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Career Choices in Marine and Environmental Sciences

Navigating a Sea of Options

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ABSTRACT. The world of science continues to train and grant degrees to an abundance of eager young investigators, yet the number of tenure-track positions in oceanography and related fields is not increasing. Nevertheless, academic institutions and scientific research programs still largely emphasize academic careers for PhD recipients. Rarely do graduate programs explicitly provide information on, or preparation for, careers outside of the university setting. Here, we describe a series of four workshops on careers and networking that were organized and led by graduate students and postdocs from the Center for Microbial Oceanography: Research and Education (C-MORE). This grassroots effort allowed young scientists to sculpt and organize the information and training sought by their peers. As these efforts were highly successful, we recommend that graduate students at other academic institutions consider using this approach.

BACKGROUND

Early exposure to a wide range of career options is becoming increasingly important as more and more recent PhDs are entering non-academic careers. A recent analysis of the 2009 National Science Foundation's Survey of Earned Doctorates¹ (NSF, 2009) found that only ~ 14% of PhDs in the biological sciences held tenure-track research faculty

positions five to six years after graduation (Sauermaann and Roach, 2012). The combination of an increasing number of graduates and a flat or decreasing number of tenure-track positions has caused many PhDs to seek careers outside of the traditional academic path (Cyranoski et al., 2011; Taylor, 2011; Fix the PhD, 2011). In a study of over 4,000 PhD candidates at 39 tier-one

US research universities, Sauermaann and Roach (2012) found that interest in non-academic positions increases as PhD students approach graduation (Figure 1). This may be due, in part, to economic circumstances that have made it increasingly difficult to obtain research funds. Fortunately, young scientists have a wide range of academic and non-academic career choices. However, budding scientists tend to be less aware of the non-academic career pathways or the best ways to prepare accordingly. For this reason, students should be informed about the breadth of career opportunities before embarking on a long journey through a graduate program and, possibly, postdoctoral studies.

To optimize the career success of graduate students and postdocs², we propose the following approaches to broaden their opportunities and experiences and cultivate well-informed

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¹ The Survey of Earned Doctorates is an annual census of all individuals who receive research doctorates from a US academic institution in an academic year (July 1 through June 30 of the following year). The 2009 census covered individuals who earned doctorates in the academic year ending June 2009. NSF's Science Resources Statistics division compiled the results of the survey.

² For easier reading, we will use the term "students" to collectively refer to graduate students and postdocs.

