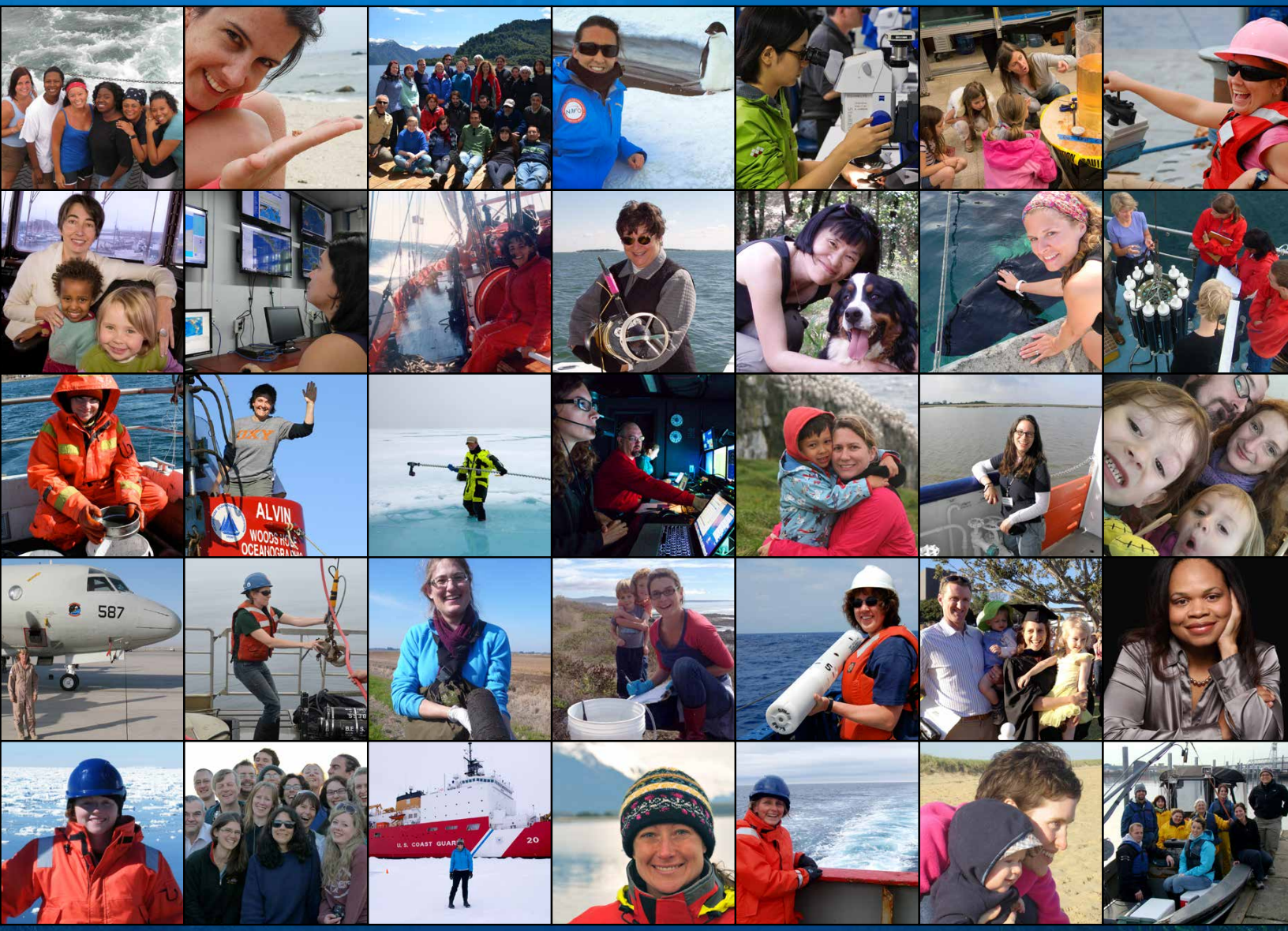
Women in Oceanography

A Decade Later



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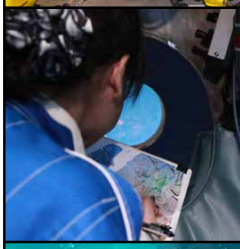
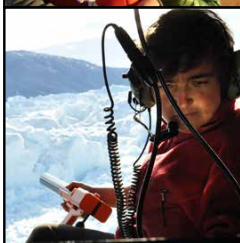
Contents





FEATURES

SIDEBARS

AUTOBIOGRAPHICAL SKETCHES

List of Autobiographies

Natsue Abe
Fatima Abrantes
Diane K. Adams
Miho Asada
Amanda Babson
Johanna Baehr
Barbara Balestra
Sibel Bargu
Lisa Beal
Janet M. Becker
Claudia Benitez-Nelson
Kelly Benoit-Bird
Heather Benway
Elisa Berdalet
Kim S. Bernard
Joan M. Bernhard
Nihayet Bizsel
Carol Anne Blanchette
Paula S. Bontempi
Helen Bostock
Mya Breitbart
Deborah A. Bronk
Sandra Brosnahan
Kristen Buck
Lisa Campbell
Elizabeth A. Canuel
Antonietta Capotondi
Claudia Cenedese
Ivona Cetinić
Silvia Chacón-Barrantes
Teresa Chereskin
Sanae Chiba
Mireille Chinain
Sallie (Penny) Chisholm
Gail Christeson
Joan S. Cleveland
Paula Coble
Robyn N. Conmy
Sarah Cooley
Marie-Helene Cormier
Meghan F. Cronin
Kendra L. Daly
Kate Darling
Xujing Jia Davis
Marie de Angelis
Agatha de Boer
Christina L. De La Rocha
Laura de Steur
Petra S. Dekens
Virginia P. Edgcomb
Henrietta N. Edmonds
Katherine B. Emery
Gemma Ercilla
Carlota Escutia
Marta Estrada
Kelly Kenison Falkner
Kristina Faul
Helena L. Filipsson
Rana A. Fine
Jessica Fitzsimmons
Kathryn H. Ford
Eleanor Frajka-Williams
Marga García
Carmen García-Comas
Marisol García-Reyes
Joan M. Gardner
Silvia L. Garzoli
Deidre M. Gibson
Sarah N. Giddings
Sarah Gille
Mirjam Sophia Glessmer
Patricia M. Glibert
Shana Goffredi
Jennifer A. Graham
Hazel Grant
Cheryl Greengrove
Silvia B. Gremes-Cordero
Annalisa Griffa
Cécile Guieu
Naomi Harada
Lois Harwood
Rachel Haymon
Kate Hendry
Stephanie Henson
Karen J. Heywood
Barbara Hickey
Jenna C. Hill
Tessa M. Hill
Penny Holliday
Bärbel Hönisch
Emilie Hooft
Meredith D.A. Howard
Julia M. Hummon
Susan E. Humphris
Deborah R. Hutchinson
Alexandra Isern
Libby (Elizabeth) Johns
Ashanti Johnson
Elizabeth (Libby) Jones
Ellen Kappel
Miriam Kastner
Suzan Kholeif
Gail C. Kineke
Emily M. Klein
Karen L. Knee
Yoshimi Kubota
Elizabeth Kujawinski
Kara Lavender Law
Sonya Legg
Erika Lentz
Frances Lightsom
Susan Lozier
Allison Luengen
Amy Maas
Jennifer MacKinnon
Maria Beatrice Magnani
Briony Mamo
Clara Manno
Nancy Marcus
Irina Marinov
Marinna Martini
Patricia A. Matrai
Erin McClymont
Cecilia M. Gonzalez-McHugh
Galen A. McKinley
Marcia McNutt
Erika McPhee-Shaw
Ellen L. Mecray
Sunshine Menezes
Amélie Meyer
Anna Michel
Furu Mienis
Rachel Mills
Mary Ann Moran
Colleen Mouw
Barbara Muhling
Lauren Mullineaux
Sarah J. Norris
Joanne O'Callaghan
Mónica V. Orellana
Tuba Özkan-Haller
Jaime Palter
Uta Passow
Adina Paytan
Sara Pensieri
Renellys C. Perez
Laetitia Pichevin
Helle Ploug
Julie Pullen
Andrea M. Quattrini
Berit Rabe
Nicole Raineault
Beatriz Reguera
Clare E. Reimers
Angelika Renner
Mariana Ribas Ribas
Mary Jo Richardson
Paola Malanotte-Rizzoli
Robin Robertson
Anastasia Romanou
Leslie Rosenfeld
Carolyn Ruppel
Ann D. Russell
Grace Saba
Claudia Schmid
Astrid Schnetzer
Magali Schweizer
Tiziana Sgroi
Evelyn B. Sherr
Amelia E. Shevenell
Ingunn Skjelvan
Caroline Slomp
Deborah K. Smith
Heidi M. Sosik
Kristen D. Splinter
Janet Sprintall
Rachel Stanley
Deborah K. Steinberg
Fiamma Straneo
Kathryn Sullivan
Chaojiao Sun
Kazuyo Tachikawa
Patricia Tester
Debbie Thomas
Anne Williford Thompson
Diane Thompson
LuAnne Thompson
Kristen Thyng
Masako Tominaga
Marta E. Torres
Elizabeth Turner
Tina van de Flierdt
Diana E. Varela
Lourdes Velo-Suárez
Penny Vlahos
Kathleen Wage and
Lora Van Uffelen
Angelicque E. White
LeAnn Whitney
Gunda Wieczorek
Branwen Williams
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Karen Wishner
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Şükran Yalçın Özdilek
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Introduction

By Ellen S. Kappel

WHY ANOTHER "WOMEN IN OCEANOGRAPHY"?

A decade ago—March 2005—The Oceanography Society published a special issue of this magazine on "Women in Oceanography." The issue's goal was to explore why men continued to vastly outnumber women at the higher levels of the field, even as the number of female graduate students grew steadily. We captured our story through statistical measures, longer narratives, articles describing some innovative US programs that were conceived to promote women and retain them in science, technology, engineering and mathematics (STEM) fields, and one-page autobiographical sketches written by women oceanographers (http://tos.org/oceanography/archive/18-1.html). In stitching together this latest compendium, "Women in Oceanography: A Decade Later," the steering committee (Box 1) used the same tools to illuminate both the progress that has been made in addressing career barriers since the last volume was published and areas where further attention might still be needed.

Some of the women who were invited to contribute to this supplement wanted to know why we needed to perform this exercise again, implying that gender equity is an outdated issue. Look around—professional women are more visible at every level. Women oceanographers have won major awards. They are directors of large oceanographic institutions and head major US federal government agencies. But despite these well-deserved achievements, the numbers make clear that the oceanographic community should not be complacent and must continually expose inequities and consciously promote our female colleagues because gender bias still exists, even in our highly educated circles.

The seed for this second "Women in Oceanography" volume was planted a few years ago during informal discussions with a small group of women oceanographers. They advised that the timing had to be right. The consensus was that 10 years after last volume was published made the most sense. A decade was a reasonable period of time over which to evaluate any progress made in retaining women in the field, and some of the programs described 10 years ago would have matured to a point where evaluation was possible. The next step was to elevate our group into a more formal steering committee and include some early career women oceanographers and others who were interested in the topic.

Like the first "Women in Oceanography" volume, this compendium consists of a few articles that review the issues and evaluate the numbers, two articles that review US programs intended to help promote women and retain them in oceanography, and more than 200 autobiographical sketches that provide a more personal view of the joys and struggles of being a woman oceanographer. **ORCUTT AND CETINIĆ** provide an overview of STEM issues related to gender and the unique challenges that women oceanographers face in pursuing a successful career. They probe a bit more deeply into the number of junior, mid-career, and senior faculty at 26 institutions in the United States with oceanography programs, review the number of women chief scientists on some US and non-US research vessels, and offer some recommendations for overcoming the challenges. **O'CONNELL** compares the numbers of PhD graduates in the geosciences and those in the specific oceanography discipline at US universities to the percentage of women who serve on oceanographic institution faculties, have been co-chief scientists on scientific ocean drilling ships, or have been named fellows of geoscience

BOX 1. STEERING COMMITTEE

CHAIR: Ellen Kappel, Geosciences Professional Services Inc.

Robin Bell, Lamont-Doherty Earth Observatory of Columbia University

Kristen Buck, University of South Florida

Sarah Clem, Duke University

Peggy Delaney, University of California, Santa Cruz

Sonya Legg, Princeton University

Susan Lozier, Duke University

Amelia Shevenell, University of South Florida

LuAnne Thompson, University of Washington

societies in the past decade. **KAPPEL AND THOMPSON** look more specifically at how many women have been invited speakers at small conferences, first authors of *Oceanography* articles, and American Geophysical Union Ocean Science Fellows. **HOLMES** discusses some of the barriers to retaining women in STEM fields exposed by the US National Science Foundation's ADVANCE program and offers solutions that focus on transforming the institutions, not fixing the women. **CLEM ET AL.** review the success of the Mentoring Physical Oceanography Women to Increase Retention (MPOWIR) program in retaining women in that specific field and how the program continues to evolve and improve after each evaluation.

While these articles focus on US numbers and issues, the autobiographical sketches contributed by women from around the globe provide a broader view of women in oceanography. These essays trace the career trajectories of women who shared their stories a decade ago and the twists and turns navigated by a new crop of scientists. Several early career scientists emphasize how much the 2005 special issue inspired them when they were graduate students (Box 2). More senior women provide advice on how to navigate career obstacles (Box 3). These autobiographies also provide readers with a wonderful sense of what oceanographers do. The authors describe their science simply, thoughtfully, and passionately. Many cite the enduring friendships and gratifying international collaborations that result from going to sea. The stories bring out the excitement of being on a research vessel to deploy instruments and gather data and the privilege of visiting Antarctica or other exotic places. The stories also demonstrate how committed these women scientists and engineers are to adding critical knowledge about our planet on topics as varied as climate change, ocean health, and natural hazards.

The autobiographical sketches disclose some positive signs for women oceanographers. Many early career women say that they haven't felt any gender bias—though some acknowledge that it is still out there and stay attuned to the signals. These young scientists recognize the efforts of earlier women oceanographers who worked hard to remove barriers to advancement in the field and to going to sea. More-senior women tell of how there are noticeably more women at scientific conferences—heavens, a line at the women's bathroom—and how women are much more visible on ships in the various roles of scientist, technical support staff, and crew. They see more women on their hallways and at faculty meetings, which makes it easier to openly discuss gender-related issues. Deans and department chairs no longer need to be informed of their institutions' stop-the-tenure-clock policies for parents of young children. Some universities now work very positively with dual-career couples who apply for faculty positions.

And yet, the number of women rising through the tenure track appears to be stagnant—and not close to what might be expected given the number of PhDs earned by women a decade or two ago. Similarly, the number of women being elected society fellows, holding chief scientist positions, or being invited to speak at small conferences lags. Several women note in their autobiographies the exceptionally poor turnout of women versus men recently applying for faculty positions at their institutions. If some women

BOX 2. THE 2005 "WOMEN IN OCEANOGRAPHY" SPECIAL ISSUE INSPIRED A NEW GENERATION

One gratifying aspect of putting together this compendium was reading notes from early career scientists saying how the 2005 "Women in Oceanography" volume was an inspiration. If there was any question at all as to whether publishing another compendium was needed, some of these emails dispelled any doubts. Some examples:

"Thanks…for the 2005 issue which was an inspiration while I was in grad school."

"I am excited to contribute—I was a graduate student when the first article came out and I felt really inspired by the women's autobiographies, all of which I eagerly read!"

"As a graduate student who was inspired by the 2005 volume, it'd be my honor if my article will make a contribution to the upcoming volume."

"As an aside, thank you very much for making another issue of this topic. Coming out the year before I started graduate school, the first issue gave me important insight into the complex pathways women took in oceanography and served as a fount of advice as I made my own choices. I am looking forward, in particular, to seeing how the lives of all of these women have changed in the past 10 years."

"I have a copy of the 2005 edition and it was certainly an inspiration to me when I was looking for my job at that time."

remove themselves from seeking academic jobs early in their careers, and others take jobs but later "leak from the pipeline," then parity at the full professor level is a long way from being attained.

MANY OF THE SAME ISSUES REMAIN

This "Women in Oceanography: A Decade Later" compendium demonstrates that some issues that plagued women a decade ago persist. Nearly every autobiography describes the work-life balance as the biggest challenge. For a female scientist, having a partner who supports her career and does an equal amount of childcare and housework is the biggest factor in being able to remain competitive, including going to sea for weeks at a time, attending meetings in far-flung places, or staying in the lab for extended hours. Women speak of their well-traveled children who learned early on how to wheel a suitcase or who come to the lab with them on weekends. The flexibility to write papers and proposals at home is cited as another positive family-friendly factor in remaining in academia. This kind of flexibility is valuable for not only staying home with a sick child, but also for caring for aging parents. Needless to say, such flexibility benefits men as well as women.

Doing fieldwork, especially going to sea for weeks or months at a time, will always be a consideration for women (and men) who choose to be observationalists. Some women took a hiatus from going to sea for several years when their children were young. Others temporarily changed their scientific focus to nearshore problems that didn't require being away for long periods on ships. A few others moved into more computational areas, using publicly available oceanographic data (e.g., from satellites or drifters) so that they didn't have to go to sea. Another solution that worked for some was to send their graduate students to sea to collect data, at least for a while. Technology has also made it easier to stay on shore and still participate in a cruise. To pursue the science they love and a career that they believe in, women find many creative solutions to maintaining active scientific programs.

The "two-body problem" of partners seeking academic positions at the same institution doesn't seem to loom as large as it did a decade ago, at least in the United States. One autobiographical sketch from a US scientist stated: "We have been positively overwhelmed by the numerous resources available to us to solve our 'two-body problem.'" Another discusses how her family's two-body problem was solved at a supportive US institution in a manner that would have been impossible, or at least much more difficult to solve, at home in Europe. Not all the stories are as rosy. Some couples commute long distances or live apart for years in different states or countries to seize the best career opportunities, or one partner compromises his or her career so that the couple can live together. Moreover, sometimes building a career in scientific research prevents women from even reaching the stage of confronting the two-body problem. Early career scientists often move from country to country for postdocs and for jobs until landing something more permanent. While living in another culture can be enriching and the science experience broadening, being a nomad can make it difficult to build long-term relationships, and being far from family and friends can be stressful and lonely.

BOX 3. SOME ADVICE

Women whose autobiographical sketches were published a decade ago were asked to include advice for early career scientists in their updated profiles for in this compendium. By far the most cited advice is to find mentors (women and men) both inside and outside their own institutions—and lean on and gain strength from them. Having a variety of mentors during the early career stages can be essential to success. Having peers helps, too. Several women talked about being part of a group of female colleagues who meet at specified intervals and how these women have been very valuable sounding boards at all stages of their careers.

Our contributors were not shy about offering advice. A few samples:

- Remain focused and keep your priorities clear; be persistent.
- Work on problems that keenly interest you, work with colleagues with whom you feel free to say something stupid or share a laugh, gather mentors, become a mentor yourself, build community.
- Take advantage of all opportunities to expand your horizons and collaborate with colleagues from diverse fields.
- Take something positive from every professional experience—you don't know what skills will come in handy down the road.
- Take care of female colleagues and find opportunities to enrich our community of women scientists. Reach out to a female colleague and start a new collaboration, co-chair a committee, co-advise a student, or co-teach a course.

Many of the autobiographical sketches brought up the issue of funding, which affects women and men alike, both within and outside of the United States. Spending long hours writing proposal after proposal is stressful, and having to propose new and clever ideas when the data gathered from ongoing projects have not been fully analyzed is frustrating. The contraction in science funding creates other anxieties, such as whether sufficient funding will be available to retain graduate students, postdocs, and technical staff and conduct all planned activities. Obligations such as conducting "broader impact" activities and sharing and reporting data eat into productivity. Some women cited the difficulty of remaining optimistic and motivated when constantly struggling to maintain funding. While there is no magic solution to this perennial problem, some of the autobiographies offer suggestions on how to increase funding prospects, such as broadening research in new directions, seeking new collaborations, and applying for funding from a larger variety of sources (from federal agencies to local foundations).

Despite the variety of the impediments encountered along the path to a successful career, the overwhelming majority of the authors of the autobiographies say they love their science and are very happy with their careers. The joy of scientific discovery and the sense of adventure far outweigh the pebbles, boulders, and occasional mountains that they encountered along their journey. Some challenges turned out to be opportunities.

SOME FINAL THOUGHTS

This compendium demonstrates that two complementary paths should be taken to increase retention of women in oceanography. Over the longer term, mentoring and creating supportive work environments are essential. With a concerted effort through organized programs such as MPOWIR and through informal mentoring efforts that become widespread, the number of women who choose academic jobs as a career—and remain to become full professors or senior scientists—should increase, though perhaps slowly. Similarly, family-friendly practices at institutions need to become commonplace as well. More immediately, the oceanographic community consciously needs to promote deserving female colleagues, nominate women for awards, and invite women to speak at a conferences or department seminars and first-author articles in journals. All of these practices will quickly increase the visibility of outstanding women scientists within and outside of their institutions, whether academic, government, nongovernmental, or industry, and will create positive feedback loops. With women more visible at high-level positions on shore and at sea, gender bias will likely decline as well. If we work together as a community to retain more women in the ranks of professional oceanography, perhaps one last "Women in Oceanography" volume a decade from now can be devoted to highlighting how parity for women has been achieved.

ACKNOWLEDGEMENTS. I would like to thank the members of the "Women in Oceanography" steering committee for their thoughtful advice in putting together this compendium. Not only were they an excellent sounding board and a source of wisdom, they shared the work of inviting articles and conducting peer review. I would also like to thank the Office of Naval Research for generously providing funding for production of this *Oceanography* magazine supplement.

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Women in Oceanography: Continuing Challenges

By Beth N. Orcutt and Ivona Cetinić

ABSTRACT. Women began to join US oceanographic expeditions in about 1960, contemporary with the modern women's rights movements in the industrialized world. Female representation in academic research has increased since then, but the ratio of women to men at higher ranks in oceanography still lags, even though women have comprised roughly half of oceanography graduate students during the past decade. Here, we examine recent trends in the representation of women in oceanography, highlighting indicators of under-representation among oceanographic faculty and chief scientists of oceanographic expeditions, and also noting positive signs of improvement. We discuss modern challenges to women in academic science, and oceanography in particular, and how they influence the career choices of women in oceanography. We provide recommendations for overcoming internal and external obstacles to career success that should be useful to students and early career women oceanographers as well as search committees, deans, department chairs, and program managers who have the power to hire and promote female colleagues.

INTRODUCTION

Significant contributions of women to the scientific investigation of the ocean have been relatively recent. With very few exceptions, the genesis of ocean-going women oceanographers in the Western world can be traced to the late 1950s and early 1960s, as detailed in Bonatti and Crane's (2012) article on the early challenges of women in oceanography. Remarkably, the first female oceanographer allowed to sail on a United States oceanographic expedition in her own right—Betty Bunce of the Woods Hole Oceanographic Institution—was also the 1959 expedition's chief scientist. Bunce also has the honor of being the first woman scientist to dive in the *Alvin* submersible and the first female chief scientist in the Deep Sea Drilling Project (Lavoie and Hutchinson, 2005). The women who preceded her at sea—Jeanne Baret French in the 1760s, Marie Poland Fish in the 1920s, Helen Raitt and Barbara Lawrence in the early 1950s, and Roberta Eike in the mid 1950s—stowed away, dressed as a man, or were only permitted to sail because their husbands were also on board. However, these trail-blazing women set the stage for future generations of female oceanographers.

As early career female oceanographers puzzled by the relative dearth of female role models at the top levels of academic oceanography, we set out to examine the modern trends and obstacles to female participation in our field, based on efforts that began a decade ago to understand and tackle this issue (Bell et al., 2005; Lavoie and Hutchinson, 2005; Lozier, 2005; Marcus, 2005; O'Connell and Holmes, 2005). Undoubtedly, since the early 1960s, the acceptance of women at sea has improved, yet the representation of women in top levels of oceanography today remains low. This article presents broad trends related to the general challenges women encounter in science and then chronicles the current state of women in oceanographic academia. We focus on statistics from the United States, where we are oceanographers, but include data from other countries where available. We offer this analysis with the hope that it will provide guidance to students

considering a career in oceanography, to early career women navigating the career ladder, and to search committees, deans, department chairs, and program managers who make decisions that affect women in oceanography.

WOMEN IN SCIENCE IN THE UNITED STATES

The percentages of female role models in US academic faculty remain remarkably low, even several decades after enactment of equal opportunity and antidiscrimination laws, including Title IX (1990) and the Women in Science and Technology Equal Opportunity Act (1990). This paucity is not likely due to a lack of women in the pipeline (Shen, 2013), as determined by a National Science Foundation survey (NSF, 2013) and summarized in Table 1. For example, over the past decade, more than half of all science and engineering undergraduates were women (57%), more than half of bachelor's degrees (56%) and master's degrees (52–54%) have been awarded to women, and nearly half of doctoral degrees (44–47%) were earned by women (NSF, 2013). In contrast, women employed in the academic ranks of science and engineering fields at four-year universities comprised only 43% of the assistant professor level, 34% at the associate professor level, and 21% at the full professor level (NSF, 2013). Moreover, only 26% of currently tenured professors and only 39% of tenure-track professors are women (NSF, 2013). These data show that the gender gap is smaller at the junior faculty level than at the senior faculty level; women comprise 43% of assistant professors, similar to the percentage of women awarded doctoral degrees over the past 10 years (NSF, 2013).

WOMEN IN OCEANOGRAPHY

To better understand how women academics in oceanography are faring, we examined trends for women in leadership roles, including percentages of women faculty at oceanographic

Table 1. Summary statistics on gender ratio in various aspects of academia, as presented in the 2013 report from the National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering* (NSF, 2013). S&E = science and engineering.

	2002			2012			Source Table
	Total	Female	% F	Total	Female	% F	
STUDENTS							
Undergraduate Students – All	14,444,738	8,178,266	57%	17,963,547	10,151,705	57%	2-1
S&E Graduate Students – Science	na	na	na	413,033	207,997	50%	3-1
S&E Graduate Students – Oceanography	na	na	na	2,642	1,481	56%	3-1
DEGREES							
Associate's Degrees – Science	49,913	21,287	43%	81,103	35,376	44%	4-1
Bachelor's Degrees – Science	355,378	198,626	56%	506,067	281,558	56%	5-1
Master's Degrees – Science	73,740	38,148	52%	118,221	63,665	54%	6-1, 6-2
Master's Degrees – Oceanography	114	53	46%	153	86	56%	6-1, 6-2
Doctoral Degrees – Science	19,058	8,417	44%	26,487	12,518	47%	7-1, 7-2
Doctoral Degrees – Oceanography	90	36	40%	115	55	48%	7-1, 7-2
Postdocs – Science	na	na	na	36,378	14,076	39%	8-1
Postdocs – Oceanography	na	na	na	446	203	46%	8-1
S&E OCCUPATIONS							
Full Professor	na	na	na	75,800	15,800	21%	9-23
Associate Professor	na	na	na	51,700	17,600	34%	9-23
Assistant Professor	na	na	na	47,900	20,500	43%	9-23
Other Faculty	na	na	na	13,700	6,100	45%	9-23
Tenured	na	na	na	110,800	28,500	26%	9-23
On Tenure Track	na	na	na	37,300	14,600	39%	9-23
Not On Tenure Track	na	na	na	27,900	11,800	42%	9-23
S&E OCCUPATIONS AVERAGE SALARIES							
All S&E Degrees	na	na	na	$83,000	$69,000	83%	9-16
Doctoral Degrees	na	na	na	$95,000	$72,000	76%	9-16

institutions and of chief scientists on oceanographic research expeditions, as compared to the percentages of women who earned oceanographic PhDs in the United States from a few years ago to just over a decade ago (Tables 1, 2; Figures 1, 2). Our analysis shows that women continue to drop out as they progress along the tenure track, similar to the patterns identified across all fields of science mentioned above, as well as to results of similar but smaller surveys presented elsewhere (O'Connell and Holmes, 2005; Thompson et al., 2011; O'Connell, 2014, in this supplement). However, there are also some signs of improvement over the past decade.

Examining current faculty gender ratios at 26 major oceanography programs in the United States reveals several trends (Table 2, Figure 1). First, the median percentage of females at all faculty levels is lower than expected given the percentage of oceanography doctoral degrees awarded in the past decade or more (compare to Table 1). Second, the percentage of females decreases with increasing faculty rank, from 40%

Table 2. Gender ratio of student population and current faculty in major oceanography programs in the United States, sorted by student population size. Student population demographics were gathered from publicly available data from the Peterson's Nelnet LLC online database in fall 2014, and faculty demographics from publicly available institution websites in fall 2014 (excluding emeritus and adjunct faculty). Note that student numbers do not separate undergraduate versus graduate level students.

Institution	Students		Assistant Professor		Associate Professor		Full/Senior Professor	
	Total #	% Female	Total #	% Female	Total #	% Female	Total #	% Female
Scripps Institution of Oceanography	269	47%	14	29%	11	27%	74	16%
MIT/WHOI* Joint Program	128	48%	37	27%	60	23%	107	18%
University of South Florida	102	59%	5	40%	8	25%	13	15%
University of Washington	78	51%	13	23%	20	30%	42	21%
Louisiana State University	77	56%	7	14%	9	22%	14	0%
University of Hawaii	77	58%	0	0%	10	30%	44	14%
University of Rhode Island	73	63%	2	0%	5	100%	20	15%
Texas A&M University	70	50%	1	100%	4	50%	14	14%
University of Colorado Boulder	60	47%	4	100%	4	25%	4	25%
University of Alaska Fairbanks	58	69%	13	46%	10	40%	23	35%
University of Massachusetts Dartmouth	58	47%	3	0%	4	0%	15	13%
Florida State University	57	51%	6	50%	0	0%	11	9%
University of Maine	54	56%	2	50%	6	67%	19	21%
University of Southern Mississippi	53	42%	3	0%	4	0%	5	20%
Oregon State University	46	50%	23	48%	23	13%	56	20%
College of Charleston	45	73%	10	40%	15	40%	9	0%
University of Miami	42	24%	4	50%	18	44%	51	6%
University of California, Santa Cruz	40	65%	2	100%	1	0%	6	33%
University of North Carolina, Chapel Hill	40	58%	4	0%	3	0%	14	21%
Old Dominion University	38	55%	5	20%	11	45%	7	0%
University of Connecticut	38	58%	4	75%	7	43%	9	11%
University of Georgia	32	56%	6	33%	9	33%	11	27%
Rutgers University	29	66%	5	80%	4	50%	21	5%
University of California, Santa Barbara	21	67%	0	0%	2	50%	23	17%
University of Delaware	na	53%	12	50%	17	29%	29	14%
University of Southern California	na	na	1	100%	4	25%	13	8%

* MIT/WHOI: Massachusetts Institute of Technology/Woods Hole Oceanographic Institution

at the assistant professor level to 30% at the associate professor level to 15% at the full or senior faculty level. This trend is consistent with those observed earlier for the field of oceanography (Marcus, 2005; O'Connell and Holmes, 2005) and in a more recent survey (O'Connell, 2014, in this supplement). However, it is worth noting that the percentages of women at all levels have increased by roughly 5% to 15% in the past decade. For example, an earlier study reported oceanography faculty-rank female gender percentages of 25–30% at the assistant professor level, 17–25% at the associate professor level, and roughly 10% at full professor level (O'Connell and Holmes, 2005), while more current assessments indicate increases to 35%, 33%, and roughly 20% at the assistant, associate, and full professor levels, respectively (O'Connell, 2014, in this supplement). While the percentages reported here vary from those reported elsewhere (O'Connell, 2014, in this supplement), note that our analysis includes 26 oceanographic institutions whereas other analyses include far fewer programs, and all may suffer from the statistics of small numbers. The final trend is the larger variation at lower faculty ranks, where some programs have 100% female faculty, which may reflect increased efforts at female recruitment for lower rank positions.

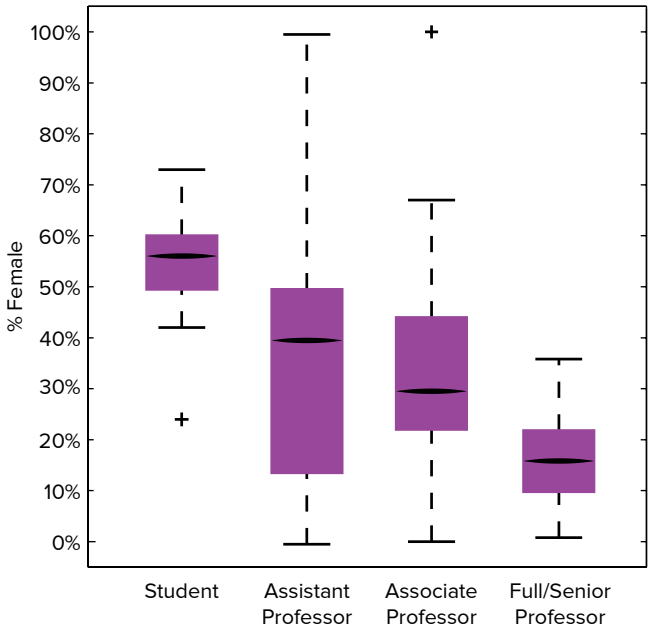

Figure 1. Box-and-whisker plot of the median, upper and lower quartiles, and maximum and minimum female representation in student population and assistant, associate, and full/senior professors for major oceanographic programs in the United States, based on the data presented in Table 2. Outliers are depicted by + symbol.

Although less than 30% of chief scientists on research vessels in the last decade have been women, the trend is improving (Figure 2). We surveyed various national and international programs, including the ocean drilling programs (Deep Sea Drilling Project, 1969–1986; Ocean Drilling Program, 1986–2003; and Integrated Ocean Drilling Program, 2003–2013), the US national research fleet coordinated by UNOLS (the University-National Oceanographic Laboratory System; data available from 2000 to 2014), the German *Polarstern* research vessel (data from 1998–2013), the *Alliance* research vessel of the North Atlantic Treaty Organization (NATO; data from 1999–2013), the private sailing research vessel *Tara* of French Tara Expeditions (data from 2009–2014), and the private research vessel *Falkor* of the Schmidt Ocean Institute (data from 2012–2014). This analysis shows that the percentage of female chief scientists has generally doubled in the last decade from roughly 10% to 20% on UNOLS vessels and from 15 to 30% on *Polarstern*, though the percentage of women co-chief scientists on drilling vessels remains low (12%). These percentages are roughly equal to the percentage of women in full professor or senior researcher ranks in US oceanography programs, but lower than those at the assistant or associate professor level (Table 2, Figure 1).

