Life Science: Sharks
The Atlantic White Shark Conservancy

Science Grade [Biological Evolution] Grade 3

This unit engages students in a study of the Great White Shark's return to Cape Cod. Students will use multiple sources of information to understand the sharks life cycle, traits that led to their success as a species, how they have adapted over time, and how habitat change on Cape Cod has allowed them to thrive. Students will create data driven graphs on seal and shark populations and analyze trends to form an argument as to how changes in the waters around the Cape affect the ability of sharks to live in that habitat. Students integrate the information they learned to create a product that increases Shark "Awareness" to be shared with our local community.

Please provide us some background information on the unit development. In order to help others who are interested in this topic understand a bit more about what you created, we will write a short introduction to each unit and provide some images, in addition to posting the completed units on the Cape Cod Regional STEM Network website (www.capecodstemnetwork.org). Please help us by answering the questions below after you have completed your unit.

1. Who helped to create this unit?

Names	School (Grade/course taught)
Kate Skehill	East Falmouth Elementary School Grade 3

2. What were some sources of inspiration for this unit?
   Recent Great White Shark activity on Cape Cod and finding a unit to cover the new 3rd grade life science standards

3. In your own words, what are you hoping students learn—big picture—through this unit?
   Organisms survive or become extinct due to inherited and environmental factors that happen over time.

4. What might students find exciting in this unit?
   Focus on sharks and the real world application of their knowledge on Cape Cod

5. What science standards or real-world content did you strive to emphasize?
   Life Science Standards Grade 3

6. How would you say that this unit "matters" to the STEM community? Or to our community on Cape Cod? Or to the larger community?
   Cape Cod and larger community = shark awareness and safety, seal/shark pop and how if affects fisheries, fishermen, quotas, policy.

   STEM: Focus on the interdependence of Science, Engineering, Math, and Technology and how they support each other. Tools and instruments are used to answer scientific questions while scientific discoveries lead to the development of new technologies.
7. What's the most important lesson you learned as you created this?
   The local fish -> seal -> shark -> discussion is very much evolving as this unit is written with the sighting of orcas now on the outer cape.
   There are lots of different opinions on this depending on who you are talking to and public safety shark policy is emerging throughout the cape.

Anything else you would like fellow teachers or others to know about this unit?
   There are so many possible extension activities some thoughts are listed below
   ELA: Explore the shark sighting protocol in your town if there is or isn't.
       Letter to town admin re: feasibility
   Math: OCEARCH app tracking travel distance
   SCI: Dissection of skate or dogfish

Table of Contents

Stage 1 Desired Results

MA STE Standards

3-LS1-1. Use simple graphical representations to show that different types of organisms have unique and diverse life cycles. Describe that all organisms have birth, growth, reproduction, and death in common but there are a variety of ways in which these happen.

3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere.

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals within the same species may provide advantages to these individuals in their survival and reproduction

3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.

3-LS4-4. Analyze and interpret given data about changes in a habitat and describe how the changes may affect the ability of organisms that live in that habitat to survive and reproduce

ESSENTIAL QUESTIONS

EQ 1 How does awareness and understanding of an organism keep us safe?

EQ 2 What changes to a habitat affect the ability of an organism to survive well?

UNDERSTANDINGS

U1 Different types of organisms have unique and diverse life cycles

U2 Plants and animals have characteristics that are influenced by both inheritance and environment and variation of these traits exist in a group of similar organisms.

U2 Some changes may force an organism to move or the organism may adapt to accommodate the change; not all changes in an environment lead to extinction.

U3 Organisms depend on each other and their environment for continued survival.

U4 Scientific arguments rely on relevant evidence (data) and logical reasoning.

4

3-LS4-5(MA). Provide evidence to support a claim that the survival of a population is dependent upon reproduction. **Mathematics** **3.MD.B.3. Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.** **English Language Arts and Literacy** **W3.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.**	**TRANSFER** *Students will be able to independently use their learning to…* T1 Study the interactions between and influence of organisms,, humans, and their environment. T2 Use data, evidence, and reasoning to analyze living systems. T3 Use data, evidence, and reasoning to develop scientific claims and engage in discussions.
	Cross-Curricular Connections **Stability and Change:** In grades 3–5, students can measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change. **Interdependence of Science, Engineering, and Technology:** In grades 3–5, students can describe how science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. **Math:** Students will analyze data to support ideas and use data to create graphs **ELA:** Students will examine a topic to convey ideas and information clearly

Stage 2 Evidence

Formative Assessment Ideas:
Science Notebook
Shark Tooth Lab Sheet
Graph/ Graph Analysis
KWL Chart
Teacher observations
Classroom discussions

Summative Assessment Ideas:

Curriculum Embedded Performance Assessment :
Students will take on the role of research scientists. Using their knowledge students will create a public service message that showcases awareness, understanding, and safety information about the Great White Shark. This public service message can be in the form of a brochure, slide show, poster, or video. Public Service message should include 3-5 facts on shark anatomy/ shark behavior and 3-5 safety tips. Student's will present their work to an audience and share their findings.

Stage 3 Learning Plan

Summary of Key Learning Events and Instruction

Engagement and Pre Assessment

Lesson One: KWL: Introduction to Sharks

KWL: What do you know about sharks? Create curiosity and assess background knowledge! Share ideas on how this apex predator has changed over time, why this species has been so successful and why we have seen a return of the great white shark to Cape Cod.

Lesson Two: Life Cycles

Students will understand that different organisms have unique and diverse life cycles. Using diagrams of shark, skate, and turtle create awareness of the differences in life cycles (live young, mermaid purses, eggs). Discuss the life cycle of a white shark and how it is similar to all life cycles in that it includes birth, growth, reproduction, and death.

Lesson Three: Fossils: Shark Teeth:

Students will investigate shark teeth to determine if all shark teeth are the same and identify the species of shark based on the detail of the tooth. They will formulate ideas about why some sharks or versions of their teeth might be extinct, how the differences in shark's teeth provide advantages and meet the needs of that species.

Lesson Four: The Great White Comeback:

Students will be introduced to shark scientist Eugenie Clark, a brief history of the gray seals on Cape Cod, and the Marine Mammal Protection Act of 1972. As a class students will ask questions that can be investigated and predict reasonable outcomes based on patterns, such as cause and effect relationships.

Lesson Five: Tag! You're It!:

Students will investigate the science and engineering behind shark tags, explore the various shark apps (such as Sharktivity) and evaluate the information they find. Students will choose a local shark a gather physical and behavioral data to share with the class. Students will engage in a tag/recapture game that models the shark tagging process.

Lesson Six:You're Gonna Need a Bigger Boat

Given population data on gray seals and white sharks, students will organize simple data sets to reveal patterns that suggest relationships. They will construct and/or support an argument with evidence and data. They will use data to evaluate claims about the cause and effect.

Lesson Seven: Shark Savvy

Students will understand basic shark behavior, public safety information, and local shark policy. Civic Participation: Students will apply their learning to relevant situations and contexts to be analytical thinkers and problem solvers with the ability to act on that knowledge.

Evaluation

CEPA:

Student will use their knowledge to create a public service piece that showcases awareness, understanding, safety information about the Great White Shark. This public service message can be in the form of a brochure, slide show, poster, or video. Public Service piece should include 3-5 facts or info bits each on (1) shark anatomy/ shark behavior (2) Safety tips. Student's will present their work to an audience and share their findings.

Lesson 1: Introduction to Sharks

Overview of the Lesson: KWL: What do you know about sharks? Create curiosity and assess background knowledge! Share ideas on how this apex predator has changed over time, why this species has been so successful and why we have seen a return of the Great White Shark to Cape Cod. Students will understand that different organisms have unique and diverse life cycles. OPTIONAL: Buoyancy Lab; see additional resources 30 min (Buoyancy Experiment http://kidminds.org/shark-science-bouyancy/) **Time (minutes):60 Min**
Standard(s): What standards (s) will be the focus of the lesson? • 3-LS1-1. Use simple graphical representations to show that different types of organisms have unique and diverse life cycles. Describe that all organisms have birth, growth, reproduction, and death in common but there are a variety of ways in which these happen. • 3-LS4-5(MA). Provide evidence to support a claim that the survival of a population is dependent upon reproduction.
Essential Question(s): • What makes a shark unique?
Science Objectives • Students will identify the parts of a shark • Students will compare the life cycles of sharks, skates, and turtles
Language Objectives and/or Targeted Academic Language dorsal fin   lateral line   buoyancy pectoral fin   gills   Apex caudal fin   cartilage pelvic fin   liver denticles   organism
Anticipated Student Preconceptions/Misconceptions (optional)

Instructional Materials/Resources/Tools
- Life Cycle Diagrams : Turtle, Skate, Shark
- Chart Paper
- Blow up Shark (from AWSC kit)
- Great White Diagram Page
- Plastic Denticles
- AWSC Shark video (4min**) Atlantic White Shark Conservancy**

Assessment: How will you know that the students got it?
Results of the KWL Chart
Science Notebooks
Shark Diagram

Science and Engineering Practices included (put the included ones in bold):
1. Asking questions (for science) and defining problems (for engineering)
2. **Developing and using models**
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. **Obtaining, evaluating, and communicating information**

Notes about Science and Engineering Practices included:

Lesson Overview:
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Opening/Engagement: 15 min
1. Have students look at a picture of a person on s SUP or surfboard with a shark in the water. http://www.dailymail.co.uk/news/article-1373199/Risky-business-Shark-expert-sets-prove-remote-threat-humans-surfing-just-FEET-away-great-white.html   Ask: What would you do if you saw a shark in the water? How would you feel? Let students share their ideas.
2. Introduce the essential question: How does awareness and understanding of an organism keep us safe? In this unit we explore how awareness and understanding of white sharks can keep humans and white sharks safe.

