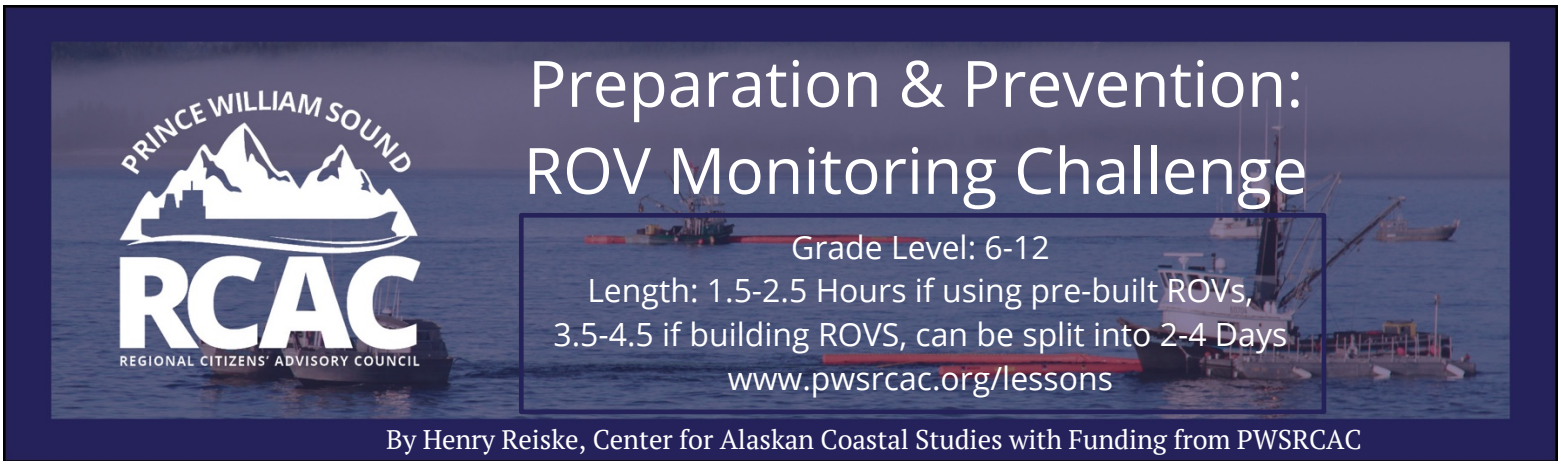

Preparation & Prevention: ROV Monitoring Challenge

Grade Level: 6-12
Length: 1.5-2.5 Hours if using pre-built ROVs, 3.5-4.5 if building ROVS, can be split into 2-4 Days
www.pwsrcac.org/lessons

By Henry Reiske, Center for Alaskan Coastal Studies with Funding from PWSRCAC

NGSS Standards

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Crosscutting Concepts

Scale, Proportion, & Quantity In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Related Resources

Worksheets Transect & Pipeline Inspection Report Sheet; ROVs for Preparation & Prevention

Slideshow ROVs for Preparation & Prevention

Pair With Oil's Wandering Path Lesson

Overview

ROVs with video capability can be used to monitor the environment and perform inspections to prevent oil spills.

Objectives

- Students will learn ways that ROVs can be used to perform inspections to prevent oil spills.
- Students will learn ways that ROVs can be used to collect ecological data to establish baselines before a spill and/or the damage done after a spill.
- Students will demonstrate how to operate equipment similar to real life research and inspection equipment.

Materials

- ☐ Laminated Animal Pictures with Weights, or Toy Animals to use for Transect Challenge
- ☐ Markers for Beginning and End of Transect
- ☐ PVC Pipes - Mark them with symbols or mock evidence of wear and tear that students will look for during pipeline inspection
    - 12 ft length of PVC pipe cut into 3 sections and connected by angled elbows either weighted to bottom of pool, or attached to floats and a tether for use in natural bodies of water
- ☐ ROVs with Camera for Each Station
- ☐ Meter Sticks
- ☐ Transect & Pipeline Inspection Report Sheet
- ☐ PowerPoint Presentation: ROVs for Preparation & Prevention
- ☐ ROVs for Preparation & Prevention Worksheets

Notes

>>Educator Tip: This lesson can be done on its own using pre-built ROVs with cameras, such as the Trident ROV. However, you can also use ROVs built by students. If you plan to do that, see materials and directions for the Oil's Wandering Path lesson. Then have students add underwater cameras to the ROV they've built and connect the cameras via the tether to viewing screens out of the water. Contact the Center for Alaskan Coastal Studies (907-235-6667, info@akcoastalstudies.org) for additional tips on how to do this.