The low percentage of female chief scientists on research expeditions in the past decade, in comparison to the percentage of women in oceanographic academia, may indicate that fewer women than men are proposing seagoing research. In the United States, chief scientists are typically the principal investigators of successfully funded projects and are not chosen through a formal application process. However, this metric is difficult to quantify, because the ratio of male to female proponents of successful and unsuccessful proposals with ship time requests is not publicly available, to our knowledge. For the ocean drilling programs, co-chief scientists are most often selected for an expedition from the initial proponents of a drilling proposal. It can take years to schedule a drilling leg, and if women are not involved in the initial scoping and proposing stage of a project, it is unlikely that they will be considered for co-chief scientist positions.

Where it is possible to evaluate the gender ratio of cruise participants, such as in the ocean drilling programs, the percentage of female participants can be seen to have increased through the Ocean Drilling Program toward 30% (O'Connell and Holmes, 2005) but to have become more erratic in the Integrated Ocean Drilling Program (see O'Connell,

2014, in this supplement). However, observations suggest that the ratio of female to male cruise participants roughly matches the gender ratio in the applicant pool (J. Schuffert, Consortium for Ocean Leadership, *pers. comm*., 2014).

MODERN CHALLENGES TO ACADEMIC WOMEN IN SCIENCE

To provide some explanation for the trends we found regarding women in scientific leadership positions, and in oceanography in particular, we explored the array of challenges women face.

The possibilities for women to transition to higher levels in academia begin at the hiring level. Some have argued that the lower proportion of female applications for tenure-track jobs, as compared to degree holders, could reflect the notion that women do not see other women in these positions (i.e., they do not see people like themselves; Handelsman et al., 2005; Shen, 2013). Others have shown that starting a career in a non-tenure-track position, which women may accept more frequently than men, often does not lead to a tenure-track position (Schuster and Finkelstein, 2006). In terms of advancement once a tenure-track position is secured, recent studies show that gender bias and discrimination, harassment, and lack of resources for sustaining a family while building a career are some key reasons that women do not advance academically (see further discussion below).

Gender bias, both conscious and unconscious, may contribute to the loss of women from the academic pipeline (Hill et al., 2010). For example, a recent study documented the tendency for elite male scientists to discriminate against females when hiring postdoctoral scientists (Sheltzer and Smith, 2014). Other recent studies found that conference sessions chaired exclusively by men also strongly select for male presenters over female presenters (Isbell et al., 2012; Casadevall and Handelsman, 2014). Yet another study documented that papers authored by women received fewer citations than those authored by men (Larivière et al., 2013). It was also found that both women and men would offer male candidates more money and mentoring in a scientific position when given fictitious resumes for candidates, with the (equal on paper) female candidate perceived as less competent (Moss-Racusin et al., 2012). Gender bias is also evident in some peer-review processes for fellowship applications, where male achievements are over-estimated and female achievements are under-estimated (Wennerås and Wold, 1997), though we cannot say whether bias remains in the 18 years since this study was conducted. There is a tendency for women in academia to be invited (or required) to participate in committees and projects because male colleagues "need a woman" to round out diversity (Park, 1996; Handelsman et al., 2005). Such invitations leave female academics feeling that their utility is solely based on their gender rather than their accomplishments, and experiencing burnout faster than male colleagues (Marcus, 2005).

Biases against women obtaining research funding have also been noted. For example, a recent study documented that the average size of US National Institutes of Health (NIH) research grants awarded to women is 83% of grants to men (Shen, 2013). However, the gender ratio of women on NIH grant panels that made funding recommendations

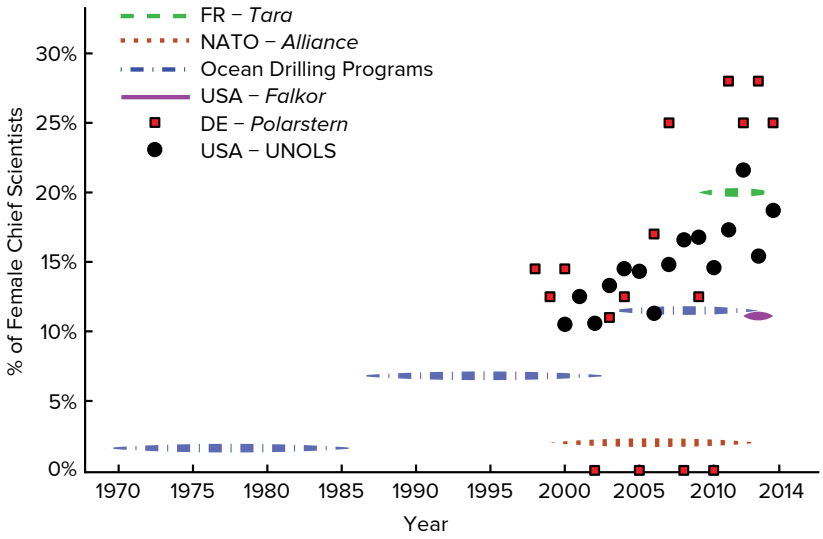

Figure 2. Percentage of female chief scientists on oceanographic cruises from several representative programs over the past 50 years. While UNOLS (University-National Oceanographic Laboratory System) and R/V *Polarstern* data report yearly values, other data sets show values for respective time periods. Vessels and programs represented are the French Sailing Vessel *Tara* of Tara Expeditions; the NATO (North Atlantic Treaty Organization) Research Vessel *Alliance*; the German Research Vessel *Polarstern*; the US R/V *Falkor* of Schmidt Ocean Institute and the US vessels managed under the UNOLS umbrella. The data presented for "Ocean Drilling Programs" represent the Deep Sea Drilling Project (1969–1986), the Ocean Drilling Program (1986–2003), and the Integrated Ocean Drilling Program (2003–2013).

was similar to the gender ratio of grant applicants, suggesting that gender bias in review committee composition was not a factor in this outcome (Shen, 2013). In contrast, recent reports from the US National Science Foundation (NSF), which funds a majority of academic oceanographic research, indicate that the number of proposals submitted by women to the Division of Ocean Sciences increased from one in five to one in four over the 2002–2012 period; within this time period, the average success rate of proposals submitted by women was roughly equal to or 5–10% lower than the success rate for men, although this varied by program and did not show a clear trend (NSF, 2012). The percentage of female panelists ranged from 15–22% and proposal reviewers from 17–32% for the period 2009–2011 (NSF, 2012), which is in the same range as the proportion of women in academic positions (Table 2) and the percentage of female-led proposal submissions.

Recent studies show that there is a continuing—and inexcusable—threat of sexual harassment in the scientific work place (as in other professional settings), demonstrated in a survey on sexual harassment or assault in fieldwork settings (Clancy et al., 2014). While it may be possible that those who experienced harassment and assault were more likely to complete the survey, two-thirds of respondents (i.e., over 400 people) claimed to have experienced sexual harassment in the field, with more than 20% reporting sexual assault (Clancy et al., 2014). A recent survey of science writers showed similar trends, with almost half of respondents (mostly women) claiming sexual harassment in the workplace and 20% reporting uninvited physical contact (Aschwanden, 2014). Moreover, respondents commonly lacked appropriate mechanisms for reporting and addressing such issues, which erodes women's empowerment to resolve incidences and effect change to prevent future occurrences. Hence, we are in a situation many decades after enactment of anti-discrimination laws where bias and harassment continue to affect the progress of women in professional careers.

Unlike the Clancy et al. (2014) study that surveyed the prevalence of sexual harassment and assault across a broad swath of scientific fields, we know of no formal report or survey of these types of behaviors in modern oceanography. While such behaviors may occur, modern oceanography is conducted under stronger anti-harassment policies that include anti-sexual harassment training at the beginning of cruises and clear reporting procedures, should an event occur (UNOLS, 2009). These policies are intended to provide safety for all cruise participants and to empower those who may experience adverse conditions in the field, as knowledge of such resources can be critical (Jahren, 2014).

Women also continue, on average, to earn less than men in academia. While a career in science can be immensely rewarding for those who have a passion to search for knowledge and find solutions to applied problems, it can be less rewarding in terms of financial support. In the United States, women earn an average of 17% less than male colleagues in science and engineering occupations at all degree levels (NSF, 2013; Shen, 2013), and an average of 24% less in occupations requiring a doctoral degree (Table 1). Even when controlling for other variables such as age and institution type, the inequality in salary is still significant. In the EU, women earn 25–40% less than men (European Commission, 2009; Shen, 2013). Part of this discrepancy may be attributed to the cultural phenomenon of women not asking for raises, as has been discussed in studies of negotiation and the gender divide (Babcock and Laschever, 2003). Another reason for the disparity is the lower likelihood of women holding senior faculty ranking (West and Curtis, 2006).

In academia, women are more likely than men to encounter the "two-body problem," as the percentage of female academics with a partner who is also an academic or professional is higher than it is for male academics with academic or professional partners (Schiebinger et al., 2008). This challenge is enhanced for female academic *scientists*, as shown in a study that found 83% of female scientists with a partner were partnered with another academic, whereas this percentage was only 54% for male scientists (Schiebinger et al., 2008).

Starting and raising a family also pose unique challenges to women. Growing evidence documents that having children, or even planning to have them, coincides with both lower rates of women applying for and obtaining tenure-track jobs (Wolfinger et al., 2008) and higher rates for leaving research (Goulden et al., 2009; Shen, 2013). Of the women who remain in academia, female faculty have fewer children, on average, than their male colleagues, and fewer than they desire (Ecklund and Lincoln, 2011; Shen, 2013). One explanation for this phenomenon is that having a family is a higher burden on women than on men (Handelsman et al., 2005). The often-insufficient support offered to families by many US institutions contributes to this burden. For example, there are different levels of personal (i.e., family) leave offered at

different levels of academia: fewer resources are available to graduate students than to postdoctoral scientists or faculty (Goulden et al., 2009). Beyond leave issues, there are also differences in other family resources, such as organized childcare or extended tenure clocks. A career in science often requires frequent moves to new institutions and universities to work with experts, which can be challenging for those who wish to start a family because they may lack help with childcare in an unfamiliar environment. Moreover, it is more difficult for breastfeeding women to be able to participate in the daylong or off-site meetings commonly required in academia. Family-unfriendly policies significantly impact a woman's choice to stay in academia (Rosser and O'Neil Lane, 2002), and may in part explain the leak in the pipeline at the transition from assistant to associate professor (Table 1).

Fieldwork also presents unique challenges for women considering starting a family, beyond general issues of being separated from young children during formative stages of their lives. These include the possibility of going to sea while pregnant, and accommodation for lactation while at sea. There is a dearth of formal information available to US women regarding whether or not they can participate in research cruises while pregnant, and under what circumstances (e.g., allowable if a ship is within a certain distance of shore, or if there is a medical doctor on board, or depending on stage of pregnancy, or at the discretion of captains or chief scientists). For example, as of the summer of 2014, UNOLS, the program that coordinates the US oceanographic research fleet, does not have a formal policy regarding pregnant women going to sea. (By comparison, the US Antarctic Program has a policy that pregnancy is a "not physically qualified" condition for working at any time and at any station or on research vessels in Antarctica.) The lack of a formal policy leads to misinformation or worse—women choosing to go to sea while pregnant and hiding this information, which can be dangerous for all involved if there is an emergency. There are even fewer resources available for women who have recently given birth and may want to pump breast milk while at sea (e.g., insufficient private lactation space on board, non-existent facilities for storing collected breast milk). There are alternative solutions for some of these issues, such as sending a student or technician to sea in place of a pregnant or breastfeeding female scientist; however, these options can be limiting for early career women who lack the financial resources to support these alternatives, and potentially counterproductive for a woman who needs at-sea experience to become a chief scientist on a future expedition.

In recognition of some of these issues, the NSF provides funding specifically to support and promote women in faculty and leadership positions through the ADVANCE program started in 2001 (see Holmes, 2014, in this supplement for a more detailed discussion of the ADVANCE program) and the Career-Life Balance (CLB) Initiative launched in 2012. Over $230 million has been awarded through these programs to date. In addition, some recent NSF policy changes (as of December 26, 2014) permit charges to *all* NSF grants for dependent-care expenses, such as daycare, that are above and beyond normal expenses as long as the institution allows such costs (see http://www.nsf.gov/pubs/policydocs/pappguide/nsf15001/sigchanges.jsp). NSF allows CLB supplements to existing grants for salaries for project personnel who replace individuals on a leave of absence due to dependent care (see CLB FAQs at http://www.nsf.gov/pubs/policydocs/clb/clbfaqs.jsp). It is unclear how successful ADVANCE-enabled female recruiting will be at retaining female faculty in the long term, but evidence suggests that the program is having some impact (Holmes, 2014, in this supplement).

RECOMMENDATIONS FOR OVERCOMING MODERN CHALLENGES FOR WOMEN IN ACADEMIC OCEANOGRAPHY

To secure the pipeline of women working toward tenure-track and senior-scientist positions, and to retain women in oceanography in particular, we provide the following recommendations.

1. **Institutions should solicit the names of women at the search committee phase when hiring for new positions** to help avoid unconscious gender bias that may work against women being named as potential candidates (West and Curtis, 2006; Moss-Racusin et al., 2012).
2. **University departments and mentors should be more proactive in educating master's and doctoral students about the possibility of extending tenure clocks and professor rank expectations to allow family leave**, so that female students know that there can be support networks for having children while staying in academia. Others take this one step further and recommend that institutions consider leveraging resources to provide on-site daycare for faculty (Ecklund and Lincoln, 2011).

3. **Faculty should be mindful of proven unconscious gender bias by both sexes**, and of how diminished competency judgments, rewards, and mentoring may discourage female students and junior faculty from successfully competing for higher ranking career positions (Handelsman et al., 2005; Moss-Racusin et al., 2012).
4. **Institutions are encouraged to have written policies for hiring and retaining dual-career academic couples**, and even to announce dual-career opportunities in recruitment materials.
5. **People in positions of authority—such as department chairs, directors, and deans—should ensure that all employees follow appropriate codes of conduct and sexual harassment prevention policies in the laboratory and in the field, with clear mechanisms for reporting incidences of harassment** (Clancy et al., 2014), and they should ensure that common discrimination pitfalls are avoided.
6. **All scientists should be mindful of common gender bias in such things as selection of plenary speakers at conferences** (Kappel and Thompson, 2014, in this issue) and work toward unbiased and more representative gender distribution (Martin, 2014).
7. **Women should harness the power of support groups and social media to surround themselves with female role models, and they should seek mentoring.** We encourage women oceanographers to embrace these mechanisms by, for example, joining programs that promote and support women in marine science (the Society for Women in Marine Science is one example), actively engaging in social media groups focused on women in oceanography and other science fields, and participating in mentoring programs such as Mentoring Physical Oceanography Women to Increase Retention (Clem et al., 2014, in this issue).
8. **Institutions are encouraged to "recognize the financial constraints fieldwork places on young parents, and explore alternative ways of supporting young parents in the field"** (Bell et al., 2005). For example, the Earth Institute at Columbia University has made additional research assistance available for women during family-life "transitional" periods (such as childbirth) and has enabled childcare for women needing to be in the field (Bell et al., 2005).
9. **We encourage UNOLS to adopt a formal policy related to the ability of pregnant women to participate in seagoing fieldwork that is not overly restrictive and is based on sound scientific and medical advice.** In cases where expedition length or timing precludes safe participation by young mothers or mothers-to-be, we encourage women to speak with their departments or program managers about options for supporting additional personnel to participate as their representatives. We highlight the increasing use of telepresence that in some cases could enable young parents to participate in fieldwork remotely (Fundis et al., 2012; Van Dover et al., 2012).
10. **We encourage program managers involved in evaluating proposals that include ship time requests to explore whether proposals with female leads are disproportionately unsuccessful**, and if so, whether there are mechanisms to address this issue.

CONCLUSION

There have been some promising improvements in the representation of women in oceanography over the past decade, as seen in the percentage increases in females in academia and as chief scientists (Figures 1, 2; Tables 1, 2), but more work needs to be done to even the field, especially at top levels. This article highlights opportunities to advocate for the career needs of female oceanographers. We end by acknowledging the recent promotion of several women to top-level positions related to oceanography—such as directors of oceanographic programs, administrators of federal programs, program managers, and chief editors of science magazines, as discussed in more detail elsewhere (O'Connell, 2014, in this supplement). We hope their success is an indication of sustained change that will encourage women to remain active in the field of oceanography.

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REFERENCES

Aschwanden, C. August 11, 2014. Harassment in science, replicated. *The New York Times*.

Babcock, L., and S. Laschever. 2003. *Women Don't Ask: Negotiation and the Gender Divide*. Princeton University Press, 240 pp.

Bell, R., J. Laird, S. Pfirman, J. Mutter, R. Balstad, and M. Cane. 2005. An experiment in institutional transformation: The NSF ADVANCE Program for Women at the Earth Institute at Columbia University. *Oceanography* 18(1):25–34, http://dx.doi.org/10.5670/oceanog.2005.67.

Bonatti, E., and K. Crane. 2012. Oceanography and women: Early challenges. *Oceanography* 25(4):32–39, http://dx.doi.org/10.5670/oceanog.2012.103.

Casadevall, A., and J. Handelsman. 2014. The presence of female conveners correlates with a higher proportion of female speakers at scientific symposia. *mBio* 5(1):e00846-13, http://dx.doi.org/10.1128/mBio.00846-13.

Clancy, K.B.H., R.G. Nelson, J.N. Rutherford, and K. Hinde. 2014. Survey of Academic Field Experiences (SAFE): Trainees report harassment and assault. *PLoS ONE* 9(7):e102172, http://dx.doi.org/10.1371/journal.pone.0102172.

Clem, S., S. Legg, S. Lozier, and C. Mouw. 2014. The impact of MPOWIR: A decade of investing in mentoring women in physical oceanography. *Oceanography* 27(4) supplement:39–48, http://dx.doi.org/10.5670/oceanog.2014.113.

Ecklund, E.H., and A.E. Lincoln. 2011. Scientists want more children. *PLoS ONE* 6(8):e22590, http://dx.doi.org/10.1371/journal.pone.0022590.

European Commission. 2009. *She Figures 2009: Statistics and Indicators of Gender Equality in Sciences*. EUR 23856, Publications Office of the European Union, Luxembourg, 160 pp.

Fundis, A.T., D.S. Kelley, G. Proskurowski, and J.R. Delaney. 2012. Maximizing ship-to-shore connections via telepresence technologies. Abstract #ED21B-0717, American Geophysical Union, Fall Meeting 2012, San Francisco, CA, USA.

Goulden, M., K. Frasch, and M.A. Mason. 2009. *Staying Competitive: Patching America's Leaky Pipeline in the Sciences*. Berkeley Center on Health, Economic, & Family Security, The University of California, Berkeley, Berkeley, CA, USA, 52 pp.

Handelsman, J., N. Cantor, M. Carnes, D. Denton, E. Fine, B. Grosz, V. Hinshaw, C. Marrett, S. Rosser, D. Shalala, and J. Sheridan. 2005. More women in science. *Science* 309:1,190–1,191, http://dx.doi.org/10.1126/science.1113252.

Hill, C., C. Corbett, and A. St. Rose. 2010. *Why so Few? Women in Science, Technology, Engineering and Mathematics*. American Association of University Women, Washington, DC, 109 pp, http://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf.

Holmes, M.A. 2014. Advancing women in oceanography: How NSF's ADVANCE program promotes gender equity in academia. *Oceanography* 27(4) supplement:30–38, http://dx.doi.org/10.5670/oceanog.2014.112.

Isbell, T., T. Young, and A. Harcourt. 2012. Stag parties linger: Continued gender bias in a female-rich scientific discipline. *PLoS ONE* 7(11):e49682, http://dx.doi.org/10.1371/journal.pone.0049682.

Jahren, A.H. September 18, 2014. Science's sexual assault problem. *The New York Times*.

Kappel, E.S., and L. Thompson. 2014. Invited scientific papers and speakers and fellow awardees: Little progress for women oceanographers in the last decade. *Oceanography* 27(4) supplement:24–28, http://dx.doi.org/10.5670/oceanog.2014.110.

Larivière, V., C. Ni, Y. Gingras, B. Cronin, and C.R. Sugimoto. 2013. Bibliometrics: Global gender disparities in science. *Nature* 504:211–213, http://dx.doi.org/10.1038/504211a.

Lavoie, D., and D. Hutchinson. 2005. The US Geological Survey: Seagoing women. *Oceanography* 18(1):39–46, http://dx.doi.org/10.5670/oceanog.2005.69.

Lozier, M.S., 2005. A community effort toward the retention of women in physical oceanography. *Oceanography* 18(1):35–38, http://dx.doi.org/10.5670/oceanog.2005.68.

Marcus, N. 2005. Oceanography, science, and academia: Women making a difference. *Oceanography* 18(1): 51-55, http://dx.doi.org/10.5670/oceanog.2005.71.

Martin, J.L. 2014. Ten simple rules to achieve conference speaker gender balance. *PLoS Computational Biology* 10(11):e1003903, http://dx.doi.org/10.1371/journal.pcbi.1003903.

Moss-Racusin, C.A., J.F. Dovidio, V.L. Brescoll, M.J. Graham, and J. Handelsman. 2012. Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 109(41):16,474–16,479, http://dx.doi.org/10.1073/pnas.1211286109.

NSF (National Science Foundation). 2012. *Report of the 2012 Committee of Visitors: Research and Education Programs, Division of Ocean Sciences: Years 2009–2011*. http://www.nsf.gov/geo/adgeo/advcomm/fy2012_cov/oce-geo-ocean-sciences-edu-report-2012.pdf.

NSF. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering*. National Science Foundation, National Center for Science and Engineering Statistics, NSF 13-304, Arlington, VA, http://www.nsf.gov/statistics/wmpd/2013/start.cfm.

O'Connell, S. 2014. Women of the academy and the sea: 2000–2014. *Oceanography* 27(4) supplement:15–22, http://dx.doi.org/10.5670/oceanog.2014.108.

O'Connell, S., and M.A. Holmes. 2005. Women of the academy and the sea. *Oceanography* 18(1):12–24, http://dx.doi.org/10.5670/oceanog.2005.66.

Park, S.M. 1996. Research, teaching, and service: Why shouldn't women's work count? *Journal of Higher Education* 67(1):46–84.

Rosser, S.V., and E. O'Neil Lane. 2002. Key barriers for academic institutions seeking to retain female scientists and engineers: Family-unfriendly policies, low numbers, stereotypes, and harassment. *Journal of Women and Minorities in Science and Engineering* 8:161–189.

Schiebinger, L., A.D. Henderson, and S.K. Gilmartin. 2008. *Dual-Career Academic Couples: What Universities Need to Know*. Michelle R. Clayman Institute for Gender Research, Stanford University, 108 pp.

Schuster, J.H., and M.J. Finkelstein. 2006. *The American Faculty: The Restructuring of Academic Work and Careers*. The Johns Hopkins University Press, Baltimore, MD, 600 pp.

Sheltzer, J.M., and J.C. Smith. 2014. Elite male faculty in the life sciences employ fewer women. *Proceedings of the National Academy of Sciences of the United States of America* 11:10,107–10,112, http://dx.doi.org/10.1073/pnas.1403334111.

Shen, H. 2013. Inequity quantified: Mind the gender gap. *Nature* 495:22–24, http://dx.doi.org/10.1038/495022a.

Thompson, L., R.C. Perez, and A.E. Shevenell. 2011. Closed ranks in oceanography. *Nature Geoscience* 4:211–212, http://dx.doi.org/10.1038/ngeo1113.

UNOLS (University-National Oceanographic Laboratory System). 2009. *Research Vessel Safety Standards*, 9th ed. UNOLS, University of Rhode Island–Graduate School of Oceanography, Narragansett, RI, USA, 145 pp., http://www.unols.org/sites/default/files/2009RVSS_web2012updates%281%29.pdf.

Van Dover, C.L., C.R. German, D.R. Yoerger, C.L. Kaiser, and L. Brothers. 2012. Telepresence field research experience for undergraduate and graduate students: An R/V *Okeanos Explorer*/AUV *Sentry* success story. Abstract #OS51D-1909, American Geophysical Union, Fall Meeting 2012, San Francisco, CA, USA.

Wennerås, C., and A. Wold. 1997. Nepotism and sexism in peer-review. *Nature* 387:341–343, http://dx.doi.org/10.1038/387341a0.

West, M.S., and J.W. Curtis. 2006. *AAUP Faculty Gender Equity Indicators*. American Association of University Professors, Washington, DC, 84 pp.

Wolfinger, N.H., M.A. Mason, and M. Goulden. 2008. Problems in the pipeline: Gender, marriage, and fertility in the Ivory Tower. *The Journal of Higher Education* 79(4):388–405, http://dx.doi.org/10.1353/jhe.0.0015.

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SIDEBAR. A Brilliant Impostor?

By Mya Breitbart

Upon hearing that I had been selected one of *Popular Science* magazine's "Brilliant 10" young scientists last year, a rush of emotions came over me. First I was doubtful. Then humbled, flattered, elated, and terrified—in that order, all within a matter of seconds. Being called "brilliant" made me cringe. Every time that word gets repeated in a press release, progress review, or speaker introduction, I still cringe. Am I smart? Sure. Do I generate good ideas, work hard, and disseminate good, reliable results with proper interpretations? Sure. No confidence issues there. But brilliant??? Not by a mile. I can quickly generate a mental list of brilliant scientists, and not for a second can I reasonably accept that I belong among their ranks. This feeling of self-doubt, frequently dubbed "impostor syndrome," has plagued me for many years.

It's easy to think other people are more productive, smarter, faster, work harder, or have better work-life balance. This sort of thinking and self-doubt can certainly be damaging. Aside from sucking up valuable time, brainpower, and energy, impostor syndrome can be truly confidence shaking. To the extent that some scientists suffer (junior, female scientists seem to be disproportionately afflicted), this syndrome is damaging and can even be personally debilitating or fatal for a scientific career. But is impostor syndrome all bad? If a magic confidence pill existed to cure impostor syndrome, should all assistant professors take it? Maybe not. Impostor syndrome keeps you on your toes. It keeps you continually striving to be better. Striving to be the person who your colleagues/students/mentors think you are. To work extra hard on that review because you're not sure you're the one *Nature* or the National Science Foundation should be asking to evaluate the work or ideas of the leaders in the field. To dedicate your heart and soul toward preparing and giving a memorable presentation that you can be proud of. Finally, impostor syndrome keeps you honest and humble. Complete elimination of this phenomenon would probably lead to an overabundance of self-proclaimed geniuses running around.

Because even the best among us suffer from impostor syndrome, I would like to suggest a few positive steps we can take toward combating impostor syndrome without becoming a league of narcissists.

1) FOCUS ON YOUR PROUD MOMENTS. Embrace and remember that positive sensation you get when you know you did a good job. And realize that your nagging self-doubt, however annoying it may be, likely contributed to your doing a good job in an effort to prove yourself. Don't focus on what others think, or on all the failures along the way, or on the never-ending to-do list. You will never believe the positive hype that you hear about yourself if you can't compile your proud moments and focus your attention on them. Determine your priorities, and catalog your achievements toward these goals. If you're not making progress in the areas that are most important to you, consider shifting your efforts to the things you value the most.

2) EMULATE YOUR IDOLS. Think of the people you really, truly respect in different areas of your field (e.g., scientific ideas, presentation skills, teaching, personal qualities that make them good collaborators or good parents; think broadly about the characteristics that you value). Think about why you respect these people and strive to emulate these characteristics into your life (and maybe notice that you're already more like them than you recognize or give yourself credit for). Think about whether any of these people might also struggle with impostor syndrome. Most likely, at least one person on your list does, at least in one aspect of his or her life. That's ridiculous, right? After all, they are your science idols, and how could anyone that influential to you possibly be insecure...believe it, there are things they doubt. They might even be shocked to find out that they were on someone's "science idols" list. And they most likely have their own lists of people that they strive to be more like.

3) PROMOTE EACH OTHER. Many of the rewards/honors/invitations in science are based on nominations, and very frequently these recognitions require self-nomination, an idea that is absolutely petrifying to us impostors. Knowing how hard it is for each of us to believe in our own brilliance and worth, it is critical that we support and promote our colleagues in similar situations. Don't hesitate to step up and nominate scientists whom you respect for prestigious awards. Or encourage them to apply themselves by telling them how qualified you think they are and/or offering to write them a strong letter of support. Suggest junior speakers for a high-profile plenary session or invite them to give a seminar at your institution. Give other people (especially those who you sense might be struggling with impostor syndrome) a chance to shine. The people with the worst impostor syndrome will often work the hardest to make sure they don't disappoint. This will become a proud moment for them, and success begets success. Maybe next time they won't write off applying for a highly prestigious scholarship or accepting a position that makes them slightly uncomfortable, just because they remember that someone important to them (by the way, this is YOU) believed in them.

In the end, it's about believing in yourself and taking risks and positive steps to step out of your comfort zone to combat impostor syndrome. Because that is a daunting task, you may find it easier to push toward elevating the careers and confidence of the people you most respect. Finally, build and record your own moments of pride, and try to remember that when your colleagues call you "brilliant," they probably really mean it, even if you can't quite accept it (yet).

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Women of the Academy and the Sea: 2000–2014

By Suzanne O'Connell

There is good news and bad news for twenty-first century women oceanographers. Tremendous progress has been made in breaking the glass ceiling, both in positions and in prestigious awards and medals (Table 1). There were many firsts, including the first woman to head the National Oceanic and Atmospheric Administration (NOAA; Jane Lubchenco) and the first woman to head the United States Geological Survey (USGS; Marcia McNutt). Commendably, other women are succeeding the first women in these very high level positions. Kathy Sullivan, the first woman to walk in space, succeeds Lubchenco. McNutt's successor at the USGS not been confirmed; however, Suzette Kimball, has been nominated to succeed her and is serving as Acting Director.

At the Environmental Systems Research Institute (ESRI), oceanographer Dawn Wright (Deep-Sea Dawn), a developer of Arc Marine, is the first woman to become chief scientist. Women now head three—half—of the six oceanographic institutions featured in our 2005 paper (O'Connell and Holmes, 2005): Margret Leinen is Director of the Scripps Institution of Oceanography, Virginia Armbrust is Director of the University of Washington College of Oceanography, and Susan Avery is President and Director of the Woods Hole Oceanographic Institution.

It is often difficult to decide which disciplines encompass "oceanography." Are marine biologists (e.g., Sylvia Earle?) or atmospheric chemists, who look at ocean/air interactions, oceanographers? Is a structural geologist who studies ocean crust on land (ophiolites) an oceanographer? In this paper, I attempt to be inclusive, but no doubt am biased by my knowledge of more oceanographers with an Earth science focus.

Since 2000, women oceanographers have begun to receive prestigious geoscience medals. In 2014, Maureen Raymo became first woman to receive the Wollaston Medal, established in 1831 by the Geological Society of London (GSL). Susan Kieffer became the first woman to be awarded the Geological Society of America's (GSA) Penrose Medal. Three women, Marcia McNutt (2007), Miriam Kastner (2008), and Ellen Thomas (2012), have now received the Maurice Ewing Medal, established in 1974 and given annually by the American Geophysical Union (AGU) to one honoree in recognition of "significant original contributions to the ocean sciences." Inez Fung received AGU's Revelle Medal in 2004, and remains the only woman to have received it. Ahead of the

Table 1. Medal citations for four oceanography-related scientific societies whose first female recipients were named in the twenty-first century. GSL = Geological Society of London. AGU = American Geophysical Union (AGU). AMS = American Meteorological Society. GSA = Geological Society of America.

Medal Name	Estab.	Society: Information
Wollaston	1831	GSL: "This medal is normally given to geologists who have had a significant influence by means of a substantial body of excellent research in either or both 'pure' and applied aspects of the science."
Penrose	1927	GSA: "To encourage original work in purely scientific geology."
Sverdrup	1964	AMD: "To researchers who make outstanding contributions to the scientific knowledge of interactions between the oceans and the atmosphere."
Ewing	1974	AGU: In recognition of "significant original contributions to the ocean sciences."
Revelle	1991	AGU: In recognition of "outstanding contributions in atmospheric sciences, atmosphere-ocean coupling, atmosphere-land coupling, biogeochemical cycles, climate or related aspects of the Earth system."

twenty-first century, Kristina Katsaros received the American Meteorological Society's (AMS) Sverdrup Medal in 1997.

Female scientists have also received an increasing number of national honors in the United States, such as being inducted into the National Academy of Sciences (NAS) and being awarded the National Medal of Science (Figure 1). The NAS was established in 1863 during the Lincoln administration to provide scientific and technical advice to the government. Membership is by election in "recognition of distinguished and continuing achievements in original research." There are approximately 2,200 members and 400 foreign associates. All 21 NAS presidents have been male. Fortunately, there are many female members. Disciplines are designated by "Section." Of the 31 sections, none is directly related to oceanography, marine science, or atmospheric science. Three sectional disciplines house most of the oceanography-related NAS members: Environmental Science and Ecology (e.g., Jane Lubchenco), Geophysics (e.g., Inez Fung), and Geology (e.g., Tanya Atwater, Terry Plank). I surveyed gender balance of the elected members of these sections and recorded the total percentages of female members by the decade in which they were elected. These numbers include men and women who are not oceanographers and range from 0% females in the 1960s to 28% females in the early 2010s (2010–2014).

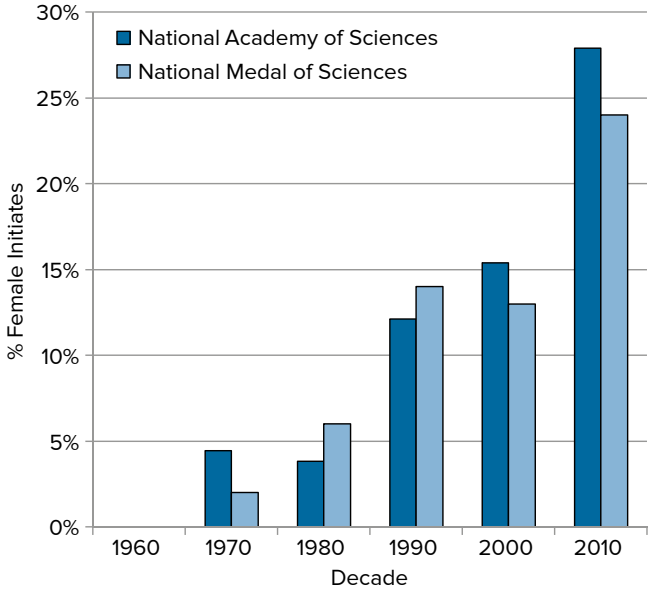

Figure 1. Plots of the percentages of women members inducted into the National Academy of Sciences (NAS) Sections of Geology, Geophysics, and Environmental Sciences and Ecology, and of all recipients of the National Medal of Sciences (NMS). NAS member data for 2010 includes 2010–2014, while corresponding NMS data includes 2010–2012 and begins in 1962.

