FUTURE U.

Energy Team Classroom Visit

A (Nursery) School of Fish

Overview

The partnership between NOAA and Boeing with the Wave Glider has opened up infinite possibilities for discovery. One recent discovery is surface slicks, the ocean's own private childcare. With an imaginary trip to Kona, Hawaii, students will get hands-on as they act as scientists using sand to replicate sifting through all the species ocean experts found in slicks. Students will also examine the sustainable technology innovations outfitted on the Wave Glider as it continues to collect and share data. They will walk away with actionable steps they can take to be ocean protectors.

Background

Kona, on the big island of Hawaii, stretches along the west coast. It is best known for Kona coffee, but also its calm waters full of scuba divers, snorkelers, and deep-sea fishers. One of the more popular adventures offered in Kona is swimming with manta rays.

According to NOAA, "The people of Hawai'i have long recognized slicks as an important part of the seascape. The traditional Hawaiian mele (song), Kona Kai `Ōpua, references the "Ke kai ma`oki`oki," or "the streaked sea," in the peaceful seas of Kona. Despite these historical observations, scientists have only recently begun to understand the biological and ecological importance of surface slicks." The Wave Glider can help scientists understand through further scientific studies.

The Wave Glider is a 3-meter-long uncrewed ocean robot attached to a sub with wings that can conduct research. The sub converts waves and sun into propulsion and energy, spending months at sea monitoring ocean health. The Wave Glider offers an additional propulsion system using stored solar energy. The additional directional thrust increases mobility and precision and helps to navigate challenging ocean conditions (doldrums, high currents, and hurricanes/cyclones), or accommodate mission changes. The solar energy system also recharges batteries that power sensors. Liquid Robotics, a Boeing Company, added high tech sensors and surveying equipment to the Wave Glider. One robot, Mando, used microscopes to survey microplastics and provided NOAA with invaluable research. Wave Gliders also support a broad spectrum of ocean research, including weather and climate modelling, tsunami and seismic monitoring, fisheries research, and support of offshore energy. Overall, the uncrewed surface vessels have spent more than 44,200 days at sea and traveled about 1.5 million nautical miles across five oceans, surviving shark attacks and 17 hurricanes along the way. Wave Glider "Benjamin Franklin" holds the Guinness World Record for the longest single mission for an autonomous surface vehicle — a 15-month, 7,939-nautical-mile journey from San Francisco Bay to Queensland, Australia.

The fisheries' research has focused on ocean slicks off the coast of Kona. They are formed from the convergence of ocean currents, tides, and variations in the seafloor. From NOAA: "The remarkable diversity of fish found in slick nurseries represents nearly 10 percent of all fish species recorded in Hawai'i. We were

shocked to find larvae of so many species, and even entire families of fish, that were only found in surface slicks," Dr. Whitney says. "This suggests they are dependent on these habitats." These nurseries are full of phytoplankton, zooplankton, and debris to provide food and shelter for over 100 species of fish larva. Sadly, these slicks pick up a large amount of microplastics that are often ingested as well.

Nearly 8.8 million tons of plastics end up in the ocean each year, and with the help of Wave Glider, scientists are learning best practices for cleanup and future prevention.

Materials—to prep ahead of your visit

1 sand kit per group of students:

- gallon-size bag of sand containing microplastics, debris, organic material
- mesh strainers to use as sieves
- large bucket to catch sand falling through the sieves
- tray to sort microplastics from other debris
- magnifying glass
- tweezers
- microscope
- data collection sheet

Introduction (10 minutes)

1. Introduce yourself and your role at Boeing. What is your background and what made you want a career in STEM? Begin to build relationships with the students by asking them what surprises them about the ocean? What types of vessels help us explore the ocean? What do they look like? What TV shows or movies have they watched that use the ocean as a setting or even as a main or supporting character? What about underwater vessels?

2. Share with students that there is a hidden world just under the surface of the ocean. When tides, currents, and varied seafloors come together, they create smooth ribbon-like bands of ocean water called surface slicks. These interconnected water highways act as a nursery for over 100 different species of marine life. Fish that are important for human consumption grow up here as well, such as mahi mahi.

   (Great interactive story map from NOAA to help visualize slicks if technology allows: https://arcg.is/1zPiqT)

3. Ask students to imagine being a tiny, freshly hatched fish off the coast of the big island of Hawaii in a district on the west coast called Kona, known for its snorkeling, scuba diving, and deep-sea fishing. You need to spend the first few weeks hiding from predators while you eat, grow and develop. Surface slicks naturally pick up zooplankton, a food source for fish larva, and debris like seaweed and sticks that can act as a hideout for these prey animals. Little is known about surface slicks and the needs of fish during the larval stage. However, Hawaiians have historically seen slicks as important parts of the seascape, even writing songs about it. But a new ocean robot, called the Wave Glider, is helping scientists learn more each day.