Background

ROVs (Remotely Operated Vehicles) can be used in a variety of ways related to oil spill prevention, response, and ecosystem monitoring. ROVs can allow people to gather baseline information on the environment before an oil spill and gather data about the damage inflicted by an oil spill. They can help prevent oil spills and protect the environment through infrastructure inspections and maintenance, and they can be used to respond in the event of a spill. Although ROVs were not used in the cleanup effort for the Exxon Valdez oil spill, they were used heavily in the cleanup and documentation of the BP/Deep Horizon oil spill and are used regularly to inspect oil infrastructure for signs of wear, leaks, and to test safety equipment.

Researchers are able to use ROVs to gather data that can be used to establish environmental conditions and populations to serve as a baseline in the event of a spill or inform fishery and environmental policy. They can also be used to document conditions following a spill either visually or through sample collecting.

In this activity students will learn about the ways that ROVs can be used to prevent oil spills and in environmental research. They will then use ROVs equipped with cameras to perform a simulated population survey and pipeline inspection. Students will consider challenges based on ocean conditions and discuss how they might address these challenges in real life.

Preparation

1. For this activity you will first need the "ROVs for Preparation and Prevention" PowerPoint and worksheet. This PowerPoint and accompanying worksheet will provide students with an

introduction to ROVs and how they can be used. Print a copy of the ROVs for Preparation and Prevention worksheet for each student. Print copies of the Transect & Pipeline Inspection Report Sheet where students will record information during the challenges and reflect on their experience.

2. If you are using commercial/pre-built ROV, set them up in the appropriate areas. Make sure that you have an ROV for every 3-4 students, or enough stations for them to work through during the activities so that no more than four students are using each camera ROV at one time. Make sure that ROV and screen/controller batteries are charged and do not need any maintenance, such as software updates, before the activities. If you are building ROVs as a class, prepare as directed in the Oil's Wandering Path – ROV Challenge lesson.
3. The second portion of this activity should take place in a pool or natural body of water such as a shallow pond or section of the harbor. If you are using a pool, place laminated animal pictures with weights or other weighted toy animals in a semi-random pattern loosely along a general line in a portion of the pool about 20-30 feet long by 5-10 feet long. In a pool, this is best done by someone entering the pool to distribute the mock animals. This same person can collect the items afterwards. If you are doing the activity in a natural body of water with mild to moderate currents, you can attach string or rope (5-20 feet long, depending on how far you'd like to distribute the items) to the weighted pictures/toy animals, tie them off to something on shore, and then place them in the water for the current to distribute for you. Record a bearing for the transect line (if ROVs are equipped with a compass that can be read from the control screen) or a clear start and end point for the transect line that students will attempt to follow.

>>*Educator Tip: It is fun if the transect items look like the animals common in local marine or aquatic habitats, but they do not have to. The important part is that they are different sizes/colors/shapes. You should have a few different types of items to allow for different transect challenges.*

4. For the inspection challenge, you will need to set up a model pipeline. This can be either supported on the bottom of the pool by stands or suspended by floats. The PVC pipe should be cut into sections of various lengths which can be connected by joints. This design allows you to create angles in the pipeline, which can make it more challenging to inspect. You can also make the length of the pipeline longer or shorter to fit the time you have available and the

difficulty of the challenge you want to present. Mark the pipe with symbols or mock signs of wear and leaks for the students to discover on their inspection.

>>*Educator Tip: If you do not want to build a PVC pipeline, you can mark spots on the side of a dock, pool wall, or other large underwater surface. The ROV will be used in a similar way to inspect the surface and can be compared to how ROVs are used to conduct underwater inspections of oil tanker hulls.*

Introducing the Lesson

Hand out the "ROVs for Preparation and Prevention" worksheet to each student. Present the "ROVs for Preparation and prevention" PowerPoint to the class. Provide students with plenty of opportunities to ask questions and provide suggestions about designing an ROV and responding to the challenges. Give students time to respond to the worksheet questions.

Activity

1. Divide the class into groups of 3-4 students and review water safety procedures. Before you go to the pool or natural body of water, remind students that there will be no swimming or wading and remind them to keep any "top side electronics" (this may include a iPad, controller, video screen, and/or battery pack) away from the water. Explain that when the ROV is being operated there must be always be a tether manager.
2. Hand out a copy of the Transect & Pipeline Inspection Report Sheet to each group. If the students did not build their ROVs, introduce the ROVs that you will be using for the program and show students how they are controlled. Review the safety rules again with the group. After the introduction, give each group a chance (10-15 min) to practice driving their ROV before the challenges. Make sure that each student gets the chance to control the ROV during this practice session.
3. Next, begin the transect and inspection activities. Each group should proceed to a station. Each station needs an adult leader to monitor students and introduce the task. Students will be working as a group to document what is seen during transects and pipeline inspections on their report sheet. Explain that students should take turns driving. Each student should complete one transect OR pipeline inspection before handing off control to the next student.

