

*Free-Choice Learning*

# "How can we make them get it?" Findings from research on communicating ocean sciences to public audiences.

CSULB, STARS Seminar,  
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COSEE PACIFIC  
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EDUCATION EXCELLENCE

Sea Grant  
Oregon

# People know very little about oceans and ocean sciences.

- The Ocean Project (1999) found that 46% of Americans surveyed stated that they did not know enough information about the ocean to offer an opinion as to the health of the ocean.
- A SeaWeb survey found that although many people believe the ocean is in need of protection most incorrectly think pollution is the greatest problem.
- A report in 2005 found that of the 1233 citizens they surveyed, the average score on a short quiz about general knowledge of the ocean was 2.23 out of a possible score of 5 points.
- Educational research reveals that students, even those living in coastal areas, perceive ocean resources as limitless and think coral reefs are widespread throughout the ocean.

- More than 86% of the elementary, middle, and high school students in a study in Maine lack many of the concepts essential to understanding ocean science and ocean resources.
- They also held robust misconceptions that would significantly impact their ability to make informed decisions about marine resources. Few students knew the role of nutrients in ocean ecosystems and at least 50% of students believed that ocean resources are limitless.
- Another study found that students in South Africa had similar difficulties understanding sources of salinity, wave propagation, and human impacts.

**Knowledge about habitats of crab, salmon, shrimp, and halibut:**

	Percentage incorrect answers or “don’t know”	Percentage correct answers
Where Crab Live	3%	97%
Where Salmon Live	4%	96%
Where Shrimp Live	59%	41%
Where Halibut Live	75%	25%

N=313

**Our audiences do a bit better on some things.**

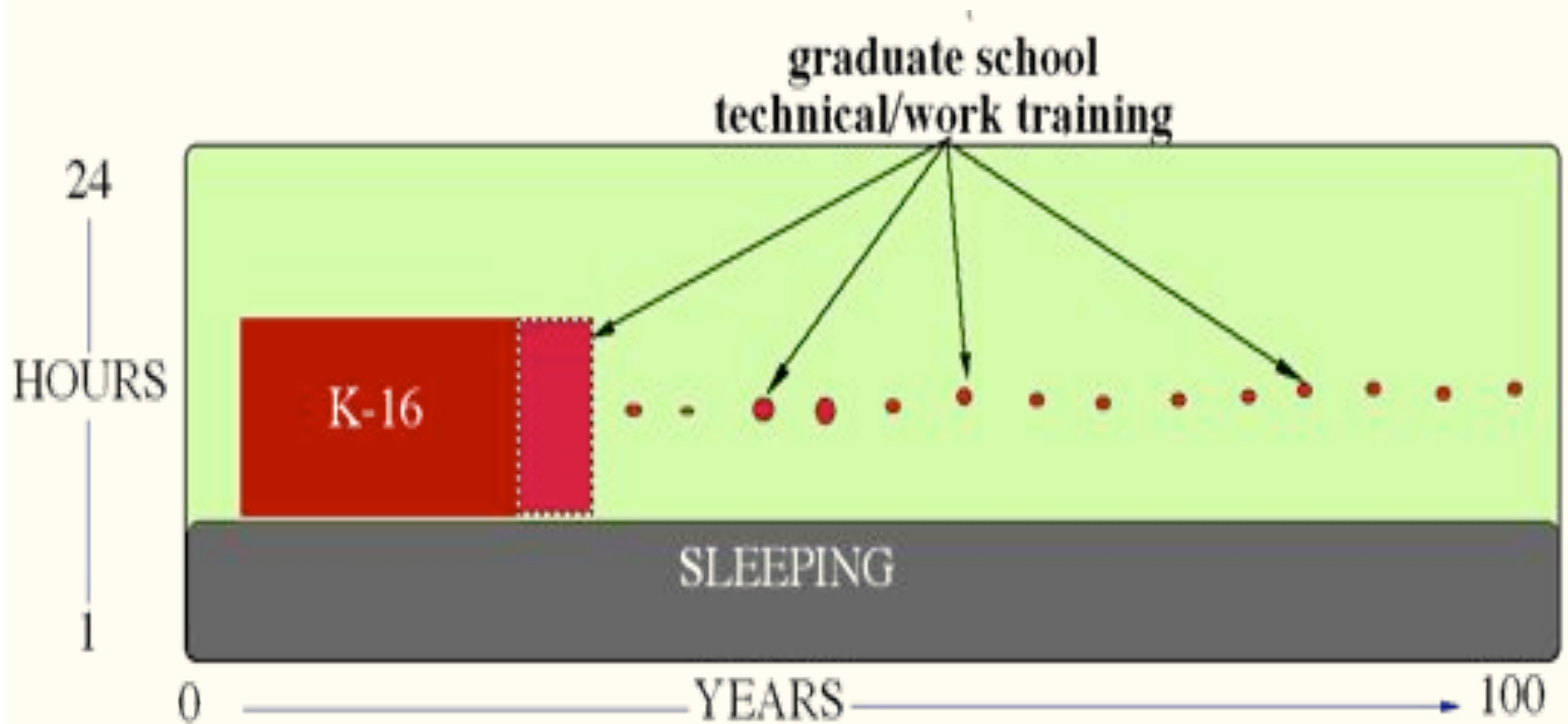
**Knowledge about how crab, salmon, shrimp, and halibut are caught off the Oregon Coast:**

