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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

Students will **argue from evidence** that white sharks have a **long evolutionary history** and that recent increases in white shark encounters can be **attributed to** a recovery of the population as a result of **human intervention to protect vulnerable marine species**. The public should understand that **tracking technology** has revealed that **patterns [of white shark populations] can be used to identify cause and effect relationships [between shark presence and interactions with humans, and between shark age/size and diet]**.



## Investigative Phenomenon

Return to the anchoring phenomenon: Numerous reports suggest an increase in white shark encounters in the United States in recent years and the public is worried.

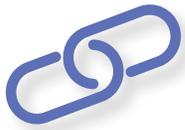


## Standards

Refer to Appendix 8.10 for NGSS, CCSS (ELA), California ELD, and EP&C standards.

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

## 8.10 White Shark Public Service Announcement



### Storyline Link

This is the final evaluation of the learning sequence. Prior to this, students have learned about how data from tracking devices can help us understand relationships between human activity and white shark populations.

In this final evaluation, students consider the body of information learned throughout the unit. They are charged with considering how tracking technology has informed white shark research, and what information would be useful and important for an apprehensive public to understand white sharks. The overall learning goal is for students to engage in a process of argumentation, informed by the iterative *constructing an explanation* process (built over the learning sequence) and extensive use of cause and effect (especially in the context of influencing student discourse) and make a persuasive public service announcement (PSA). The goal of this PSA is to educate the public about what scientists today understand about white sharks and how we have acquired that information, and show that legislation geared to protect vulnerable marine species is working. The messaging should alleviate public concerns about the increase in the white shark population. It should convey that we should always use caution when entering their habitat, and fears that are often exacerbated by the media and public are unwarranted as Southern California is a nursery for baby white sharks, and although very large, young white sharks are fish eaters, the adults that pose a greater risk to humans tend to spend more time further offshore.

Students create a PSA targeted to a specific audience to address specific concerns and independently choose crosscutting concepts that best facilitate the connections they are making. These PSAs provide an opportunity for students to show understanding of the phenomena during the preparation and delivery of an oral and written argument supported by empirical evidence and scientific reasoning to both support and refute explanations. PSAs can be scored as a summative assessment to the unit.

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

## 8.10 White Shark Public Service Announcement



### Time

255 minutes

Part I	45 minutes	Engage
Part II	210 minutes	Evaluate



### Materials

#### Whole Class

- Great White Sharks Are Coming Back in California and That's a Good Thing* video, <https://qz.com/701779/great-white-sharks-are-coming-back-in-california-and-thats-a-good-thing/>

#### Per Group of 4

- Devices equipped with audio and video recording capabilities (smartphones or tablets work well)
- Video editing software
- Whiteboards and markers (chart paper can be substituted)
- Sticky notes (optional)

#### Individual

- Science Notebook
- 8.1.H2: Scientist Communication Survival Kit (from Lesson 8.1: Shark Encounters)
- 8.1.H4: Crosscutting Concepts for Middle School Students (from Lesson 8.1: Shark Encounters)
- 8.10.H1: Public Service Announcement
- 8.10.H2: White Shark Project Public Service Announcement
- 8.10.H3: Final Public Service Announcement Rubric

#### Teacher

None

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### Advance Preparation

1. Prepare to project student notebooks (for sharing explanations).
2. Preview the video *Great White Sharks Are Coming Back in California and That's a Good Thing*. (Step 2 of Procedure)
3. If interested, locate recent news reports on white sharks. (Searching for “white sharks Southern California” will be fruitful. We encourage you to be thoughtful about what information and images are shared with students.)
4. Check working order of equipment and software for video recording.
5. Duplicate **8.10.H1: Public Service Announcement** for each student. (Step 10 of Procedure)
6. Duplicate **8.10.H2: White Shark Project Public Service Announcement** for each student. (Step 11 of Procedure)
7. Duplicate **8.10.H3: Final Public Service Announcement Rubric** for each student. (Step 11 of Procedure)

## 8.10 White Shark Public Service Announcement



### Procedure

#### Part I

Engage (45 minutes)

