenges to deep sea exploration?
  - ✓ Possible answers: Extreme pressures and temperatures, no light, using electronics equipment in an aquatic environment.
- 2. What are some ways data can be collected in the deep sea?
  - ✓ Possible answers: Use robots with HD cameras to collect video and photo imagery of the habitats; use various types of sensors to collect information about pH, water temperature, salinity, etc.; use sampling equipment to collect biological specimens or geological components such as rocks. Use of sonar mapping systems to determine seafloor bathymetry.
- 3. What is the benefit of using remote sensing to explore the oceans?
  - ✓ Possible answers: can learn a tremendous amount of information remotely, or without actually sending humans to the site. This is a safer, more efficient and less costly method to study our planet and beyond.
- 4. Provide some examples of data collected by remote sensing.
  - ✓ Possible answers: seafloor bathymetry maps (http://nautl.us/2FhzBlp):



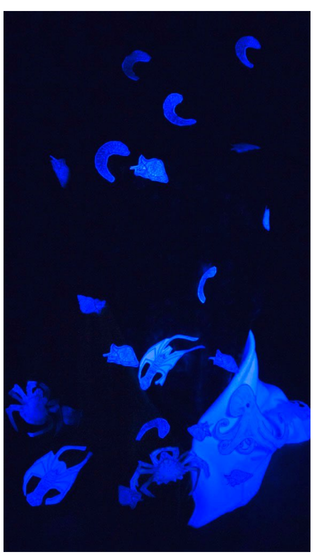
Bathymetry image processed with QPS Maritime Solutions software. This image of a seamount off the coast of Mexico is a composite of thousands of individual depth measurements from E/V Nautilus. The spectrum of colors represent variation in ocean depth. This underwater mountain is artificially colored so red represents the shallow peak and purple represents the deepest depths.

REMOTE SENSING | EDUCATOR

Extensions & Adaptations

Introductory | For smaller or younger groups, the habitat can be modified to contain fewer zones or organisms. Younger students could also hold a camera instead of driving a vehicle. Use a blacklight and have students wear UV safety goggles to create more ambience in the habitat.

Advanced | Complete an inter-class unit by having classes research and design their own deep sea habitat for another class to explore. Activity can be set up in a larger area or outside and drones can be used to survey the habitat. Affix lasers to vehicle to approximate sizing of objects seen.



Habitat set-up shown with blacklight.

Individual images taken by cameras on ROVs can be put together by specialized computer programs to create a "whole" picture of what features look like on the seafloor. This can be helpful when examining shipwreck sites or other notable seafloor habitats or features.

Photomosaic image processed by NOAA ONMS/URI Roman Lab/Ocean Exploration Trust, Inc. This image was created by special software "stitching together" thousands of individual images captured by cameras mounted to ROV Hercules. This mosaic is a segment of the USS Macon wreck site. This dirigible aircraft carrier crashed in the Pacific Ocean during a storm in 1935 while carrying four biplanes. Read more about the survey and mapping of this site here: http://nautl.us/256N4c7.

- 5. Can you think of another environment where remote sensing would be useful? What are some similarities and differences in exploring that environment versus the deep ocean?
  - ✓ Possible answers: Remote sensing is used by NASA to obtain information about other planets and our solar system. Instruments mounted to aircraft or space-based platforms can measure electromagnetic radiation which is helpful in determining the type, substance, and spatial distribution of distant objects. Satellites orbiting Earth help provide weather data that can be translated into digital imagery such as showing a hurricane on a map, or showing an aerial view of surface topography on a GPS map. Similar to the deep ocean, remote sensing is a useful tool in studying extreme environments such as outer space due to the difficulty of getting equipment and people to the actual site of exploration.

Activity/Tasks

Students will:

- read the introduction and complete guiding questions,
- determine team jobs,
- follow job duties to complete exploration of an unexplored habitat,
- collect and analyze data,
- complete the wrap-up questions.

