

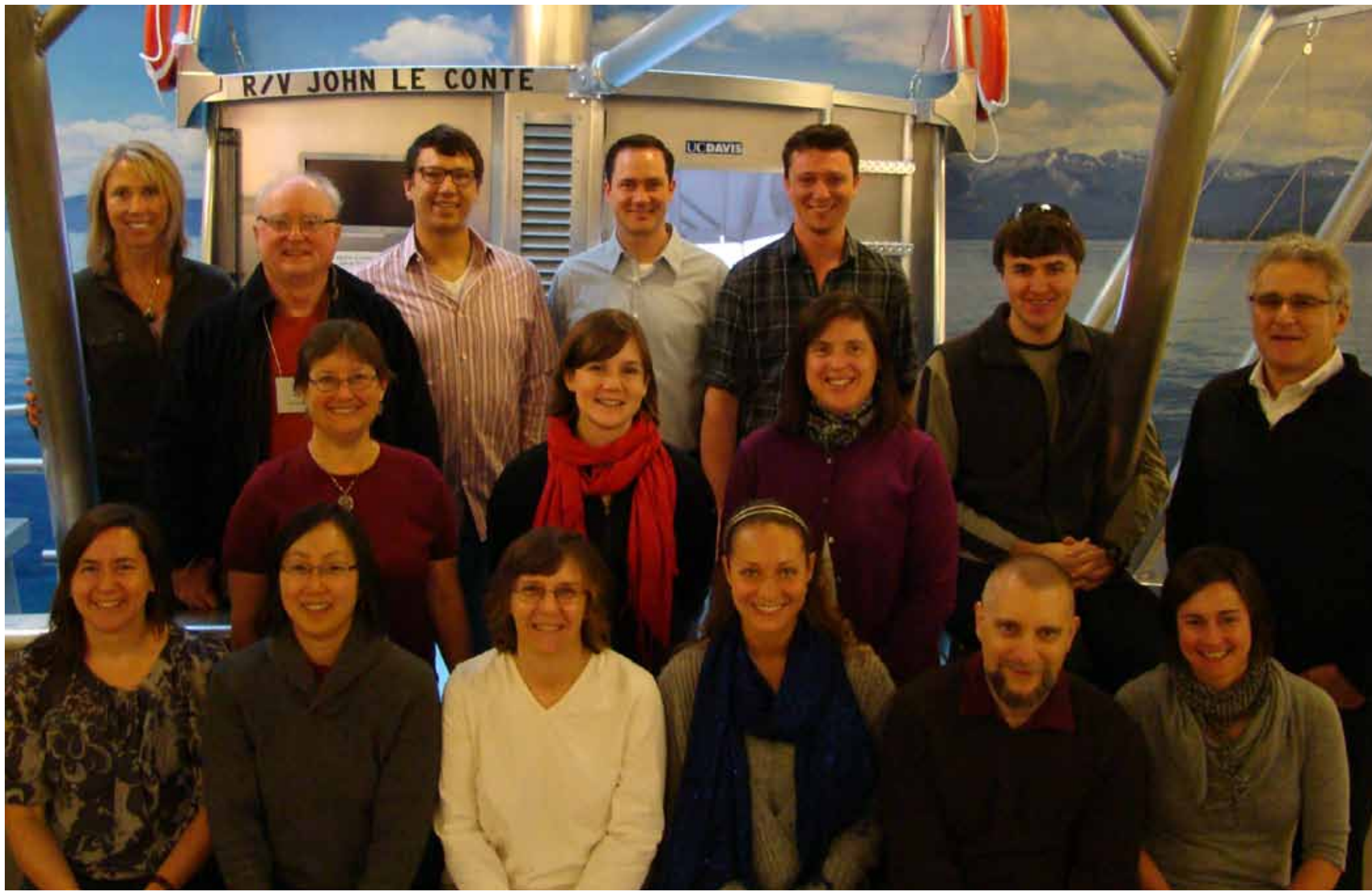
NSF #1114663

To advance the exploration of 3-D visualizations as a tool for informal science education

