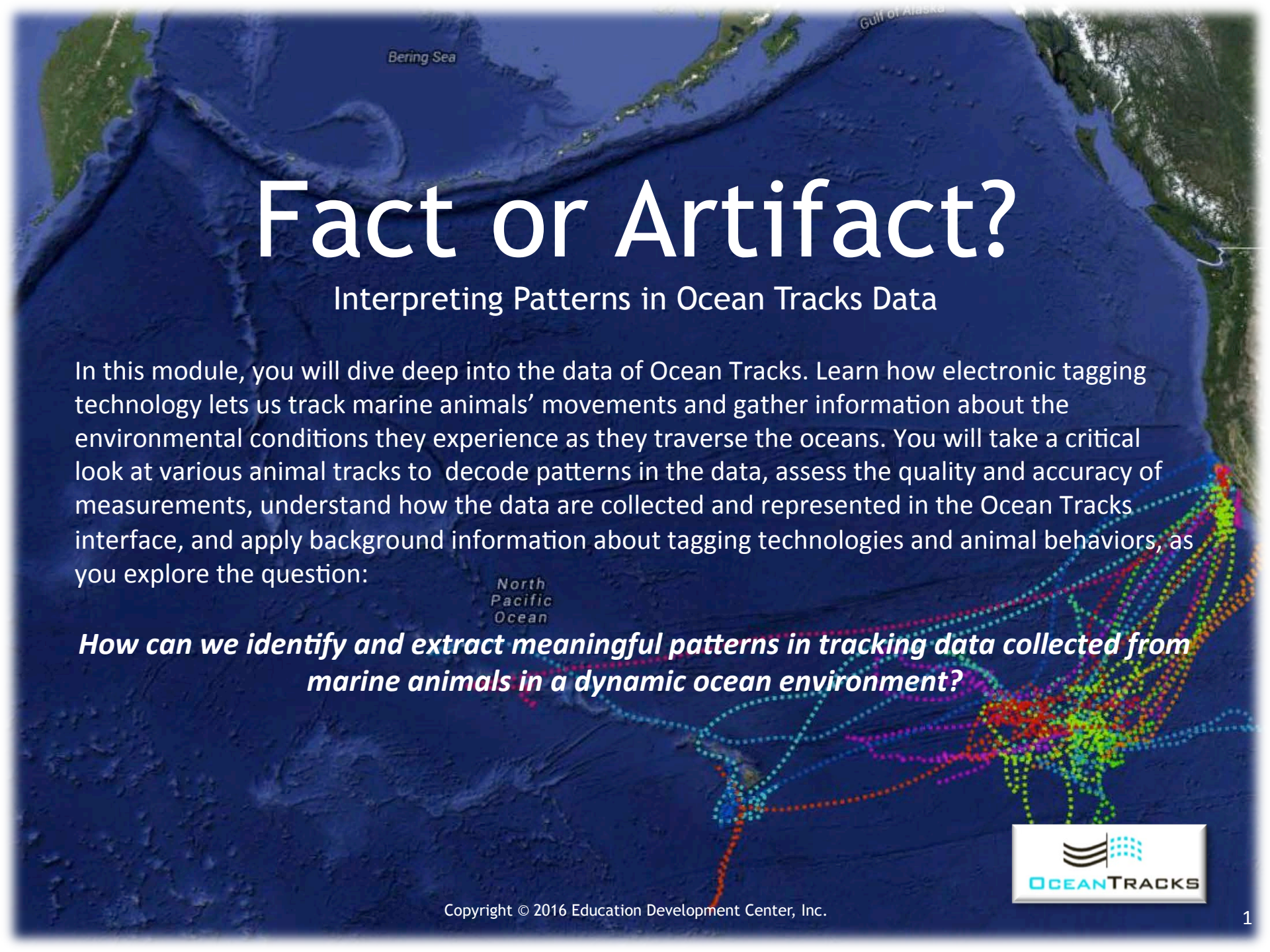


Fact or Artifact?