Educator: Lesson Procedure/Directions

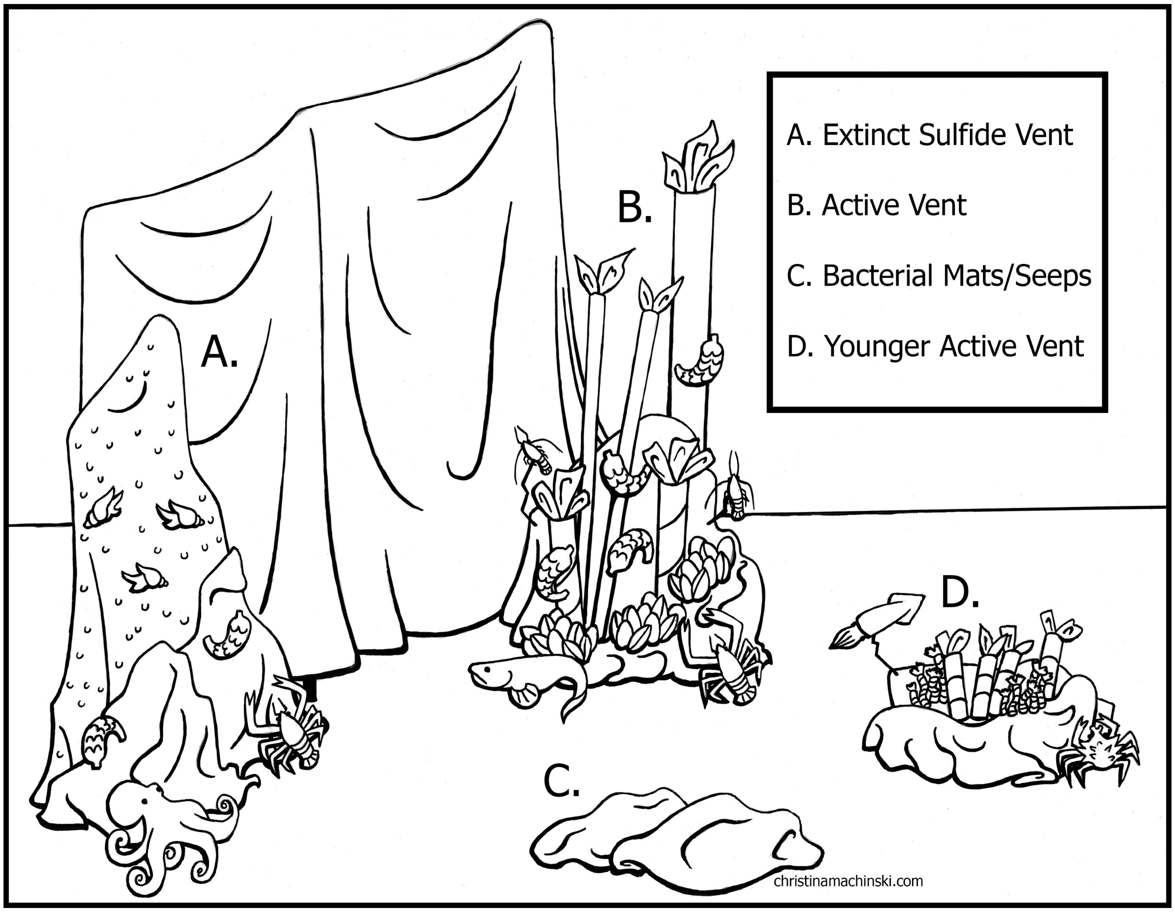
✓ **LESSON SET-UP |** To save time, money & resources, one habitat scene can be utilized per class. Split students into 2-3 groups, and have them "explore" the habitat on different days/times. The groups not actively exploring can work on finishing up this assignment, reading introductory information about it, or completing other, related tasks.

☐ **Habitat Set-Up:** See the following page for the example used in this lesson. The habitat represents an area of venting activity, with four zones (A-D) represented. This depiction is based off visual data as captured by cameras on ROV *Hercules* during *Nautilus* expeditions.

