# What are our motivations for teaching with data?

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Oceans of Data Institute, EDC

**Presented at: Ocean Observatories Initiative (OOI) Teaching with Data Workshop**
**May 20-22, 2016**


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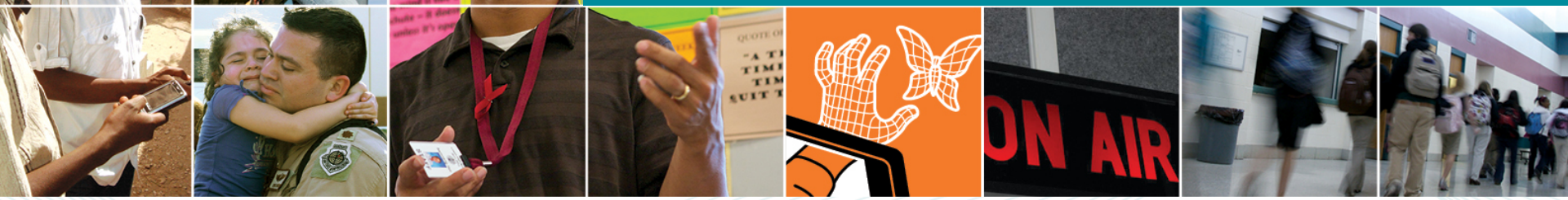
# About EDC


A global nonprofit organization that develops innovative programs to solve some of the world's most urgent challenges in education, health, and economic development

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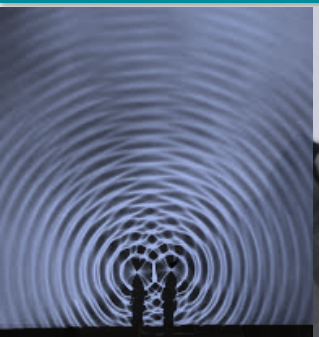
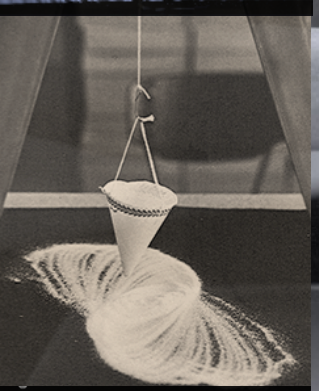
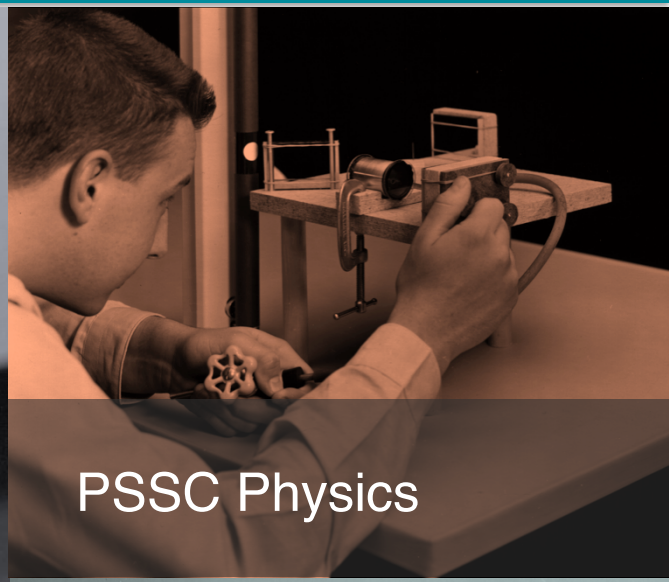
# EDC's history in STEM education





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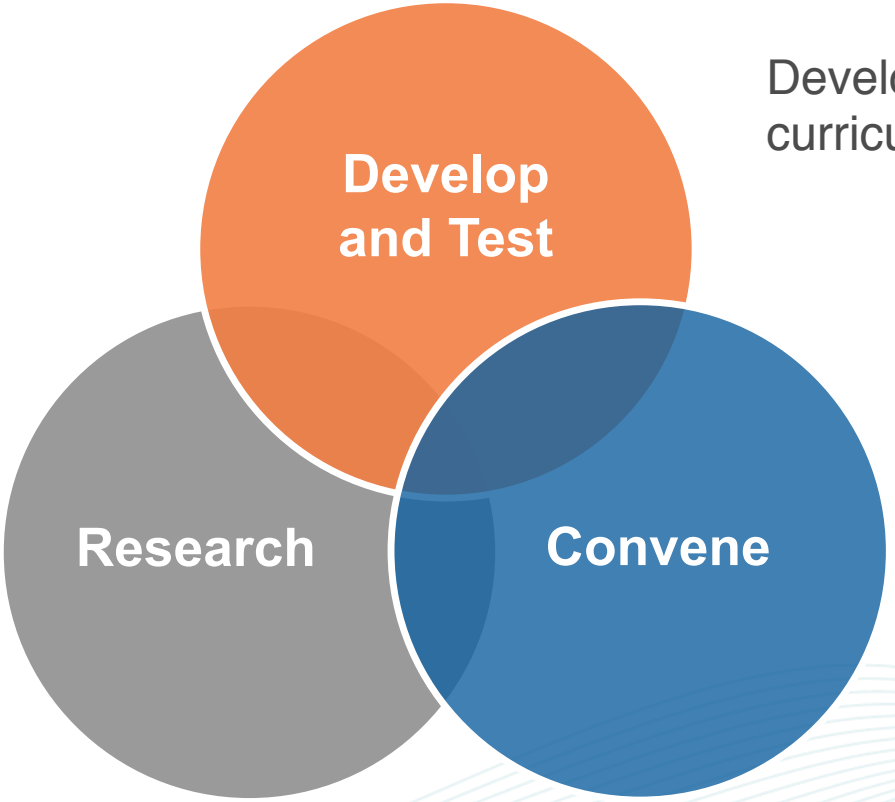
# Oceans of Data Institute:
## Promoting the data literacy of K-16 students




Develop and test curricula and tools

Build a research-based learning progression

Act as a hub for diverse stakeholders

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# Why teach with data?

1. We live in a data-intensive world.
2. The job market demands it.
3. Data literacy is an integral part of learning science.
4. Because we can.

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# 1. We live in a data-intensive world.

**2.5**

**QUINTILLION**

bytes of data are created daily

*Source: "The Big Picture on Big Data," GovCon Exec, Spring 2012.*

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# 2. The job market demands it.


**Get Familiar With Big Data Now—or Face 'Permanent Pink Slip'**

Demand Rises for Analytics Professionals, Data Scientists (2014)

***"Basic skills in working with data that every person should have are not being taught in K-16 schools. Thus, they are lacking at the highest levels in the broad array of professions that are becoming increasingly data-driven."***

Juan LaVista, Principal Data Scientist at Microsoft

"By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the know-how to use the analysis of big data to make effective decisions." (McKinsey Global Institute, 2011)

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# Students recognize the importance of data literacy

The Oceans of Data Institute surveyed 300+ students from community college and university settings:

- 85% of respondents agreed or strongly agreed that the ability to make sense of data is **important to get a good job and will help in their future careers**.

- 90% of respondents agreed or strongly agreed that learning to make sense of data will help them be **more effective and informed citizens.**

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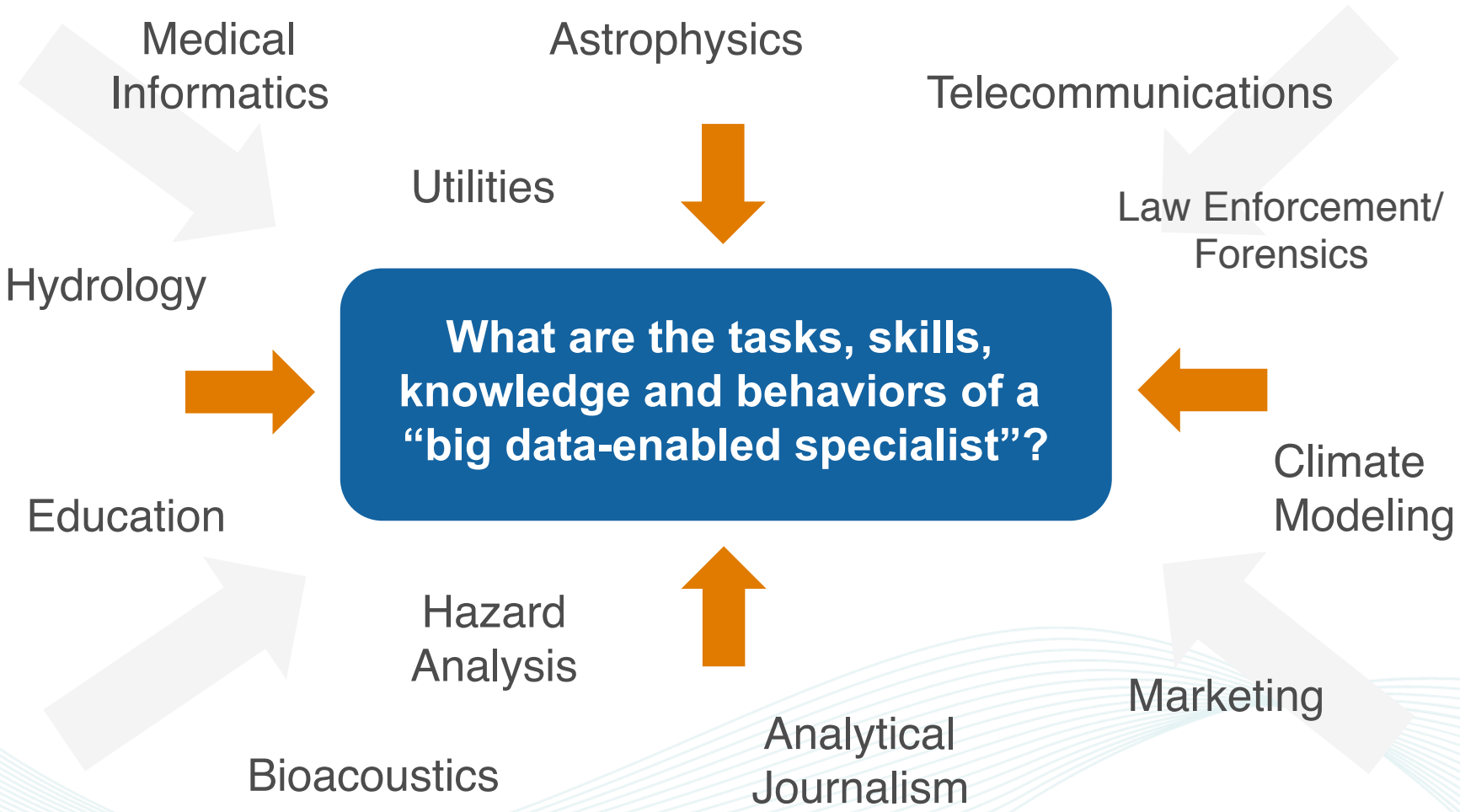
# Developing an Occupational Profile