*Ask questions to define the problem of inaccurate public perceptions about white sharks, what causes these perceptions, and how we can counter them.*

#### 1. Sharing Explanations

Begin asking a few students to come to the front of the room and project their Science Notebook to share their explanations (from the previous lesson). Discuss with the class and ask students to identify the following:

- a. Evidence used that is sufficient to determine a causal relationship between human impact/activities and an increase in the white shark population
- b. A chain of reasoning that connects the evidence and evaluation to the claim (as seen in Lesson 8.9: Sharks and Humans):
  - i. As our human population grew, so did the demand for seafood.
  - ii. This resulted in advances in fishing technology that could allow fishers to be more efficient in their work (specifically, gillnets that could catch large amounts of fish at a time) to keep up with the demand for seafood.
  - iii. Fish reproduction couldn't keep up with the demand, and the dramatic decline in fish populations as a result prompted legislation to regulate these fisheries and ban nearshore gillnetting.
  - iv. This led to the recovery of the white shark population in part because the primary source of food for YOY and juvenile white sharks is fish (the same fish being protected) and because the very same YOY and juveniles that use shallow Southern California coastal waters as their nursery (the area that was once heavily fished) didn't become accidental bycatch and drown. (This is a small detail, but white sharks must constantly keep swimming to ram water over their gills in order to get oxygen. If stuck in a net, they do not get enough oxygen.)
  - v. This is perhaps the single greatest recovery of a vulnerable, and ecologically critical, species in California.

#### 2. Discovering through the Lens of Cause and Effect

Play the following video, [Great White Sharks Are Coming Back in California and That's a Good Thing](#), for the class and ask students to use the lens of cause and effect and record any *aha's*. (Direct students to use **8.1.H4: Crosscutting Concepts for Middle School Students** (from Lesson 8.1: Shark Encounters) to target specific elements of cause and effect in the 6–8

## 8.10 White Shark Public Service Announcement

grade band, in the On-Target column. One example, using the last question in the On-Target column, might be that if a source like Discovery Channel continues to create shows that portray sharks in a negative way, an effect of giving false perceptions to the public is highly likely, but still uncertain.)

- a. Restate the final quote from, Dr. Chris Lowe,

***“This is something people are going to have to get used to, it’s the new norm. And we really have to do a lot more to educate the public about how to share the ocean.”***

Ask students to brainstorm about the following ideas in their Science Notebook:

- i. What perceptions does the public hold on white sharks and where do these ideas come from?
  - ii. Are these perceptions accurate (given what we have studied and what we have learned from tracking devices)?
  - iii. Select one or two of the inaccurate perceptions. Think about what information would be needed to change that perception. Jot down your ideas in your Science Notebook.
  - iv. How can we best educate the public to shift inaccurate perceptions?
3. Share What You Think

Give groups a chance to share what they recorded and then engage the class in a whole group discussion about public perception of white sharks. What shifted their thinking about white sharks? How can building scientific understanding and, most importantly, gathering evidence, influence public perception of white sharks? Finally, given the increase in reports of white shark encounters, what is something that they, as 8th grade scientists, can do to help shift public perception of white sharks? Ask students to imagine that if they were student interns in the CSULB Shark Lab, what would be a mechanism they could use to get their message out to the public?

### TEACHER NOTE

Students will generate ideas about how to shift public perception. These generally include writing an article for a paper or filming their report. This lesson supports the second idea, to film their report as a public service announcement. However, interested classes could replace that with a written article or other student-generated idea. Either project presents an opportunity for a Nature of Science connection. Science is a human endeavour (people need science, not just scientists) and the knowledge generated by science is based upon logical and conceptual connections between evidence and explanations.

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### Procedure

#### Part II

Evaluate (210 minutes)

Students will *argue from evidence* that white sharks have a *long evolutionary history* and that recent increases in white shark encounters can be *attributed to a recovery of the population as a result of human intervention to protect vulnerable marine species*. The public should understand that *tracking technology* has revealed that *patterns [of white shark populations] can be used to identify cause and effect relationships [between shark presence and interactions with humans, and between shark age/size and diet]*.