☐ **Habitat Set-Up Materials:**

- 1 set of organism printables (http://nautl.us/2DtHLLZ)
- Assorted cardboard boxes
- Assorted wrapping paper tubes, paper towel tubes
- Red construction paper (to create tube worm plumes)
- Masking tape
- Duct tape
- Assorted fabric (old comforters, sheets, pillow cases can also be used!)
    - 1-2 yards yellow fabric (bacterial mat)
    - 1-2 yards white fabric (bacterial mat)
    - 2.5 yards blue pattern fabric - represents ciliates (http://nautl.us/2rjtBLW) on extinct vent
    - *Optional: Dampened toilet paper or paper towel can be spread around the "seafloor" to make smaller bacterial mats; 3 yards of opaque black fabric to be used as backdrop

☐ **Habitat Set-Up Instructions:** Follow the pictures and guides on the following pages to create the habitat set-up. This lesson is a great way to utilize recycled materials. In the scene shown, recycled wrapping paper and paper towel tubes, along with foam pool noodles covered with brown all purpose masking paper, and a white corrugated tube, were used to make tube worm colonies. A combination of chairs, stools and cardboard boxes were used to drape fabric over to create the mounded "vent" sites. Be creative with what you already have on hand or enlist students' help in bringing in supplies!


A. Extinct Sulfide Vent
B. Active Vent
C. Bacterial Mats/Seeps
D. Younger Active Vent
A.
B.
C.
D.
christinamachinski.com

A. Extinct Sulfide Vent: This is a site that is no longer actively releasing geothermal heated water. It has been colonized by ciliates, bacteria, and several species of animals.

1. Drape blue fabric draped over a chair/stool/stacked cardboard boxes = ciliate colony (http://nautl.us/2rjtBLW).
2. Drape yellow fabric over a smaller chair or box. = bacterial mat.
3. Fold white fabric next to the yellow to represent a different type of bacteria.
4. Use masking tape to secure the following creatures as shown:
    - 10- 15 Scaleworms
    - 1 Octopus
    - 2-4 Squat Lobsters
    - 5-10 Snails (Gastropods)
    - 2-4 Spiky Crabs

B. Active Vent: This is an active, older area of venting activity. Here, Riftia tube worms (http://nautl.us/2DXR9bI) out-compete their smaller cousins, *Tevnia*. Bacteria remains the primary producer of energy for all trophic levels in the deep sea.

1. Drape a dark fabric over several chairs/stools or stacked cardboard boxes.
2. Use recycled tubing (wrapping paper tubes, PVC tubing, etc.) to make the *Riftia* tube worms. Cut 2 tear shaped "plumes" out of red construction paper and secure to the top of the tube opening. Fold yellow and white fabric at the base.
3. Printables:
    - 15-20 scaleworms
    - 10-15 vent shrimp
    - 2-4 squat lobsters
    - 6-10 gastropods
    - 5-6 *Tevnia* clusters (secure amongst *Riftia*)
    - 10-15 clusters of mussels (secure around base of tube worms).

C. Bacterial Mats/Seeps: Often, large clusters of bacterial colonies are found near or at areas of hydrothermal venting or seep sites. Seeps are sites where chemicals seep from fissures or cracks in the Earth's crust, but at the same temperature as the surrounding seawater. Bacteria are able to utilize the chemicals to provide a useable energy source for all deep sea life in a process called chemosynthesis.

1. Fold one piece of yellow fabric next to a piece of a differing color, such as white.
2. Printables:
   - Use pieces of cardboard to stand 2-4 Eelpout fish and
   - 1-2 squid between the different zones.
3. Optional: Use pieces of dampened paper towel or toilet paper in between the zones to represent smaller sections of bacteria.

D. Younger, Active Vent: At the site of a newly formed vent, early colonizers include bacteria, mussels and *Tevnia* tubeworms. As the site becomes more established, *Riftia* will often out-compete *Tevnia* for food and space, due to it's larger size.

1. Cover a medium sized cardboard box or container with a darker fabric.
2. Yellow and white fabric at the base for bacterial mats.
3. Use paper towel tubes to represent young *Riftia*.
4. Printables:
   - 10-15 *Tevnia* clusters
   - 3-5 scaleworms
   - 3-5 snails
   - 5-10 mussel clusters
   - 5-10 vent shrimp

☐ **Student Teams Set-Up:**

- Have students research job roles utilizing the Exploration Team Job cards and additional information found under each person's biography here: https://nautiluslive.org/people.
- Each student team will have 1 navigator and 1 pilot in the actual habitat space. The navigator will be telling the pilot how to move the RC truck based on the instructions from the science team via walkie talkie.
- The rest of the team will remain in an area without direct view of the habitat. They will be utilizing a monitor that is showing the view from the camera mounted to the truck, and a walkie talkie to communicate with the navigator.