In terms of scientific recognition and prestige, the National Medal of Science (NMS) is more exclusive. Established in 1959, its purpose is to acknowledge individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, or engineering sciences." Social and behavioral sciences were added in 1980. The first NMS was awarded in 1962 and the most recent in 2012. Awardees total 497. Again, there is no category for oceanography or marine science. Some women oceanographers, for example, Sallie (Penny) Chisholm, an MIT professor who studies the ecology and evolution of microbes in the ocean and their influence on biogeochemical cycles, have been honored with this medal. As with NAS membership, the percentages of female recipients in all fields have grown since the latter half of the twentieth century and range from 0% in the 1960s to 24% in the first three years of the 2010s.

Women oceanographers have been recognized beyond the scientific community. Two women ocean scientists have been named MacArthur Fellows in the twenty-first century. Kelly Benoit-Bird, a marine biologist at Oregon State University, received the award in 2010. She uses acoustic engineering to study the behavior of marine creatures and food chains. In 2012, Terry Plank, a geochemist at Columbia University who studies the chemical and thermal forces that drive plate motion, was also named a MacArthur Fellow. Several other female oceanographers have been awardees, including Jane Lubchenco in 1993.

Another indication of women's progress in oceanography is the selection of plenary speakers at international congresses and meetings. At the 2014 meeting of the International Association of Sedimentologists (IAS), all four plenary speakers were women. Two would be considered oceanographers: Carlotta Escutia from Spain has sailed on several scientific ocean drilling expeditions and was co-chief scientist on Expedition 318 to Antarctica. Anny Cazenave, from France (NAS Foreign Associate 2008), uses satellite altimetry to study sea level change and is a member of the Intergovernmental Panel on Climate Change. The two other plenary speakers were Isabel Montanez from UC Davis, who focuses on paleoclimate including paleo-oceans, and Marjorie Chan, University of Utah, who studies the sedimentology of marine and terrestrial environments through time on Earth and Mars. Chan was also the Geological Society of America's Distinguished International Speaker in 2014, the first female

in that position. Despite the progress, there is still work to do (see Kappel and Thompson, 2014, in this supplement).

Within societies, the title of "fellow" recognizes both scientific achievement and service to the society. Women have lagged behind their representation in societies' memberships as recipients of this recognition and as recipients of medals (Holmes et al., 2012; O'Connell, 2013). Professional societies that ocean scientists are likely to join include the American Geophysical Union (AGU), the American Meteorological Society (AMS), and the Geological Society of America (GSA). In 2014, women became fellows in these organizations at the rate of 18%, 18%, and 12% respectively, far below their percentages as society members and PhD recipients 20 years ago (Figure 2).

DEGREE DATA

Women continue to receive increasing numbers of PhDs in Earth, atmospheric, and ocean sciences (EAOS). Between 2002 and 2012, female PhD recipients in EAOS disciplines increased from 177 in 2002 (32%) to 319 in 2012 (43%), primarily because of the increase in Earth science PhDs (Figure 3A; NSF, 2013). Overall, the percentage of female PhD recipients also continues to rise, with females receiving the highest percentages of PhDs in ocean sciences (40% in 2002 and 48% in 2012, with a peak of 54% in 2009) and the lowest in atmospheric sciences (31% in 2002 and 39% in 2012, with a nadir of 20% in 2008) (Figure 3B; NSF, 2013).

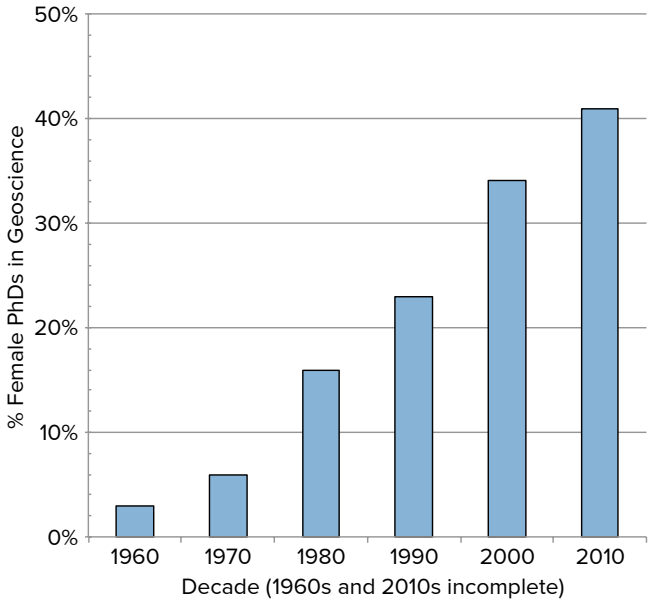

Figure 2. Percentages of females receiving PhDs in Earth, atmospheric, and ocean Sciences (EAOS) by decade (NSF, 2004, 2013).

Missing from female (and male) PhD recipients are underrepresented minorities (URMs), defined by the National Science Foundation (NSF) as US citizens and permanent residents from African-American, Hispanic, Native American, Alaskan Native, and Pacific Island ethnicities (Figure 4). For the past decade, URM women have earned about 12% of the EAOS PhDs awarded to female US citizens and permanent residents, far below their percentage in the US population. It is here that more direct attention needs to be focused, as the population of these demographic groups is growing at a higher rate than that of the white population. Federal attention to increasing diversity in science, technology, engineering, and mathematics (STEM) fields and, in particular, NSF's Opportunities for Enhancing Diversity in the Geosciences program that began in 2001 (Huntoon and Lane, 2007; Prendeville and Elthon, 2001), needs to be continued.

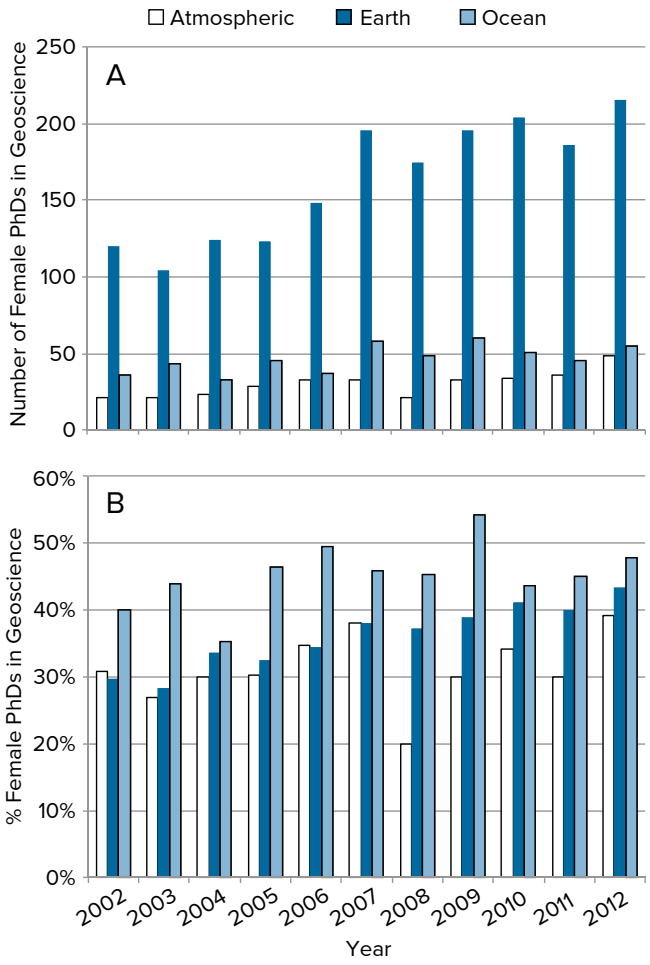

Figure 3. (A) Numbers of females by subdiscipline earning EAOS PhDs. (NSF 2013, Table 7-2). (B) Percentages of females earning PhDs in EAOS subdisciplines (NSF, 2013, Table 7-2).

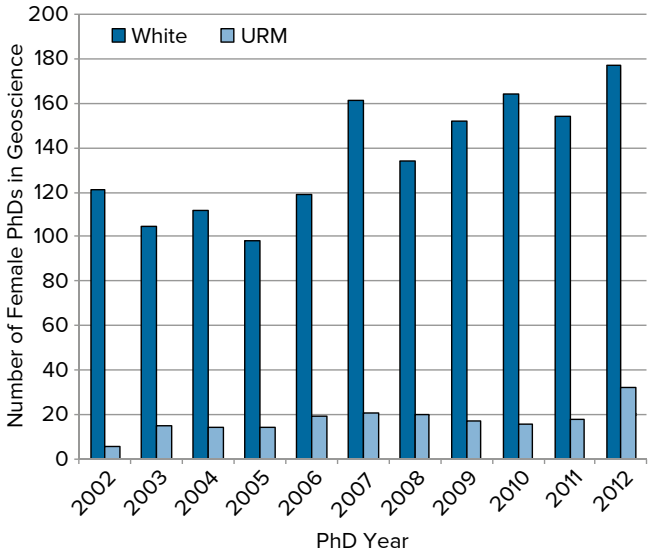

Figure 4. Numbers of white and under-represented minority (URM) females (US citizens and permanent residents) receiving PhDs in EAOS (NSF, 2013, Table 7-7).

ACADEMIC EMPLOYMENT

Women are still not faring as well as their degree numbers might suggest in securing tenured and tenure-track academic positions. This problem is compounded by the lack of positions. There are several ways to dissect the data. Here, I've looked at the employment at six oceanographic institutions, the same six O'Connell and Holmes (2005) considered (Table 2). These six institutions employ about half of the academic-based oceanographic faculty in the United States. A more complete assessment, including data from more schools, can be found in Orcutt and Cetinić (2014, in this supplement).

All tenured and tenure-track faculty were counted at the six institutions (adjuncts, lecturers, and researchers were not included). Associate professors/scientists without tenure were included with assistant professors, so associate means the faculty member has been awarded tenure. Faculty in departments that were only present at one institution (e.g., ocean engineering or atmospheric sciences) were not included. These six institutions employ approximately 500 faculty. The percentages of women in each subdiscipline by rank show that, with the exception of physical oceanography, women are continuing to make progress in securing tenure-track jobs and tenure (Figure 5). Over 30% of the assistant professors in the four disciplines at these six oceanographic institutions are women.

Table 2. Six oceanographic institutions for which faculty were counted.

Oregon State University College of Earth, Ocean and Atmospheric Sciences
Scripps Institution of Oceanography, University of California, San Diego
Rosenstiel School of Marine and Atmospheric Science, University of Miami
University of Rhode Island Graduate School of Oceanography
University of Washington School of Oceanography
Woods Hole Oceanographic Institution

Thompson et al. (2011) addressed the decline in tenure-track positions in physical oceanography by examining the numbers of male and female PhD recipients at 17 institutions offering a physical oceanography degree. They found that as a percentage, women were actually losing ground in obtaining tenure-track positions. For PhDs awarded between 1980 and 1995, 28% of the men and 15% of the women held tenure-track positions. For PhDs awarded between 1996 and 2009, 27% of men held tenure-track positions, while only 8% of women PhDs held tenure-track positions. The reasons for this decline are only speculative, but it is hoped that programs such as Mentoring Physical Oceanographers to Increase Retention (MPOWIR; see Lozier, 2006; Clem et al., 2014, in this supplement) will help more women to navigate the intricacies of the academy.

The percentage data do not show how few tenure-track

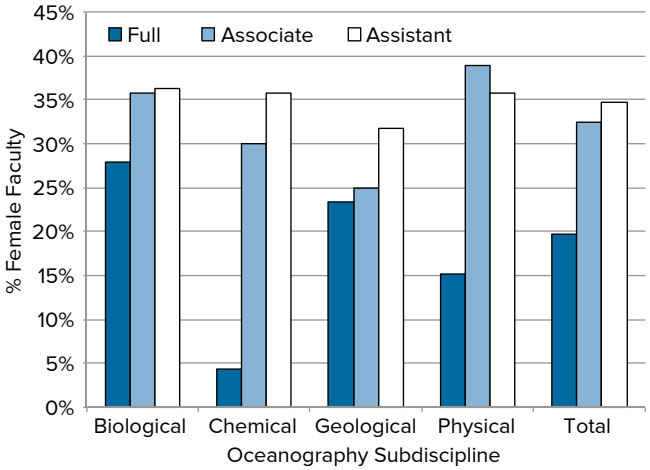

Figure 5. Percentages of faculty at six oceanographic institutions (Table 2), by rank and subdiscipline. Not all oceanographic subdisciplines could be identified at each institution. For example, at Scripps Institution of Oceanography, the Climate, Atmospheric and Physical Oceanography (CASPO) department was included under physical oceanography, and there was no distinct chemical oceanography department. Data were collected from institutional websites in fall 2014.

positions there are. The total number and percentages of women faculty at the six oceanographic institutions has increased, but there are few positions for any gender (Table 3). In fact, there are fewer than 100 assistant professors at all 26 institutions tabulated by Orcutt and Cetinić (2014, in this supplement).

Elsewhere in the EAOS academy, the representation of female faculty is not doing as well. Glass (2015) compiled information on faculty at the top 106 geoscience research departments, as reported by *US News and World Report*, that had five to 50 faculty during the 2010–2011 academic year (Figure 6). Compared to oceanographic institution data presented by Orcutt and Cetinić (2014, in this supplement), which show that 20% of women are at the full professor level, 30% at associate professor level, and 40% at the assistant professor level, Glass' percentages show an even lower concentration of female faculty at the rank of full (13%), associate (24%), and assistant (36%) professor. This result is surprising because Glass' data (Figure 6) include both research and tenure-track faculty, so it might be expected that her percentages of women would be higher because female faculty are less likely than males to be in tenure-track positions.

Among the 106 institutions reviewed by Glass (2015), the percentages of female faculty ranged from 0% to 40%. The institutions with the highest percentages of female faculty, in order, are: the University at Buffalo, Louisiana State University at Baton Rouge, University of New Hampshire, University of Massachusetts, and University of Nevada-Las Vegas. Of these five institutions, only the University of New Hampshire offers a graduate degree with an oceanography specialization.

Oceanographic and research universities are not the only educational institutions with limited openings for tenure-track faculty. According to the American Federation of Teachers (AFT, 2009), between 1997 and 2007, the number of full-time tenured and tenure-track faculty declined from roughly one-third of post-high school instructional staff to slightly more than one-quarter. Women were more likely to have part-time and adjunct positions (AFT, 2009), which does not bode well for the large numbers of women currently earning PhDs.

The reasons women are less likely to enter and stay in the academy are multidimensional. Some impediments, especially thanks to the ADVANCE program (see Holmes, 2014, in this supplement), are being overcome. Many institutions now stop the tenure clock for family needs (e.g., childbirth, adoption, care for a sick family member), and departments educate faculty search committees about ways to counteract implicit bias (Banaji and Greenwald, 2013) and deal with stereotype issues (Steele, 1997). Despite this, because of the subtle changes that are needed to deal with the accumulated disadvantage of being part of an under-represented group, it may take more time for both women and minorities to reach parity in the oceanographic community. However, the abundance of women and minorities with EAOS PhDs means that it is possible to change the demographics of the academy to look more like those of the United States. This is an opportunity that should be vigorously pursued.

Table 3. Number of tenure-track women faculty by rank in four subdisciplines at the six oceanographic institutions listed in Table 2. Even though the percentage of female faculty is rising (Figure 5), the absolute numbers at the assistant and associate level have only increased slightly.

Rank	2004	2014
Full	24	52
Associate with tenure	26	30
Assistant	20	26
Totals	**70**	**108**

SCIENTIFIC OCEAN DRILLING

Scientific ocean drilling is a thread that connects many women in oceanography, especially chemical oceanography and marine geology and geophysics. Of the women named in the introduction as major awardees or directors of institutions, five have participated in a scientific ocean drilling expedition:

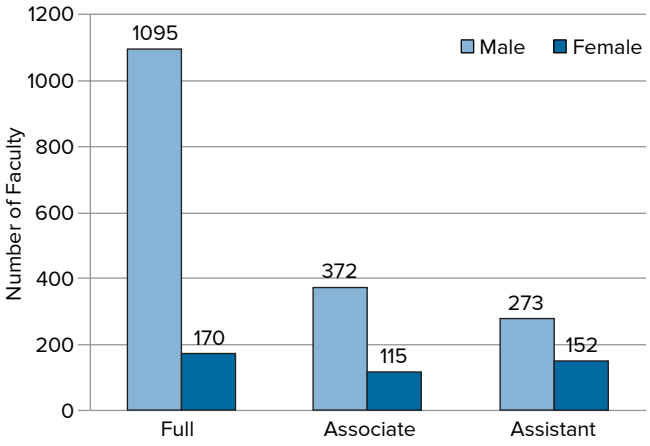

Figure 6. Numbers of women in faculty positions (research and tenure track) at the top 106 US Earth science departments in 2010–2011 (from Glass, 2015).

Table 4. Co-Chief scientists by gender and platform for Integrated Ocean Drilling Program Expeditions 301–346 (2004–2013), excluding 328, which was a short "School of Rock" program for educators. CC = co-chief scientist. MCC = male co-chief scientist. FCC = female co-chief scientist. Drilling components that make up the IODP platforms: *Chikyu* = Japanese riser drilling vessel. JR = US-operated drillship *JOIDES Resolution*. MSP = Mission Specific Platforms operated by a European science consortium. Some of the *Chikyu* expeditions (e.g., Nantroseize Project) had more than two co-chief scientists.

Platform	# of Expeditions	Total CC	Total MCC	Total FCC	USA		Japan		Other		Total % FCC	% Non-Japanese FCC
					MCC	FCC	MCC	FCC	MCC	FCC		
Chikyu	13	30	28	2	10	1	12	0	6	1	7%	11%
JR	29	58	49	9	17	4	18	0	14	5	16%	23%
MSP	5	10	9	1	1	1	2	0	6	0	10%	13%
Total	**47**	**98**	**86**	**12**	**28**	**6**	**32**	**0**	**26**	**6**	**12%**	**18%**

Miriam Kastner, Margaret Leinen, Maureen Raymo, Ellen Thomas, and Dawn Wright. The power of this program is what attracted me to this field over 40 years ago, offering opportunities to go to sea and explore Earth's history recorded in ocean sediments, to connect the ocean and the land, and to work with colleagues from other disciplines to understand Earth's behavior. And the male geology faculty at my undergraduate college spoke in awe of Helen Forman, a researcher in the department, who sailed as a radiolarian micropaleontologist on several *Glomar Challenger* expeditions.

In O'Connell and Holmes (2005), we were optimistic about the progress made in increasing women's participation in scientific ocean drilling. Although women weren't common as co-chief scientists, their percentages of shipboard scientific parties had grown from about 15% in the early 1980s at the end of the Deep Sea Drilling Project (DSDP) to over 25% in the early years of the twentieth century Ocean Drilling Program (ODP; 1985–2003). Then, ODP expanded into the multiplatform Integrated Ocean Drilling Program (IODP) that operated from June 2004 to September 2013. IODP encompassed Expeditions 301 through 348. Expedition numbers are consecutive, but the actual expeditions did not always occur in sequence and were on different platforms (Table 4). The majority of expeditions (29) were on *JOIDES Resolution*, followed by *Chikyu* (13), with five on Mission Specific Platforms (MSP).

Assembling a scientific party is a complicated task. Expedition staffing requires specific disciplinary expertise be present on the ship to ensure the scientific objectives are met, for example, a micropaleontologist with expertise in a specific time interval and microfossil, or a geochemist adept in organic geochemistry. In addition, under IODP memoranda of understanding between government funders, each member country was allotted a certain number of co-chief scientists and shipboard positions. National interests need to accommodate disciplinary requirements for an expedition and this requires staffing flexibility.

On *JOIDES Resolution*, which had the highest number of participants, the percentage of females in the scientific party ranged from 15% to 45%, and for all 29 expeditions averaged 30% (Figure 7A). During these same expeditions, the percentage of graduate students in the scientific party ranged from 14% to 50%, averaging 26% (Figure 7B). Of the graduate students, as few as 14% (one) to as many as 100% (six) were females, with an average of 45%. Forty-five percent is slightly higher than the percentage of female Earth science PhD graduate students (Figure 2) during the past decade. This suggests that a large number of women (almost 100) have participated as graduate students as part of the *JOIDES Resolution* scientific party. Over 100 have participated when all three platforms are considered. These women could be a tremendous resource for gender equity in future scientific ocean drilling expeditions as both shipboard participants and co-chief scientists.

Of the 98 co-chiefs on all expedition platforms, only 12 were female (12%), but when the percentage of female co-chiefs without Japanese co-chiefs or just the percentage of female US co-chiefs is considered, the percentage of female co-chiefs increases to 18% for both. *JOIDES Resolution*, with US management, has the highest percentage of female co-chief scientists (16%) and the riser drilling ship *Chikyu*, under Japanese management, has the lowest (Table 4, Figure 8).

In the new International Ocean Discovery Program (also IODP), there are no constraints on nationalities of co-chief scientists on any platform. Sadly, even without national

constraints, women co-chief scientists have continued to fare poorly. Of the 16 co-chief scientists that have been selected for *JOIDES Resolution* Expeditions 349–356, only one (6%) is a female. The European-run MSP program is doing considerably better. Although its last old IODP Expedition 347 (Baltic Sea Basin Paleoenvironment) had two male co-chief scientists, its first expedition in the new IODP Expedition 357 (Atlantic Massif) will have two female co-chief scientists. No new expeditions are currently scheduled for the riser drilling ship *Chikyu* (see http://iodp.tamu.edu/scienceops/expeditions.html). When they do get scheduled, it would be wonderful to select a female Japanese co-chief scientist to head the expedition.

Beyond Expedition 358, funding is not guaranteed, but the expedition objectives are known and coring sites have been selected for Expeditions 359–363 on *JOIDES Resolution*. Co-chief scientists have also been chosen. Three of the 10 are women, one from the United States and two from Europe.

How does someone become a co-chief scientist? "Co-chief scientist" is not an honorary position. These men and women are usually among the lead scientists who have been active in planning for a particular research expedition for a long time and are principal investigators on the proposals submitted to IODP. This requires participating in activities such organizing pre-cruise site surveys and assembling the necessary data to frame the questions that will be addressed during the expedition. Much of the groundwork for these expeditions is formulated at workshops supported by the agencies that fund the program. Early career female scientists need to be at these workshops so that they can become leaders for addressing specific scientific questions and be recognized as potential co-chief scientists. There are over 100 graduate student and early career women with shipboard scientific drilling experience who should be encouraged to take a leadership role in planning the future of scientific ocean drilling.

SUMMARY

The twenty-first century has seen women oceanographers assume several prominent roles in the scientific community, and there have been many firsts, with women receiving prestigious professional society award medals. However, the ocean sciences remain far from gender parity, especially when it comes to academic positions.

Several actions can be taken to reach gender parity. PhD advisors need to make sure that female students are mentored so that they will learn the skills needed to assume

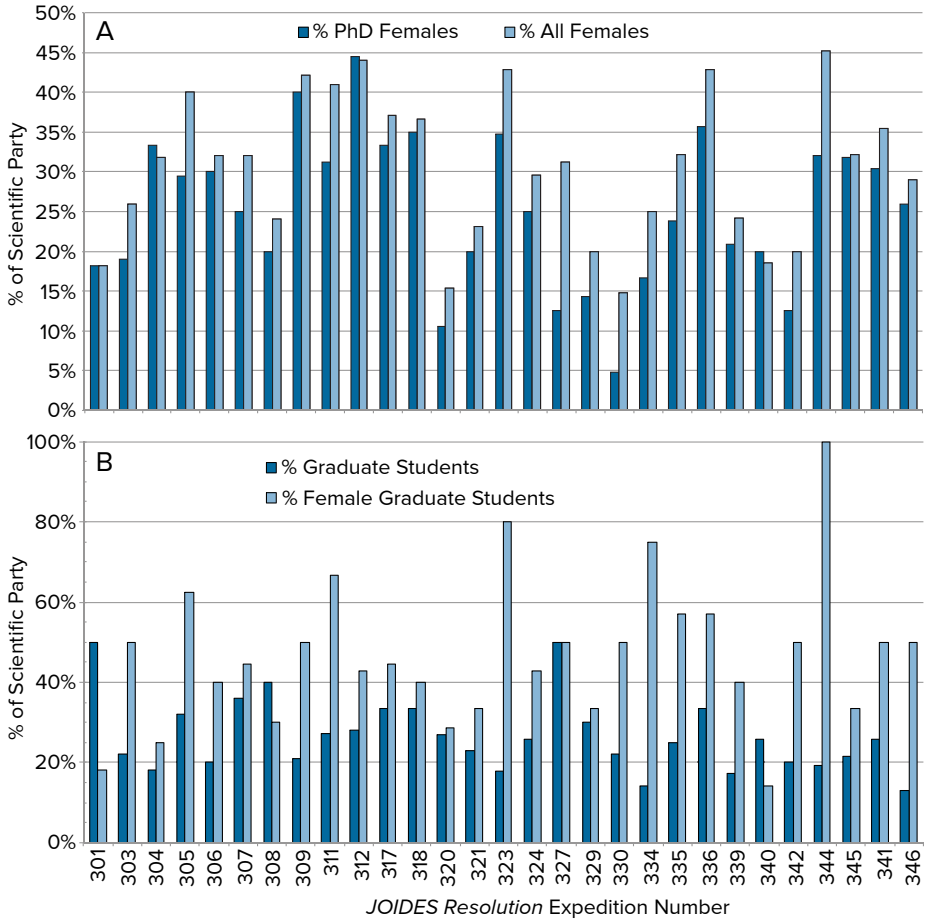

Figure 7. (A) Percentages of women in *JOIDES Resolution* scientific parties by expedition as a percentage of non-students (e.g., participants with PhDs) and as a percentage of the total party including female graduate students. Integrated Ocean Drilling Program (IODP) Expedition 301 sailed from June 27–August 21, 2004, and Expedition 346 sailed from July 29–September 27, 2013. (B) Percentages of graduate students in *JOIDES Resolution* scientific parties by expedition and percentages of graduate students who are women.

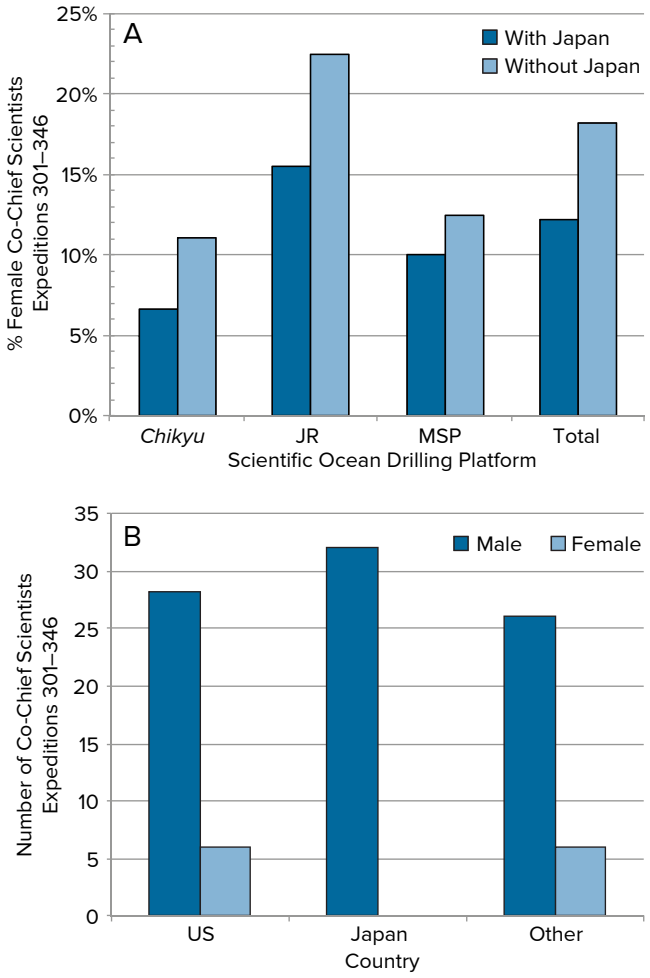

Figure 8. (A) Percentages of female co-chief scientists on IODP Expeditions 301–346 (June 2004–September 2013) by platform and percentages of female co-chief scientists by platform when Japanese co-chief scientists are not included. (B) Numbers of male and female co-chief scientists on IODP Expeditions 301–346 by country (June 2004-September 2013). Drilling components that make up the IODP platforms: *Chikyu* = Japanese riser drilling vessel. JR = US-operated drillship *JOIDES Resolution*. MSP = Mission Specific Platforms operated by a European science consortium.

leadership positions in the ocean sciences. Both men and women on academic search committees should be educated about gender-implicit associations and the resulting gender bias (Moss-Racusin et al., 2012) and be aware of specific strategies to reduce gender bias (Holmes et al., 2015). Once women enter the academy, departments and administrations should follow the many practices developed through the NSF ADVANCE program to retain and promote their female faculty. With so many female EAOS PhD recipients, meeting the challenge of gender parity within the next half decade can be accomplished. It is an exciting time to be involved in oceanography, and women will be equal participants.

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REFERENCES

AFT (American Federation of Teachers). 2009. *The State of the Higher Education Workforce 1997–2007*. American Federation of Teachers, 28 pp., http://www.aft.org/sites/default/files/aa_highedworkforce0209.pdf.

Banaji, M., and A. Greenwald. 2013. *Blindspot: Hidden Biases of Good People*. Delacorte Press, NY, NY, 272 pp.

Clem, S., S. Legg, S. Lozier, and C. Mouw. 2014. The impact of MPOWIR: A decade of investing in mentoring women in physical oceanography. *Oceanography* 27(4) supplement:39–48, http://dx.doi.org/10.5670/oceanog.2014.113.

Glass, J. 2015 (May). We are the 20%: Updated statistics on female faculty in Earth sciences in the US. In *Women in the Geosciences*. M.A. Holmes, S. O'Connell, and K. Dutt, eds, American Geophysical Union and Wiley.

Holmes, M.A. 2014. Advancing women in oceanography: How NSF's ADVANCE program promotes gender equity in academia. *Oceanography* 27(4) supplement:30–38, http://dx.doi.org/10.5670/oceanog.2014.112.

Holmes, M.A., P. Asher, J. Farrington, R. Fine, M.S. Leinen, and P. LeBoy. 2012. Does gender bias influence awards given by societies? *Eos, Transactions American Geophysical Union* 92:421–422, http://dx.doi.org/10.1029/2011EO470002.

Holmes, M.A., S. O'Connell, and K. Dutt, eds. 2015 (May). *Women in the Geosciences: Practical, Positive Practices Toward Parity*. American Geophysical Union, Wiley, 135 pp.

Huntoon, J.E., and M. Lane. 2007. Diversity in the geosciences and successful strategies for increasing diversity. *Journal of Geoscience Education* 55:447–457.

Kappel, E.S., and L. Thompson. 2014. Invited scientific papers and speakers and fellow awardees: Little progress for women oceanographers in the last decade. *Oceanography* 27(4) supplement:24–28, http://dx.doi.org/10.5670/oceanog.2014.110.

Lozier, M.S. 2006. MPOWIR: Mentoring Physical Oceanography Women to Increase Retention. *Eos, Transactions American Geophysical Union* 87:123–126.

Moss-Racusin, C.A., J.F. Dovidio, V.L. Brescoll, M.J. Graham, and J. Handelsman. 2012. Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 109:16,474–16,479, http://dx.doi.org/10.1073/pnas.1211286109.

NSF (National Science Foundation). 2004. *Division of Science Resources Statistics, Science and Engineering Degrees: 1966–2001*. NSF 04-311, Project Officers, Susan T. Hill and Jean M. Johnson, Arlington, VA, USA, http://www.nsf.gov/statistics/nsf04311/sectb.htm.

NSF. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering*. National Science Foundation, National Center for Science and Engineering Statistics, Special Report NSF 13-304, Arlington, VA, http://www.nsf.gov/statistics/wmpd/2013/start.cfm.

O'Connell, S. 2013. Consider nominating a woman for an AGU award. *Eos, Transactions American Geophysical Union* 94(10):99, 10.1002/2013EO100003.

O'Connell, S., and M.A. Holmes. 2005. Women of the academy and the sea. *Oceanography* 18(1):12–24, http://dx.doi.org/10.5670/oceanog.2005.66.

Orcutt, B.N., and I. Cetinić. 2014. Women in oceanography: Continuing challenges. *Oceanography* 27(4) supplement:5–13, http://dx.doi.org/10.5670/oceanog.2014.106.

Prendeville, J., and D. Elthon. 2001. *Report of the Geosciences Diversity Workshop, August 2000, Appendix to NSF 01-53* (Strategy for Developing a Program for Opportunities for Enhancing Diversity in the Geosciences). Arlington, VA, http://www.nsf.gov/geo/diversity/geo_diversity_workshop_final_report_august_00.jsp.

Steele, C.M. 1997. A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist* 52:613–629.

Thompson, L., R. C. Perez, and A. E. Shevenell. 2011. Closed ranks in oceanography. *Nature Geoscience* 4:211–212, http://dx.doi.org/10.1038/ngeo1113.

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SIDEBAR. Mary Johrde and the Birth of the UNOLS Fleet

By Ellen S. Kappel

Most US ocean scientists today take ship scheduling, coordinated via UNOLS (University-National Oceanographic Laboratory System), for granted. They are too young to remember a time when oceanographic institutions such as Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, and Lamont Geological Observatory (now the Lamont-Doherty Earth Observatory) ran their own ships and scheduled research cruises, with little attention or concern for operational efficiency or the needs of the broader community. It was unusual for a scientist to sail on another institution's vessel, especially as a chief scientist. All of that changed in 1971, in large part due to the inexorable Mary Johrde of the National Science Foundation (NSF), who stood up to a group of not-very-happy lab directors who saw UNOLS as a way of losing control over their ships.

Mary Johrde, a petite biologist—not an oceanographer by training, but with extensive NSF experience in the field of facilities operations—was articulate and smart as whip with strong convictions that the existing system could not endure. She was given the responsibility within NSF for creating a new National Oceanographic Laboratory System (NOLS). In January 1971, she put together the "NOLS Planning Document: Short Version," which laid out NSF's vision for management of the academic research fleet, including NSF's role (see Byrne and Dinsmore, 2000, for a more complete and detailed history of the origins of UNOLS). NSF had several reasons for putting forth this plan, including the rising cost of ship operations, declining Office of Naval Research funding, the need for greater accountability, and pressure to accommodate a broader community on the ships. Mary Johrde was strong in her defense of the plan, and stood her ground against the lab directors. "Eight or so lab directors on one side; Mary Johrde on the other—the odds were almost even" (Byrne and Dinsmore, 2000, p. 111). In the end, a compromise was made, and later that year, UNOLS was born.

