Science & Literacy Activity

ACTIVITY OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to how scientists study the ocean.

This activity has three components:

1. **BEFORE YOUR VISIT**, students will read a content-rich article that will provide context for the visit, and also help them complete the post-visit writing task.
2. **AT THE MUSEUM**, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). This information will help them complete the post-visit writing task.
3. **BACK IN THE CLASSROOM**, students will draw on the first two components of the activity to complete a CCSS-aligned explanatory writing task.

Materials in this packet include:

For Teachers

- Activity overview (pp. 1-2)
- Article with teacher notes: "Listening to Life in the Deep" (pp. 3-9)
- Assessment rubric for student writing task (pp. 10-11)

For Students

- Article: "Listening to Life in the Deep" (pp. 12-17)
- Student worksheet for the *Unseen Oceans* exhibition visit (pp. 18-19)
- Student writing task and rubric (pp. 20-22)

Common Core State Standards

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2 Determine the central ideas or conclusions of a text provide an accurate summary of the text distinct from prior knowledge or opinions.

WHST.6-8.2 Write informative/explanatory texts, including the narration of scientific procedures/experiments.

Next Generation Science Standards

Connections to the Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of methods and tools to make measurements and observations.

Science is a Human Endeavor
- Men and women from different social, cultural, and ethnic backgrounds work as scientists and engineers.

SEPP 8: Obtaining, Evaluating, and Communicating Information
- Critically use scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific information to describe evidence about the natural world.
- Communicate scientific information in writing.

1. BEFORE YOUR VISIT

Students will read a content-rich article about how scientists study the ocean and its inhabitants. This article will provide context for the visit, and will help them complete the post-visit writing task.

Preparation

- Familiarize yourself with the student writing task and rubric (pp. 20-22).
- Familiarize yourself with the teacher version of the article (pp. 3-9), and plan how to facilitate the students' reading of the article.

Instructions

- Explain the goal: to complete a writing task about how scientists use tools to meet the challenges of studying the ocean.
- Tell students that they will read an article before visiting the Museum, and will read additional texts during the visit.
- Distribute the article, student writing task, and rubric to students.
- Review the rubric with students and tell them that it will be used to grade their writing.
- Read and discuss the article, using the teacher notes to facilitate.

2. DURING YOUR VISIT

At the Museum, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). The information they gather from these multiple sources will help them complete the post-visit writing task.

Preparation

- Review the educator's guide to see how themes in the exhibition connect to your curriculum and to get an advance look at what your students will encounter. (Guide is downloadable at **amnh.org/unseen-oceans-educators**)
- Familiarize yourself with the student worksheets (pp. 18-19) and the map of the exhibition.

Supports for Diverse Learners

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, or locating information in the Museum) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

Instructions

- Explain the goal of the Museum visit: to read and engage with texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models), and to gather information to help students complete the post-visit writing task.
- Distribute and review the worksheet and map. Clarify what information students should collect, and where.

Additional Suggestions for Facilitating the Museum Visit

- Have students explore the exhibition in pairs, with each student completing his or her own student worksheet.
- Encourage student pairs to ask you or their peers for help locating information. Tell students they may not share answers with other pairs, but may point each other to places where answers can be found.

3. BACK IN THE CLASSROOM

Students will use what they have learned from the pre-visit article and at the Museum to complete a CCSS-aligned explanatory writing task about how scientists use tools to meet the challenges of studying the ocean.

Preparation

- Plan how you will explain the student writing task and rubric (pp. 20-22) to students.

Instructions

- Distribute the student writing task and rubric. Explain that they will use it while composing, and will also use it to evaluate and revise what they have written.

Suggestions for Facilitating Writing Task

- Before they begin to write, have students use the writing task to frame a discussion around the information that they gathered at the Museum. They can work in pairs, small groups, or as a class, and can compare their findings.
- Referring to the writing prompt, have students underline or highlight all relevant passages and information from the article and from the notes taken at the Museum.
- Students should write their essays individually.

ARTICLE WITH TEACHER NOTES

Lexile: 1050

Word Count: 1485

Text Complexity: The Lexile level for this text falls toward the end of the 6-8 CCSS grade complexity band. This text is suitable as a read aloud for students in grades 6 through 8. Teachers should use their professional judgment and knowledge of students' independent reading levels regarding assigning this text for independent reading.

Key for Teacher Notes

- Green text
  specific strategies
- Regular text
  instructions for teachers
- *Italicized text*
  teacher's instructions to students
- Underlined text
  important domain-specific words

Note:

- Assign each student a "talk partner" and have each pair designate "partner A" and "partner B."
- Set aside space on whiteboard or chart paper for a word wall.
- This interactive read-aloud is built around students making notes on the attached worksheet. The teacher notes provide recommended stopping points for students to Think-Pair-Share and Stop and Jot on their worksheets, but use your judgment about how you would like to use the worksheet with your students: it can be completed as a guided activity, but it can also be used as a tool for students to record notes as they read independently.

Listening to Life in the Deep

Preview the Text: *Let's read the title and subtitles to get an idea of what we can expect to learn from this article . . .*

Think-Pair-Share: *Turn and tell your partner what you think this article will teach us.*

When Dr. Kelly Benoit-Bird was in third grade, her family took a vacation at SeaWorld. There she learned how animals like dolphins use sound instead of light to sense their world, a process called **echolocation**. They make clicking noises that bounce off objects and animals, then listen for the echoes. She was fascinated by the idea that dolphins can't see very well underwater, even during the day, so they use sound instead. "I got really excited about how different the ocean world was from ours. It's like another planet—really alien," she says.