☐ **Equipment Set-Up:**

- 1 set of walkie talkies; navigator will use 1 and the scientists will use the other.
- 1 remote controlled vehicle with a GoPro or similar type camera attached or robot such as Cozmo (http://nautl.us/2n37lAf) which can bluetooth with another device (tablet or phone).
- An active wifi connection is needed for this lesson.
- Follow installation instructions for your equipment to connect the camera properly to a viewing screen. Many cameras require the installation and pairing with an App.
    - GoPro tutorial: https://www.youtube.com/watch?v=SjNz1V8XHK0
- Use duct tape to secure camera to the top of the RC truck.

☐

- [ ] **Helpful tips:**
  - ✓ Enlist student's help to color in or paint the printables.
  - ✓ Set up a test drive course (without the habitat set up) so students can practice their "robot" driving skills! This may also help in deciding who will play "pilot" during the activity.
  - ✓ Use black lights (w/ safety glasses) for added dramatic effect! A small LED powered flashlight can be secured to the RC truck with tape to enable better viewing in a darkened area.
  - ✓ **SAMPLE VIDEO: http://nautl.us/2n1Hs4J**

- [ ] **Example of bluetooth camera feed:**

Click here (http://nautl.us/2BFqlxW) for video

Wrap-Up Questions | Answer Key

1. Area A - Most likely an extinct vent due to the absence of tube worms which rely on nutrient-rich fluids provided to the mutualistic bacteria that live inside their bodies to create energy for them. The tall chimney-like structures indicate the site was once active.
   Area B- Active, mature vent due to the diversity of species including tube worms at the site. Height of the tube worms and chimneys indicates a more mature vent.
   Area C - Potential seep area due to the wide coverage of bacteria. A seep is an area of the seafloor where hydrogen sulfide, methane and other hydrocarbon-rich fluid escapes due to cracks or fissures in the ocean's crust caused by tectonic activity. The nutrient-rich fluids, only slightly above the temperature of the surrounding seawater (hence the name 'cold'), provide an energy source for various types of bacteria. The bacteria are specialized in the uptake and conversion of these chemicals to provide an energy base for the food webs that exist in these sunless, non-photosynthetic environments.
   Area D - This site is showing signs of a younger, newly formed hydrothermal vent due to the lower height of the chimney structures and tube worm species. The organisms here are also not as prolific (fewer in population number) than at site B.
   All of these areas are formed due to tectonic activity beneath the Earth's surface. Vents can form at subduction zones, where one plate is converging with another and is getting pushed underneath, or at divergent plate boundaries, areas where plates are spreading apart and magma rises up to fill the gaps, eventually cooling to create new crust. When the moving crust moves away from the magma source, they become inactive.

2. Higher food chain predators: Eelpout fish, Squid, Octopus
   Lower food chain: Bacteria (producers - produce the base of energy that will supply the rest of the trophic levels), tubeworms, mussels, gastropods

3. Differences in the zones include differences in types and number of organisms observed, tube worm height, and chimney height.

4. A scaling measurement system could be added such as 2 rods/sticks attached to the front of the RC vehicle so the ends can be seen on the display monitor to determine size. On Hercules, 2 scaling laser beams are used with a distance of 10 cm between the dots on the screen. Lights and sampling tools are also helpful when exploring in the deep sea.

5. Answers will vary.

REMOTE SENSING | STUDENT

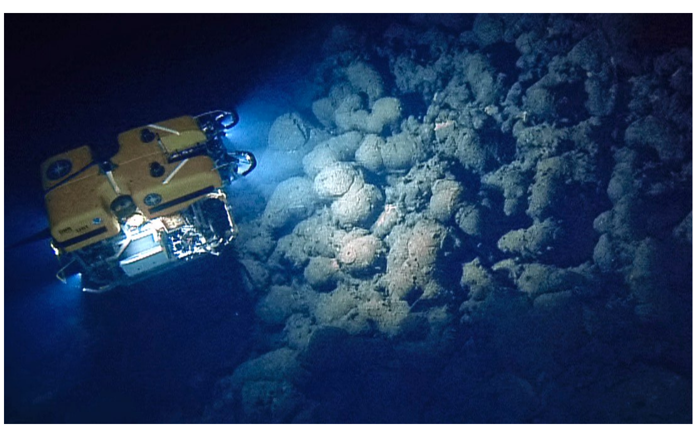
Learning Goals

- Learn about remote sensing and its applications to ROV piloting and deep sea exploration.
- Model a deep-sea remote sensing ROV team using remote controlled trucks and a blue-toothed camera system.
- Learn about the process of collecting and analyzing data from a deep sea habitat.