Interpreting Patterns in Ocean Tracks Data

In this module, you will dive deep into the data of Ocean Tracks. Learn how electronic tagging technology lets us track marine animals' movements and gather information about the environmental conditions they experience as they traverse the oceans. You will take a critical look at various animal tracks to decode patterns in the data, assess the quality and accuracy of measurements, understand how the data are collected and represented in the Ocean Tracks interface, and apply background information about tagging technologies and animal behaviors, as you explore the question:

How can we identify and extract meaningful patterns in tracking data collected from marine animals in a dynamic ocean environment?

OCEANTRACKS

Anatomy of an OT-CE Module

All Modules have 3 main sections:

Engage

Engage discussions and activities are meant to pique your interest, spark curiosity, & set the stage for your exploration by introducing a challenge/research question for the entire module.

Explore

Explore activities help you build data skills and gather the information and images you will need to complete the Synthesize assignment at the end of the module. Responses to Explore questions may be collected by your instructor.

Synthesize

Synthesize assignments help you pull together and share what you've learned throughout the module. Activities may include writing assignments, presentations, or other "projects" to turn in.

Some Modules may also include:

Pre-Lab Assignment

Pre-lab assignments are to be completed before you begin a module in class/lab. They provide background information needed to complete the module and/or context for how the module connects to other content in your course.

Extend

Extend activities offer additional opportunities to extend your knowledge and apply what you've learned to new situations. Your instructor will let you know if an Extend activity is a required part of your assignment.

OCEANTRACKS

Staying On Track

KEEP TRACK OF YOUR WORK

Throughout the **Engage** and **Explore** sections, you may be asked to take notes, answer questions, and/or save screenshots. It is strongly suggested that you create a "notebook" to write things down and a folder on your computer or in the cloud to store images.

NOTEBOOK

Your notebook can be an actual paper notebook or an electronic document. It will be a valuable (and time-saving) resource for keeping track of what you learn and for preparing your final **Synthesize** assignment at the end of the module. Your instructor will let you know if and when you are expected to turn in your notebook for review.

SCREENSHOTS

When asked to save screenshots, save all images in one location where you can easily find them later. Name your image files in a way that makes them easy for you to identify. If you've never taken a screenshot before or need a quick refresher, check out http://www.take-a-screenshot.org/. If you decide screenshots just aren't your thing, you can also snap a photo with your phone or camera.

Engage

Ever wonder where marine animals go? How fast they swim? How deep they dive? Electronic tagging has opened a new window into the world of the open ocean. Ocean Tracks gives you access to data collected by real, live, migrating marine animals, drifting buoys, and satellites, along with tools that allow you to display and analyze these data to investigate current and important scientific questions about how these animals interact with the ocean environment.

TELLING STORIES WITH DATA

Tracking data can be a powerful tool for helping scientists tell stories about marine animals' migratory behaviors and what influences the ocean environment might have on the animals' movements. However, it is important to remember that there are limitations to what we can conclude from the data alone.

Learning Objectives

- Recognize how animal movement is represented in the Ocean Tracks interface
- Relate track features to data collection techniques and technologies
- Identify and extract meaningful patterns in tracking data
- Critically evaluate data/ limitations of data

Interpreting data requires a critical eye. Animals can be unpredictable. Technology isn't perfect. Data processing can sometimes introduce **artifacts** (false signals in the data). These are just a few things to keep in mind when working with data. In this module, you will learn valuable techniques for separating fact from artifact, as you investigate the question:

How can we identify and extract meaningful patterns in tracking data collected from marine animals in a dynamic ocean environment?