Kelly Benoit-Bird is an ocean ecologist at Oregon State University and the Monterey Bay Aquarium Research Institute.

Setting a purpose for reading: *I overheard many of you say that we will learn about the work of a scientist who studies ocean life, specifically predator-prey interactions. Dr. Benoit-Bird is an ocean ecologist* (place on word wall; you will define when the word appears in the article). *Let's read this article through the lens of science and engineering practices that are used by scientists across all disciplines. The practices that are highlighted in this article include asking questions, defining problems, and designing solutions.* Put these terms on the word wall and have pairs of students construct definitions; use student suggestions to construct class definitions on the word wall. Explain that students will stop periodically to record notes on the worksheet about the work of ocean ecologist Dr. Benoit-Bird.

Today Kelly Benoit-Bird is an **ocean ecologist**, a scientist who studies how living things interact with one another in a marine environment. It's easy to observe dolphin behavior in a place like SeaWorld, but Benoit-Bird wanted to know how they use echolocation in their natural environment. For example, how do dolphins find food when there aren't any humans around feeding them from a bucket? How do they tell the difference between two species of fish?

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Such questions about animal behavior can be difficult to investigate. That's especially true in the open ocean, the vast expanse of water beyond the continental shelf. There are no landmarks or fixed boundaries to help scientists keep track of where things are. Most sunlight penetrates only the top 200 meters (650 feet) of the water. Further down in the ocean's depths, it's too dark for cameras to help much. It's also hard for people to get there, because the farther down you go, the more water presses down on you from above. This increased

Word Wall: Put echolocation and ocean ecologist on the word wall. Invite students to locate the definition of each in the text, and then to work with a partner to paraphrase that definition and add it to the bottom section of their worksheet. (Prompt students to study the diagram on page 10 representing echolocation).

Think-Pair-Share: *What practices do you think Dr. Benoit-Bird is engaging in so far?* (Listen in and select students to share out. Students should notice that Dr. Benoit-Bird is asking questions and identifying problems).

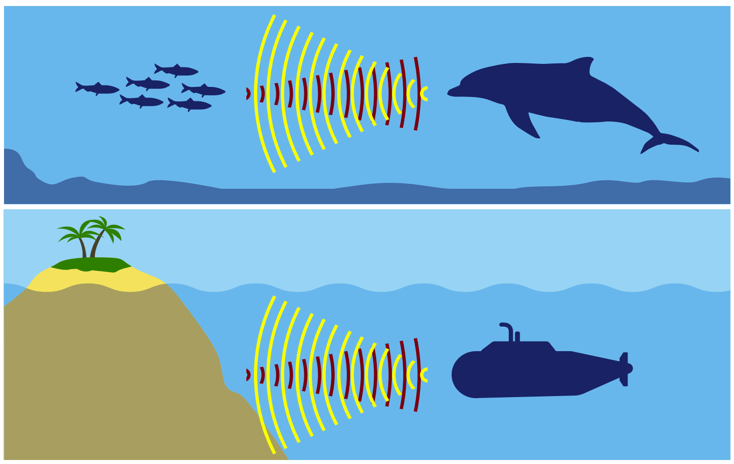
Stop and Jot: *Look at your worksheet and identify questions that you think you can answer based on what you have read so far. Answer the questions.* Students should be able to answer "What are they studying" and "What are the challenges of studying this?" You might:

- Invite students to share their responses with their partners
- Select students to share out their responses

Using Sound to Study Life Underwater

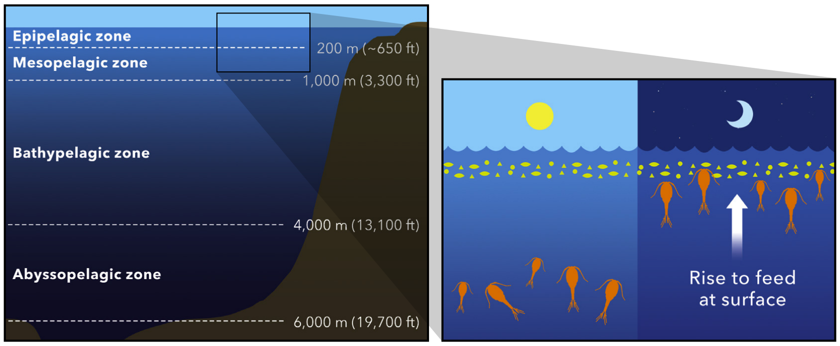
Benoit-Bird wanted to know: How do animals interact in the complex and mysterious world beneath the waves? The difficulties of studying the ocean's depths don't scare her. Instead, they excite her, because there's so much new to discover.

First she needed the right tools. That's where her love of tinkering came in. The only child of a mechanic, she grew up helping her father in his garage. "My dad can fix and build pretty much anything," she says. "Some of the best memories I have of my childhood are of being his 'second pair of hands.'" When she can't find the tools she needs, she makes new ones.



Sonar uses echolocation in the same way that dolphins use clicks.

Most of Benoit-Bird's tools involve sound. Unlike light, which travels only a few meters through water, sound can travel long distances. Engineers have developed a tool called sonar that works much the same way as dolphins use clicks. Sonar operators send out sound waves and then record and analyze the echoes. That allows them to create images of the physical environment and of the animals living and interacting underwater. Early sonar operators discovered something very surprising: The ocean floor seemed to be rising at night and falling during the day! This turned out not to be the ocean floor at all. Instead, their sonar was bouncing off a vast layer of small marine organisms that were rising at night to feed at the surface. The ocean floor was sitting still, of course—only the animals were moving. Scientists called this group of animals that travel daily up and down the "deep scattering layer."