3. Ask students, " What do you know about sharks? Turn and talk to a classmate. After a few minutes " Ask, " What are some perceptions people have about sharks. As a class elicit thoughts/understandings. Add thoughts and ideas to a class KWL Chart. Give students time to think about what they want to learn about great white sharks and add to the KWL. Later in the unit you can return to the chart and add what the class has learned.
During the Lesson: 30 min 4. Introduce science notebook. Let students know that the information they collect here will be used to help them in their final project! 5. Watch AWSC Shark Video: Have Students take notes. After, share notes writing key points on chart paper. 6. Use Inflatable shark (AWSC) or diagram to discuss the basic anatomy of a shark. Focus on external features (fins, skin, eyes etc) but mention that a shark has an oily liver which helps keep them afloat. 7. Students will label their shark diagram or draw and label their own diagram.
Lesson Closing 15 min 8. Note that sharks as a species have certain characteristics that have make them successful and that these characteristics have changed over time. 9. Note that they will be using a scientific notebook throughout the unit to record evidence and their ideas about awareness, understanding, and safety as it relates to the return of the Great White Shark to Cape Cod. 10. Introduce the CEPA: Student will use their knowledge to create a public service message that shows cases awareness, understanding, and safety information about the Great White Shark. This public service message can be in the form of a brochure, slide show, poster, or video. Public Service message should include 3-5 facts on shark anatomy/ shark behavior and 3-5 safety tips. Student's will present their work to an audience and share their findings.
Instructional Tips/Strategies/Suggestions for Teacher: The Buoyancy Lab is optional

Lesson 2: Life Cycles

Overview of the Lesson:
Students will understand that different organisms have unique and diverse life cycles.

Standard(s):
- 3-LS1-1. Use simple graphical representations to show that different types of organisms have unique and diverse life cycles. Describe that all organisms have birth, growth, reproduction, and death in common but there are a variety of ways in which these happen.
- 3-LS4-5(MA). Provide evidence to support a claim that the survival of a population is dependent upon reproduction.

Essential Question:
- What can we learn from the life cycles of different animals?

Science Objective:
- Students will compare the life cycles of sharks, skates, and turtles
- Understand that all animals have a life cycle that includes being born, developing into an adult, reproducing, and eventually dying
- Understand that the details of life cycles vary from one organism to another
- Observe the changes that occur during the growth and development of sharks, skates, and turtles
- Sequence the stages of life of selected animals

Language Objective and/or Targeted Academic Language:
life cycle
pup
mature

Instructional Materials/Resources/Tools:
- life cycle diagram: turtle, skate, shark
- chart paper
- science notebook

Assessment:
white shark life cycle diagram

classroom discussion

Science and Engineering Practices:
  1. Asking questions (for science) and defining problems (for engineering)
  2. Developing and using models
  3. Planning and carrying out investigations
  4. Analyzing and interpreting data
  5. Using mathematics and computational thinking
  6. Constructing explanations (for science) and designing solutions (for engineering)
  7. Engaging in argument from evidence
  8. Obtaining, evaluating, and communicating information

Lesson Overview:
This lessons deepens students' understanding of similarities and differences in the life cycle of organisms. Students will compare the life cycles of skate, turtles, and white sharks. Through discussions, students will compare and contrast the diagrams. Students will construct a diagram of the white shark life cycle in their science notebook using science vocabulary.

Opening/Engagement:
  1. Ask students "What is a life cycle?" Have them turn and talk to their neighbor.
  2. Discuss responses. Clarify that all life cycles include birth, growth, reproduction, and death.
  3. Ask students " Are the life cycles the same?" How are they similar? How are they different?

During the Lesson:
  4. Explain that today you will look at the life cycles of skates, turtles, and white sharks. Notice the similarities and   differences.
  5. Using diagrams of skate, turtle, and shark create awareness of the differences in life cycles (live young, mermaid purses, eggs)
  6. Discuss the white shark life cycle and how it is similar to all life cycles in that it includes birth, growth, reproduction, and death.
  7. Model how to create a diagram of the white shark life cycle.
  8. Students should create their own diagram with labels in their science notebook.

Lesson Closing:.
  9. Offer opportunity to share diagrams.
  10. Note that different types of organisms have unique and diverse life cycles. They all have birth, growth, reproduction, and death in common but their are a variety of ways in which these happen.

Lesson 3: Fossils: Shark Teeth

Overview of the Lesson: Students will investigate shark teeth to determine if all shark teeth are the same. They will identify the species of shark based on the detail of the tooth. They will formulate ideas about why some sharks or versions of their teeth might be extinct. They will explain how the differences in shark's teeth provide advantages and meet the needs of that species. **Time (minutes): 60**
Standard(s): What standards (s) will be the focus of the lesson? • **3-LS4-1. Use fossils to describe types of organisms and their environments that existed long ago and compare those to living organisms and their environments. Recognize that most kinds of plants and animals that once lived on Earth are no longer found anywhere.** • **3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals within the same species may provide advantages to these individuals in their survival and reproduction.**
Essential Question(s): What essential questions will be addressed in this lesson? • Are all shark teeth the same? • How might sharks teeth meet the needs of that species, How do the differences in sharks teeth provide advantages? • Why might some versions of the shark teeth be extinct?
Science Objectives • Students will understand what a fossil is. • Students will use fossils, shark teeth and an identification chart to determine what species the fossil is from.
Language Objectives and/or Targeted Academic Language fossil serrated extinct
Anticipated Student Preconceptions/Misconceptions (optional)
Instructional Materials/Resources/Tools **Ted ed VIDEO: Why Are Sharks So Awesome** : https://www.youtube.com/watch?v=svlEfxTyJQE Lab Sheet   AWSC Kit: Shark teeth, I.D. Charts, wire, cord Scissors Magnifying Glass

Assessment:
Investigation Lab Sheet
Science Notebook
Observations during investigation
Class Discussion

Science and Engineering Practices included (put the included ones in bold):
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3**. Planning and carrying out investigations**
4. **Analyzing and interpreting data**
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. **Engaging in argument from evidence**
8. **Obtaining, evaluating, and communicating information**

Notes about Science and Engineering Practices included:

Lesson Overview:
- Students will plan and investigate shark teeth to determine if all shark teeth are the same. They will analyze the teeth and identify the species of shark based on the detail of the tooth. They will formulate ideas about why some sharks or versions of their teeth might be extinct. They will explain how the differences in shark's teeth provide advantages and meet the needs of that species.

Opening/Engagement: 10 min
1. Students will watch the Ted ed video *Why Are Sharks So Awesome*
2. Explain that a fossil is the preserved remains or traces of a plant, animal, or other organism from the distant past. A shark's tooth can become a fossil.
3. Ask " Are all sharks teeth the same?" discuss responses. "How might they be different?" (size, shape etc). Chart responses. "Why might sharks have different types of teeth?"
4. Inform the students that scientists can use observation as a tool during scientific investigations. They use their power of observation to observe fossilized shark teeth and new shark teeth and compare them to an identification chart to determine what species of shark the tooth came from.

During the Lesson: 35 min

5. Explain that students will observe and compare various shark teeth.
6. Introduce the lab sheets and student expectations. Using the lab sheet students will describe, diagram, and classify three different shark teeth. Encourage students to choose teeth that are noticeably different.
7. Have students work in small groups. Each group will have a small cup of shark teeth, lab sheet, magnifying glasses, and an identification chart.
8. Stop briefly after about 10 min and draw students' attention to "extinct teeth" on the chart (ex: Tiger Shark). Tell students that the shark is not extinct but that version of tooth has become extinct over time. Through biological evolution this version of shark tooth has changed to better meet the needs of that species. Together discuss what looks different (angle of tooth, size of serrations) and why that might help the shark meet its needs.
9. Let students return to explore teeth and work on lab sheet. Observe student conversations and facilitate with questioning. How is that different, similar? What could that shape be helpful for? What type of shark could that belong to?
10. Wrap up investigation and call group together. Ask "what did you discover?"
11. Explain Shark teeth can be classified in 4 basic categories based on what the shark eats (see teacher info page) . Make sure to point out that one of the great white's favorite meals is the seal. Show the teeth purpose information to students and have they copy into their science notebooks.

Lesson Closing 15 min

12. Students can choose one shark tooth to make a necklace (see directions in teacher info section). This can be done as a center, or students can be called up one at a time while others are copying categories of shark teeth into their notebooks.

Instructional Tips/Strategies/Suggestions for Teacher:

Lesson 4: The Great White Comeback

Overview of the Lesson: Students will be introduced to shark scientist Eugenie Clark, a brief history of the gray seals on Cape Cod, and the Marine Mammal Protection Act of 1972. As a class students will ask questions that can be investigated and predict reasonable outcomes based on patterns, such as cause and effect relationships.

Time (minutes): 60 min

Standard(s): What standards (s) will be the focus of the lesson?
- **3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.**
- **3-LS4-4. Analyze and interpret given data about changes in a habitat and describe how the changes may affect the ability of organisms that live in that habitat to survive and reproduce. Clarification Statements: • Changes should include changes to landforms, distribution of water, climate, and availability of resources. • Changes in the habitat could range in time from a season to a decade. • While it is understood that ecological changes are complex, the focus should be on a single change to the habitat.**
- **3-LS4-5(MA). Provide evidence to support a claim that the survival of a population is dependent upon reproduction. State Assessment**

Essential Question(s):
- Why are Great White Sharks returning to Cape Cod?