OCEANTRACKS

Engage

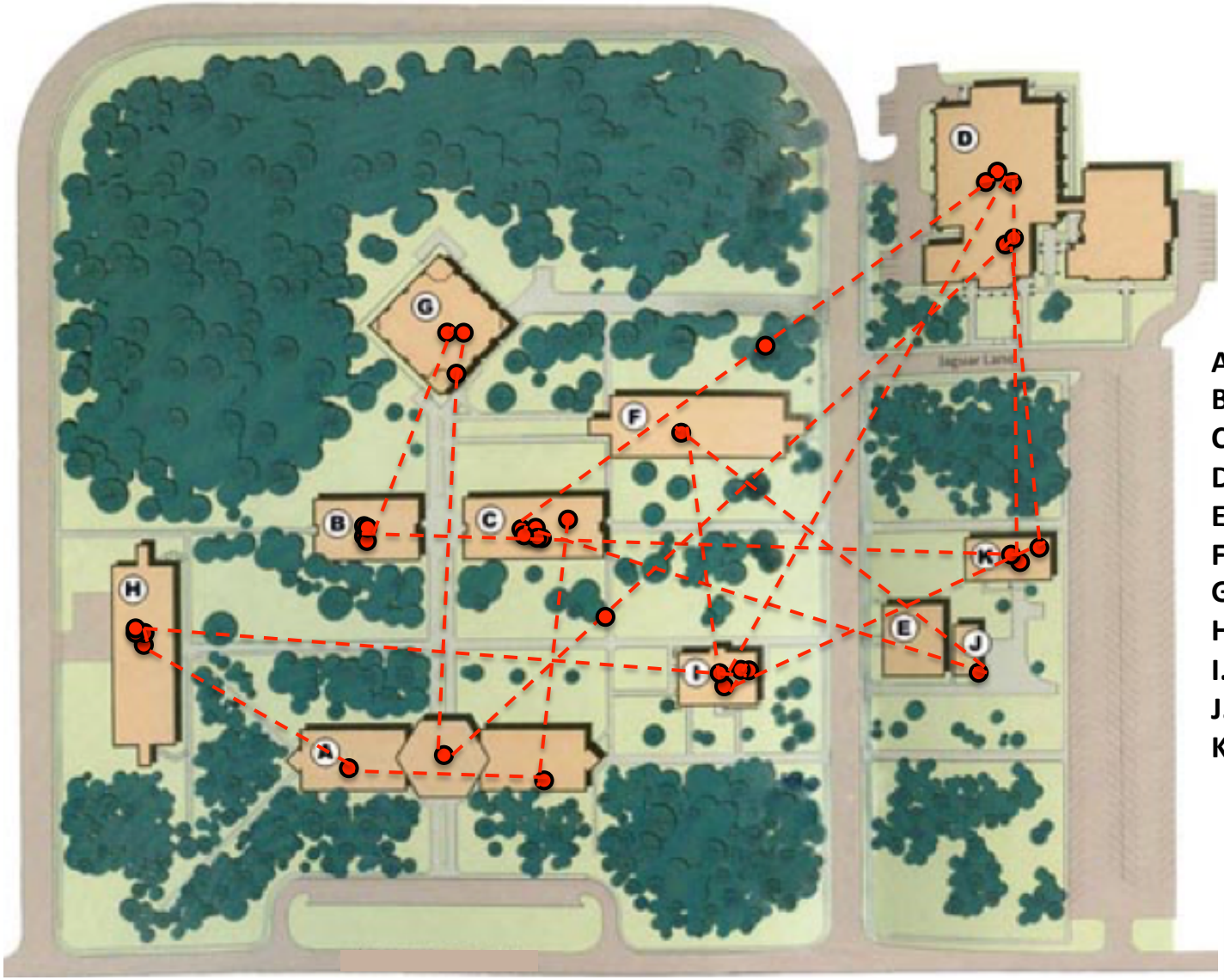
WHAT WOULD YOUR TRACK LOOK LIKE?

If you were wearing a location tracker, what would a map of your movements look like over the course of a day? A week? A year? What patterns would you see in the data? What stories could you tell with that data? How close to reality would those stories be?