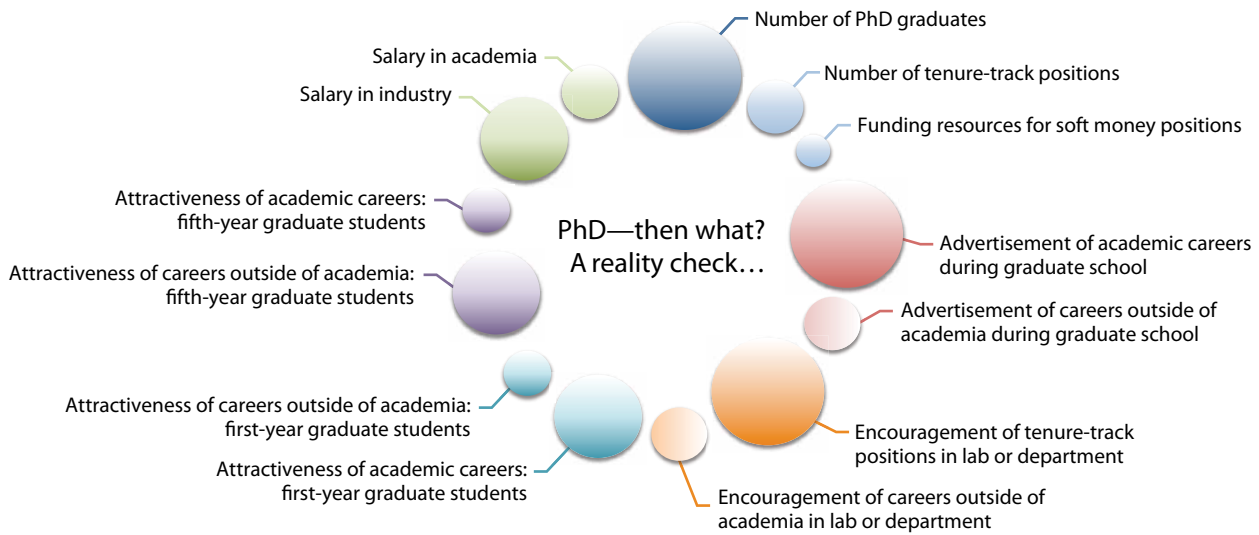


Figure 1. Current circumstances for graduate students with respect to the job market, including graduate students' perspectives on the attractiveness of academic versus alternative careers. Findings depicted in the schematic are colored to highlight categorical groupings and were obtained from the studies of Russo et al. (2010, 2011), Cyranoski et al. (2010), and Saueremann and Roach (2012). Within each set of groups, the representation of graduate student perceptions or employment situations is scaled according to circle size.

career decisions: (1) expose students to different career options and to professionals who are working in those fields, (2) create an environment where students can openly engage in discussion and encourage honest reflection about which careers might best fit their skills and interests, (3) provide opportunities to develop and expand transferable skills, (4) encourage students to build networks and engage in meaningful collaborations, and (5) actively involve students in the leadership and organization of such career-related training. We highly recommend that universities and other like-minded institutions integrate these approaches into their graduate training.

THE C-MORE PROFESSIONAL DEVELOPMENT TRAINING PROGRAM

A key goal of NSF is to promote “science and engineering education programs at all levels and in all the various fields of science and engineering” (NSF, 2014). Some of the more prestigious NSF awards support multi-institutional Science and Technology Centers (STCs) that tackle complex, interdisciplinary research and education challenges requiring long-term funding. Established in 2006, the Center for Microbial Oceanography: Research and Education (C-MORE) is an NSF-STC based at the University of Hawaii (UH) and involves six additional

institutions: Massachusetts Institute of Technology (MIT), Woods Hole Oceanographic Institution (WHOI), Oregon State University (OSU), University of California Santa Cruz (UCSC), the Monterey Bay Aquarium Research Institute (MBARI), and Columbia University. One of C-MORE’s missions is to train the next generation of microbial oceanographers by providing academic coursework, cutting-edge training in laboratory and field research, and professional development.

The C-MORE Professional Development Training Program (PDTP) offers eight core training modules as well as “on-demand” workshops for C-MORE students (Bruno et al., 2013). Each module, summarized in Table 1, consists of practical training in areas such as leadership, teaching, mentoring, outreach, science communication, diversity, proposal writing, and developing research collaborations. A certificate is conferred upon the completion of each module. Further information is available from the C-MORE PDTP

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website: <https://sites.google.com/site/cmoredprofdevtable/home>.

To supplement the core modules, the Professional Development Organizing Committee (PDOC), a leadership council composed of students from across C-MORE institutions, organizes additional professional training. Typically, this happens when the PDOC learns of professional development needs that are not addressed by the core modules—either formally (e.g., by actively polling students through online surveys) or informally (e.g., by word of mouth). Then, the PDOC works with the C-MORE education office to develop and deliver additional “on-demand” workshops or other training activities in areas of specific interest.

Recently, C-MORE’s PDOC offered a four-part workshop series on careers and networking. In this paper, we describe these workshops and discuss their impact on broadening students’ career perspectives and capacity to engage in collaborative exchanges. We describe the student-led planning process, workshop content, and evaluation results, and conclude with reflections from the workshop organizers. Our work highlights the effectiveness of offering professional development beyond traditional graduate student training.

WORKSHOP SERIES OVERVIEW

During fall 2012, three workshops were held at C-MORE institutions in California, Hawaii, and Massachusetts to explore a range of academic and non-academic careers. Then, in February 2013, all participants were invited to attend a national workshop aimed at promoting networking and fostering research collaborations. The idea for this four-part workshop series came to fruition over the course of a year,

during which monthly teleconferences were held by PDOC members to flesh out ideas and write a grant proposal.