Science Objectives
- Students will understand Elasmobranchology is the study of sharks and rays.
- Students will investigate the Elasmobranchologist Eugenie Clark and her contributions to shark research
- Students will recognize the cause and effect relationship between the bounty on gray seals, the MMPA of 1972, return of the gray seal and the return of the Great Whites to the cape.
- Students will explain in writing their understanding of this cause and effect relationship.

Language Objectives and/or Targeted Academic Language

marine   Marine Mammal Protection Act 1972

bounty   Cause and Effect

Elasmobranchologist: scientist who studies sharks and rays

Elasmobranchology: the study of sharks and rays
Anticipated Student Preconceptions/Misconceptions (optional) •
Instructional Materials/Resources/Tools **Swimming with Sharks: Eugenie Clark by Heather Lang (AWSC Kit)** Get to Know Genie : http://www.heatherlangbooks.com/swimming-with-sharks/ For students: Marine Mammal Protection Act Information: https://www.oceansoffun.org/marine_mammal_protec For teachers: Gray Seal and Shark connection http://nasrc.whoi.edu/research/sharks For teachers : Marine Mammal Protection Act Fact Sheet http://www.nmfs.noaa.gov/pr/pdfs/mmpa_factsheet.pdf Seal Population Data Chart Cause and Effect Graphic Organizer
Assessment: Student Discussions Science Notebooks Cause and Effect Writing
Science and Engineering Practices included (put the included ones in bold): 1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. **Analyzing and interpreting data** 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. **Engaging in argument from evidence** 8. **Obtaining, evaluating, and communicating information** **Notes about Science and Engineering Practices included:**

Lesson Overview:
- Students will be introduced to shark scientist Eugenie Clark, a brief history of the gray seals on Cape Cod, and the Marine Mammal Protection Act of 1972. As a class, students will ask questions that can be investigated and predict reasonable outcomes based on patterns, such as cause and effect relationships.

Opening/Engagement: 20 min
1. Explain that the study of sharks is called Elasmobranchology and Elasmobranchologists are the scientists in that field.
2. Explain that you are going to introduce them to a famous Elasmobranchologist Eugenie Clark
3. Read : Swimming With Sharks by Heather Lang
4. Discuss: What contributions did Eugenie Clark make toward the study of sharks? Take notes on chart paper.
5. Students should write 3 facts they learned in their science notebook.

During the Lesson: 60 min
6. Introduce the students to the history or gray seals on the lower cape. Discuss the seal bounty 1888 - 1962
7. Discuss the Marine Mammal Protection Act of 1962 and the effects on the gray seal population. See *Gray Seal Population Data Chart*
8. Discuss the effects of the gray seal population on the habitat and its possible role in bringing back the white shark.
9. Whole class: Use the Cause and Effect Graphic organizer to establish this relationship and how changes in this habitat (availability of resources) affect the the ability of sharks to live, survive, and reproduce.
10. Discuss other results of the return of the seals (fisherman competing for same species, nuisance, tourism) and sharks (public safety, ecotourism, tourism, orcas return?)
11. Have students (or pairs) turn their organizers into paragraphs explaining the relationship between the changes in policy, habitat, and the return of the great white sharks. Students can have the option creating an illustration to go with their writing.

Lesson Closing 10
12. Students can volunteer to share their paragraphs with the class.
13. Classmates offer feedback in the form of compliments, comments, or questions.

Instructional Tips/Strategies/Suggestions for Teacher:

Lesson 5: Tag! You're it!

Overview of the Lesson: Students will understand that there is shark research on Cape Cod. Students will investigate the science and engineering behind shark tags, explore the various shark apps (such as Sharktivity) and evaluate the information they find. Students will choose a local shark and gather physical and behavioral data to share with the class. Students will engage in a tag/recapture game that models the shark tagging process. **Time (minutes): 60**

Standard(s): What standards (s) will be the focus of the lesson?
    • **3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.**
    • **3-LS4-4. Analyze and interpret given data about changes in a habitat and describe how the changes may affect the ability of organisms that live in that habitat to survive and reproduce.**
    • **Cross-Curricular Connections**
    • **Stability and Change:** In grades 3–5, students can measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.
    • **Interdependence of Science, Engineering, and Technology:** In grades 3–5, students can describe how science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.

Essential Question(s): What essential questions will be addressed in this lesson?
    • How do we find sharks to study?
    • How do we know how many sharks there are around Cape Cod?

Science Objectives
    • Students will recognize the interdependence of Science, Engineering, and Technology
    • Students will compare types of tags currently used to track sharks, how they work and what information they provide.
    • Students will explore the Sharktivity App. and OSEARCH App
    • Students will research a specific local shark and gather data to report to class
    • Students will participate in a Mark and Recapture math activity to simulate population studies

Language Objectives and/or Targeted Academic Language

• Satellite Tag (PSAT)
• Hydroacoustic Tags
• Spot Tag
Anticipated Student Preconceptions/Misconceptions (optional) •
Instructional Materials/Resources/Tools • Shark Tag Info Sheet • Sharktivity and/or OSEARCH app or websites • Local Shark Data Reporting Sheet • Mark / Recapture Math Activity Directions • Mark/ Recapture Math Student Sheets • Shark beads or beads different colors (AWSC Kit)
Assessment: How will you know that the students got it? Class discussions Completed Local Shark Data Sheet Completed Mark/Recapture Student Sheets
Science and Engineering Practices included (put the included ones in bold): 1. Asking questions (for science) and defining problems (for engineering) 2**. Developing and using models** 3. **Planning and carrying out investigations** 4. **Analyzing and interpreting data** 5. **Using mathematics and computational thinking** 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information **Notes about Science and Engineering Practices included:**
Lesson Overview: Students will understand that there is shark research on Cape Cod. Students will investigate the science and engineering behind shark tags,

explore the various shark apps (such as Sharktivity) and evaluate the information they find. Students will choose a local shark a gather physical and behavioral data to share with the class. Students will engage in a tag/recapture game that models the shark tagging process.

Opening/Engagement: 15 min
1. Tell students that important shark research is happening on Cape Cod. Scientist are trying to find out more about the Great White Shark's behavior, migration, life cycle, and just how many sharks live in our waters during the warmer months. The belief is that awareness inspires conservation. The more we know about sharks the better we can protect them.
2. Introduce the essential questions. We want to investigate how scientists find sharks to study and how we can find out how many sharks are in our waters.
3. Introduce the idea of shark tags. Explain that scientist use engineering and technology to develop tags that track the shark. They can give us information on their movements (location and depth) and general conditions of their habitat (water temp).
4. Pass out shark tag handout. Explain that local shark researchers like Greg Skomal have been using two types of tags. 1. Satellite pop ups (refer to sheet) and 2. Hydroacoustic Tags (refer to sheet).

During the Lesson: 70
5. Explore how the AWSC tags sharks. Shark tagging off of Chatham, MA
6. Explain that when the crew goes out to tag a shark they work with a spotter airplane that finds the sharks and sends the coordinates of where it is to the boat. The plane has the ability to spot a shark that could be submerged up to 20 ft below the surface. Once the boat has spotted the shark they need to wait until it has risen at least 4 feet from below the surface. The scientists then use a tagging pole with a dart on the end to attach the tag to the shark. The dart only punctures about 3 inches into the back of the shark, and causes no harm to the animal. Think of getting your ears pierced. The shark swims on after the tag is inserted. Tags transmit information to apps such as Sharktivity and Osearch.
7. Explain that OSEARCH is another organization that tracks sharks on Cape Cod. They are based in Nantucket. Their method of tracking is different in that they bring the shark onto a submerged platform and raise them up for tagging. They use GPS tags and work with a satellite to provide real time GPS location of sharks. Tagging Katherine of Cape Cod
8. Explore the Sharktivity Sharktivity   and OSEARCH OSEARCH apps. You can use the interactive map on their website or download the app.
9. Analyzing Acoustic Data: Tracking the path of a shark: Using Sharktivity Data (see teacher resources) students should choose a local shark and track its path. It is a good idea to model this for the students first or complete on together.
10. Analyzing Acoustic Data: Tracking The Path of A Shark
11. Invite students to participate in an activity that demonstrates how researchers track white shark movements.

Give students a data worksheet and golf pencil. Tell them that there are 10 'receivers' around the center (see teacher resources) and they need to offload the data by recording the tag numbers, timestamp of the ping, and the receiver location (printed on the receiver).

12. Ask students to come back with their data and ID the sharks by matching the tag number with the name of the sharks as provided on the 'tagged shark catalog.' They can then use the names to find the ID number of the shark. While they are IDing the sharks, you can talk about how sharks are identified.
13. Students might notice that not all of the tag numbers belong to sharks, locally, striped bass are also tagged and researchers in other areas study different kinds of animals.
14. Hand out Sharktivity Data sheet to students. Discuss what information is presented (shark name, location and date of "ping" at acoustic receiver.
15. Hand out Map. Go over locations of receivers (general area).
   Step 1: Model how to track Gillie (data works best for this)
   Step 2: Have them look at the receiver data and find the very first time that shark pinged in and identify what receiver he/ she pinged in at.
        They should then place their marker at that receiver on their map and place a dot.
   Step 3: Have students find the next consecutive date when their shark pinged in and identify the receiver.
        They should then place a dot at that receiver and connect the dots.
   Step 4: Students should continue to add dots, and draw lines to connect the dots to show how their shark moved around the Cape.
        For students who finish quickly, they can choose another marker and draw the path for the other shark, or even a few and compare the different movements.