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# What are the knowledge, skills, and behaviors of a "big data-enabled specialist"?

As identified by an expert panel of big data users, and verified by ~150 big data users:

**Knowledge:**

- Analytic Thinking (89%)
- Algorithms (76%)
- Data Modeling (70%)
- Data Structures (70%)
- Best Practices (69%)
- Statistics (69%)

**Skills:**

- Analytical Thinking (96%)
- Critical Thinking (84%)
- Problem-solving (75%)
- Applying Statistical Methods (74%)
- Data Manipulation (70%)

**Behaviors:**

- A problem solver (89%)
- A lifelong learner (78%)
- Willing to question (78%)
- A seeker of patterns (67%)
- Open-minded (67%)

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# 3. Data literacy is an integral part of learning science

"Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential."

*Next Generation Framework for K-12 Science Education, NRC 2011, p. 2-3*

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# Using data helps develop key problem-solving skills and increase relevancy of science content.

Use of authentic scientific data in classrooms enables students to engage in learning activities that are more deeply inquiry-based and enable higher development of problem-solving skills, address more complex concepts, and offer greater relevance to students' lives than traditional learning activities.

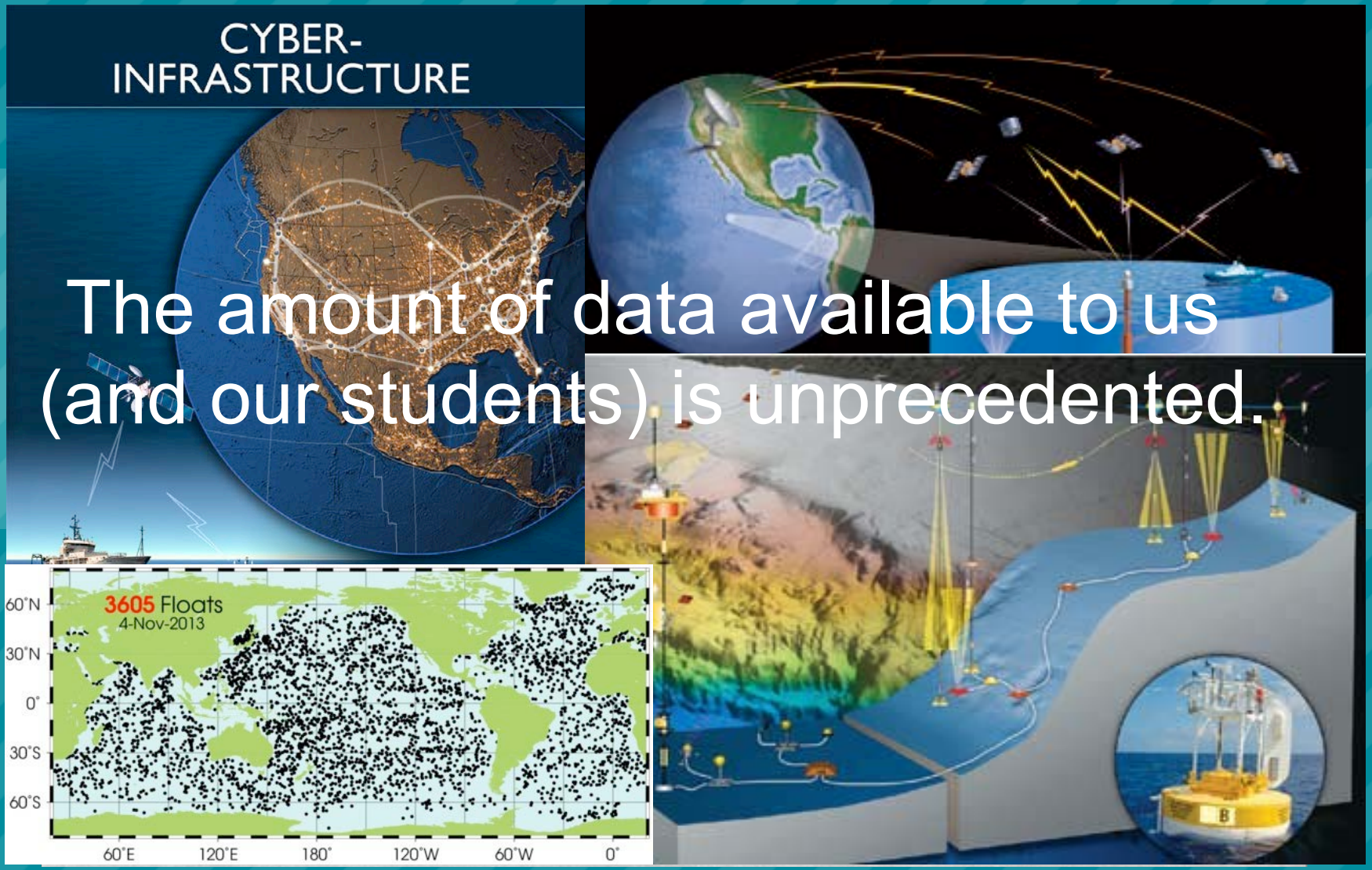
*(Hotaling, 2005; Parsons, 2006, Simmons, Wu, Knight, & Lopez, 2008)*

# Using data will help students gain a deeper understanding of content.

There is now considerable evidence that knowledge acquired by students via simply “taking in” or memorizing information is fragile and can be superficial. To build a more robust and enduring understanding of content, students in science classrooms need to actively engage with new information, connecting and applying concepts as they construct scientific explanations for observed phenomena.