	Percentage incorrect answers or “don’t know”	Percentage correct answers
How Crab Caught	60%	40%
How Salmon Caught	49%	51%
How Shrimp Caught	43%	57%
How Halibut Caught	50%	50%

N=313

**And not quite so well on others...**

97% (or more) of your life spent outside of school or formal education/training



Working science knowledge develops  
across multiple contexts over the  
lifespan.

1. 43% Free-Choice learning
2. 34% School
3. 23% Work-Related

John Falk and Lynn Dierking

# 90% Get Ocean Sciences Info Like This



AM 10:53  
JAN. 20 1998



## Free-Choice Learning Involves

- High internal motivation
- Socially meaningful or personally meaningful activity
- Activity that is just beyond one's current level of competence
- Connecting with prior knowledge and experience
- “Flow” experiences

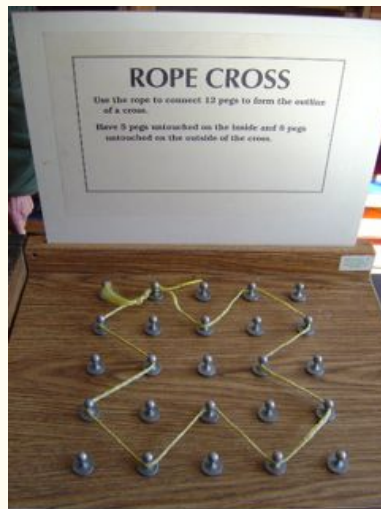
Our research helps leverage free-choice learning to support learning about ocean sciences research.

- 1) Pay attention to what visitors and staff do and say about what they like and fear (Free-Choice Math?)
- 2) Redefine situations for visitors into learning situations (iPods and games)
- 3) Use real data, but make it accessible (Seeing Satellite Data; Visitors and Visualizations).

And it is applicable to any science learning in informal settings.

# Pay attention to what they like and what they fear.

## Free-Choice Math



Olga Rowe  
Shawn Rowe

# Why Math?

There is growing interest among funders, curriculum developers, and informal educators in science centers, zoos and aquaria as sites for bringing together mathematics and science.

# Math Content is appearing Science Center programming nationwide.

- exhibits on games and interactive mathematics exhibits as well as Family Math curricula at Lawrence Hall of Science
- exhibits on calculus at Science Museum of Minnesota
- St. Louis Science Center's Math Cart
- the NSF funded Building Mathematics Momentum in Science Centers
- The "Where's the Math?" teacher institute, math exhibits, and math activities for the web at Exploratorium

# Basic math skills mirror basic science skills

- data collection and analysis,
- measurement
- problem solving skills
- reasoning
- “formulating questions that can be addressed with data and collecting, organizing, and displaying relevant data to answer them” (NCTM, 2000, p. 49).

# So, what do visitors, staff, and volunteers think about math in the science center?

69 visitors (22 adults over 16 and 47 children under 16) were surveyed about

- their attitudes toward including mathematics content explicitly in the museum,
- the kind of mathematics content they wanted to be covered in the museum, and
- their own attitudes to mathematics.
- In addition, museum staff and volunteers filled out surveys, answered interview questions, and provided feedback informally.

