REMUS

8.4

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Anchoring Phenomenon

Numerous reports suggest an increase in white shark encounters* in the United States in recent years and the public is worried.

Lesson Concept

Clarify and/or seek additional information from careful observations of phenomena to understand how a sound-wave enabled tracking device gathers information on a white shark.

Investigative Phenomenon

The REMUS "shark cam" provides a more reliable method of getting information on white sharks at the expense of potentially interrupting/influencing white shark behavior.

Standards

Refer to Appendix 8.4 for NGSS, CCSS (ELA) and California ELD standards.

*Encounters include sightings and census estimates, as well as physical interactions between humans and sharks.

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Storyline Link

In the prior lesson, students learned about white shark history and evolution in the fossil record and looked into fisherman logs of shark landings to try and establish an idea of typical shark population size only to encounter numerous frustrations with the inaccuracy of such methods.

This lesson begins by utilizing students' increased sophistication of their understanding of asking questions around the need for a more accurate way to study white sharks by introducing students to REMUS (Remote Environmental Monitoring UnitS, an autonomous underwater vehicle). This leverages student opportunity to observe the phenomena and guide their work to seek additional information. REMUS presents a way scientists today are able to better study white sharks: tracking devices. Students begin to explore specifications of this technology, which brings new insight into the behavior of sharks, but also a new suite of challenges. Students are perceptive to the fact that white sharks interact with REMUS—potentially changing their behavior to do so—and demonstrate their knowledge of cause and effect (by using, from the 6–8 grade band, elements of cause and effect independently). They explore common shark adaptations that support successful survival and reproduction, but may present challenges in observing their natural behavior without detection.

This lesson moves towards altering student preconceptions about shark senses. In doing so, students begin to wonder, *Can sharks detect electrical and/or magnetic fields emitted by a tracker?*, which will be explored in the next lesson.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where instruction may change in response to students' level of understanding and making sense of phenomena.

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Time

100 minutes

Part I	30 minutes	Engage
Part II	45 minutes	Explore 1/Explain 1
Part III	25 minutes	Explore 2/Explain 2

Materials

Whole Class

- ❑ 8.1.C1: Shark Encounter Claim Chart (from Lesson 8.1: Shark Encounters)
- ❑ *REMUS Shark Cam: The Hunter and the Hunted* video, https://vimeo.com/101165012

Per Group of 4

- ❑ Internet enabled devices

Individual

- ❑ Science Notebook
- ❑ 8.1.H2: Scientist Communication Survival Kit (from Lesson 8.1: Shark Encounters)
- ❑ 8.1.H3: My Shark Encounter Claim Chart (from Lesson 8.1: Shark Encounters)
- ❑ 8.1.H4: Crosscutting Concepts for Middle School Students (from Lesson 8.1: Shark Encounters)
- ❑ 8.4.H1: Understanding White Sharks

Advance Preparation

1. Preview and prepare to project the REMUS Shark Cam, *REMUS Shark Cam: The Hunter and the Hunted* video. (Step 4 of Procedure)
2. Prepare Internet enabled devices for group use. (Step 6 of Procedure)
3. Make sure that **8.1.C1: Shark Encounter Claim Chart** from Lesson 8.1: Shark Encounters, is posted in the room.
4. Duplicate **8.4.H1: Understanding White Sharks** for each student. (Step 6 of Procedure)

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Procedure

Part I

Engage (30 minutes)

Ask questions that arise from careful observations of cause and effect relationships to predict phenomena and establish the need for tracking devices to gather information on white sharks.