ABSTRACT

This project seeks to raise public awareness and increase understanding and stewardship of freshwater lake ecosystems and earth science processes using immersive three-dimensional (3-D) visualization of lake and watershed processes, supplemented by tabletop science activities and media. This is being accomplished by:

1. The development of tools and approaches to enable the effective design of 3-D data visualizations from scientific data
2. Documenting the development process and workflow
3. Developing supplementary learning materials including table top interactives, exhibits, media, and website, and
4. Evaluating products and outcomes to improve visitor experiences and learning from 3-D visualizations.

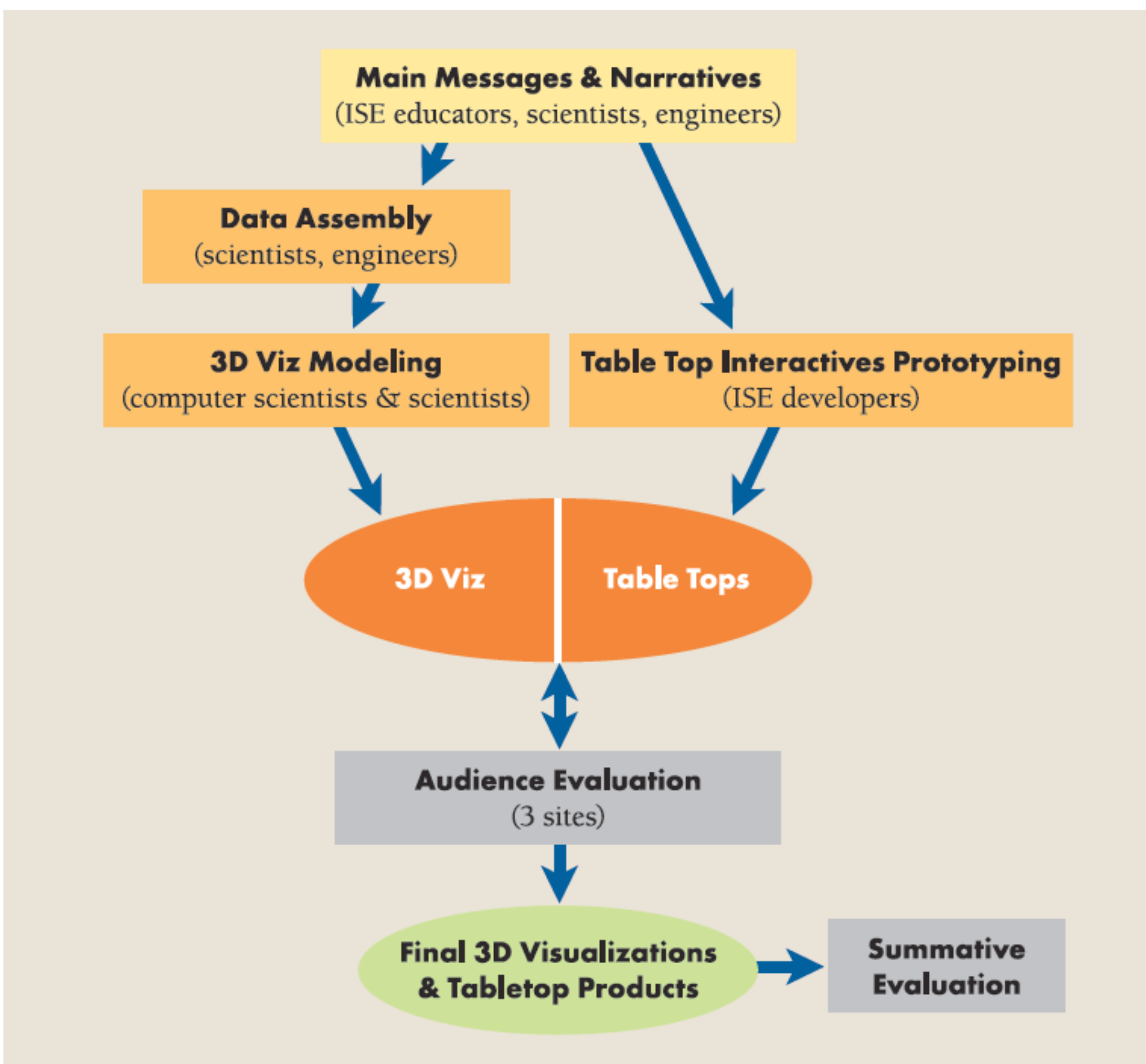


PROJECT IMPLEMENTATION SITES



KEY QUESTIONS