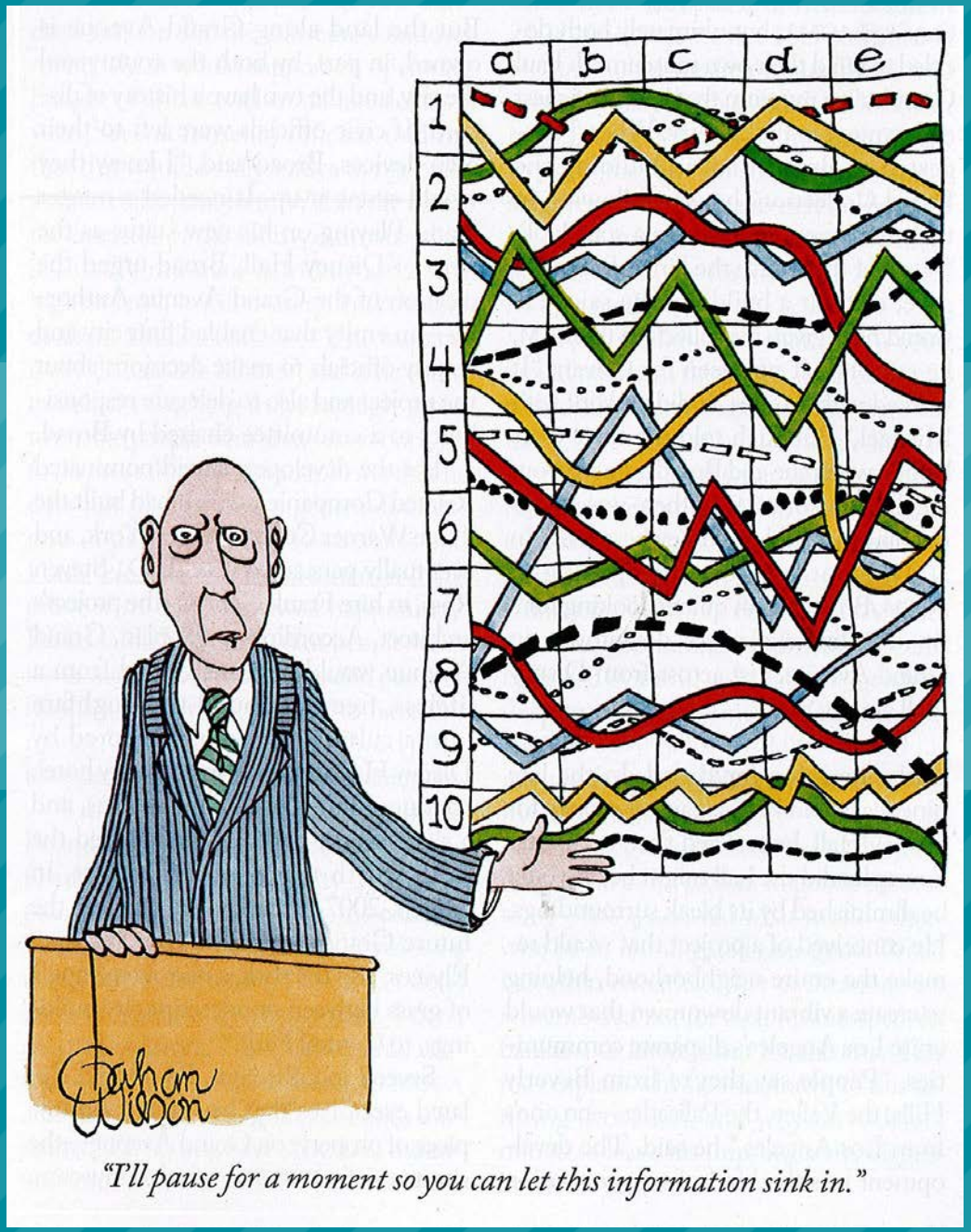
*(NRC, 2000, 2012)*

# 4. Because we can.




The amount of data available to us (and our students) is unprecedented.

**Building students' skills in working with large, complex datasets is important, but challenging.**




*"I'll pause for a moment so you can let this information sink in."*

Source: *The New Yorker*, December 6, 2010.

# What are some of those challenges?

- **Schools (K-16) aren't currently developing students' data-using skills**, particularly those skills necessary to work with large, complex data sets.
- **Very little research** has been done that tells us how to develop these skills.
- **Limited awareness** of the importance of ramping up the teaching of these skills.

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# What's different about "big" data sets?

***C**omplex* – include different types of data, collected different ways

***L**arge* – there are more data than you need to answer any particular question

***I**nteractive* – you are able to explore the data interactively, comparing different sets of data via a variety of data visualizations

*Professionally-collected* – it was collected by "others" (not the student)

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# Challenging transitions

Embodied, experiential grasp of the natural setting and data collection methods

Metadata

Photo credits: (left) School in the Forest powerpoint, http://www.blackrockforest.org/docs/about-the-forest/schoolintheforest (right) Using a Digital Library to Enhance Earth Science Education, Rajul Pandya, Holly Devaul, and Mary Marlino)

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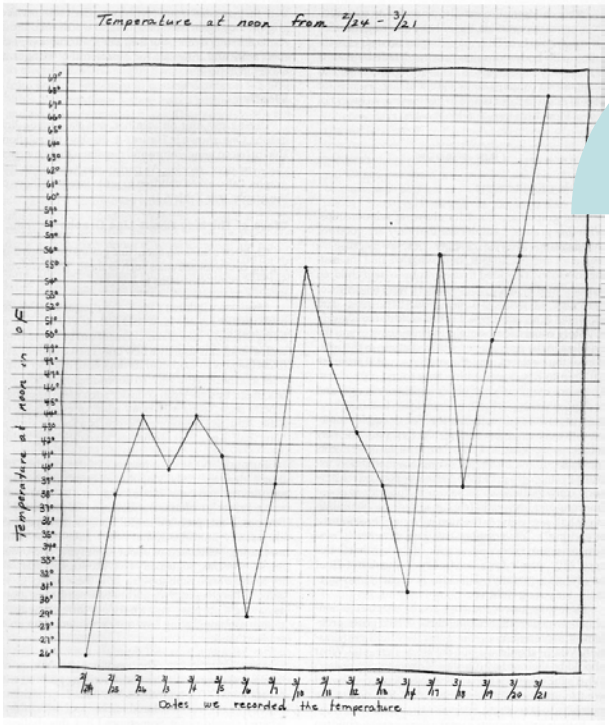
# Challenging transitions

## Dozens of data points




## Petabytes

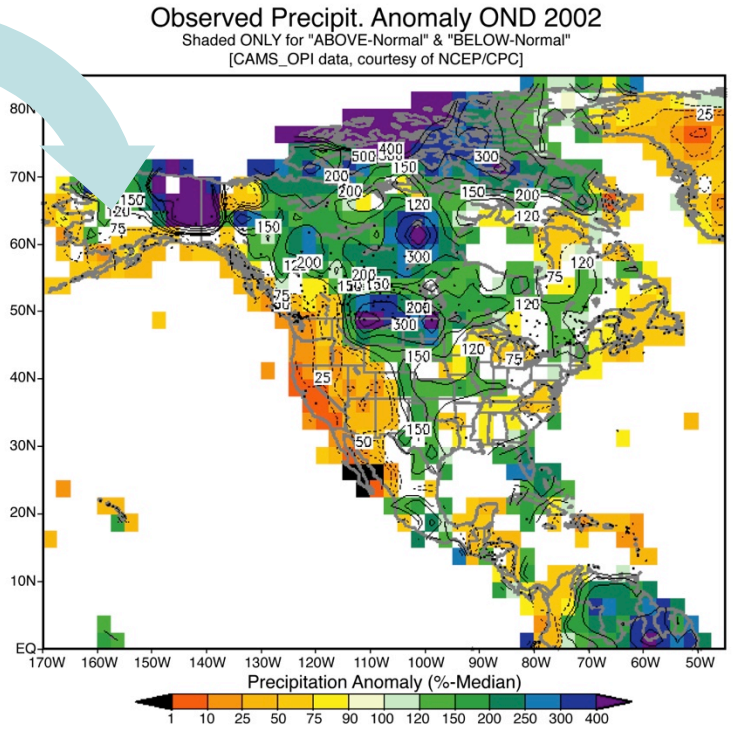



Image credits: (left) from Clement, 2002

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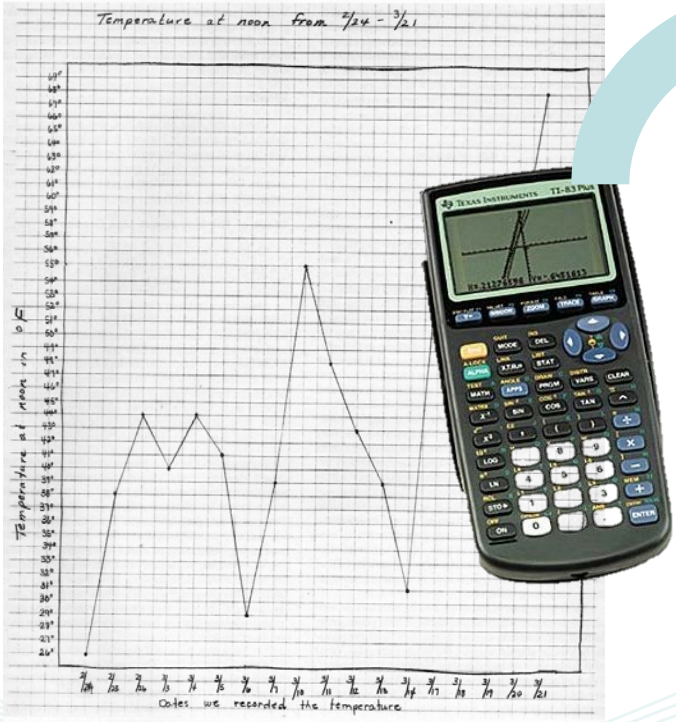
# Challenging transitions

## Simple, transparent tools and techniques




## Sophisticated tools and techniques

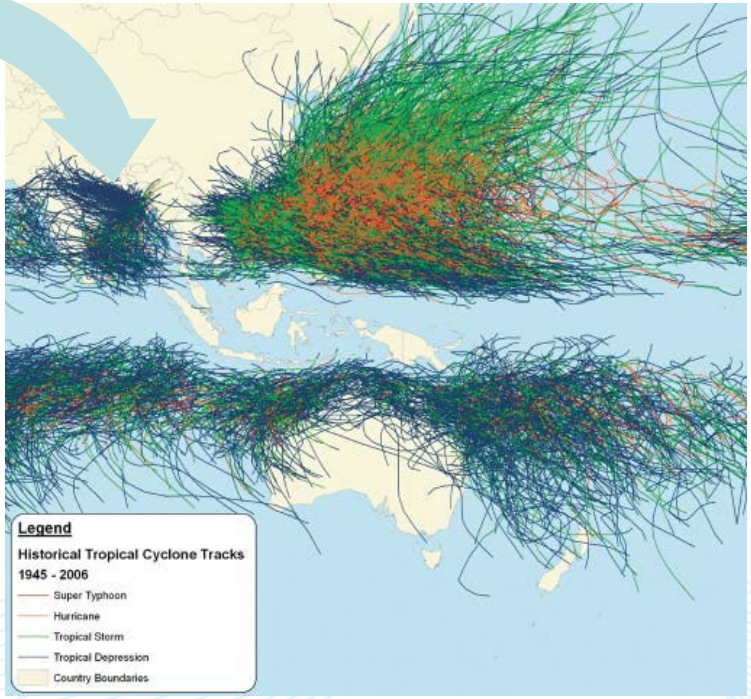



Image credits: (left) from Clement, 2002; (right) http://www.esri.com/library/ebooks/climate-change.pdf