Establishing Need for More Reliable Data and Information and Prior Knowledge of Tags

1. Begin by asking groups of students to discuss where they left off with their revision of **8.1.H3: My Shark Encounter Claim Chart** in Lesson 8.3: Fisher Logs. Have a brief class discussion to reflect on the following (recalling fossil evidence and fisher logs):

    a. What do we understand about sharks?

    b. What do we not understand about sharks?

    c. What additional information is eventually needed to build a strong explanation to address the question (part of the anchoring phenomenon): *Are there really more shark encounters now than in the past?*

2. This discussion should yield students establishing need for more reliable data (relevant and sufficient) to be able to address the anchoring phenomenon (How else can we gather modern information on white sharks to explain the phenomenon that numerous reports suggest an increase in white shark encounters in the United States in recent years and the public is worried?). ▶ If not, probe students by asking targeted questions to elicit these ideas and remind students as to what the anchoring phenomenon is for struggling students as needed.

3. Ideally some students will suggest studying sharks in some way, like a census count from the shore (using a lifeguard tower), a boat, or a drone. Although scientists still use these methods, many today are relying on data from tags. ▶ If students don't mention the ability to tag and track a shark, ask questions such as, "How do you think scientists monitor or count other animals?" and "If a lost dog was caught, how would we know who it's owners were?" and "Think of animals that you might have heard about in the news that come into neighborhoods that are next to an undeveloped area, like mountain lions or bears. We sometimes hear those animals referred to with a name like 'P-22'; how do they know it's P-22? If P-22 has a tag, how did it get that?" This should yield discussions about microchips and tags. Shift the conversation back to sharks and ask, "Assuming scientists can tag a shark, what sorts of structures can scientists use to get a tag in a shark?"

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4. Introduce the idea that a group of scientists from Woods Hole Oceanographic Institution have used a very high tech device to track white sharks; it is called the REMUS SharkCam. Queue up the video *REMUS SharkCam: The Hunter and the Hunted* and instruct students to record as many observations and questions as they can in their Science Notebook while watching the video, then play the video.

    a. Expected student responses include:

Observations	Questions
❑ The tracker is being bitten or attacked. ❑ A shark snuck up on it and bit the mid-end section. ❑ The sharks are territorial. ❑ REMUS has six cameras. ❑ REMUS is made of tough material. ❑ The tracker is following the shark. ❑ The shark sees the tracker. ❑ The shark is bothered by the tracker.	❑ Why did the shark feel threatened by the tracker? ❑ How is REMUS made? ❑ Would the same thing happen if it was a human? ❑ Why did the shark attack the tracker? ❑ Is the shark attracted to REMUS? ❑ How does the tracker know where the shark is?

5. Play the video again and make sure to emphasize that the goal of the REMUS was to film and track white sharks in their environment. Instruct students to keep this in mind while watching the video again and list any other observations or questions they have in their Science Notebook. Ask students to reference **8.1.H4: Crosscutting Concepts for Middle School Students** and to add to their observations and questions as well as generate two statements or questions informed by the On-Target column for cause and effect.

    a. Expected student responses include:

Cause and Effect Statements
❑ I think the shark is bothered by REMUS because of REMUS's movement. So when any object is moving in the water I predict sharks will bite it. ❑ Another cause that might help explain the phenomenon is that sharks will bite anything. ❑ I predict the tracker has a way to follow the shark because most animals we follow have tags or microchips. ❑ REMUS swims in the water (is that a cause?) and there's a pattern of sharks consistently attacking REMUS. ❑ I'm not confident I have enough information to make a cause and effect statement. I would want to know more about how REMUS is working and how white sharks know REMUS is in the water.

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Procedure

Part II

Explore 1/Explain 1 (45 minutes)

Obtain and evaluate information from multiple appropriate sources to determine if the patterns in the data can establish cause and effect relationships between white sharks, as they are adapted to existing conditions today, and perceived public concerns.

Should the Public Be Worried? Gathering Information on White Shark Adaptations to Sense Their Environment and Locate Food

TEACHER NOTE

The Explore activity has students tease apart the two parts of the anchoring phenomenon (report of white shark encounters increasing, and the public worried). As written, students attempt to understand the second half first, "the public is worried." The reason for this is because "reports suggest an increase in white shark encounters" will provide a natural segue into Lesson 8.5: Magnetic Fields. However, if student interest is strong in exploring "reports suggest an increase in white shark encounters" first, go for it.