The original proposal requested funds to bring students from all C-MORE institutions together for a single two-day workshop. It was submitted to EDventures, an internal C-MORE competition for educational projects that are reviewed according to the two key NSF merit criteria: Intellectual Merit and Broader Impacts (C-MORE, 2013). Reviewers declined the proposal but encouraged resubmission. Based on reviewer comments, the original concept was reformulated into the more cost-effective four-part workshop series described above. The revised proposal was resubmitted to EDventures and fully funded. Thus, even before any training was provided by the various workshops, each PDOC member received valuable hands-on experience on collaboratively developing project ideas, writing an NSF-style proposal (including project summary, project description, budget,

and biographical sketch), obtaining letters of support, and revising and resubmitting a proposal.

CAREER WORKSHOPS

The three local career workshops aimed to: (1) expose students to a range of careers and to professionals within those fields, (2) encourage participants to reflect upon their own skills and interests and consider which careers they might wish to explore further, and (3) actively involve students in planning these workshops to further build their transferable skill sets. PDOC members from the various C-MORE institutions worked closely together to plan these workshops. Three host locations (MIT, UCSC, and UH) were selected due to their critical masses of C-MORE personnel as well as their proximity to the remaining C-MORE institutions (WHOI, MBARI, and OSU). Students were asked to pre-register and to vote for up to three careers to be represented at the workshop from a list of 10 choices.

Table 1. Overview of the Professional Development Training Program modules offered to C-MORE students. Modules generally consist of a combination of training and action components.

Module	Components
Outreach	Complete outreach training and lead one or support three outreach events
Leadership	Serve one year on the PDOC ^a or as review panelist for the EDventures Program ^b , or be (junior) chief-scientist on a C-MORE expedition
Proposal Writing	Participate in a proposal writing workshop, subsequently submit a proposal
Science Communication	Attend a workshop in science communication, subsequently write a communication piece about your science
Diversity	Complete online training, interview someone whose job involves diversity, participate in a C-MORE diversity teleconference plus at an event aiming at broadening participation
Teaching	Fulfill online or in-person training, subsequently practice teaching at any academic level of your choice
Mentoring	Read mentoring booklet, meet with C-MORE’s Education Director and mentor a student on a research project
Research Exchange	Outline proposed research, visit one of the C-MORE institutions to carry out your study, submit a final report

^a PDOC = Professional Development Organizing Committee

^b Internal C-MORE competition for educational projects

The top two selections were governmental institutions and the industry/biotechnology sector, followed by marine science education, environmental consultancy, and “soft-money” research at an academic institution (Figure 2). Following this pre-survey, PDOC members invited leading professionals in the most sought-after fields in each region (Table 2). Each invited speaker was asked to prepare a presentation that included such information as why he or she decided to pursue this career, what he or she liked/disliked about the job, and ways in which graduate-level training could help prepare for this career.

The three workshops each lasted half a day and followed similar formats. In total, there were 70 participants: 27 UH students attended the UH workshop, 31 participants from WHOI and MIT attended the MIT workshop, and 12 students from UCSC, MBARI, and OSU participated in the UCSC workshop. Two PDOC representatives from each geographic region organized and led each workshop. Following welcoming remarks and participant introductions, a panel of four to five invited speakers each gave a ~20–30 minute talk. All

presentations were videotaped and uploaded to a restricted-access area of the C-MORE website. At UH and MIT, the career presentations were followed by questions and an informal networking session over coffee. At UCSC, each career presentation was followed by 15 minutes of questions and informal discussion, and there were two formal afternoon presentations on professional skill development (interviewing and resumes/networking).

All three workshops were evaluated using nearly identical surveys that were administered at the end of each workshop. Mean responses are given in parentheses below. The first section of each survey asked participants to evaluate each speaker’s presentation on a five-point scale: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). Of the 70 participants, 52 (or 74%) completed the post-workshop survey, including 27 at UH, 18 at MIT, and 7 at UCSC. Several MIT and UCSC participants left early and did not complete the evaluation forms. Workshop attendees found the speakers interesting and engaging (UH 4.4–4.8; MIT 4.6–4.7;

UCSC 4.6–5.0) and indicated that the presentations significantly enhanced their understanding of the given career paths (UH 4.6–4.7; MIT 4.4–4.7; UCSC 4.6–5.0).

