

**Undergraduate and Graduate
Education in Oceanography:
What we can do and what you can do**

**(Sub-title: More lasting than Lillie,
More sedulous than Stratton)**

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My purpose in presenting this testimony on education in ocean sciences is to catalyze discussion and hopefully initiate action in areas of education where often neither faculty nor graduate students nor agency managers in ocean sciences venture.

The link between academic institutions and the Federal Government is one that requires much greater attention, especially more attention than it has received in the past 74 years since the F.R. Lillie report to the National Academy. Over the past 20 years the partnership between states and the Federal government to support higher education has broken. States which used to see their role as providing the infrastructure to support higher education now look to produce the maximum number of undergraduates per tax dollar and pass as much of the costs on to the students in the form of higher tuition. The Federal agencies increasingly look to purchase contract research from universities rather than investing in the capacity building of the intellectual wealth of the country.

Education links to the Federal government were much stronger in the nineteenth century than today. There was a freer exchange of people. Such leaders of science as John Wesley Powell and G.K. Gilbert both held university positions, both became directors of the US Geological Survey and both published some enduring scientific papers while serving in DC, and going into the field in Utah! Today, even as the Federal government supports immense research infrastructure in research universities, the exchange between the two sides has dwindled.

The US has been the world leader in ocean research and education because of the historic strength of the academic enterprise which was largely built by ONR in the 1950s and 1960s and upon which NOAA and NSF could capitalize. A couple of quick statistics for reference. NOAA has about 12,500 employees. The academic institutions belonging to CORE have about 10,000 employees. There are about 1500 students pursuing Master's degrees and a similar number pursuing doctoral degrees. At the undergraduate level there are about 1600 students pursuing marine biology degrees, and only about 400 pursuing undergraduate degrees in oceanography or fishery sciences. Physics has almost 5 times as many undergraduate students as it has graduate students. In oceanography and fisheries the ratio is almost the inverse. How did we end up with this imbalance?

The history of education in ocean sciences in the US was determined broadly with the National Academy report of 1928. Lillie's committee made only four comments on education of which two are:

“The advance of Oceanography in America now suffers from one of its greatest handicaps, for progress in this science is a matter not only of ships, laboratories and money, but far more of men, which implies opportunities for education. And it is of men that there is now the most serious shortage.

“It is in fact, one of the most serious obstacles to advances in this field that it is not now possible for a student to obtain a course of instruction, properly graded upward from the elementary introduction to advanced research, in any one American University.”

Regrettably F.R. Lillie then proceeded to ignore what was obviously a key obstacle to oceanography entirely, namely education. He focussed on the creation of a facility for research. The Lillie Report did enhance research facilities that were used by both a small group of resident scientists and a group of visiting scientists and their students, working, as was the style of the time, in an apprenticeship mode.

Arguably the most influential report on ocean sciences was published in 1969. It is often referred to as the Stratton Report but its full title is “Our nation and the Sea: a Plan for National Action.” However, this report is as weak as the Lillie report in its recognition of the role and responsibilities of education in ocean sciences. It makes two just recommendations:

“NOAA be assigned responsibility to help assure that the Nation’s marine manpower needs are satisfied and to help devise uniform standards for nomenclature of marine occupations.” (Note NOAA wisely, or by default, did not achieve this!)

“NSF should expand its support for undergraduate and graduate education in the basic marine-related disciplines and plan post-doctoral programs in consultation with academic and industrial marine communities.”

Conclusion: This commission has an opportunity to step forward and make substantive and implementable recommendations that can affect the types and quality and availability of graduate and undergraduate students coming from the 60 or more academic institutions that produce doctoral students, and the one or two universities that are also engaged in undergraduate teaching of ocean science majors.

As education is truly a shared responsibility between the academic institutions and the federal government,

What can we do as a science?

There are three arenas in which we can make a difference. Let me review the three areas of Bachelor’s, Master’s, and doctoral opportunities.