Mary Johrde, along with Feenan Jennings, went on to lead the formation of the Division of Ocean Sciences in the mid-1970s. By then, Mary had been at NSF almost 20 years (she arrived there in November 1958). She started her NSF career as a program assistant to the newly established Specialized Facilities Program in the Biological and Medical Sciences Division (BMS), one of two original NSF divisions (the other was Mathematics, Physics, and Engineering [MPE]). In 1965 she became an assistant program director in Earth science when the Earth and Atmospheric Science sections were split off from MPE and put in the new Division of Environmental Sciences (DES). In that role, Mary attempted to "establish a single NSF Advisory Panel for Ship Operations, block funding for ships, and guidelines for evaluating and managing this very essential support for the community" (Johrde, 2000, p. 94). In a next reorganization of NSF programs in 1968, NSF made her program director for the DES Oceanographic Facilities Program, where she made her mark in the early UNOLS years. In 1971, NSF created the Office for Oceanographic Facilities and Support to implement management support for the NOLS concept, which Mary headed until 1981 when she retired from NSF after a long and very distinguished career.

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REFERENCES

Johrde, M. Ocean science at the National Science Foundation: Early evolution. Pp. 93–95 in *50 Years of Ocean Discovery: National Science Foundation 1950–2000*. Ocean Studies Board, National Research Council, National Academy Press, Washington, DC.

Byrne, J.V., and R.P. Dinsmore. 2000. Two years of turbulence leading to a quarter century of cooperation: The birth of UNOLS. Pp. 107–115 in *50 Years of Ocean Discovery: National Science Foundation 1950–2000*. Ocean Studies Board, National Research Council, National Academy Press, Washington, DC.

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Invited Scientific Papers and Speakers and Fellow Awardees

Little Progress for Women Oceanographers in the Last Decade

By Ellen S. Kappel and LuAnne Thompson

As part of this supplement to *Oceanography*, we reviewed how women oceanographers have progressed over the last decade or more in three categories of professional activities: (1) first authors of invited papers to *Oceanography* special issues, (2) invited speakers or discussion leaders at small conferences, and (3) AGU Ocean Sciences Fellow recipients. The same theme emerges in all the data that we tallied: women are not being invited or are not accepting invitations to write first author papers, are not being invited to speak or are declining invitations at small specialized conferences, and are not being awarded honors from societies commensurate with their numbers in academia when taking into consideration the percentage of women earning PhDs over the last several decades. There has been little improvement in the last decade across all of these areas. The purpose of this article is to raise awareness that gender bias, whether intentional or not, still exists in the representations of women in a wide range of important professional activities in the ocean sciences.

OCEANOGRAPHY FIRST AUTHORSHIP (2004–2014)

Conley and Stadmark's (2012) analysis of the gender distribution of authors of *Nature*'s News & Views articles and of Perspectives in *Science* for 2010 and 2011 motivated us to review first authorship of articles included in the special issue sections of *Oceanography* (Figure 1). While not a technical journal where ocean scientists publish their primary research results, *Oceanography* currently ranks eighth among the 20 journals listed in the Google Scholar top oceanography publications, based on h5-index and h5-median rankings.

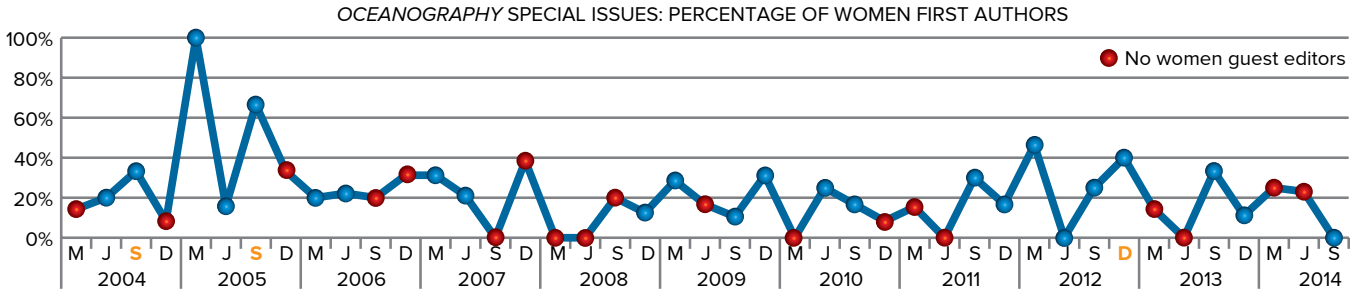

Figure 1. A decade of *Oceanography* special issue authorship as percentage of women first authors. The March 2005 issue that shows 100% women authorship was the previous special issue on "Women in Oceanography." The three issues that did not have a special issue section and were a mix of invited and unsolicited papers are denoted by orange text in the year axis. Red dots indicate the special issues that did not have any women guest editors. Information on authorship is available through *Oceanography's* online archive at http://tos.org/oceanography/issues/archive.html.

Guest editors assemble the tables of contents, invite scientists to write articles, and conduct the peer review. Some new results may be presented, but much of the journal's content consists of integrative reviews of particular research areas, or the issues may have a programmatic focus. Here, we tallied only full-length articles; no one- or two-page sidebars, highlights, or spotlights were included in the totals.

Out of 556 authors counted in the last decade (starting with March 2004) for this analysis, 120, or about 22% had women scientists as first authors (Figure 1). Three issues (September 2004, September 2005, and December 2012) did not have a special issue section but rather included a mix of invited and unsolicited manuscripts. The March 2005 special issue that had 100% female authorship was the previous "Women in Oceanography" special issue.

Out of the 40 special issues analyzed, eight special issues did not have any woman first authors: Marine Population Connectivity; Salinity; NURC: Celebrating 50 Years of International Partnerships in Ocean Research and Operations; Mountains in the Sea; Sea Level; Internal Waves; Ocean Remote Sensing with Synthetic Aperture Radar; and Navy Operational Models. Of these eight special issues, six didn't have any women guest editors. There were 27 women out of a total of 107 (25%) guest editors in the last decade, with 19 issues—nearly half—having no women guest editors (Figure 1). Guest editors are nominated by a variety of means, and where there is more than one guest editor, there is often a lead guest editor who invites others for their specific expertise on the topic of the issue (generally, there are from one to four guest editors for each special issue).

SMALL CONFERENCES

We reviewed a small set of conferences where the main session speakers or discussion leaders were by invitation only—Gordon Conferences, Aha Huliko'a conferences, and International Liège Colloquia. We did not review speakers or authors of abstracts from large community meetings such the Ocean Sciences Meeting.

Gordon Conferences cover a wide range of topics and are important meetings for subdisciplines within oceanography where collaborations are established and students and postdocs are introduced to their chosen area of study. Each topic is typically featured at meetings every other year. According to the Gordon Conference website (https://www.grc.org/about.aspx), each conference chair is "completely responsible for the content and conduct of the meeting as well as the selection of discussion leaders, speakers, and attendees. The primary criteria for attendance at a Conference are scientific accomplishment and, implicitly, the commitment to participate actively and meaningfully in the discussions."

We analyzed the participation of women in four different Gordon Conference topics covering different oceanography fields over time periods where the meeting programs, with names of discussion leaders and invited speakers, were readily available (Figure 2): Oceans and Human Health (2008–2014), Coastal Ocean Modeling (1999–2013), Chemical Oceanography (1995–2013), and Polar Marine Science

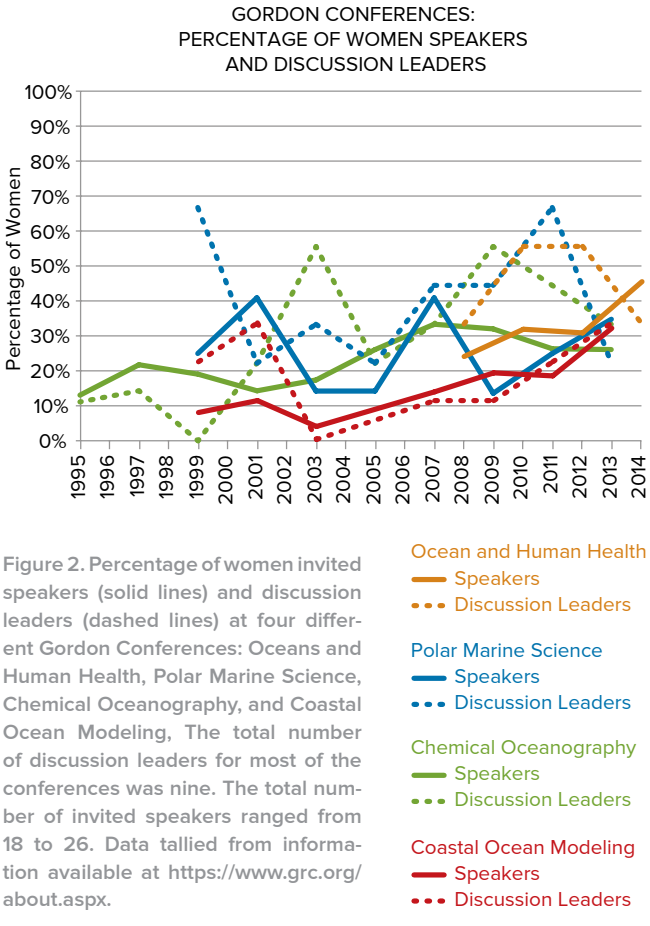

Figure 2. Percentage of women invited speakers (solid lines) and discussion leaders (dashed lines) at four different Gordon Conferences: Oceans and Human Health, Polar Marine Science, Chemical Oceanography, and Coastal Ocean Modeling, The total number of discussion leaders for most of the conferences was nine. The total number of invited speakers ranged from 18 to 26. Data tallied from information available at https://www.grc.org/about.aspx.

(1999–2013). For all but two of the meetings that we reviewed, nine discussion leaders were invited for each conference, with the number of invited speakers ranging from 18 to 26.

Figure 2 shows the results of our tallies. In general, women are better represented among discussion leaders than among the speakers. The Oceans and Human Health theme, a more recent addition to the Gordon Conference topic area, generally includes a fairly high percentage of women discussion leaders (more than 50% in two of the years), while the number of invited women speakers varies from about 24% to 45% (orange lines in Figure 2). The percentage of women discussion leaders at the Chemical Oceanography conferences has fluctuated widely, from 0% to 55%, while the percentage of women invited speakers seems to have increased from an average of about 20% from 1995 to 2003 to an average of roughly 30% from 2005 to the present (green lines in Figure 2). The percentage of women invitees to the Polar Marine Science conferences has also fluctuated greatly (blue lines in Figure 2), with women listed as invited speakers less often than discussion leaders, as is generally the case with the other Gordon Conferences we tallied. The percentage of women speakers and discussion leaders at the Coastal Ocean Modeling Gordon Conferences has increased steadily from 2003 to present, with 32% women in 2013 (red lines in Figure 2). Conferences on this topic have fewer women participants in either category than the others we reviewed. It is likely that these numbers at least partly reflect the overall smaller percentage of women that populate the more physics- and mathematics-oriented disciplines like modeling.

We also examined the Aha Huliko'a conference of specialized physical oceanography topics. Those conferences were held every other year from 1987 to 2007 and were by invitation only. The percentage of women participants remained low (on average, 5% to 10%) throughout the 20-year lifetime of this conference, only reaching above 20% in 1998 when the topic was *Biotic Impacts of Extratropical Climate Variability in the Pacific* (Figure 3).

Finally, we reviewed the percentage of women keynote speakers in the International Liège Colloquia in ocean dynamics. The last four conferences had a small number of keynote talks (Table 1), and for the colloquia in 2011 and 2012, there were no women speakers. However, in 2013 and 2014, the number of women speakers was much higher, but the topics were more biological.

AGU FELLOWS (2004–2014)

Election as a fellow of a society is a way for colleagues to recognize accomplishment in the field. In both the American Geophysical Union and The Oceanography Society, any member may nominate another member for such a professional distinction. Here, we reviewed the number of women who have been elected Fellows of the American Geophysical Union in the Ocean Sciences section over the last decade (Figure 4). O'Connell (2013) analyzes AGU Fellow nominations and recipients for the whole society and over a longer time period. Our tallies show that from 2004 to 2012, zero or one woman Fellow was elected in the AGU Ocean Sciences sections out of nine to 11 total Fellows, with the exception of 2006 when there were two. In 2013, four of 12 Fellows were women and in 2014, the numbers decreased again to just two women of the 10 elected AGU Ocean Sciences Fellows. The Oceanography Society doesn't have as extensive a fellow program, but since the start of the TOS Fellow program in 2005, six of the 17 TOS Fellows have been women (data from http://tos.org/awards_honors/fellows_program.html).

DISCUSSION

The National Science Foundation does completion surveys for PhD students, and the data are readily available for ocean sciences since 1965 (http://nces.ed.gov/ipeds). In reviewing the completion numbers, we find a steady increase in the percentage of women awarded PhDs in ocean sciences: 1980–1989, 19% of PhDs were women; from 1990–1999,

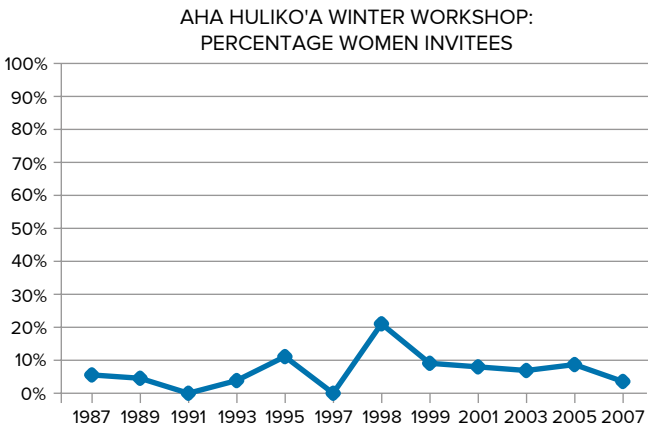

Figure 3. Percentage of women invited to participate in the Aha Huliko'a conferences, which covered specialized physical oceanography topics. Total number of participants in each conference ranged from 18 to 33. Data were tallied from the Aha Huliko'a website, http://www.soest.hawaii.edu/PubServices/AhaHulikoa.html.

Table 1. Participation in International Liège Colloquia. Numbers tallied from http://modb.oce.ulg.ac.be/colloquium.

Year	Topic	# of keynotes	% of women
2014	Low oxygen environments in marine, estuarine, and fresh water	11	45
2013	Primary production in the ocean: From the synoptic to the global scale	9	22
2012	Remote sensing of color, temperature, and salinity	7	0
2011	Tracers of physical and biogeochemical processes, past changes, and ongoing anthropogenic impacts	4	0

31% were women; and from 2000–2008, 39% were women. If the career progression were the same for women and men, the percentage of women participating in professional activities would be expected to be commensurate with the percentage of women earning PhDs one to two decades previously. The limited sampling of professional activities presented here—first authorship of *Oceanography* articles, invitations to speak at small conferences, and election as society fellows—indicates that the representation of women across a range of activities falls short by 10 to 20 percentage points even when accounting for year the PhD was earned.

In reviewing *Oceanography* data, it is clear that there needs to be improvement in the number of women scientists who contribute as first authors and as guest editors to special issue sections. Of the 40 special issues tallied, nearly three-quarters have ~20% or less women first authors than might be expected, given the number of PhDs earned. In contrast to society fellows, who tend to be at least 20 years post-PhD, there's no expectation that first authorship is reserved for the most senior scientists in the field. Even for the issues where women served as guest editors, there was no increase in women first authorship as compared to issues where there were no women guest editors; however, six of the seven issues that had no women guest editors also did not have any women first authors.

Representation of women at the small conferences we surveyed has generally been increasing slowly over the last decade, but remains below expectations. Invited participation by women is higher in chemical and biological oceanography and in interdisciplinary conferences than in conferences covering physical oceanography topics. Using the completion rates for physical oceanographers from major oceanographic institutions, we find that in the 1980s, 21% of the PhDs were granted to women. This figure tracks the numbers reported by NSF for all ocean sciences disciplines. However, in the 1990s and 2000s, while the number of PhDs earned by women in physical oceanography is 27% and 35%, respectively, these figures are both lower than the NSF ocean sciences numbers (Thompson et al., 2011). These data suggest that while some of the lag in the physical oceanography percentages can be explained by fewer women in this discipline than in other areas of ocean science, the Aha and physical oceanography Liège meetings stand out as meetings whose invited speaker lists are particularly sparsely populated by women.

Women are better represented as discussion leaders than as speakers (Gordon Conferences). These observations suggest that the women are attending the conferences, but are not being invited to give talks, or when they are invited, they are declining the invitations at higher rates. Schroeder et al (2013) did a comprehensive analysis of the gender ratio of different types of plenary speakers at the European Society for Evolutionary Biology. They found that women speakers were under-represented among invited speakers relative to contributed speakers, but also found that women were more likely to decline invitations. It may be that the most prominent women are being over-tasked by invitations to participate in professional activities, and that a more nuanced approach is warranted.

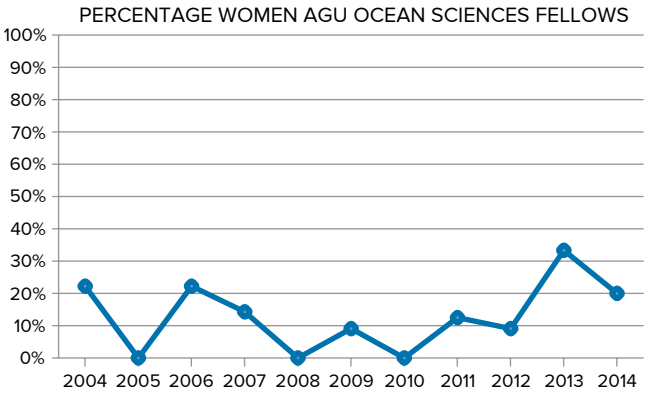

Figure 4. Percentage of women elected Fellows of the American Geophysical Union (AGU) in the Ocean Sciences section. Data for 2004–2010 from http://oceans.agu.org/honors. Data from 2011–2104 are the Fellows elected by the Ocean Sciences section, as provided to the authors by AGU for this study. Prior to 2011, the designation of Fellows was directly associated with a member's status in a section.

The percentage of women honored as AGU Fellows lags at least 10 to 20 percentage points below the number of PhDs awarded to women in ocean sciences even when accounting for the fact that Fellows are generally nominated from a pool of more senior scientists. The information we have does not reveal where the gender bias may be: are fewer women being nominated, or are they nominated but not elected as society fellows—or both?

The information we tallied suggests that gender bias remains an issue. Below, we make some recommendations on how we, as a community, can increase the number of women participating in high profile professional activities.

RECOMMENDATIONS

1. Whether inviting authors to contribute papers to special issues of journals or nominating colleagues for awards, be aware of unintended gender bias. Everyone—women and men—should make sure to include more women in the pool of scientists being considered.
2. Meeting organizers should pay attention not only to the gender distribution of invitations but also to the actual distribution of invited talks of the resulting conference. Because women may be more likely to decline invitations, it is important to take this into account when invitations are made. Women who already have achieved prominence in science may be overburdened by invitations, suggesting that meeting organizers should consider inviting women whose contributions may have been overlooked.
3. Because small, specialized conferences are often key places where early career scientists establish their professional network and find mentors, special attention should be given to the gender distribution of invited speakers at those conferences so that it more closely reflects the completion rates in recent decades.
4. The number of female AGU Fellows increased by a small amount in 2013 after O'Connell (2013) pointed out the dearth of women among past awardees. This suggests that we need to continue to report on the gender disparities in both awards and invited speakers at specialized conferences in order to provide opportunities for women in our field to succeed.

REFERENCES

Conley, D., and J. Stadmark. 2012. Gender matters: A call to commission more women writers. *Nature* 488:590, http://dx.doi.org/10.1038/488590a.

O'Connell, S. 2013. Consider nominating a woman for an AGU award. *Eos, Transactions American Geophysical Union* 94:99, http://dx.doi.org/10.1002/2013EO100003.

Schroeder, J., H.L. Dugdale, R. Radersma, M. Hinsch, D.M. Buehler, J. Saul, L. Porter, A. Liker, I. De Cauwer, P.J. Johnson, and others. 2013. Fewer invited talks by women in evolutionary biology symposia. *Journal of Evolutionary Biology* 26:2,063–2,069, http://dx.doi.org/10.1111/jeb.12198.

Thompson, L., R.C. Perez, and A.E. Shevenell. 2011. Closed ranks in oceanography. *Nature Geoscience* 4:211–212, http://dx.doi.org/10.1038/ngeo1113.

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SIDEBAR. Women Exploring the Ocean: womenoceanographers.org Fifteen Years Later

By Deborah K. Smith

Fifteen years ago as the millennium was drawing to a close, a group of us (the author, a Web designer, and a writer) decided that the time was right to introduce a new website highlighting the contributions that women make to marine science. We envisioned a site where students considering careers in oceanography could read about the experiences of successful women and learn from the choices they made. Such a site would convey the excitement of groundbreaking research in oceanography and serve as a resource for teachers, scientists, and the general public. Finally, we wanted a site that would commemorate the achievements of a group of remarkable women and bring a human face to those working in marine science.

In the fall of 1999, we received a grant from the US National Science Foundation's "Awards to Facilitate Geoscience Education" to make this site a reality, and in the winter of 2000, we launched Women in Oceanography (http://www.womenoceanographers.org). Five years later, our site contained the profiles of 15 women, each with a unique story to tell. Even though funding ran out, I continue to host the site on an external server, and 15 years later, Women in Oceanography remains available to those interested in reading about the diverse career paths in marine science.

Lessons Learned

As our website came together and evolved, we found that it does more than celebrate the achievements of the scientists. It provides a realistic view of their professions and the challenges they face while pursuing their careers. The site also demonstrates that there are no typical scientists or career paths. With each profile completed, we learned something new and gained new perspectives on marine science. For example, we found that the women had varied interests and have faced different challenges, and they have made unique contributions to the study of oceanography and to our knowledge of Earth and its ocean.

One of the most rewarding aspects about this experience was that, without exception, each woman was extremely cooperative and generous with her time. All of the women shared the goal of making the site a worthwhile, entertaining, and educational experience for users, and they all spent a significant amount of time working with us. Before each of the women was interviewed, we sent a list of questions we planned to ask. During the interviews, which generally lasted about two hours, we discussed the research or other work each woman was engaged in, and then moved to the question and answer portion. The entire interview was videotaped, and following the interviews, Edwin Schiele, the science writer, wrote the introduction and edited the question and answers. I wrote the "Learn More" lessons. Each woman was asked to review and comment on what we had written, and they were invited to provide photographs, write their calendars, and provide links to publications and other relevant sites. In hindsight, their generosity with their time was remarkable.

Although we can infer that many of the people entering our site are interested in oceanography, we have no way of determining what percentage are students, teachers, scientists, or interested members of the general public. Nor do we have any quantitative measure of whether our site has influenced any students, although several middle school students have contacted one of the profiled women to interview her for a school science project. These have been very positive experiences for the women, with only one exception when an overzealous parent became too involved in the project. The profiled women referred colleagues and potential students to the site. And we heard anecdotally from other scientists that they often visited the site, and were especially interested in the weekly calendars to see how colleagues balance their time.

One of the biggest challenges was publicizing the site. We contacted a number of organizations and urged them to add links to our site from their websites. In March 2000, the American Geophysical Union's *Eos Transactions* published a favorable review of our site, doubling the traffic in the days following publication. In June 2000, the site was listed as one of the San Francisco Exploratorium's "Ten Cool Sites."

Based on Web statistics, we knew early on that much of our traffic came through the Woods Hole Oceanographic Institution's home page, the Stanford University marine website, and other school websites. These links no longer exist, and the site is found primarily through web searches. The top Google search phrases leading to our site include women scientists, oceanographers, marine biologists, oceans, and oceanography.

Personally, I find the site just as compelling and usable today as I did 10 years ago. And current Web statistics suggest that people are still visiting the site with as many as 30 unique visitors per day, even though the site is no longer promoted. If resources were available, I would update the careers of each of the women to show where their jobs have led them over the last decade, but for now and as long as the site continues to attract users as is, my plan is to keep it active.

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Advancing Women in Oceanography

How NSF's ADVANCE Program Promotes Gender Equity in Academia

By Mary Anne Holmes

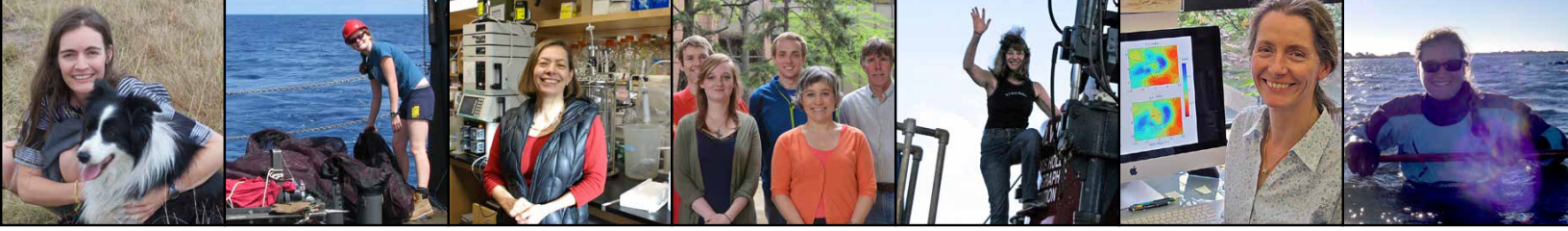
ABSTRACT. Gender equity in science, technology, engineering, and mathematics (STEM) has remained elusive because there are multiple causes of inequity that interact in complex ways. These causes have been the subject of interdisciplinary research funded by the National Science Foundation's ADVANCE program. Outcomes demonstrate that some barriers to women's retention in faculty and leadership positions in STEM result from individual challenges, such as lack of networks, mentors, and advocates. Some barriers result from interactional challenges among colleagues, such as implicit assumptions about who "does" science. And some barriers are institutional, the product of a system designed for men with families to support their personal lives. Solutions designed by research address one or more of these causes with source-specific interventions. For individual barriers, professional development workshops help make the implicit explicit. For interactional barriers, learning about implicit bias can reduce its impact. For institutional barriers, policy review and reform, such as enacting stop-the-tenure clock and dual-career policies, make the academy more people-friendly. To include as many excellent minds as possible in the STEM enterprise, it is necessary to transform the institution, not "fix the women." Such transformation must be well thought out and purposefully enacted. Still, change is slow: even the best programs will take a decade or more to reap the benefits.

GENDER INEQUITY IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM)

The proportion of ocean science doctoral degrees awarded to women has increased from 0% in 1966 (NSF, 2004) to 40% in 2002 and 48% in 2012 (NSF, 2013). However, as Orcutt and Cetinić (2014, in this supplement) show, with a couple of exceptions, there are fewer women on the faculties of oceanographic institutions than the number of women PhDs would predict: 20% at the full professor level, 30% at the associate professor level, and 40% at the assistant professor level.

In response to a mandate from Congress, the National Science Board (the US National Science Foundation's [NSF] governing body) has provided data biannually since 1966 on science and engineering indicators. These data reveal gaps in the supply of women to STEM (science, technology, engineering mathematics). Among the findings: women are earning an increasing share of STEM undergraduate and graduate degrees, but there are not corresponding increases in STEM faculty. During the 1980s and 1990s, NSF program officers responded to this issue by launching a series of programs (Rosser and Lane, 2002), including grants for visiting professorships, graduate fellowships, and POWRE (Professional Opportunities for Women in Research) awards, all designed to retain women in the academic pipeline by providing them with financial support. These programs were well intentioned, but yielded frustratingly few results: the numbers of women retained in faculty positions did not increase substantially, particularly in the physical sciences (Rosser, 2004).

In 1999, MIT released a report on data gathered by the



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institution's own faculty demonstrating that MIT resources were not distributed evenly by gender after accounting for years at rank and productivity of faculty (MIT, 1999). The MIT president then convened a January 2001 meeting with presidents of eight additional prestigious universities, along with women scientists, to discuss gender inequality. The participants released a statement admitting there was structural, systemic gender inequity at their institutions, and announced steps they would undertake to address the issue (Rosser, 2004; MIT News Office, 2001). MIT published an updated report in 2011, describing the progress made in gender equity at that institution (MIT, 2011).

Two months after the release of the 2001 report, NSF launched the ADVANCE (not an acronym) program (NSF, 2001). The program offered several "tracks" (types of grants). One track, which is no longer available, took a traditional approach, offering fellowships to women in career transitions. The signature track, Institutional Transformation (IT), which is still being funded, takes a different route to gender equity. It acknowledges and addresses what is now understood to be a systemic problem: the academic institution, including its climate, its policies, and practices. ADVANCE-IT is designed to fix the institution, not the women, to transform academia into a place where women as well as men can thrive. IT awards go to academic institutions and enable self-study to identify institutional barriers to women's success and to devise and implement creative ways to lower the barriers.[1] Each institution is unique; some barriers may be idiosyncratic while others are shared among many or most institutions of higher education. As of this writing, 60 institutions have received ADVANCE-IT awards, and analyses of the impacts are currently in press (see NSF's ADVANCE website for a portfolio analysis to be released soon).

The IT-Catalyst track (formerly IT-START) has a similar goal of institutional transformation. These awards go to historically funding-challenged institutions to conduct self-studies to begin the process of institutional transformation. Additional tracks in the ADVANCE program include Leadership, replaced by PAID grants, and PAID, recently replaced by Partnerships for Learning and Adaptation Networks, PLAN. These grants are awarded to individuals or collaborators to target specific challenges women face within a discipline, set of disciplines, institution, or set of institutions. All of these ADVANCE awards have yielded a significant body of research revealing the multiple small inequities that add up to significant barriers for many women trying to become successful scientists, and, importantly, offering strategies to address them.

Of the 25 US institutions identified as having oceanographic programs by reviewing the American Geological Institute's 2011 *Directory of Geoscience Departments*, 10 have received ADVANCE awards (IT, IT-Catalyst, or PAID): Texas A&M

[1] IT awards go to teams at academic institutions that include men and women administrators, lab-and-bench STEM women faculty, and scientists who specialize in social sciences, organizational sciences, and studies of higher education. The team uses demographic and survey or focus group data from the institution that allows the team to identify the institution's own barriers to women's hiring, retention, and promotion.

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University, Oregon State University, Lamont-Doherty Earth Observatory of Columbia University, and the Universities of Delaware, Maryland-College Park, Miami, Rhode Island, Washington, and Wisconsin-Madison. At these institutions, women constitute 17% of the oceanography faculty compared to 14% of the faculties of the remaining 15 institutions that did not receive ADVANCE awards (Florida International, Dauphin Island, Louisiana State University, the Naval Postgraduate School, Nova Southeastern, Old Dominion, Princeton, University of Texas-Austin, UCLA, UC San Diego, University of Connecticut, University of Hawai'i-Manoa, University of Massachusetts-Boston, University of South Carolina, and University of South Florida).

WHY DOES INEQUITY PERSIST? WHAT CAN WE DO ABOUT IT?

Research from ADVANCE awards reveals that barriers for women have different sources; thus, strategies for addressing a given barrier should be designed to fit the source or sources. The first two rounds of IT awardees experimented widely with strategies while conducting detailed sociological, psychological, ethnographic, and/or organizational research on the processes they were undertaking (e.g., Bilimoria and Liang, 2011). Later awardees built on these results and expanded and refined strategies. I offer here a personal summary of what's been found that works, and in what context. It is not meant to be a scholarly evaluation of the impact of ADVANCE strategies, but rather some suggestions that, in my experience, work effectively to make academic institutions more gender neutral.

There are barriers to women's success that arise from omissions in training, misperceptions, and misconceptions among individuals in the academy. There are barriers that arise in social settings as faculty interact with one another and with students, staff, and administrators. There are barriers that arise from institutional practices and policies (Risman, 2004). Different approaches are required for addressing a given type of barrier, and they are discussed in turn. Potential barriers, along with solutions devised by ADVANCE awardees, are also described.

INDIVIDUAL BARRIERS » ***If women are not linked to networks where informal mentoring takes place, they may not know the rules that men pick up in informal settings (e.g., the bar, the racquetball court, around the water cooler). We are usually not aware when informal mentoring occurs—it seems a natural part of a conversation. Women do perceive exclusion from informal networks within academic departments (e.g., Maranto and Griffin, 2010, and references therein).***

Solution 1 » Professional development for women at all career stages. These activities may take place at workshops or panel discussions, possibly led by professional facilitators or local faculty. Topics might include "How to Start Up Your Lab," "How the Teaching Evaluation Process Works" for new hires, or "How to Put Together Your Promotion-to-Full Packet" for faculty at associate professor rank. Workshops and panel discussions have the added benefit of bringing professionals from across an institution or from several institutions to an informal setting for networking (providing food as an incentive to attend always helps). Although much attention has rightly been paid to the needs of beginning faculty, ADVANCE research indicates that the promotion-to-full process is obscure for many faculty—of both genders (Britton, 2010; Berheide, 2014); fully promoted faculty also benefit from professional development.

Solution 2 » Assign mentors (note that the plural "mentors" means more than one mentor for an individual). Multiple mentors offer different perspectives on how to be successful. There may be an effective mentor within a department or from another department within the same college or institution. Mentors from outside of the institution provide confidentiality and a broader perspective on the particular discipline. A faculty member or committee should provide formal oversight to a department's mentoring program. Mentors should be given guidance on how to be a good mentor (Pfund et al., 2006); mentor-mentee pairs should meet on a regular basis with a goal for each meeting. When the pair is not a good fit, it should be OK to acknowledge it and reassign faculty with no guilt and no blame.

Note that these solutions are not intended to "fix the woman," to mold her to fit the institution. The purpose of these solutions is to make the implicit explicit, to help leaders identify and communicate the information necessary for their colleagues to succeed. Note also that such programs will benefit men as well. Not all men are plugged into the "right" informal network, particularly men from under-represented groups, including those who were not born in the United States. ADVANCE teams discovered early on that what makes good practice for promoting the success of STEM women is good practice for promoting the success of all STEM faculty.

Susan Lozier of Duke and her colleagues developed an excellent mentoring program for early career scientists in physical oceanography: MPOWIR (Mentoring Physical Oceanographers to Increase Retention; see Clem et al., 2014, this supplement). This program hosts a biennial conference that brings aspiring physical oceanographers together with seasoned veterans (men and women) who formally mentor their junior colleagues and welcome them into their professional networks. Connections are then maintained and strengthened through regularly scheduled teleconferences (Lozier, 2009; Gerber, 2010). ASCENT (Atmospheric Science Collaborations and Enriching NeTworks) is a similar program for women in meteorology (Avallone et al., 2013; Hallar et al., 2015).

In addition, women may lack *advocates*. Mentors provide advice and counseling; advocates will stand up for a colleague and actively promote his or her advancement.