- How does engaging with the 3-D visualizations affect peoples' awareness of, attitudes towards and learning about freshwater ecosystems and the challenges they face?
- What practices are needed for ISE institutions to make use of 3-D visualization technology for science education?
- What is the workflow for translating scientific data into visualizations for the public?
- What are current and potential visitors' attitudes and knowledge about freshwater ecosystems, watersheds, and habitats? (Are participants getting the main message and understanding the content?)
- How should materials (tabletops, media, activities) be used to best supplement 3-D visualization?



MAIN MESSAGES

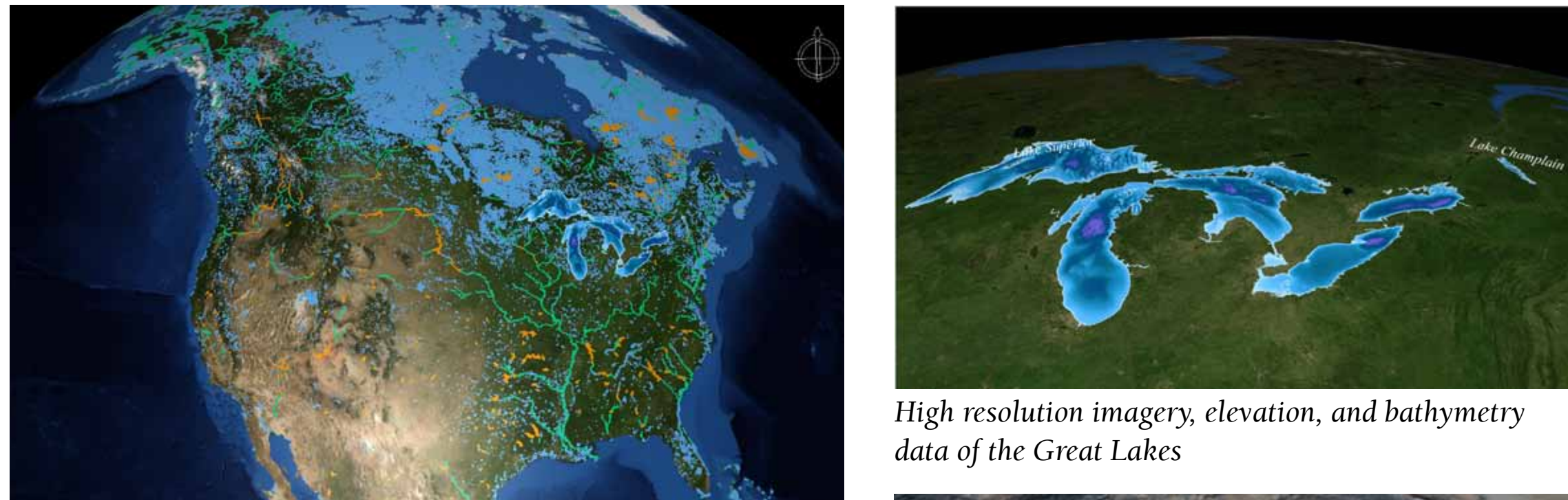
1. Water connects all Earth systems: water, land, air and life
2. Freshwater ecosystems are dynamic, complex and diverse
3. Humans affect freshwater ecosystems both locally and globally