4. At the transect station, students will try to estimate population density for a particular organism represented by one of the item types on the transect path. They will first need to estimate the length of the transect and the width of the swath along the transect that the ROV will allow them to view. This information on the area surveyed will be used to calculate density. Instruct them to measure the approximate width of the swath of the transect using the meter stick. The length of the transect, bearing of transect or location of end point and overall pool/pond/harbor size will be told to them by the leader before they start. Their leader should also designate which "species" they are recording.

>>Educator Tip: If done in a pool, students may be able to directly see the items on the transect line, the pipeline, and the ROV. This makes the challenges much less challenging! To avoid this, you can have them stand far back from the pool or only allow one student to see the ROV in the water. This latter option increases the teamwork aspect of the activity.

>>Educator Tip: If this is going to be done in a natural body of water you may want to perform the transect using the natural common animals or algae in your area (rather than laminated pictures or toy animals). This is a rewarding experience, but it can make it more difficult for the group to keep on the transect path. If the situation is conducive to it, you can help with this challenge by laying a weighted rope or other appropriate marker on the bottom to represent the transect line.

5. As one student drives the ROV and one student serves as the tether manager, the other 1-2 students should observe the underwater images shown on the screen and tally a count for their assigned "species" on the report sheet. Once the transects has been completed, students will calculate an estimated density for the area they surveyed. Then, working from the assumption that this is a representative sample, they will use this density to estimate the overall population of the pool/pond/harbor. Provide students time to respond to all of the questions.
6. If there is extra time students can run a second transect with a different driver and target species.
7. Simultaneously, other group(s) of students will be working at pipeline inspection station(s). The objective at these stations is to identify and record "evidence" of wear or leaks on the model pipeline. The leader at this station will introduce this idea to the students.
8. In addition, the students must inspect an end-cap. Designate a specific symbol (perhaps an X) that represents an end cap that is a

piece of equipment in need of testing. At that symbol the students will try to keep the symbol in the frame for 5 seconds and then nudge that piece with the front of the ROV to simulate testing.

>>*Educator Tip: The pipeline inspection does not need significant modification in a natural body of water. However, it will be more difficult if the water is murky, or there is a significant current. In these conditions, consider making the symbols much more apparent and/or the pipeline itself larger and closer to the surface*

9. Once all students understand the challenge and have a chance to ask questions, begin the challenge station. As one student drives the ROV and one student serves as the tether manager, the other 1-2 students should observe the underwater images shown on the screen and record the portions of the pipeline in need of repair. Then have a different student drive the ROV back in the other direction as the other students double-check which portions of the pipeline show evidence of wear or leaks. Once the transects has been completed, students will calculate an estimated density for the area they surveyed. Provide students with time to answer their final questions for the challenge.

>>*Educator Tip: You can sink items around the pipeline as clues that represent how the pipeline damage occurred. Students should look for these clues as they do the inspection and record them to start an investigation of how the damage was caused.*

10. If there is extra time, students can perform a second inspection to look for any symbols that they missed.

>>*Educator Tip: Make sure to provide enough time at the stations so that all students have an opportunity to drive the ROV at least one time.*

Wrap-up

Once all groups have completed the challenge, have the groups come together to debrief. Guide students through a discussion to compare what they saw and the conclusions they came to on their Transect & Prevention Report Sheet. Review concepts of marine research and spill prevention and how we can use technology to make these processes easier. “Jigsaw” students so that they are in a new group of 2-5 students, with representatives from the other challenge teams. Ask students to discuss the following prompts in these small groups:

- How could ROVs be useful in oil spill prevention?
- How could ROVs be useful in environmental monitoring research?
- What are some of the challenges to using an ROV for research or prevention?
- What are some of the benefits?

Ask each student to consider how they would utilize an ROV for monitoring, inspection, or repairs that could prevent or mitigate the impacts of an oil spill. Instruct them to use writing or an annotated drawing in their science notebook to design a simple monitoring, inspection, or repair plan. Explain that their plan should identify any specialized equipment that would need to be added to the ROV, the environment in which the work would be done and how the environment would affect their ability to do the work, the frequency of the ROV work, and any other pertinent details.

Assessment

Review the Transect & Prevention Report Sheet for completeness and demonstrated understanding of the purpose and process of the transect survey and pipeline inspection. Because driving the ROVs can be difficult, students should be evaluated on attention to detail and effort during challenges rather than actual results. Assess student entries into their science notebooks. Students who meet the performance expectation will demonstrate that they have (1) applied scientific principles and (2) designed a method for ROV-based monitoring or prevention that can help to minimize the negative impacts of humans on the environment.

Pair With

- Oil's Wandering Path ROV Lesson Plan