6. In Step 6 and Step 7, the class will reflect on observations, questions, and cause and effect statements and identify those that would help build understanding of the anchoring phenomenon: *Numerous reports suggest an increase in white shark encounters in the United States in recent years and the public is worried.*

    a. To begin, work with students to tease the phenomenon into its two distinct parts and discuss what is known vs. unknown. This is intended to help students with sensemaking of the phenomenon.

    Begin by looking into the second part of the phenomenon: Why would the public be worried? (Fears of being attacked by a shark)

        i. Ask students to identify which observations or questions generated while watching the REMUS SharkCam video would relate to this part of the phenomenon. Using the example given above, they would likely identify some of the following:

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Observations	Questions
❑ *The tracker is being bitten or attacked.* ❑ *A shark snuck up on it and bit the mid-end section.* ❑ *The sharks are territorial.* ❑ ~~*REMUS has six cameras.*~~ ❑ ~~*REMUS is made of tough material.*~~ ❑ ~~*The tracker is following the shark.*~~ ❑ *The shark sees the tracker.* ❑ *The shark is bothered by the tracker.*	❑ *Why did the shark feel threatened by the tracker?* ❑ ~~*How is REMUS made?*~~ ❑ *Would the same thing happen if it was a human?* ❑ *Why did the shark attack the tracker?* ❑ *Is the shark attracted to REMUS?* ❑ ~~*How does the tracker know where the shark is?*~~

Cause and Effect Statements
❑ *I think the shark is bothered by REMUS because of REMUS's movement. So when any object is moving in the water I predict sharks will bite it.* ❑ *Another cause that might help explain the phenomenon is that sharks will bite anything.* ❑ ~~*I predict the tracker has a way to follow the shark because most animals we follow have tags or microchips.*~~ ❑ *REMUS swims in the water (is that a cause?) and there's a pattern of sharks consistently attacking REMUS.* ❑ ~~*I'm not confident I have enough information to make a cause and effect statement. I would want to know more about how REMUS is working and how white sharks know REMUS is in the water.*~~

ii. Given these observations, questions, and statements—and what we know about sharks—are these fears substantiated? Our research so far has only given us very general information on sharks. Ask students: "What would we need to know in order to determine if our fears of being attacked by a white shark reflect what scientists know about sharks? What else might help answer these questions you have identified?" Have a brief conversation to solicit student ideas about what we would need to know (for example, *what do sharks usually eat?; how would a shark know if a human was in the water?; are humans a part of the white shark diet?*).

iii. Guide students to focus on two key aspects of white sharks that will address their questions and the fear portion of the phenomenon: senses and feeding behavior.

a. To begin, ask students to have a brief group discussion about what they can remember about senses and what is meant by *feeding behavior*.

i. Regarding senses, encourage students to think of humans or other animals they may be familiar with. What are some examples of senses? What is their purpose/why are they important?

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ii. Regarding feeding behavior, it might be best to direct students to think of animals they are very familiar with (like dogs) as well as animals that don't live with or interact with humans. (Consider predatory animals in their natural habitat that would be familiar to your students, such as mountain lions, hawks, orcas, etc.) How would you define feeding behavior? What is the purpose of the behavior? What are some key differences, and why is the feeding behavior of animals in their natural habitat so different from humans and animals that are dependent on humans?

b. Point out that sharks are adapted to life in the water, humans are adapted to life on land (and offer an example of another animal that may have been discussed by students). Regardless, each has traits that support successful survival and reproduction in their respective environments. ▶ Ask students to recall what they know about successful survival and reproduction as well as adaptations and help clarify that understanding. Provide some examples of human adaptations to serve as a contrast. (These should be traits such as the presence of true hair, mammary glands that produce milk, opposable thumbs, broadened hip bones that allow for walking upright, etc.)