4. Brainstorming an Explanation for an Argument by Identifying Relevant Evidence and Generating Claims
  - a. Give groups a whiteboard and ask them to record the following question in the center:

*What explanation, grounded in scientific understanding, might influence (or counter) inaccurate public perceptions and arguments of white sharks?*
  - b. Encourage each group to use their Science Notebooks and to think of information and evidence they have gathered over the learning sequence that would help answer the question (including models, investigations, and other sources). Have students individually write ideas/evidence on separate sticky notes. When they share, place the notes on the whiteboard and organize them in related “clumps,” asking students to verbally explain their thinking for sticky note placement. (Sticky notes are optional, but helpful as they give students flexibility in moving ideas around. If the budget doesn’t allow for sticky notes, students can write directly on the paper/board but will need to pre-think categories.)

#### TEACHER NOTE

Monitor students as they are working. To help ensure students pull information from the body of the learning sequence, begin by asking groups targeted questions about aspects they might be missing. For example, “Would any evidence from our exploration of tags and the various waves they use provide evidence?” Some students may benefit by having a list of big topics explored in the learning sequence on the class board or an explicit reminder of which pages in their Science Notebook they should peruse. **IMPORTANT:** ► If students do not include discussion of the “big learning” in Lesson 8.9: Sharks and Humans—that the coastal waters of Southern California have predominantly YOY and juvenile sharks AND these sharks primarily eat fish—direct students to review their notes from Lesson 8.9 as well as on **8.4.H1: Understanding White Sharks: Where Does Lunch Come From?** in Lesson 8.4: REMUS.

## 8.10 White Shark Public Service Announcement

- c. Ask students to identify and provide rationale for which sticky notes in a particular clump have information that would be strong evidence to build a respective claim that would address the question:

*What explanation, grounded in scientific understanding, might influence (or counter) inaccurate public perceptions and arguments of white sharks?*

- d. Once evidence is pulled for a particular question, students should consider the body of evidence identified and generate a claim to answer the questions using the lens of cause and effect to do so (e.g., What does this relationship help predict? Is that a causal claim? Why or why not?) Direct students to use **8.1.H4: Crosscutting Concepts for Middle School Students** (from Lesson 8.1: Shark Encounters) to target specific elements of cause and effect in the 6–8 grade band in the On-Target column. Students should check that the evidence matches the respective claim and retain, remove, or edit sticky notes as necessary.

### 5. Customizing the Explanation/Argument for a Target Audience

- a. At this point, we begin to transition student evidence and claim into an argument. Ask students to imagine they are having a conversation with a worried member of the public and customize their claim and evidence chosen for their target audience.
- b. Students can identify their own target audience. Below are some examples:
  - i. 5th graders who are interested in learning about white sharks
  - ii. A person who might need to think of their own safety, e.g., a surfer or swimmer
  - iii. A person who might need to think about the safety of others, e.g., a lifeguard, or city leader
  - iv. A parent wondering if they should enroll their child in the Junior Lifeguard program at the beach
  - v. Producers interested in making a special TV show (think, “mock”-umentary) where they share frightening, outrageous, and mostly fictional white shark stories
  - vi. Visitors to an aquarium at the coast who have never seen a shark and have many misconceptions about sharks
  - vii. A donor or investor who might want to financially support an effort to maintain and even enhance studies that continue to monitor white sharks
  - viii. The WHOI engineering team that built REMUS (opportunity for interested students to include technical aspects of REMUS)
  - ix. A person who might want to study a novel question (identify the novel question) about white sharks, e.g., a graduate student at the CSULB Shark Lab

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Student groups may choose their target audience (they may even identify others) or you may assign one of these to each group. If the suggested examples are used, they are presented in order of complexity to allow for differentiation:

- › **i** is simply reteaching what they understand in a simplified manner.
  - › **ii–iv** also involve reteaching and require students to merge multiple ideas, but would be more accessible to students as they involve a personal connection (more relatable).
  - › **v–vi** increase in complexity by building on a reteach and require students to merge ideas in a novel context (beyond personal safety).
  - › **vii–ix** are the most sophisticated and require students to include technical social or science/engineering application.
- c. Once the target audience is identified, ask student groups to predict what the target audience might say about shark encounters. Have students revise their claim into one they think could help inform this member of the public and record on a whiteboard or chart paper. Have students write their claim in a way that makes it explicit to the audience (i.e., what is important for this target audience to know about white sharks).
- d. Ask students to then include the evidence previously identified that supports their claim to better inform this target audience.

