Graduate Education in the Ocean Sciences

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What This is Talk is Not About

- Lots of statistics
- New approaches to teaching and learning
- The myriad (and sometimes persistent problems) facing graduate education in the ocean sciences
What This Talk Is About

• Step back and look at the graduate education *ecosystem*

• And think about what we are trying to achieve
  • Future scientists?
  • Workers?
  • Improve national rankings?
Ecosystems

- Components
- Relationships
- And a wealth of emergent properties
- They are subject to changing environmental pressures
  - Adjust or adapt
  - Evolve
  - Or go extinct
Looking at the Education Ecosystem

• Content
• Delivery
• Outcomes
• And external forces
  • Changing scientific interests and questions
  • Undergraduate students
  • Administrative expectations and funding
  • And others
THE

PHYSICAL GEOGRAPHY

of

THE SEA.

BY M. F. MAURY, LL.D.,

LIEUT. U. S. NAVY.

THIRD EDITION, ENLARGED AND IMPROVED.

NEW YORK:

HARPER & BROTHERS, PUBLISHERS,

329 & 331 FIFTH STREET,

FIFTH AVENUE,

1855.
Coastal Upwelling Ecosystems Analysis (1972-1980)

“The goal of the CUEA Program is to understand the coastal upwelling ecosystem well enough to predict its response far enough in advance to be useful to mankind.”
Interannual variability – Supercharged upwelling of 2006

Cumulative wind stress since Spring Transition

Equatorward, Upwelling favorable

two extremes in two years!

Barth et al. 2007
River Flow, Iron and Phytoplankton

- Summer biomass increases from south to north
- Upwelling ecosystems can be iron limited
- Phytoplankton and river input and shelf width are correlated
- Long-term accumulation and subsequent mobilization of riverine iron on the shelf may be important for determining phytoplankton biomass
- And in Pacific NW, also linked to logging in watersheds and PDO
“Achieving a sustainable human future in the face of both gradual and abrupt environmental change is one of the most significant challenges facing humanity. NSF will contribute to addressing this challenge by supporting the science and engineering research needed to understand and overcome the barriers to sustainable human well-being.”
Some Graduate Program Characteristics

- Generally about 2500 enrolled at any one time
- About 2800 applications/year, about 1/3 are admitted, and about half of these enroll (between 500 and 600 per year)
- Time to degree is about 3 years for a Master’s and about 6 years for a PhD
- Between 150 and 200 PhDs finish every year
Discipline Distributions

- “Other oceanography” includes physical and chemical
- “Other” includes policy and application-focused programs

Courtesy Russ McDuff
And Students are Changing

- We suspect that there are different interests and fundamentally different expectations
  - Social networks as an obvious example
- Though we have little quantitative knowledge
Peter Thiel: “We're in a bubble and it's not the Internet. It's higher education.”
Tech Crunch, April 2011

President Obama: “So let me put colleges and universities on notice. If you can’t stop tuition from going up, the funding you get from taxpayers will go down. Higher education can’t be a luxury — it is an economic imperative that every family in America should be able to afford.”
State of the Union, January 2012
Continuing Disruptions in 2012

• Harvard and M.I.T. Team Up to Offer Free Online Courses – May 2012

• Coursera Aims To Make America’s Higher Ed System Interactive And Public, Secures $22 Million – July 2012

• Stanford Creates Vice Provost For Online Learning To “Fundamentally Reshape Education” – August 2012
Administrative Expectations and Controls

• Papers as the primary output
• But now economic impacts
• And social impacts
Academic Articles/$1M Academic R&D
Academic Articles/1000 Academic Doctorate Holders

- California
- Oregon
- Washington
- Massachusetts
OCE Funded Senior Personnel (PI's and CoPI's)
Leaner Times?

NSF/OCE Funding and Success Rates

- Median Annual Grant
- Success Rate
Everyone wants STEM Education

• US ranks 27\textsuperscript{th} out of 29 developed countries for percentage of STEM college degrees

• More than half of freshmen STEM majors will switch to a non-STEM major by the end of the sophomore year

• Most cite teaching programs as primary reason

• “The challenge is to persuade faculty members, who want to be good teachers, to implement these practices in their own classes. This, as has been pointed out by many, will require cultural change at universities.” – AAU 2011

• And we all live in an institutional culture and a disciplinary culture
Advanced Natural Science and Engineering Degrees per conferred NS&E degrees (%)
State Funding for Public Research Universities/Enrolled Student ($)
Undergraduate Charge/Disposable Income (%)
Technology and the Delivery of Education

- Processing
- Storage
- Networking
Models of Scientific Discovery

- Well-defined, rigorous hypothesis testing
  - Aligned with publishing, promotion and tenure processes

- Data-intensive science, seeking complex and unexpected relationships
  - Not just volume but complexity of data
  - *Explore-then-test*, rather than *predict-then-act*
  - Analogous to network gaming

- Shift from well-defined processes to a more unruly “knowledge ecosystem”
Challenges to Universities

• Loose networks of students and educators

• Closer relationships between those who create and those who acquire and use knowledge

• “Health care and education, in my view, are next up for fundamental software-based transformation. My venture capital firm is backing aggressive start-ups in both of these gigantic and critical industries. We believe both of these industries, which historically have been highly resistant to entrepreneurial change, are primed for tipping by great new software-centric entrepreneurs.” *Marc Andreessen, 2011*
Or do we think differently?

• Substantially lower costs have driven innovation out to the edges of networks

• Balance of science and technology, individuals and groups, and systems thinking

• Small, flexible teams organized around specific issues and topics

• "The network is the critical resource. The best way to get knowledge to the people who need it is by broadening the scope and reach of the new invisible college. Instead of trying to control the circulation of researchers and ideas, policymakers need to focus on building an environment that encourages researchers to self-organize in pursuit of answers to important problems. Allowing researchers to find the places where they can do their best work and encouraging them to pick and choose collaborative opportunities will increase the efficiency of the knowledge system as a whole."
  
  • Caroline Wagner, The New Invisible College
Recap

• Content, especially changing nature of science
• Delivery, especially technology
• Outcomes, especially new expectations
What are the new emergent properties from today’s education ecosystem?

• Less attention to fundamentals?
• Less willingness to learn tools?
• Less willingness to support basic research?
• Greater focus on learning outcomes?
From Darwin in London
What Are We Trying to Achieve?

• More scientists and professors?
• More federal agency workers?
• New businesses?
• Chasing latest technology?
• Or something else?
What Do We Need to Protect?

• Core knowledge and skills?
• A well-understood (and comfortable) set of educational processes and cultures?
• Or develop something more flexible and creative?
“Ante-Disciplinary” Science?

“But what's most depressing comes from purely selfish reasons: if groundbreaking science really requires assembling teams of people with proper credentials from different disciplines, then I have made some very bad career moves...

Looking around my desk at the work I'm trying to build on, I do see the human genome paper, but even more, I see the work of individual pioneers who left old disciplines and defined new ones—writing with the coherence, clarity, and glorious idiosyncrasy that can only come from a single mind.”

*PLoS, Sean Eddy, 2005*
Starting the Discussion

- New content
- New partnerships
- New pathways for teaching and learning
- New emergent properties (i.e., outcomes)