Light, temperature, pressure, and salinity change with depth, creating a vertically stratified environment. Many species migrate between the two upper zones every night. During the day they hide from predators in the mesopelagic zone, and during the night they rise to feed in the epipelagic zone.

The tools that Benoit-Bird and her colleagues developed help them tell marine organisms apart. Different animals reflect sound in different ways. Mammals such as dolphins, for example, with their air-filled lungs, create a very strong echo. Many bony fish have swim bladders, gas-filled organs that help them maintain their buoyancy and also create distinctive echoes. Large squid, with their soft, airless bodies, and tiny shrimp-like krill also bounce back distinctive echoes.

Think-Pair-Share: *What more have you learned about Dr. Benoit-Bird's use of science practices?* Students should notice that Dr. Benoit-Bird is continuing to ask questions ("How do animals interact in the complex and mysterious world beneath the waves?") and is designing solutions (sonar operators).

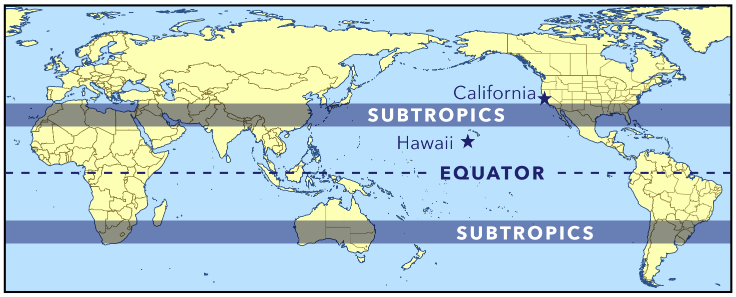
Stop and Jot: *Look at your worksheet and identify questions that you think you can answer based on what you have read so far. Answer the questions.* Students should be able to begin to answer the questions under the heading "How do they study the ocean?" (Include "Tool/ Technology used; Draw and label the tool; Describe the tool: What is it made of? How does it work? What does it do?) You might:

- Invite students to share their responses with their partners
- Select students to share out their responses

How Dolphins Herd Their Prey

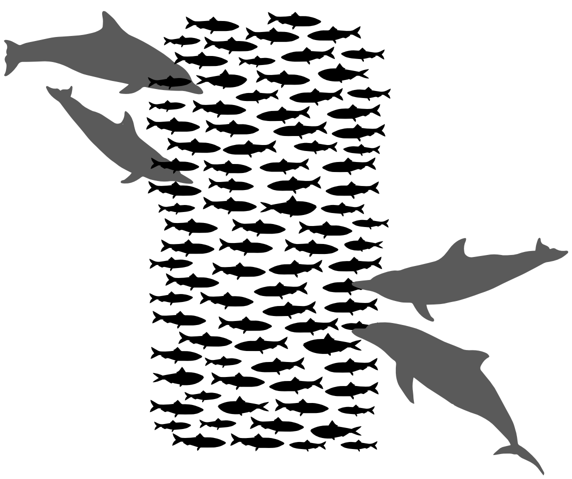
Benoit-Bird wanted to know how predators such as marine mammals and large fish find enough to eat in the ocean, where food is spread out over a large area. She compares the dolphins' prey to a single bag of popcorn in a big movie theater. Instead of being collected neatly in a bag, however, the popcorn is scattered unevenly all through the theater, from floor to ceiling—and instead of sitting still and waiting to be eaten, the popcorn is fleeing for its life! So how do predators eat enough to survive, without spending more energy hunting the food than they get from eating it?

Spinner dolphins, for example, live in the subtropics and hunt at night. They eat small prey such as lanternfish, shrimp, and squid, which are part of the deep scattering layer. The prey are so small that to keep from starving, each dolphin must eat, on average, about 1.25 of them every minute. From prior observations and research, Benoit-Bird knew that groups of dolphins hunt together in the same areas at the same time. She now wanted to investigate the following question: Were spinner dolphins helping each other catch their food?



Food is especially scarce in the oceans of the subtropics, which lie roughly between the tropics at latitude 23.5° and the temperate zones at latitudes 35–66.5° north and south of the Equator.

To do this Benoit-Bird and her team used their acoustic techniques to study groups of spinner dolphins hunting off the coast of Oahu, Hawaii. During this study they repeatedly observed the following behavior: Groups of 16 to 28 dolphins would line up in pairs and swim together until they found a spot where prey happened to be more densely clustered than usual. Then the dolphins would tighten the line. Each pair would swim closer to the next pair. They would push forward fast, plowing the fleeing prey ahead of them into an even denser clump. Next they would surround the prey, swimming in circles in a column. The confused prey, trying to flee and swimming chaotically, would head into the center of the column. This dance would create a high concentration of prey inside the circle, on average 60 times the ordinary density. The pairs of dolphins would take turns diving in and feeding for a few seconds. It was as if they'd herded their popcorn into an imaginary bag and were taking turns diving in to chow down. The whole thing would last four to five minutes at a time. Then the dolphins would swim back to the surface for a lungful of air. This led the scientists to make the exciting conclusion that the spinner dolphins were indeed cooperating to herd fish and other prey.



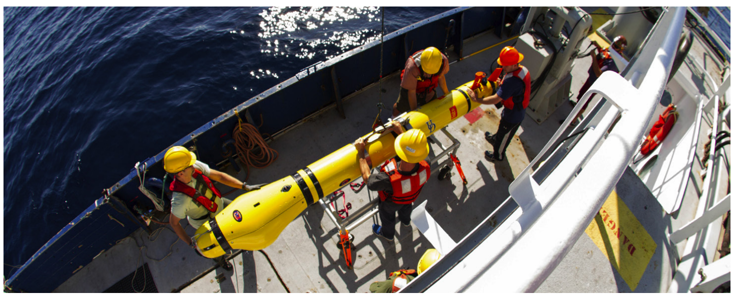
Pairs of dolphins swim in circles to create a column of fish that is 20 to 40 meters (65 to 130 feet) in diameter.

