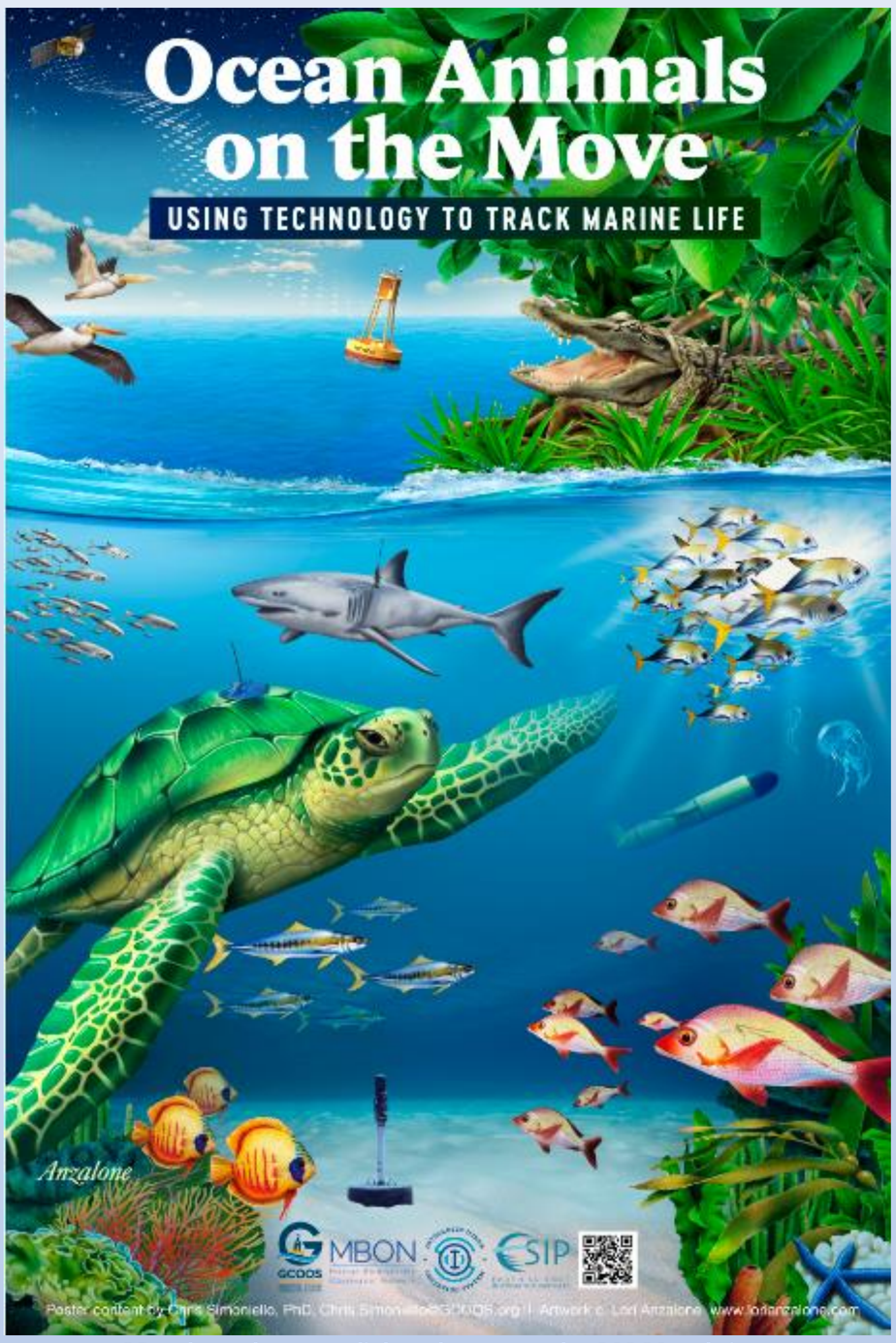
Animals on the Move
Using Technology to Track Marine Life and Understand Environmental Change
An ESIP FUNding Friday Collaboration

