HEADWATERS SCIENCE INSTITUTE

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Student Investigation

In this lesson, students will investigate how tides influence shark populations near shore by analyzing model drone images of a coastal habitat. Using images collected during simulated research surveys, students will examine how changes in water level and tidal conditions affect the number of sharks and other marine animals observed in shallow coastal waters.

As they analyze the images, students will compare shark sightings across different tide stages to identify patterns in animal presence and distribution. They will record and graph their observations, then use their data to explore how tidal changes may influence when and where sharks move through nearshore environments. Through this investigation, students will practice analyzing models, interpreting data, and developing evidence-based explanations about how environmental factors shape marine animal behavior and populations.

Watch "Lunch with a Scientist Live featuring Dr. Yannis Papastamatiou" prior to beginning this investigation.

NGSS STANDARDS

HMS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

AP Topics:

APES: Topic 1.1: Introduction to Ecosystems, Topic 1.2: Terrestrial and Aquatic Biomes, Topic 2.4: Ecological Tolerance, Topic 2.5: Natural Disruptions to Ecosystems

AP Biology: Topic 7.7: Variation in Populations, Topic 8.1: Responses to the Environment

Investigating Coastal Shark Ecology

Along many coastlines around the world, sharks use shallow coastal waters for feeding, hunting, and traveling. Scientists study these habitats to better understand when and why sharks move close to shore. One way they do this is by using drones, which capture aerial images without disturbing the animals. By comparing drone images taken at different tide levels, researchers can investigate how changing water depth influences the number of sharks and other marine animals observed near the shoreline. This information helps scientists better understand shark behavior and the coastal ecosystems they depend on.

SHARK MOVEMENT AND BEHAVIOR

Sharks are highly adapted marine predators that play an important role in maintaining healthy ocean ecosystems. Many shark species travel long distances throughout their lives as they search for food, find suitable habitats, and reproduce. These migrations are influenced by environmental factors such as ocean currents, tides, water temperature, and the availability of prey. Changes in tides can affect where sharks travel and feed by moving nutrients and attracting prey, while water temperature can help determine when and where sharks migrate. By studying shark ecology, scientists can better understand how sharks use different habitats for feeding, migration, and mating and how changes in ocean conditions may impact their survival.

TOOLS SCIENTISTS USE TO STUDY SHARKS

To better understand shark behavior, movement, and ecology, scientists use a variety of tools to collect data in the ocean. Researchers may use satellite tags, underwater cameras, acoustic tracking systems, and drones to observe sharks and record information about their movements, habitats, and interactions with the environment. Drones have become an important tool in shark research because they allow scientists to safely observe sharks from above, collect detailed images and videos, and study behaviors that can be difficult to see from boats or underwater. By combining data from these technologies, scientists can learn more about where sharks travel, how they respond to changing ocean conditions, and how to better protect these important marine predators.

HOW TIDES SHAPE MARINE ECOSYSTEMS

Tides are the regular rise and fall of ocean water caused primarily by the gravitational pull of the Moon and, to a lesser extent, the Sun. As Earth rotates, the changing position of the Moon and Sun creates differences in ocean water levels, producing high and low tides. These movements constantly reshape coastal habitats by moving water, nutrients, and organisms throughout marine ecosystems. Many marine animals rely on tides for survival, some species use incoming tides to access feeding areas, while others depend on tidal changes to reproduce, migrate, or avoid predators. By studying tides, scientists can better understand how changing water conditions influence the movement, behavior, and health of marine life, including sharks and their prey.

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Student Investigation

In this investigation, you will step into the role of a marine scientist by using simulated drone data to study shark populations and uncover patterns in their movement and habitat use. You will analyze drone images showing different tidal conditions and marine life to investigate how environmental factors influence where sharks and other species are found. By identifying patterns in the data, you will explore how scientists use technology to understand shark populations and the connections that shape healthy ocean ecosystems.

How do tidal changes influence shark movement and habitat use?

Developing a Hypothesis: Create a hypothesis that answers the question: How do tidal changes influence shark movement and habitat use? Use evidence from the background information to explain your prediction and describe how you think sharks may respond to different tidal conditions. Your hypothesis should include what you think will happen and why you think it will happen.

Hypothesis:

_____
_____
_____

The location being studied is a tropical coastline where ocean conditions change throughout the day due to regular tidal fluctuations. This dynamic environment provides important habitat for a variety of marine life, including sharks, fish, and other coastal species. The beach is also a shared space where humans and wildlife interact, making it an important place for scientists to study how environmental changes influence animal movement, behavior, and habitat use.