   The Wave Glider is powered by the sun and the sea. While the solar panels charge batteries for the equipment on the vessel, it is also attached to a sub that converts waves into energy and forward motion. The Wave Glider is able to collect water samples and send cameras and microscopes down into the ocean to look closely at surface slicks as well as assess ocean health and even do climate modeling.

Plastic pollution can be seen on land all around us. Much of it ends up in streams, rivers, and oceans. Plastic never goes away. It continues to break down into smaller and smaller pieces until they are microplastics, which are just the right size for the babies in the surface slicks to eat. This is bad for the fish babies, but as the food chain progresses, it is also unhealthy for humans!

(Video from Liquid Robotics to assist all learning styles with visualizing the vessel: https://youtu.be/m7gmf4Mfba4)

Activity (30 minutes)

1. Explain to students that they are now scientists working for Boeing, in collaboration with NOAA, to explore a surface slick in Kona, Hawaii. They will each receive a bag of sand that represents an ocean sample collected from the Wave Glider. This models the collaboration of scientific research and the types of samples engineers work to acquire for scientists. It is their job to sift through the water (sand) sample and sort the zooplankton (unfiltered rocks) from the fish larva (larger shells, sticks, and natural debris) and microplastics (actual plastic pieces).
2. Break students up into groups of 3–4 and decide who will be sifters and who will be sorters. Have the groups predict how much of each group they will find. As they sift the sand into the bucket, they will then spread the leftover debris onto the tray and begin sorting. They should record the quantity of each group that they collect on the data sheet provided.
3. Encourage students to look at the sifted sand under a microscope (if available).
4. Ask students to share what they recorded. How did it differ from what they predicted? Was anything surprising? Add all the groups' findings together to see the quantities in the collective gallons of sample "ocean water."

   If technology allows, you could explain the significance of (in Background) and play the song Kona Kai `Ōpua in the background as students work. One version here: https://m.youtube.com/watch?v=MEEp2RPuKvU&feature=youtu.be

Wrap Up (5 minutes)

1. Summarize with students that ocean slicks are filled with zooplankton and fish larva, as the students have demonstrated with their work as scientists. As the Wave Glider continues to explore the oceans and studies ecosystems like ocean slicks, it will help scientists create a game plan for what to do to protect our oceans for us now and for the future. There are things that students can do in their daily life to protect the oceans and bring down their plastic usage. Ask them if they have any ideas of how they can help and create a list of their suggestions.
2. Encourage students to do or continue to do the following:
   - Keep local land and water clean.
   - Use reusable shopping bags, lunch bags, and water bottles.
   - Say no to straws and single use plastics (bags, food containers, cutlery, etc.).
   - Turn off the water. As more water is wasted, it pushes more trash into waterways.
   - When you are out, pick up trash and dispose of it properly.

- Get outside and explore! We protect what we love.
- Tell others what you are doing and encourage them to get involved, too.
- Investigate careers to be part of the solution.
- Keep learning and advocating!

Extensions

If time allows during the activity, students can create a graph (bar, pie, or line) to depict their findings and present to the class.

References

- https://www.boeing.com/company/about-bca/washington/innovative-ocean-robot-sets-its-microscopic-sights-on-a-global-problem.page
- https://www.liquid-robotics.com/wave-glider/how-it-works/
- https://www.pnas.org/content/116/48/24143
- http://www.blueoceansociety.org/blog/microplastics-sampling-fun-in-the-classroom/
- https://oceana.org/living-blue/10-ways-you-can-help-save-oceans
- https://www.fisheries.noaa.gov/feature-story/surface-slicks-are-pelagic-nurseries-diverse-ocean-fauna

- https://www.gohawaii.com/islands/hawaii-big-island/regions/kona

Slick Data Collection Sheet

You are acting as scientists working for Boeing, in collaboration with NOAA, to explore a surface slick in the waters of Kona, Hawaii. You will receive a bag of sand that represents an ocean sample collected from the Wave Glider. It is your job to sift through the water (sand) sample and sort the zooplankton (unfiltered rocks) from the fish larva (larger shells, sticks, and natural debris) and microplastics (actual plastic pieces).

Data Collection	
Sample	**Quantity**
Zooplankton (unfiltered rocks)	
Fish Larva (other natural debris)	
Microplastics (plastic pieces)	