### 6. Peer Review

Once groups have clearly identified their target audience and built their claim with supporting evidence, have groups switch places to peer review the work of another group. Ask each group to evaluate the strength of the claim and supporting evidence and provide feedback to the other group. Sticky notes are the safe way to leave feedback, as they won't interfere with original work; in the absence of sticky notes, use colored pens.

- a. Yellow notes: ask for clarification
- › What do you mean by \_\_\_\_?
  - › Can you elaborate on how \_\_\_\_ is evidence for the claim?
  - › I respectfully disagree with \_\_\_\_ because \_\_\_\_.
- b. Blue notes: build on/add ideas
- › I want to add to your idea: \_\_\_\_.
  - › This is a great start; I would suggest you could also add \_\_\_\_.
  - › If you look at information in your Science Notebook from \_\_\_\_, you might find more evidence to support this claim.

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c. Orange notes: agree and praise ideas

› I agree with your thinking on \_\_\_\_.

If time permits, repeat this process so groups review a second group.

### 7. Revising

When groups return to their areas, give them time to review their feedback and discuss. Ask groups to use the time to revise their claim and evidence. ► Students should also check that evidence is appropriate and sufficient. (Monitor student work.)

### 8. Adding Reasoning

Next, ask students to provide reasoning (scientific concepts) that they have learned in the learning sequence that will connect various types of evidence (suggesting possible causal or purely correlational relationships) to the claim and explain how the evidence supports the claim. Reasoning should connect to evidence and discuss how the evidence is adequate for the explanation.

### 9. Check for Adequacy

Finally, ask students to identify circumstances where their claim might not hold true and what additional evidence would be needed to strengthen the claim.

### 10. Building an Argument: Public Service Announcement (PSA)

The next step in the process is for students to consider their explanation and how it can be used to build a persuasive argument. This argument will be the basis for a PSA that the group is to create with the goal of better informing the public about white sharks.

- a. Students should use **8.10.H1: Public Service Announcement** to structure their explanation and argument and to plan for filming the PSA.
- b. ► Once you approve their idea (checking closely for inaccurate ideas and that what students are describing was their actual intent), students can begin filming the PSA.
- c. Students should have access to video editing software to edit their PSA.

#### TEACHER NOTE

A common technique used by language arts teachers, “Modes of Persuasion” are incorporated into this project alongside components to have students engage deeply in the Science and Engineering Practice of Engaging in Argument from Evidence. As we all know, scientific arguments (Logos: persuasion using logical proof/actual evidence) aren’t always compelling enough to convince people who have strong emotions/opinions. Students will also be asked to generate an Ethos (target the feelings or morals of your audience) and a Pathos (persuade your audience by revealing experts with credentials who agree with your side) statement as well to help shape their argument targeted for a specific (likely, non-scientist) audience. Students may need some introduction to this if it is new to them.

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### 11. ► Evaluating the PSA

- a. **8.10.H2: White Shark Project Public Service Announcement** should be given to students early on in the project to help track work. All students are to complete self and group evaluation prior to completion of the project.
- b. If you haven't already, distribute **8.10.H3: Final Public Service Announcement Rubric** to students so they can evaluate their own work.
- c. Evaluate student work using **8.10.H3: Final Public Service Announcement Rubric**.

#### TEACHER NOTE

As a strategy to engage learners, consider giving students a forum for sharing beyond the classroom. PSAs are powerful to share during a family science night or school open house! They could also be published online for broader viewing, presented at a board or other community meeting. Students will be eager to come up with ways to share their message to help improve public perception of white sharks, and their learning is more authentic and powerful when they know that families and their community are invested in their education (strategy for motivated students).