CLASS DISCUSSION:

Look at the campus map on the next slide showing the location of a college student, Jane, every 30 minutes for just over a day. As a class, discuss the following questions:

1. What parts or features of the track (if any) don't seem to make sense?
2. How accurately do you think this simplified representation depicts what Jane was doing?
3. What can you infer about what Jane was doing at each point along her path?
4. What other information would help you tell a more complete story?
5. How might the track look different if:
    - you increased or decreased the time resolution (i.e., location was plotted every 5 minutes or every 4 hours instead of every 30 minutes)?
    - you tracked this student during a vacation week rather than a regular school week?
    - Jane accidentally left her tracker in her dorm room for a few hours?



A. Student Union
B. Theater Bldg.
C. History Bldg.
D. Dorm
E. Math Bldg.
F. Science Bldg.
G. Gym
H. English Bldg.
I. Library
J. Coffee Shop
K. Dining Hall

OCEANTRACKS

Explore

In this section, you'll explore tracks of several marine animals using the Ocean Tracks interface. One of the most important things to ask yourself when looking at data is, "*Does this make sense?*" Sometimes you will immediately know the answer and other times you might have to investigate further to find out. Your challenge is to take a critical look at these tracks to learn how to identify and extract meaningful patterns from the data.

PART 1: HOW ARE MARINE ANIMALS TAGGED AND TRACKED?

When you collect your own data, you already know a lot about how those data were collected—what methods you used, the accuracy of the instruments, and what technical malfunctions (if any) may have occurred, to name a few. When using data collected by someone (or something) else, you might need to do a little background research to find that information. Before we dive into the Ocean Tracks data, it's important to understand where the data come from and how they are displayed in the Ocean Tracks interface, so you can better discern data patterns and identify potential errors in data sampling and processing.

- Watch the video *From Tags to Tracks* http://oceantracks.org/library/tags/from-tags-to-tracks/
- Make a table like the one below to record information about the accuracy of the tagging technologies used to track the marine animals in the Ocean Tracks interface.
- As you watch the video, pay special attention to how each is animal tagged and how their movements are represented as data points on the Ocean Tracks map.

Tag Type	Animals Tracked	Accuracy
Satellite Telemetry Tags		
Archival Tags		

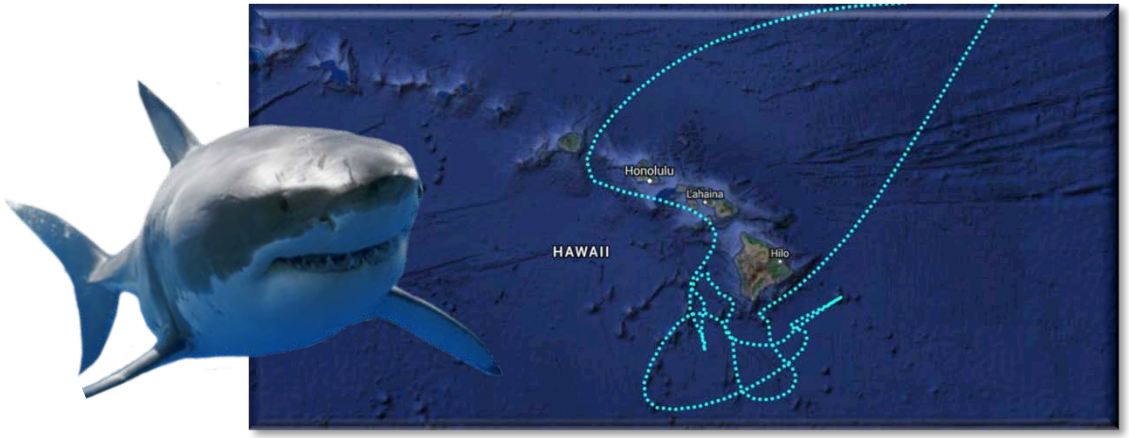
More information about how each species is tagged and tracked is available in the **Ocean Tracks Library:** http://oceantracks.org/library/species/