Introduction | Exploring the deep sea can be quite challenging for many reasons. Beyond 200 meters depth, light is significantly reduced and absolutely no light penetrates past 1,000 m. There is also an extreme amount of pressure as you descend from the ocean's surface. For every 10 m of depth, water pressure increases by 1 atmosphere (atm) or 14 pounds per square inch (psi). That means, for example, at 100 m, you would experience 10 atm of water pressure, or 140 pounds pushing in on every square inch of your body! Travel to 1,000 m depth and most organisms with gas-filled spaces (e.g., lungs) would be crushed by the pressure that other deep-sea life experience. The deep sea is also extremely cold, typically about 5° C (41° F) at 1,000 m, although water temperatures in the vicinity of hydrothermal vents can vary by nearly 400° C. Due to the high pressure, the water does not boil at these depths!

To observe extreme locations takes quite a bit of innovative thinking, technology and creative engineering. **Remote sensing** is the process of acquiring information about an object or phenomenon without making physical contact with that object. It is the science of obtaining information about areas from a distance, typically from aircraft or satellites. Exploration Vessel *Nautilus* uses two Remotely Operated Vehicles (ROVs), *Argus* and *Hercules*, to collect an extensive amount of data and make "sense" of the deep sea habitats they explore. Equipped with powerful lights, high definition cameras, and powered via a cable connected to the ship, these ROVs are crucial instruments in understanding the vastly unexplored ocean landscape.

In this lesson, you will take on and learn various roles within a typical ROV exploration team, explore a deep sea habitat, and work with your team members to collect and analyze data from that habitat.



ROV *Hercules* explores the undersea world of Ecuador's Galapagos Islands in 2015. *Hercules* is controlled by a pilot onboard *Nautilus* during exploration.

REMOTE SENSING | STUDENT

Helpful Resources:

- What is remote sensing? https://oceanservice.noaa.gov/facts/remotesensing.html
- What is remote sensing used for? https://www.usgs.gov/faqs/what-remote-sensing-and-what-it-used-0?qt-news_science_products=7#qt-news_science_products
- NASA Remote Sensing Introduction & History: https://earthobservatory.nasa.gov/Features/RemoteSensing/

Guiding Questions |

1. What are some challenges to deep sea exploration?

2. What are some ways data can be collected in the deep sea?

3. What is the benefit of using remote sensing to explore the oceans?

4. List three (or more) example data types collected by remote sensing.

5. Can you think of another environment where remote sensing would be useful? What are some similarities and differences in exploring that environment versus the deep ocean?

REMOTE SENSING | STUDENT

NAUTILUS NEWSFLASH

It takes an entire team to ensure a successful deep sea expedition. On E/V *Nautilus*, a team sits watch during ROV dives in a closed room on the ship called the control van.

The team includes scientists, 2 ROV pilots, a video/ film engineer, data logger, navigator, watch leader, plus education/ communication specialist. In the van, there are 30+ screens to monitor the ROVs' position in relation to one another, as well as watch the live video stream that feeds back from the cameras mounted on each ROV.

The ROVs act as our explorers' eyes on the seafloor and can stay underwater for long periods of time, making them effective unmanned tools. Learn more about each team member's position here: http://nautl.us/2bimupx.

Materials | Each group will need the following items:

- 1 Remote Control (RC) Monster Truck or car
- 1 Bluetoothed enabled tablet, computer or cell phone device
- 1 Bluetoothed enabled video camera (such as a second cell phone, Go Pro or similar) and MicroSD card
- Duct Tape
- 1 set of walkie-talkie radios
- 1 time-keeping device or clock
- 1 set of Exploration Team Jobs Cards
- Student data worksheets

Procedure |

1. Distribute the Exploration Team Jobs Cards on the next page to delegate roles during the activity.

2. Securely fasten the camera to the RC car as shown. Use duct tape to secure if needed.

3. Connect devices via Bluetooth™ and check devices are transmitting from car to viewer.

4. Navigator & RC Pilot: Move the car/camera to the habitat with 1 walkie talkie.

5. All other team members - Observation Team: Move out of view of the habitat with the video monitor display and 1 walkie talkie.

