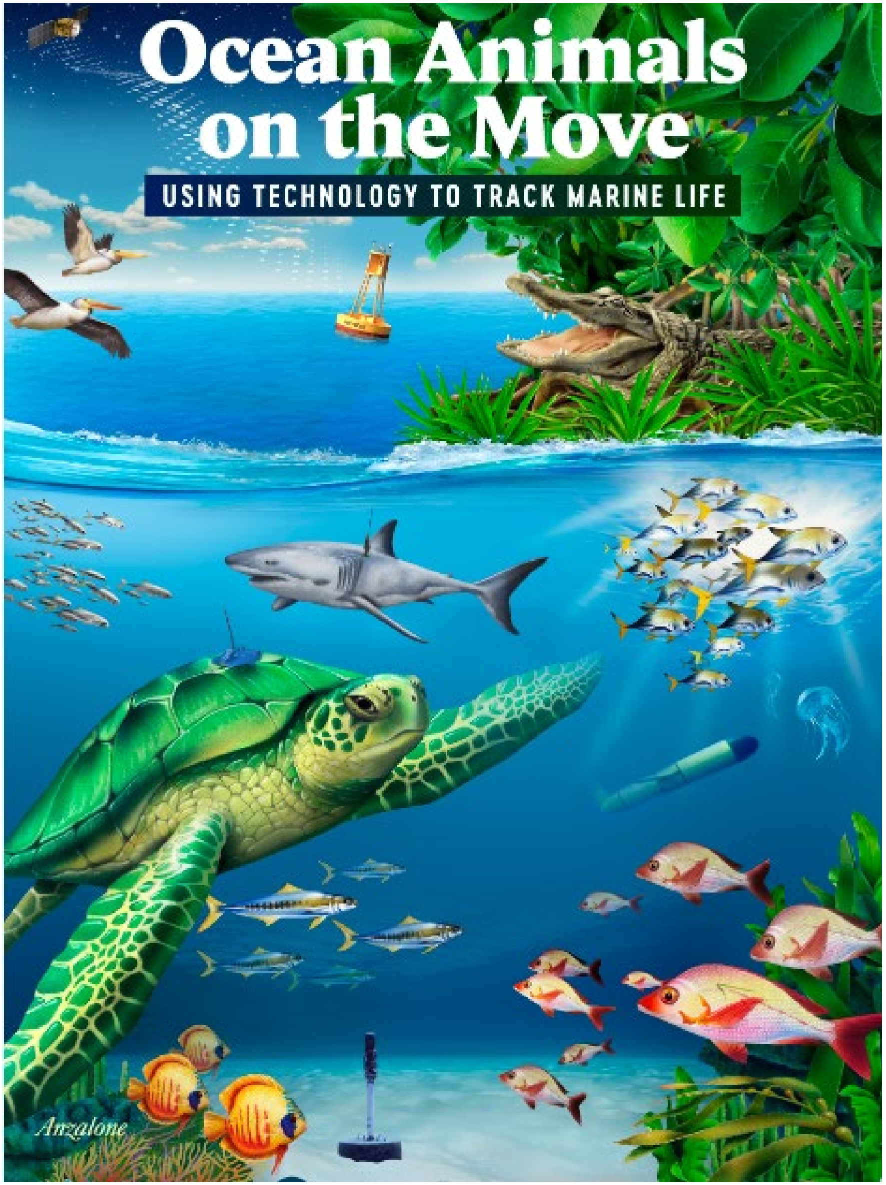

Ocean Animals on the Move

Using Technology to Track Marine Life and Understand Environmental Change

An ESIP FUNding Friday Collaboration

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Objective

To understand the purpose and process of animal tracking, and the data stewardship practices needed to apply the information to real-world challenges.

Three lessons targeting Grades 8-12 support this objective:

Lesson 1 Introduction to Animal Tracking

Lesson 2 Animal Tracking Tools and Technology

Lesson 3 Using Passive Acoustic Telemetry to Study the Movement Ecology of Bull Sharks

Content in this slide deck constitutes Lesson 1 of 3

National Education Standards

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

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-LS2-7.Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8.Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS2.D: Social Interactions and Group Behavior

LS2.D: Biodiversity and Humans

ETS1.B: Developing Possible Solutions

Image credit: University of Miami Rosenstiel School of Marine and Atmospheric Sciences

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HS-LS2 Ecosystems: Interactions, Energy, and Dynamics (Cont.)

Science and Engineering Practices

Using Mathematics and Computational Thinking

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)

Constructing Explanations and Designing Solutions

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

Scientific Knowledge is Open to Revision in Light of New Evidence

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2),(HS-LS2-3)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6),(HS-LS2-8)

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale Proportion and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)

Lesson 1 of 3

Introduction to Animal Tracking: Track Your Classmate

In this activity, students will learn about the type of information that animal tracking can provide. They will simulate data acquisition from both active and passive acoustics. You will need a space suitable for different pathways to be set up for students to move through.