3-D Visualization Tools for Enhancing Awareness, Understanding, and Stewardship of Freshwater Ecosystems

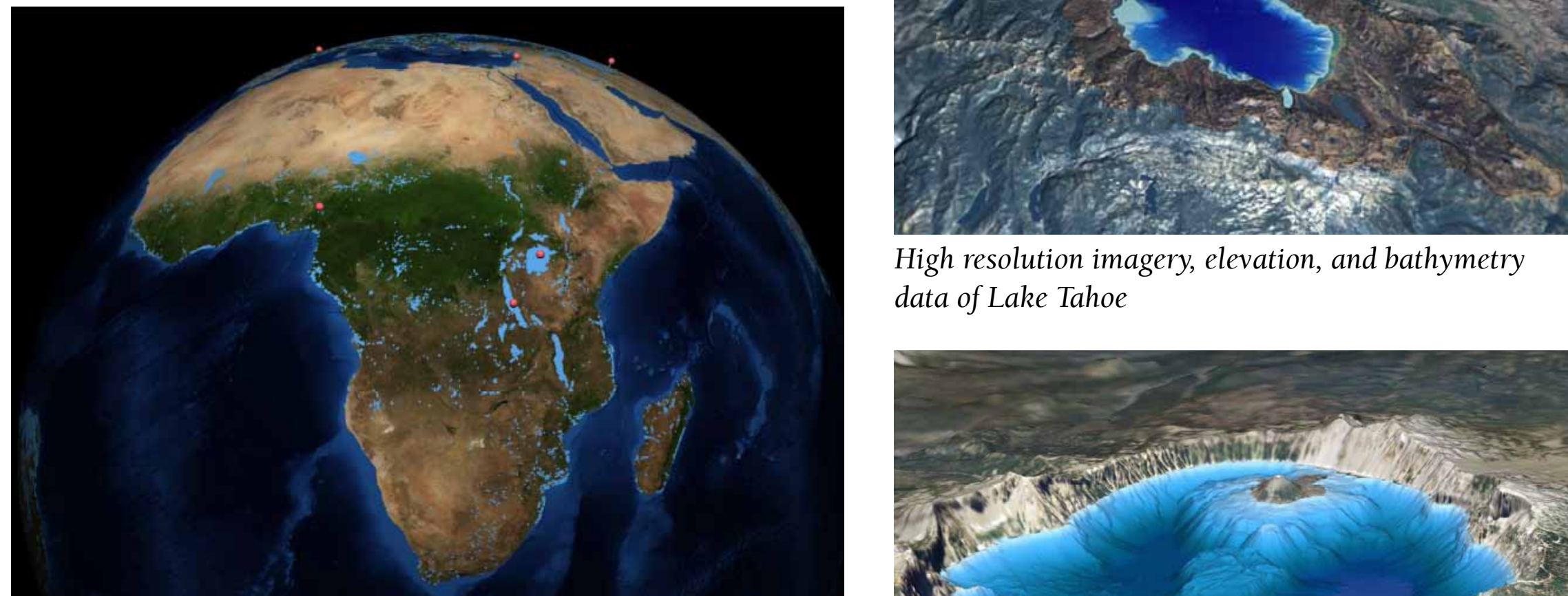
<http://LakeViz.org> & <http://www.3DH2O.org>
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 1-UC Davis Tahoe Environmental Research Center, 2-UC Davis Department of Geology/KECK Caves, 3-UC Berkeley Lawrence Hall of Science, 4-ECHO Lake Aquarium & Science Center / Leahy Center for Lake Champlain, 5-Audience Viewpoints Consulting

3-D VISUALIZATIONS

3-D visualization experiences were created and evaluated with the public. In the production of the 3-D visualizations, new datasets were added, and electronic billboards were designed and also incorporated to provide contextual information. Visualizations include both autorun and interactive facilitated tours.