6. Observation Team: use the radio to direct the Navigator and RC Pilot to explore the habitat and collect data. Observers will record information on the student data sheets.

7. If needed, the recorded video from the MicroSD card can be downloaded to a computer for closer examination.

Exploration Team Jobs | Use the descriptions provided to assign each member in the group a job, or have each member randomly select a card. The numbers designate how many people are needed for each role.

Expedition Leader (1)

The expedition leader is responsible for ensuring operations run smoothly during exploration. This person is responsible for reporting any issues or concerns to the teacher, and handing in the group's work following the activity.

Scientists (1-3)

Scientists are responsible for watching the tablet/phone video monitor and coordinating with the RC pilot and the navigator via walkie talkie to communicate exploration directions to collect data from areas of interest.

Data Engineer (1-2)

Data engineer(s) are responsible for syncing the video camera properly with the scientists viewing device. Ensure team members can view a habitat as the RC car maneuvers through it, and handle any technical issues that may arise.

RC Car Pilot (1)

The pilot is responsible for maneuvering the RC car through the habitat following direction from the science team. The pilot works closely with the navigator whose safety cues will help position the vehicle around habitat structures.

Data Loggers (1-3)

Data loggers record important information on the data sheets during exploration. Data loggers and scientists will communicate often and must consult with each other while recording the data.

Navigator (1)

The navigator will communicate with the science team via walkie talkie and provide safety and directional cues to the pilot to help them navigate the habitat.

Student Data Sheet | Each student is responsible for obtaining the data from the data loggers' sheet and answering the wrap-up questions that follow.

Time *When was the observation recorded?*				
Habitat observations *Describe sizes, shapes and colors of the physical features and biological terrain.*				
Biology observations *Describe or sketch each creature observed.*				
Organism count *Estimate the number of each type of creature observed.*				
Species identification *Use your resources to identify each species.*				
Additional notes *Other things to document about this habitat.*				

Student Data Sheet Page 2 |

Time *When was the observation recorded?*				
Habitat observations *Describe sizes, shapes and colors of the physical features and biological terrain.*				
Biology observations *Describe or sketch each creature observed.*				
Organism count *Estimate the number of each type of creature observed.*				
Species identification *Use your resources to identify each species.*				
Additional notes *Other things to document about this habitat.*				

Wrap-Up Questions |

1. Scientists often conduct exploration in order to characterize, or describe, an environment in a certain way. The deep sea has been vastly unexplored. Researchers use a variety of digital imagery, robots, and sampling techniques to find out more about deep seafloor features. Some areas that have been discovered include hydrothermal vent sites (http://nautl.us/2CkNcfr), methane seeps (http://nautl.us/2E3QJQ2) and sponge reefs (http://nautl.us/2CDeRf2). What would be some terms you would use to characterize the habitat you explored and why? What types of geological/Earth processes are responsible for creating these types of habitats?

2. Looking at your data and observations, which organisms would you predict to be higher on the food chain versus lower? Explain your reasoning.

3. Did your habitat have the same physical and biological features positioned throughout it? If not, what were some of the differences in the various zones or areas you explored?

4. What additional features could be added to the remote control vehicle to aid your data collection?

5. How did your role in this activity compare to this job aboard *Nautilus*? Watch this behind-the-scenes video to learn more about life on the ship: https://oceanbites.org/science-behind-the-scenes-10s/.