# Visitors and staff were afraid of math and viewed it very narrowly.

- Limited view of math (counting, number operations)

*did not realize that puzzles and math were connected,*

*asked for help with the questionnaire*

- Seeing “mathematics” and “practical” as opposites

*Woman, 46 years old, said that exhibit on math might help “to calibrate how many gallons of water” there are in the tanks for measuring the tanks. But, as she said, it would not help cleaning the tanks (a practical task).*



Visitors and staff weren't sure how to build math in, but thought it was a great idea.

*“How many different types of fish are there?” (a child 7 years old)*

*Exhibit on dolphins (female, 31 years old)*

*“number of organisms in a bucket of sea water (female, 46)*

*calculating “the probability of fish reproduction” (an adult female, age undisclosed)*

*“I would want the exhibit to be on algebra – this is something everyone has difficulty with, why not help them out?” (male, 28 years old, college degree).*

# Redefine situations for them into learning situations.



Which way will it go?  
OR  
How does it work?



# Made to invade?

There is no sure way yet to predict aquatic invasions. Any nonnative plant and animal can cause problems under the right conditions. However, invaders often share some of these traits:

- Tolerate wide ranges of temperatures and other environmental conditions
- Reach sexual maturity quickly
- Produce lots of offspring
- Grow rapidly
- Spread out naturally on their own
- Have a broad diet
- Group together during part of their life cycle
- Tolerate human disturbance

**Wheel of misfortune.**

Scientists often compare introductions of nonnative species to a roulette wheel. Most introductions do not cause serious problems. But it's hard to predict when or why a particular species will invade. Each new introduction becomes a game of chance, with low odds but potentially high consequences. Like the "Wheel of Misfortune" a spin. Who will be the invader this time around?

For certain groups of plants and animals, studies show invasions are:

- Low odds: 1 out of 10 species introduced to the wild become established as demonstrated by the wheel below.
- Unpredictable: 1 out of 10 established species become "pests"
- High consequences: Pests impact habitat, reduce native species, and cost taxpayers money to manage.



Photo by D. Stevens, Center for Aquatic and Invasive Plants, University of Florida

Photo by "Paul" (anonymous), Oregon State University

Before...

# Made to invade?

**Wheel of misfortune**

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**Place your bet.**

Place your bet and give the "Wheel of Misfortune" a spin! Who will be the invader this time around?

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The freshwater pearl mussel grows up to one inch in size. It produces a wide range of high-temperature, acidic, and alkaline water.

After...

# Situation Definitions

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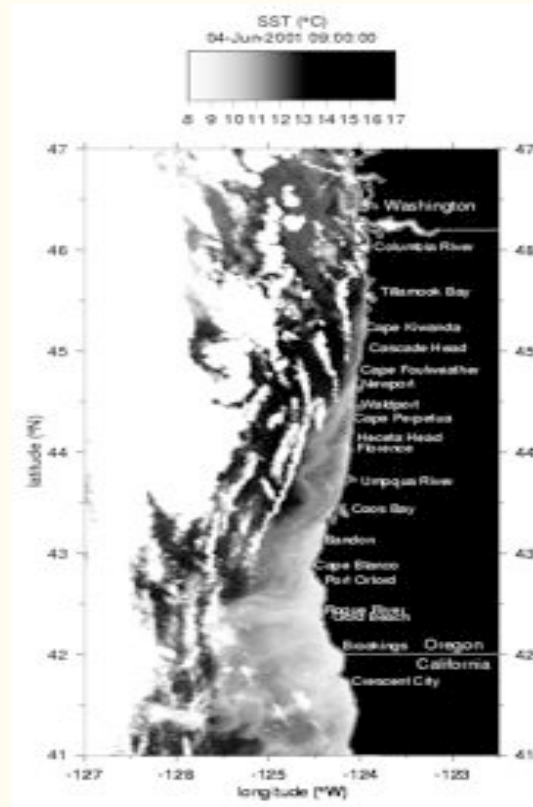
- Spinning
  - Single or repeated spinning
  - Usually not waiting for wheel to stop
- Reading
  - Scanning text/pictures
  - Reading out loud (optional)
- Betting
  - Indicating a choice of organisms on the wheel
  - Spinning the wheel
  - Waiting for the wheel to stop
  - Commenting on the identified organism (optional)

