Swimming on an Empty Shark Tank

What can cause white shark activity levels to vary between individuals within the species?

Overview

The amount of energy we exert on a given day is dependent on multiple factors- our environment, how big we are, what activity we are doing, and how efficient we are at that activity. Animals in the wild are no different. Using biologging tags attached to white sharks in California and South Africa to measure tailbeat frequencies (a proxy for activity), students will explore how activity levels in the largest predatory fish in the ocean compare between regions and between groups (sex and size) within regions. Additionally, students will compare the food sources/average caloric needs of white sharks to those of a human.

Essential Questions

- *How is energy acquired (input) and expended (output)?*
- *How is energy calculated and measured?*
- *How can you use statistical measures to compare energy expenditures between individuals in a population?*
- *How can you use statistical measures to make inferences about populations?*

Learning Goals

Students will learn the following:

- *Energy expenditure varies between individuals of a population.*
- *The amount of energy needed for survival is directly affected by an animal's activity levels.*
- *All else being equal, sharks need more food than humans to maintain healthy energy levels.*

Learning Objectives

Students will be able to:

- *Use data to compare energy costs of white shark groups in different regions and within regions, visually and verbally.*
- *Use scientific knowledge and student-generated sources of evidence to describe what factors may cause differences in energy expenditure between different groups of sharks.*
- *Use proportions and unit rates to compare the caloric needs of sharks and humans.*

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Grade Level

7-10

Time

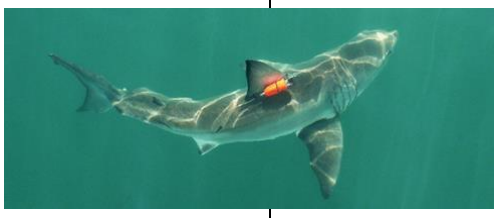
7 days

Anchoring Phenomenon

Swimming on an Empty Shark Tank

Driving Question

What can cause white shark activitiy levels to vary between individuals within the species?



White shark In South Africa wearing a camera tag. Source: T. Chapple

Standards

Next Generation Science Standards

LS2.A – Interdependent Relationships in Ecosystems
LS2.B – Cycles of Matter and Energy Transfer in Ecosystems
LS2.C – Ecosystem Dynamics, Functioning, and Resilience

Common Core Math Standards

7.SP.A.1
7.SP.A.2
7.SP.B.4
7.RP.A.1

Introduction

Different individuals in a population have varying activity levels dependent on a variety of factors including their present environment, the activity they are undertaking, and how efficient they are at that activity and their size. Understanding energetic expenditure is critical as the more energy an animal exerts, the more energy it must consume to survive, grow and reproduce. In the wild, measuring activity is difficult, so we use different metrics as proxies for activity. Much like you might measure footsteps in a day to assess your activity, we can measure tailbeat frequency in sharks as a measurement of energy expenditure.

In this unit, students will explore how energy expenditure varies across individuals using tailbeat information recorded by accelerometers attached to swimming white sharks. The students will compare between different classes of sharks (male v female and adults v subadults) from two different regions (South Africa v California) to determine what factors affect energy expenditure in the wild. Students will use connections between activity, size, and required food intake to determine the average caloric needs of white sharks as well as the food sources and proportions necessary to meet those needs. For context, students will also compare diets of sharks and humans. Finally, students will use these data to create restaurant menus for both sharks and humans, with proportional servings of food for each group in order to compare and contrast the needs of the groups.

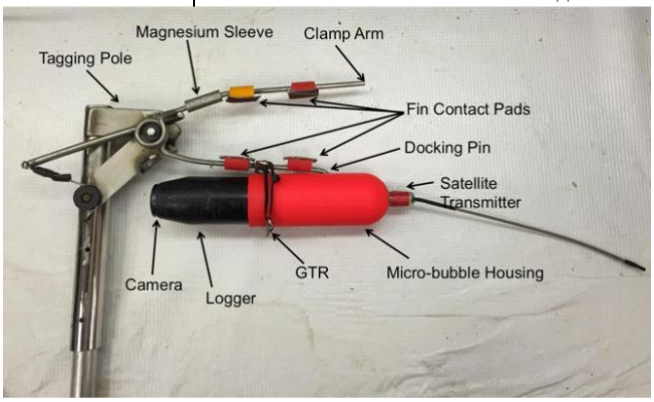
LESSON RESOURCES

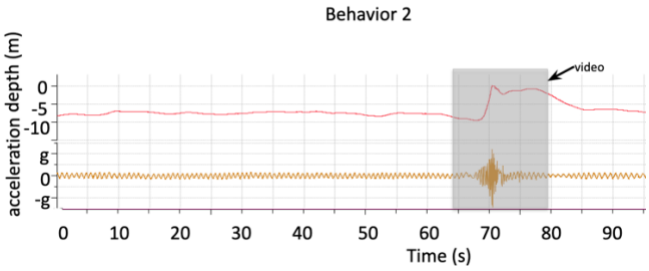
Video and Frequency Matching

- *Video data #1*
- *Video data #2*
- *Video data #3*
- *Video data #4*
- *Frequency v Time Graphs (pdf)*
- *Teacher Guide (pdf)*

White shark
Source: T. Chapple

Datalogger and graph output
Source: T. Chapple





Lesson Procedure

ENGAGE

Day 1: This unit begins with a visual hook video that gets students thinking about the different types of shark activity and the connection between activity level and tailbeat frequency.