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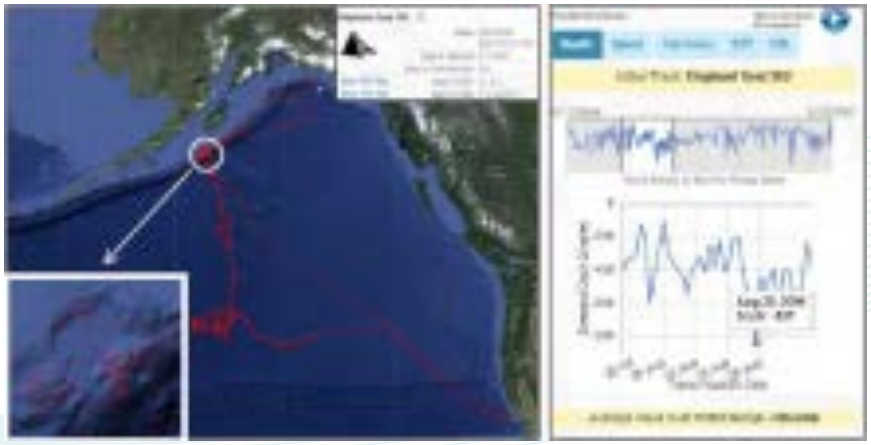
# Other challenges

- Expert data access and data representations may be baffling to students.
- Working with real data can be messy and without clear answers.

# How ODI Approaches Teaching with Data

## OCEAN TRACKS—COLLEGE EDITION

The project is creating an interactive Web-based learning resource to help students at different types of undergraduate institutions develop valuable skills in analyzing and learning from large, authentic scientific datasets. This project is investigating how a learning resource that includes a data interface, set of analysis tools, and curricula can be used to motivate diverse populations of college students to learn and do science with real data, bringing opportunities to engage broad student populations in scientific practice.



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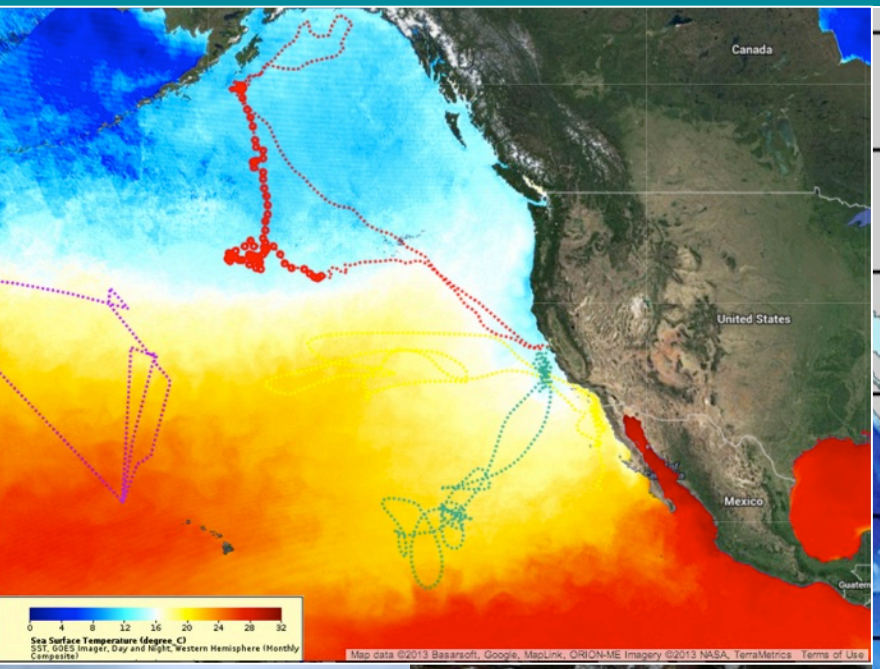
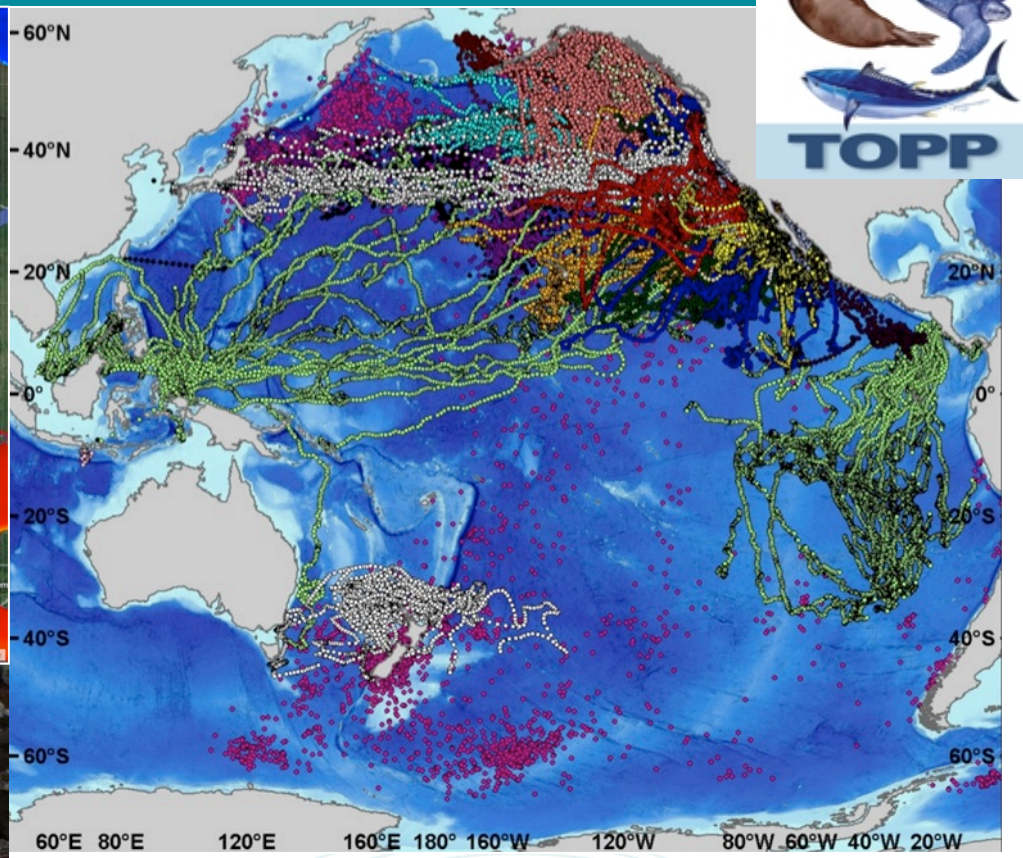
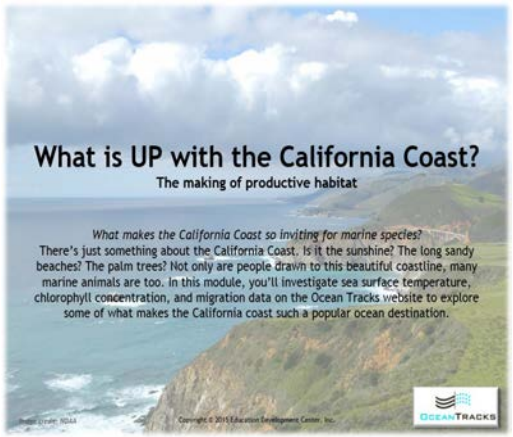
# The Data

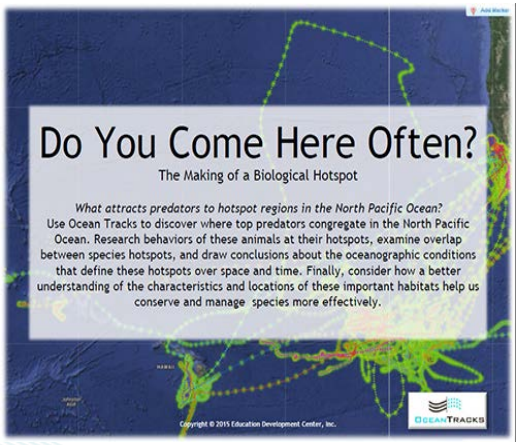


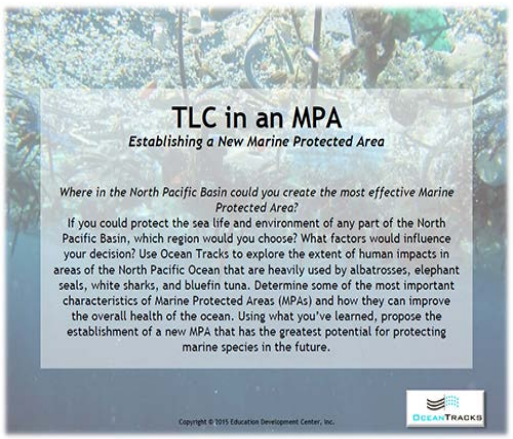

# OT-CE Curriculum Modules







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# OT-CE Data Skills

- Decoding and describing data patterns
- Explaining why a data pattern occurs using background info/content knowledge
- Providing appropriate or relevant data to support a claim or hypothesis
- Providing multiple sources of evidence to support a claim or hypothesis
- Providing reasoning for how data measurements or patterns support a hypothesis or claim, referring to scientific principles or processes
- Generating a hypothesis or claim that addresses a given research question

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# Goals for students

**Explore questions of current scientific interest using compelling data sets.**

- What might influence the movement of marine species?
- Why might movement be affected by oceanographic factors?
- How does the importance of these factors differ across species?
- Can we predict where marine species will congregate in the future, to target for protection?