# When there was more betting, there was more potential learning conversation.

- 58% of stoppers read, 80% of them were adults and 20% children.
  - 7 kids read the label
  - 8 adults spun the wheel
  - 18% of stoppers had any kind of conversation about the wheel at all
  - **23% of conversations included information from the label**
- 70% of stoppers read, 76% of them were adults and 24% children
  - 10 kids read the label
  - 12 adults spun the wheel
  - **33% of stoppers had any kind of conversation about the wheel at all**
  - **61% of conversations included information from the label**

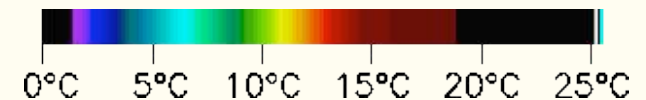
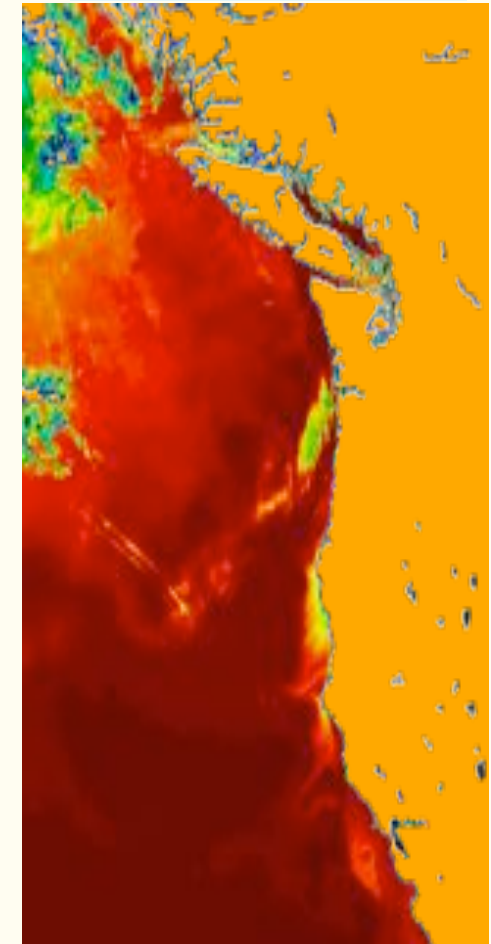
# Use real data, but make it accessible.

- What do people see when they look at satellite data?
- What are people interested in learning about satellites and satellite data?
- Are there simple things we can do to help people see the data in a satellite image?



