The Truth About Sharks
Investigating Shark Tagging

Grade: 9-12	Implementation Practice: Using Mathematics and Computational Thinking; Claim, Evidence Reasoning
Subject Area: Life Science	Estimated Duration: One 45 minute period

Learning Objectives - Students will be able to:
- **apply** knowledge of satellite tagging technology to **analyze** movement patterns of short-fin mako sharks
- **propose** a claim, supported by evidence, that summarizes similarities and/or differences between populations of makos
- **evaluate** a claim using reasoned argument based on data regarding movement patterns of two populations of mako shark

Standards Supported

NGSS	Performance Expectation **HS-LS2-2.** Use mathematical and/or computational representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.		
	Disciplinary Core Idea(s)	Science and Engineering Practices	Crosscutting Concept(s)
	● LS2.C: Ecosystem Dynamics, Functioning, and Resilience	● Using Mathematics and Computational Thinking ● Engaging in Argument from Evidence	● Cause and Effect

Activity Summary

Students investigate satellite tagging technology in order to analyze movement patterns of short-fin mako sharks. Students then propose a claim, supported by evidence, that summarizes similarities and/or differences between populations of makos. Lastly, students evaluate a claim regarding movement patterns of two populations of mako sharks.

Advance Preparation

- Review the Student Guide
- Review Content Background Information.
- Gather necessary materials (listed below)

Materials Needed

- Student guide: one per student. Consider delivering this resource digitally so that students may modify their work space as necessary.
- Instructor Rubric: one per student
- Digital assets:
  - Guy Harvey Ocean Foundation shortfin mako video
  - Access to OCEARCH Shark Tracker

Instructor Notes

Depending on your students' familiarity with the Claim, Evidence, Reasoning (CER) writing model, you may wish to do an example as a group using a familiar topic.

Content Background Information

Electronic Tagging and Tracking of Sharks

Electronic tagging and tracking are useful research tools for studying sharks, giving scientists invaluable insight into large-scale movement patterns, behavior, and physiological changes in response to the environment. The data from these tools has been instrumental in helping scientists use data to inform shark conservation efforts. Tracking of sharks can be used by management agencies to set protection boundaries and/or ensure that fishing vessels are not moving into critical habitat areas. Other conservation benefits of tagging and tracking data include revealing areas to prioritize for protection (mating, feeding, nursery habitats), determining sites where sharks are most likely to be impacted by fishing pressure, evaluating whether marine protected areas are sufficiently sized or placed, and predicting the impact of climate change on shark movement and distributions.

Many different types of tools are used for tagging and tracking sharks. Two of the most powerful are popoff-satellite archival tags (PAT) and smart position or temperature transmitting tags (SPOT). Both of these tools make use of global positioning systems (GPS) satellites to relay data to scientists.

Pop-up satellite archival tags are designed to track animals that don't spend enough time at the ocean surface to allow the use of traditional satellite tags. The ability to obtain the data without the animal being recaptured is extremely important as it allows fisheries independent means of tracking species. Prior to the advent of this technology, tagged animals had to be recovered (usually dead from fishing) or recaptured.

PAT tags record environmental data including pressure, ambient temperature, and light levels. Scientists attach the tag to the outside of the shark using an anchor made of surgical material that doesn't cause harm. A monofilament line connects the tag to the anchor. The line attaches to a metal pin at the base of the tag. This metal pin is connected to a battery. A timer incorporated into the tag is programmed to turn the battery on at a preprogrammed time. When the battery turns on, it causes a chemical reaction that dissolves the pin, allowing the tag to float to the surface and transmit data to a satellite. Most PAT tags generate position estimates using light-based geolocation.

SPOT tags can be used to study species that are at the surface regularly. This tag does not need to be recovered to collect the data; it relays its data to a satellite via radio waves every time the tag comes in contact with the air. When used on sharks, these tags are often attached to the first dorsal fin as it will often break the surface of the water. Positions calculated by the data transmitted by these tags are considerably more accurate than those based upon light-based geolocation. This tool can be used to track the movements of large open sea animals for years to a high degree of accuracy.