Solution 3 » Assign advocates. If a faculty member feels that he/she cannot advocate for a junior faculty member, then try another one. If no one wants to advocate for a junior faculty member, that person is not likely to succeed at promotion and tenure time.

INTERACTIONAL BARRIERS 1 » ***How do we treat one another in the academic setting? Do we feel that we belong? Is it easy to discuss scientific and other issues with colleagues? Do we feel as though we can do our best work where we are, or we can't wait to leave? The answers to these and similar questions measure sociological climate. ADVANCE researchers use surveys of faculty to determine departmental-level and institutional-level climate. Negative climates have been demonstrated to reduce a faculty member's intention to stay at an institution, and they can have a negative effect on a faculty member's productivity (e.g., Fox and Mohapatra, 2007). There are external forces that impact faculty members' perceptions of their institution or department, such as budget cuts, scandal, or legislative or regent/trustee actions. Within departments, however, how we treat one another, and whether department chairs and heads hold faculty members accountable for their behavior, has a large impact on departmental climate and faculty intentions to leave or stay.***

Solution » Faculty must behave in a civil, adult, respectful manner toward one another. The academic department is like a family that must live together for a decade or several decades. Conflicts cannot be allowed to persist and fester. Conflict resolution training and outside intervention can help. Many institutions have a facilitator who can help a department achieve civility. Generally, most faculty want a civil atmosphere; engaging these faculty as allies to turn around a negative atmosphere can be effective. Hiring the right people is also important; but this does not mean hiring people "just like me" (Sutton, 2007).

INTERACTIONAL BARRIERS 2 » ***Implicit bias is a more insidious interactional issue that may also be known as implicit assumptions or unconscious bias. Implicit assumptions are the unexamined assumptions we have about one another that we may not even be aware of. They may even conflict with our stated beliefs. They are shared***

by all members of a given society or culture because they are generated by the culture, by family, by media. Men and women share the same implicit assumptions, and in our society, that means "scientist" = "male." In a recent study, for example, both men and women faculty in the physical sciences preferred to hire a fictional male as a lab assistant over a female with the same qualifications; both men and women faculty offered a lower starting salary for the fictional female applicant; women faculty offered the lowest starting salaries (Moss-Racusin et al., 2012). Additional examples of our communal bias for hiring men for STEM positions abound in the literature (see Resources, below).

Implicit bias impacts every form of assessment we undertake of one another, for example: selecting graduate students, selecting short lists for faculty searches, selecting the new faculty member from the short list, annual evaluations, evaluation of tenure and promotion packages, selecting speakers for a symposium or conference, nominations for awards, selecting awardees, and nomination for leadership positions at an institution and in professional societies.

A little bit of bias may not matter, but it accumulates through each selection process, winnowing the pool until the under-represented disappear altogether. Computer simulations that provide a 1% better evaluation for one group over another yield smaller and smaller percentages of the disadvantaged group with each successive move up the career ladder (Martell et al., 1996). Valian (1999) calls this the "accumulation of disadvantage."

Solution » Reduce the impact of implicit bias. Learn about it (take the original Implicit Association Test available at https://implicit.harvard.edu/implicit) or educate the faculty about it by bringing in a speaker. There is probably someone on your campus who can speak about implicit bias, or a network of experts can be found through Virginia Tech's ADVANCE portal (see Resources below). Many ADVANCE institutions form faculty committees dedicated to educating themselves about the impact of implicit bias—the original was the University of Michigan's STRIDE Committee (Meyerson and Tompkins, 2007; see also Resources). Faculty on these committees are a great resource for learning about implicit bias.

Before evaluation of any sort occurs (selecting graduate students, creating a short list of candidates for a new faculty position, annual evaluations), decide what criteria will be used to make the assessment. Should your next faculty member, for example, have a certain number of publications? In specific journals? Or do grant dollars to date carry heavier weight? How will you weigh the candidate's alma mater or major professor compared to publication history? Before the selection committee reads through applications, the criteria should be explicit. It may be helpful to use a rubric that lists the criteria and the relative weighting of each criterion. The University of Wisconsin's ADVANCE program, WISELI, provides sample evaluation rubrics (see Resources).

Question selections and hold evaluative committees accountable. Once selection from the pool is made, stop and ask: does this list/selection have evidence of our implicit biases? Can we take another look at the applications to make sure we haven't skipped over a promising candidate? Is our evaluation biased? Both men and women write better letters of recommendation for men than for women (Trix and Psenka, 2003).

Pay attention to which of your faculty have been nominated for what prestigious awards, for awards from the institution, as well as awards from professional societies.

Make sure any search or evaluation committee is diverse, but this need must be balanced with not overloading faculty from under-represented groups with service work. The University of California, Irvine's ADVANCE program initiated a Gender Equity Advisor program that has been replicated at many ADVANCE institutions (see Resources). This program trains faculty to serve as representatives of under-represented groups while not necessarily being from those under-represented groups (such a program may overlap with the STRIDE-type committee). This practice shares the responsibility of equity "eyes and ears" among all faculty and relieves faculty from under-represented groups from being the only voices to speak up for equity. Such faculty are often in lower status positions in departments and may not wish to speak up on what might seem a controversial topic. The Equity Advisor relieves them of this burden.

INTERACTIONAL BARRIERS 3 » The Applicant/Candidate Pool. *Not only is selection from a pool subject to bias, forming the pool from which we draw candidates and nominees is subject to bias as well.*

Solution » ADVANCE institutions have generated a number of practices designed to broadly expand the pool of applicants. These mechanisms generally involve taking a

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long-term approach to a search by seeking and cultivating potential candidates even years in advance of an anticipated search and advertising in minority-serving venues such as the National Association of Black Geoscientists (NABGG), the Association for Women in Geoscience (AWG), and the Earth Science Women's Network (ESWN). SACNAS (Society for Advancement of Hispanics/Chicanos and Native Americans in Science) holds annual meetings showcasing research results from students from these under-represented populations. The Society of STEM Women of Color (see Resources, below) holds annual conclaves. One or more faculty should be designated to be on the lookout at all times, particularly at conferences, for potential new colleagues. Invitations should be extended for potential colleagues to present at a colloquium series as a sort of "first look" for both candidate and department.

INSTITUTIONAL BARRIERS » ***Women, and increasingly men, lack access to basic support for their families, including physical structures, such as affordable, conveniently located childcare. For new mothers, federal law now mandates lactation facilities. In addition to the physical structure of the workplace, policies and practices that support faculty are needed (Quinn et al., 2004; Monroe et al., 2014). At one Midwestern ADVANCE institution, only 13% of STEM faculty have a stay-at-home partner who handles all family logistics (Hill et al., 2014); all others are in dual-career situations or are single. Having children should not be an insurmountable barrier to a career in science: on average, women leave the workforce for only two years over the arc of a career (Hewlett and Luce, 2005). As Shirley Malcolm, former president of the American Association for the Advancement of Science said: "This is NOT a woman's problem; it is a HUMAN problem."***

Solutions » For physical structures, if building a daycare facility is not possible (and potential funding sources have been fully explored), many ADVANCE institutions have created referral services. Tech Valley Connect spun off the Rensselaer Polytechnic Institute's (RPI's) ADVANCE program (Dean and Koster, 2013). It not only provides referrals for childcare services, but helps new hires at RPI (and many local academic institutions and private firms) find housing, schools, services for kids with special needs—all challenges new faculty may face when moving to a new home. It helps partners find work in the area as well (see Dual Careers, below).

Solutions for Policies and Practices »

1. Most ADVANCE institutions have enacted "stop-the-tenure clock" policies for births, adoptions, care giving, health issues, and eldercare. For faculty who use such policies, departments and institutions need to give careful thought to the letter that is written to external letter writers for delayed tenure bids, explaining how the policy works.
2. Temporary assignment shifts, for example, a faculty member's full-time equivalent (FTE, or whatever acronym is used by your institution) may be assigned to all research, or all teaching for short terms, as needed.
3. Leave for fathers should be equal to leave for mothers. Recent research indicates that men need and take such leaves to help their families and not to "game the system" by using the time to write papers and grant proposals; STEM faculty in general are less likely to take leaves for fear of falling behind in their research (Lundquist, et al., 2012). Institutions should provide a climate that supports using the policies.
4. Part-time appointments, whether temporary or not, can enable faculty to get through critical family transitions while the institution need not lose its investment in the faculty member.

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5. Address Dual Careers. Eighty percent of STEM women are partnered with a STEM man; nearly 60% of STEM men are partnered with a STEM woman (Schiebinger, et al., 2008). ADVANCE-generated solutions include the Rensselaer-spawned Tech Valley Connect (see above). The University of Nebraska-Lincoln temporarily had an office that sent a letter to each short-list candidate describing possibilities for the partners of potential hires and had a “point person” to facilitate communication among the necessary players when a dual-career opportunity arose (Holmes, 2012). One mechanism to address ubiquitous (and no longer unusual) dual-career needs is for colleges/institutions to hold back some percentage of potential new positions to enable hiring qualified partners. Institutional self-study can indicate what that percentage should be. In addition to ADVANCE-generated solutions, there is a Dual Career Network that links higher education dual-career offices for exchanging information on useful strategies. And there is the Higher Education Recruitment Consortium (HERC), which provides a website for all member institutions in a given geographic area to post open positions; couples can use the website postings to look for two positions in a given geographic area.

In addition to having the policies, the policies must be widely known and understood through repeated dissemination. A single mailing or email blast will have little impact on entrenched practices within departments. ADVANCE institutions offer department head/chair workshops, newsletters explaining policy, departmental visits from institutional leaders, and workshops and informal gatherings for faculty to disseminate the policy and information on how to implement it. Because the policies are not used often, one department chair/head can have a steep learning curve for implementing new policy; he or she can be a great resource for other heads and chairs who face new policy implementation. Policy opt-out might be a more effective means of encouraging faculty to use the policies (i.e., the faculty member is automatically given the extension or leave rather than having to ask for it; Risman and Adkins, 2014).

SUMMARY

Thirteen years since the first ADVANCE awards were made, we are beginning to see changes in the academy. At the 2014 ADVANCE PI meeting in Alexandria, Virginia, Abigail Stewart, a first-round IT awardee from the University of Michigan presented data demonstrating the improvement in departmental and institutional climate as well as increased hiring, retention, and promotion of excellent STEM women faculty 12 years after the award began. No significant improvements were observed in climate after only five years. Institutional transformation is difficult; it takes concerted effort, continued attention, and time to see changes. Many ADVANCE institutions have experienced initial declines in climate indicators as consciousness and expectations were raised. But it takes time to formulate and enact policies, and further time, as well as continued attention and effort, to disseminate the policies on campus, to educate the faculty on the policies’ existence, and to support the faculty to develop practices that enable individuals to use the new policies without stigma (Drago, et al., 2006). It takes time to convince faculty that the way we’ve been doing things needs to change, to provide and model mechanisms to enact change, and to develop support and accountability systems to see the change though.

One of the great strengths of the ADVANCE program is its interdisciplinarity: the partnership of men and women in science, technology, engineering, and mathematics with colleagues in the social and behavioral sciences as well as organizational and higher education scholars. This issue is, after all, one of human behavior and human interactions. Social and behavioral scientists bring training and perspectives to the table that enable bench and field scientists and mathematicians to view their routine practices in a new light. Bench and field scientists enlighten social and behavioral scientists with their perspectives on current practices and what language to use to communicate to colleagues that a new way of conducting routine business holds promise for hiring and keeping excellent faculty.

Higher education is evolving rapidly: online and blended courses and MOOCs (massive open online courses) are placing new demands on faculty. Funding remains flat, or, if it rises, as when National Institutes of Health funding doubled in the early part of this decade, a flood of new PIs arises to share in the enterprise (White, 2013). Computer science is an increasingly essential component of geoscience research; new mechanisms are needed to harvest useful information from "big data." These factors suggest that the type of work the academy most values may be undergoing a radical shift.

Another set of factors affects how our newest colleagues obtain their first jobs. Postdoctoral positions last longer, and excellent people move from one postdoc to another with no promising "permanent" job in sight. Many students begin their careers saddled by debt. These students are lured away from academia by jobs that will help them eliminate that debt. Will excellent students be lost from the academic pipeline forever? We might contemplate what the business world calls "on-ramps" and "off-ramps" (Hewlett and Luce, 2005): mechanisms to ease faculty into and out of non-academic hiatuses, hiatuses that enrich their experiences and make those who take them even more valuable to the academy. The University of Washington's ADVANCE program developed an "on-ramps" workshop for engineers (http://www.engr.washington.edu/onramp). Would such a program be effective for oceanography?

Ensuring faculty diversity is not just about being fair. Diversity has been demonstrated to improve creativity in working groups: when a set of people in a group feel as though "we are all the same," they implicitly assume that all hold the same knowledge and often fail to share unique knowledge. But in a group where it is clear that people come from different backgrounds, that implicit assumption doesn't activate, and group members share more knowledge, arriving at more creative solutions to problems (Page, 2008; Phillips, 2014). The ADVANCE program has taught us a great deal about what needs to change in the academy and how to change it to be more equitable to all. The ocean sciences will benefit if we keep thinking about our work as a social enterprise that welcomes the best and brightest, whatever they look like.

RESOURCES

Association for Women in Science RAISE project to increase the number of women who receive awards from professional societies: http://www.awis.org/?Awards_Recognition

Dual Career Networking: An annual conference is hosted by a different institution each year; search "Dual Career Network" on the Internet to find the next one. The HERC (Higher Education Recruitment Consortium) website offers a list of institutions with Dual Career programs: http://www.hercjobs.org/dual_career_couples/campuses_with_dual_Career_programs

Gender Bias Bingo, a way to introduce faculty and staff to the impact of implicit bias: http://www.genderbiasbingo.com

FASIT: Texas A&M ADVANCE program to address civility between faculty and staff: http://advance.tamu.edu/index.php/FASIT/FASIT-interaction.html

Society of STEM Women of Color: http://www.sswoc.net

Tech Valley Connect: http://www.techvalleyconnect.com

Virginia Tech Portal attempts to capture all ADVANCE programs and research: http://www.portal.advance.vt.edu

University of California, Irvine Equity Advisors program: http://advance.uci.edu

University of Michigan STRIDE Committee: http://sitemaker.umich.edu/advance/stride_committee

University of Washington "On-Ramps into Academia" workshop: http://www.engr.washington.edu/onramp

University of Wisconsin WISELI (evaluation rubrics): http://wiseli.engr.wisc.edu

REFERENCES

Avallone, L.M., A.G. Hallar, H. Thiry, and L.M. Edwards. 2013. Supporting the retention and advancement of women in the atmospheric sciences: What women are saying. *Bulletin of the American Meteorological Society* 94:1,313–1,316, http://dx.doi.org/10.1175/BAMS-D-12-00078.1.

[B]erheide, C.W. 2014. Gender differences in the path to full professor at two liberal arts colleges in the United States. Paper presented at the XVIII ISA World Congress of Sociology, July 13–19, 2014, Yokohama, Japan, Abstract RC32-551.6.

Bilimoria, D., and X.F. Liang. 2011. *Gender Equity in Science and Engineering: Advancing Change in Higher Education*. Routledge Studies in Management, Organizations and Society, New York, NY, 266 pp.

Britton, D.M. 2010. Engendering the university through policy and practice: Barriers to promotion to full professor for women in the science, engineering, and math disciplines. Pp. 15–26 in *Gender Change in America: Re-Mapping the Fields of Work, Knowledge, and Politics from a Gender Perspective*. VS Verlag für Sozialwissenschaften, http://dx.doi.org/10.1007/978-3-531-92501-1_2.

Clem, S., S. Legg, S. Lozier, and C. Mouw. 2014. The impact of MPOWIR: A decade of investing in mentoring women in physical oceanography. *Oceanography* 27(4) supplement:39–48, http://dx.doi.org/10.5670/oceanog.2014.113.

Dean, D.J., and J.B. Koster. 2013. *Equitable Solutions for Retaining a Robust STEM Workforce: Beyond Best Practices*. Academic Press, 224 pp.

Drago, R., C.L. Colbeck, K.D. Stauffer, A. Pirretti, K. Burkum, J. Fazioli, and T. Habasevich. 2006. The avoidance of bias against caregiving: The case of academic faculty. *American Behavioral Scientist* 49:1,222–1,247, http://dx.doi.org/10.1177/0002764206286387.

Fox, M.F., and S. Mohapatra. 2007. Social-organizational characteristics of work and publication productivity among academic scientists in doctoral-granting departments. *The Journal of Higher Education* 78:542–571.

Gerber, L.M. 2010. Mentoring women in physical oceanography: MPOWIR Pattullo Conference; Charleston, South Carolina, 23–26 May 2010. *Eos, Transactions American Geophysical Union* 91:291–291, http://dx.doi.org/10.1029/2010EO330004.

Hallar, A.G., L. Avallone, H. Thiry, and L.M. Edwards. 2015. ASCENT: A discipline specific model to support the retention and advancement of women in science. In *Women in the Geosciences: Practical, Positive Practices Toward Parity*. M.A. Holmes, K. Dutt, and S. O'Connell, eds, Wiley Press, 135 pp.

Hewlett, S.A., and C.B. Luce. 2005. Off-ramps and on-ramps: Keeping talented women on the road to success. *Harvard Business Review* 83:43–46.

Hill, P.W., M.A. Holmes, and J. McQuillan. 2014. The new STEM faculty profile: Balancing family and dual careers. Pp. 3–20 in *Gender Transformation in the Academy.* Advances in Gender Research, vol. 19, V. Demos, C.W. Berheide, and M.T. Segal, eds, Emerald Group Publishing Limited, http://dx.doi.org/10.1108/S1529-212620140000019001.

Holmes, M.A. 2012. Working together. *Nature* 489:327–328, http://dx.doi.org/10.1038/nj7415-327a.

Lundquist, J.H., J. Misra, and K. O'Meara. 2012. Parental leave usage by fathers and mothers at an American university. *Fathering: A Journal of Theory, Research, and Practice about Men as Fathers* 10:337–363.

Lozier, M.S. 2009. A successful first Pattullo Conference. *Oceanography* 22(1):224–225, http://dx.doi.org/10.5670/oceanog.2009.25.

Maranto, C.L., and A.E. Griffin. 2010. The antecedents of a 'chilly climate' for women faculty in higher education. *Human Relations* 64:129–159, http://dx.doi.org/10.1177/0018726710377932.

Martell, R.F., D.M. Lane, and C. Emrich. 1996. Male-female differences: A computer simulation. *American Psychologist* 51:157–158, http://dx.doi.org/10.1037/0003-066X.51.2.157.

Meyerson, D., and M. Tompkins. 2007. Tempered radicals as institutional change agents: The case of advancing gender equity at the University of Michigan. *Harvard Journal of Law & Gender* 30:303–322.

MIT (Massachusetts Institute of Technology). 1999. A study on the status of women faculty in science at MIT. *The MIT Faculty Newsletter*. http://web.mit.edu/fnl/women/women.pdf.

MIT. 2011. *A Report on the Status of Women Faculty in the Schools of Science and Engineering at MIT, 2011.* 32 pp., http://web.mit.edu/faculty/reports/pdf/women_faculty.pdf.

MIT News Office. Leaders of 9 universities and 25 women faculty meet at MIT, agree to equity reviews. http://newsoffice.mit.edu/2001/gender.

Monroe, K.R., J. Choi, E. Howell, C. Lampros-Monroe, C. Trejo, and V. Perez. 2014. Gender equality in the ivory tower, and how best to achieve it. *PS: Political Science & Politics* 47:418–426, http://dx.doi.org/10.1017/S104909651400033X.

Moss-Racusin, C.A., J.F. Dovidio, V.L. Brescoll, M.J. Graham, and J. Handelsman. 2012. Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 109:16,474–16,479, http://dx.doi.org/10.1073/pnas.1211286109.

NSF (National Science Foundation). 2001. ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers; Program Solicitation. National Science Foundation, Arlington, VA, http://www.nsf.gov/pubs/2014/nsf14573/nsf14573.htm.

NSF. 2004. *Science and Engineering Degrees: 1966–2001*. National Science Foundation, Division of Science Resources Statistics, NSF 04-311, Project Officers, S.T. Hill and J.M. Johnson, Arlington, VA, http://www.nsf.gov/statistics/nsf04311.

NSF. 2013. *Women, Minorities, and Persons with Disabilities in Science and Engineering.* National Science Foundation, National Center for Science and Engineering Statistics, Special Report NSF 13-304, Arlington, VA, http://www.nsf.gov/statistics/wmpd/2013/start.cfm.

Orcutt, B.N., and I. Cetinić. 2014. Women in oceanography: Continuing challenges. *Oceanography* 27(4) supplement:5–13, http://dx.doi.org/10.5670/oceanog.2014.106.

Page, S.E. 2008. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton University Press, 456 pp.

Pfund, C., C.M. Pribbenow, J. Branchaw, S.M. Lauffer, and J. Handelsman. 2006. The merits of training mentors. *Science* 311:473–474, http://dx.doi.org/10.1126/science.1123806.

Phillips, K.W. 2014. How diversity makes us smarter. *Scientific American* 311(4), http://www.scientificamerican.com/article/how-diversity-makes-us-smarter.

Quinn, K., S.E. Lange, and S.G. Olswang. 2004. Family-friendly policies and the research university. *Academe* 90:32–34.

Risman, B.J. 2004. Gender as a social structure theory wrestling with activism. *Gender & Society* 18:429–450, http://dx.doi.org/10.1177/0891243204265349.

Risman, B., and T. Adkins. 2014. The goal of gender transformation in American universities: Toward social justice for women in the academy. Pp. 99–113 in *Social Justice and the University: Globalization, Human Rights and the Future of Democracy*. J. Shefner, H.F. Dahms, R.E. Jones, and A. Jalata, eds, Palgrave Macmillan, http://dx.doi.org/10.1057/9781137289384.0010.

Rosser, S.V. 2004. Using POWRE to ADVANCE: Institutional barriers identified by women scientists and engineers. *NWSA Journal* 16:50–78.

Rosser, S.V., and E.O.N. Lane. 2002. A history of funding for women's programs at the National Science Foundation: From individual POWRE approaches to the ADVANCE of institutional approaches. *Journal of Women and Minorities in Science and Engineering* 8(3):50.

Schiebinger, L.L., A.D. Henderson, and S.K. Gilmartin. 2008. *Dual-Career Academic Couples: What Universities Need to Know*. Michelle R. Clayman Institute for Gender Research, Stanford University, Palo, Alto, CA, 98 pp, http://gender.stanford.edu/sites/default/files/DualCareerFinal_0.pdf.

Sutton, R.I. 2007. *The No Asshole Rule: Building a Civilized Workplace and Surviving One that Isn't*. Hachette Digital, Inc, 236 pp.

Trix, F., and C. Psenka. 2003. Exploring the color of glass: Letters of recommendation for female and male medical faculty. *Discourse & Society* 14:191–220, http://dx.doi.org/10.1177/0957926503014002277.

Valian, V. 1999. *Why So Slow? The Advancement of Women.* The MIT Press, Cambridge, MA, 421 pp.

White, M. 2013. How we're unintentionally defunding the National Institutes of Health. *Pacific Standard*, http://www.psmag.com/navigation/health-and-behavior/unintentionally-defunded-national-institutes-health-70470.

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The Impact of MPOWIR

A Decade of Investing in Mentoring Women in Physical Oceanography

By Sarah Clem, Sonya Legg, Susan Lozier, and Colleen Mouw

ABSTRACT. MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) is a US community-initiated and community-led mentoring program aimed at improving the retention of women physical oceanographers in academic and/or research positions. This article describes the MPOWIR program elements designed by the US physical oceanography community, quantifies the participation in these programs, describes MPOWIR's impact to date, and outlines future directions. An examination of surveys to date indicates that MPOWIR, several years after its implementation, is having a positive impact on the retention of junior women in physical oceanography, primarily by giving them a broad professional network and focused mentoring.

OVERVIEW OF MPOWIR

Program History

MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) traces its roots to the spring of 2004 when a handful of women physical oceanographers gathered to discuss the retention of women in the field. These discussions were prompted by the recently released Nelson diversity study (Nelson, 2004), as well as by personal observations of the career trajectories of female colleagues in the field. The Nelson diversity study showed that efforts over several decades toward increasing the number of women entering science and engineering fields had largely been successful, with women receiving on average between 30% and 50% of the PhD degrees awarded (Nelson, 2004). However, the percentage of women occupying tenure-track positions had not risen commensurably. Across the board, women in science and engineering filled on average only 15–25% of academic positions at the turn of the century. Because the number of women in graduate school had been sufficiently large for at least a decade, the lower percentage of women in entry-level faculty positions could not be attributed to a small pool of potential candidates. Essentially, this analysis quantified what had to date been colloquially termed the "leaky pipeline."

In 2004, ocean sciences provided no exception to these trends. The proportion of women receiving their PhDs in physical oceanography had approached 35–40% at most major oceanographic institutions; however, the number of women with principal investigator status remained fairly low. A 2005 survey of 16 universities/institutions, as well as two government laboratories, found that women comprised only 19% of physical oceanographers in associate level positions that could reasonably be assumed to be held by those who earned their PhDs between 1991 and 1999. Enrollment data from Joint Oceanographic Institutions (JOI) averaged from 1988–2001 showed that women constituted ~ 35% of oceanography graduate students. These statistics implied that the retention rate for women in academia was half that for men over this time period.

With these numbers and their concern, these women approached program managers and division directors at the National Science Foundation (NSF) and the Office of Naval

> MPOWIR has been a phenomenal resource that I have not found anywhere else. The ability to regularly talk with peers from around the country (and globe) about issues that we all have in common has greatly reduced the feeling of isolation and helped provide perspective on initiating and moving through a career. The connection with senior scientists has greatly expanded my professional network. MPOWIR has most definitely had a significant impact on my confidence pursuing all sorts of opportunities from awards and funding to employment. I feel very fortunate that MPOWIR was starting just when I was at the stage of needing the support the most (nearing the end of graduate school) and has provided so many opportunities over the last several years as I moved through postdoc, research scientist and now assistant professor positions.

Research (ONR) in the summer of 2004 for the purpose of securing financial support to investigate and subsequently address the issue of retention of women in physical oceanography in academia. The effort quickly coalesced around mentoring. While it was recognized that many factors contributed to the lack of retention of women scientists—competition between family building and career building, competition with career goals of spouse/partner, lack of female role models, and lack of adequate mentoring—it was believed that the latter problem was one that a discipline-based community could most effectively address.

NSF and ONR were receptive to the proposition that funding agencies, with a small investment, could protect their larger investment in the graduate education of women students. Thus, ONR and NSF invited a proposal for a workshop whose goal would be the design of a mentoring program for junior women. The proposal was funded in the fall of 2004. Physical oceanographers from a spectrum of workplaces, as well as from different career stages, were invited to participate in this workshop. Importantly, the organizing committee decided to invite men to participate. Men had been providing the bulk of mentoring in the field for many years and the committee believed it was important to gain from their experience in this endeavor. Such inclusion was a statement that the committee believed the lack of retention for women in the field was not a "women's issue," but was instead a community issue.

As a result of these efforts, an NSF and ONR-funded workshop was conducted at the Airlie Center in Warrenton, Virginia, on October 9–12, 2005, with 29 physical oceanographers as participants (Lozier, 2005, 2006). A community-wide survey conducted prior to the workshop provided important input for the mentoring program design. From the survey and workshop discussions, it was concluded that transitions from PhD to postdoc and then from postdoc to entry-level position were the most vulnerable times for a junior woman in the field.

Having identified how mentoring could help young women in the development of their early careers, workshop participants established five main goals for an effective community-based mentoring program:

1. The program should provide continuity of mentoring from a young woman's graduate career through her postdoctoral years to the first years of her permanent job.
2. The program should establish a collective responsibility within the physical oceanography community for the mentoring of junior women in the field. Rather than assigning a mentor for each young woman, the aim is to collectively mentor the young women in the field.
3. The program should provide a variety of mentoring resources and mentors on a variety of issues.
4. The program should cast a wide net to avoid exclusiveness.
5. Involvement in this mentoring program should be open to those who self-identify as a physical oceanographer.

In the nine years since this workshop, these goals have been unchanging and have provided a clear mandate for MPOWIR.

In addition to elucidating the goals for MPOWIR, the workshop participants also delineated program elements. To make mentoring accessible to junior women in a wide variety of positions and at different types of workplaces (e.g., research institutions, government labs, universities, industry), workshop participants decided on a multi-prong approach with several elements, each described in detail below.

> The MPOWIR program has had a significant impact on, and been a positive influence in, my career since 2009. I have benefited from several MPOWIR efforts including the Pattullo Conference, NASA Speaker Series, and a Mentoring Group. Each of these activities provided me with an opportunity to network with junior and senior scientists within and outside my field, discussing research interests and potential collaborations, sharing professional experiences, and providing advice and strategies for professional success. An example of the latter is the advice and feedback I received from my MPOWIR mentoring group and senior scientists at the Pattullo Conference on job offer negotiations that proved extremely useful when discussing terms with my current employer.

Following the workshop, funding from NSF, the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and ONR was secured for the implementation of MPOWIR program activities in the spring of 2007. Since that time, MPOWIR activities have been ongoing, as documented in the following section. It is important to note that all NSF proposals have been peer reviewed and, as such, have been supported by the community. Early program elements included the Pattullo Conference, a website, and Town Hall meetings. After a couple of years, a NASA MPOWIR Speaker Series and a National Oceanic and Atmospheric Administration (NOAA) MPOWIR internship were added. Thus, at this nine-year mark, funding from five federal agencies has contributed to the success of the MPOWIR program.

In this article, we describe the MPOWIR program elements designed by the physical oceanography community, quantify community participation in these programs, describe MPOWIR's impact to date through self-assessment surveys, and then comment on future directions. A community survey will be conducted in 2015 to examine progress made in the community as a whole following a decade of MPOWIR activities. That survey will consider those who have been involved in MPOWIR and, as a control group, those who have not. While ultimately the success of MPOWIR will be to drive itself out of business, in the interim we believe the program, the community, and the funding agencies are best served by a strong focus on metrics that indicate whether MPOWIR is indeed moving the needle on retention. The main objective of this article is to describe our efforts to date toward that goal.

Program Elements

The core activities of MPOWIR are the Pattullo Conference and the mentoring groups. The biannual Pattullo Conference is named to honor the memory and contributions of the first woman in the United States to receive a PhD in physical oceanography, June Pattullo. She received her PhD from Scripps Institution of Oceanography in 1957 and then went on to a successful research career at Oregon State University, where she is also remembered as a remarkable mentor and teacher.

The Pattullo Conference brings together about 30 junior women participants, who are generally at the postdoctoral level, with about 15 male and female senior scientists for two and a half days of intensive interaction. Junior scientists apply to attend, and selection is made primarily by career stage, with preference given to those at the beginning of their postdoctoral appointments. The aim is to allow every junior female physical oceanographer an opportunity to attend at least one Pattullo Conference during her early career. Senior scientists are invited by the MPOWIR steering committee, with a 90% acceptance rate. The main goals of the Pattullo Conference are:

- To provide junior women with career advice and feedback on their research
- To build community networks with peers and senior scientists
- To build confidence and skills for promoting one's research
- To raise awareness of issues confronting junior women among the senior scientist community

The conference format includes (1) panel discussions on proposal writing and on the identification of funding opportunities, (2) feedback on effective communication

and presentations, (3) workshop activities on negotiations, (4) small group discussions on the next steps in the junior women's research careers, and (5) a question-and-answer session on the careers of senior scientists. Four Pattullo Conferences have been held thus far, with a total of 98 junior participants and 52 senior scientist participants, some of whom have attended more than once in order to provide continuity and leadership. Travel expenses for all participants have been funded by the supporting funding agencies.

To assess and fine-tune Pattullo Conference programming, MPOWIR conducts a survey of all junior and senior participants. The conference format over the years has evolved considerably in response to these surveys. Based on survey feedback, it is apparent that the Pattullo Conference is a valuable experience for everyone (see Table 1). Nearly every participant said they would "definitely recommend this conference to another junior scientist." Importantly, the survey indicates that all conference goals were accomplished. In evaluations and in conversations, many junior women spoke of increased confidence and were impressed by the networking opportunities not only with senior scientists but also with their peers. One junior participant commented, "I am leaving with more confidence in myself and a much better idea of where I want to go in my career and why I want to do it." Another participant remarked that, "This was a very helpful experience for me as a junior scientist and has definitely increased the likelihood that I will stay in the field." Many participants state the immediate, tangible benefits of the conference as well: "It provides an opportunity for you to build up your research network, to learn how to apply for funding, and how to manage your time among research and life, etc."

The Pattullo Conference includes elements important to career success that are not customarily built into most graduate programs or postdoctoral training. During the Pattullo

Table 1. Post-Pattullo Surveys (2008, 2010, 2011, and 2013) of Junior and Senior Scientists

	Junior Scientist Response		Senior Scientist Response	
	Average	St. Dev.	Average	St. Dev.
Please rate on a scale of 1–5 (poor – excellent)				
Networking opportunities	4.79	0.41		
Professional development opportunities	4.54	0.58		
Feedback on research	3.69	0.90		
Please rate on a scale of 1-5 (strongly disagree – strongly agree)				
My skills and expertise were used to their fullest			4.37	0.59
My time was well spent at this conference			4.83	0.38
I had enough information/background about the conference to participate fully			4.54	0.50
I would attend another Pattullo Conference			4.89	0.32
Please rate on a scale of 1–5 (not valuable – extremely valuable)				
Value to current position	4.68	0.53		
Value to future position	4.61	0.59		
Overall value	4.76	0.43		
Perceived value of conference to a junior scientist			4.80	0.40
Perceived value of conference to another senior scientist			4.46	0.60
Please rate on a scale of 1–5 (definitely not – definitely)				
Would you recommend this conference to another junior scientist?	4.97	0.15	5.00	0.0
Would you recommend this conference to another senior scientist?	4.61	0.55	4.86	0.42

> “I had the chance to attend the MPOWIR Pattullo Conference early in my postdoctoral career, and the successful pathway I followed since then, over the past five years, would certainly have been a less pleasant experience without the continuous support of MPOWIR. The women I met through the MPOWIR network gave me a true living example that it was possible to be a recognized talented scientist and a fulfilled woman. These women that I respect and admire never pretended that succeeding in a male-dominated community was an easy task to achieve. They were all honest about the struggles they had to face as a minority group. But by investing their valuable time to share their experience and reaching out to early career scientists like me, they helped me feel more confident that balancing family and work was possible and that building a support network was key for achieving a satisfying, fulfilling and well-balanced life both personally and professionally. I am very grateful for the practical, emotional, and scientific support I received though MPOWIR as a mentee. As a mentor today, I hope that I can relay part of what I learned so that all the smart younger women that I meet among the students and postdocs don’t give up on a career they would like to pursue because they perceive that it is beyond their potential.”