TEACHER NOTE

It's not terribly important to the storyline to spend a lot of time on senses or feeding behavior at this point, especially since students in the next part will be formally recording their prior knowledge. The discussion here is simply meant to get ideas flowing to help with the next part. By the end of the lesson, students should come to the understanding that the dominant sense of sharks is different from that of humans as a result of selection acting out in the environment it lives in, and animals (that do not rely on humans) tend to be opportunistic feeders. This is all intended to help dispel some myths the public holds about white sharks.

Should students want to do more research on the electroreceptors for sharks, this will help inform them for the next lesson and offer a way to encourage highly motivated students.

c. Distribute **8.4.H1: Understanding White Sharks** and instruct students to answer questions 1–3 on page 1, Senses, using only their prior knowledge.

d. Work with the class to fill out the table, comparing human and white shark sensory adaptations. Instruct students to list adaptations in the order of most relied upon/used to least. It's advisable to use humans as an example first; ask students to identify human senses and list them in order from most to least relied upon. Students might order human senses as vision (primary), hearing, touch, smell, and taste. When discussing sharks, students might say that

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sharks also rely on vision as their primary sensory adaptation simply because humans do. This is a great opportunity to clear up this misconception; remind students of the discussion they had about how animals who do not live with humans and who live in the water are adapted for living in a different environment. Do not lead further than this, as the research students will do later should clear up inaccurate preconceptions. Allow students to share their ideas on the order of shark senses. This order can be debatable for students; return to this AFTER they have done further research. The order of senses on which white sharks rely is (approximately) electroreception, touch/lateral line, smell, taste, vision, hearing.

e. Instruct students to work, individually or in pairs, on an Internet enabled device to visit the websites suggested on the various pages of **8.4.H1: Understanding White Sharks** and answer the remaining questions. Circulate the classroom and help students with their research; encourage motivated students to dive deeper into the websites if they're curious about learning more about sharks. (Some of the websites have amazing videos that illustrate shark behavior, but also list the challenges of observing them without disturbing their natural behavior.) Provide additional text support and sentence frames for students struggling with language; allow students to co-construct responses to questions, and/or provide additional time.

f. For each section of **8.4.H1: Understanding White Sharks** where a new website is used, ask students to evaluate the website using the source check for the section (at the bottom of the page).

g. Ask students to share individually with their group what they have learned and then ask each group to share a unique key finding with the class. Revisit student answers to the sensory comparison chart in **8.4.H1: Understanding White Sharks, Senses** (page 8.4.16) and verify that students understand that the order in which white sharks rely on senses, circumstance dependent, is (approximately) electroreception (most relied on), touch/lateral line, smell, taste, vision, hearing (least relied on).

h. Ask students to reflect on their responses and to think back to the "public worry" portion of the phenomenon. They should have a brief discussion about it and make notes in their Science Notebook. Given what they now know about white shark senses and feeding behavior, ask

   i. Would a white shark know a human is in its environment? What is your evidence for this?

   ii. Consider what was shared regarding white shark feeding behavior; were there any patterns in the research/data that could establish a cause and effect relationship?

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iii. If a white shark knows a human is in its environment, does it matter? Consider feeding behavior. What do white sharks, at different age classes, eat? What is your evidence for this?

iv. Thinking of a worried member of the public, what claim would you make to communicate to the public about white shark senses and feeding behavior? Is your evidence adequate for supporting this claim?

Procedure

Part III

Explore 2/Explain 2 (25 minutes)

Clarify and/or seek additional information from careful observations of phenomena to understand how a sound-wave enabled tracking device gathers information on a white shark.

How Do Trackers Work to Ultimately Help Us Build Understanding about White Shark Population Size?