As a field, oceanography has been significantly absent from undergraduate education. In part this is because many universities have their oceanography programs located at a distance from the center of mass of their undergraduate programs. But in part it is a self-sustaining result. We didn’t have undergraduates in the past, so we don’t have undergraduates, so we don’t want undergraduates. But the entire field of earth sciences has changed. Global environmental science has become of more immediacy to local and national politics, and earth system science has recently become possible through structured and linked models and global observing networks. The future for oceanography may lie in much stronger linkages to other geosciences including atmospheric sciences, geo-hydrology, environmental chemistry and sustainable

biospheres. The isolation of the ocean sciences from undergraduate education may soon become a major handicap to future university programs.

Second, ocean sciences has yet to fully capitalize on the value of a science-based master's degree. Too often a Master's student is regarded as a failed doctoral student: but economic data show that a Master's Degree is the most economically advantageous degree. A science-based master's degree with broad focus on large questions of climate change, the role of the management of the oceans and its impacts, for example on resources, on water predictability, on land use, would be welcomed across many sectors of society. Ocean sciences as a field is missing out on the chance to lead the burgeoning interest in interdisciplinary education even though the subject by its nature is inherently interdisciplinary. It is a problem that could be readily addressed at the local level.

The one issue most central to the hearts of most faculty is doctoral education. While we may do a superb job in training students for research careers in oceanography the variability in funding, the decline in national interest in science and the decreasing numbers of students interested in becoming faculty all suggest that we have some work to do to better prepare our students for a life other than that of a research scientist. We must ensure that graduate education is more than a research apprenticeship. In the past the thesis was seen as piece of lone scholarship developed by the individual student working as independently as possible of everyone else. But today many of the problems which are being investigated require multi-disciplinary teams and teams that have programs that last longer than the duration of a student's thesis years. How do we develop team-based collaborative research and teach students how to make significant creative contributions to shared societally relevant problems?

What can the Commission do?

The issue of graduate student support is the key to the stability and growth, to the quality and success of graduate and undergraduate education in the field.

Mission agencies, especially NOAA need to recognize that as they are a major consumer of the product they should be a major supporter of the students while they receive their training. Unlike NIH where they have placed a great deal of emphasis on graduate support and traineeships, NOAA has totally ignored graduate support and education except in tiny pockets such as SeaGrant Knauss Fellows. In the NSF compilation of Federal agency support for graduate education, (fellowships, traineeships, RAs etc), NSF and NIH lead followed by other agencies such as DoD, NASA. Regrettably NOAA does not even appear in this list: it is lumped with "all other agencies," as its contribution is so small.

I recommend that the Commission request the White House to ensure

- NOAA directs its Labs in OAR and NMFS to encourage their scientists, in practical and beneficial ways, to join in partnership with nearby academic institutions in teaching courses, advising students and providing experiential learning opportunities

for undergraduates. This will require direction from NOAA to their distributed offices. It will ensure broad educational opportunity of service to the field and our society.

- NOAA must take responsibility to provide training funds to universities to support students, not just buy cheap research help. NOAA should create and manage a multi-track traineeship program to support the best students interested in ocean sciences as broadly defined to include all aspects of the marine and fishery sciences and the policy components. Traineeships, rather than RAs provide the flexibility to the student and reward the best students rather than just being money given to faculty members to hire someone to help with their research. Approximately 400 traineeships per year are required. NOAA, as the largest group in Federal agencies, must take this responsibility seriously rather than just complain that there are few qualified students when they look to hire a fisheries acoustician or a quantitative resource manager.
- NSF should break down the barriers between its science directorates and its education directorate. To support undergraduates for internships, field experiences and experiential learning in university and government labs requires NSF to get the money from the education directorate into the hands of the managers in the science directorates who can judge what are good training programs in excellent universities and government labs.
- NSF should look at the NIH institutional traineeship model that has proved so effective in the health and medical sciences.
- ONR should reconsider its dwindling investment in graduate education and consider how it could provide increased number of fellowships under the NDSEG heading especially as a long-term investment in homeland security.
- The Commission should encourage universities to increase the teaching of oceanography at the undergraduate level. As the value of interdisciplinary education is more appreciated and the value of experiential learning is realized, the field is in a perfect position to point out that is what oceanography is about. By doing this we might see a greater investment from institutions in support of their faculty and thus a reduction in the dependency on the Federal government for faculty support. In addition we might also increase the number of high school teachers who have a broader scientific training beyond biology and a deeper appreciation for the integration of complex dynamic earth systems.