"Lakes of the World" highlights the location of freshwater ecosystems including lakes, rivers and reservoirs



"Lakes of the World" highlights the location of lakes around the world with pins, labels and billboards at appropriate level of zoom



"Following a Drop of Water" follows precipitation from the mountains to the lake at TERC, Lake Tahoe

TABLETOP INTERACTIVES & SCIENCE ACTIVITIES

In this project year, the following tabletop interactives and activities have been developed and evaluated:



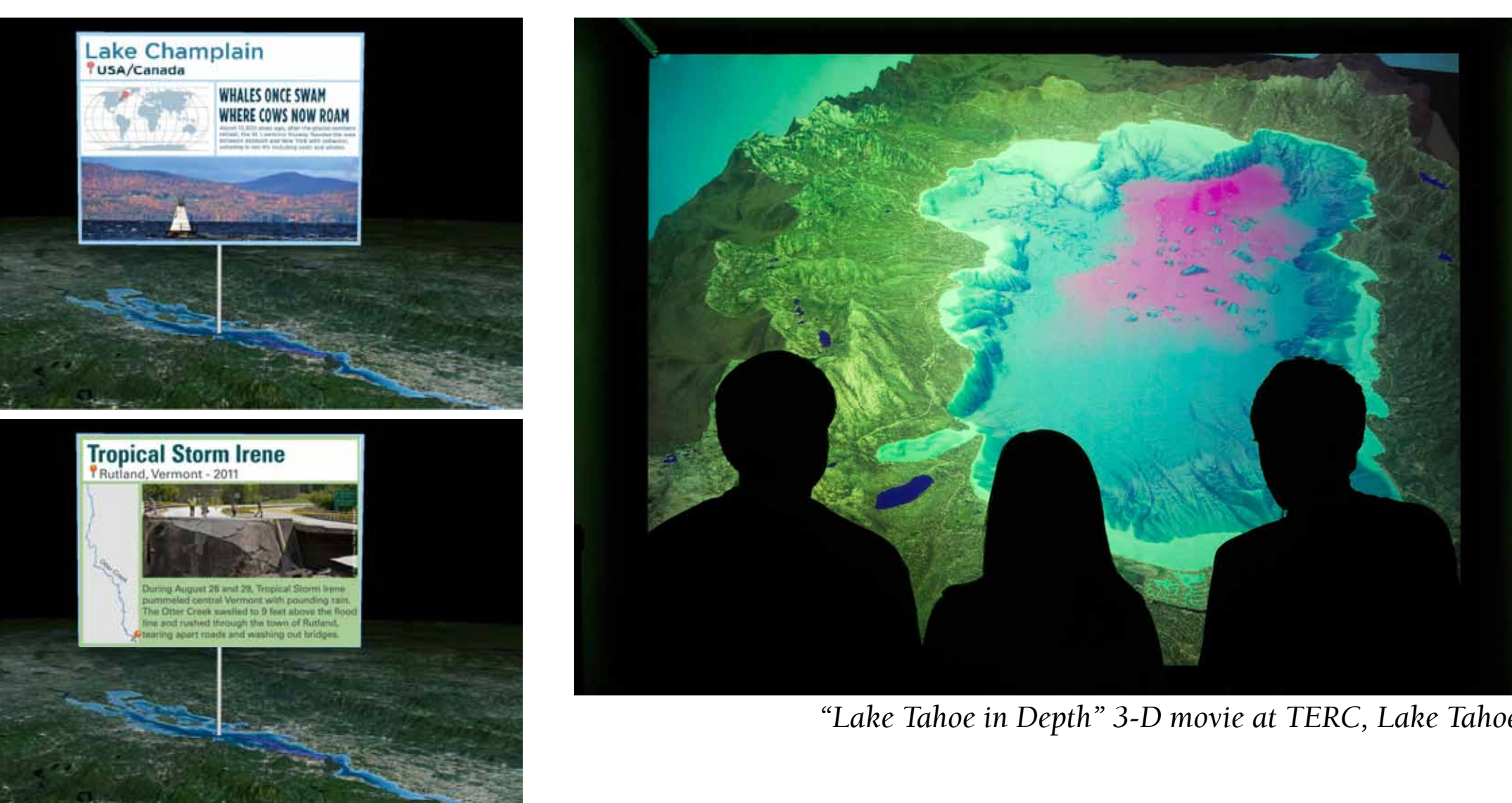
Seiche wave and density stratification models