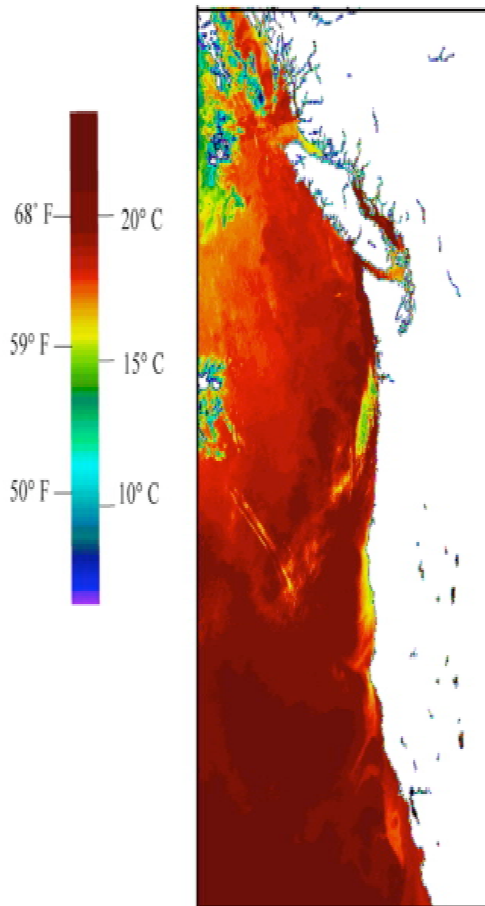
Shawn Rowe  
Molly Phipps

SST June 16, 2000

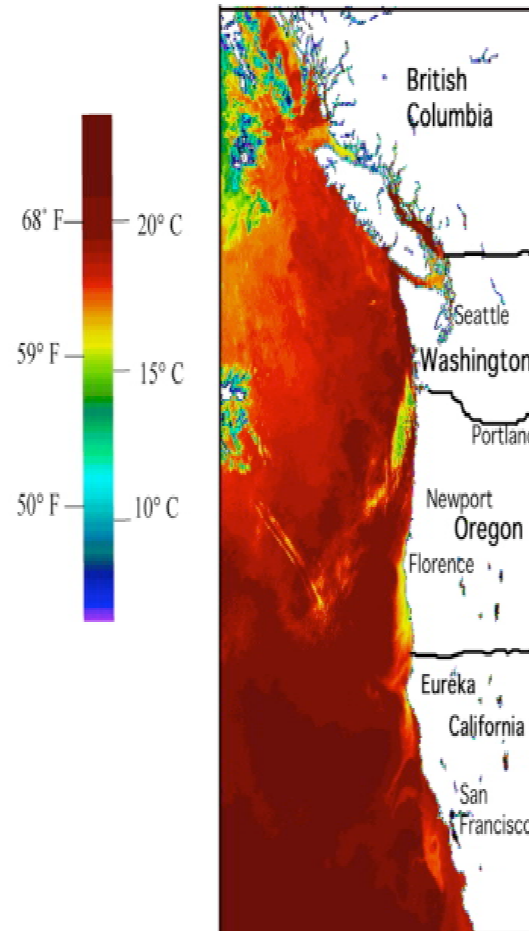