Conference, there is a significant amount of time for the participants to get to know each other and to talk directly with each of the senior scientists. This activity allows for connections on many levels; while a senior scientist may not be researching the same oceanography topic as a junior scientist with whom he/she is interacting, there may be a shared life experience or career path that provides a mentoring opportunity.

MPOWIR mentoring groups, established in 2008, each consist of about six junior women and two senior women group leaders, who meet monthly by teleconference for confidential mentoring. Group leaders and other group members provide advice and respond to specific questions raised by participants as they encounter issues in their careers. To ensure groups cover a range of topics, and are of benefit to attendees, the junior women are asked to formulate specific goals that they wish to work toward during the coming year. Prior to the first meeting of the mentoring group, each member and mentor leader receives a notebook containing the biography and goals of each participant. These goals, along with other topical issues, are discussed during the mentoring group calls.

Based on the 2011 survey, 100% of mentoring group participants reported that they made progress on their stated scientific, professional, and personal goals. Mentoring groups remain together for two to three years, at which point junior members may join a new group, choose to continue as a peer-mentoring group, or leave the groups altogether. By asking for a commitment of two to three years, and putting a strong emphasis on confidentiality, participants form long-term relationships, making groups particularly valuable to members negotiating delicate issues in their careers. Sixteen groups to date have involved a total of 84 junior women and 23 senior women as group leaders. New groups are established annually, following an open call for new participants. Currently, eight mentoring groups are operating, with four of the 16 leaders drawn from the ranks of former junior participants.

To evaluate the effectiveness of the mentoring groups, MPOWIR conducts an annual survey. Survey feedback is used to provide guidance to group leaders on most effective practices. As part of this survey, participants are asked what they value about their mentoring groups and what has been the effect of being in a mentoring group on their current positions (Figure 1) along with questions about group logistics and setup. Based on the survey conducted in 2012, all participants rated mentoring group participation as a valuable experience, with particular value placed on feedback on professional development and on personal matters (Figure 2).

Like the Pattullo Conference, mentoring groups complement the training received from a graduate or postdoctoral adviser. These groups serve the dual purpose of focusing on an individual and finding common experiences among the group. As for the latter, many junior participants have commented that hearing about other’s experiences has helped them realize that others at a similar career stage experience struggles similar to their own, thus easing their feelings of isolation and providing them with a broader perspective for achieving their goals.

NOAA and NASA support MPOWIR by providing grants to facilitate interaction and networking between junior women and the agency laboratories. NOAA funds internships for female graduate students to spend a summer working with a NOAA researcher at the Geophysical Fluid Dynamics Laboratory (GFDL), the Pacific Marine Environmental Laboratory (PMEL), or the Atlantic Oceanographic and Meteorological Laboratory (AOML) on a project of mutual interest. The internship introduces junior women to the research environment of the lab and exposes the NOAA researchers to promising students in the field. Nine NOAA summer internships have been awarded over the past six years. NASA funds an annual Speaker Series, through which two junior women are invited to present seminars: one each to the Jet Propulsion Laboratory (JPL) and the Goddard Space Flight Center (GSFC). In addition to showcasing their research, the young women interact with NASA scientists during their stay and learn about the lab's mission and research priorities. Ten women have participated in this speaker series over the past five years. MPOWIR facilitates the annual application process for both programs, while NOAA and NASA scientists make the final selection for their respective programs.

All of the above activities are open only to women who are residents of the United States, who self-identify as physical oceanographers, and who are in the career stage between the final two years of a PhDs and the first two years in a faculty or permanent research position. There is one exception to these restrictions: members of an existing mentoring group may continue to participate even if their career takes them abroad. MPOWIR also organizes several programs aimed at a wider audience, with the goal of developing a supportive community within physical oceanography as a whole. Town Hall meetings organized at the biannual Ocean Sciences Meeting highlight topics of interest to both men and women at many different career stages as well as oceanographers from all disciplines. Past topics for these Town Hall meetings include the balance between work and family, dual career challenges and opportunities, and non-academic paths for

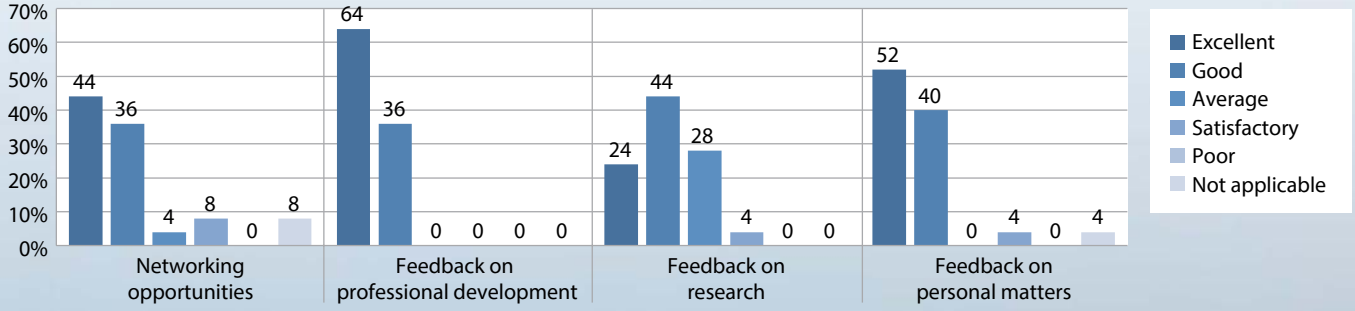

Figure 1. Results of the 2012 survey of Mentoring Physical Oceanography Women to Increase Retention (MPOWIR) mentoring group participants show the value of the these groups. Values are shown as percentages.

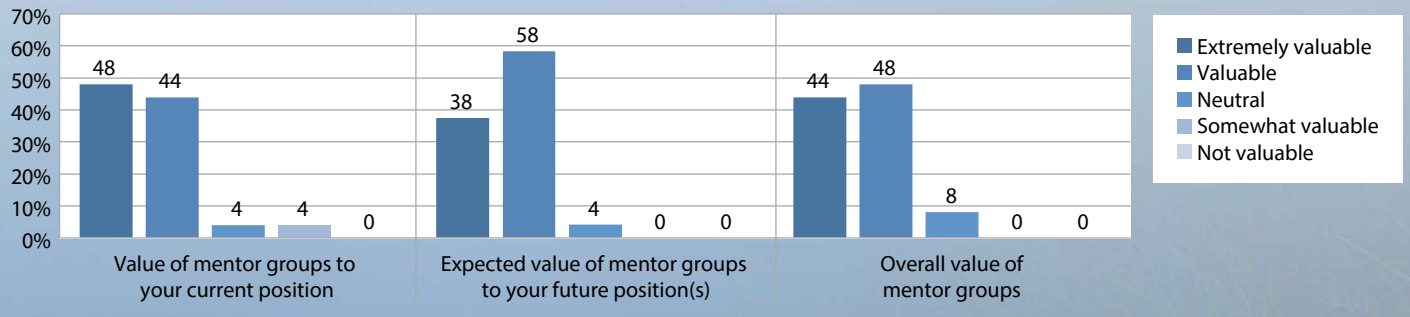

Figure 2. Results of the 2012 survey of MPOWIR mentoring group participants indicate the qualities of different elements. Values are shown as percentages.

oceanography doctorates.

The MPOWIR website (http://mpowir.org) serves as a repository for information on the program and mentoring resources, and is the mechanism for junior scientists to apply for participation in the MPOWIR activities described above. A highlight of the website is the MPOWIR blog, which includes job listings, links to articles of interest (such as studies on subconscious gender bias), and short entries written by MPOWIR mentors and participants. Accessible to all regardless of gender or discipline, the website serves as an important gender-neutral resource to the community. The program opportunities are advertised on the MPOWIR website and sent out to an extensive email list of junior and senior physical oceanographers, as well as graduate school administrators. MPOWIR aims to include every junior physical oceanographer who wishes to participate and satisfies the criteria described above.

ASSESSING MPOWIR'S IMPACT

From its initiation, MPOWIR's leadership understood the need to measure the program's effectiveness. Thus, from the start, MPOWIR has used surveys to assess and evaluate the effectiveness and impact of its program elements, as discussed above for the Pattullo Conferences and mentoring groups. Also, a community-wide survey in 2005 aided in the initial development of MPOWIR, primarily by demonstrating the discrepancy between graduation rates for women and the rate at which women occupied research positions in physical oceanography across the United States. A similar community survey will be conducted in 2015 to examine progress made in the community as a whole following a decade of MPOWIR activities. In the interim, we decided to conduct a survey of the first MPOWIR participants in order to get an early indication of whether MPOWIR is making a discernible difference in the career development of those junior women.

2013 Survey Results

The 2013 survey of early participants assessed MPOWIR's impact and provided leadership with insight into program components that junior women have found particularly beneficial. For this survey, we reached out to participants whose first involvement, via a Pattullo Conference and/or a mentoring group, was between 2008 and 2010. The goal of this survey was to determine how the careers of these first participants are evolving after several years of involvement with MPOWIR programs. There was no control for this survey (i.e., we did not survey a similar group of female physical oceanographers who had not participated in MPOWIR), but comparison with statistics of retention and career progression obtained through earlier surveys prior to the implementation of MPOWIR provides a means of assessment.

Overall, the survey had an 86% response rate with 56 of the 65 contacted participants responding. Of the participants who responded, none were currently working in a field unrelated to oceanography. Two were currently enrolled as students, and all of the others were effectively still working in physical oceanography, with a remarkable 80% conducting research at a university or research institution.

Evidence of What Works

While the initial number of participants retained in the field of physical oceanography is certainly encouraging, transferring this success into lessons for other disciplines and similar programs requires an understanding of the specific skills that MPOWIR has provided to the participants.

As part of the 2013 survey, individuals were asked to rank the extent to which MPOWIR had impacted various aspects of their professional growth. These aspects included efforts to obtain their current position, exposure to professional development skills, broadening of their professional network, mentoring on work and family balance, performance in current position, and raising awareness of mentoring in career development. Participants overwhelmingly indicated that MPOWIR had positively impacted all of these aspects (Figure 3). In particular, an impressive 95% of survey participants expressed that MPOWIR has exposed them to useful professional development skills "to a great extent," and 89% consider MPOWIR to have positively impacted their professional network "to a great extent."

Success in Participant Career Progression

An important part of MPOWIR's mission is to enable participants to move up the career ladder, thus diminishing the "leaky pipeline." As MPOWIR has grown over the past 10 years from a concept (Lozier, 2005) to a flourishing, fully funded program, we can begin to assess whether that goal is being met. Of those participating in the 2013 survey, 55% first became involved in MPOWIR as graduate students. At the time of the survey, only two remained in graduate school. Figure 4 shows the position held in 2013 relative to the

position held by that individual at the time of her initial participation in MPOWIR.

Clearly, MPOWIR participants are moving up the career ranks to tenure-track and research positions (Figure 4). Because the pipeline has historically been "leakiest" at the post-PhD transition, we believe that such retention shows remarkable progress. In our survey, the majority of participants were two years from their PhDs at the time of initial involvement. Their current job positions are well distributed over all post-PhD categories: the greatest percentages of positions held are at research institutions (non-academic) or government agencies (29.3%), followed closely by non-faculty research positions at universities (27.6%) and faculty at research universities (22.4%). The remaining positions held (four-year college faculty, profit or nonprofit company, policy, and graduate students) collectively make up 19%.

An additional indicator of MPOWIR's success has been its ability to entrain volunteers from the community. Initially, there was a clear divide between junior and senior MPOWIR participants. But now, several years down the road, some of those early junior participants have transitioned into leadership roles within MPOWIR. In fact, one has recently assumed the role of co-chair of MPOWIR, while several others are now co-leaders of the mentoring groups. The decisions of these young women to contribute to MPOWIR in leadership positions is a testament to the value MPOWIR has brought to their individual careers. Furthermore, this leadership progression and continuity of involvement brings a rich sense of community and a broad perspective to the program. As to the latter point, the career stage spectrum in MPOWIR leadership now stretches from those who have recently transitioned to early career positions to those who are veterans in their positions.

MPOWIR's Impact on Individuals and the Community

While the program's impact can be measured by survey statistics, the full impact on individuals may be better reflected by the testimony of the participants themselves. Many junior participants cite MPOWIR as an "exceptional resource" where they have made "lasting connections." Many note that they are "developing confidence" in themselves as scientists as a result of MPOWIR's programs, and that they have become

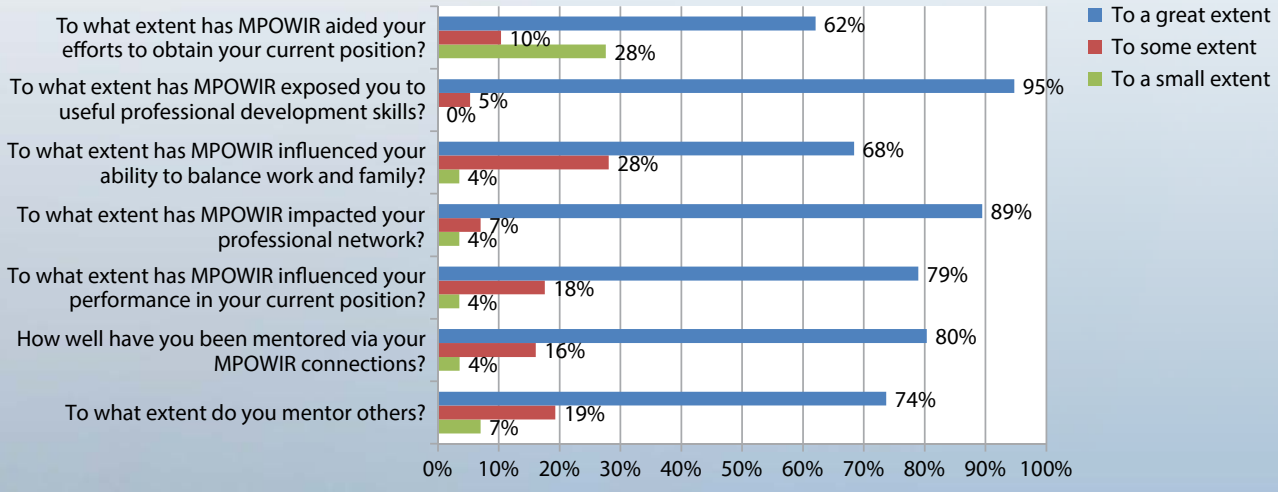

Figure 3. Results of the 2013 survey of MPOWIR participants who first participated in the program between 2007 and 2010.

far more aware of the "importance of mentoring" in their own careers. For example, one person noted that her involvement in MPOWIR provided "tangible role models, proactive mentoring, and an embracing network." This expression encapsulates an unstated goal of the MPOWIR program: that the junior participants will more likely act as mentors as their careers develop. With this downstream effect, the culture of mentoring that MPOWIR strives to achieve is effectively propagated. The callouts in this article are examples of individual impacts.

In addition to helping junior women physical oceanographers progress in their careers, MPOWIR has provided multiple benefits to the senior participants. In the words of one senior participant, "Participating in MPOWIR activities has been one of the most rewarding experiences in my career." Both male and female participants in Pattullo Conferences have increased their understanding of the most pressing issues faced by junior scientists today. MPOWIR plays an important role in educating both men and women about subconscious gender bias. In the words of one senior male participant, "As a man, the conference deepened my awareness of how difficult it can be for the majority to really get how it is for the minority." Senior participants learn to listen to junior scientists in a new way and improve their ability to communicate with junior women researchers, thereby enhancing their ability to act as effective mentors. This education does not stop with the end of the Pattullo Conference, because senior participants then share their experiences from the conference with other senior scientists at their home institutions.

A female senior participant remarked that a significant benefit of MPOWIR involvement has been the reduction in feelings of isolation. In her words, "learning about the social and psychological research behind gender issues…has legitimized my personal struggles, both external and internal, with gender bias."

A further benefit of involvement in MPOWIR has been the opportunity to network with talented junior scientists with lots of innovative scientific ideas to share. In the words of one senior participant, "from a scientific perspective, that keeps me up to date with what is relevant and exciting to our young scientists today." The senior scientists and junior scientists often maintain connections made at Pattullo

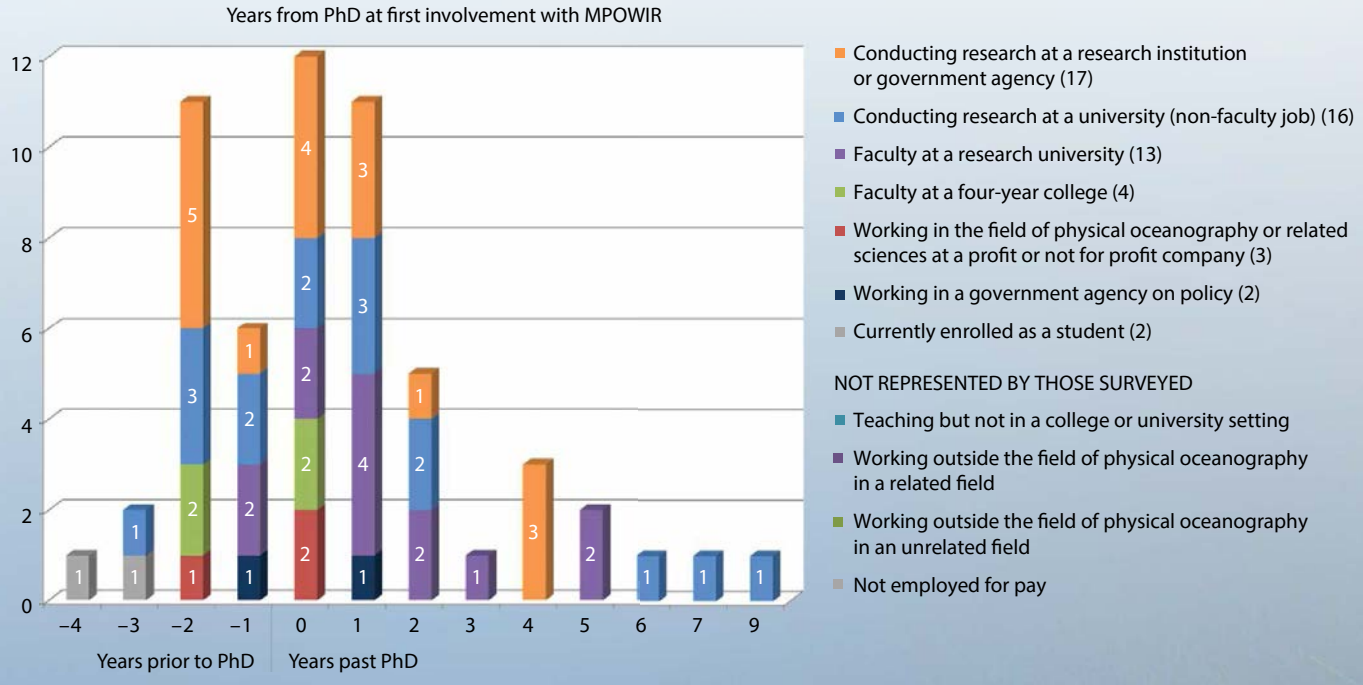

Figure 4. Timeline of early MPOWIR participants' career progressions based on the 2013 MPOWIR participant survey. The data show the distribution of 2013 career choices as a function of the career stage when the participant started MPOWIR relative to her position in 2013. The x-axis indicates where each participant was relative to PhD completion at the time that she first became involved in MPOWIR. The y-axis indicates the number of individuals at the same career stage and the type of positions held (color) at the time of the 2013 survey. For example, an individual who joined MPOWIR four years prior to finishing her PhD was still enrolled as a student in 2013.

Conferences and in mentor groups and through the NOAA Internships and NASA Speaker Series. These connections can enhance the research and careers of both the senior and junior scientists via opportunities for collaboration and, in some cases, employment.

From the collective survey input and from participation rates for the various MPOWIR program elements, we believe that MPOWIR has benefited the community as a whole and not simply the individuals who have personally participated in those programs. First and foremost, MPOWIR has benefited the community by aiding the retention of those young women who have participated. Secondly, participants at the Pattullo Conferences, in mentoring groups, and at the Town Halls have all been made aware of issues, such as subconscious gender bias and the challenges of work/life balance, that impact the career development of women in the field. Such awareness permeating home departments and institutions will, in time, make a difference in the diversity of the workforce in these departments/institutions. Finally, the community benefits from the strong networks formed between the junior scientists and the senior scientists, as well as from the intragroup networks.

FUTURE DIRECTIONS

Because the overall goal of the MPOWIR program is to increase retention, the ultimate metric of success is a clear quantification of retention improvement. As discussed above, prior to the start of MPOWIR, a survey was taken of all institutions across the country with oceanography departments. An assessment was made of the gender breakdown at the assistant, associate, and senior scientist levels. We plan to conduct a similar survey at the seven-year mark of MPOWIR activities in the spring of 2015 (the 2008 Pattullo Conference is considered the start of MPOWIR activities) to assess the degree to which women have moved into the ranks of assistant scientist/professor. We plan to use the field of chemical oceanography as a control, because it has not had a mentoring program during this time frame, it is a closely related discipline, and its retention statistics were similar to physical oceanography prior to the initiation of MPOWIR.

At this point in time, we do know that since the start of its activities in 2008, MPOWIR has engaged over 130 unique women in its various programs (Pattullo Conference, mentoring groups, NOAA Internship, and NASA Speaker Series). Of the women who have been involved in MPOWIR, 48% have participated in more than one activity. These opportunities have clearly been beneficial to the careers of the 56 women who were early participants. MPOWIR has received many positive anecdotal responses to programs and offerings, and recent surveys of past participants show remarkable retention thus far. Some key aspects of MPOWIR that we encourage other disciplines to consider in developing their own mentoring program are: the teleconference mentoring groups, which are a highly cost-effective mechanism for providing confidential mentoring outside the confines of a single institution; the involvement of a large group of senior scientists, both male and female, which helps make mentoring an all-community effort and serves to educate the wider community on issues and possible solutions to the leaky pipeline; grass-roots community involvement combined with support from multiple funding agencies to ensure program longevity, which is a necessity for tackling the gender disparity in retention; and a focus on discipline-specific mentoring so that mentors can provide the most relevant information and the most germane networking opportunities. MPOWIR strongly encourages scientists in other fields to adopt a similar community mentoring model and will readily facilitate those efforts. The benefits of such mentoring programs will surely enrich the entire oceanographic community by creating a more diverse workforce.

ACKNOWLEDGEMENTS

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REFERENCES

Lozier, M.S. 2005. A community effort toward the retention of women in physical oceanography. *Oceanography* 18(1):35–38, http://dx.doi.org/10.5670/oceanog.2005.68.

Lozier, M.S. 2006. Mentoring Program for Women in Physical Oceanography. *Eos, Transactions American Geophysical Union* 87(12):123/126, http://dx.doi.org/10.1029/2006EO120005.

Nelson, D.J. 2004. *A National Analysis of Diversity in Science and Engineering Faculties at Research Universities*. 43 pp., http://faculty-staff.ou.edu/N/Donna.J.Nelson-1/diversity/briefings/Diversity Report Final.pdf.

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Women in Oceanography
Autobiographical Sketches

INTRODUCTION

For the first "Women in Oceanography" issue published in March 2005, Peggy Delaney and I started by sending emails to women we knew—and asking each recipient to invite two others to contribute sketches. For this compendium, I began by sending a similar email to all of the women who contributed sketches a decade ago—and asked them to forward the email to two others. The email invitation was also sent to women who have been involved in MPOWIR. The resulting 200+ autobiographies included in this section thus span the spectrum from early career, to mid-career, to late career scientists, and they cover the breadth of oceanography disciplines.

In preparing their autobiographical sketches, we asked women who did not submit an autobiographical sketch in 2005 to address the same topics suggested a decade ago:

1. Briefly, what are your scientific and research interests?
2. How did you choose your field of study?
3. What have you found most rewarding about being an ocean scientist and why?
4. What have been your greatest career challenges? How have you responded to these challenges?
5. How have you balanced your career and personal life? How has this balance influenced your career choices and your personal life?
6. Are the conditions for women in your area of the field different now than when you began your career? If so, how has that affected your work?
7. What other topics or issues would you like to address?

For women whose sketch was published in the 2005 special issue of *Oceanography*, we asked that they:

1. Summarize their employment status 10 years ago.
2. Discuss the career path they have taken since then.
3. Include any challenges they faced and how they handled them.
4. Provide any advice for young women oceanographers.

Reading these sketches makes me proud to be part of this amazing community of women oceanographers. I hope these stories inspire another generation of young women to become scientists.

— Ellen S. Kappel, Editor

Natsue Abe

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I participate in deep-sea research expeditions to sample rocks using submersible dives, dredging, and ocean drilling to study the petrology of the upper mantle and lower oceanic crust. As a proponent of the "MoHole project," I look forward to being a member of the International Ocean Discovery Program's shipboard party when we are ready to undertake ultra-deep drilling into the mantle. Our goal is to penetrate the mantle in order to illuminate the evolution of the oceanic lithosphere and its role in solid Earth dynamics.

I first became interested in planets when I saw Venus, Jupiter, and Saturn through a telescope with my brother at an early age. When I chose my undergraduate research, I only had a faint idea that I wanted to study the petrology of meteorites in order to understand our planet. When I asked my supervisor about this possibility, he initiated my training by giving me a sample of peridotite, the rock most similar in composition to a chondrite (unaltered meteorite). My fascination with the beautiful specimen, especially under the microscope, set my career path toward continuing to study deep Earth rocks. Twelve years later, I obtained my first position at JAMSTEC and began my ocean science career.

Observing intact outcrops on the seafloor from the submersible *Shinkai 6500* is my great pleasure, although any scientific discovery is the greatest reward for me. The ocean floor is the least explored place on Earth, and it's full of new opportunities. I also like the teamwork on board ships. We cannot accomplish anything alone during cruises. I strongly feel a sense of achievement that can only result from the teamwork of shipboard members. Nature's beauties—double rainbows, tornadoes, migratory birds, dolphins, sunrises and sunsets—always relax me.

In 2009, I led a two-month multidisciplinary cruise aboard R/V *Mirai* for geology, geophysics, biology, and atmospheric and ocean sciences, crossing from northern Japan to southern Chile via Tahiti. I found it to be very tough both mentally and physically, but I felt great accomplishment when we finished it successfully. The MoHole also promises to be really hard, but I believe we can overcome all the problems with a team effort.

Though I have made little effort so far to balance my work and personal life, I hope to make them seamless. The number of women researchers around me has steadily increased since I began my career in this field, although there are many fewer Japanese women ocean scientists than Americans and Europeans. However, many female students have participated in research cruises recently, and I expect the number of female senior researchers to increase in the future.

One of my goals is to help develop people's science literacy in order to mitigate damage from natural disasters—I believe that we can enlighten legions of people through our research.

Describing cores aboard *JOIDES Resolution* during Ocean Drilling Program Leg 209 to the Mid-Atlantic Ridge in 2003. I was so exited about all of the interesting cores that came on deck day after day.

Fatima Abrantes

Investigadora Principal com Agregação, Instituto Português do Mar e da Atmosfera (Senior Researcher with habilitation), Portuguese Institute for the Sea and Atmosphere (IPMA), Lisbon, Portugal, fabrantes22@gmail.com

Fatima getting ready to help recover a plankton net during the PhD course "Benthic Research at Sea 2014" onboard R/V *Dana*. This is a "learning by doing" course organized by The Center for Geomicrobiology (Aarhus University, Denmark) together with GEUS, Department of Geosciences (Aarhus University, Denmark) and the collaboration of IPMA (Portugal). *Photo credit: Marion Jaussi*

In 1991, I created a paleoceanography/paleoclimate research group at the Portuguese Geological Survey and have been coordinating it ever since. Between 2000 and 2011, I also led the Marine Geology Department (DGM), covering areas such as continental margin geology, natural hazards, mineral resources, and coastal geology. During the last 10 years, my goal has been for DGM to attain a level of excellence. The group has succeeded in securing external funding from competitive programs and in attracting national and foreign PhD students, postdocs, and researchers, and it has grown to 57 people, including only seven support staff. The mix of cultures and disciplines not only increased its scientific capacity but it also generated a wonderful, productive environment that brought international recognition. Any important event for a colleague provided a reason for a group celebration.

During the difficult periods, the group remained cohesive. We survived three reorganizations of the national laboratory for geology research, the lack of basic lab conditions for paleo research, and an abrupt decrease in institutional financial support, mostly after 2008. In 2011, the DGM was incorporated into the newly formed IPMA.

I have gotten a tremendous amount of satisfaction out of working students at short training programs, advising master's and PhD students, and supporting postdocs. It is a joy to see their professional successes and accompanying personal growth. Many of those students are now young researchers with their own students and groups.

The past decade was also marked by intense participation in scientific committees or as the national delegate to European and international programs and/or organizations. Such volunteer work provides great learning experiences and promotes contact with different oceanographic research communities. I especially cherish my participation in the European Science Foundation Committee for Life, Earth and Environment Science (ESF-LESC) core and standing committees, which provided me with the opportunity to learn from outstanding scientists about the complexity and the various aspects of those sciences.

My scientific interests have not changed. I still focus on the challenges posed by climate reconstruction. Mainly, I promote the need to fully integrate modern and past ocean observations and to use multidisciplinary approaches. My interest in understanding the processes related to primary productivity in the ocean, and finding possible proxies for them, requires close collaboration with physical, biological, and chemical oceanographers. My work with climatologists came later when my study of historical records required a better understanding of the atmospheric processes driving modern and past climate signals. Concomitantly, I continue to promote the importance of paleo research to both the climatology and oceanography communities and the general public through outreach activities.

My research accomplishments remain far from my expectations because dealing with bureaucracy requires a tremendous amount of time and energy to get modest results. I must also mention my deep feelings about the state of science policy in Portugal in recent years, which is forcing young, dedicated, productive researchers to leave the country, putting national oceanographic research at risk. To have excellent paleo research in Portugal has been my dream, my life, and my objective, and "we shall never surrender." This is my advice for the young researchers.

Diane K. Adams

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Like many other oceanographers, I fell in love with the sea while roaming the seashore near my childhood home. It also helped that it was a family business—my father graduated in an early cohort of the MIT/WHOI Joint Program (1976), and my parents met in Woods Hole. But it was at the wise age of 11, when I read a *National Geographic* article on the 1991 eruption at 9°N, East Pacific Rise (EPR), that I cemented my decision to become an oceanographer and study the deep, dynamic realm of hydrothermal vents.

Indeed, my PhD work in the MIT/WHOI Joint Program was on larval dispersal at the EPR, and on my 22nd birthday, DSV *Alvin* took me to the bottom of the ocean to witness the awe of hydrothermal vents. My childhood ambition came full circle, when 9°N erupted again and I headed to sea (just over a month before my wedding) to assess the state of the vent communities. I continue to study larval dispersal and development at hydrothermal vents, coral reefs, and other environments as a young assistant professor at Rutgers in a department rich with hydrothermal vent history.

With such early goals set and followed, it might be expected that my path has flowed straight and true—not quite. But, the twists and tangents have only enriched my research, career, and life. During my defense celebration, my labmates stealthily switched my champagne glass for sparkling apple cider; I was pregnant. I consciously chose a postdoctoral position that would teach me cutting-edge molecular techniques and reduce my time at sea, so I could start a family. This turn brought me to a sea urchin developmental biology lab at the National Institutes of Health. I was certainly the only oceanographer on campus. Yet, my lab was extremely supportive of both my growing family and integrating marine ecology with organismal development.

I have been fortunate to have numerous female mentors who each chose her own career path and her own way of balancing work and family—from choosing not to have kids to doing it all as single mothers. Thus, I have always been confident that I could find my own unique way forward—there was no "right way" or "right time" for family or my career. So, with two young kids and an extremely understanding husband in tow, I dabbled with applying my science to international conservation and policy at the US Agency for International Development before returning to academia and to work at sea. The salt spray felt all the better after emerging from years in offices and labs with a new perspective on the role for science and the ocean in global society and on the joys of getting my feet wet.

Recent events have caused me to reflect on my work and life. The rejections, the late nights and early mornings (work and kids), the global adventures, the friendships forged in faraway places, coming home to my loving family, the salty sea air—I wouldn't change a thing.

During Diane's first trip to sea in seven years, she returned to the first ship she sailed on, R/V *Point Sur*, as chief scientist for its last research cruise. The gravity core miraculously sampled the only benthic macrofauna for the cruise—a sea urchin that was returned to sea unharmed. *Photo credit: D. Eason*

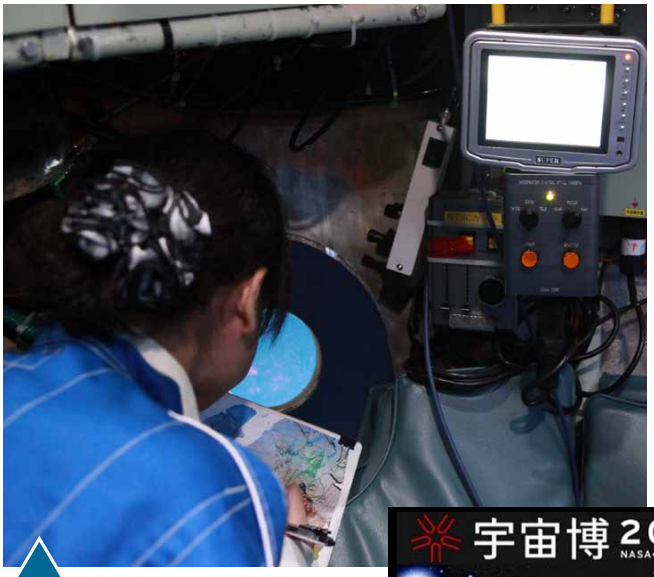
Miho Asada

Research Scientist, Research and Development Center for Earthquake and Tsunami, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan, asadam@jamstec.go.jp

I am interested in understanding seafloor features based on investigating their marine geological context through acoustic observations. Large-scale seafloor features such as ridges and troughs can be imaged with shipboard acoustic equipment. However, higher-resolution acoustic imaging acquired with autonomous underwater vehicles (AUVs) or deep-tow systems reveals much finer-scale features, such as small ridges, troughs, lava flow lines, hydrothermal chimneys, fault planes, fissures, and, sometimes, intriguing features with anomalous acoustic backscatter intensity. While direct visual observations confirm the existence of the mapped ridges, troughs, fissures, and faults, they also often reveal unexpected biotic communities or recent lava flows. By combining acoustic imagery with visual observations, I strive to gain new insights into our collective understanding of seafloor features, expanding the small pool of knowledge that currently exists. It is challenging work that never gets boring.