Before viewing the drone images, consider the tropical coastal location and answer the following questions:

1. What types of marine life would you expect to find in this environment? Explain why.

2. What do you predict the shoreline and surrounding habitat will look like during high tide and low tide?

3. How might changes in water levels and available habitat influence where sharks move and how they use this area?

4. Why might sharks be attracted to this location at certain times or conditions?

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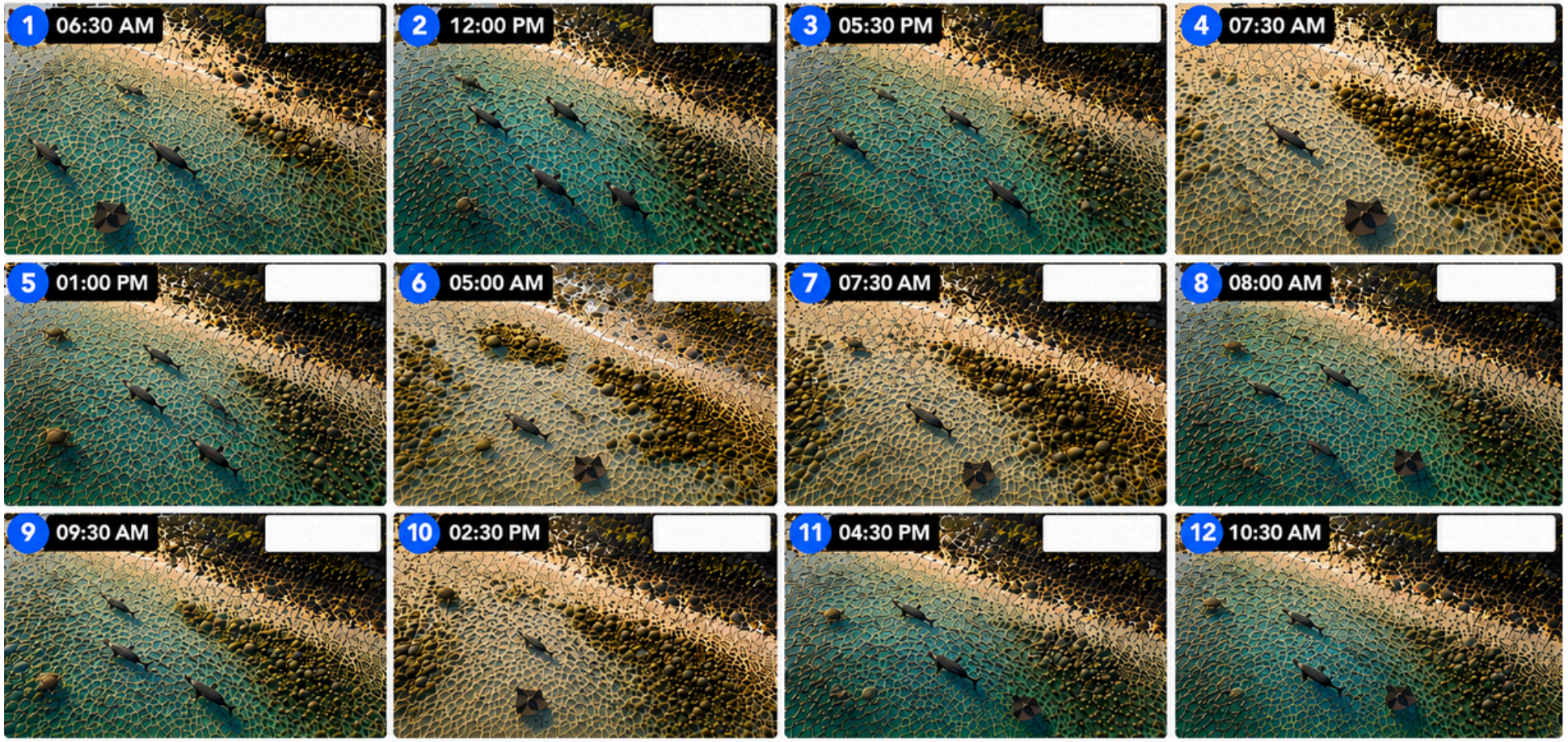
Analyzing Drone Images:

Examine each drone image carefully and look for clues that show the water level and marine life present in the area. Label each image as either high tide or low tide based on the amount of exposed shoreline and water coverage. Then, carefully observe each image and circle all sharks you see.