C. Simoniello[1,2A,B], M.J. Rider[3C], L. Anzalone[4D], M.M. Biddle[5E], F.C. Gayanilo[2,6F] and G. Craig[2B]
[1]Texas A&M University-CS, [2]GCOOS, [3]University of Miami, [4]Anzalone & Avarella Studios, [5]US IOOS, [6]TAMU-CC
[A]Oceanographer, [B]Outreach & Education Specialist, [C]UM RSMAS PhD Candidate, [D]Artist, [E]Physical Scientist, [F]Enterprise IT Technologist

The objective of this collaboration was to develop resources that help middle and high school students understand the purpose and process of animal tracking, and the data stewardship needed to apply the information to real-world challenges.

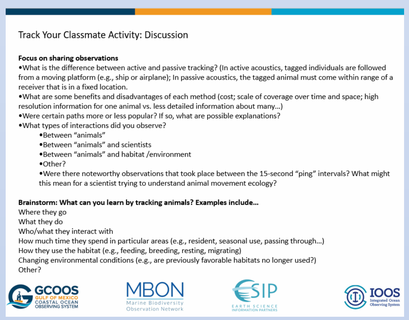


QR code on the poster links to lessons on the GCOOS website.

Deliverable: Ocean Animals on the Move poster with a link to lessons targeting Grades 8-12.

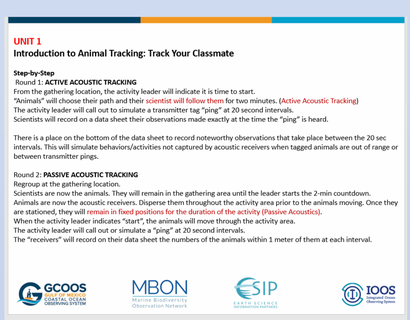
Unit 1 Introduction to Animal Tracking: Track Your Classmate Activity

In this activity, students learn about the range of information that animal tracking can provide and applications of these data in the real world. They simulate data acquisition from both active and passive acoustic telemetry. Lessons are aligned to standards and include assessment examples.


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 or airplane); 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 (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?
- 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 15-second "ping" intervals? What might this mean for a scientist trying to understand animal movement ecology?

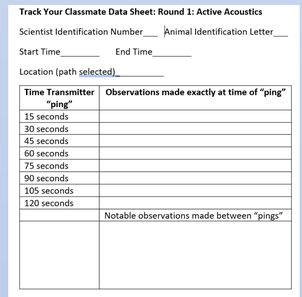
Brainstorm: What can you learn by tracking animals? Examples include…
Where they go
What they do
Who/what they interact with
How much time they spend in particular areas (e.g., resident, seasonal use, passing through…)
How they use the habitat (e.g., feeding, breeding, resting, migrating)
Changing environmental conditions (e.g., are previously favorable habitats no longer used?)
Other?


UNIT 1
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 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 are now the animals. They will remain in the gathering area until the leader starts the 2-min countdown.
Animals are now 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 numbers of the animals within 1 meter of them at each interval.

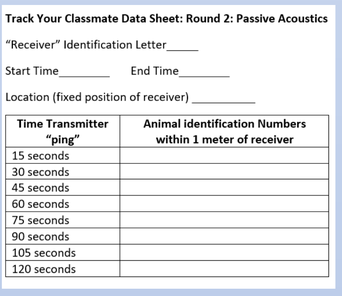

Track Your Classmate Data Sheet: Round 1: Active Acoustics

Scientist Identification Number___ Animal Identification Letter___

Start Time_____ End Time_____

Location (path selected)_____

Time Transmitter "ping"	Observations made exactly at time of "ping"
15 seconds	
30 seconds	
45 seconds	
60 seconds	
75 seconds	
90 seconds	
105 seconds	
120 seconds	
	Notable observations made between "pings"