Advice: Be sure to review student work for accidental inaccuracies and encourage students to read their script out loud a few times before recording audio. (Sometimes students can be hard to hear or speak so quickly they are difficult to understand.)

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### Accommodations

By making the final assessment a Public Service Announcement (PSA), student engagement often increases because they can use preferred technology. Consider leveraging use of the PSAs to engage in broader community outreach—showcase the PSA at a family science night, PTA meeting, school board meeting, or local science center, or present to an environmental science class at the local high school. Students near a coastal community might consider showcasing at a local aquarium with lifeguards; they could even contact news media. When students know that their work has a purpose greater than a final grade, their intrinsic motivation tends to increase.

To aid struggling writers, consider using a scaffold to structure writing. For example, as students construct their explanation, a table like the one below can help:

1. EVIDENCE	2. CLAIM
a.	
b.	
c.	
d.	
e.	
REASONING	

► Some students will struggle with identifying relevant evidence. Ask groups with such students to use sticky flags to tag Science Notebook pages that have relevant evidence. Use of the Science Notebook supports language development, conceptual development, and metacognition.

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.

When showing short videos, it's often helpful to students to watch the video once to get a sense of the purpose. Showing the video a second (and sometimes third time) allows students to focus on important details that can be recorded in their Science Notebook and discussed.

Provide frequent check-ins to help organize the work of students who may struggle with an open-ended project.

Consider allowing students who need literacy support to work in pairs. Alternatively, allow students to do this work in their native language.

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Use of the Responsibilities and Group Evaluation pages of **8.10.H2: White Shark Project Public Service Announcement** up front will help students who struggle with communication and teamwork on a collaborative project. As a whole class, consider starting a Responsibilities chart based on the Responsibilities page of **8.10.H2: White Shark Project Public Service Announcement** to help students have a vision for what needs to be done.

### References

Olsen, E. (2016). Learning to love white sharks. Quartz media. Retrieved from <https://qz.com/701779/great-white-sharks-are-coming-back-in-california-and-thats-a-good-thing/>

### Toolbox Table of Contents

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## Public Service Announcement

Group members: \_\_\_\_\_  
\_\_\_\_\_

1. Identify key science ideas you have learned throughout this learning sequence. Highlight those that should be included in your explanation, or a combination of some that lead to a single piece of evidence.
  - a. Shark Encounters: \_\_\_\_\_
  - b. Fossil Evidence: \_\_\_\_\_
  - c. Fishers Logs: \_\_\_\_\_
  - d. REMUS: \_\_\_\_\_
  - e. Magnetic Fields: \_\_\_\_\_
  - f. Tags and Waves: \_\_\_\_\_
  - g. Digitized Signals: \_\_\_\_\_
  - h. Light, Which Way Does It Go?: \_\_\_\_\_
  - i. Sharks and Humans: \_\_\_\_\_
2. Who is your target audience? \_\_\_\_\_
3. What is your claim? *Use the lens of cause and effect to frame your thinking. (Choose an element from the On-Target column of Crosscutting Concepts for Middle School Students.)*
4. Record your full explanation (claim + evidence + reasoning):

## Public Service Announcement (continued)

5. What are three key Logos messages (persuasion using logical proof/actual evidence) you think are important to convey to your audience that help explain your claim and the cause and effect relationship(s) you have identified?

a.

b.

c.