7. Ask students to revisit their observations and questions after watching the REMUS SharkCam video and identify those that would help build understanding of the first part of the phenomenon: is there an increase in the white shark population? How could a tracking device, such as REMUS, help us address this part of the phenomenon?

    a. Ask students to identify which observations, questions, or statements generated would relate to this part of the phenomenon. In the example given, they would likely identify the following:

Observations	Questions
❑ ~~*The tracker is being bitten or attacked.*~~ ❑ ~~*A shark snuck up on it and bit the mid-end section.*~~ ❑ ~~*The sharks are territorial.*~~ ❑ *REMUS has six cameras.* ❑ ~~*REMUS is made of tough material.*~~ ❑ *The tracker is following the shark.* ❑ ~~*The shark sees the tracker.*~~ ❑ ~~*The shark is bothered by the tracker.*~~	❑ ~~*Why did the shark feel threatened by the tracker?*~~ ❑ *How is REMUS made?* ❑ ~~*Would the same thing happen if it was a human?*~~ ❑ ~~*Why did the shark attack the tracker?*~~ ❑ ~~*Is the shark attracted to REMUS?*~~ ❑ *How does the tracker know where the shark is?*

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Cause and Effect Statements
❑ ~~*I think the shark is bothered by REMUS because of REMUS's movement. So when any object is moving in the water I predict sharks will bite it.*~~
❑ ~~*Another cause that might help explain the phenomenon is that sharks will bite anything.*~~
❑ *I predict the tracker has a way to follow the shark because most animals we follow have tags or microchips.*
❑ ~~*REMUS swims in the water (is that a cause?) and there's a pattern of sharks consistently attacking REMUS.*~~
❑ *I'm not confident I have enough information to make a cause and effect statement. I would want to know more about how REMUS is working and how white sharks know REMUS is in the water.*

b. Give students the opportunity to explore their questions around REMUS by researching at http://www.whoi.edu/osl/sharkcam and keeping track of information in their Science Notebook. Once again, circulate the classroom and help students with their research. Encourage motivated students to dive deeper into the website if they're curious about learning more about REMUS. Provide additional text support and sentence frames for students struggling with language; allow students to co-construct responses to questions, and/or provide additional time. Following the research phase, ask each group in the class to target a different key question, observation, or statement, and share what they learned. Offer a way for the groups to share key findings for the class.

An example of a key finding is:

Cause and Effect Statement: I predict the tracker has a way to follow the shark because most animals we follow have tags or microchips.

Trackers are able to follow tagged sharks. Our research showed that there is a transponder tag attached to a shark and the vehicle (REMUS) is programmed to communicate with that tag. There is an Omni-directional Ultra Short Base Line (OUSBL) that uses sound waves to communicate with the transponder.

c. At some point, connect this research to the work done earlier on senses by asking students to work in groups and think back to their white shark research. Ask, "Which part(s) of REMUS do you think stimulated the white shark's senses and resulted in an attack on REMUS?" Share and discuss with the whole class.

Expected student response:

The Smithsonian Ocean Portal website makes me think that the white shark sensed both the GPS navigation and communication systems using electroreception, and that resulted in an attack on REMUS.

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d. Ask students to identify any remaining questions they have in their Science Notebook and inform them that these will be explored in the coming days.

Expected student responses:

How does REMUS use sound waves to communicate with the transponder?

Does the shark use its electro-reception to sense the navigation and communication systems of REMUS?

What senses is the shark using to home in on REMUS?

Revisiting Claims Chart

8. As groups finish, ask them to revisit **8.1.H3: My Shark Encounter Claim Chart** from Lessons 8.1–8.3 and add any new information that could be used to support any of the claims and subsequent evidence and reasoning.

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Accommodations

To accommodate students who need help with reading tasks (such as those needing literacy or language support), ask the class to skim information on websites first, and identify any words for which they might want clarification. Clarify the directions, then ask students to work together doing a "group read" (have one person in the group read the article out loud) and to articulate aloud information that would be useful in recording.

If you have students that would struggle with a higher writing load (such as those needing literacy or language support), consider having groups that include these students share **8.4.H1: Understanding White Sharks** and take turns recording information. Ask each student to use a different colored pencil/pen for individual accountability.