# Seeing Sea Surface Temp

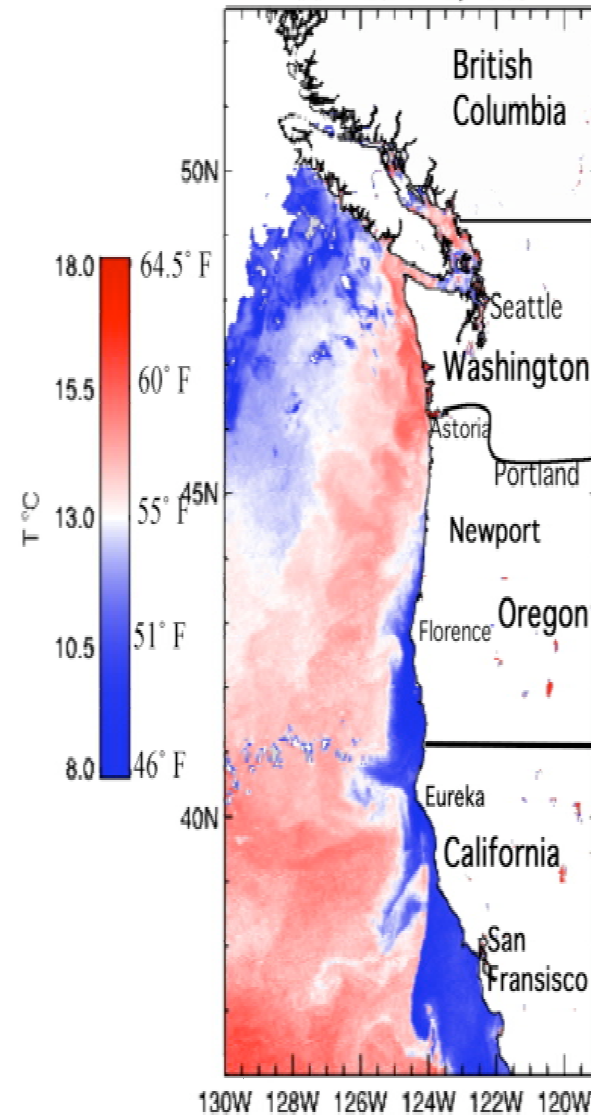
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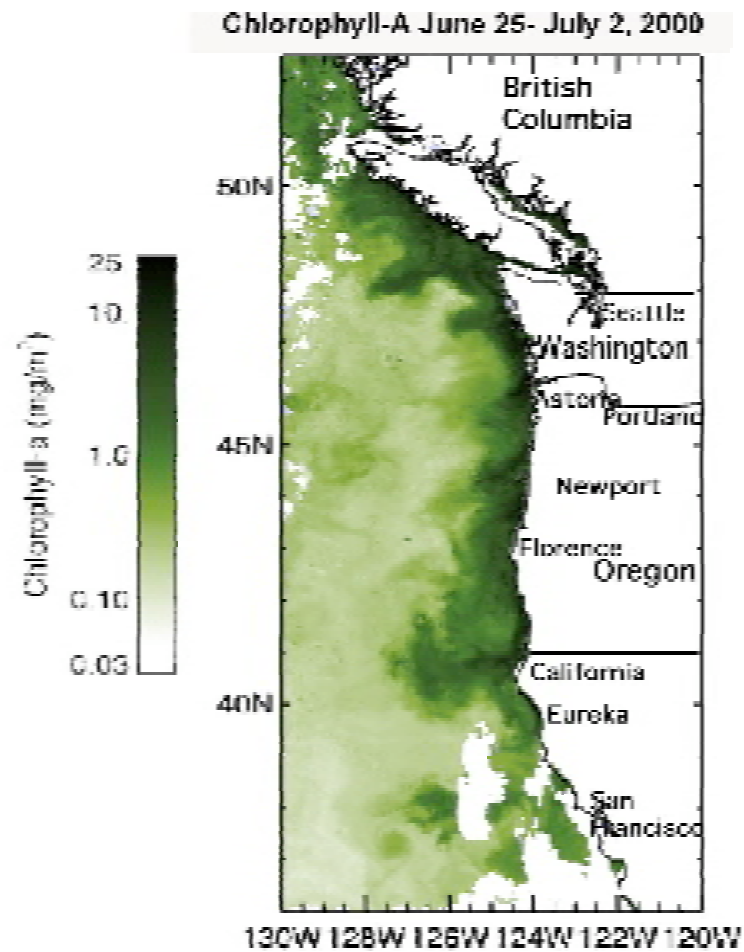