Apps: "DIY Lakes" (2015) & "Healthy/Unhealthy Lakes" DIY Lakes iPad App about lake science (coming 2015)



"Life in the Flood Zone: A 3-D Watershed History Tour" at the ECHO Lake Aquarium & Science Center, Lake Champlain



Textual information is provided using "billboards" that auto-rotate to face the viewer



3-D video footage of a bluegill eating mysis shrimp shows the Lake Tahoe food web in action



"Shaping Watersheds" interactive sandbox exhibit at ECHO Lake Aquarium & Science Center, Photo by Julie Silverman

AUGMENTED REALITY EXHIBIT

- "Shaping Watersheds" is a tangible sandbox exhibit:
- Augmented in real time by color projection of elevation map and contour lines
- Simulated water using depth-integrated version of the Navier-Stokes equations
- Interactivity using closed loop Microsoft Kinect 3-D camera
- Moldable "kinetic" sand
- Installed at Lawrence Hall of Science, Tahoe Environmental Research Center, and ECHO Lake Aquarium and Science Center

RESULTS FROM EVALUATION

Key technical infrastructure was established to enable 3-D visualizations to be supported at each project site

- Planning Grant Research (2008—2010)
- Quasi-experimental study with 246 Middle School Students, studying the potential of 3-D to positively impact learning and caring about lakes and lake issues
- Viewing the Lake Tahoe visualization resulted in learning and awareness of human impacts on the lake
- Changed how participants thought about the lake
- Research showed potential for 3-D to result in positive outcomes

- Front-end Study (2012—2013)
- Purpose: get feedback from museum professionals and the general public about the project
- Data collected at Tahoe Environmental Research Center (TERC), Lawrence Hall of Science (LHS) and ECHO Lake Aquarium and Science Center
- First round included focus groups (n=70 participants), second round included on-site interviews (n=268)
- Visitors had limited knowledge of freshwater ecosystems
- Visitors had connections to freshwater ecosystems, mostly because they lived near them, took vacations or grew up near them
- Visitors saw the potential for 3-D visualizations, in keeping their attention, showing changes over time and providing unique experiences and perspectives
- Students preferred the hands-on tabletop experiences
- For content, the most popular topics were the questions scientists are trying to answer, tools and technologies used, and the kind of data they are collecting. There was less interest in how they were collecting the data
- Visitors perceived humans as having far more negative impact on freshwater ecosystems than positive

- Formative Studies (2013—2014)
- Six formative studies have been conducted at TERC, LHS and ECHO
- Tested "Lake Tahoe in Depth" visualization, "Following a Drop of Water" visualization, "Lakes of the World" visualization, "Shaping Watersheds" Augmented Reality sandbox exhibit, Augmented Reality iPad apps, and multiple tabletop exhibits/games
- For the visualizations, the clarity and smoothness was seen as very important, and participants especially liked seeing and visiting places they were familiar with. They were also excited about the 3-D aspects and viewing places from a different perspective.
- The Augmented Reality Sandbox provided visitors with a very compelling experience, allowing multiple points of entry for intergenerational groups
- The tabletop components offered hands-on experiences about a variety of topics, and students particularly enjoyed playing the games about lakes and freshwater ecosystems