Using Tracking Data to Conserve Mako Sharks

The shortfin mako shark, *Isurus oxyrinchus*, is a highly mobile pelagic shark found globally in tropical and temperate waters. These predators are best known for their speed and excellent vision. Makos, like most shark species, are overfished. Makos in particular are fished for their meat, fins, and sports. Unfortunately, there are no catch limits set for this vulnerable population. In 2017, a study showed that 30% of juvenile mako sharks tagged in the Atlantic were captured in fisheries. The following

year, the International Union for Conservation of Nature (IUCN) Red List added this species as globally "endangered" due to their declining populations. Mako tagging data demonstrates that this species undergoes long migrations, subjecting them to various fishing pressures and regulations. In addition, makos have been shown to use a variety of habitats, including open-ocean and more shallow waters along the continental shelf. While makos may be protected in some exclusive economic zones (EEZs), they may not be in others. The protection of this species requires international cooperation and management as a result of their movements through, and use of habitat within, many EEZs. Makos are not provided any protection within the EEZ of the United States. The European Union (EU) is responsible for most of the reported shortfin mako fishery. While the EU has co-sponsored a proposal to list makos under CITES (Convention for International Trade in Endangered Species), they have yet to impose any catch limits on their shark fishery.

The Truth About Sharks
Investigating Shark Tagging Rubric

Name:

Glows: Student meets or exceeds performance standard	Performance Standard	Grows: Improvement needed in order to meet performance standard
	- Student can apply knowledge of satellite tagging technology to analyze movement patterns of short-fin mako sharks	
	- Student can propose a claim, supported by evidence, that summarizes similarities and/or differences between populations of makos	
	- Student can evaluate a claim using reasoned argument based on data regarding movement patterns of two populations of mako shark	

Comments:

Name: _____ Date: _____

The Truth About Sharks
Investigating Shark Tagging
Student Guide

Engage

1. Watch the video linked here outlining the Guy Harvey Ocean Foundation supported research on Atlantic shortfin makos.

2. Use what you learned to write a three sentence caption for the image below in the space provided.

Caption

Explore

Use the Internet to research shark tagging and tracking, as well as threats facing mako sharks. Make sure your sources are credible and cite them by including the name of the website and the url. Summarize your research in the tables below. Include at least three salient points for each topic.

Types of Tags	
PAT Tag	SPOT Tag

Threats to Makos

Citations: Website Name; url.

Explain

Use the OCEARCH Shark Tracker to compare and contrast movement patterns of makos tagged in the Caribbean and Gulf of Mexico to those tagged in the North Atlantic Ocean. Choose three adult animals tagged in each location to collect the following data.

Note: Ocearch tags a variety of marine species, be sure you're looking at short fin mako tracks!

Gulf of Mexico Mako Shark Data			
	Shark # 1	Shark #2	Shark #3
Shark Name			
Length			
Weight			
First Ping			
Last Ping			
Days Tracked			
Distance Traveled			
General Observations			

North Atlantic Mako Shark Data			
	Shark # 1	Shark #2	Shark #3
Shark Name			
Length			
Weight			
First Ping			
Last Ping			
Days Tracked			
Distance Traveled			
General Observations			

Elaborate

1. Use the data you collected in the *Explain* to make a claim about observed patterns of movement behavior between North Atlantic and Gulf of Mexico makos. Your claim could be either a similarity or a difference. The **claim** is the conclusion that you have reached in relation to the research question. Record your claim below.

Claim:

2. State the evidence you have for your claim. The **evidence** is scientific data you used to arrive at, and which supports, the claim. To be considered evidence, the data used needs to be relevant to the question. In addition, to adequately support the claim, there needs to be multiple pieces of evidence in support of the claim. State your evidence below.

Evidence:

Evaluate

1. Write a paragraph (five to seven sentences) explaining the reasoning for your claim. The **reasoning** is a logical justification that explains why the data works as evidence to support the claim. You should elaborate on why you chose the data and how the data supports the claim. In addition, you should make a connection to the significance of the claim by including appropriate scientific principles. It is here that you should explore the greater implications of the data and the real world relevance of the claim.

Reasoning:

2. Complete the Self Reflection on the next page.

Investigating Shark Tagging
Self-Reflection

Glows: Things I can do well	Standard	Grows: Things that I need to improve
	I can apply knowledge of satellite tagging technology to analyze movement patterns of short-fin mako sharks.	
	I can propose a claim, supported by evidence, that summarizes similarities and/or differences between populations of makos.	
	I can evaluate a claim using reasoned argument based on data regarding movement patterns of two populations of mako shark.	

My favorite part of investigating shark tagging was…

The most important thing I learned is…

Something I'd like to know more about is...