REMOTE SENSING | ASSESSMENT

OBJECTIVE	CRITERIA			
	4 Exemplary	3 Commended	2 Emerging	1 Developing
Knowledge & Understanding |	Student consistently, correctly and thoroughly answers all questions. Uses an abundance of relevant vocabulary and is able to explain relationships within the content using examples. Can apply the content to other topics or real life.	Student is able to consistently answer most questions correctly. Uses an adequate amount of relevant vocabulary. Can explain relationships within the content and can apply content to other topics or real life.	Student is able to answer some questions correctly. Uses some relevant vocabulary. Student does not elaborate on relationships within the content or make connections between the content and real life.	Student is able to answer a few questions correctly. Inconsistently uses relevant vocabulary. Student does not elaborate on relationships within the content or make connections between the content and real life.
Content Organization, Methodology & Analysis |	Student effectively organizes complex ideas, concepts, and information to make important connections and distinctions. This may include detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses.	Student is able to organize ideas, concepts, and information to make connections and distinctions. This may include mostly detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses.	Student attempts to organize ideas, concepts and information to make some connections and distinctions. Student is able to provide basic procedures, data tables, graphs, diagrams and/or analyses.	Student has difficulty organizing ideas, concepts and information to make connections and distinctions. Student is unable to provide basic procedures, data tables, graphs, diagrams and/or analyses.
Self-Directed Learner |	Student is actively engaged in the learning process; consistently contributes to class discussions and asks clarifying questions. Seeks out and shares additional resources with the class or teacher. Advocates for his/her learning needs.	Student is engaged in the learning process. Often contributes to class discussions and asks clarifying questions. Advocates for his/her learning needs.	Student is inconsistently engaged in the learning process. Sometimes contributes to class discussions or asks clarifying questions. Inconsistently advocates for his/her learning needs.	Student is weakly engaged in the learning process. Rarely contributes to class discussions or asks clarifying questions. Rarely advocates for his/her learning needs.
Technological Tools |	Use of digital resources is always appropriate for the task. Willing to learn and use technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is appropriate for the task. Willing to use technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is sometimes appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is rarely appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message.
Collaboration Skills |	Consistently works effectively and respectfully with a diverse group of learners. Actively checks with others for understanding and how he or she may be of help. Student listens when others speak and incorporates or builds off of the ideas of others.	Works effectively and respectfully with a diverse group of learners. Checks with others for understanding and how he or she may be of help. Student listens when others speak.	Sometimes works effectively and respectfully with a diverse group of learners. Sometimes checks with others for understanding and how he or she may be of help. Student listens when others speak.	Has difficulty working effectively and respectfully with a diverse group of learners. Rarely checks with others for understanding and how he or she may be of help. Student may talk over other students or does not listen when others speak.
Total Score: ____________	**Comments:**			

How Large is Nautilus Nation?

Tracking the reach of Ocean Exploration Trust's education programs is essential in ensuring we are funded to continue making discoveries and inspiring the next generation of explorers.

Name: **My Community (City, State):**

Email Address:

School's Name:

Instruction date: **Grade level instructed:**

Subject area:

My education space is a...	Who did you engage in your teaching?
❑ Classroom ❑ After school program / Club meeting ❑ Fair / Festival / Event ❑ Museum / Science Center ❑ Other. Tell us more:	# Students # Community Members

Select all the OET materials you used in your instruction:

- ❑ STEM Learning Modules. Which ones? ______________________________
- ❑ Digital Resource Library materials. Which ones? ______________________________
- ❑ Nautilus Live website: photo albums ☐ highlight videos ☐ live stream
- ❑ Meet the Team STEM mentor profiles
- ❑ Facebook (NautilusLive) ☐ Twitter (@EVNautilus) ☐ Instagram (@nautiluslive)
- ❑ Other. Tell us more: ______________________________
  ____

What made working with OET resources valuable to your instruction (select all that apply)?

- ❑ Hands-on activities ☐ STEM career connections
- ❑ Easy to use lessons ☐ Standards-based lessons
- ❑ Website resource access ☐ Real world application of curricula topics
- ❑ Excitement of cutting-edge discoveries / Unfamiliarity of deep ocean
- ❑ Another reason. Tell us more: ______________________________
  ____

Using OET resources increased my confidence in teaching my science, technology, engineering, or math subjects.	☐ Yes	☐ No
OET provided me with helpful and relevant teaching resources.	☐ Yes	☐ No
Using OET resources increased my awareness of STEM careers.	☐ Yes	☐ No
If yes, how so? How can we improve?		

Please scan this document or snap a picture of it with your phone. Email the feedback or questions to education@oet.org. You can also submit feedback online: http://nautl.us/2cp3PNu

Thank You For All You Do!