Track Your Classmate Data Sheet: Round 2: Passive Acoustics

"Receiver" Identification Letter_____

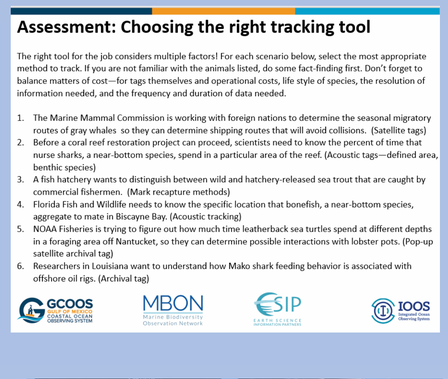
Start Time_____ End Time_____

Location (fixed position of receiver) _____

Time Transmitter "ping"	Animal identification Numbers within 1 meter of receiver
15 seconds	
30 seconds	
45 seconds	
60 seconds	
75 seconds	
90 seconds	
105 seconds	
120 seconds	

Unit 2 Animal Tracking Tools and Technology

In this lesson, students learn about the different types of tracking techniques, and balancing benefits and challenges to find the right tool for the job. Lessons are aligned to standards and include assessment examples.


Assessment: Choosing the right tracking tool

The right tool for the job considers multiple factors! For each scenario below, select the most appropriate method to track. If you are not familiar with the animals listed, do some fact-finding first. Don't forget to balance matters of cost—for tags themselves and operational costs, life style of species, the resolution of information needed, and the frequency and duration of data needed.

1. The Marine Mammal Commission is working with foreign nations to determine the seasonal migratory routes of gray whales so they can determine shipping routes that will avoid collisions. (Satellite tags)
2. Before a coral reef restoration project can proceed, scientists need to know the percent of time that nurse sharks, a near-bottom species, spend in a particular area of the reef. (Acoustic tags—defined area, benthic species)
3. A fish hatchery wants to distinguish between wild and hatchery-released sea trout that are caught by commercial fishermen. (Mark recapture methods)
4. Florida Fish and Wildlife needs to know the specific location that bonefish, a near-bottom species, aggregate to mate in Biscayne Bay. (Acoustic tracking)
5. NOAA Fisheries is trying to figure out how much time leatherback sea turtles spend at different depths in a foraging area off Nantucket, so they can determine possible interactions with lobster pots. (Pop-up satellite archival tag)
6. Researchers in Louisiana want to understand how Mako shark feeding behavior is associated with offshore oil rigs. (Archival tag)


University of Miami

Unit 3 Using Passive Acoustic Telemetry to study the movement ecology of bull sharks

In this lesson, students learn about the importance of data stewardship and analyze research from a project focused on the movement of bull sharks along the U.S. SE Atlantic Coast & Gulf of Mexico (Rider et al., 2021*). Lessons are aligned to standards and include assessment examples.

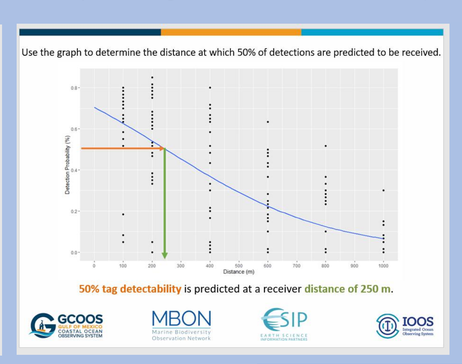
*Rider, M.J., McDonnell, L.H., and Hammerschlag, N. 2021. Multi-year movements of adult and subadult bull sharks (Carcharhinus leucas): philopatry, connectivity, and environmental influences. Aquat Ecol. https://doi.org/10.1007/s10452-021-09845-6(0123456789().,-volV)(01234567


UNIT 3
Using Passive Acoustic Telemetry to study the movement ecology of bull sharks

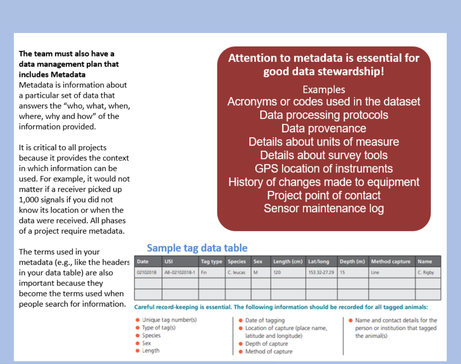
Research Question: How are bull sharks (*Carcharhinus leucas*) moving along the U.S. Southeast Atlantic Coast and Gulf of Mexico over space and time?