Think-Pair-Share: *What new information have you learned? What questions can you begin to answer? After talking with your partner, answer the questions on the worksheet, and/or add to responses you already started.* Students should be responding to the questions "What are the scientists learning using this tool? Why do the scientists need to use this tool?"

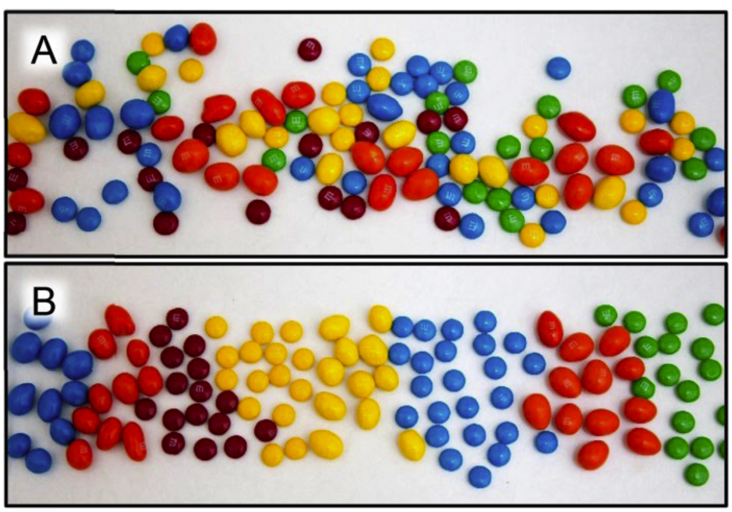
After listening to peer conversation and looking at students' responses, select students to share their thinking about these questions with the class. Encourage students to talk through the hunting behavior that Dr. Benoit-Bird and her team discovered.

How Prey Work Together to Foil Hunters

These days, Benoit-Bird is studying how prey in the deep scattering layer avoid being eaten in a different part of the world: the California coast. She and her team put their acoustic instruments on an underwater robot. Cramming the equipment into the slender vehicle took some doing, but fortunately, Benoit-Bird is an expert tinkerer. Then they sent the robot down into the deep scattering layer off the eastern coast of Catalina Island, California. Previously, scientists looking down at the deep scattering layer from their ships at the surface had believed that the animals were all jumbled together in it like different colored M&Ms in a bag. Benoit-Bird's underwater robot was able to dive below the surface and look at the deep scattering layer from the inside. The robot showed the scientists that the deep scattering layer is made up of distinct groups of organisms side by side. Each group consists of the same type of animal of the same size. It was as if the M&Ms were sorted into small patches, each of a single color and size. These schools of marine animals coordinate their movements in a highly organized way.



Scientists equip an underwater robot with acoustic instruments.



Each color of M&Ms represents a different species of animal. From the ocean surface, it looks like the species are all jumbled together (A). But from the point of view of the underwater robot, it's clear that individuals within each species are actually grouped together (B).

Just as interesting was the animals' behavior when a predator appeared. In California the researchers often noticed a different species of dolphins, called Risso's dolphins. These dolphins seemed to be hunting their favorite food, squid. Kelly Benoit-Bird and her colleagues asked a question: Do the squid try to avoid being eaten, and if so, how do they do it? During their study they discovered that when the Risso's dolphins approached a school of squid, the squid moved nearer to their fellows. This highly organized behavior is called "flash compression." The behavior makes it more difficult for predators to target individual prey. The squid arranged themselves into dizzying patterns. This way they confused the dolphins' senses, making it hard for the dolphins to single out any one squid to attack.

Benoit-Bird's research into how animals behave in the mesopelagic zone, 200 and 1000 meters (660 and 3300 feet) beneath the ocean's surface, is important. Ten billion metric tons of animals live there, making up more than half the total weight of all the fish on Earth. These animals are a vital food source for many predators, from tuna and salmon to dolphins, whales, and penguins. But in 2018, for the first time, countries began issuing fishing permits for access to the mesopelagic. We are in a race, says Benoit-Bird, to figure out what impact that harvest might have on the ecosystem, and how to make it sustainable. She says, "Now is the perfect time to address these questions before we've made potentially irreversible changes."

Think-Pair-Share: *What new question did Dr. Benoit-Bird and her team seek to answer in this last section? What conclusion was drawn?* After listening in and selecting students to share their thinking, you might invite students to add details to their worksheet.

Think-Pair-Share:

- *What did you learn from this article that surprised you?*
- *What questions do you have after reading this article?*

Listen in to peer conversations and facilitate a whole-group discussion based on ideas you select from students' stop and jots and/or peer conversations. You can also invite students to check their understanding by discussing Dr. Benoit-Bird's use of science practices (referring to the notes on their worksheets). You might do this by using discussion prompts such as:

- What discoveries did Dr. Benoit-Bird and her team make? How did their use of science practices lead to these discoveries?
- What obstacles motivated Dr. Benoit-Bird and her team to use innovation and design solutions?
- Why is Dr. Benoit-Bird's research important at this moment in time?