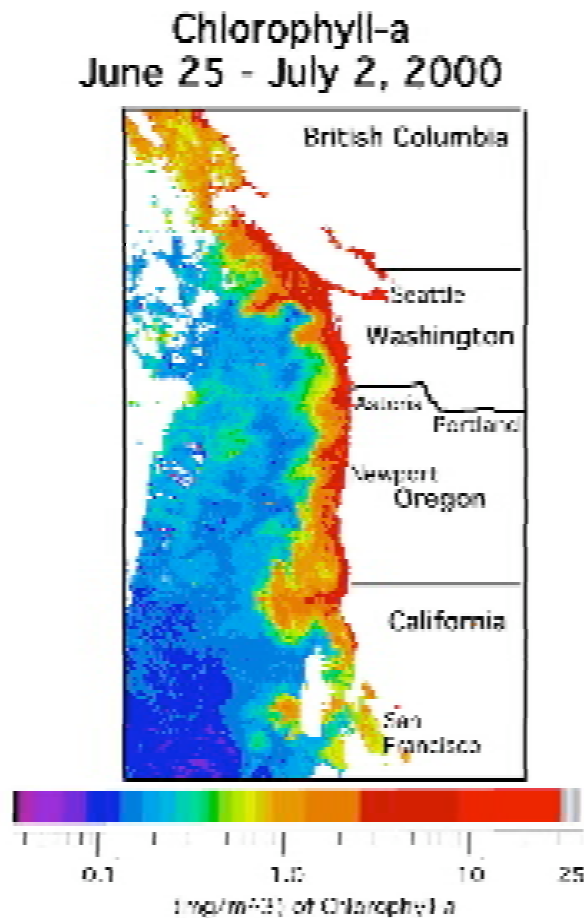
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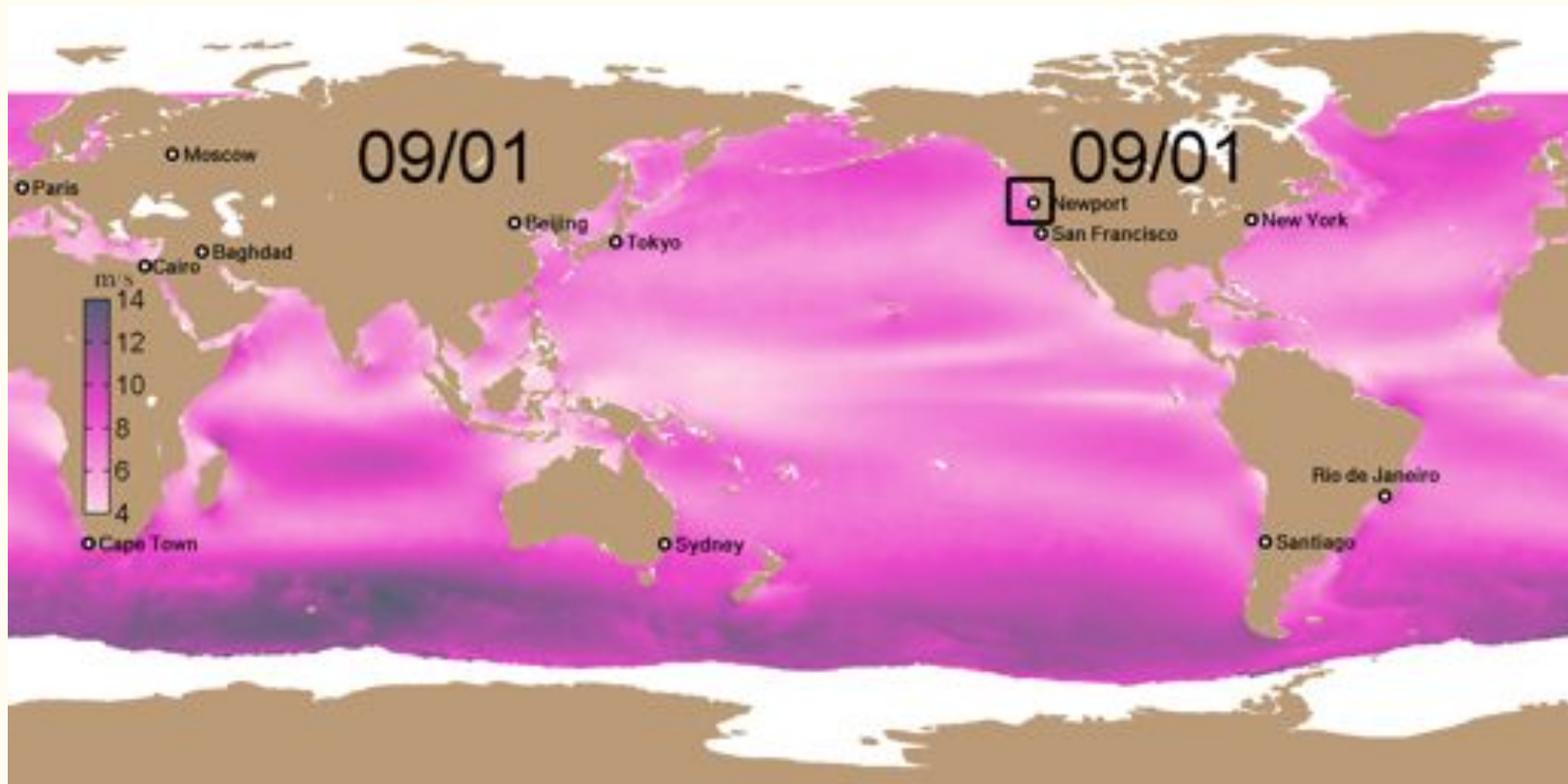