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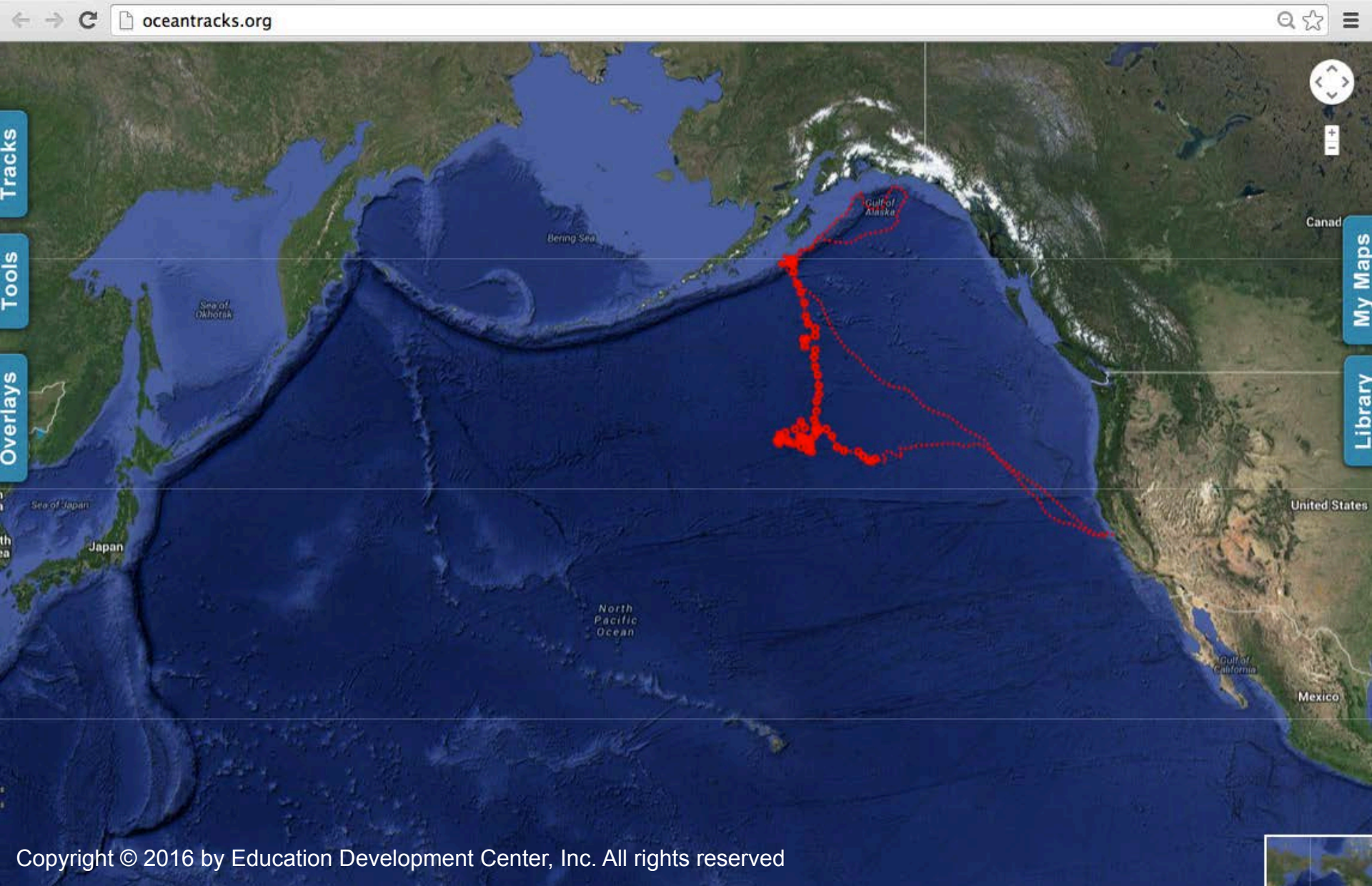
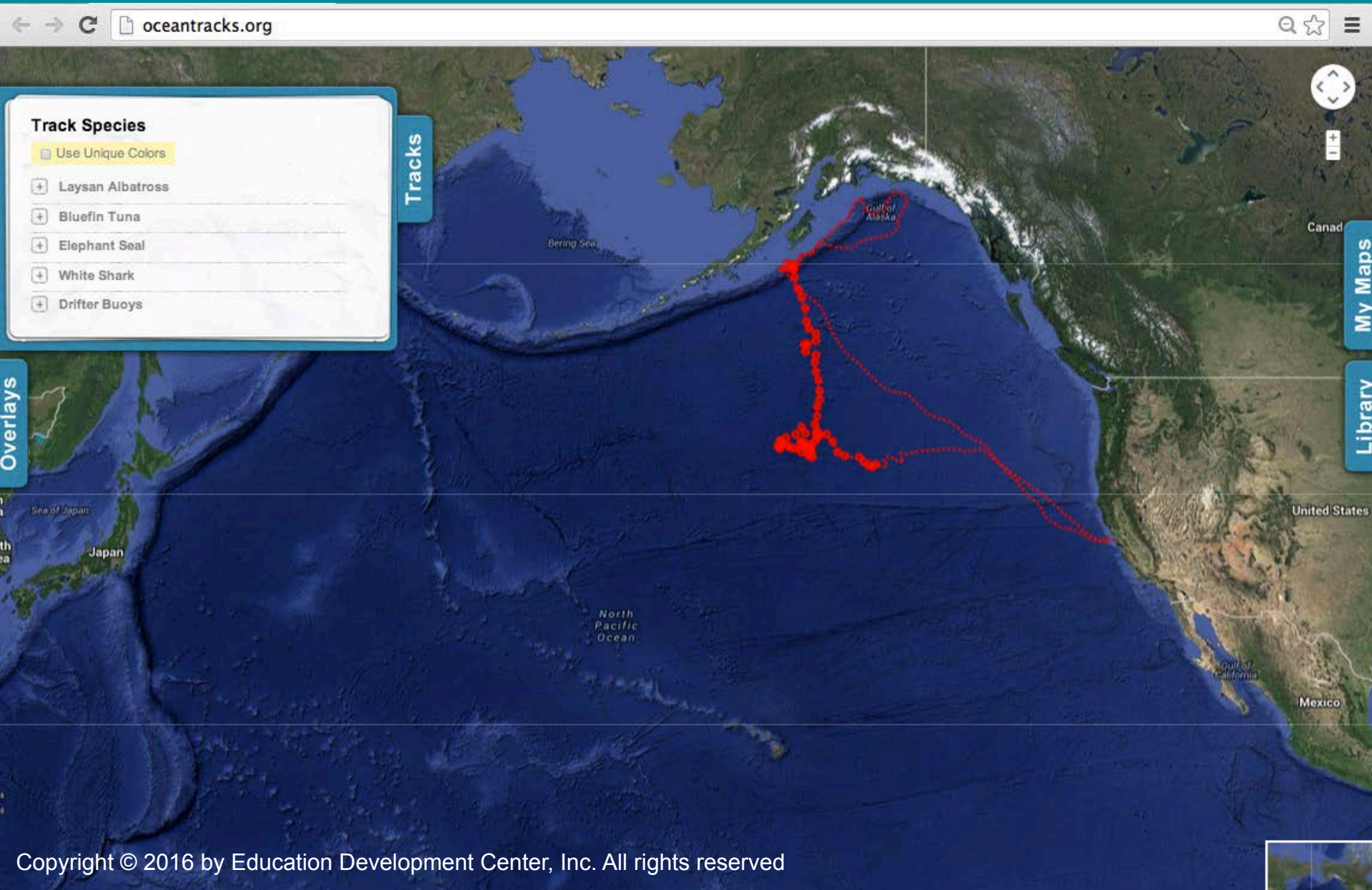
# The Interface