Set Up Activity Space

Set up your activity space to have multiple path options for students—e.g., between rows of desks in the classroom or spaces around work benches in the lab. Try to make each path appealing so students spread out. Label each pathway with a number or name. (Note: if you entice students to end the activity in a common location by providing a treat (e.g., a bowl of candy), you can incorporate the concept of "hotspots" into the discussion.)

Pair students so that one is the scientist and the other is the animal being tracked. Assign each scientist a unique number designation and each animal a unique letter designation.

Gather everyone in a location as far from the start of the path options as possible and provide instructions:

- Fill out the top part of your team's data sheet (Slide 7)
- No going back on a path once you start down it; if you get to the end of one path, you can start down another
- No talking within scientist/animal pairings; other talking is ok (you want students to capture a variety of interactions).
- Use the data sheet provided to record observations over a two-minute period.

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Introduction to Animal Tracking: Track Your Classmate

Step-by-Step

Round 1: **ACTIVE ACOUSTIC TRACKING**

From the gathering location, the activity leader will indicate it is time to start.

"Animals" will choose their path and their scientist will follow them for two minutes. (Active Acoustic Tracking)

The activity leader will call out to simulate a transmitter tag "ping" at 20 second intervals.

Scientists will record on a data sheet (see slide 7) their observations made exactly at the time the "ping" is heard.

There is a place on the bottom of the data sheet to record noteworthy observations that take place between the 20 sec intervals. This will simulate behaviors/activities not captured by acoustic receivers when tagged animals are out of range or between transmitter pings.

Round 2: **PASSIVE ACOUSTIC TRACKING**

Regroup at the gathering location.

Scientists from Round 1 are now the animals. They'll remain in the gathering area until the leader says "go".

The animals from Round 1 now become the acoustic receivers. Disperse them throughout the activity area prior to the animals moving. Once they are stationed, they will remain in fixed positions for the duration of the activity (Passive Acoustics).

When the activity leader indicates "start", the animals will move through the activity area.

The activity leader will call out or simulate a "ping" at 20 second intervals.

The "receivers" will record on their data sheet the individual numbers of the animals that are within 1 meter of them at the exact moment they hear the "ping". They will not record any information about behavior. They should enter a "0" if no animals are present at the time of the ping. This will let you discuss the concept of a zero value meaning "no animal present" vs "no data" meaning a potential problem with a tag or receiver (e.g., animal present but not detected).

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Introduction to Animal Tracking: Track Your Classmate Activity Data Sheets

Track Your Classmate Data Sheet: Round 1: Active Acoustics

Scientist Identification Number___ Animal Identification Letter___

Start Time_________ End Time_________

Location (path selected)___________

Time Transmitter "ping"	Observations made exactly at time of "ping"
20 seconds	
40 seconds	
60 seconds	
80seconds	
100 seconds	
120 seconds	
	Notable observations made between "pings"

Track Your Classmate Data Sheet: Round 2: Passive Acoustics

"Receiver" Identification Letter_____

Start Time_________ End Time_________

Location (fixed position of receiver) ___________

Time Transmitter "ping"	Animal identification Numbers within 1 meter of receiver
20 seconds	
40 seconds	
60 seconds	
80 seconds	
100 seconds	
120 seconds	

Track Your Classmate Activity: Discussion

Focus on sharing observations

- What is the difference between active and passive tracking? (In active acoustics, tagged individuals are followed from a moving platform (e.g., ship); In passive acoustics, the tagged animal must come within range of a receiver that is in a fixed location.
- What are some benefits and disadvantages of each method (e.g., cost; scale of coverage over time and space; high resolution information for one animal vs. less detailed information about many)
- Were certain paths more or less popular? If so, what are possible explanations?
  - Did you create an especially desirable location by offering an incentive like candy? Hotspots are places where many animals tend to aggregate because of preferred conditions, e.g., food, shelter, favorable currents or temperatures
- What types of interactions did you observe?
  - Between "animals"
  - Between "animals" and scientists
  - Between "animals" and habitat /environment
  - Other?

Were there noteworthy observations that took place between the 20-second "ping" intervals? What might this mean for a scientist trying to understand animal movement ecology? (A lot happens between tag detections! If high resolution behavioral information is needed, passive acoustic telemetry might not be the best option.)

Brainstorm: What can you learn by tracking animals? Examples include…

Where they go
What they do
Who/what they interact with
How much time they spend in particular areas (e.g., resident, seasonal use, passing through)
How they use the habitat (e.g., feeding, breeding, resting, migrating)
Changing environmental conditions (e.g., are previously favorable habitats no longer used? Are previously avoided habitats now used?)
Other?