WORD WALL

Vocabulary Term	**Definition from article (verbatim)**	**Explanation of this term in my own words**
Echolocation		
Ocean Ecologist		
SEP: Asking Questions		
SEP: Defining Problems		
SEP: Designing Solutions		

SEP = Science and Engineering Practice
(select additional terms from the article that you think are most essential for your students to know)

ESSAY SCORING RUBRIC: TEACHER VERSION - page 1

	Exceeds	Meets	Approaches	Needs Additional Support
	4	3	2	1
Research: "Listening to Life in the Deep" Article	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the article	Presents paraphrased information from the article relevant to the prompt with sufficient accuracy and detail	Presents information from the article mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the article or relevance to the purpose of the prompt
Research: *Unseen Oceans* Museum Exhibition	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the exhibition	Presents paraphrased information from the exhibition relevant to the prompt with sufficient accuracy and detail	Presents information from the exhibition mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the exhibition content or relevance to the purpose of the prompt
Science Explanations	Integrates relevant and accurate science content with thorough explanations that demonstrate an understanding of scientists and the tools they use to study the ocean	Presents science content relevant to the prompt with sufficient accuracy and explanations that demonstrate understanding of scientists and the tools they use to study the ocean	Presents science content mostly relevant to the prompt; shows basic or uneven understanding of scientists and the tools they use to study the ocean	Attempts to include science content in explanations, but lacks understanding of scientists and the tools they use to study the ocean
	Consistent and effective use of precise and domain-specific language	Some or ineffective use of precise and domain-specific language	Little use of precise and domain-specific language	No use of precise and domain-specific language
	Uses labeled and captioned illustrations of two tools that scientists use to study the ocean to effectively communicate relevant information	Uses labeled and captioned illustrations of two tools that scientists use to study the ocean to sufficiently communicate relevant information	Illustrations are unlabeled or uncaptioned	Only one illustration OR no illustrations

ESSAY SCORING RUBRIC: TEACHER VERSION - page 2

	Exceeds	Meets	Approaches	Needs Additional Support
	4	3	2	1
Development	Includes a relevant opening section that clearly and effectively previews the essay to follow	Includes a sufficient and relevant opening sections	Includes an opening section that is insufficient or irrelevant	Does not include an introduction
	Includes highly relevant and highly detailed descriptions of scientists and the tools they use to study the ocean to address the writing prompt	Includes sufficient descriptions of scientists and the tools they use to study the ocean to address the writing prompt	Includes descriptions of scientists and the tools they use to study the ocean, but not sufficient to fully address the prompt	Does not include any descriptions of scientists and the tools they use to study the ocean
	Provides a concluding section that follows from and effectively supports the information or explanation presented	Provides a concluding section that follows from and sufficiently supports the information or explanation presented	Provides a concluding section that mostly supports the information or explanation presented	Provides a concluding section that does not support the information or explanation presented OR provides no concluding section
Conventions	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors; response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt	Demonstrates a command of standard English conventions and cohesion, with few errors; response includes language and tone appropriate to the purpose and specific requirements of the prompt	Demonstrates an uneven command of standard English conventions and cohesion; uses language and tone with some inaccurate, inappropriate, or uneven features	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics

ARTICLE

Listening to Life in the Deep

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Such questions about animal behavior can be difficult to investigate. That's especially true in the open ocean, the vast expanse of water beyond the continental shelf. There are no landmarks or fixed boundaries to help scientists keep track of where things are. Most sunlight penetrates only the top 200 meters (650 feet) of the water. Further down in the ocean's depths, it's too dark for cameras to help much. It's also hard for people to get there, because the farther down you go, the more water presses down on you from above. This increased pressure can harm divers and crush equipment. Because of these challenges, much less is known about life in the open ocean than in coastal regions.

Using Sound to Study Life Underwater

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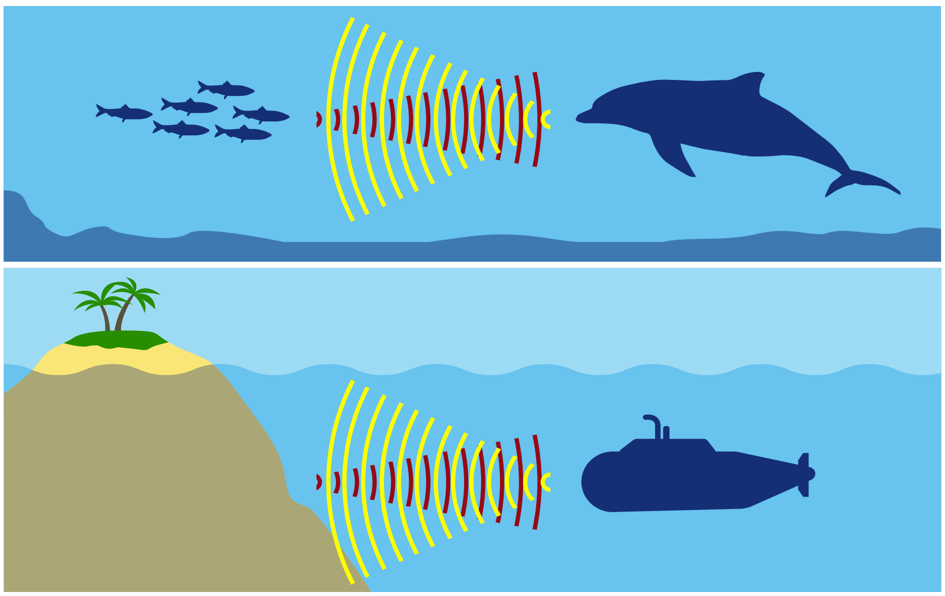