When working on **8.4.H1: Understanding White Sharks**, check in with each group when they have completed page 2, Where Does Lunch Come From?, to make sure students understand the source check before they move on to page 3, How Do Senses Help Find Lunch?

By seating students in groups (groups of 4 work well) and encouraging regular conversation, students have time to interact more with content and naturally help those that need more support. Use of **8.1.H2: Scientist Communication Survival Kit** (from Lesson 8.1: Shark Encounters) helps to make sure that students who don't feel comfortable sharing (often because of language, literacy level, uncertainty of content knowledge, etc.) are prompted to do so in a supportive way.

Use of a sense-making Science Notebook supports student language development, conceptual development, and metacognition. Students should be prompted to use their Science Notebook for

- ❑ tracking prior knowledge of phenomena,
- ❑ noting exploration of phenomena and data collection,
- ❑ making sense of phenomena, and
- ❑ recognizing metacognition.

Consider providing sentence frames to students with low literacy, second language learners, and those struggling with work in Step 7 (which involves higher level thinking work linking multiple ideas together). The use of graphic organizers can help struggling students manage Science Notebook work. To support students learning English, allow conversations and Science Notebook work to happen in the language that the student is most comfortable expressing understanding, and then encourage expression using simple English phrases (or more complex for students with increasing proficiency).

As this lesson is rich with discourse opportunities, consider partnering second language learners with a "language broker" (another student who is bilingual in English and the student's home language) to allow these partners to first discuss ideas in their home language. Monitor this pairing and provide additional language support as needed.

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Toolbox Table of Contents

8.4.H1 Understanding White Sharks 8.4.16

Understanding White Sharks

Senses

In order to successfully find food and avoid predators, white sharks, like all other species, must be able to gather information from their environment.

Image courtesy of CSULB Shark Lab

1. How do you think white sharks can sense things in their environment (under water)?

2. What do you think adult white sharks prey on (eat)? What about YOY? Juveniles?

3. How do you think adult white sharks hunt their prey (food)? How about YOY? Juveniles?

Sensory Comparison between Humans and White Sharks

	Humans	White Sharks
Most Relied On ↑		
↓ Least Relied On		

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Understanding White Sharks

Where Does Lunch Come From?

Go to https://marinebio.org/species/great-white-sharks/carcharodon-carcharias/ and https://www.montereybayaquarium.org/animals/animals-a-to-z/white-shark to answer the following prompts about white sharks.

a. Describe the white shark's size and appearance (YOY vs. juvenile vs. adult).

b. Describe what white sharks feed on at various age classes (YOY vs. juvenile vs. adult).

c. Explain where white sharks are located around the world.

d. Describe white shark feeding behavior for various age classes (YOY vs. juvenile vs. adult).

e. Does anything in the research specifically suggest that humans are lunch for any age class (YOY vs. juvenile vs. adult)?

Source Check

Source	Credibility	Accuracy	Possible Bias	Methods Used	Supported by Evidence

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Understanding White Sharks

How Do Senses Help Find Lunch?

Go to https://ocean.si.edu/ocean-life/sharks-rays/great-white-shark and list the special features (with two or three details) of white shark senses in the table below. Note if there are any differences for different age classes (YOY vs. juvenile vs. adult).

SMELL	HEARING	VISION	ELECTRO-RECEPTION	TASTE	TOUCH

Source Check

Source	Credibility	Accuracy	Possible Bias	Methods Used	Supported by Evidence

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Understanding White Sharks

The Lunch Line

Go to one or two of these sites:
https://www.youtube.com/watch?time_continue=83&v=XtSAnt2HnhU&feature=emb_logo

https://www.youtube.com/watch?v=t8ptvfPQp2c

https://www.youtube.com/watch?v=2SLc6I1Iwco

https://www.youtube.com/watch?v=7Sg5aY2QbKM

https://www.newsweek.com/great-white-shark-hunting-seal-1462991

Scroll through the site and watch some of the white shark hunting videos. List a few details you found interesting about white shark hunting behavior and how this behavior helps white sharks get lunch. Note any differences for different age classes (YOY vs. juvenile vs. adult).