# *Get students quickly to the data*



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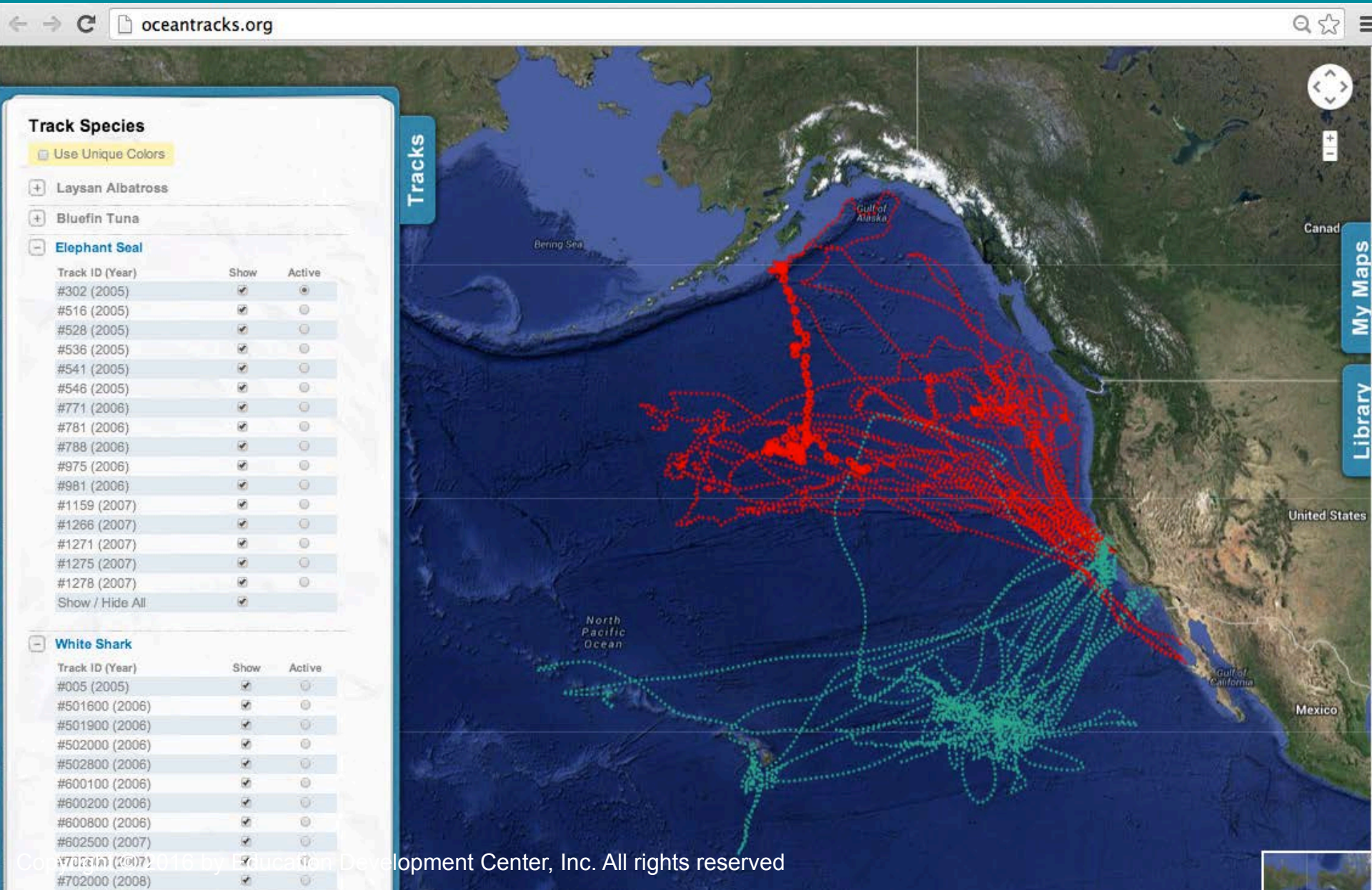
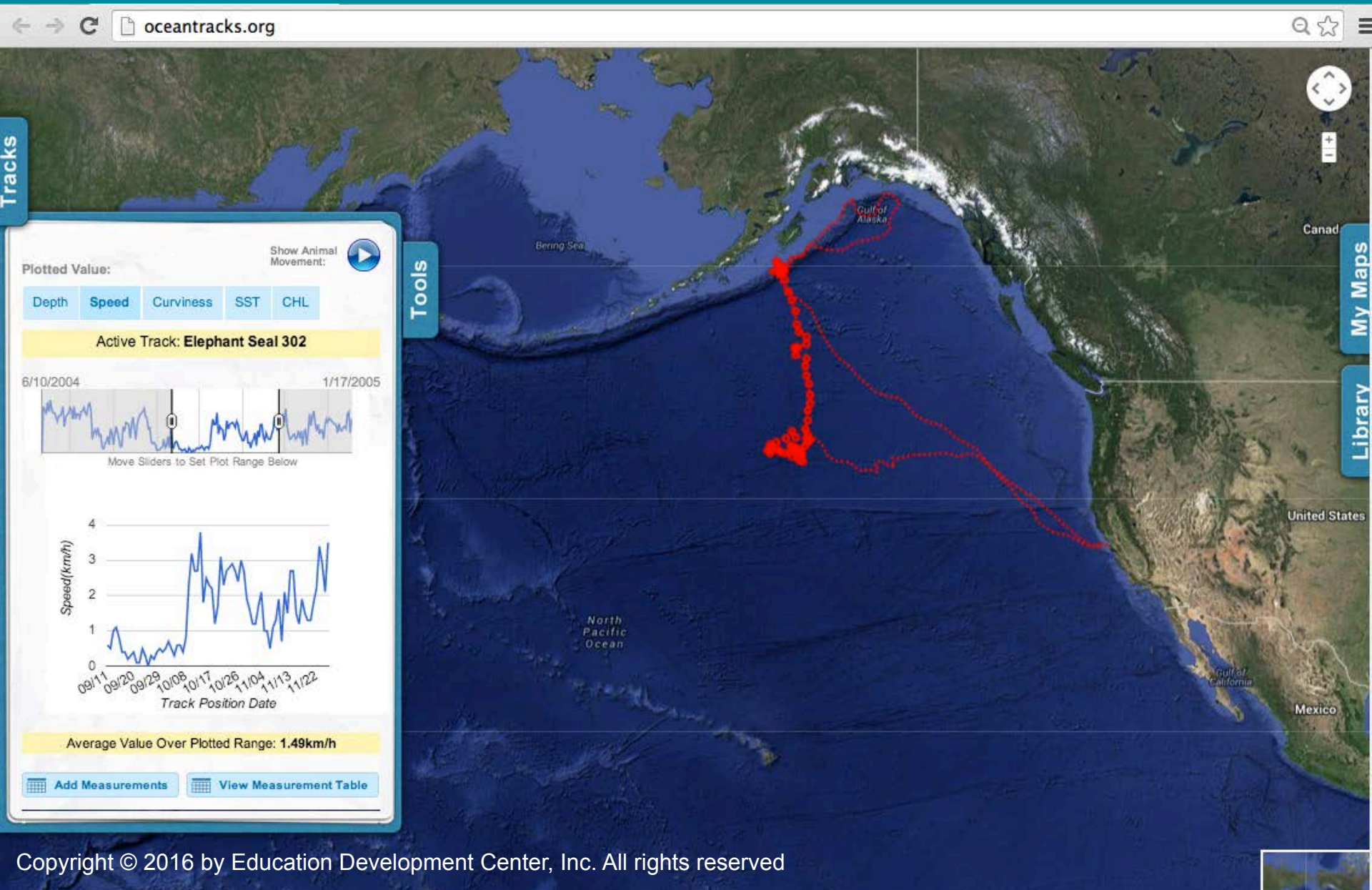