When I was master's student, I had the great opportunity to dive in the French submersible *Nautile* in the Indian Ocean. Early on the morning of this (my first) deep-sea dive, we lost a deep-towed magnetometer that I was managing. The cruise team kindly encouraged me (and gave me French coffee) to dive anyway, but I was not feeling well before reaching the seafloor, so I have almost no recollection of that precious first dive, except that I was very impressed with the infinite expanse and rich colors of the deep ocean. Since then, I have continued to use a variety of acoustic imaging techniques to study the seafloor, such as shipboard multibeam echosounders (MBES), AUV-mounted side-scan sonar, and observations from dives in *Shinkai 6500*. When digital acoustic data and the real world are brought together, I can feel life in the acoustic imagery. These moments are the most rewarding of my current scientific life, and they encourage me to continue trying to understand the significance of everything that can be revealed in acoustic imagery.

Admittedly, I have some difficulty keeping up with my research position. I have two lovely children and a husband who has a demanding career in industry, and almost all the housekeeping and child rearing are left to me. Every workday,



(above) Miho in the submersible *Shinkai 6500*, in 2010, at a hydrothermal site in the southern Mariana trough, observing the seafloor and making notations on meter-scale bathymetry map. (right) Miho with her husband (behind the asteroid Itokawa) and their two children at an astronomy exhibit.

I must switch off my scientific thinking in the evening as I pick up my children from daycare. The brief workdays limit my ability to devise new research schemes. Family responsibilities also make it difficult to participate in scientific meetings and research cruises. Although I have accumulated much experience in these past years, somehow it does not seem to be contributing enough to my work performance.

For the moment, I cannot expect as brilliant a career as I wished; however, I am grateful for my husband and children and enjoy my current scientific work and environment.

Amanda Babson

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I lead National Parks' science and resource management efforts for coastal climate change adaptation, primarily in the northeastern United States. My current research interests are in developing tools that help support climate adaptation decisions and devising methods for evaluating the effectiveness of adaptation strategies. Much of my focus is on preparing for sea level rise and storm surge, but the breadth of topics I end up covering is gradually expanding.

I made my way into coastal climate adaptation via physical oceanography. Though oceanography is no longer the biggest part of my research, I still enjoy delving into oceanography and modeling topics and making the connections from them to salt marsh migration or protecting historic sites. My PhD research at the University of Washington concerned estuarine circulation modeling related to water quality questions for Puget Sound, Washington. I moved from academic research to more applied management questions through a AAAS Science and Technology Policy Fellowship. As a fellow, and then continuing as a postdoc, I focused on climate change vulnerability assessments in support of the Climate Ready Estuaries program at the US Environmental Protection Agency.

Working for the federal government is a much better fit for me than academia, especially where I get to explore the interface between research and resource management. It's rewarding and empowering to work on a piece of the climate change puzzle, and for my work to help protect places I care deeply about. Going into graduate school, I thought that I'd want to work for a government agency one day—I just didn't know that a job as amazing and challenging as mine would exist.

The balance I have managed to achieve between my career and personal life is pretty satisfying. I prioritize my personal time with friends and family, time to myself, and vacation. I don't let the fact that I don't have kids mean that my personal time isn't valuable, but it does mean that I can be more flexible about travel than my colleagues who have kids. This balance may affect how dedicated or driven I am perceived by others, but I'm totally happy with the level of success I've been able to achieve while working a reasonable amount. During transitions between jobs, I've arranged to take off big chunks of time for grand kayak adventures. While I hope to stay in this position for a long time, I'm already planning for when I can next take off enough time for a big kayak expedition.

Amanda enjoys scalloping as a way to peer into eelgrass ecosystems, spend time with her family, and then get to eat delicious seafood.

Johanna Baehr

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My career in physical oceanography was triggered by a profound interest in physics. In school, I was fascinated by both math and physics. But faced with the decision on how to spend my professional life, I quickly realized that it had to be more palpable than the spin of a particle that most of the world doesn't even know exists. Yet, theoretical physics was much closer to my heart than experimental physics. That's how I ended up in ocean modeling. I did undergraduate and graduate education in physical oceanography in Kiel (Germany) and Southampton (UK), and for my PhD research in Southampton and Hamburg (Germany), I tested observing-system strategies for studying North Atlantic circulation. Subsequently, I went to MIT as a postdoc.

Today, I work on the ocean's role in the climate system. I use and improve models to study the ocean's dynamics, and attempt to make climate system predictions for the next season to the next decade. In particular, I combine models and observations (data assimilation) to enhance the initialization of seasonal-to-decadal climate predictions. Hence, the ocean has become just one component of the climate system to me, as I now work to increase understanding of the processes that connect the deep ocean and the stratosphere.

As a PhD student or postdoc, it didn't feel exceptional to be a female oceanographer; the number of female colleagues was just enough to reach critical mass. However, that changed completely when I returned almost six years ago as a junior professor (the German equivalent to an assistant professor) to Hamburg, where I was welcomed as "the first female professor in the history of the Institute of Oceanography." I still don't know of any other female junior professors in the entire geosciences department. Hence, my story isn't complete without a note on my personal life: I have two children and a husband who works full time. The older child was 10 weeks old when I started my postdoc position just four weeks after defending my thesis; the younger one was born in the first summer teaching break of my junior professorship.

Photo credit: Universität Hamburg/CEN/M. Zapf

In retrospect, it was only through our children that I managed to develop a true work-life balance. As a grad student and before kids, I felt insecure and worked extra hours to make up for my feelings of inadequacy, frequently calling my husband to let him know I would be late as I "just needed to finish something." As a postdoc with one child, I put in intense research time, and dashed off from my desk at 4 p.m. to pick up our son, initially accepting, but increasingly enjoying, the fact that "I'll come home an hour later" was simply not an option. On a tenure-track position with two kids, I settled on my personal concept of work-life balance: I'll put in whatever I can to get tenure, and at the same time I'll be there with and for my family. There was no guarantee that I'd get tenure no matter how much time I put in, but there was a guarantee that I'd only have an intact family life if I spent time with them.

Barbara Balestra

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Coccolithophores are a major group of marine, unicellular, calcareous phytoplankton that are sensitive indicators of environmental conditions because they depend on temperature, salinity, and nutrients, as well as the availability of sunlight. Therefore, fossil remains of coccolithophores (coccoliths) are useful tools for paleoceanography in addition to biostratigraphy. Surely, when I started my geology studies at the Università degli Studi di Firenze in Italy, I did not imagine that I would become a paleoceanographer focusing on this phytoplanktonic group. I was more excited by dinosaurs!

Through the years of studying oceanography, marine geology, and micropaleontology, my interests shifted. I was fascinated to learn how tiny phytoplankton that lived in past oceans and that are now preserved in marine sediments enable us to unravel ocean history. So, I became a micropaleontologist specializing in coccolithophores. After my master's degree, I decided to continue studying coccolithophores, and during my PhD I had the opportunity to travel to different institutes and countries and participate in several oceanographic cruises, all of which enriched my experience as a researcher. I happily discovered that looking through a microscope on a boat in rough seas doesn't bother me at all.

Since graduating in 2004, I have been working intermittently as a coccolithophore micropaleontologist. I am saying intermittently because balancing career and personal life has always been quite a challenge, especially because my husband is a scientist as well and lives in another country. I finally moved to the United States to join my husband in 2009. So far, my research interests have been primarily focused on the ecology of extant coccolithophores, biostratigraphy, paleoceanography, and paleoclimate reconstruction. In 2011 and 2012, while I was working at Queens College (CUNY) in New York City, I had the great opportunity to participate in Integrated Ocean Drilling Program Expedition 339 (Mediterranean Outflow) as a calcareous nannofossil analyst. Sailing on the drillship *JOIDES Resolution* was a dream come true. Since then, I have been involved in several projects linked to that expedition. In particular, I am studying the changes in absolute abundances and paleofluxes of calcareous nanoplankton and looking for interactions with abiotic and biotic paleoecological factors other than paleoceanographic changes.

In 2013, my husband and I moved to California, and I started working at the University of California, Santa Cruz, as an assistant project scientist, a soft-money position. This new working experience is giving me the opportunity to develop another line of research, studying the chemical and stable isotopic composition of coccolithophores and foramanifera as indicators for climate-induced changes in marine productivity and oceanic ecosystem structure. I am still juggling work and life, as now there are three members in our family with the birth of my daughter Mia. Coming to California really worked well in a lot of aspects for us, although challenges remain. But looking at my life and my career so far, I can say that nothing is impossible.

Sibel Bargu

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I chose to be an oceanographer, even though I get totally seasick and ocean scares me—but I love it all the same. I am a biological oceanographer with special interests in ecological issues related to estuarine and marine plankton. I graduated from the Department of Biology at Istanbul University and then entered the master's program at the Institute of Higher Technology in Gebze, Turkey. While at the Institute of Higher Technology, I was awarded a full government scholarship to pursue both master's and doctoral degrees at any institution of my choosing in the United States, and was subsequently accepted into the graduate program at the University of California, Santa Cruz (UCSC). At UCSC, I completed my master's degree on trace metal effects on marine diatoms with Ken Bruland, and then completed my PhD under the supervision of Mary Silver on the ecology of toxic algal blooms.

Currently, I am a faculty member at Louisiana State University (LSU), Department of Oceanography and Coastal Sciences. The shelf waters of Louisiana provide some of the best-studied examples of the effects of coastal eutrophication, including harmful algal blooms and hypoxia. My research interests at LSU focus on food web interactions, the effects of anthropogenic stressors (i.e., nutrient loading, predator loss, pollutants, and phycotoxins) on aquatic food web dynamics such as energy flow and community structure.

I love what I do. I love the science, I love interacting with students—all very rewarding! Sometimes I get to work on a topic that has a very fun side story to it. Once, we worked on the historical contamination of pelagic species within the Monterey Bay Sanctuary, a productive near-coastal environment of the Central California Current upwelling system. This study utilized the unique long-term CalCOFI sample collections to investigate gut samples of herbivorous zooplankton to discover whether they contain toxic phytoplankton. The zooplankton samples, dating back to the 1960s, did indeed consume toxic diatoms. Results of this project were recently published with the title "Mystery behind Hitchcock's birds." The study explained the cause of the 1961 seabird behavior fancifully described in Hitchcock's film, and strongly suggested that domoic-acid-producing phytoplankton have been agents of marine animal mortality in the California Current system for at least the past 50 years.

Challenges…I think they are not that unique to women in oceanography. Being in academia and having a family with two little kids is/was both hard and easy. Going through the tenure process was a little stressful when I was having my kids and trying to meet all the academic expectations. It is still hard to go to meetings and on field trips—but I am driven and love my job, and these forces always make me creative enough to keep the balance going. Now my kids are little older and my job gives me the flexibility to be with them when they need me (e.g., sick calls, doctors' appointments). So, overall it has worked out fine.

My two morning lights: Deniz and Bora. Deniz in Turkish means "sea" and Bora means "northern wind."

Lisa Beal

Professor of Ocean Sciences, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL, USA, lbeal@rsmas.miami.edu

My research focuses on ocean circulation and property transports, particularly within the intense western boundary systems of the Indian Ocean. The observations I collect and analyze contribute to improving our understanding of the ocean's role in climate and climate change.

I studied aeronautical engineering at Southampton University in the UK before switching to oceanography as a second-year undergraduate. Physics was my favorite subject in school, I loved to work on cars with my dad, and I was obsessed with being in the air—whether in a plane, glider, hot air balloon, or helicopter—so aeronautical engineering seemed a natural choice. However, the military and industrial application alienated me, so I looked for something more aligned with my love of the natural world, and found physical oceanography.

As scientists, we are always learning, constantly challenged, and repeatedly pushed outside our comfort zones. This is sometimes overwhelming, other times exhilarating, and ultimately very rewarding. Being a scientist has led to personal achievements, travel, and friendships far beyond what I ever dreamed of! And I feel privileged and proud to be a small "part of the solution" when so many people must simply work to earn a living. The biggest challenge in my career has been "impostor syndrome": a sense that I am not clever enough, dedicated enough, or knowledgeable enough to be a good scientist, a sense that standards must have slipped to allow me through! I expected these anxieties to be quelled with success, but they are a continuing challenge.

A day-to-day balance of work, exercise, and socializing has always been very important to me. As a postdoc, I saw some people working all hours of the day and night and began to worry that I must emulate their behavior to "make it." But I made a conscious decision that if I couldn't be successful doing as much as I could within a normal work day, keeping evenings and weekends for myself, then oceanography was not a sustainable career for me. Since then, this decision has empowered me and given me control over how much of myself I give to my science.

During my early career, I put up with some harassment and gender bias in the lab and at sea and was given advice that amounted to "ignore it and keep your head down." Fortunately, policies are now more enlightened and conditions for women have improved. Many of the challenges for women in science are far more subtle and are now better documented and understood than when I was a student. As a result, we are in an exciting time, when men and women are working together to create a more collaborative and inclusive science community in which everyone can excel.

Janet M. Becker

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My scientific career has focused on understanding the effects of nonlinearity on physical systems. My path has been strongly influenced by my family. I was exposed to science from an early age as my parents both hold PhDs in chemistry. My late father was a professor of biochemistry at Oregon State University, where my mother was a part-time researcher (nepotism rules kept her underemployed). I enjoyed mathematics from an early age, and fell in love with physics in high school, as the only female student in Pat Cannon's AP physics class. I completed my undergraduate physics degree at the University of California, San Diego, because I also love the beach, and discovered physical oceanography by proximity to the Scripps Institution of Oceanography (SIO).

For my dissertation research under John W. Miles at SIO, I analyzed a symmetry breaking instability in surface gravity waves described by Michael Faraday in 1831. During my time in graduate school, I enjoyed playing service yard basketball and ultimate Frisbee with my future husband. Our first daughter, Sophia, was 14 months old when I defended my dissertation.

With two postdoctoral positions and a child-friendly environment, Australia was our solution to the three-body problem. I studied explosive resonant triads in stratified shear flows with Roger Grimshaw at the University of New South Wales and had our second daughter, Anna, with three full months of paid maternity leave. After two wonderful years down under, the National Science Foundation awarded me a postdoctoral fellowship that allowed us to optimize our next career move, and the four of us returned to SIO, where I studied the effects of a western continental slope on a uniform density model of wind-driven circulation with Rick Salmon and taught electric circuit theory in the mechanical engineering department. Our next stop, lasting 20 years (so far), was the University of Hawaii, where we accepted two tenure-track positions. Currently, I am an associate professor in the department of geology and geophysics at UH. I teach applied mathematics tailored to Earth (solid) and ocean (fluid) mechanics. For my geological research, I have worked on problems in elasticity and non-Newtonian fluid dynamics.

The family celebrating the graduation of our youngest daughter, Anna, from MIT during the remnants of Tropical Storm Andrea (June 2013).

In 2005, I had my first of three bouts of breast cancer, which gave me pause, and motivated me to reinvent my research identity. I realized that I really wanted to work with field data, and was fortunate that several new projects in nearshore oceanography needed attention. Since then, I have been engaged in a series of field programs designed to understand wave transformation over fringing reefs, in particular, to assess the impact of wave-driven inundation on low lying atolls under future sea level scenarios. I have really enjoyed learning a new set of skills to mine the field data and then developing theoretical explanations for the observed patterns in the data. I also love interacting with students and teaching applied mechanics. My husband, a professor of oceanography at UH, and I worked hard to balance our careers and our family time. Professionally, we did not collaborate until after we both had independent research identities (and tenure), and we now work together on the wave transformation projects.

Now that our daughters are in the field at MIT/WHOI (Sophia, physical oceanography) and SIO (Anna, climate dynamics), we get to attend conferences together.

Claudia Benitez-Nelson

College of Arts & Sciences Distinguished Professor in Marine Science, Marine Science Program & Department of Earth & Ocean Sciences, University of South Carolina, Columbia, SC, USA, cbnelson@geol.sc.edu

Claudia, center, with University of South Carolina undergraduate Hollings Scholar winners, left to right, Chandler Green, Ari Robbins, Kelly McCabe, and Charlotte Eckmann.

Ten years ago, I submitted my first "Women in Oceanography" profile as a newly minted assistant professor at the University of South Carolina. I still think I have the best job in the world.

My research is in marine biogeochemistry, and it's a bit eclectic. My graduate and postdoctoral work focused on using naturally occurring radionuclides to study processes ranging from atmospheric mixing to upper ocean particle export and sediment accumulation on the seafloor. I still conduct research using radioisotopes, but over the past decade, I have expanded into studying the composition and bioavailability of phosphorus; the fate of marine toxins, specifically domoic acid; and the processes that influence the composition and bioavailability of sinking organic matter. I'm easily distracted, and I love testing new ideas and finding the unexpected.

During graduate school, my husband and I decided to have children. I was concerned at the time that having two children before tenure would hurt me professionally. This has not been the case. My incredibly supportive husband takes more than his fair share of childcare and household duties. Further, my work has provided me with the flexibility to attend my children's school events and to work from home when need be. There are not many jobs that allow for such opportunities. I did make the conscious decision to move my research to nearshore projects to reduce my sea time and focused on time-series data sets where samples were already available for analysis. Now that my children are older, I am beginning to go back to sea to conduct research in areas that I have been waiting to explore.

I work hard, but I am very careful with my time. As an assistant professor, I received excellent advice from a colleague that I still follow today. She told me that as a woman in science, I would be asked to do more than my colleagues. She was right. So I share these rules (with a few minor additions) in the hopes that they provide you with guidance as well.

1. Never say yes in the first phone call.
2. Don't count, or feel the slightest bit guilty, about how many times you say no—you have to count and closely monitor the times you say "YES."
3. If you do the work, get yourself the deserved title and the recognition.
4. Do things you learn something from or that offer some reward.
5. Don't ever join a committee without (a) finding out who is chairing it first, especially if people think it's going to be you, and (b) finding out who is likely to be on it.
6. Don't ever join a committee without asking (a) do they need ME specifically or just someone, and (b) do I have something to learn from this that I want/need to learn.
7. Work with people you like. You'll be more efficient when you don't dread the interactions.

Using these rules, I have successfully managed a number of large research programs. I've served as both the undergraduate director and overall director of the Marine Science Program. I learned a tremendous amount in both positions about how universities are run, how to be a good manager, and how to move things forward in a positive manner. I still try to do too much and feel guilty for saying no. But, when I agree to do a job, I am all in.

As a female oceanographer, I want young scientists to realize that it is possible to become a successful research scientist and have a family (even before tenure). It requires a supportive partner, but so does any job. Too many of us are leaving the field before even giving it a try. We must reverse this trend.

Kelly Benoit-Bird

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I am an ocean ecologist interested in understanding why the complex spatial and temporal dynamics of ocean life matter. My research lab has examined the interactions of 1 mm to 20 m long animals representing a variety of taxa (crustaceans, fish, cephalopods, birds, and mammals) living in temperate, tropical, and high-latitude ecosystems. Integrating these studies has provided a comparative framework to elucidate general principles of pelagic ecology that can be applied beyond the conditions and species within a particular study or site.

My work emphasizes the development and thoughtful application of active acoustic techniques (sonar) to observe animals, often in collaboration with engineers. Studying ecosystems is generally a collaborative effort, bringing together teams with different techniques, disciplines, and questions. The intellectual energy generated by a diverse working group is fun and inspiring.

Ten years ago, when I last wrote a biography for *Oceanography*, I was a brand new assistant professor. I hadn't yet taught my own course, I was trying to recruit my first graduate student, and I was just getting my first proposals out. Since that time, I've spent more than 450 days at sea, had students graduate, taught four new courses, written more proposals than I care to count, and have been promoted to professor. More importantly, during the last decade, I've made a life and home in my adopted town—cultivating deep friendships with colleagues and putting down roots.

My husband and I have a four-year-old son. Having a child is a great adventure—one we spent a lot of time preparing for, both emotionally and practically. Before my son was born, it was typical for my husband (who is my research technician) and me to spend three or more months of the year at sea together. About a year before we were ready to start our family, I changed the kinds of science I was proposing, adding projects with long equipment development times that would postpone fieldwork, coastal work on small boats instead of large ships, and synthesis efforts. I didn't want to eliminate ship-based research altogether, so we've alternated which of us goes and relied on the generosity of out-of-town grandparents for long-term babysitting while we're at sea together. Our preschooler has also accompanied us on field efforts, going out on one small boat and spending time at field sites with hired caregivers while we were out on day-long trips. During these adventures, my son discovered that the ocean can actually be warm enough to swim in and made observations about tidal cycles and waves. The acute challenges (and joys!) of balancing life and the work I love are coupled with the mundane, daily challenges that are amplified by living far away from family. I have been fortunate to have resources to facilitate solutions, a supportive professional environment, and a husband who is an equal parent and partner. The benefits are awesome—in addition to joy and lots of laughter, my family both grounds me and encourages me to soar.

Kelly at the Oregon coast with her husband Chad and their son Kaelan.

Heather Benway

Executive Officer, Ocean Carbon & Biogeochemistry Program, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, hbenway@whoi.edu

My research has focused on the circulation and nutrient dynamics of the Gulf of Maine as well as tropical and high-latitude paleoceanography, both highly interdisciplinary fields involving the complex interplay between marine ecosystems and biogeochemistry. During my MS program, I ran nutrient analyses for baseline water quality monitoring in Boston Harbor and Massachusetts Bay. This exposure to applied science inspired an early interest in marine policy development and the decision-making process, so I pursued a John A. Knauss Marine Policy Fellowship, which landed me in a bustling climate office at the National Oceanic and Atmospheric Administration (NOAA). It was exhilarating to obtain this broader view of ocean and climate science. I remained at NOAA for another two to three years to manage a paleoclimatology research program before returning to graduate school to pursue a PhD. My doctoral and postdoctoral research focused on the abrupt, large-scale climate and ocean changes of the last deglaciation and associated feedbacks between the tropics and high latitudes. The highlight of this research was sailing on ocean drilling cruises between Chile and Panama to collect deep-sea sediments in order to develop high-resolution temperature and salinity reconstructions. I became an avid micropaleontologist and sedimentologist with expertise in stable isotope and trace element geochemistry.

Heather enjoying some "family sea time" with her youngest daughter Aurelia (now three) at a favorite beach in Woods Hole. *Photo credit: Andreas Kuehn Photography*

At the conclusion of my postdoc in 2007, I accepted a position as executive officer of the Ocean Carbon & Biogeochemistry (OCB) Program at Woods Hole Oceanographic Institution (http://www.us-ocb.org). I have since focused my energy on community building and facilitating the science of others. While at times I miss doing research, I feel equally inspired and impactful by taking the broader view of how it all fits together. I work with federal agency managers and a continually growing network of scientists across a broad range of disciplines to cultivate new research areas and funding opportunities. In this position, I have harnessed my knowledge and talents to build a program and a community that will serve as a legacy for years to come. Along my circuitous career path, I've seen firsthand how many diverse and important roles there are to play in advancing ocean science. Each step of my journey has helped prepare me for the next, and I am grateful to many supportive mentors along the way.

I always gravitated toward math and science, in part due to the encouragement of dedicated, creative teachers at an early age. I think the grand challenges we face as scientists are the increasing mistrust of science and the diminishing scientific literacy of our public. The solution starts with our education systems. Fear of math and science among students necessitates a movement toward more engaging, hands-on learning experiences that foster curiosity and innovation.

I started a family during my postdoc. For me, work-family balance means setting priorities and boundaries, being creative, and sometimes making difficult choices. Rather than dwelling upon missed moments and opportunities in the short term, I tend to focus more on the integration of my choices over time. Through this lens, the age-old paradigm of "having it all" seems much more attainable.

Elisa Berdalet

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My research is focused on increasing our understanding of ecophysiological responses of marine microplankton to natural physico-chemical forcing. Currently, I am investigating harmful algal blooms, a worldwide problem, with the aim of providing clues for their management.

I had always wanted to study and protect nature, enjoyed terrestrial botany during my undergraduate studies at the University of Barcelona (Catalonia, Spain), then moved to the marine world for graduate work. In 1987, I started my PhD thesis under the supervision of Marta Estrada at the Institut de Ciències del Mar (CSIC, Barcelona). She offered me a challenging topic: to understand the underlying mechanisms of the sensitivity of dinoflagellates to small-scale turbulence. With Marta, I had the great opportunity to interact with the much-loved ecologist Ramon Margalef.

I like working in open-minded teams, collaborating, integrating different skills and disciplines. Marine research, multidisciplinary by definition, makes me happy. My greatest reward has been serving the international scientific community through UNESCO's GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) program, including serving as a member and as vice chair of its Scientific Steering Committee (2009 to 2014).

When I started my PhD studies at the ICM, research had very limited funding and its old building was inappropriate for meeting the new challenges of marine research. Nevertheless, it was a good time for a country that had only recently opened up to democracy and the European Union. The funds available for science and education were invested in enthusiastic young students and mentors who worked hard to foster and internationalize science in Spain and Catalonia. Today, a global economic, ecologic, and ethical crisis threatens humanity and science. Science, itself, is affected by increasing emphasis on competitiveness and decreasing collaboration—one of the original cornerstones of scientific research. Having a permanent position and management responsibilities in my research center, I feel a special commitment to work for a better future. It's not an easy task.

I am passionate about my work, my whole family, and classical music. The dual priorities of my children's education and my career have oscillated throughout my life. It has been a team task, undertaken with my always-supportive and generous husband, a general practitioner and epidemiologist who sees the world through "women's eyes."

Elisa with her husband, Rafael, and their two children, Joaquim and Judit, in Alfacs Bay (Ebre Delta, Northwest Mediterranean).

My career began and has developed during a golden age for science that facilitated women's involvement in research. Unfortunately, in recent years I've noticed that the choice of motherhood pushes more women out of science following completion of their PhDs.

I am concerned about the future of science, as it may be indicative of the future of humanity. We need excellence in science, of course we do. However, to me, the competitiveness that pervades it is not good for anybody, neither men nor women. In times of crisis, women tend to be more affected than men, mainly because of biological reasons. Therefore, we might see a decrease in their numbers in the coming years. With a generous spirit and a positive vision, we can work collaboratively for the benefit of science and humanity as a whole.

Kim S. Bernard

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I am a biological oceanographer specializing in high-latitude zooplankton ecology. My research focuses primarily on zooplankton communities and trophic interactions. I am particularly interested in patterns of community structure at various spatial and temporal scales and how their variability impacts higher and lower trophic levels and biogeochemical cycling.

Maybe it's a sign of the changing times, or maybe I was just fortunate, or oblivious, but it never once occurred to me that I might not be able to pursue a career in oceanography because I was a woman. Growing up near the coast in South Africa, I have always had a deep love of the ocean and knew from a very early age that I wanted to study marine science and ultimately help protect the ocean (a lofty goal for a 10-year-old). At the time, though, I had no idea that the field of oceanography even existed. A few years later, my father, who is a professor in zoology, came home from work one day with stories about colleagues of his who had recently been to Antarctica—two months on a ship, sailing to the bottom of the world, conducting research on zooplankton. From that point on, I decided I would join that group of explorers and I would go to "the ice," as they so fondly referred to it. First, I needed to find out what zooplankton were…

Following my passion, I earned my PhD in marine biology at Rhodes University (in South Africa), advised by one of the Antarctic zooplankton researchers my father had told me about all those years before. After a brief hiatus in science management in South Africa, I returned to Antarctic research as a postdoc on the Palmer Antarctica Long Term Ecological Research project with Debbie Steinberg (Virginia Institute of Marine Science), and finally landed a position as a high-latitude researcher with the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University.

My career in ocean sciences has taken me to one of the most extreme and beautiful places on the planet, Antarctica, allowing me to achieve my childhood dream. But the rewards of my career extend well beyond that. I am driven by curiosity, by the desire to understand how our ocean functions, how it's changing. Having the freedom and flexibility in my career to pursue these questions is extremely rewarding. Oceanography tends not to be a field where you work in isolation, and addressing oceanographic questions typically requires multiple investigators, often from varied disciplines. One of my favorite aspects of being an oceanographer is the people I get to work with.

It is this camaraderie and the support I have from my "academic family" here in the United States that has helped me through one of my biggest challenges, leaving my family and home in South Africa in pursuit of my career in ocean science. Creating a strong academic network has been essential to my progress, as has finding truly awesome mentors and role models.

Kim with her border collie, Tanah (age 15), on a recent trip to South Africa.

Joan M. Bernhard

Senior Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, jbernhard@whoi.edu

Early in 2004, I joined the Woods Hole Oceanographic Institution's (WHOI's) scientific staff as a tenured associate scientist. My entire career prior to that was spent in non-tenure-track "soft money" positions. I am delighted to be part of the WHOI community, even though my appointment relies exclusively on grant funding.

During my first year at WHOI, I was tasked with designing two new labs: a temporary one to use "immediately" and another to serve as my permanent lab in a building under construction. These efforts took an inordinate amount of time (just ordering equipment took much more time than I ever could have envisioned), but at last, in October 2005, my lab moved into the Stanley W. Watson (biogeochemistry) Laboratory on WHOI's Quissett Campus.

Over the past decade, my focus has broadened beyond deep-sea and polar benthic ecology to include some temperate and tropical projects that have taken me to many exciting places around the world. Recently, my colleagues and I have studied the famed stromatolites of Shark Bay, Western Australia, and diverse microbialites of Highborne Cay, Bahamas. We have also had the pleasure to use ROV *Jason* to study benthic eukaryote communities of hypersaline anoxic basins in the deep (> 3 km) Eastern Mediterranean. ROVs *Jason* (WHOI), *Ventana* (MBARI), and *Hyperdolphin* (JAMSTEC) have allowed me to study seeps off California and seeps and vents off Japan. In addition to these field studies, we continue to conduct many lab-based studies, including culturing of bathyal benthic foraminifera to assess geochemical proxy fidelity, dispersal (biogeography), and impacts of ocean acidification (OA). Most recently, we are completing a project to assess multistressor impacts (OA, warming, and oxygen depletion) on benthic foraminiferal communities. Developing methods, most of which involve transmission electron microscopy or use of fluorescent probes, remains one of my research goals. In the past decade, I have had visiting fellowships in France and Japan. In 2010, I was promoted to Senior Scientist at WHOI and in 2012 was awarded a three-year Robert W. Morse Chair for Excellence in Oceanography appointment.

Joan snorkeling to collect stromatolite samples from Hamelin Pool in Shark Bay, Western Australia, in 2011. *Photo credit: Phoebe Cohen*

By far the most challenging issue for today's oceanographic research career is federal funding levels. The US federal government sequestration, in addition to other earmarks, has caused ever more challenging funding competitions. Even if projects are funded today, the original requested budget is typically cut so drastically that the planned activities are severely impacted. Unfortunately, the projection for federal funding for the foreseeable future is not bright. Today, big-science collaborations are the norm, at the expense of independent sole-PI projects. My advice to early career scientists is to find a societally relevant niche about which you are passionate, build a network of colleagues with whom you truly enjoy working, and diversify your funding sources.

Nihayet Bizsel

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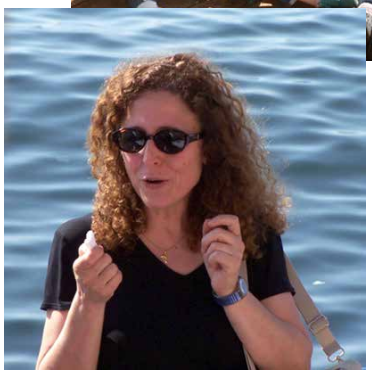
To the memory of my father, who literally dedicated his life to the education of his seven daughters, despite cultural and political barriers in our part of the world for female education.

I was born in Hozi, a small village at about 3,000 m altitude in southeastern Anatolia, in Hakkari province, where the Taurus and the Zagros Mountains meet. I saw the sea for first time at the age of seven—the Gulf of İskenderun in the eastern Mediterranean. During high school, I had no idea which job I would prefer, but I knew that it should be very dynamic. While I was watching a documentary on Jane Goodall, I felt a spark that enlightened me: "Doing research on environment or ecosystem has the dynamism I was looking for!" Thus, I found myself as a biology student and then research assistant at the Institute of Marine Sciences at Middle East Technical University. Now, my research field is nutrient dynamics and phytoplankton ecology.

While studying for an MSc degree, I married another marine scientist, K. Can Bizsel. Having an incredibly supportive colleague and husband provided not only a great opportunity but also a bitter challenge for getting a permanent position. I defended my PhD thesis when my son, Ali, was about six years old and my daughter, Solin, about 10 months old. Our children are now in university and high school. Even if the flexibility in my job was helpful for spending more time with my family, there are some memories that still twist my heart when I remember them. When my son was less than two years old, I participated in a four-month study on an international project in Sicily and missed his second birthday. I still remember how I wanted to fly like a bird just to see my son. When I look back at that time, I understand why women often leave research careers. To be trapped between children and profession is a tough dilemma, and it can be hard to overcome. In spite of recent significant increases in the number of woman researchers in oceanography in Turkey, they are still underrepresented in leading positions and science administration. I am very proud of being a mom who is able to do scientific research.



Mesocosm experiment in Chilean Patagonia (MESOPAT) in November 2014 in the EU framework project OCEAN CERTAIN. *Photo by Murat Van Ardelan*

Balancing work and home life is an adventure. Sometimes I forget everything and focus only on experiments, and sometimes I forget the experiments and focus only on my family and social life. Helpful and understanding spouses can make remarkable differences for women striving for scientific careers. My 26-year career has been so rewarding and provided challenging research opportunities. I love being able to visit different parts of the world and meet and work with so many wonderful colleagues. I have been fortunate to have opportunities to work with samples from different marine environments such as Antarctica, Norwegian and Patagonian fjords, and Mediterranean and Black Seas within the framework of projects including AMLR, GEOTRACES, OCEAN CERTAIN, and DEVOTES. Life is full of challenges and excitement.

Carol Anne Blanchette

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I grew up on the New Jersey shore and have been in and around the ocean since birth. My grandfather was a fisherman, and my grandmother had taught us how to fillet fish by the time we could hold a knife, and importantly, what all the different parts of the fish were and what they did. This early experience began a lifelong obsession with biology and science in general.

I spent my undergraduate years in Indiana, far from the ocean, but I took a summer-long course in aquatic biology at the University of Notre Dame's environmental research center—a large property loaded with lakes in the northern woods of Wisconsin. There, I studied limnology (and fished a lot) and began to develop my thinking as an ecologist.

Eager to return to the marine environment and apply my aquatic ecology training, I moved to Oregon, where I started in a PhD program studying marine ecology. My PhD focused on the connections between rocky shore communities and nearshore oceanography. Following graduate school, I wanted to understand more about the interactions between physics and biology in the context of organism structure and function. Next came a move to Monterey, California, for a year as a postdoc at Hopkins Marine Station working on the biomechanics of organisms that live in extremely wave-exposed rocky shores.