Explore

PART 2: LAND SHARK

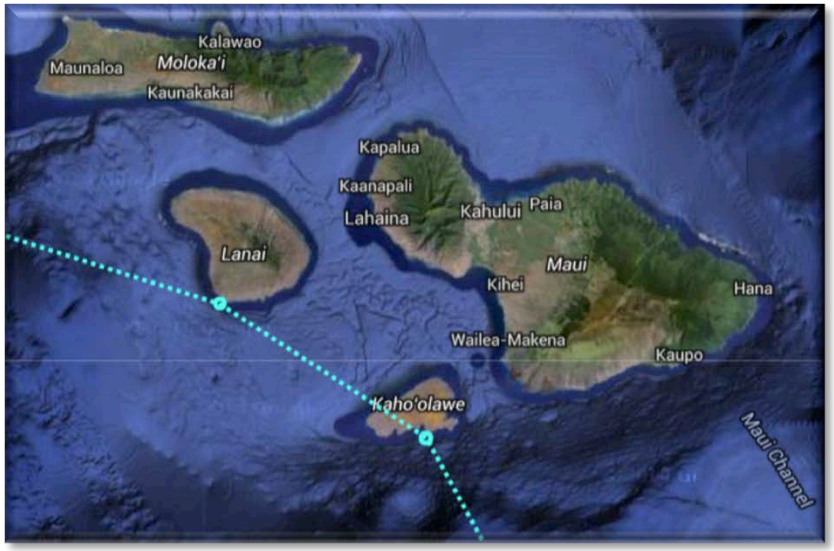
Tracks plotted on the Ocean Tracks map, like the one shown below, are simplified representations of what animals were actually doing during the time they were being tracked. Sometimes these simplifications result in track features or patterns that don't quite make sense based on what we know about these animals and how they are tagged and tracked. Let's look at an example.

- Go to http://oceantracks.org/map.
- Click on the **Data and Tools** tab.
- Use the "+" to expand the **Tracks** menu and the **White Shark** tracks.
- **Show** and **Graph** the track for White Shark #502800. NOTE: You may want to turn off the default track (Elephant Seal #302) so that only the white shark track appears on the map.
- Click **Show Animal Movement** in the **Tools** menu to animate the track on the map. Look for patterns in the track that might tell you something about what the shark is doing along its journey. For example, you might look for sections of the track that are particularly straight/curvy or where the shark is traveling faster/slower.



Explore

- Zoom in and explore the shark's path around the Hawaiian Islands and find where the shark appears to travel over land.



EXPLORE PART 2 QUESTIONS

1. *What patterns did you see in the shark's track? What inferences can you make about the shark's behavior from these patterns?*

2. *How strongly do the data support the idea that White Shark #502800 actually traveled over land? (HINT: Revisit the **From Tags to Tracks** video or the **Ocean Tracks Library** if you're stumped.)*