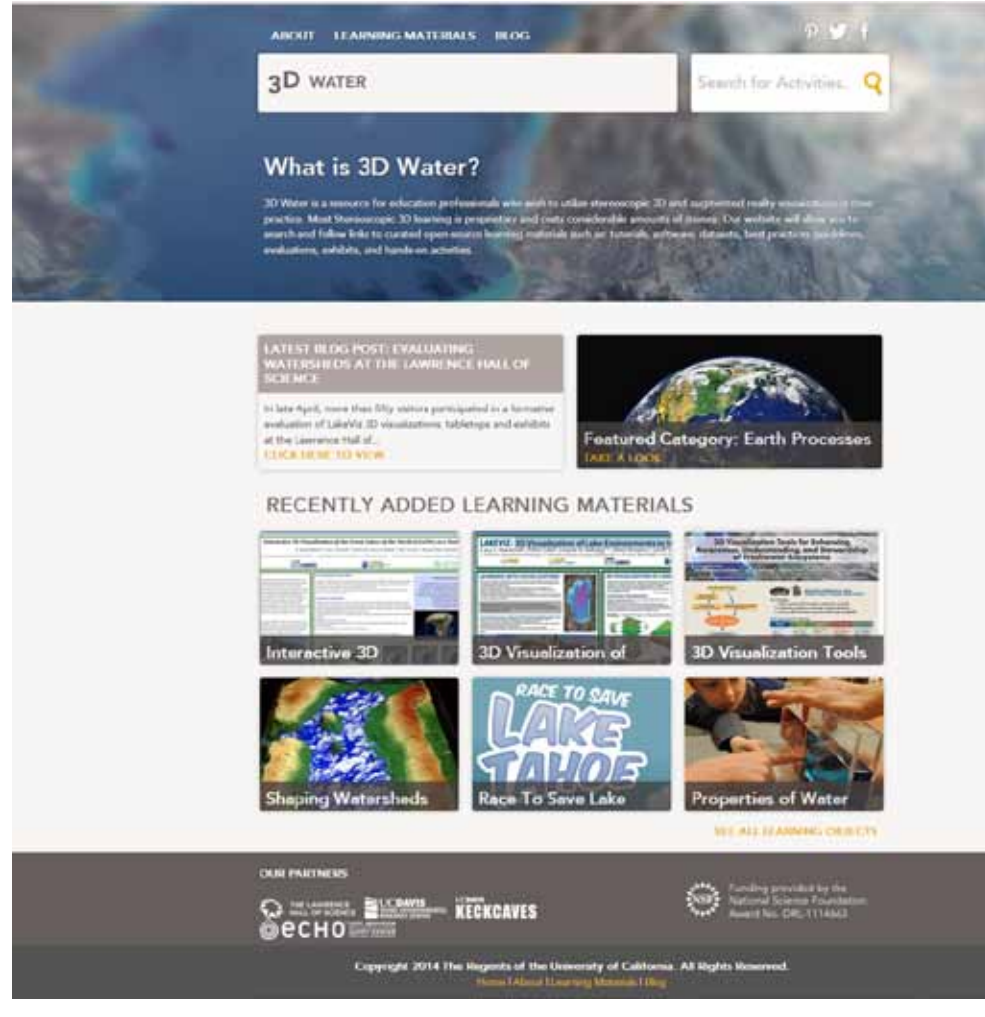


CHALLENGES

- Data wrangler and relationships are needed to access and process scientific data sets
- How to begin to write compelling stories from interrogating the imagery and data.
- 3-D visualizations need additional interpretation and explanation that are specific to each lake and institutional culture.
- One size doesn't fit all - 3-D visualizations also need customized local technical solutions and infrastructure to work.
- Interaction with hi-resolution primary data requires operator assistance, training for science center staff, and/or user-friendly interfaces.
- (Corollary: Software and tools derived from research are not immediately usable for informal educators.)

3DH2O.ORG WEBSITE & LAKEVIZ.ORG BLOG

- Searchable digital library of learning materials
- Open educational resources about stewardship and 3-D Visualization



"Let's Go Jump in the Lake" 3-D movie about lake physics and food webs at Lake Tahoe (2015)

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