Lesson Closing 5 min
16. Gather together and share maps. Explain that this is the type of data the tags collect and the Sharktivity App calculates. Ask why is this information useful?(we can get to understand where the sharks are and make predictions about future movements).
17. Have students add their maps to their science notebook.
18. Optional: Mark/Recapture activity: see notes at bottom of this lesson.

Instructional Tips/Strategies/Suggestions for Teacher: Spend a few minutes getting familiar with the Sharktivity and OSEARCH apps. There is a Mark/Recapture Math Activity included in teacher resources that fits well with the idea of gathering population data.

Mark/Recapture: 30 Min This activity can be added onto this lesson if time permits or it can be conducted at another time that is available. It fits best between lessons 4 and 5 but can be used at any time during this unit. This activity works well for small advanced math groups. For complete instructions see teacher resources.

Lesson 6: You're Gonna Need A Bigger Boat

Overview of the Lesson: Given population data on Gray Seals and White Sharks, students will organize simple data sets to reveal patterns that suggest relationships. They will construct and/or support an argument with evidence and data. They will use data to evaluate claims about the cause and effect. **Time (minutes):60 min**
Standard(s): What standards (s) will be the focus of the lesson? • **3.MD.3 Measurement and Data: Represent and Interpret Data: Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.** • **3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.**
Essential Question(s): What essential questions will be addressed in this lesson? • How do we know if a species (Great White Shark) is thriving or struggling? • How do we use data to form an argument or support an idea?
Science Objectives • Students will use Google Sheets (or some similar program) to create a data chart using seal and shark population data. Data is estimated as the shark population study is ongoing at this time. Data IS realistic. • Students will use the data charts to create a graph showing the correlation (or relationship) between population boom of the gray seal and the return of the great white shark to our waters. • Students will analyze the data to solve problems. • Students will write 5 facts about their graph/data sets. • Students will construct an argument based on data that there is a connection between sharks and the population of gray seals.
Language Objectives and/or Targeted Academic Language • Data • Chart

• Graph (bar, picture, line)
• population estimate
Anticipated Student Preconceptions/Misconceptions (optional)
Instructional Materials/Resources/Tools   • Computer Graphing Application or graph materials   • Seal/Shark data
Assessment: How will you know that the students got it?   Student data chart   Student Graph   Student 5 facts   Class discussions
Science and Engineering Practices included (put the included ones in bold):   1. Asking questions (for science) and defining problems (for engineering)   2. Developing and using models   3. Planning and carrying out investigations   4. **Analyzing and interpreting data**   5. **Using mathematics and computational thinking**   6. Constructing explanations (for science) and designing solutions (for engineering)   7. **Engaging in argument from evidence**   8. **Obtaining, evaluating, and communicating information**   **Notes about Science and Engineering Practices included:**
Lesson Overview: • Given population data on gray seals and white sharks, students will organize simple data sets to reveal patterns that suggest relationships. They will construct and/or support an argument with evidence and data. They will use data to evaluate claims about the cause and effect.
Opening/Engagement: 10 min   1. Ask students to remember what has happened to the population of gray seals on Cape Cod over the last 50 + years. (bounty, Marine Mammal Protection Act, increase in population).   2. Have student predict in their science notebooks: What impact do you think this had had on the white shark population on Cape Cod?   3. Question: Do you think that has anything to do with why the great white sharks have returned to Cape Cod? elicit responses

4. Tell students that scientists analyze the data they have collected to answer questions and solve problems. Explain that today you are a scientist and need to analyze gray seal and shark data to determine if there has been a change in the sharks environment (food resource) that could explain what is happening to the shark population locally.

During the Lesson: 40 min
5. Hand out Seal and Shark Data (see teacher resources)
6. Have students create a table from the data (see teacher resources)
7. Using the table have students insert or create a graph that showcases seal data (line chart, bar graph).
8. Using the table have students insert a graph that showcases shark data (line chart, bar graph).
9. Students should answer questions about the data such as the following: How many more seals are there now than there were in 1990? What year (aprox) did the sharks arrive? How many more sharks were there in 2010 then in 1980? What is the difference between the number of seals and the number of sharks in 2010?
10. Students should spend some time and analyze their graphs. They can add 5 facts or statements about their data. EX: The data shows that number of seals has been increasing since 1980. This can be done independently, in pairs, or as a whole group.
11. Students should make a claim supported by their data. This is the "big idea" that the data leads them to. ex: The Great White Sharks have returned to Cape Cod because they now have a large food supply to aid in their survival.

Lesson Closing 10 min
12. Have students share some of their facts or findings regarding their data.
13. Students make predictions: If the number of grey seals continues to increase on Cape Cod what will happen to the number of white sharks that visit our waters?
14. Think ahead: While it is important that the great white sharks are returning and the population appears to be on the rise, there are other issues that are arising due it's return. We will talk about them next time.

Instructional Tips/Strategies/Suggestions for Teacher: If you do not have access to a graphing program it is fine to have students create hand-made graphs that show the data. NOTE: It is a good opportunity to talk about error in data. Early shark sighting may be inaccurate due to spotter error (mistake a basking shark for a white shark etc). Recently sighting has become more accurate with tags and research scientist actively searching for whites with the ability to accurately identify the species.

Lesson 7: Shark Savvy

Overview of the Lesson: Students will understand basic shark behavior, public safety information, and local shark policy. Civic Participation: Students will apply their learning to relevant situations and contexts to be analytical thinkers and problem solvers with the ability to act on that knowledge. **Time (minutes): 60**
Standard(s): What standards (s) will be the focus of the lesson?   **Civic Participation: Students will apply their learning to relevant situations and contexts to be analytical thinkers and problem solvers with the ability to act on that knowledge.**   **3-LS4-3. Construct an argument with evidence that in a particular environment some organisms can survive well, some survive less well, and some cannot survive.**   **3-5-ETS1-1. Define a simple design problem that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost that a potential solution must meet.**
Essential Question(s): What essential questions will be addressed in this lesson?   - Can humans and sharks successfully share the same environment?   - As residents of Cape Cod how can we be Shark Smart?   - What steps can local officials take to create awareness and understanding that increases public safety?
Science Objectives   - Students will understand and take notes on shark safety using brochures, video segments, and class discussions.   - Students will make a connection between research, understanding, and public safety.   - Students will recognize that some communities have a shark "policy" in place.   - Students will design a surfboard that increases surfer safety using the "Surf's Up" activity.
Language Objectives and/or Targeted Academic Language   - encounter   - caution   - policy   - procedure

• Harbormaster

Anticipated Student Preconceptions/Misconceptions (optional)
  •

Instructional Materials/Resources/Tools
  • AWSC safety video
    http://www.atlanticwhiteshark.org/public-safety/

  • Chatham, MA shark policy
  • AWSC safety (AWSC Kit)
  • ASWSC Cape Cod Great White Shark Safety brochure (AWSC Kit)
  • AWSC purple flag (AWSC Kit)
  • "Surfs Up" activity

Assessment: How will you know that the students got it?

Science notebooks

class discussion

"Surfs Up" activity

Science and Engineering Practices included (put the included ones in bold):
1. **Asking questions (for science) and defining problems (for engineering)**
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. **Constructing explanations (for science) and designing solutions (for engineering)**
7. **Engaging in argument from evidence**
8. **Obtaining, evaluating, and communicating information**

Notes about Science and Engineering Practices included:

Lesson Overview:
  • Students will understand basic shark behavior, public safety information, and local shark policy. Civic Participation: Students will apply their learning to relevant situations and contexts to be analytical thinkers and problem solvers with the ability to act on that knowledge.

Opening/Engagement: 5 min

1. Remind students that they have been learning about the comeback of the great white to the North East Atlantic. The sharks have been drawn back to the cape because there is a HUGE food supply (gray seals). The gray seal population has rebounded due to the Marine Mammal Protection act of 1962. We have focused on the scientific research being done. Through research we gain a better understanding of sharks and their behavior. This is all good news!
2. However, the seals are not the only ones affected by the change in recent habitat changes. **Local fishermen** often compete with the ever growing number of seals for the same species. It can affect the number of fish they are allowed to catch (quota). **Tourism** has boomed in response to the Great White shark arrival promoting the sale of shark related merchandise (clothing, jewelry, toys etc), shark sighting tours, and visitors spending their money in local communities. As a bonus to **researchers,** this interest in Great Whites has allowed them to increase public awareness, understanding, and ultimately conservation of this magnificent creature. Not to mention it helps to secure more funding!
3. One of the biggest concerns about the return of the sharks is of course **PUBLIC SAFETY.** Today we will focus on public safety information, local shark policies, and how engineers can help when it comes to public safety.

During the Lesson: 50
4. AWSC, the National Seashore, the Towns of Cape Cod and the Islands, and the Massachusetts Division of Marine Fisheries, have worked together to produce shark advisory signs, brochures, and a safety video that provide education and safety tips for beach users.
5. Watch Safety video from AWSC: AWSC Safety Video (5:40) Students can take notes or you can discuss and add notes to a class chart
6. Read safety brochures, beach signs, and show students safety flag. Discuss how all this information helps the public remain safe?
7. Show students that Chatham, MA has a shark policy so town employees and officials know what to do if a shark is spotted near a beach. It is not necessary for students to read this document rather they should be aware that multiple town agencies work together to ensure public safety.Chatham Shark Policy
8. Have students write key points from brochures and video in their notebook. Remind them that the information in their notebook will be used in their final project.
9. introduce SURF'S UP activity. Hand out or display surfer/seal image. Read the introduction with the class and discuss.
10. Tell students that they will use what they know about shark senses can you re engineer this surfboard to help sharks realise they are a surfer and not a seal? You will draw a label your redesigned board. Think shape, sounds, vibrations, scent etc. Include a few sentences about your design and why it might help public safety. Students should make their initial engineering design in their science notebook. Final design can be made on construction paper, butcher roll paper, or with cardboard.