3. *Provide an alternative explanation for why the shark appears to cross land.*

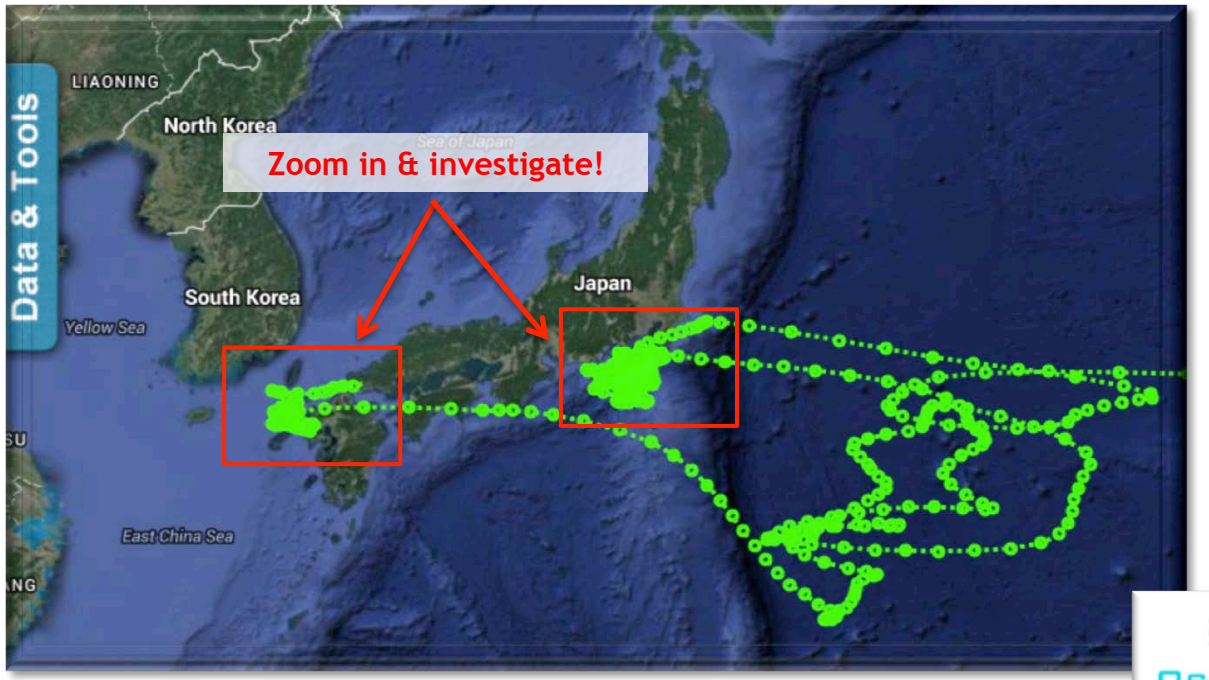
4. *What types of additional Ocean Tracks data could you use to evaluate whether or not White Shark #502800 actually traveled over land?*

Explore

PART 3: INTERPRETING INTERPOLATION

As you've just seen, sometimes the average daily positions and track paths represented in the Ocean Tracks interface don't quite match our expectations and intuitions for how animals behave. In this section, you will further explore the accuracy in tracking data using bluefin tuna track #506600.

- **Show** and **Graph** the track for Bluefin Tuna #506600.
- Zoom in and explore the tuna's track around the coast of Japan.



Explore

- Make and complete a table like the one below to document and explain four features of bluefin tuna track #506600 that potentially don't make sense as realistic patterns of movement for a living tuna. Some cells in the table have already been filled in as examples to get you started.

Date Range	Location	Track Feature	Possible Explanation	Evidence	Alternative Explanation
7/2/2007-7/7/2007	Near Sasebo, Japan	Track goes sharply inland.	The land crossings are probably processing artifacts. It's likely the tuna was swimming close to shore in Sasebo Bay, within the accuracy limits of average daily position estimates from the tracking technology.	Daily position estimates from archival tags have latitude and longitude margins of error of roughly 100 km and 200 km respectively.	
6/17/2007-6/19/2007					
		Jagged, sharp angled track			
		Track ends on land			

Explore

EXPLORE PART 3 QUESTIONS

1. *Describe at least two things you feel pretty confident you are able to say about the behavior of the tuna from examining this track.*

2. *What questions does this track raise for you about what the tuna is doing at different points along the track?*

3. *What additional information would be useful for making a more complete interpretation of the tuna's actual path around the coast of Japan?*