# *Allow them to easily create and interact with data displays*



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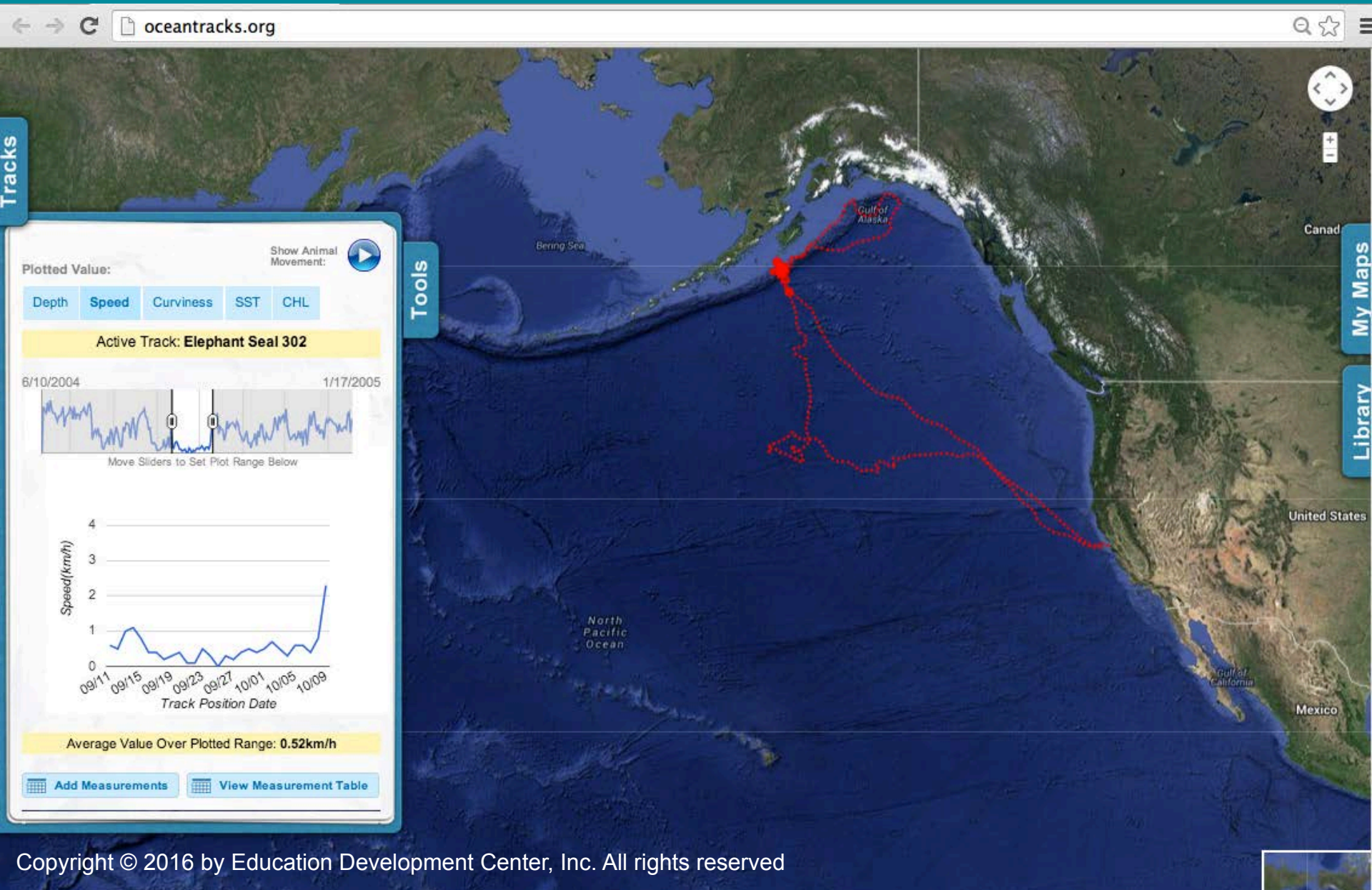

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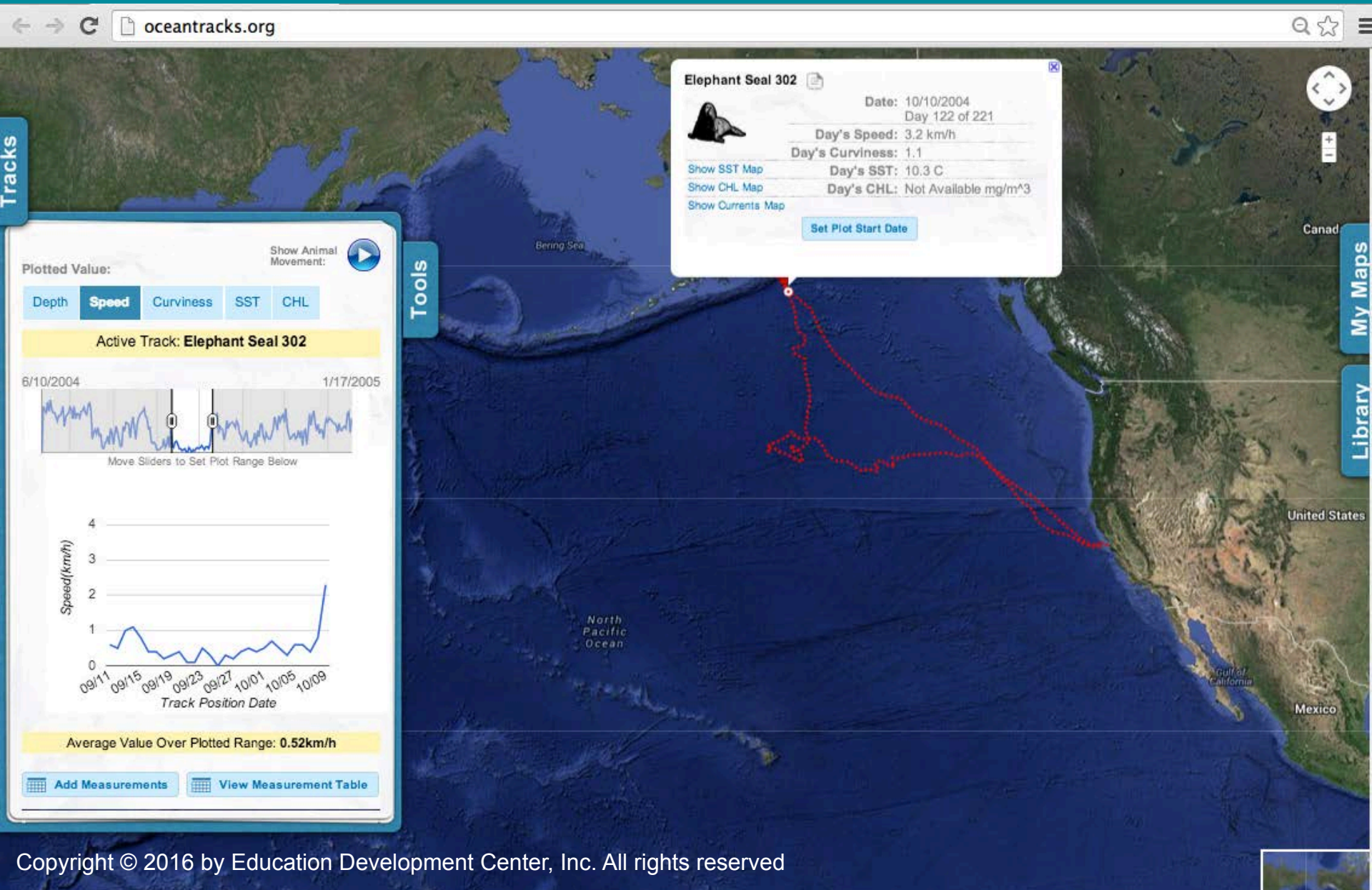