Lesson Closing
11. Gather together and share engineered designs.
12. Ask essential questions: Can humans and sharks successfully share the same environment? As residents of Cape Cod how can we be Shark Smart?
13. Collect notebooks for final review.

Instructional Tips/Strategies/Suggestions for Teacher: Surf's Up can be done as an independent activity or started and completed at another time as your schedule allows.

Get to Know Your Neighbor

Curriculum Embedded Performance Assessment
(CEPA; if applicable)

Students will take on the role of research scientists and use their knowledge to create a public service announcement that shows cases awareness, understanding, and safety information about the great white shark. This public service message can be in the form of a brochure, slide show, poster, infographic,or video. Public Service piece should include 3-5 facts on shark anatomy/ shark behavior and 3-5 safety tips, and pictures/illustrations/diagram. Student's will present their work to an audience and share their findings. Students can work independently, in pairs, or small groups according to your preference.

Materials
Student Science Notebook
Computer
Construction Paper for Brochure
Poster Board or Chart Paper
Video Recorder (optional)
crayons, markers, colored pencils

CEPA: Time estimate: three 1 hour sessions

Instructions

- Explain to students now that they have learned about great white sharks returning to Cape Cod, you will create a public service message to present your learning.
- Show students the options:
  - Brochure: Show students examples of brochures. Students can create their brochure from construction paper or they can use a computer template.
  - SlideShow: Students should have prior experience with this application for this option to be considered. Students should have a title slide and at least 3 other slides presenting other information (no more than 8 is recommended)
  - Poster: Students can draw or print images for their poster and type or write information. Make sure students take size into account and write or adjust fonts as necessary. They should have a title that is visible at the top.
  - Infographic: using a sight such as canva.com, easel.ly, or piktochart.com students can use graphic design to create an infographic that has the appropriate number of facts and images.
  - Video: Students must create a script, rehearse, and create or obtain props. (maps, pictures). As a newscaster student(s) will go over informational points and safety tips.

All final projects will contain at least 3 facts about shark anatomy/behavior and 3 facts highlighting shark safety. Your writing should be neat and carefully edited for spelling, grammar, and punctuation as well as factuality. Pictures should be neat and colorful with captions or labels. Make sure your project has an eye catching title and that your name is included somewhere that makes sense for your public safety piece.

- Final projects will be shared in class and other classrooms within the school as appropriate.
- Review CEPA Rubric with students

SHARK CEPA Rubric   Name _____   **Scoring Rubric for Shark Presentation**

Category	Scoring Criteria	Total Points	Score
Organization **(15 points)**	Presentation is completed on time.	5	
	Information is presented in a logical sequence.	5	
	Presentation appropriately conveys information.	5	
Content **(45 points)**	Title is clear	5	
	Unit vocabulary is used and spelled correctly	5	
	Presentation contains accurate information.	10	
	Material included is relevant to the overall message/purpose.	10	
	Appropriate amount of material is prepared 3-5 facts on 1) shark anatomy/behavior and 2) shark safety	10	
	Presentation shows effort in spelling and neatness	5	
	Speaker maintains good eye contact with the audience and is appropriately animated (e.g., gestures, moving around, etc.).	5	

Presentation **(40 points)**	Speaker uses a clear, audible voice.	5	
	Speaker shows an understanding of the information presented.	5	
	Good language skills and pronunciation are used.	5	
	Visual aids are well prepared, informative, effective, and not distracting.	5	
	Speaker was able to answer questions about their presentation.	5	
	Information was well communicated.	10	
Score	**Total Points**	**100**	

Unit Resources

Information to Support Teacher Learning

Atlantic White Shark Conservancy www.atlanticwhiteshark.org

OSEARCH http://www.ocearch.org/

Lesson One: Teacher Information

What is a shark? A shark is a fish! It is an aquatic vertebrate with gills for respiration (breathing) and fins for locomotion (moving). They are top predators and are critical for maintaining a healthy and balanced marine ecosystem.

What Makes a shark a shark? Sharks have a vertebrate or back bone. Their skeleton is made up entirely of cartilage (no bones). Their fins have rigid structure. They don't bend, flutter, or fold up against the body like the fins of other fish. A shark must have 5-7 gill slits. They have a caudal fin, or tail fin which is used for thrust and lift. A shark's teeth are continually replaced and their upper jaw is not firmly attached to the skull. They have placoid scales, also known as dermal denticles, that help reduce drag. There denticles are so effective that scientists used them as a model (biomimicry) to create wetsuits for competitive swimmers. It was so effective that they were later banned for use in competition!
https://www.mnn.com/earth-matters/wilderness-resources/photos/7-amazing-examples-of-biomimicry/sharkskin-swimsuit

How many different types of sharks are there? There are approximately 400 known species of sharks.

Where do sharks live? You can find sharks in all of the oceans and seas across the world. Some Sharks can travel for thousands of miles or swim to great depths.

How long do sharks live? Well as a species sharks have existed for more than 400 million years. They have survived all 5 mass extinctions! To put it into perspective, recorded civilization only goes back only 5000 years. As for modern sharks, that's a tough question for scientists. They don't have a lot of data on the maximum age of sharks. Current tagging programs may help to find the answer to that question in the coming years. We do know that different species have different lifespans. Scientists can determine how old a shark is by counting the rings in its spine much like the growth rings on a tree.
Smooth Dogfish - 16 yr   Porbeagle- up to 46 yr   Whale Shark- up to 100 yrs!

The Fins of a Shark:
Each and every shark has 5 types of fins
Pectoral Fin : help the shark steer, as well as provide additional lift in the water column

Dorsal Fin: provides stability for the shark, prevents them from rolling over

Anal Fin: Helps reduce drag caused by the caudal fin

Pelvic Fin: helps in balancing of the shark in the water

Caudal Fin: (tail) provides lift and thrust, propels it through the water, has an upper and lower lobe