The second section of each survey asked participants to rank the usefulness of the post-presentation sessions on a five-point scale: 1 (not at all useful), 2 (slightly useful), 3 (moderately useful), 4 (useful), and 5 (very useful). As the content of these sessions varied among institutions, the questions varied accordingly. UH and MIT participants found that the question-and-answer time was very useful (UH 4.5; MIT 4.9) and that the discussions further increased their understanding of various careers and career paths (UH 4.4; MIT 4.8); these questions were not included in the UCSC survey. The informal networking sections at UH and MIT were found to be useful (3.9) and moderately useful (2.9), respectively. At UCSC, the more formal resume/networking session was rated highly (4.2), and the interview skills talk received highly favorable reviews (5.0). On a scale of 1 to 10, the participants gave the UH, MIT, and UCSC workshops an average overall ranking of 8.5, 8.9, and 9.3, respectively. When asked “Would you recommend this workshop to a peer?” or “Would you consider attending future C-MORE events?” all respondents answered “Yes.” Open-ended comments included: “It was great to hear from such a diverse group of speakers. It introduced me to jobs I didn’t know existed or didn’t understand the nuts and bolts of.” “I appreciated that the speakers were all young and had recent experience with the job market.” “Very refreshing to hear about career opportunities outside of academia.”

Although all three workshops received strong evaluations overall,

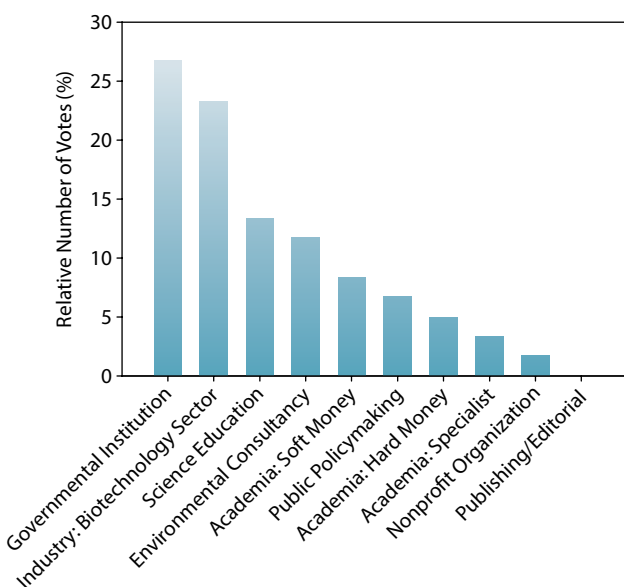


Figure 2. In a pre-survey, registered participants were asked to vote for up to three careers to be represented at their local career workshops. Results varied by region but are combined here. Speakers in each region were invited in view of pre-survey results (see Table 2).

the networking sessions received the lowest rankings. Participant comments included: “Not much time for this” (MIT), or “It would have been nice to have had multiple networking sessions, especially an additional session at the end of the morning after all speakers presented” (UH). Even though the more formal format chosen as part of the UCSC workshop was rated as more useful (4.2, compared to 3.9 at UH and 2.9 at UH), some participants felt that “The networking session was not targeted towards the graduate student and post-doc level.” Fortunately, the upcoming networking workshop provided a second chance to address these deficiencies.

NETWORKING WORKSHOP

The national networking workshop was held in conjunction with the Aquatic Sciences Meeting in New Orleans, Louisiana, in February 2013. The main objectives of this final workshop were to: (1) provide an opportunity for students to network and communicate their science to their peers, (2) create a foundation for potential future collaborations, and (3) actively involve students in planning the workshop to further build their transferable skill sets.