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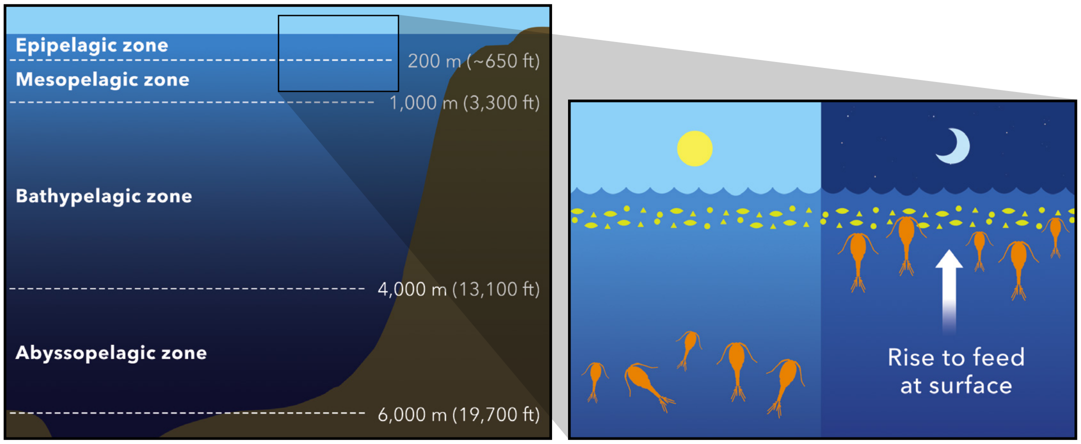

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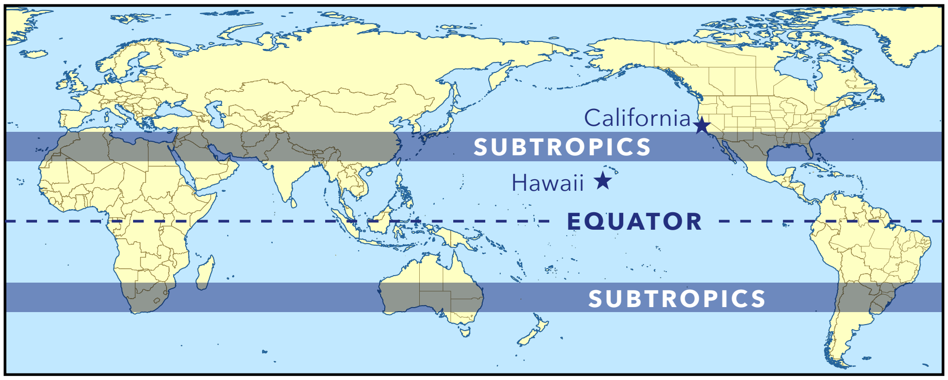
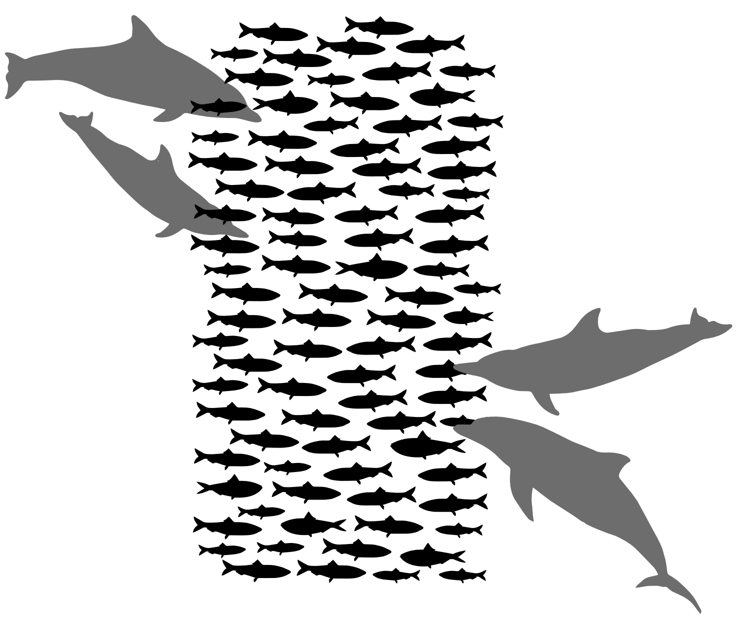
Benoit-Bird wanted to know how predators such as marine mammals and large fish find enough to eat in the ocean, where food is spread out over a large area. She compares the dolphins' prey to a single bag of popcorn in a big movie theater. Instead of being collected neatly in a bag, however, the popcorn is scattered unevenly all through the theater, from floor to ceiling—and instead of sitting still and waiting to be eaten, the popcorn is fleeing for its life! So how do predators eat enough to survive, without spending more energy hunting the food than they get from eating it?

Spinner dolphins, for example, live in the subtropics and hunt at night. They eat small prey such as lanternfish, shrimp, and squid, which are part of the deep scattering layer. The prey are so small that to keep from starving, each dolphin must eat, on average, about 1.25 of them every minute. From prior observations and research, Benoit-Bird knew that groups of dolphins hunt together in the same areas at the same time. She now wanted to investigate the following question: Were spinner dolphins helping each other catch their food?



Food is especially scarce in the oceans of the subtropics, which lie roughly between the tropics at latitude 23.5° and the temperate zones at latitudes 35–66.5° north and south of the Equator.