NOTE: The size and shape of fins varies from one species of shark to another.
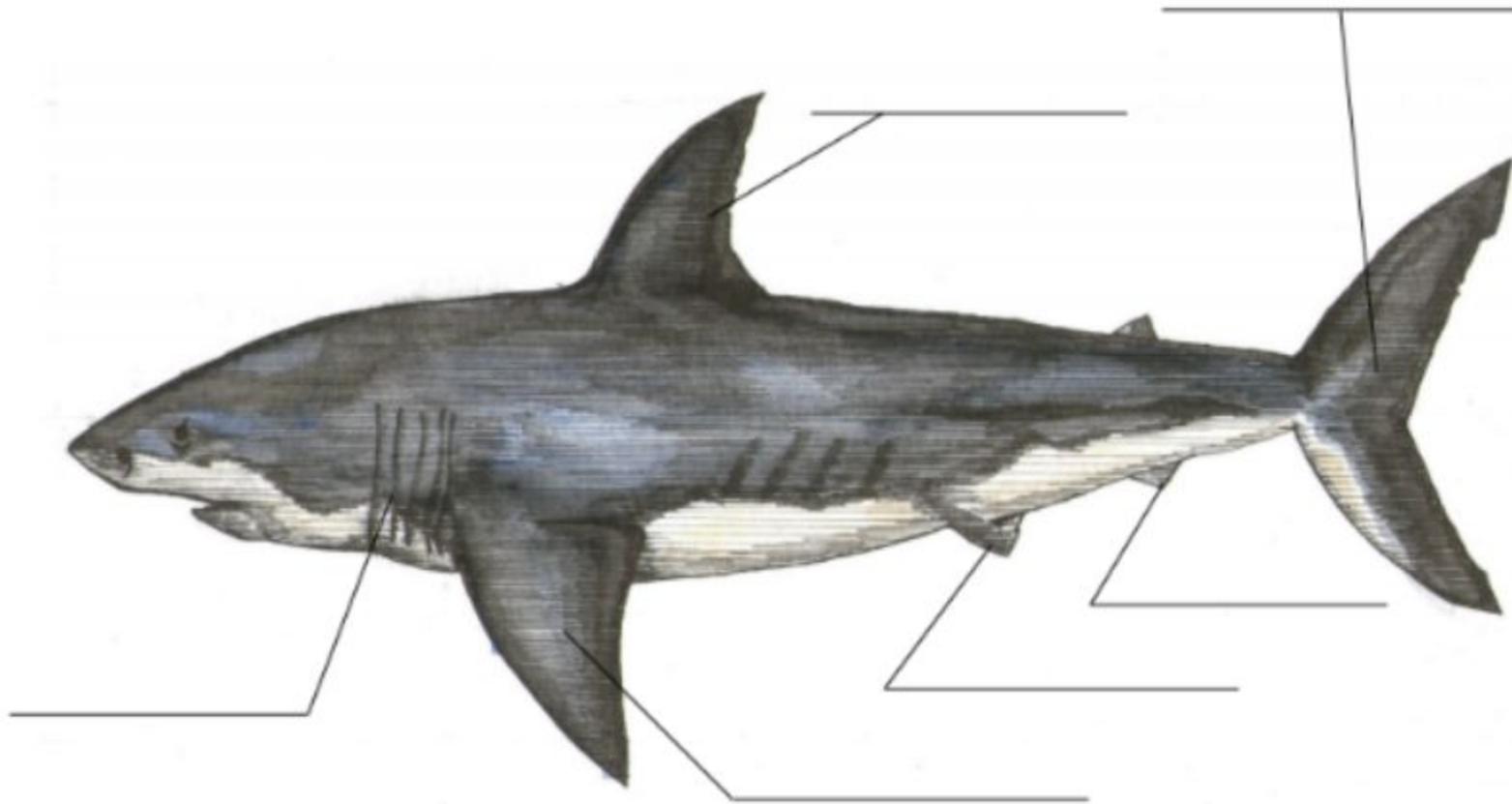
Diagram Key
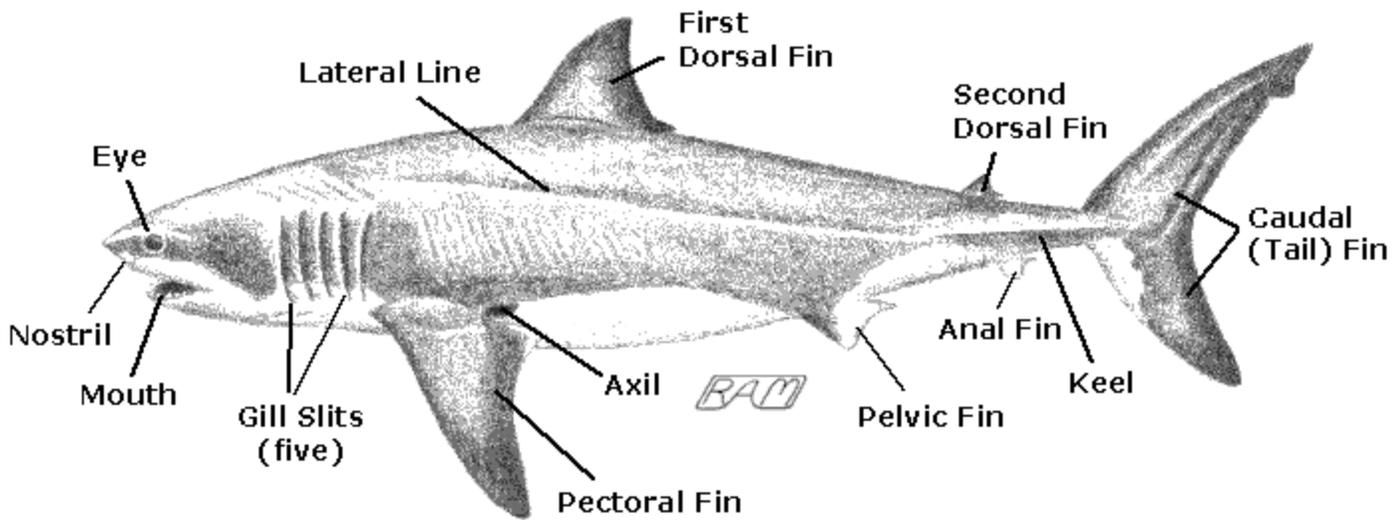
Shark Diagram for kids. Download and print one for each student
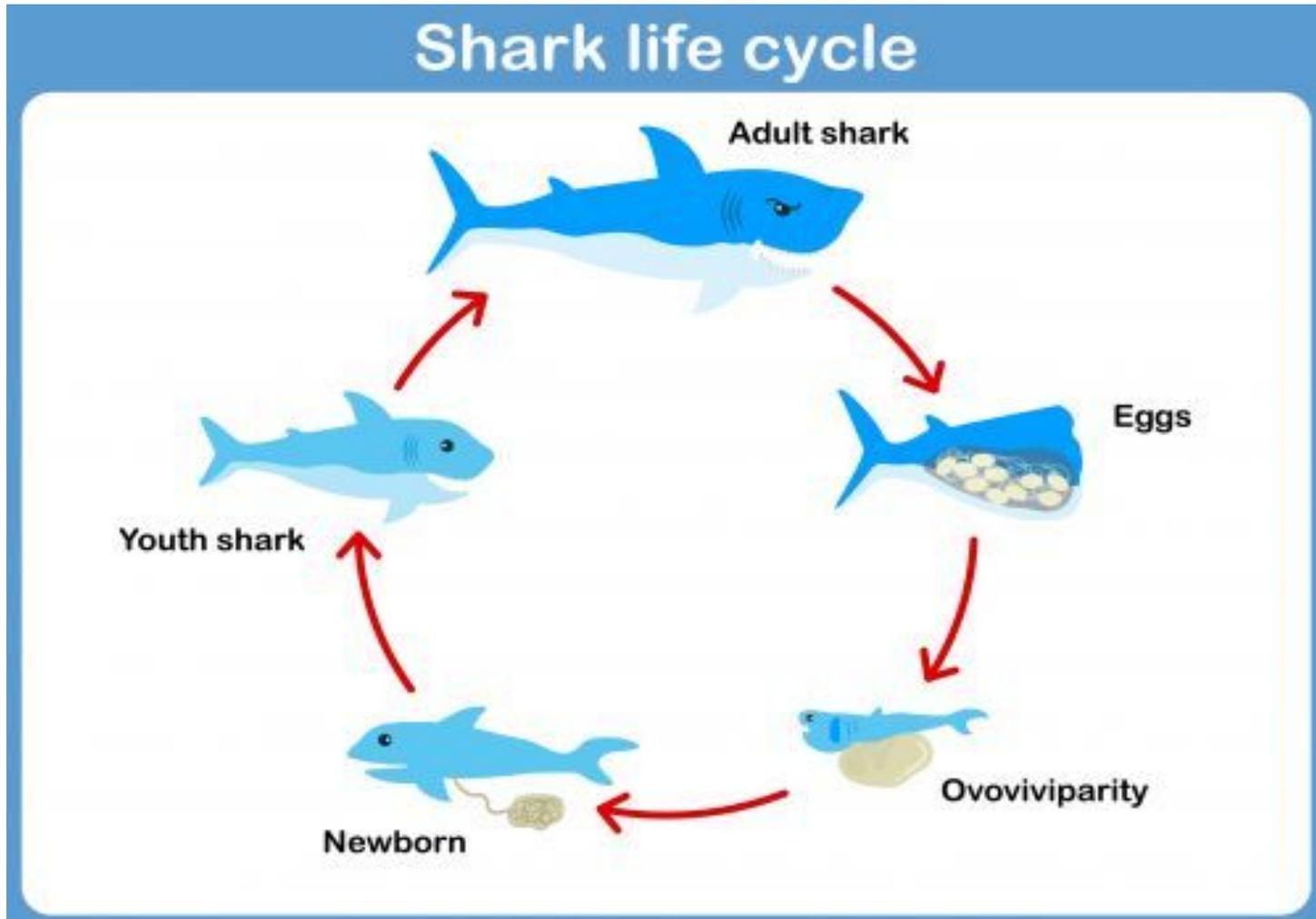
External Anatomy of a Shar

Shark Anatomy

Name:

Lesson Two: Life Cycles
Sea Turtle Life Cycle

Skate Life Cycle

Why Don't Sharks Sink?

The point of this experiment is to help kids understand how oil in shark's liver help them float. In contrast to other fish, who have bladders filled with gas, sharks have liver filled with low-density oil that is similar to vegetable oil.

Materials:
Vegetable Oil
Tap Water
3 8oz Plastic Bottles (or balloons)
Large Tub of water of sink full of water.

Procedure:
1. Fill one 8oz bottle with regular water (no air)
2. Fill one 8 oz bottle with just air
3. Fill one bottle with oil
4. Take turns putting the bottles in the tub of water. Observe what happens.
5. Determine which bottle is more like a shark in how it floats in the water?

Explanation:
Buoyancy is the upward force we need from the water to stay afloat. Most fish have a bladder that is filled with gas.   This is what keeps them balanced in the water. Sharks do not have such a bladder but they have developed different adaptations that help them achieve the same results. These adaptations are: no bones, larger liver, and steering fins. Sharks do not have bones, but cartilage which is lighter than bones. However, the shark's body is still heavier and denser than water, so they use their fins to keep moving and propelling them forward at all times. Lastly, a shark's liver is 25-30% of their body mass (only 5% for mammals). This liver is filled with low-density oil (similar to vegetable oil we used in the experiment) and it acts like a swim bladder of other fish by giving them neutral buoyancy. **Neutral buoyancy** meals that an object within a liquid is neither rising nor sinking, but maintaining the same depth.

This experiment is modified from kidsmind.org
http://kidminds.org/shark-science-bouyancy/
LESSON TWO

Lesson Three: Teacher Information

Sharks have numerous teeth that lie flat within the shark's mouth. At one time most adult sharks have 50-100 functioning teeth. The shape and size of the teeth differ from one species of shark to another. Teeth are designed to catch and consume prey. Because each species of shark has its own unique tooth shape making up the jaw, you can identify a specific shark species by tooth. The teeth are loosely embedded into the mouth of the shark. They are designed to easily fall out, because the shark has many replacements ready to move forward.

While sharks' teeth do share the common traits described above, they have very different shapes and uses. There are four basic groups of shark diets and because of this there are four basic types of shark teeth.

Shark Teeth Chart Info

-Sharks that typically eat fish have **long, narrow, needle-like teeth** ideal for gripping something as slippery and streamlined as a fish.

