SCIENCE·3D

MASTERS OF THE DEEP: SPERM WHALES

In this packet, sample student answers are provided in red and notes to teachers are in blue.

In this **STEM Project**, students will investigate the role of technology in science, define criteria and constraints involved in sperm whale research, and design solutions to help scientists put cameras on different animals.

Activity 1: Science and Engineering

1. List and describe three ways that the research team used technology to study sperm whales.

Options include: sonar to map prey, hydrophones to listen for whales, cameras to see what the whales are doing, GPS to navigate the boats, radios to keep in touch with the team, radio tracking devices to find the camera after it releases from the whales, and others.

2. Choose one of the technologies that you listed above. Do you think that the team could have answered their questions without this technology? **Write** a short paragraph to support your statement.

Some sample answers:

Sonar: Students may say this would not be possible because it is so difficult to measure prey in the deep sea. It would also be acceptable to argue that the questions could be answered without sonar using nets, or some other physical measure, to catch and count prey. Students should recognize that other methods would either sample much less area or be more time intensive.

Hydrophones: It would be possible, but much more difficult because the team would only be able to see whales during the brief time at the surface, and they would have to guess where they went while they were underwater.

GPS: There are other ways to navigate and map the position of boats, but it is much more difficult and less accurate.

Radio: The team could live without these, but it would be much harder and not as safe. The team would not be able to split up to find whales because they wouldn't be able to easily signal to the other boats that they found whales.

Tracking devices to find cameras: Without these, the team would not be able to do the work unless they got lucky and a camera washed up on the shore after it released.

Activity 2: Defining the Problem

We recommend having students work in small groups to develop the list of criteria and constraints. Once students have completed their lists, have them report back to the entire class and update their own lists.

To observe how sperm whales behave underwater, the team has to attach cameras to the sperm whales. Before Mehdi, the engineer, can design the camera, he has to define the problem. He needs to come up with a design that will be successful. These are the *criteria*. Then he has to find the limitations of his design. These are the *constraints*.

1. **Write** several sentences to define the engineering problem that the team needs to solve to get video from the back of a sperm whale.

The team needs to figure out how to build a camera system that can survive the crushing depths of the ocean, gather video where there is no light, release from the whale, and be retrieved.

2. Think about all the things the camera systems need to do. What are all the challenges? **List** the criteria for the design and then the constraints. Be sure to think about the diving conditions.

CRITERIA:

Possible answers include:

- must record enough video to see foraging
- must be attached to an animal and stay attached until it is time to release
- must be able to be retrieved
- must be able to survive crushing depths
- must be able to record video in near-darkness

CONSTRAINTS:

Possible answers include:

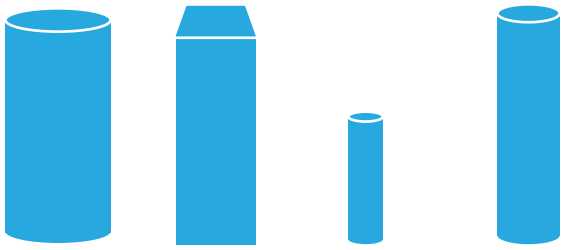
- cannot be too large for animal
- cannot be too heavy to deploy on animals
- cannot be too expensive
- cannot consume too much power

Activity 3: Build Your Camera

Now it is time to design some camera systems of your own! We can start with a sperm whale camera. Here are some things to remember:

- Sperm whales dive deep, sometimes to about 2,000 m (1.25 mi).
- Square designs crush more quickly than cylindrical designs.
- The camera system should be small relative to the size of the animal.
- Deep sea animals can't see red lights well, but red light doesn't go as far as blue or white.
- Headlights require battery power.
- Heavier cameras are more difficult to deploy.

HOUSINGS



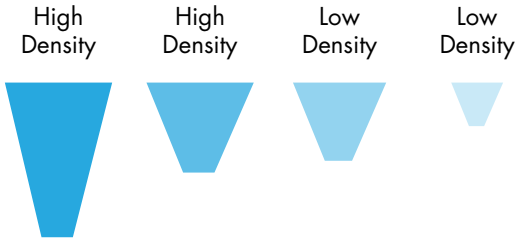
MAXIMUM DEPTH			
3,000 m	800 m	200 m	1,200 m
MASS			
1 kg	0.6 kg	0.25 kg	0.8 kg

TRACKING TRANSMITTER = 0.1kg

BATTERIES

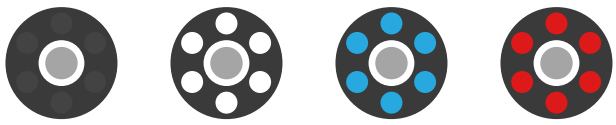
RECORDING TIME			
3 h	6 h	11 h	22 h
MASS			
0.05 kg	0.1 kg	0.2 kg	0.4 kg

FLOATATION



MAXIMUM DEPTH			
3,000 m	800 m	200 m	1,200 m
LIFT			
1.8 kg	1.2 kg	1.8 kg	0.75 kg

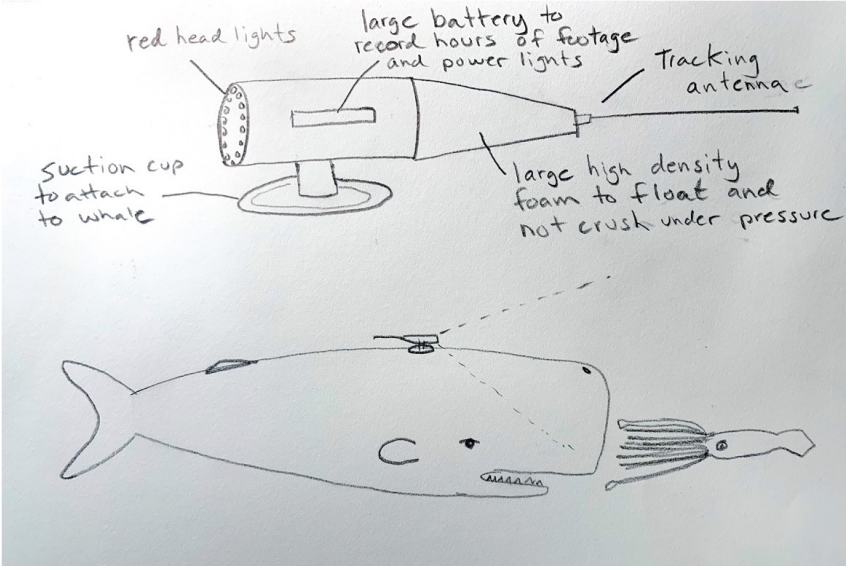
DOME AND HEADLIGHTS (FRONT VIEW)



HEADLIGHTS			
None	White	Blue	Red
RECORDING TIME LOST TO POWER USE			
0 h	2 h	1.5 h	0.5 h

1. Use the information on the previous page to **draw** a diagram of the camera you would build to study sperm whales. Label each piece of your camera and explain why you chose each part. Be sure to think about how you will attach the camera to the sperm whale and include it in your drawings.

Accept well-reasoned answers. See example below.



2. For one of the next missions, the team wants to see how baby bull sharks catch their food. Baby bull sharks are only about 1.3 meters long. They live in water that is less than 10 meters deep so there is plenty of light. Because bull sharks are cold-blooded, they do not have to feed very often. Use this information to **draw** a baby bull shark camera. Label each piece of your camera and explain why you chose each part. Be sure to think about how you will attach the camera to the shark and include it in your drawing.

Accept well-reasoned answers. It's acceptable to put it on the fin to record feeding. See example below.