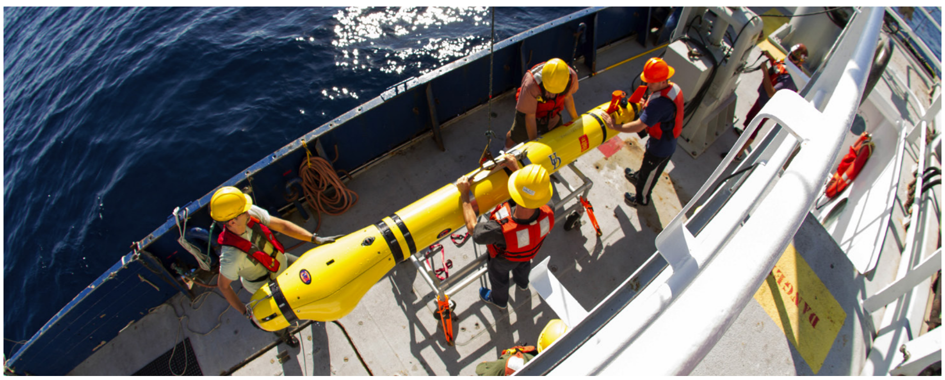
To do this Benoit-Bird and her team used their acoustic techniques to study groups of spinner dolphins hunting off the coast of Oahu, Hawaii. During this study they repeatedly observed the following behavior: Groups of 16 to 28 dolphins would line up in pairs and swim together until they found a spot where prey happened to be more densely clustered than usual. Then the dolphins would tighten the line. Each pair would swim closer to the next pair. They would push forward fast, plowing the fleeing prey ahead of them into an even denser clump. Next they would surround the prey, swimming in circles in a column. The confused prey, trying to flee and swimming chaotically, would head into the center of the column. This dance would create a high concentration of prey inside the circle, on average 60 times the ordinary density. The pairs of dolphins would take turns diving in and feeding for a few seconds. It was as if they'd herded their popcorn into an imaginary bag and were taking turns diving in to chow down. The whole thing would last four to five minutes at a time. Then the dolphins would swim back to the surface for a lungful of air. This led the scientists to make the exciting conclusion that the spinner dolphins were indeed cooperating to herd fish and other prey.



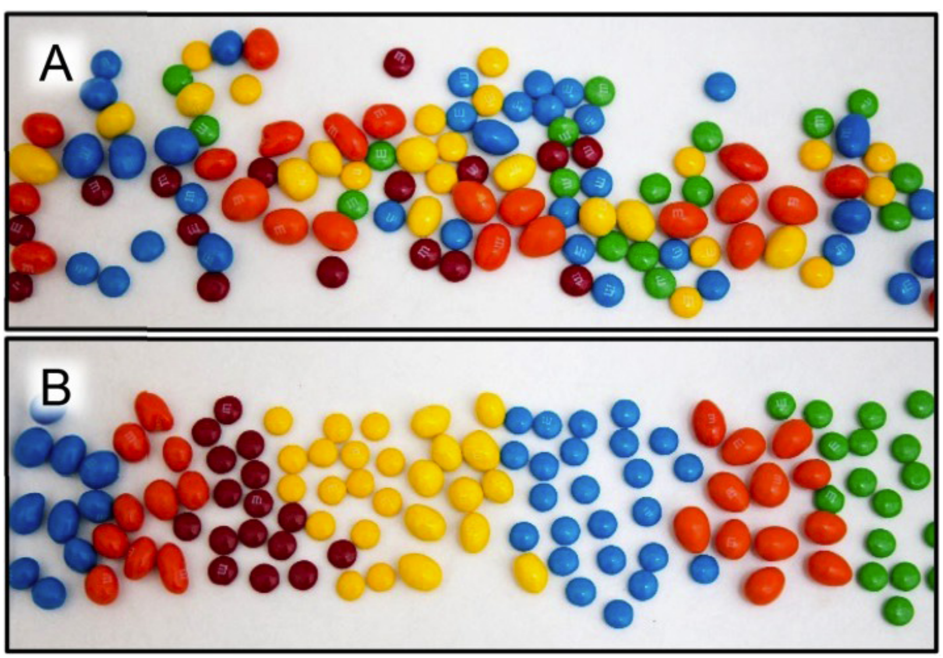
Pairs of dolphins swim in circles to create a column of fish that is 20 to 40 meters (65 to 130 feet) in diameter.

How Prey Work Together to Foil Hunters

These days, Benoit-Bird is studying how prey in the deep scattering layer avoid being eaten in a different part of the world: the California coast. She and her team put their acoustic instruments on an underwater robot. Cramming the equipment into the slender vehicle took some doing, but fortunately, Benoit-Bird is an expert tinkerer. Then they sent the robot down into the deep scattering layer off the eastern coast of Catalina Island, California. Previously, scientists looking down at the deep scattering layer from their ships at the surface had believed that the animals were all jumbled together in it like different colored M&Ms in a bag. Benoit-Bird's underwater robot was able to dive below the surface and look at the deep scattering layer from the inside. The robot showed the scientists that the deep scattering layer is made up of distinct groups of organisms side by side. Each group consists of the same type of animal of the same size. It was as if the M&Ms were sorted into small patches, each of a single color and size. These schools of marine animals coordinate their movements in a highly organized way.



Scientists equip an underwater robot with acoustic instruments.



Each color of M&Ms represents a different species of animal. From the ocean surface, it looks like the species are all jumbled together (A). But from the point of view of the underwater robot, it's clear that individuals within each species are actually grouped together (B).

Just as interesting was the animals' behavior when a predator appeared. In California the researchers often noticed a different species of dolphins, called Risso's dolphins. These dolphins seemed to be hunting their favorite food, squid. Kelly Benoit-Bird and her colleagues asked a question: Do the squid try to avoid being eaten, and if so, how do they do it? During their study they discovered that when the Risso's dolphins approached a school of squid, the squid moved nearer to their fellows. This highly organized behavior is called "flash compression." The behavior makes it more difficult for predators to target individual prey. The squid arranged themselves into dizzying patterns. This way they confused the dolphins' senses, making it hard for the dolphins to single out any one squid to attack.