6. What else could persuade your audience? Generate a Pathos statement and an Ethos statement.

*Ethos (target the feelings or morals of your audience):*

*Pathos (persuade your audience by revealing experts with credentials who agree with your side):*

7. What is a counter-argument (rebuttal) someone could make about your argument?

8. What evidence might help you address the counter-argument?





White Shark Project Public Service Announcement (continued)

Self Evaluation

**Scoring Key:** 4–Totally Jawsome; 3–Close to Fintastic; 2–Smelling like Chum; 1–Missed the Boat

- \_\_\_\_\_ I am proud of the quality effort and time I spent working on this project.
- \_\_\_\_\_ I continuously made efforts to improve the quality of my work on this project.
- \_\_\_\_\_ I made an effort to communicate positively and encourage all members of my group on this project.
- \_\_\_\_\_ I not only did what was expected of me, but was a positive facilitator to my group as well.
- \_\_\_\_\_ I made appropriate choices and worked hard to stay on task during this project.
- \_\_\_\_\_ I worked hard to stay organized while working on this project.
- \_\_\_\_\_ I acquired new knowledge I can use in the future.
- \_\_\_\_\_ I am proud of the work we did and feel it’s of sufficient quality to share with the public.

If you were to grade yourself based on the rubric, what grade would you get on this project? \_\_\_\_\_

What are at least two areas identified in the rubric where you can improve your work if you were to do this project again?

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Consider how you have supported the project and group.

Three of my strengths on this project were:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

Three of my weaknesses on this project were:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

On future projects, I can better support the project and group by: \_\_\_\_\_

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White Shark Project Public Service Announcement (continued)

Group Evaluation

Consider each member of your group. Identify two positive contributions s/he made to support the project or group and one way s/he can improve in the future:

	NAME: _____	NAME: _____	NAME: _____
Positive contribution			
A way to improve			
Positive contribution			

## Final Public Service Announcement Rubric

**Rubric** for engaging in an argument from evidence and constructing explanations and designing solutions using the crosscutting concept of cause and effect in a public service announcement.

4	3	2	1
<p><b>Claim</b> is appropriately and clearly conveyed to identified target audience and appropriate context is given for audience to understand its significance.</p>	<p><b>Claim</b> is somewhat conveyed to the identified target audience in some appropriate context.</p>	<p><b>Claim</b> is somewhat conveyed in little to no context.</p>	<p><b>Claim</b> is missing, unclear, or contains major errors No context is given.</p>
<p>Scientific <b>evidence</b> is used to support the claim and cited for validity. It is portrayed as clearly and accurately as possible. All <b>counter-arguments</b> have been clearly thought of and addressed.</p> <p>Examples of evidence:</p> <ul style="list-style-type: none"> <li>• Data from researchers reveals legislation that was effective in managing fisheries.</li> <li>• Data from tracking devices reveal an increase in YOY and juvenile white sharks.</li> <li>• People often misperceive the size of sharks because of light refraction.</li> <li>• Humans can have a positive influence on the recovery of an ecosystem.</li> </ul>	<p>Scientific <b>evidence</b> is used to support the claim and cited for validity. It is portrayed as accurately as possible. Some <b>counter-arguments</b> have been thought of and addressed.</p>	<p>Scientific <b>evidence</b> is somewhat used to support the claim and cited for validity. It is vaguely portrayed. Little to no <b>counter-arguments</b> have been thought of and addressed.</p>	<p>No correct relationship(s) are identified between <b>evidence</b> and claim.</p>
<p><b>Reasoning</b> uses <b>evidence</b> at an appropriate level for target audience. It explicitly uses the crosscutting concept of <i>cause and effect</i> (a specific On-Target element) as a <b>central frame</b> for the explanation.</p>	<p>The <b>reasoning</b> can be used to provide an explanation that is grounded in science and includes meaningful limitations of the explanation. <i>Cause and effect</i> is mentioned, but not used as a central frame in the argument.</p>	<p>The <b>reasoning</b> can be used to provide an explanation that demonstrates partial understanding of the science. <i>Cause or effect</i> is alluded to. (No link between the two is identified.)</p>	<p>The <b>reasoning</b> cannot be used to connect the claim and supporting evidence.</p>

Note: Final Public Service Announcement Rubric from NGSS Rollout #3. CA NGSS Collaborative, 2016. Adapted with permission.

# Appendix 8.10

## White Shark Public Service Announcement

### Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
<b>MS-ESS1-4</b>	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]
<b>MS-ESS3-4</b>	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]
<b>MS-LS4-1</b>	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]
<b>MS-LS4-6</b>	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.]
<b>MS-PS2-3</b>	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]
<b>MS-PS2-5</b>	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.]