-Sharks that are benthic feeders, eating bivalves and crustaceans, have **thick, plate-like teeth** perfect for crushing the shells of their prey.

-Tiger sharks, great white sharks, and other sharks that primarily eat seals and other mammals have **sharp, serrated cutting teeth** for tearing off chunks of flesh.

-Finally, we have the gentle giants of the shark family, the basking sharks and whale sharks, that eat krill and other forms of plankton. While they have many teeth, they are **tiny** and useless, as these sharks feed by filtering water through their gills.

http://www.sharksavers.org/en/education/biology/shark-teeth1/

A shark's jaw is very unique. The upper jaw of the shark is attached to the skull, but it has the ability to detach itself when attacking prey. This allows the shark to thrust it's mouth forward and upward to obtain prey.

To order shark teeth:
Contact the Aurora Fossil Museum in Aurora, NC
1(252) 322-4238
at the time of creating this unit a bag of 50 pieces was $2.50 + shipping

Identification Chart

Shark Fossils and Teeth Data Sheet

Tooth #1

Species:	Size:
Benefit of Shape of Tooth:	Diagram:

Tooth #2

Species:	Size:
Benefit of Shape of Tooth:	Diagram:

How to make a shark tooth necklace

Place the front (the more lumpy side) of the tooth over the twists

Bring both pieces of the wire to the back and twist them around each other creating a stop, fold that piece down to prevent it from poking, then cut the excess wire

Create a loop in the middle by twisting the wire around your index finger

Continue this step about 4 times, being sure to alternate sides, and pull the wire tight

Pull a ribbon through the loop and tie it around your neck!

Cut a piece of craft wire to be 8-10 inches

Lift one wire up, across and then around the tooth (so the wire comes back down to where it started), followed by the other side

Lesson Four: Teacher Information

Dr. Eugenie Clark
From NOAA

Few women, let alone those of Japanese American descent, were working in the male-dominated field of marine biology shortly after World War II. Dr. Eugenie Clark changed all that. A scientific pioneer who greatly contributed to people's knowledge of sharks and other fish, Clark worked to improve sharks' reputation in the public eye. Perhaps more importantly, she challenged the stereotypes surrounding women in science by proving that women had much to contribute to the scientific community.

Image Courtesy of Mote Marine Laboratory and Aquarium

Click link for full article
https://oceanservice.noaa.gov/news/may15/eugenie-clark.htm

History

From 1888 - 1962 Massachusetts had one of the longest running seal bounties on record. For 74 years seals were hunted in order to address decline in fish stocks. During this time noses or tails could be turned in ($5 per nose) to the state. It is estimated that up to 136,000 seals were killed for bounty. By the 1960's seals were gone from our shores.

In the early 1960's Massachusetts stopped paying bounties on seals. In 1972 the Marine Mammal Protection Act was enacted Federally protecting all marine mammals. Seal populations have rebounded especially in the last 20 years and that is a main reason why the white sharks have returned to Cape Cod.

Great White sharks are listed as "vulnerable" on the ICUN redlist of threatened species.

This information is summarized from WHOI article discussion history and connection of Grey Seals and Great Whites by Elizabeth Bradford.
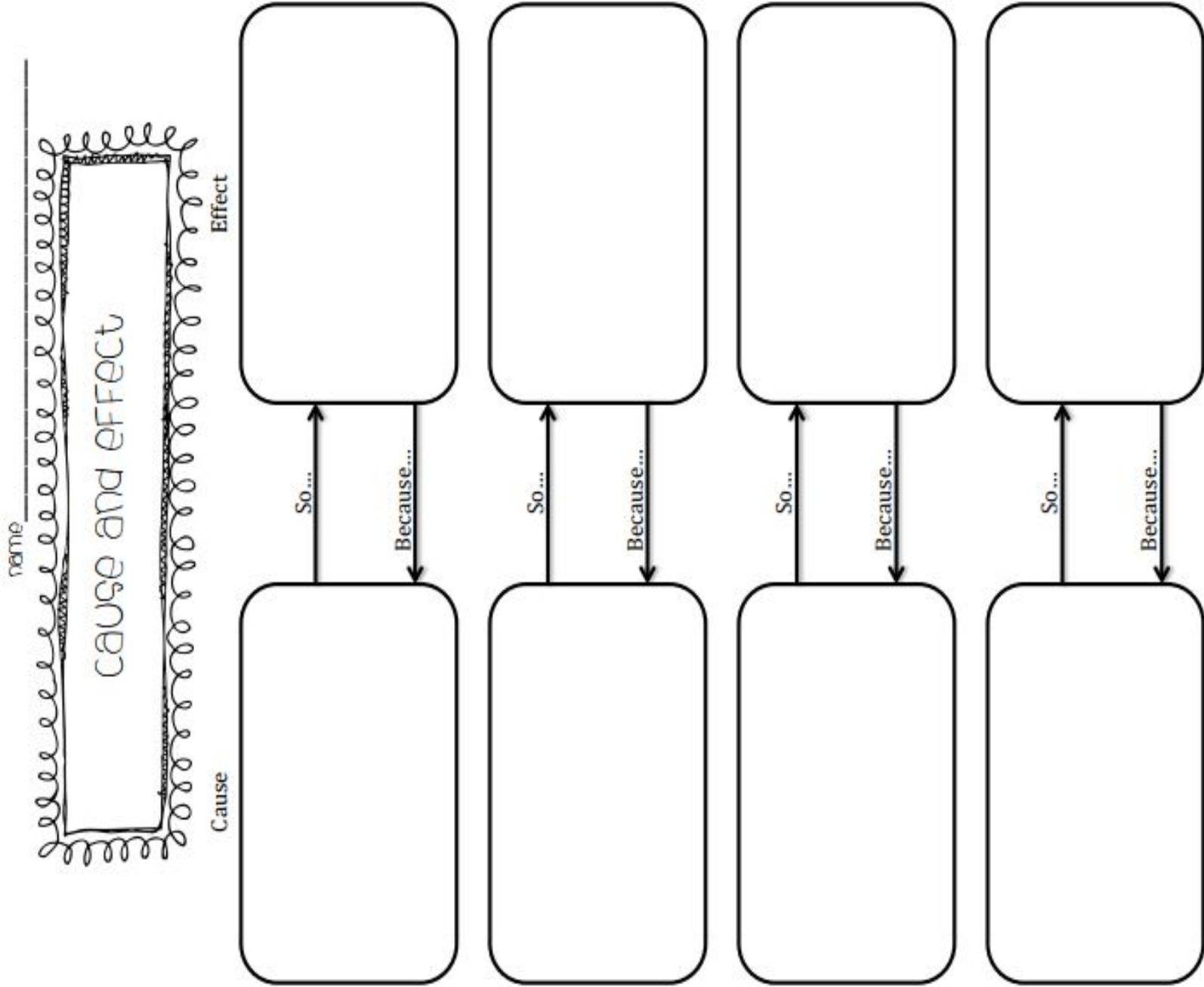Read full article here:
http://nasrc.whoi.edu/research/sharks

Grey Seal Estimated Population Data

Year	Population (individual seals)
1977	5
1987	2,010
1997	5,611
2007	8,352
2017	15,756

Great White Shark Sighting Data

Year	Population (individual sharks)
1977	10
1987	22
1997	30
2007	80
2017	270

name _____

cause and effect

Effect

Cause

So... Because...

So... Because...

So... Because...

So... Because...

Cause and Effect Answer Key

Shark Bounty 1888-1962 → no more grey seals on the Cape

No more grey seas on Cape → Eliminated bounty + Marine Mammal Protection Act 1972

Marine Mammal Protection Act → rebound of the seal population

Rebound of the seal population → return of the Great White Shark

Lesson Five: Teacher Information Shark Tagging

FROM AWSC:

Shark Tagging
Facilitator Guide

Background Information: Little is known about the behavior of white sharks or about how many white sharks there are in our oceans. Determining population size can be difficult because white sharks are migratory, have a sparse distribution, and not many aggregation sites are known. Cape Cod is the only known aggregation site of white sharks in the western North Atlantic. In 2004 Gretel, a white shark that became trapped in a coastal salt pond on Naushon Island and was tagged using the first high-tech tag in the North Atlantic (before she was helped back to the ocean). Since then, over 100 sharks have been tagged off of Cape Cod using acoustic tags, SPOT tags, or PSAT tags.

The SPOT tag allows for real-time satellite tracking and transmits GPS coordinates and temperature when the shark surfaces and the tag dries (at least 90 seconds out of water). The PSAT tag records water temperature, depth, and light penetration data for up to 12 months. After which it releases (ring on model represents the bobby-pin like part that attaches and releases from shark) and floats to the surface (bulb on receiver for floatation) where it transmits the data to a satellite and the tag can possibly be recovered. Because of these tags, researchers have learned that white sharks can dive up to 3,000 feet and tolerate 30°F water. The acoustic tag transmits underwater "pings" to receivers, which records the tag number and informs researchers as to which individual sharks have been within 300 meters of the receiver and at what time. Receivers are fixed at set locations off of the coast.

Acoustic Tags:

Acoustic tags transmit an underwater sound signal (ping) that sends identification information (tag number) to receivers when a tagged shark swims within 300 meters of the receiver. Receivers are set in fixed locations along the coastline. The black canister in the exhibit is the receiver, the cigar shaped tag is the acoustic tag, and the large yellow buoy holds the receiver and visually marks its location in the water.