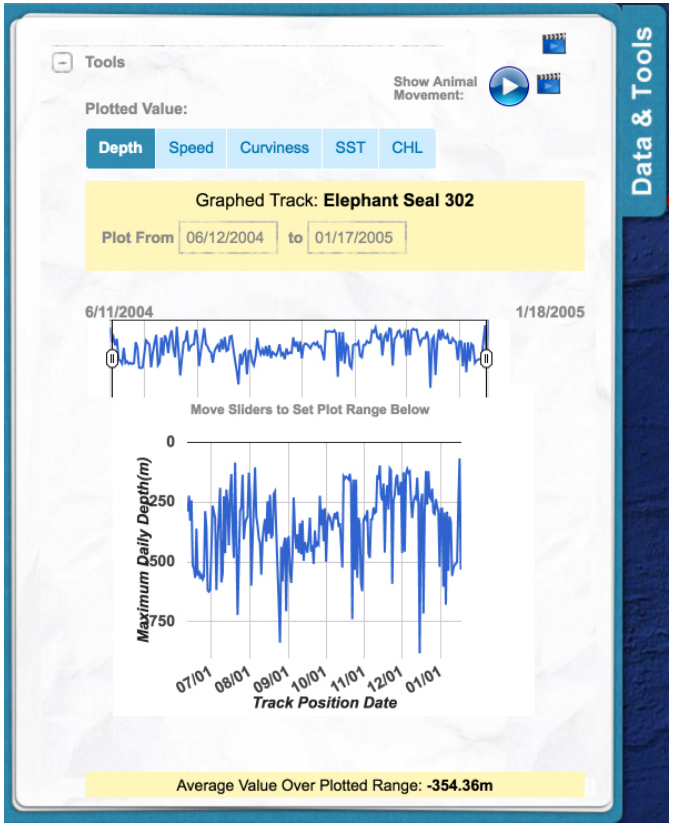
Explore

PART 4: DIVE DEEPER INTO OCEAN TRACKS DATA

Map displays aren't the only way to explore data in the Ocean Tracks interface. Under **Tools,** you can graph additional data parameters like Speed, Depth, and Curviness and ocean conditions the animals encounter along their tracks, like Sea Surface Temperature (SST) and Chlorophyll concentration (CHL).

In this section, you'll use these data to look for meaningful patterns and to investigate and evaluate the validity of **outliers** (observation points that are abnormally distant from other data points).

- **Show** and **Graph** the track for Bluefin Tuna #704500.
- Click the "+" to open **Tools**.
- Carefully examine the **Depth** data. Move the sliders to see how the graph looks for different time intervals. Look for patterns that tell you something about the tuna's behavior as well as outlier values or patterns in the data that don't make sense based on what you know about tuna.



Ocean Tracks graphing tool showing depth data for Elephant Seal #302.

Explore

EXPLORE PART 4 QUESTIONS

1. *Based on the depth graph, how would you describe the "typical" diving behavior of this tuna?*

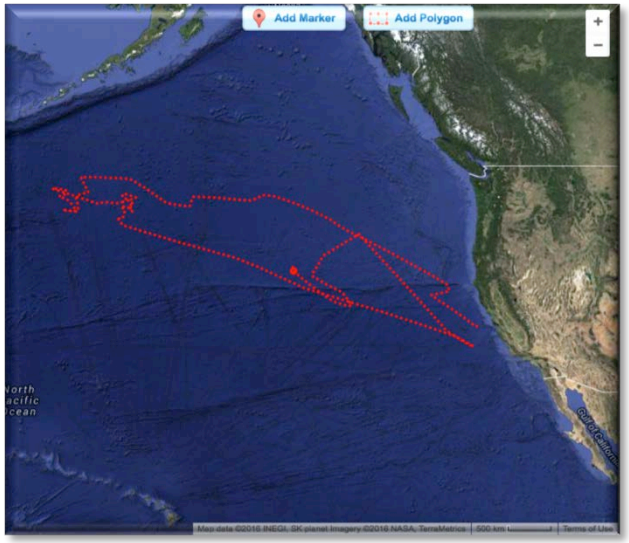
2. *Which sections of the track seem inconsistent with the expected diving behavior of this bluefin tuna (e.g., what sections contain potential outliers)? Consider both the depth and time scales when interpreting the graph. You might also want to revisit the* ***Ocean Tracks Library*** *(http://oceantracks.org/library) to learn more about typical tuna behavior. What is a possible explanation for these inconsistencies? Be sure to include date ranges and depth values as evidence in your response.*