This lesson is based on research led by Mitch Rider and presented in the journal Aquatic Ecology.

Rider, M.J., McDonnell, L.H., and Hammerschlag, N. 2021. Multi-year movements of adult and subadult bull sharks (Carcharhinus leucas): philopatry, connectivity, and environmental influences. Aquat Ecol. https://doi.org/10.1007/s10452-021-09845-6(0123456789().,-volV)(01234567


Use the graph to determine the distance at which 50% of detections are predicted to be received.

50% tag detectability is predicted at a receiver **distance of 250 m.**


The team must also have a data management plan that includes Metadata
Metadata is information about a particular set of data that answers the "who, what, when, where, why and how" of the information provided.

It is critical to all projects because it provides the context in which information can be used. For example, it would not matter if a receiver picked up 1,000 signals if you did not know its location or when the data were received. All phases of a project require metadata.

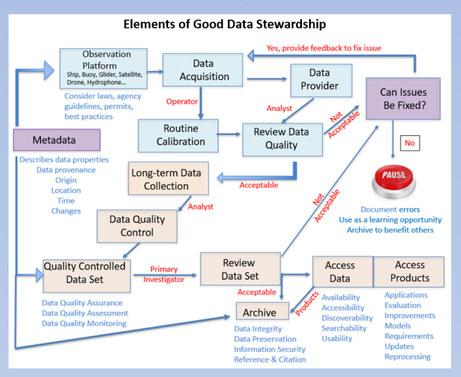
The terms used in your metadata (e.g., like the headers in your data table) are also important because they become the terms used when people search for information.

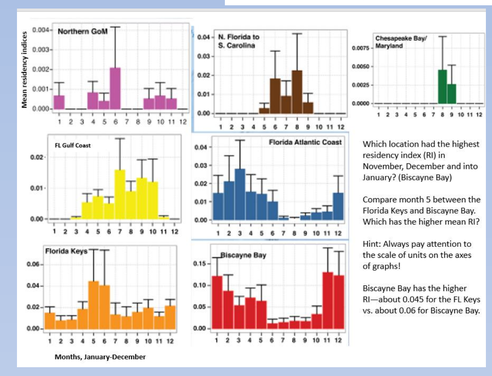
Attention to metadata is essential for good data stewardship!
Examples
Acronyms or codes used in the dataset
Data processing protocols
Data provenance
Details about units of measure
Details about survey tools
GPS location of instruments
History of changes made to equipment
Project point of contact
Sensor maintenance log

Sample tag data table

Date	UID	Tag type	Species	Sex	Length (cm)	Lat/long	Depth (m)	Method capture	Name
12102019	AE-GC102018-1	Fin	C. leucas	M	120	153.32-27.29	15	Line	C. Rigo

Careful record-keeping is essential. The following information should be recorded for all tagged animals:
- Unique tag number(s)
- Type of tag(s)
- Species
- Sex
- Length
- Date of tagging
- Location of capture (place name, latitude and longitude)
- Depth of capture
- Method of capture
- Name and contact details for the person or institution that tagged the animal(s)





Which location had the highest residency index (RI) in November, December and into January? (Biscayne Bay)

Compare month 5 between the Florida Keys and Biscayne Bay. Which has the higher mean RI?

Hint: Always pay attention to the scale of units on the axes of graphs!

Biscayne Bay has the higher RI—about 0.045 for the FL Keys vs. about 0.06 for Biscayne Bay.

MBON Marine Biodiversity Observation Network

INTEGRATED OCEAN OBSERVING SYSTEM

ANZALONE & AVARELLA STUDIOS ILLUSTRATION | PHOTOGRAPHY

GCOOS GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM

ESIP EARTH SCIENCE INFORMATION PARTNERS