SPOT Tags:

The SPOT tag works by transmitting a signal to a satellite orbiting the Earth, allowing for the shark's current GPS coordinates to be determined.The dorsal fin of the shark must be out of the water for at least 90 seconds for the signal to be transmitted and received.

PSAT Tags: Pop-up Satellite Tags are data loggers attached to the shark just below the base of the dorsal fin. They record water depth, temperature and light penetration for 12 months. When the PSAT tag detaches from the shark it floats to the surface. Once on the surface it will transmit data to the satellite. The tags have shown that sharks can dive up to 3,000 ft and can tolerate water temps in the 30 degree Fahrenheit range

Note*   See Tags PDF in teacher resources for student handout

Mark/Recapture Activity from AWSC Gills Club

Materials: bowl/container, 50 beads of color A, 10 beads of color B, cloth or cover for container, bandana or blindfold, data sheets, pencils, calculators

Background:

How do scientists figure out how *many* sharks are out there? There are lots of different ways to do this. One method that is often used to estimate an animal population's size is called the **MARK & RECAPTURE METHOD**.

A portion of the population is captured, **marked**, and released. Later, another portion is captured and the number of **marked** individuals within the sample is counted. Then using some cool math, scientists can try to estimate how many of that animal are actually out there.

Our friends at the Atlantic White Shark Conservancy use this as one of the ways they help to study the White Shark populations off the east coast of the US.   The data they collect helps scientists better understand how many white sharks are out there and combined with some of the other cool research they do, we can learn a LOT about where the sharks go and what they're doing out there!

Today, you will try to estimate a "shark" population using this method! We're not using real sharks, but we'll use the same methods to see if we can estimate how many "sharks" are in our ocean.

The bowl in front of you represents the Mystery Ocean. Scientists have been wondering how many sharks are in there. Today, you will help answer that question!

Without removing the cover, take a wild guess at how many sharks are in Mystery Ocean. Write your answer on your data sheet.

STARTING GUESS: How many "sharks" are in Mystery Ocean? _____

Now, let's test out our mark recapture method and see what we can learn about our mystery ocean! We'll look back at our guess when we're done to see how close we were to the actual population.

Walk the students through each step. They have some instructions on their data sheet, but you should talk them through the steps and ask questions.

Step 1 - Capture!
The first thing we have to do is take a random sample from our ocean (the bowl!) So go fishing and collect a total of **10** sharks (beads).

Step 2- Mark!
We are going to mark the sharks that we caught so we'll know which ones they are when we come back to catch them again.

To show which ones are marked, we will switch them out with a different color bead. Replace the 10 green beads with 10 white beads and place them back in the bowl. HOW MANY SHARKS DID YOU "**MARK**"? _____ (This number is M)

Step 3 - Recapture!
For the next step in our study, we are again going to catch 10 sharks. This time though you need to make sure you can't see what you are catching. So close your eyes and catch 10 sharks (no peeking!)
HOW MANY TOTAL SHARKS DID YOU **CATCH**? _____ (This number is C)

In the table, write down how many tagged sharks you caught or recaptured (R). Remember, the tagged sharks are the white ones. Once you have recorded your data, return all the sharks back to the bowl.

As with any scientific study, we need to do this several times to make sure our data is as accurate as possible. Repeat the RECAPTURE four more times and record your data in the table.

Trial #1	
Trial #2	
Trial #3	
Trial #4	
Trial #5	

Once you have completed all 5 trials, find the average of your study by adding up trials 1-5. Then divide that total by 5. This is the average number of sharks recaptured. Note: if you have decimals, record to the tenths place.

Add up 1 – 5 = Total	
To find the average number of RECAPTURED sharks, divide the total by 5.	
(This number is R)	.

Step 4 - Calculations
Now let's do some math!
The fancy equation for this is population = ((total # of sharks recaptured X total # of sharks marked) / (# of marked sharks caught in recapture)..

WHOA! That's kind of confusing!

Let's keep it simple. The population of sharks = (C x M) ÷ R
      C is the total # of sharks you **caught** each time you did a recapture trial.
      M is how many sharks you originally **marked** in step 1.
      R is the average number of marked sharks (the white ones) you **recaptured**.

Now write the numbers on the lines below, and then use the calculator to do the math and figure out the estimated shark population.

_____ X _____ = _____ . Divide that by _____ = _____
    C   M   R   population

Based on your mark-recapture calculations, what is the estimated shark population of Mystery Ocean? _____

Hooray! Now let's see if we were close! Count the beads in the bowl. How many were actually in there? _____

Discussion Questions:
- Was you first guess without seeing the bowl close to the actual population?
- Was your estimated population calculation close to the actual population?
- Is there anything that could make our data even closer to the actual population? (ex: more trials; larger catch size; more marked sharks; etc.)
- How do you think this works when scientists study wild sharks?
- What are some things they have to deal with that we didn't' in our experiment?
- Can we actually count ALL the sharks in the wild?
- How is information that scientists get from this type of experiment be important?

Local Shark Activity

Introduce the Local Shark Reporting Sheet. Students can choose a local shark, research using the OSEARCH app, and complete the reporting sheet. NOTE: There are many sharks named on the apps. Not all are local. A few examples of local sharks are James, Betsy, Katharine, Mary Lee, Cisco, Lydia, and Hunter. This "Local Shark" activity can be done as a center at another time or omitted.

Sharktivity Data Sheet

Name _____

_____
Local Shark Name
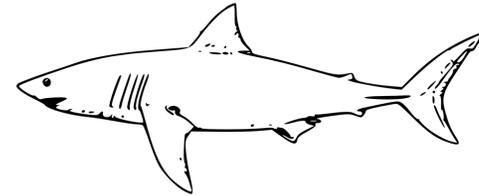
Species:	
Gender:	
Stage of Life:	
Length:	
Weight:	
Date of Tag:	
Location of Tag:	
Illustration:	

Lesson Five: Teacher Information Shark/Seal Graphing

Seal information is based on article from The Northwest Atlantic Seal Research Consortium written by Elizabeth Bradford. Numbers are realistic but NOT statistically accurate. The number of seals has increased dramatically since the 1960's and the assumption is that the increased population is what has caused the return of the great white sharks to Cape Cod

Shark data was estimated and realistic but NOT statistically accurate. As of July, 28, 2017 there were 275 individual sharks sighted per the AWSC.

When graphing the data if you make two separate line graphs both will show an obvious upward trend indicating there is a positive correlation between the seal population and the shark sighting. If data is combined on the same graph the shark data will appear flat.

Lesson Six: Teacher Information

This lesson focused on shark safety. It is a good idea to preview the safety video from the AWSC before the lesson. Help students to make the connection between different members of the community and how they work together to create a safe environment for the people on Cape Cod.

Great white sharks have been drawn back to the Cape because of the increasing seal population. Millions of people swim in the oceans each year with few shark attacks. The ocean is the shark's home. Through research we gain a better understanding of sharks and their behavior, which will allow us to improve public safety.

The Chatham Shark Policy Chatham Shark Policy

Humans are not food for sharks. The majority of shark species actually eat fish, squid, or clams. Fewer than 20% of all sharks are bigger than humans. Not all sharks have a mouth full of large pointed teeth for tearing flesh (basking shark, whale shark). Only 3% of the more than 450 species of shark are known to have bitten humans. Most shark encounters are accidents or "test bites", or they are sharks defending themselves. Few humans are killed by sharks but each year more that 100 million sharks are killed by humans.

Sharks are an important part of the food chain! Without them we would have big problems! Sharks mature slowly - they have few babies at a time and take a long time to become adults and reproduce. As a species, great white sharks are considered vulnerable. Our hope is that through this unit students gain awareness and understanding of this magnificent animal. That, we believe is key to conservation!

Surf's UP

When surfers paddle out to catch a wave, they are entering shark's habitats. Surfer's have many peaceful encounters with sharks, but sometimes sharks mistake the surfer on their board for a seal, sea lion, or sea turtle. Using the images below can you find some similarities that a shark may see, making it hard to know which is a surfer and which is a seal?

Knowing what you know about shark senses, and their eyesight, can you think of any changes a surfer could make to their board to help sharks realize they are a surfer and not a seal? Changes may include adding lights, bright colors, scent, change in shape, etc

Possible Extensions:

The Atlantic White Shark Conservancy has many opportunities for educational outreach! Field trips to the Chatham Shark Center and classroom visits can be arranged according the the age, size, and needs of your group!

Contact them at (508) 348-5901 or email at www.atlanticwhiteshark.org

References:

"Education." *Atlantic White Shark Conservancy*. N.p., n.d. Web. 26 July 2017.
OCEARCH Global Tracking Central. N.p., n.d. Web. 26 July 2017.
Great White Diagram http://www.elasmo-research.org/education/drawing/features.htm
The Shark Institue www.shark.org
Turtle life cycle https://www.education.com/slideshow/color-the-animal-life-cycles/
Skate life cycle www.sharktrust.org
Eugenie Clark https://oceanservice.noaa.gov/news/may15/eugenie-clark.html
Eugenie Clark/Heather Lang http://www.heatherlangbooks.com/swimming-with-sharks/
Chatham Shark Policy
https://www.chatham-ma.gov/sites/chathamma/files/uploads/chatham_shark_sighting_and_attack_policy_2013_-_final_versi.pdf
Buoyancy Experiment http://kidminds.org/shark-science-bouyancy/

Books
Lang, Heather. Swimming With Sharks: The Daring Discoveries of Eugenie Clark. Albert Whitman & Company: China 2016

Brochures

The Atlantic White Shark Conservancy
Cape Cod Great White Shark Safety

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