- ❑
- ❑
- ❑

Source Check

Source	Credibility	Accuracy	Possible Bias	Methods Used	Supported by Evidence

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Understanding White Sharks

The Lunch Line (continued)

REMUS for Lunch?

After going through all of your research, revisit your observations, questions, and statements about REMUS; revise your explanation as to why the white shark responded the way it did to REMUS. Consider all possible causes. Use evidence and the source of that evidence to support your explanation.

_____

_____

Identify a plausible explanation for why the white shark responded the way it did to REMUS, besides wanting lunch:

_____

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Appendix 8.4

REMUS

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]
MS-PS4-3	Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Asking Questions and Defining Problems
• Ask questions that arise from careful observation of phenomena, ~~models, or unexpected results~~, to clarify and/or seek additional information.
Analyzing and Interpreting Data
• Analyze and interpret data to provide evidence for phenomena (beginning… students engage in discussions of what is needed for evidence to be adequate).
Constructing Explanations and Designing Solutions
• Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.
Obtaining, Evaluating, and Communicating Information
• Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.

Appendix 8.4

DISCIPLINARY CORE IDEAS (DCI)
LS4.C: Adaptation
• Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.
PS4.C: Information Technologies and Instrumentation
• Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information (the lesson builds towards the element).

CROSSCUTTING CONCEPTS (CCC)
Patterns
• Patterns can be used to identify cause-and-effect relationships.
Cause and Effect
• Cause and effect relationships may be used to predict phenomena in natural or designed systems. • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

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Common Core State Standards (CCSS)

CCSS ELA SCIENCE & TECHNICAL SUBJECTS
CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-LITERACY.RST.6-8.8
Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
CCSS ELA READING: INFORMATIONAL TEXT
CCSS.ELA-LITERACY.RI.8.8
Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
CCSS ELA WRITING
CCSS.ELA-LITERACY.W.8.1.B
Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.

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Appendix 8.4

California English Language Development (ELD) Standards

CA ELD		
Part 1.8.6 Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language		
EMERGING	**EXPANDING**	**BRIDGING**
P1.8.6 a) Explain ideas, phenomena, processes, and text relationships (e.g., compare/contrast, cause/effect, problem/solution) based on close reading of a variety of grade-appropriate texts and viewing of multimedia with substantial support. b) Express inferences and conclusions drawn based on close reading of grade-appropriate texts and viewing of multimedia using some frequently used verbs (e.g., shows that, based on). c) Use knowledge of morphology (e.g., affixes, roots, and base words), context, reference materials, and visual cues to determine the meanings of unknown and multiple-meaning words on familiar topics.	**P1.8.6** a) Explain ideas, phenomena, processes, and text relationships (e.g., compare/contrast, cause/effect, problem/solution) based on close reading of a variety of grade-appropriate texts and viewing of multimedia with moderate support. b) Express inferences and conclusions drawn based on close reading grade-appropriate texts and viewing of multimedia using a variety of verbs (e.g., suggests that, leads to). c) Use knowledge of morphology (e.g., affixes, roots, and base words), context, reference materials, and visual cues to determine the meanings of unknown and multiple-meaning words on familiar and new topics.	**P1.8.6** a) Explain ideas, phenomena, processes, and text relationships (e.g., compare/contrast, cause/effect, problem/solution) based on close reading of a variety of grade-level texts and viewing of multimedia with light support. b) Express inferences and conclusions drawn based on close reading of grade-level texts and viewing of multimedia using a variety of precise academic verbs (e.g., indicates that, influences).
In addition to the standard above, you may find that you touch on the following standards in this lesson as well: **1.8.1:** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics **1.8.4:** Offering and justifying opinions, negotiating with and persuading others in communicative exchanges **1.8.5:** Listening actively to spoken English in a range of social and academic contexts **1.8.12:** Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas **2.8.6:** Connecting ideas **2.8.7:** Condensing ideas		

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