SURVEY BACKGROUND

The aerial drone images in this activity were collected during multiple research expeditions conducted at the same coastal survey site over several weeks. Because the surveys took place on different dates, the drone flights captured the area at different stages of the tidal cycle. The times shown on each image represent the time of day that particular survey was conducted and are not intended to represent a single day's sequence of tides.

It is also important to note that tide heights and the exact timing of high and low tides vary throughout the year. Tidal ranges are influenced by the positions of the Moon and Sun, seasonal conditions, local geography, and weather. As a result, the timing and magnitude of tides can differ between research expeditions, even when surveys are conducted at the same location.

TIDE SCHEDULE FOR SURVEY LOCATION

TIME	TIDE TYPE	TIME	TIDE TYPE
05:00 AM	Low Tide	12:00 PM	High Tide
06:30 AM	High Tide	01:00 PM	High Tide
07:30 AM	Low Tide	02:30 PM	High Tide
08:00 AM	High Tide	04:30 PM	High Tide
09:30 AM	Low Tide	05:30 PM	High Tide
10:30 AM	High Tide	07:30 AM	Low Tide

Student Investigation

Analyzing Drone Data

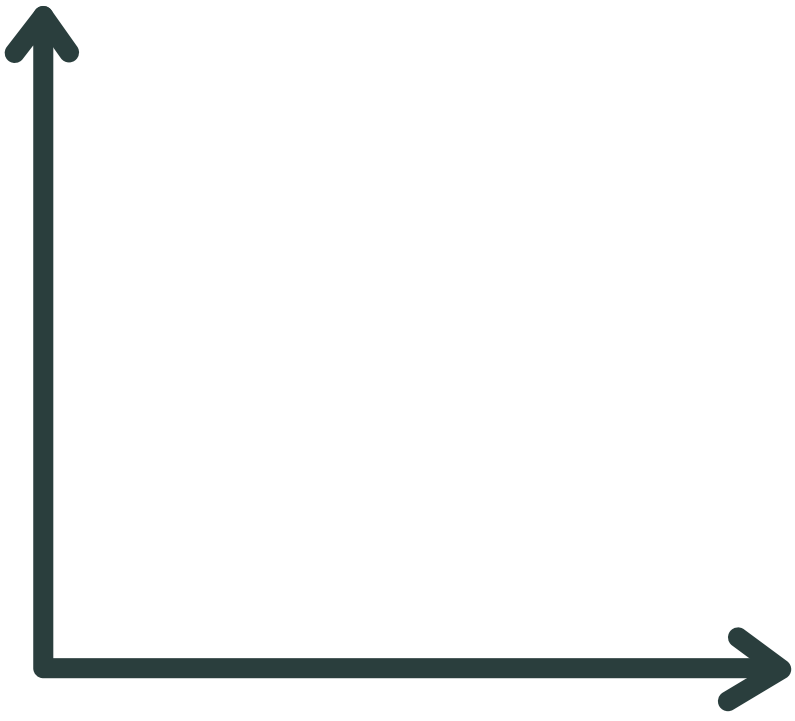
1. Review each drone image and record the number of sharks observed during high tide and low tide.
2. Calculate the average number of sharks observed during high tide and low tide.
3. Create a bar graph comparing the average number of sharks observed under each tidal condition. A bar graph is recommended because it makes it easier to compare shark numbers between high tide and low tide.

Be sure to include:

- A clear title that describes what your graph shows
- A labeled X-axis showing the tidal conditions (High Tide and Low Tide)
- A labeled Y-axis showing the average number of sharks observed

Average number of sharks at High Tide: Low Tide:

Site Number	High or Low Tide	Shark Count
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		



Student Investigation

Use your graphs and hypothesis to write a conclusion. What patterns do you see, and how do they support or challenge your hypothesis?

How do shark populations observed in the drone images change between high tide and low tide?

How does tidal variation influence where sharks are found and how they could use coastal habitats?

How might changes in water depth, available prey, and the presence of other marine life during different tidal conditions affect shark movement patterns?

In what ways might changes in coastal environments, such as rising sea levels or increased human activity, influence shark habitat use and population patterns?

How could scientists use information about shark movement patterns and tidal conditions to help people make safer decisions about when to use coastal areas for recreation and reduce the chance of shark interactions?

What future studies could scientists conduct to better understand shark movements, habitat use, and the environmental factors influencing their behavior in this coastal area?