

C. Cudaback, Opinion Piece for TOS

Ocean Literacy: There's more to it than content

Why do you study the ocean? Sure, it is a fascinating place, full of weird creatures and intriguing scientific puzzles. But do you love it, too? Did you choose this career partly out of a desire to do right by the ocean? Most oceanographers with whom I've discussed these questions do genuinely love the ocean and its inhabitants, and many promote ocean stewardship through their research. However, when teaching introductory courses, these same people often find that covering ocean science leaves them little or no time to discuss ocean stewardship.

I would like to suggest a new approach to teaching college level introductory oceanography. Most students in these courses will not have careers in science, but they are all newly-minted voters. Many students express a personal and passionate concern for the ocean (Cudaback, 2006), and are eager to learn what they can do to help the ocean. We can provide them the tools they need to make those informed decisions.

Defining Ocean Literacy: There are several published definitions of ocean literacy, mostly concerned with scientific content (NEETF, 2005; COSEE, 2005; Garrison, 2007). By contrast, public surveys focus on attitudes about ocean stewardship (Belden et al, 1999; AAAS, 2004). I believe the most important definition is that an ocean-literate person *understands* ocean science, can *communicate* about the ocean, and is able to make informed *decisions* that affect the ocean (COSEE, 2005).

Decision making requires not only scientific understanding but attitudes about the use of that understanding. Students should understand ocean science and also human impacts upon the ocean. In order to make scientifically-informed decisions about the ocean, students must also perceive science as a useful tool that can be used to protect the ocean. I find it convenient to organize these learning objectives using a 2x2 matrix like the one below.

<i>Science Content</i>	<i>Stewardship Content</i>
<i>Science Attitudes</i>	<i>Stewardship Attitudes</i>

Defining Ocean Literacy: Now we could teach the seven essential principles of ocean literacy (COSEE, 2005), or Tom Garrisons "top ten" (Garrison, 2007), but these concept lists stop short of defining the attributes a person needs to make informed decisions. Decision-making requires not only content knowledge, but attitudes about the use of that knowledge.

Most of our teaching takes place in the *Science Content* quadrant, answering the big question “How does the ocean work?” Many of these answers are provided by COSEE (2005) and Garrison (2007) and countless textbooks provide the necessary details. I shall not attempt to add to the existing lists.

The *Stewardship Content* quadrant contains answers to the big question “How to my actions affect the ocean?” For the most part, complete answers to this question are not found in textbooks. Most college level introductory texts have a single chapter about human impacts, and that chapter may or may not be up to date. Conservation organizations are a good source for this type of information, but we as instructors need to put together a solid list of key points. I offer a preliminary list of facts, just to get the conversation started:

- the vast majority of ocean pollution is runoff from land
- at the current rate of global warming, we may experience a meter of sea level rise in this century
- coastal development destroys vital nursery habitats and increases coastal erosion
- the oceans are being fished out
- the actions of individuals can make a difference to the ocean

Knowing the facts is a good start, but for students to put their learning into action, they need positive *attitudes about ocean stewardship*. For students to make decisions that benefit the ocean, they should feel 1) concerned about, 2) responsible for, and 3) empowered to improve the well-being of the ocean.

Finally, for students to use science as an effective tool for environmental decision making, they must have positive *attitudes about science*. They need to believe that science is 1) a process, not a set of facts, 2) a tool that they can use, and 3) a way to understand the real world.

Teaching Ocean Literacy: Topics related to ocean stewardship need not be tacked onto an already busy schedule. Instead, human impacts can help frame our teaching of ocean science. The hydrologic cycle moves pollutants as well as water. The structure of the water molecule and the density of ice determine the effect of melting the Arctic and Antarctic ice caps. The high heat capacity of water explains the ocean’s vital importance in climate change. The dangers of overfishing could frame the discussion of marine ecosystems. But most of all, students need to know what to do with this information. They need to learn specific actions that can make a difference to the ocean.

The best sources of information on simple steps that make a difference are the websites of marine conservation organizations. I encourage students to visit these websites and decide which simple actions fit best into their own lives. This exercise is easily adaptable to any classroom. Everyday actions like driving less and recycling more make a difference no matter where you live, and relate to large scale problems like global warming.

By contrast, regional issues, such as upgrading sewage treatment plants and planning coastal development, are addressed through the political process. I have developed some in-depth case studies for particular regions and made them available on my website (Cudaback, 2008a). This process is time consuming, but students respond very positively to learning about issues in their own backyard.

Teaching about human impacts on the ocean has a positive impact on student attitudes about ocean stewardship. For example, at the end of my course, students showed a significant increase in their understanding that the earth's resources are limited (C. Cudaback, unpublished data). Here we walk a fine line. It is not our role as educators to promote a political agenda, and we cannot grade students on their level of concern for the well being of the ocean. However, we can model that concern and teach the skills that empower students to act if they choose to do so.

A well-taught course should improve student attitudes about the nature and relevance of science. Discussing the scientific process and its impact on environmental decision-making can improve these attitudes. Active learning is of course vital to understanding the process of science; I personally favor extensive in-class discussion and daily writing assignments. Teaching about the scientific issues involved in decisions that affect the ocean can underscore the real-world value of scientific understanding.

If you choose to teach the science of ocean stewardship, you may want to test your students understanding and attitudes. My ocean literacy website has an extensive bibliography and a survey I have developed to measure all four aspects of ocean literacy (Cudaback, 20008b). Or you can simply ask the students what they learned. Quoting verbatim from end-of-class essays, I will give my students the last word on learning the science of stewardship.

I feel this class has opened my eyes as an environmentalist to protect and make informed decisions on what tax money is spent where and how tourism positively affects the economy and sometimes negatively affects the sea creatures.

Pretending we are scientists trying to figure out ... the source of beach contamination, now that is cool. And I actually learned it, not so much memorized it. I think learning something is definitely easier when it hits closer to home

It seems like now anytime I hear someone ... speak about the ocean, I just want to jump in and explain everything I know.

I understand the ocean a little better now. It's a pretty much undiscovered part of the world, and hopefully one day I can contribute to discovering something new.

People need to care more about the environment, not just what we have right now, but what our children will have for the future, and their children as well.

Resources

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Cudaback, C.N., 2006: What do college students know about the ocean?, *Eos*, 87, 418.

Cudaback, C.N., 2008a: Bootkext -- a web based resource to improve ocean literacy <http://cynthiacudaback.org/Bootkext/bootkext.htm>.

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