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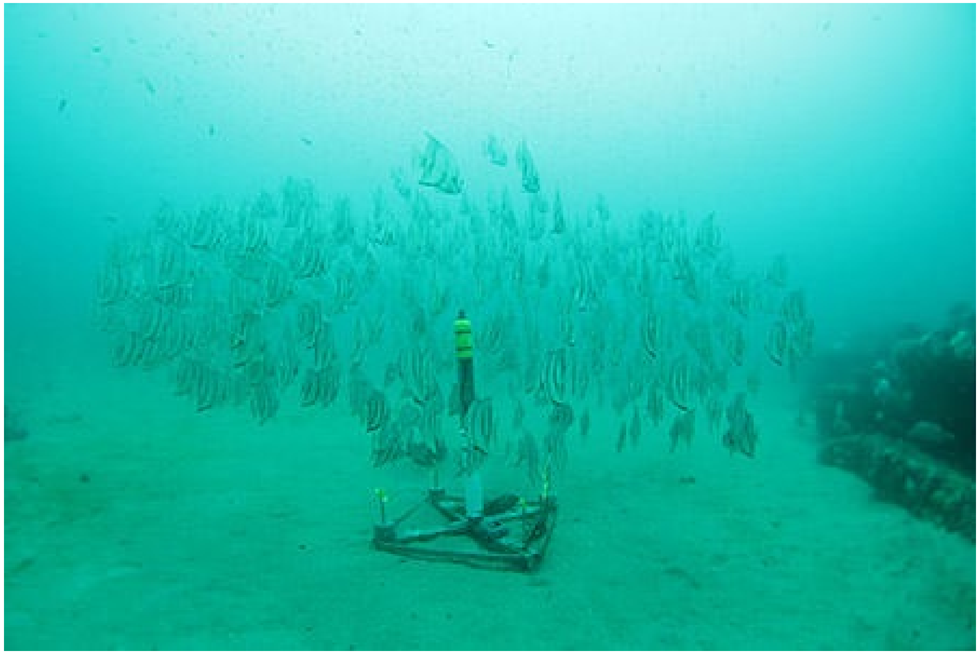
Relevance of Animal Tracking: Examples of who needs to know and why

Key Points

- Different organizations must make decisions about how to protect and use natural resources in responsible and sustainable ways.
- There are local, state and federal laws that guide decisions about the use of natural resources.
- Understanding how different species interact with each other, the environment and other species is critical to their protection.



A hydrophone on the seafloor picks up signals from acoustically tagged fish. Image credit: Peter Auster/University of Connecticut

Examples of stakeholders and how they might apply animal tracking data include:

National Oceanic and Atmospheric Administration (NOAA): needs to know where and when Highly Migratory Species like Atlantic bluefin tuna spawn so they can regulate fishing at those times and locations. They also must determine if Marine Protected Areas or other "safety zones" need to be established.

Ports: Dredging projects common in port operations kick up sediment making the habitat unfavorable to plants and animals. Environmental specialists need to assess whether animals protected under the Endangered Species Act are present and take appropriate precautions. For example, as Port Tampa looks to expand and deepen channels, they pay close attention to the presence of endangered Smalltooth sawfish and Kemp's ridley sea turtles.

State fish and wildlife agencies: need information to set seasons and catch limits for recreational and commercial seafood harvest. Because animals don't care about artificial human boundaries, these groups work with fisheries management councils to set regulations in federal waters for species that cross geopolitical boundaries.

Businesses: Scoping locations for things like offshore aquaculture and offshore wind farms require environmental impact assessments to understand what's there, how species use the environment, and how proposed activities might impact them. Knowing year-round habitat use (residential, seasonal, migratory species use) is required.

Military: Ocean noise pollution impacting species protected under the Marine Mammal Protection Act is of great concern. Things like seismic surveys, demolition, military explosives and sonar can harm marine animals so knowledge of animals in the area is required to determine if activities can take place.

These are just a few of many examples of how animal tracking data are used.

Assess Understanding

Have students identify a real-world issue that would benefit from using animal tracking technology. Ideas to get started:

- Setting fisheries catch limits and seasons
- Establishment of marine protected areas, sanctuaries, and parks
- Port expansion (widening and deepening to accommodate the growing number of container and bulk ships that are too large for original infrastructure)
- Coastal development
- Coastal restoration work
- Establishment of commercial navigation routes
- Scoping offshore energy sites or aquaculture facilities
- Siting for artificial reef construction
- Site determination for eco-tourism business
- Understanding climate change impacts to marine life (e.g., biodiversity, zoogeography)—are animals changing their patterns because of environmental changes?

Who needs the information?
What decision must be made that requires the animal(s) to be tracked?
What animal or animals need to be tracked?
What would you expect to learn from the data you gather from your tracked animal(s)?
What other information besides animal movement might you need to know? (e.g., environmental data)

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Resources

https://www.teachengineering.org/lessons/view/duk_marine_musc_less2

https://nationalzoo.si.edu/migratory-birds/what-satellite-telemetry

https://www.researchgate.net/publication/334044228_Animal-Borne_Telemetry_An_Integral_Component_of_the_Ocean_Observing_Toolkit

https://www.sciencedirect.com/science/article/abs/pii/S0169534719300242

https://link.springer.com/article/10.1007/s10452-021-09845-6

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https://masweb.vims.edu/bridge/index.cfm

https://sharks.panda.org/images/RAT/pdf/WWF_RAT_Tool5_TaggingTracking.pdf

https://graysreef.noaa.gov/science/research/fish_tagging/faqs.html

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