## Appendix 8.10

<b>MS-PS4-2</b>	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]
<b>MS-PS4-3</b>	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 challenge the premise(s) of an argument or the interpretation of a data set.

### Constructing Explanations and Designing Solutions

- Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

### Engaging in Argument from Evidence

- Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

## DISCIPLINARY CORE IDEAS (DCI)

### ESS3.C: Human Impacts on Earth Systems

- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

### ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.

### LS4.A: Evidence of Common Ancestry and Diversity

- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)

## Appendix 8.10

### 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.

### PS2.B: Types of Interactions

- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.

### PS4.A: Wave Properties

- A simple wave model has a repeating pattern with a specific wavelength, frequency, and amplitude, and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena including sound and light. Waves can transmit energy.

### PS4.B: Electromagnetic Radiation

- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.

### PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

## CROSSCUTTING CONCEPTS (CCC)

### Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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## Common Core State Standards (CCSS)

### CCSS ELA SCIENCE & TECHNICAL SUBJECTS

#### CCSS.ELA-LITERACY.RST.6-8.8

Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

#### CCSS.ELA-LITERACY.RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

# Appendix 8.10

## CCSS ELA WRITING

### CCSS.ELA-LITERACY.W.8.1

Write arguments to support claims with clear reasons and relevant evidence.

## CCSS ELA SPEAKING & LISTENING

### CCSS.ELA-LITERACY.SL.8.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

### CCSS.ELA-LITERACY.SL.8.3

Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.

### CCSS.ELA-LITERACY.SL.8.4

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

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## California English Language Development (ELD) Standards

### CA ELD

#### Part 1.8.11: Justifying own arguments and evaluating others' arguments in writing

#### EMERGING

##### P1.8.11

- a) Justify opinions by providing some textual evidence or relevant background knowledge with substantial support.
- b) Express attitude and opinions or temper statements with familiar modal expressions (e.g., *can, may*).

#### EXPANDING

##### P1.8.11

- a) Justify opinions or persuade others by providing relevant textual evidence or relevant background knowledge with moderate support.
- b) Express attitude and opinions or temper statements with a variety of familiar modal expressions (e.g., *possibly/likely, could/would*).

#### BRIDGING

##### P1.8.11

- a) Justify opinions or persuade others by providing detailed and relevant textual evidence or relevant background knowledge with light support.
- b) Express attitude and opinions or temper statements with nuanced modal expressions (e.g., *potentially/certainly/absolutely, should/might*).

**In addition to the standard above, you may find that you touch on the following standards in this lesson as well:**

- P1.8.1:** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- P1.8.2:** Interacting with others in written English in various communicative forms (print, communicative technology and multimedia)
- P1.8.3:** Offering and justifying opinions, negotiating with and persuading others in communicative exchanges
- P1.8.4:** Adapting language choices to various contexts (based on task, purpose, audience, and text type)
- P1.8.5:** Listening actively to spoken English in a range of social and academic contexts
- P1.8.7:** Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area



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- P1.8.8:** Analyzing how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area
- P1.8.9:** Expressing information and ideas in formal oral presentations on academic topics
- P1.8.12:** Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas
- P2.8.1:** Understanding text structure
- P2.8.3:** Using verbs and verb phrases
- P2.8.4:** Using nouns and noun phrases
- P2.8.5:** Modifying to add details
- P2.8.6:** Connecting ideas
- P2.8.7:** Condensing ideas

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## California's Environmental Principles and Concepts (EP&amp;Cs)

EP&C		
	<p><b>Principle 2</b> People Influence Natural Systems</p>	The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.
	<p><b>Principle 3</b> Natural Systems Change in Ways that People Benefit From and Can Influence</p>	Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
	<p><b>Principle 5</b> Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors</p>	Decisions affecting resources and natural systems are based on a wide range of considerations and decision making processes.

California Education and the Environment Initiative. 2016. California's Environmental Principles and Concepts. <https://californiaeei.org/epc/>