Activity: Video and Frequency Matching

Show students four *Videos* of sharks exhibiting various activities. Each behavior (gliding, flat swimming, accelerated swimming, and breaching) is associated with a tailbeat frequency pattern which is depicted on data graphs. After sharing the videos, give students the *Frequency vs Time Graphs* and ask them to match each video to one of the graphs. See the *Teacher Guide* for more information about how to interpret the graphs and the answer key for matching videos with graphs.

Activity: Introduce the Lesson
Introduce and describe the upcoming unit to students using the *Swimming on an Empty Shark Tank Introduction* presentation. Be sure to use and define the *Vocabulary Terms* that will be used throughout, such as frequency and energy, white shark ecology, diet, expenditure, predators, and caloric needs.

EXPLORE

Day 2 Activity: White Shark Energy
Students complete a *Webquest* to review how food provides needed energy for organisms, and to learn some basics about white shark biology and ecology.

Day 3 Activity: Calculations Jigsaw
How does tailbeat frequency vary among sharks of different sizes, sexes, or from two different locations (Africa and California)? Split up the class into four groups and give each group the *Tailbeat Frequency Figures* for eight different sharks. The data set shows the number of tailbeats recorded for each individual shark over a duration of time, and students will have to calculate the number of tailbeats per second on a *Tailbeat Frequency Calculations Worksheet*. Each group will do this for 4 individuals from each of the two locations, and will share results with each other for a total of 32 individuals (16 per location).

EXPLAIN

Day 4 Activity: Energy Cost
Students will use the *Energetic Calculations Spreadsheet* to calculate the average energy costs for each shark subgroup using the tailbeat frequency data previously collected. They will then complete an *Energy Costs Worksheet* to graph those averages in a bar graph, compare and contrast energy costs for the different subgroups, and explain why these values may differ.

ELABORATE

Day 5 and 6: Shark Restaurant Project
Students will use the *Shark Restaurant Project* challenge to create shark restaurants and menu items (with calories listed), as well as menu items at a human restaurant. Students will then need to use proportions to determine serving sizes of each meal; Each restaurant will need to serve both human portions and shark portions.

LESSON RESOURCES

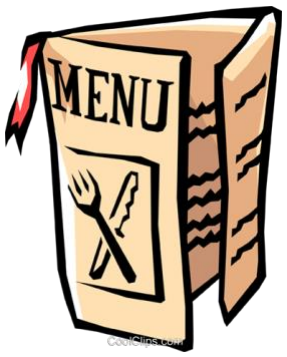
Introduce the Lesson
- *Intro Presentation (ppt)(pdf)(slides)*
- *Video: Tagging a White Shark*
- *Vocabulary Terms (pdf)(doc)*

White Shark Energy
- *Webquest (pdf)(doc)*

Calculations Jigsaw
- *Tailbeat Frequency Calculations Worksheet (pdf)*
- *Tailbeat Frequency Figures (pdf)*

Energy Costs
- *Energetic Calculations Spreadsheet (xls)*
- *Energy Costs Worksheet (pdf) (doc)*
- *Teacher Guide for Energetic Calculations (pdf)*

Shark Restaurant Project
- *Project Description (pdf)*



Activity: Career Connections
Students can learn more about Dr. Taylor Chapple and his shark research through his *Big Fish Lab* website, as well as a 2020 Oregon Sea Grant *Careers in Science* webinar in which he talks about his research and career pathway.

EVALUATE

Day 7: Shark Tank Restaurant Presentations & Gallery Walk
Student groups (aka budding Shark Tank entrepreneurs) will report on the findings of their shark subgroup as well as share their restaurant projects. Groups will then "tour" the different restaurants created their peers, and discuss the projects as a class.

Next Generation Science Standards

Performance Expectations:
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.
HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Science & Engineering Practices:
Developing and Using Models
Using Mathematics and Computational Thinking
Constructing Explanations and Designing Solutions
Engaging in Arguments from Evidence

Disciplinary Core Ideas:
LS2.A – Interdependent Relationships in Ecosystems
LS2.B – Cycles of Matter and Energy Transfer in Ecosystems
LS2.C – Ecosystem Dynamics, Functioning, and Resilience

Crosscutting Concepts:
Cause and Effect
Scale, Proportion and Quantity
Systems and System Models
Energy and Matter
Stability and Change

Career Connections

- *Dr. Chapple's Big Fish Lab*
- *Video: Careers in Science webinar*

Dr. Taylor Chapple

Why This Research Matters:

Predators help maintain the health of ecosystems. Part of understanding how White sharks help keep our coastal marine ecosystems healthy is understanding how much they need to eat. In order for a White shark to survive it needs to balance the energy it expends with the energy it takes in.

Common Core Math Standards

Math Standards:

7.SP.A.1- Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.
7.SP.A.2 -Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.
7.SP.B.4 - Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.
7.RP.A.1 - Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.

Math Practices:

2. Reason abstractly and quantitatively.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.

Acknowledgments

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See more lessons on the ORSEA webpage: https://oregoncoaststem.oregonstate.edu/orsea