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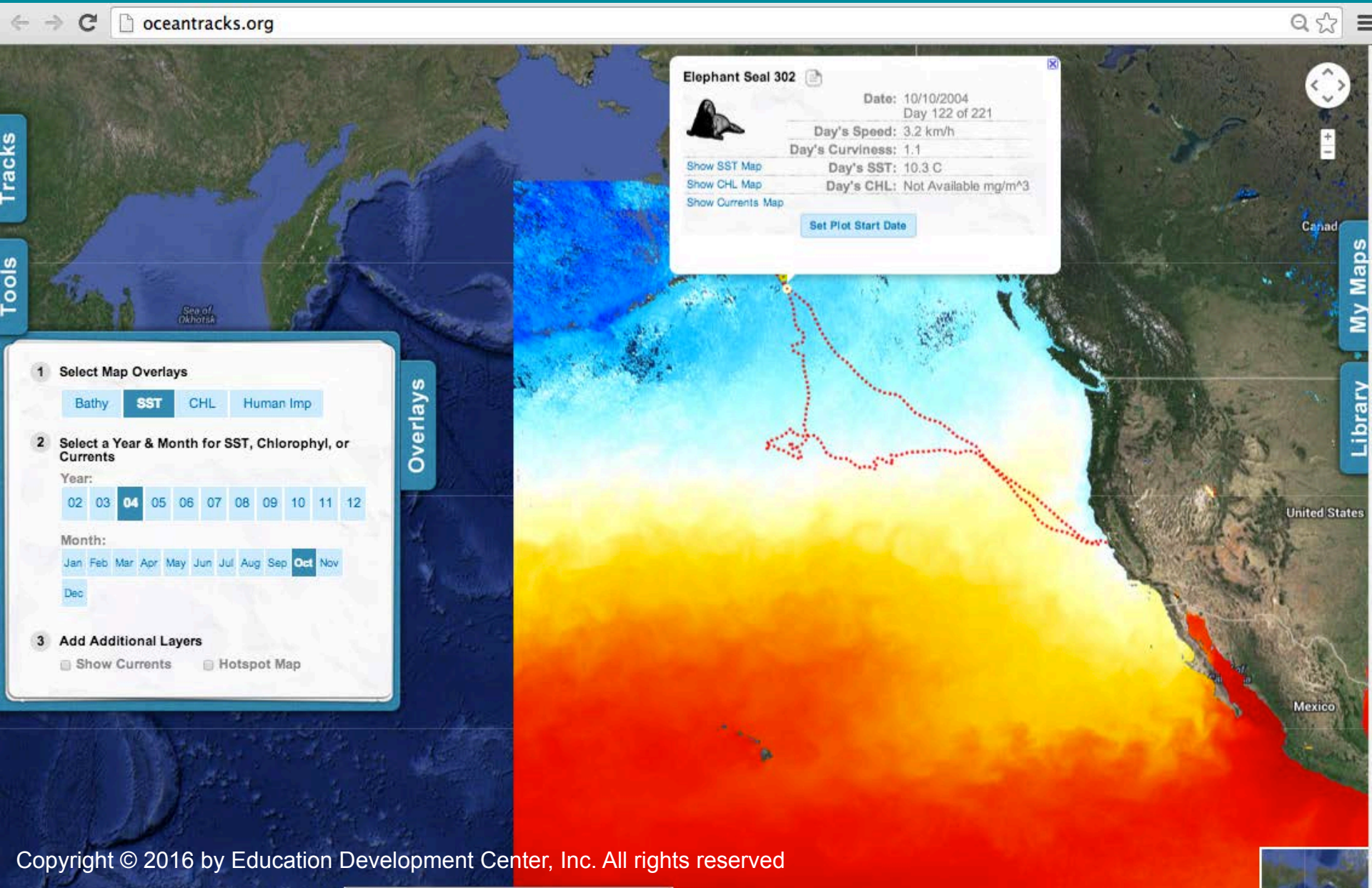
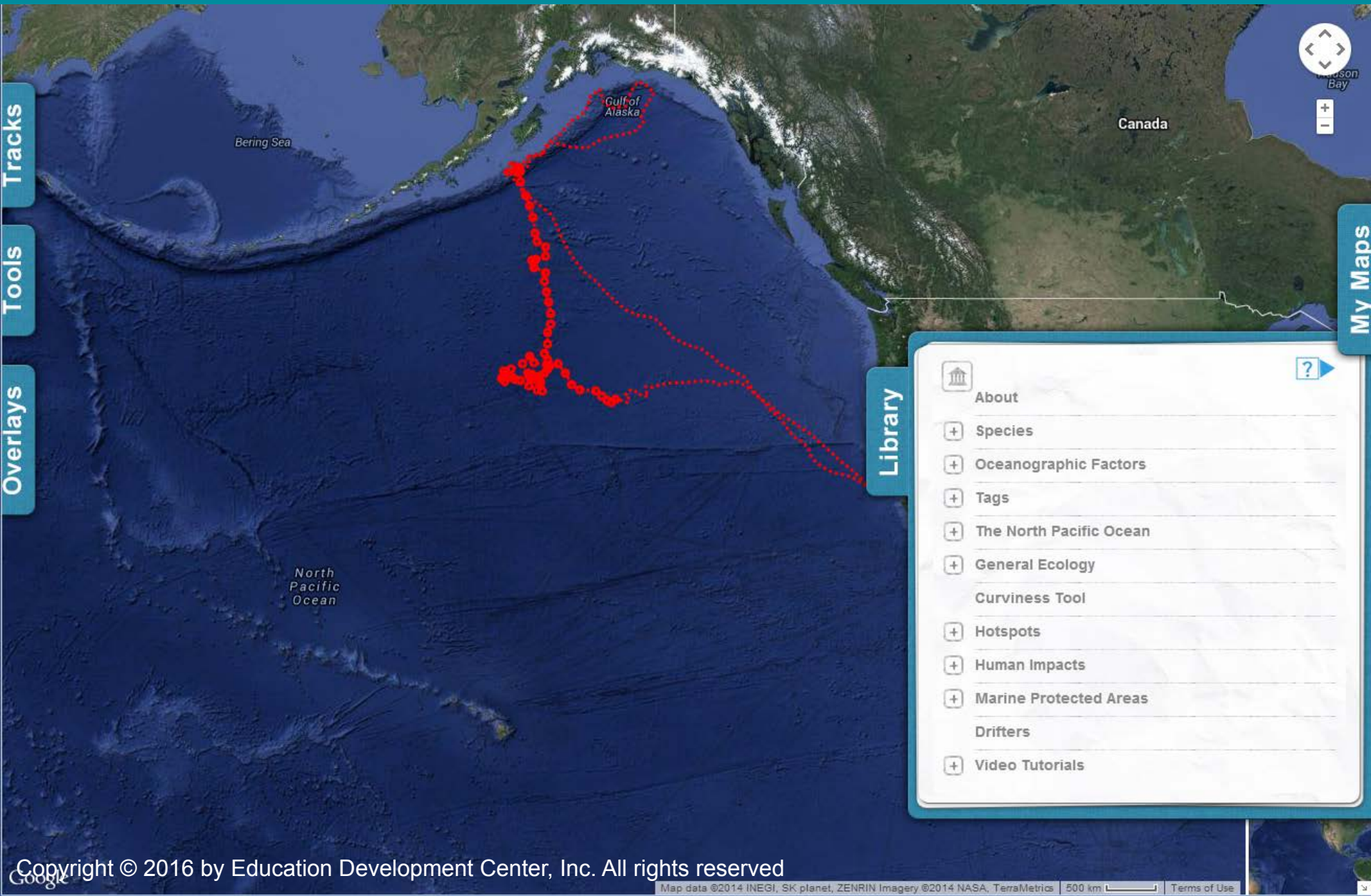


# *Provide supports that can be accessed on-demand*



# *Customized content supports*

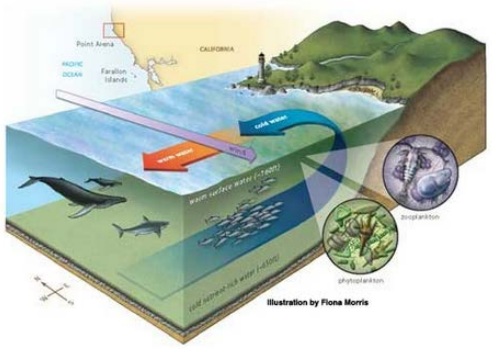
## Ocean Tracks Library

**Categories**

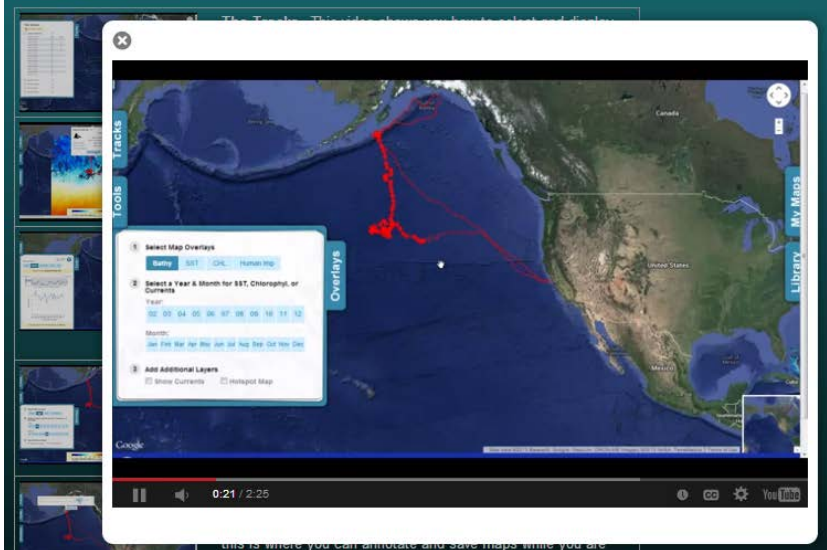
- About
- Species
- Oceanographic Factors
- Tags
- The North Pacific Ocean
  - Major Currents
  - The North Pacific Transition Zone and Transition Zone Chlorophyll Front
  - **Upwelling and the California Current**
- General Ecology
- The Curviness Tool
- Hotspots
- The Hotspot Tool
- Human Impacts
- Marine Protected Areas
- Drifters
- Video Tutorials

### Upwelling and the California Current

- The California current is the **eastern boundary current** of the North Pacific Gyre, running southward from British Columbia, Canada to Baja California, Mexico. This current draws cool, nutrient rich waters from the Alaska current down along the western coast of North America.
- Western boundary currents flow deeper and stronger than eastern boundary currents. This means that cool, nutrient-rich water is closer to the surface in eastern boundary currents than western boundary currents. This results in the creation of **rich upwelling zones** in areas with eastern boundary currents, such as the California Current.
- The intensity of the California current is influenced by strong northwesterly winds. These winds predominantly blow along shore, which because of the earth's rotation (see Eckman transport) cause water to be transported in an offshore direction. This movement of water offshore causes cooler, nutrient rich water to be upwelled over the narrow continental shelf to the surface.




1. To access the map, click here.
2. The map works like other Google maps interfaces, with zoom and pan functions on the upper right hand side of the screen. You can also click and drag the map to get to a different location.
3. A small map on the bottom right hand side of the screen shows you a zoomed out view to help you orient yourself.
4. The map interface has a set of menus that expand from tabs on the left and right hand sides of the screen. Click the tab to expand the menu.
5. The track you see on the map was made by an Elephant Seal (#302). Watch the tutorial videos below to learn how to interact with this track and others.




working.

**The Library** - This video shows you how to access and use the Library, where you'll find more information about the animals and the ocean, as well as the technologies used to explore them.

**Overview** - This video is a compilation of all the videos above. It takes you through all the elements of the Ocean Tracks map interface, just as they are listed here.

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# Implementation Research Questions

- How do students and faculty at different undergraduate institutions engage in and interact with OT-CE?
- What changes in science attitudes and interests do students show after completing OT-CE modules?
- What changes in data inquiry skills do students show after completing OT-CE modules?
- How might changes in students' science attitudes and interests and data inquiry skills be related to the ways in which faculty implement OT-CE modules?

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# For more info, visit us at:

oceansofdata.org

# Discussion

Why do *you* think it's important to teach with data?

How do you incorporate data into your teaching?