Benoit-Bird's research into how animals behave in the mesopelagic zone, 200 and 1000 meters (660 and 3300 feet) beneath the ocean's surface, is important. Ten billion metric tons of animals live there, making up more than half the total weight of all the fish on Earth. These animals are a vital food source for many predators, from tuna and salmon to dolphins, whales, and penguins. But in 2018, for the first time, countries began issuing fishing permits for access to the mesopelagic. We are in a race, says Benoit-Bird, to figure out what impact that harvest might have on the ecosystem, and how to make it sustainable. She says, "Now is the perfect time to address these questions before we've made potentially irreversible changes."

STUDENT WORKSHEET Name: ______________________

Welcome to the *Unseen Oceans* exhibition! Today you will dive beneath the waves and learn about the scientists who study this fascinating underwater world. Your task is to pick two different scientists (or teams of scientists) who use tools to meet the challenges of studying the ocean. Use the **map** below to help you select and locate the scientists; there are six options. Use the **worksheets** to gather information about each scientist (or team).

Location	Scientist (or Team of Scientists)	Tool / Technology
1	David Gruber and John Sparks	high resolution underwater camera
2	Ari Friedlaender and Jeremy Goldbogen	whale tag
3	Kakari Katija and Aran Mooney	jellyfish tag
4	Kaitlyn Becker	soft gripper
5	Dawn Wright	submersible
6	Jules Jaffe	m-AUEs (mini autonomous underwater explorers)
★	Kelly Benoit-Bird	sonar

STUDENT WORKSHEET

Name: ______________________

Who?

Scientist(s): ______________________

What are they studying? Where?

What are the challenges of studying this?

Record additional information about the scientists, such us who they are, where they work, and what motivates them. Record any details and quotes you find important or interesting.

How do they study the ocean?

Tool / technology used: ______________________

Draw and label the tool:

Caption:

Describe the tool: What is it made of? How does it work? What does it do?

What are the scientists learning by using this tool?

Why do the scientists need to use this tool? What challenge are they trying to address?

Additional info/wonderings: ______________________

STUDENT WRITING TASK

Exploring the deep ocean and the animals that live there is difficult, but scientists design solutions to meet the challenges. Write an essay in which you describe two different scientists (or teams of scientists) and explain how they use different tools to meet the challenges of studying the ocean.

Be sure to:

- Describe two different scientists who study the ocean using different tools: Kelly Benoit-Bird from the article and one scientist (or a team of scientists) of your choice from the *Unseen Oceans* exhibition.
- Provide any relevant information about the scientists. Who are they? Where do they work? What motivates them? Include additional details that you think are important or interesting.
- Discuss what each scientist (or team) studies. Explain the importance and the challenges of studying it.
- Describe and draw the tools that each scientist (or team) uses and explain how these tools address specific challenges.
- Discuss what each scientist (or team) is learning using the tools.
- Include an introduction and a conclusion in your essay.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additional Support
	4	3	2	1
Research: "Listening to Life in the Deep" Article	I have used information correctly from the article to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the article to write my essay in my own words.	I have used information from the article to write my essay, but not all of my information is correct AND/OR I didn't use my own words.	I did not use information from the article to write my essay.
Research: *Unseen Oceans* Museum Exhibition	I have used information correctly from the exhibition to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the exhibition to write my essay in my own words.	I have used information from the exhibition to write my essay, but not all of my information is correct AND/OR I didn't use my own words.	I did not use information from the exhibition to write my essay.
Science Explanations	All of the information I included about the scientists and the tools they use to study the ocean is correct and relevant. It shows I understand this topic well.	Most of the information I included about scientists and the tools they use to study the ocean is correct and relevant.	Some of the information I included about scientists and the tools they use to study the ocean is correct and relevant.	None of the information I included about scientists and the tools they use to study the ocean is correct.
	I used relevant science vocabulary whenever possible, and I used all words correctly.	I used most science vocabulary words correctly.	I used some science vocabulary words correctly.	I did not use any science vocabulary words.
	I included two labeled and captioned illustrations that help the reader understand what kind of tools scientists use to study the ocean.	I included two labeled and captioned illustrations.	My illustrations do not have captions or labels.	I included one illustration OR did not include any illustrations.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additional Support
	4	3	2	1
Development	I included a clear introductory paragraph that effectively previews the essay to follow.	I included a relevant introduction in the essay.	I included an irrelevant introduction to the essay.	I did not include an introduction.
	I included many, highly detailed descriptions of scientists and the tools they use to study the ocean.	I included enough descriptions of scientists and the tools they use to study the ocean.	I included some, but not enough descriptions of scientists and the tools they use to study the ocean.	I did not include any descriptions of scientists and the tools they use to study the ocean.
	I have written a concluding paragraph that relates to all of the information in my essay.	I have written a concluding paragraph that relates to some of the information in my essay.	I have written a concluding paragraph or sentence at the end of the essay.	I have not written a concluding sentence at the end of the essay.
Conventions	I have edited my essay for spelling, punctuation, and grammar; there are no errors.	I have edited my essay for spelling, punctuation, and grammar; there are some minor errors but the reader can still understand my writing.	I have not carefully edited my essay for spelling, punctuation, and grammar; there are errors that may make the essay hard for readers to understand.	I have not edited my essay for spelling, punctuation, and grammar; there are many errors that make the essay hard for readers to understand.