As with the three career workshops, the networking workshop was developed, organized, and facilitated by the

PDOC; C-MORE faculty played an advisory role. Prior to the workshop, participants were asked to prepare a one-page summary of their current research, potential future project interests, and the skills/expertise they could offer or would be seeking in a collaboration. These one-page summaries were compiled and distributed at the workshop along with a list of conference preparation tips to help students get the most out of the conference. The conference preparation guidelines, which included preparing business cards, updating your CV and Web presence, making a list of people to meet, and preparing an “elevator speech,” were also distributed electronically prior to the meeting.

The networking workshop lasted a full day and was attended by 24 people from six C-MORE institutions in Massachusetts, New York, California, Oregon, and Hawaii. Attendees included 10 graduate students, nine postdocs, two alumni (who currently serve as faculty at non-C-MORE institutions), two faculty, and one staff member. Participant motivations varied. For some, this workshop was an opportunity to reconnect with colleagues from other C-MORE institutions. For others, it was a chance to meet people that they had only previously communicated with online.

The workshop began with registration, welcoming remarks, and an overview of

the Professional Development Training Program. Participants then introduced themselves by stating their research interests and what they might offer/seek in potential collaborations. Participants spent the remainder of the morning in a “speed networking” exercise, where they discussed common research interests and discussed ideas for potential collaborations in pairs that rotated roughly every two to three minutes. Following a lunch break, participants self-selected into breakout groups, which were aligned with C-MORE research themes focused on microbial diversity (Theme I), metabolism and C-N-P cycles and energy flow (Theme II), remote sensing and links to climate variability (Theme III), and ecosystem modeling, simulation, and prediction (Theme IV). Each thematic subgroup spent one hour exploring ideas for potential collaborations and then reported back in a plenary session. The two faculty participants then shared practical tips on how to further develop these ideas into potential collaborations and how to obtain funding from internal (C-MORE EDventures) as well as external (e.g., NSF) funding sources. The workshop ended with an evaluation survey, and another survey was administered two months later.

Nearly all participants (23 of 24) completed the workshop evaluation survey, which was divided into four

Table 2. List of career paths represented at each workshop following the results of a pre-survey. Workshop participants were asked to vote for careers most interesting to hear about.

University of Hawaii	Massachusetts Institute of Technology	University of California, Santa Cruz
<ul style="list-style-type: none"> • Marine Science Educator • Environmental Consultant • Lead Scientist, Governmental Institution • Researcher, Academia (Hard Money) • Researcher, Academia (Soft Money) 	<ul style="list-style-type: none"> • Environmental Consultant • Program Officer, Funding Agency • Scientist, Energy Industry • Founder/Director, Nonprofit Organization 	<ul style="list-style-type: none"> • Researcher, Academia (Hard Money) • Scientist, Governmental Institution • Founder/Director, Biotechnology Company

Hard Money = Most of the salary is covered by academic institution
Soft Money = Substantial part (or all) of the salary is generated through externally founded research grants

sections: (1) pre-workshop preparation and communication, (2) the C-MORE experience, (3) planning future research collaborations, and (4) overall impressions. The first section included six questions on pre-workshop preparation and communication and asked participants to rate each on a scale of 1 (not at all useful) to 5 (very useful). Mean

section ranged from 4.0 to 4.6, indicating a high level of satisfaction with the second part of the workshop (because all statements were positively worded). The one statement “Break-out groups were effective in identifying areas for future collaborations” received a mean rating of 3.5. However, the final question in this section, “Overall, I found this session on

I already knew everyone in the one category that seemed relevant to my science. It was good to learn about other areas, but I found it hard to contribute. Perhaps if the topics were a little more broad, it might have been easier for me to contribute to more breakout topics.”

A second survey was administered electronically approximately two months following the event. It was primarily intended as a reminder to encourage participants to continue exploring collaborations. A total of 13 (or 54%) of workshop participants responded. Except for one participant, all (12) respondents indicated that they are planning to continue developing collaborations with one to four persons in the near future. In addition, some of the workshop participants were inspired to identify their own professional training needs, resulting in the successful submission of four EDventures proposals.