3. *Rewrite the claim below using a different time interval so that the claim is more strongly supported by the depth data. Explain why you chose that time interval.*

   CLAIM*: "Bluefin tuna #705400 was tracked from 12/15/2007 to 7/17/2008. Over this time period, the tuna's average maximum daily depth was 270.71 meters below sea level."*

Explore

PART 5: MORE THAN ONE WAY TO LOOK AT DATA



As you saw in Part 2, the **Show Animal Movement** animation tool can be particularly useful for finding patterns in animals' movements. It can also help identify sections of the track that might be worth further investigation. Let's use this tool to see what we can learn about Elephant Seal #1266.

- **Show** and **Graph** the track for Elephant Seal #1266.
- Animate the track by clicking the **Show Animal Movement** icon under **Tools**.
- Identify at least 2 track sections you wish to explore in more detail based on patterns that stood out to you in the animation. Watch the data tracker in the upper right corner of the screen while the track is animated or click on individual track points to narrow down the date ranges for the track sections you want to explore in more detail.
- Examine the graphs for Speed, Depth, and Curviness under **Tools**. (NOTE: If you are unfamiliar with curviness, you can learn more about it here: http://oceantracks.org/library/the-curviness-tool/)

Explore

- Make and complete a table like the one below. First, fill in the missing information in row 2 for the track feature identified between 9/25/2007 and 10/27/2007. Then fill in rows 3 and 4 with data for the track sections you identified for further investigation.

Date Range	Location	Track Feature	Possible Explanation	Evidence	Alternative Explanation
1/2/2008-1/23/2008	*West of San Jose, traveling northwest toward open ocean west of Bend, OR.*	*Track appears to "jump ahead" more than 20 days between track points.*	*Electronic tag on the seal temporarily stopped working.*	No speed, depth, or curviness data for 1/3/2008-1/22/2008	*Elephant seals wear Satellite Relay Data Logger (SRDL) tags, which transmit data through the Argos satellite. The satellite may have been experiencing technical difficulties during this time.*
9/25/2007-10/25/2007		High level of curviness over an extended period of time.			

Explore

EXPLORE PART 5 QUESTIONS

1. *Hypothesize and draw (on a screenshot or in your notebook) what you think the seal's actual track might have looked like during the 20+ day "jump" from 1/02/2008 to 1/23/2008 (e.g., How far does the seal typically travel in that amount of time in other parts of the track? What is a typical curviness for this animal? etc.).*
2. *What meaningful patterns about Elephant Seal #1266's behavior were you able to infer from the other track sections you investigated?*
3. *How were you able to distinguish these meaningful patterns from outliers and processing artifacts?*
4. *What additional information would help you tell a more complete story about the seal's activity along this track?*

Synthesize

The tracks you explored throughout this module demonstrate that tracking data can help us learn a great deal about animal behavior, but also highlight the importance of interpreting those data with a critical lens rather than just accepting them as "fact."

SYNTHESIZE QUESTIONS

1. *Summarize patterns you've seen in the Ocean Tracks data that might not make sense. What artifacts will you look for in the data as you do other Ocean Tracks modules (and other data analysis activities)?*
2. *How do the tracks in Ocean Tracks resemble the actual movements of marine animals? Give two or more examples of the types of things you can you learn about these animals from the data available in Ocean Tracks?*
3. *Give two or more examples of ways in which the tracks differ from the actual movements of marine animals? What are some questions this module raised for you about the animals' behaviors?*

CLASS DISCUSSION

As a class, discuss your answers to the Synthesize Questions above. Also, think about the challenge question you have explored throughout this module: ***How can we identify and extract meaningful patterns in tracking data collected from marine animals in a dynamic ocean environment?***

You've learned that some things you see in data are meaningful, and others aren't. Describe and discuss some examples of other kinds of data you've seen (outside of Ocean Tracks) that you would need to look at critically and try to understand better to find what is meaningful and what is not.