# Seeing Chlorophyll-a Data

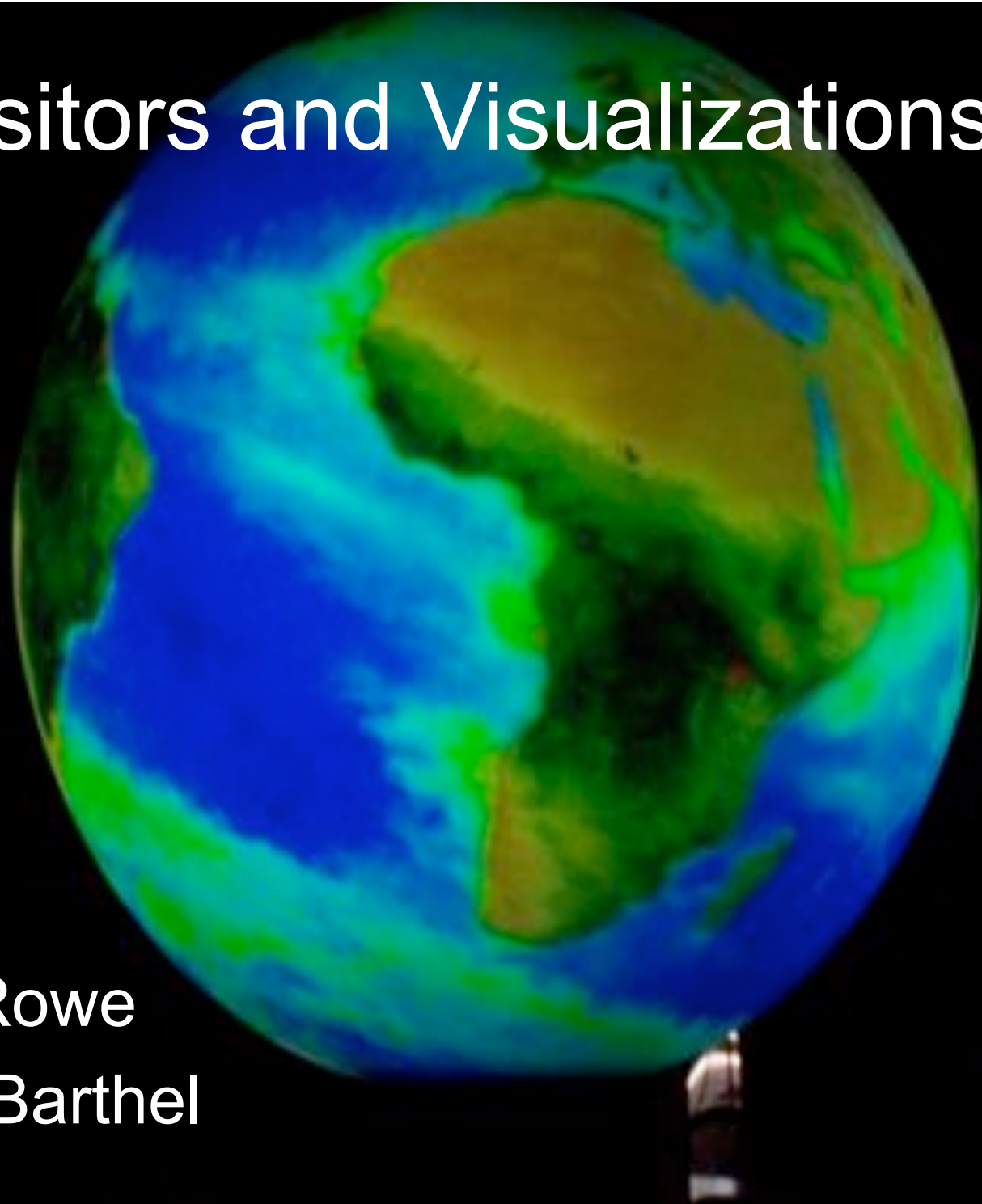




# Making Wind Speed Data Accessible



# Visitors and Visualizations



Shawn Rowe

Céleste Barthel

# Characteristics of Complex Visualizations:

Three focus areas for the study:

- WOW! Factor
- Holding power
- Interactive capabilities

The WOW! Factor: People love the pretty pictures.



# The WOW! Factor: People love the pretty pictures

- “It was really cool seeing real scientific data on the sphere!”
- “I liked the cool pictures on the globe!”
- “I liked it!”
- “The cool pictures caught my attention”

**Holding Power: Staff interaction keeps people engaged longer.**



# Holding Power: Staff interaction keeps people engaged longer.

- “It is really important to have a person here to explain the pictures or I would have walked away.”
- “The sphere was great and it was cool having a person talk to us about it.”
- “If the volunteer lady was not here to explain this stuff to me, I would have walked away. I am glad I stayed though because this is cool!”

# Interactivity: Limited staffing means developing self-guided explorations

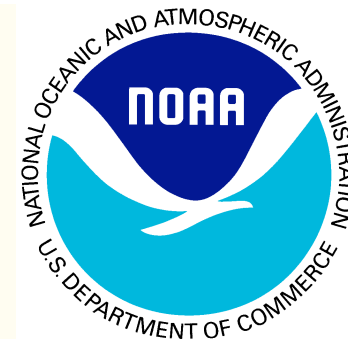
How do quantity and quality of interaction change with varying levels of choice and control over the globe?

In what ways do visitors take advantage of built in scaffolding?





# Thank You



**Western Museums Association Meeting this week, San Diego**

AGU/ASLO Oceans Meeting, Portland, OR February



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