“ WE ANTICIPATE THAT GRADUATE STUDENTS AND POSTDOCS AT OTHER ACADEMIC INSTITUTIONS WILL BE ENCOURAGED TO FOLLOW THIS EXAMPLE AND WILL BE INSPIRED TO OFFER SIMILAR WORKSHOPS TO THEIR PEERS. ”

responses to each question ranged from 3.8 to 4.3, indicating that the average participant found the advanced preparation and communication to be useful. The second section included four statements on the workshop introduction and overview presented by the PDOC and the participant self-introductions. For each statement, participants were asked to state their agreement on a scale of 1 (strongly disagree) to 5 (strongly agree). All statements were positively worded, and mean responses ranged from 4.4 to 4.8, indicating a high level of satisfaction with the first part of the workshop.

The third section of the survey focused on planning future research collaborations and included nine statements on topics such as speed collaborating, breakout groups, and faculty presentations on “next steps.” Mean responses to all but one statement in this

planning future research collaborations to be useful and informative,” received a mean response of 4.4, indicating strong to very strong agreement with this statement. The final part of the survey asked for overall impressions. On a scale of 1 (very poor) to 10 (excellent), participants gave the entire workshop a mean overall ranking of 8.3. All but one participant (96%) would recommend this workshop to a peer, and 100% of participants reported that they would be interested in attending future workshops offered by the PDOC.

The survey explicitly solicited suggestions and comments. Sample responses included: “I really liked the two-minute speed-networking session. It was very important to hear what everyone studied before we discussed further collaboration ideas.” “Breakout groups—I chose to be a part of a breakout group that was outside my area of expertise because

REFLECTIONS

Based on the participant evaluations and the workshop organizers’ own impressions, PDOC members considered the four-part workshop series to be an overall success. Some highlights included the opportunity to provide input into which careers were included, the presentations on both academic and non-academic careers, discussing common research interests, and exploring potential future collaborations with peers from the various C-MORE institutions. If given the opportunity to conduct a similar workshop series in the future, we would make a few changes, particularly regarding networking. At the career workshops, we would restructure the networking component to make it more formal. If using outside facilitators, as we did at the UCSC workshop, we would preview the content and format to ensure they

are appropriate. In addition, we would allocate time for informal small group discussions with each speaker following the presentations. These improvements would better enable students to openly ask questions, engage in discussions about careers of interest, network, and explore future job opportunities.

For the networking workshop, we would compile and distribute the booklet of research summaries further in advance. This would allow participants to better prepare for interactions with other researchers and aid with suggesting potential breakout group topics of interest. This would also increase question quality and enliven discussion during the breakout sessions, which were the most critically reviewed component of the workshop. Furthermore, we would expand the participation of faculty members because their participation, albeit limited, received highly favorable evaluations. Preferably, we would seek early-career faculty, hoping that they could share information about their current jobs and funding situations as well as any previous soft-money or temporary positions.

As organizers of the workshops, we developed team-based, transferable skills that are useful in any future career track. As a group of students from multiple institutions, we (1) wrote and submitted an NSF-style proposal and reported on our work (oral and written), (2) developed a budget in accordance with federal per diem limits and internal guidelines, (3) organized and executed the workshops, (4) constructed an evaluation survey, (5) analyzed survey data, and (6) are now submitting a manuscript on a topic other than our own research. Throughout the entire process, we benefited from the guidance of C-MORE faculty, administrators, and


senior management, which provided us with constructive feedback on all of these efforts.

CONCLUSION

Only a small percentage of PhDs continue on to academic research positions. Graduate training should—but rarely does—include comprehensive information on careers outside of academia as well as enhanced networking opportunities for connecting with professionals in a range of fields. To address this training gap, the C-MORE PDOC developed a four-part professional workshop series on careers and networking during which participants were able to explore a host of career options, develop networking skills, and explore potential future collaborations. For members of the PDOC who planned and led the workshops, this effort provided an exceptional leadership experience that has significantly contributed to our professional development in innumerable ways. We anticipate that graduate students and postdocs at other academic institutions will be encouraged to follow this example and will be inspired to offer similar workshops to their peers. In addition, we recommend that academic institutions and science education programs consider expanding time and resources devoted to professional development programs to prepare the next generation of scientists to be successful in today's competitive job market.

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