This work furthered my desire to learn more about oceanography and the importance of understanding physical processes in the ocean. Currently a research biologist at the University of California, Santa Barbara, I study nearshore oceanography and the ecology of coastal marine ecosystems, including nearshore kelp, seagrass, and rocky intertidal habitats. I have a wide breadth of interdisciplinary research interests, including biomechanics, biocomplexity, climate change, ocean acidification, sustainable resource management, science education, and environmental literacy.

One of the things that I enjoy most about science is the opportunity to constantly ask new questions and explore, both inside and outside of my research career. I have always loved getting outside, and hiking, biking, skiing, surfing, and climbing are all passions of mine. My husband Steve and daughter Neko are game for almost any adventure, and we love spending time together in the mountains, in the desert, and at the beach looking for creatures and finding new things.

My greatest challenge now is to figure out how best to apply what I have learned throughout my life and career to the next generation of scientists. I am committed to working with students and teachers to improve science education and to inspire creativity, excitement, and a spirit of innovation in those learning the process of science. We are facing great challenges in our world in the years to come, and we will rely on the young people of today to become the problem solvers of tomorrow. I feel a great responsibility to share my experiences as a scientist with students and teachers who are in the trenches, working hard to improve science education.

Carol with her husband Steve and daughter Neko, hiking and exploring the Utah wildlands at Arches National Park.

Paula S. Bontempi

Ocean Biology and Biogeochemistry Program Scientist, National Aeronautics and Space Administration (NASA), Washington, DC, USA, paula.bontempi@nasa.gov

When I was four years old, I told my parents I was going to study the ocean. My father's family were fishermen from Rimini, on the Adriatic in Italy, and many died at sea, although I did not know this story until decades later. What is in your blood is in your blood, whether you know it or not.

For the past 23 years, I have been working in some aspect of oceanography. I have held my current position as program manager for ocean biology and biogeochemistry research and missions at NASA Headquarters in Washington, DC, for the past 12 years. NASA uses remote-sensing technologies to carry out Earth system science at multiple scales. My fields include ocean biology, ecology, and biogeochemistry, but my research interests also encompass using interdisciplinary science to understand the ocean's role in the Earth system.

I began my career doing trace metal analyses on mussels in Boston Harbor while interning at the New England Aquarium. I then pursued a master of science degree from the Department of Oceanography at Texas A&M University. There, my work in phytoplankton taxonomy and biogeography sparked my interest in ocean color remote sensing. I chose remote sensing as a field of study mostly because of the challenge—I was sure it didn't work (Satellites and species? No chance.). I went to work for Jim Yoder at the University of Rhode Island's Graduate School of Oceanography, and the rest is history. In 1997, I stood in Gene Feldman's office at NASA's Goddard Space Flight Center and watched the SeaWiFS (Sea-Viewing Wide Field-of-View Sensor) launch, never dreaming that six years later I would be the SeaWiFS program scientist working in a field I once was sure could never be quantitative.

Along the way, I quit the tenure track mid-stream for competing personal and professional reasons. I now have a beautiful son. A job opportunity arose at NASA—a job where one can help influence and enable a whole community. It was a tough decision to transition from research to science management, but I serve the community and the public. I have learned two things: (1) I can only do one thing at a time, and (2) I cannot change people who judge me for my choices. I try to learn from successes and failures (sometimes this takes a decade). I am continually approached by scientists of every stripe who are chronically overwhelmed with work and life. If you need a break, take a break. I am telling you, it is okay. Work will always be there and so will new opportunities.

There are countless discoveries await us in Earth's living ocean. I will never tire of listening to scientists talk about their ideas for the future, and thinking about how I can work within NASA and with partners to facilitate those ideas. Ocean science is constantly evolving as Earth evolves: we have the opportunity to begin exploring new questions regarding our ocean gardens. Along the way, it is our duty to provide for a long-term surveillance system, both in situ and from space, not only to understand and monitor changing ecosystems but to also enable the next generations of students scientists. We need to explore, understand, and protect our home planet. Perhaps I can help.

November 2014, NASA Headquarters.

Helen Bostock

Research Scientist, National Institute of Water and Atmospheric Research, Wellington, New Zealand, helen.bostock@niwa.co.nz

As a teenager, I wanted to be an explorer and make discoveries. During my undergraduate degree work in natural sciences at the University of Cambridge, I took every opportunity I could to travel and explore, but my adventures in oceanography really started after moving to the other side of the world to undertake my PhD at the Australian National University. The aim of the project was to study the paleoceanographic history of the Southern Great Barrier Reef using sedimentology and the stable isotopes of foraminifera in marine cores. However, I realized that interpreting the paleoenvironment was impossible with our limited knowledge of the modern oceanography of this region. So, I spent half of my PhD teaching myself oceanography and working on the modern geochemistry of the South Pacific Ocean. My desire to continue my career as an oceanographer was reinforced by going to sea on *JOIDES Resolution* for Ocean Drilling Program Leg 207 in 2003 at the end of my PhD.

I am fortunate to be able to continue both my interest in modern ocean geochemistry and in paleoceanography in my current job at the National Institute of Water and Atmospheric Research in Wellington, New Zealand. With the fifth largest marine territory in the world and very complex oceanography, there is plenty of work to do in New Zealand. There are some limitations to working in the small New Zealand research community, but there are also many advantages. I have to work harder to develop international collaborations, but I also get to work with a wide range of scientists in New Zealand on many interesting multidisciplinary and applied projects.

The main thing I love about my job is its diverse nature. Some days are spent in the laboratory, others in the office working on a wide range of projects, but I also participate and lead voyages on New Zealand's research vessel *Tangaroa*. I have been involved with six voyages around New Zealand from the subtropics to Antarctica, and I have realized that I am fulfilling my ambition to be an explorer—discovering new underwater features such as canyons and volcanoes on every trip, as well as learning about the modern chemistry and past changes in the ocean. I have a small number of postgraduate students in association with the Antarctic Research Centre, Victoria University of Wellington. I encourage these students to come on voyages to provide them with the important practical hands-on experience needed to decide if this is the career for them. I also enjoy undertaking outreach, writing blogs, and giving regular talks to community groups and school children about our voyages.

Helen waiting on deck for a core to come up on R/V *Tangaroa* during voyage TAN1106 to the Solander Trough south of New Zealand. *Photo credit: Dylan Amyes*

I have had relatively few experiences of sexism in the work place. I have supportive work colleagues and have had some great mentoring from both male and female colleagues. I also have a very understanding husband who has taken the step of retraining to fit around my career.

Mya Breitbart

Associate Professor, University of South Florida College of Marine Science, St. Petersburg, FL, USA, mya@usf.edu

As the child of two scientists, I had ample exposure to the joys and challenges of scientific discovery. My mom ran the after-school science club, and I have fond memories of playing with dry ice in the kitchen sink and taste-testing new products that my food chemist dad brought home for "market research." Family trips to aquariums and beaches spurred a love for the ocean. This passion was reinforced through Girl Scout trips to participate in shipboard research on the Great Lakes and volunteering with a sea turtle nesting project in North Carolina. By the end of high school, I was confident about pursuing an academic career in marine science and began my undergraduate degree in marine biology at Florida Institute of Technology.

As an entering freshman, I had no idea how convoluted and nonlinear my career path would be. An opportunity to do organic chemistry research with an amazing female mentor led me to briefly switch my major to chemistry. Another amazing research opportunity, isolating antimicrobial compounds from Antarctic bacteria, got me excited about the microbial world, an aspect of marine science that I had never considered. This fascination with "all things small" was solidified through a Research Experiences for Undergraduates internship studying marine viruses with Forest Rohwer, who eventually became my PhD advisor at San Diego State University.

I became enamored with the world of marine virology, an exciting research area in which there were so many unanswered questions. After earning my BS, I entered a PhD program in oceanography. However, by the end of my first year, I knew the program wasn't a good fit for me, and I left, switching universities to pursue a degree in cellular and molecular biology. At the time, this felt like career suicide, and I feared I might never achieve my long-anticipated goals. But now, after almost a decade of being a successful marine science professor, I realize this risky decision was critical for my career development. Through this strange path, I mastered concepts in disparate fields, providing me with a unique background to excel in marine virology research.

Mya Breitbart (center) joins graduate student Erin Symonds and postdoc Karyna Rosario in sharing their passion for marine viruses at the Saint Petersburg Science Festival.

My current research focuses on elucidating the diversity, spatiotemporal variability, and ecological roles of marine viruses. Using metagenomic sequencing, I have generated unprecedented insight into the vast, largely uncharacterized diversity of viruses, the most abundant biological entities in the ocean. Viruses infect all marine organisms, ranging from bacteria to copepods to mammals, and therefore play critical roles in global biogeochemical cycles, as well as the health of both marine animals and the large percentage of the human population that is linked to the ocean. I love this research because of the huge potential for paradigm-shifting discoveries and because it enables me to work with an excellent, highly supportive community of researchers.

I am also extremely dedicated to mentoring and community outreach. I was very fortunate to have supportive parents and excellent teachers and mentors along the way. I was always encouraged to pursue my scientific interests, an experience that many children (especially girls) do not have. My experiences in Girl Scouts ignited a spark for marine science in my life. All these opportunities were pivotal in directing my career. As a young female scientist, I constantly strive to encourage girls in STEM fields. To give back to this community, I have run marine science and technology workshops for over 400 Girl Scouts and created a fully functional laboratory at a local Girl Scout camp. My goal is to inspire others to pursue their dreams and provide mentorship to help them realize that even if the path is long and winding, the end result is 100% worth it!

Deborah A. Bronk

Professor, Department of Physical Sciences, Virginia Institute of Marine Science (VIMS), College of William & Mary, Gloucester Point, VA, USA; currently serving as Division Director, Division of Ocean Sciences, National Science Foundation (NSF), Arlington, VA, USA, bronk@vims.edu

When I wrote my initial profile for this wonderful volume 10 years ago, I was an associate professor at VIMS. My career has taken many unexpected twists and turns since then, but I am happy to say my love of oceanography and the community that practices it are still firmly intact!

My research continues to focus on nitrogen biogeochemistry, though that too has meandered. I still work on nitrogen uptake and regeneration in the ocean, though much of it now focuses on the poles—both Arctic and Antarctic—where many important questions beg to be answered. A seminar invitation drew me into the world of environmental engineering, and some of my favorite projects over the last decade have revolved around organic nitrogen in waste reclamation facilities. It opened up a whole new avenue of more applied research, much to the benefit of my science overall.

The biggest change in the last 10 years, however, has been a much greater involvement in community service. In 2008, I was elected President of the Association for the Sciences of Limnology and Oceanography (ASLO). This six-year commitment was basically a second full-time job with lots of travel. I absolutely loved it! During this time, I also served as Member-at-Large and then Treasurer for the Council of Scientific Society Presidents (CSSP), an amazing organization that opened up a whole other world to me. While looking forward to slowing down a bit as I transitioned from president to past-president in 2012, I was approached by NSF about doing a rotation there. I feel strongly about the need for people to step up to the plate when asked, so, though the timing was bad, I put my hat in the ring and became first a section head and then the division director for the Division of Ocean Sciences. Again, I have loved it! To be in a position to work with such great people and actually have the power to make things better for many has been thrilling.

What next for me? Happily, I will be returning to my lab and research full time at VIMS early next year. Though I will miss many things about NSF, it is time to go home and slow down a bit. I'm tired. In fact, the biggest challenge over the last decade has been finding time to take care of myself. Who needs a day off when you love what you do? Having a to-do list full of things that impact your scientific community makes taking time off even harder. Women do this all the time, however, and it's stupid. We are better able to take care of others if we take care of ourselves. That is my new mantra, and I am very much looking forward to next spring.

What advice would I give young women oceanographers? Enjoy the ride wherever it takes you, choose to love the people you work with, and laugh often.

The Nitrogen Snow Ninjas: the Bronk lab at Happy Camper survival training, McMurdo, Antarctica—Rachel Sipler (Research Scientist), Debbie Bronk, and Jenna Spackeen (PhD student). *Photo credit: Alisdair Turner*

Sandra Brosnahan

Physical Scientist, Woods Hole Science Center, US Geological Survey, Woods Hole, MA USA, sbrosnahan@usgs.gov

I've always been drawn to the ocean, so I feel fortunate to have a job near the sea. When I left home for college, I was broadly interested in studying environmental science. However, I was advised to choose a degree with a narrow focus for a better chance at employment and graduated with a bachelor's degree in geoscience from Hobart and William Smith. My experiences doing water chemistry fieldwork in Africa, Venezuela, and all through the Finger Lakes of New York led to my first job with the US Geological Survey (USGS) in Woods Hole, where I've been working as a research technician for 12 years. My work focuses on the physical and chemical processes that shape our coastal and open ocean ecosystems.

I'm part of a pool of people who assist USGS scientists in a wide variety of projects. Typically, I'm assigned to one project for several weeks—until a deployment or set of lab experiments is finished, then move onto something else, often entirely different. Projects include analyzing nutrient concentrations in groundwater samples from coastal estuaries, preparing instrument tripods to study sediment processes down the East Coast, measuring carbon fluxes in and out of a marsh ecosystem, and scuba diving to quantify sea otter impacts on shellfish populations in Glacier Bay, Alaska.

One of the most rewarding and challenging parts of my job is the constant need to learn new skills. In a given year, I may spend two weeks taking radon measurements in Panama, three months troubleshooting a nutrient analyzer, another week learning a new acoustic instrument, and the balance of my time preparing for and conducting field surveys and lab experiments for multiple scientists. Focusing on one project at a time is a luxury. I learn many of my skills "under pressure" as the project success depends on getting it right the first time. These skills range from learning different chemical analyses, to deploying new instrumentation, to building waterproof cases, to analyzing data with software such as MATLAB (among many others).

I sometimes feel insecure about whether my colleagues consider me capable because I'm a woman, and also because I don't have a graduate degree. I find I'm in the minority with regard to these two criteria. I strive to make myself indispensable to our projects, and to be an enjoyable co-worker. I look for gaps in our group's skill set or else take on some of the jobs that others are unwilling to do. More than anything, my job is to help our team succeed. Luckily, I have great mentors who have encouraged me throughout my time at the USGS. They help me identify the roles I can fill in our next projects and also get me the training and resources I need to meet those needs. My job is often challenging, but it's also very rewarding. I work with a wonderful group of people and I really look forward to going to work everyday!

Kristen Buck

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My research focuses on the biogeochemical cycling of the trace metals iron and copper, and, in particular, the role of metal-binding organic ligands in the cycling of these bioactive elements. I did not consider a career path in oceanography until I was applying to graduate school, though I have been enamored with the ocean since I was a child playing in the tide pools of the Pacific Northwest. I did my undergraduate studies in chemistry at Pacific Lutheran University (PLU), initially aiming for a pre-medicine focus. But courtesy of two formative National Science Foundation Research Experience for Undergraduates (NSF-REU) appointments in chemistry, first at PLU and then at the University of Bordeaux in France (I double majored in chemistry and French), I knew I wanted to pursue graduate research.

One of my professors at PLU, Jill Whitman, who has a PhD in oceanography from Scripps Institution of Oceanography, opened my eyes to the fields of marine chemistry and chemical oceanography, and I applied to several graduate programs, including to Ken Bruland's lab at the University of California, Santa Cruz (UCSC). At the time, I knew almost nothing about oceanography, but when Ken told me about his work with iron—the challenges of measuring an element that is abundant in Earth's crust (not to mention the hull of a ship!) but so low in the ocean as to limit primary productivity in vast regions, I knew this was the field of chemistry for me. After completing my PhD at UCSC in 2006, I did a two-year postdoctoral fellowship at Scripps Institution of Oceanography with Kathy Barbeau, an amazing scientist and mentor. I left Scripps for Bermuda, where I was a soft money research scientist at the Bermuda Institute of Ocean Sciences for five years before landing at the University of South Florida's College of Marine Science earlier this year.

I feel privileged to be an oceanographer. I love going to sea, and have had the opportunity to sail in tropical, subtropical, and polar oceans on more than 20 voyages to date—including a trip through Drake Passage in austral winter (!). I am familiar with the struggles earlier generations of women faced in oceanography and especially seagoing oceanography, and I am grateful for the ground they broke for the

rest of us, as I have not known gender discrimination relating to my ability to go to sea. I do, however, see the struggles women still face in balancing career and family today. The too-often lack of support for women scientists working and raising children is unacceptable, and I think we could learn a lot about how to better support them from our peers abroad, as well as from those women who have managed to find a tenable balance. As more and more women come through our graduate programs in oceanography, I remain hopeful that our culture and institutions will catch up to support them and ensure our continued success. I know that in my case, I have had incredible mentors, both male and female, who have shown me the many faces of success through their own experiences and generous mentorship.

Lisa Campbell

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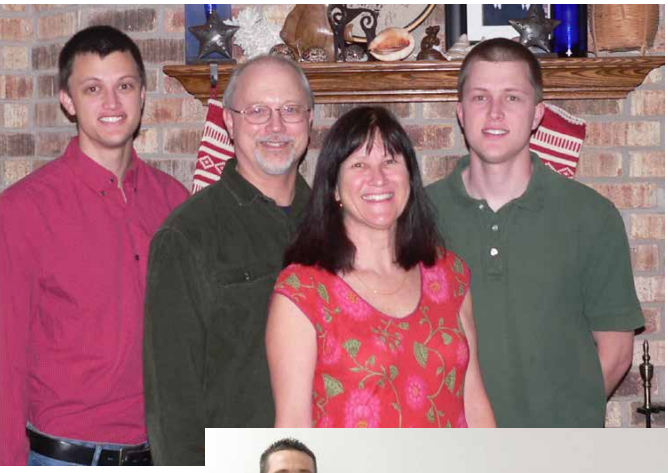
Ten years ago, I was an associate professor embarking on new directions in my research and still working to balance career and family. What has changed since then? My children grew up, graduated from university, and are now employed (I am so proud of them!). So now I do have more time to focus on research, but I also spend considerable time on service activities. In 2006, I was promoted to professor and later was fortunate to have a productive faculty development leave (aka sabbatical) that allowed me to work with a number of international colleagues. For the past seven years, I have employed the Imaging FlowCytobot to examine coastal plankton communities. My collaboration with the developers of this novel instrument, Robert Olson and Heidi Sosik at Woods Hole Oceanographic Institution, has led to a successful continuous phytoplankton time series at Port Aransas, Texas. With the unprecedented temporal resolution of these data, we are asking not-previously-possible questions regarding bloom dynamics and predator-prey interactions, and finding novel answers. My laboratory is also collaborating with my physical oceanography colleague Robert Hetland to develop a predictive model for bloom initiation and early warning of harmful algal blooms on the Texas coast.

In the past decade, I have also taken a more active role in mentoring to promote the success of women faculty. In 2002, I established the Women in Geosciences group for the female faculty in my college to promote active mentoring of new faculty and provide support in developing leadership skills. I also serve as a mentor through the TAMU Women's Faculty Network. As Secretary for the Association for the Sciences of Limnology and Oceanography (ASLO) and member of its board, I have contributed to substantial efforts in supporting students and early career scientists. Looking back, I can count more than 60 undergraduates, graduate students, and postdoctoral fellows who have worked in my laboratory, a majority of them women. I hope I have been a positive mentor, as I recall how important mentors were to me. I have enjoyed hearing from former undergraduates who have gone on to graduate school or successful careers. I am extremely proud of my graduate students who have done amazing work, won awards for their achievements, and gone on to develop their own careers.

The major challenge in my work continues to be funding for my laboratory, as federal research programs end, change focus, or become even more competitive. Advice to young oceanographers is to take advantage of all opportunities to expand your horizons and collaborate with colleagues from diverse fields.



(top) Lisa Campbell with her family, husband John Ivy and sons David and Ian (both employed in their chosen fields!), and (bottom) her current laboratory members, postdocs Darren Henrichs and Silvia Angles and graduate students Darcie Ryan and McKensie Daugherty.

Elizabeth A. Canuel

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My research focuses on using chemical tracers ("biomarkers") to study the sources of organic carbon in marine environments. When the "Women in Oceanography" special issue was published in 2005, I was an associate professor at the Virginia Institute of Marine Science (VIMS) with a growing research program focused on studying carbon cycling in estuaries and the coastal ocean. In the interim, I've been promoted to full professor, and while I have continued to conduct basic research on the carbon cycle, my work has broadened significantly. In recent years, I've co-led an interdisciplinary study investigating the combined use of algae for nutrient remediation and biofuel production. As a fellow in the Leopold Environmental Leadership program, I've learned how to communicate more effectively to diverse audiences, including policymakers and the media. I've also had the opportunity to take on leadership roles at VIMS and in the larger oceanographic community, thereby expanding my contacts and networks. One of my most rewarding activities has been to develop an undergraduate program in marine science at the College of William & Mary. Working with undergraduates has been energizing, and I've been inspired by the creativity and passion of today's students.

Work-life balance is important to me and, like many, I struggle with the competing demands of having a happy, healthy family life and a rewarding career. Although life is sometimes hectic, I've been fortunate to "share the ride" with my life partner and fellow scientist Emmett Duffy. Together, we have raised our son, Conor, now a senior in high school, who brings us tremendous joy and keeps us grounded. Being married to a fellow scientist has provided tangible benefits, such as family travel and developing friendships with colleagues across the globe, as well as intangibles such as the support we are able to give one another through our shared understanding of academic life. Like many of my colleagues, a challenge of late has been maintaining funding for my research program. Although I've been able to maintain an active and well-funded research program for 20+ years, I worry that there will come a time when I won't be able to fund a student, support my technician, find summer salary, and so on. While this is a source of some anxiety, it also inspires me to pursue new research directions and develop new collaborations, which has fed my curiosity and opened up new opportunities. Overall, staying positive helps me remain more resilient in the face of challenges.

Elizabeth Canuel (center), son Conor Duffy (left) and husband Emmett Duffy (right) with Rio de Janeiro in background.

My advice for young women oceanographers is to value their research, take time for creative work, and don't overcommit to service work. I also advise junior (and more senior) women oceanographers to take care of their female colleagues and find opportunities to enrich our community of women scientists. Reach out to a female colleague and start a new collaboration, co-chair a committee, co-advise a student, or co-teach a course. I've been fortunate to work at an institution where I have a great group of female friends and colleagues, and we've been tremendous sources of support for one another through triumphs and challenges. I wish the same for all women scientists!

Antonietta Capotondi

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My path to physical oceanography was not smooth and straightforward. After earning a degree in physics at the University of Pisa, Italy, where I studied quantum mechanics, I started working at an Italian engineering company that designed sea structures (i.e., platforms and pipelines) in different parts of the world ocean for oil exploitation. From the waves of quantum mechanics, I moved to studying ocean waves as well as any physical aspect of the ocean and overlying atmosphere that could impact the company's structures. I fell in love with the physics of the ocean, but I also faced the reality and the challenges of a woman physicist working in a male-dominated environment, within a company structure that did not leave space for personal curiosity and research. I was able to escape that environment by accepting a one-year IBM fellowship in upstate New York, where I tested the performance of a parallel computer running very high-resolution tidal models. During that year, I collaborated with scientists at Woods Hole Oceanographic Institution, and I met Paola Malanotte Rizzoli, with whom I immediately felt a strong connection. Following Paola's advice, based on her own experience within the Italian scientific community, I enrolled in the MIT/WHOI Joint Program, and began to pursue a career as a physical oceanographer.

Living very far away from the ocean in Boulder, Colorado, I use my physical oceanography background to study the role of the ocean in climate variability and change. A significant fraction of my time is spent examining climate models, assessing their performance against observations, and then using the model output to identify key processes underlying specific climate phenomena. A major focus of my research in the last few years has been the El Niño–Southern Oscillation, including its diversity, mechanism, and evolution in a warming climate. I have also been interested in physical processes than can affect ocean biology, such as mixed layer dynamics, and upper ocean stratification in the presence of global warming.

While I deeply enjoy the scientific research I'm pursuing, there have been many challenges along the way. Given my tendency to perfectionism, I have often faced insecurities about my ability to understand the real world. Also, the choice to have a family has often resulted in conflicts between family life and work commitments. However, I view these challenges as very healthy ones. Questioning oneself and one's results is fundamental for achieving sound conclusions and for continuing growing as a person and as a scientist. While having a family has certainly limited the time spent studying and working, it has made me a more complete and fulfilled human being, and helped me find a more grounded and focused approach to work.

Claudia Cenedese

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I have been interested in how water moves since childhood, riding my tricycle in my father's fluid dynamics laboratory at the University of Rome. Looking at "big" tanks full of water moving in strange and beautiful ways made me ask a lot of questions at the dinner table, and the questions did not stop during my undergraduate years in environmental engineering at the same university. I went on to the University of Cambridge (England) to earn my PhD in applied mathematics and theoretical physics. My heart was still in fluid dynamics and my PhD thesis focused on mesoscale vortices, my first link to oceanography. After spending a summer at the Woods Hole Oceanographic Institution (WHOI) Geophysical Fluid Dynamics Program (GFD), I became more interested in oceanography and found it fascinating to interact with scientists taking measurements in the ocean, a really big tank!

I moved to the WHOI as a postdoctoral fellow, fell in love with oceanography, Cape Cod, and the man that would become my husband. Sixteen years later, I am still here as a scientist in the Physical Oceanography Department. Talking to my colleagues down the hall who go to sea and observe the ocean (which I have also done a few times) inspires me. I focus my research on a variety of oceanographic flows, including mesoscale vortices, buoyancy driven coastal currents, mixing and entrainment in dense overflows, and dynamics of buoyant plumes generated by melting glaciers. I use both laboratory and theoretical models as tools. My passion for teaching and interacting with students led me to join the GFD faculty and to establish an exchange program to host Italian students at WHOI.

I would not be in the position I am without the help of several great mentors, and I try to pay it back by mentoring young researchers and giving Italian students the opportunity to study abroad that I had. It is important to have more women represented in oceanography and fluid dynamics research at all levels, from graduate students to senior faculty, and I actively seek opportunities to encourage women through collaborative and mentoring activities.

Balancing my career with my personal life has been challenging but extremely rewarding, and I could not have done it without a very hands-on and supportive husband. Going home to three lively children is quite a change in pace from the office, and it is good for my mind and my spirit. Since my early days as a scientist, I have believed that the number of hours a person works is not the only measure of dedication to her/his career. To be productive and have original ideas, I need to be well rested, to exercise, and to spend time with my family and friends. I feel extremely lucky for all of the opportunities I have been given and the great colleagues I have at WHOI and around the world.

Claudia Cenedese explains how a bathtub vortex forms to a group of first graders during the WHOI 2013 GFD (Geophysical Fluid Dynamics) Laboratory Open Week, an event she plans to run every other year (funding permitting). To share the excitement of oceanography, the GFD Laboratory hosted 10 hands-on demonstrations and displays, with something for all ages.

Ivona Cetinić

Research Associate, Ira C. Darling Marine Center, University of Maine, Walpole, ME, USA, icetinic@gmail.com

I was one of those kids who asked too many questions, did experiments on ants and fish, and caused small explosions in the kitchen. Things have not changed much: my research interests and questions are all over the place, and explosions still happen. One day I will wear the hat of an optical oceanographer and dive into the world of scattering and light. Some days, the most interesting question in the world is in the field of marine microbial ecology. Other days—I just want to study eddies. I assume this is what it means to be an "early career scientist" or a "scientific butterfly."

I majored in biology/ecology at the University of Zagreb, Croatia. After graduating, I started PhD studies in phytoplankton ecology at the same university, during which I jumped at the opportunity to participate in a big research cruise. There, I was introduced to optical oceanography. The flashing lights of backscattering sensors were enough for me to drop everything I started in Croatia and move to Los Angeles to work on a (new) PhD thesis at the University of Southern California. This is where I met Marty, my life partner. Upon completion of my PhD, we moved to Maine, where I currently work as a research scientist at the University of Maine.

I love being an oceanographer. I see the ocean as my playground, and gliders, sensors, and filters as my toys. My play buddies are some of the smartest people in the world. I wake up every day happy and looking forward to facing issues and solving problems that help us to better understand nature and ultimately to be better inhabitants of this planet.

However, there are challenges that I face every day, and while some of them are very general, some of them are specific to me being a scientist, an oceanographer, and a woman. The greatest among of them are associated with people that I love, and time I spend away from them. Every time I go away—on a trip, a cruise, or to a different continent to follow my search for knowledge—I ask myself "am I selfish for doing this?" Am I egocentric for pursuing my dreams while leaving them behind? This science that I do, all these dots and triangles that I plot in MATLAB, are they really that important?

I have yet to find the answers to these questions. Honestly, I am not sure will I ever find the answers. I just hope that by the end of my career I will be able to look back and say that all the challenges that I, and people that I love, have faced because of my choices, were worth it. This is even more so now, when two little eyes are staring at me every morning before I go to work. Two little eyes that are the color of Case I waters.

Ivona and her son, Veles, chillin' on a beach in Rhode Island, with R/V *Endeavor* in the background.

Silvia Chacón-Barrantes

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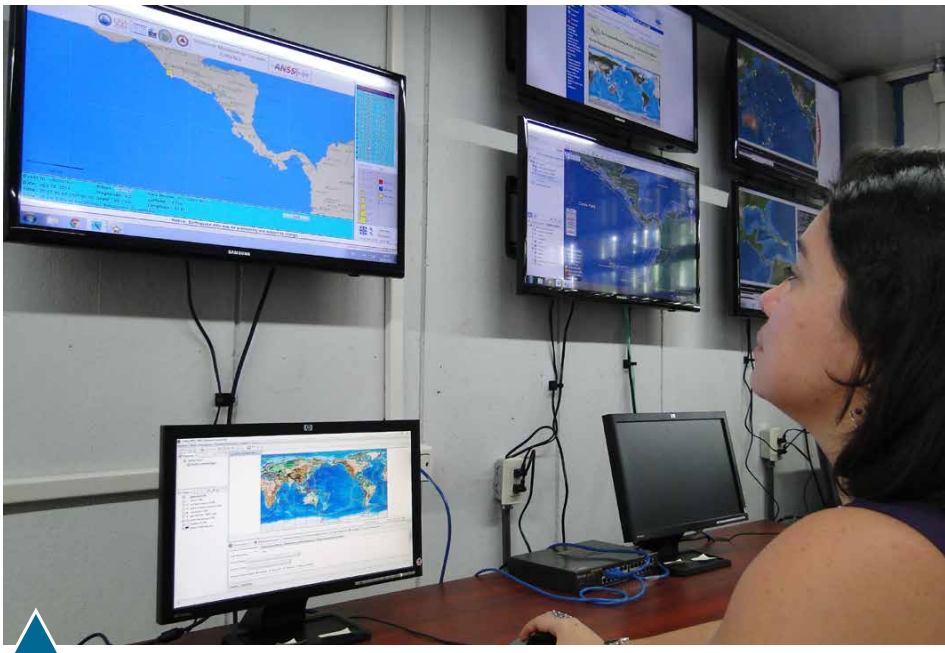

Silvia working in the SINAMOT monitoring room. "I'm very proud of it, as I worked really hard to make it possible," she says. *Photo credit: Gerardo Zamora*

I teach physics and coordinate a research program on sea level, while maintaining a specific interest in tsunamis: numerical modeling of propagation and runup, numerical modeling of morphodynamics, tsunami warnings, and prevention and mitigation measures. I don't think I chose this field of study—it was like falling in love. What I love even more about my job is being close to the ocean and being able to help people. Although my work is a desk job, every time I have to be near the sea, it is magical for me. And I love to know that what I do will be useful for the people, that I can make a difference for my country.

I have a bachelor's degree in physics from the University of Costa Rica and a master's in physical oceanography from CICESE (Mexico). In 2009, I started doctoral studies in coastal geosciences at the University of Kiel (Germany). The scholarship ended in 2013, but I'm still writing my thesis, and I hope to take the final exam in spring 2015. I came back to Costa Rica in May 2013 as a professor at the National University. On September 2013, I founded a network of Latin American and Caribbean tsunami scientists (RITLAC) to foster the exchange of scientific information related to tsunamis. The network has worked very well during tsunami warnings, and it is meant to be a platform for launching international research projects. Currently, RITLAC has members in all the Latin American countries along the Pacific basin as well as some on the Caribbean.

In April 2014, I founded the National Tsunami Monitoring System (SINAMOT), which works like a national tsunami warning center, but cannot issue warnings. In Costa Rica, by law, only the National Emergency Committee (CNE) is authorized to issue warnings and order evacuations. SINAMOT provides scientific advice to the CNE so the committee can decide whether is necessary to issue a tsunami warning. We work closely with the Pacific Tsunami Warning Center and the Caribbean Tsunami Warning Program. At this time, SINAMOT consists of four ocean scientists: two oceanographers and two ocean engineers. I'm the head of SINAMOT—and its only woman.

Being a pioneer in tsunami research in my country is a great challenge, but it also offers great opportunity. While it is not easy to find funding to do research, fortunately, tsunami research does not generally require big fancy equipment. I've managed to get a couple of second-hand computers, and now I'm searching for funds to buy new ones.

In my country, almost the only job opportunities for ocean scientists are at universities. Once you get a position, if you want to go higher and get more funding, you have to publish—and publishing when you are pregnant or have a baby is not simple. Fortunately, I have a wonderful stay-at-home husband who helps care for our seven-year-old boy. Sometimes I wish I could spend more time with my son—I hate to miss his kindergarten activities because of my work. I have postponed having another child for almost five years because I was overseas working on my PhD. Who knows now what the future will bring?

Teresa Chereskin

Research Oceanographer, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, tchereskin@ucsd.edu

When I submitted my profile 10 years ago, I didn't feel old enough to be looking back on my career; one change is that now I do! I am an observational physical oceanographer whose research interests have evolved over the course of my career from wind waves to the wind-driven circulation to the ocean's meridional overturning, and from the tropics to the Southern Ocean. I view the opportunity to reinvent oneself as one of the perks of being in a relatively young discipline. This is less true today, as oceanography has become a more mature science.

I majored in mathematics in college and discovered oceanography when I took a survey course my senior year to fulfill the last of my general science requirements. As part of the course, we viewed the documentary film *Waves Across the Pacific*, and I was fascinated by how Walter Munk and his fellow scientists could identify and track surface waves generated by Southern Hemisphere storms across the Pacific all the way to Alaska. After a gap year, I applied to graduate school in the MIT/WHOI Joint Program. My thesis topic was nonlinear surface and internal gravity waves. My surface wave results were based on laboratory and numerical experiments, but I took advantage of an opportunity to propose an internal wave study, making shipboard measurements on MIT's coastal vessel R/V *Edgerton*. Although quite short, that cruise turned out to be fairly representative of the highs and lows I have since experienced in more than 30 years of going to sea—it had its share of bad weather, instrument malfunction, and seasickness, eclipsed by the excitement of observing the predicted packets of internal waves propagating shoreward and the camaraderie of a group effort (in this case, fellow students and my advisor's engineer, who all volunteered their help).

July 2013, Gothenburg, Sweden

I have spent the majority of my career at Scripps Institution of Oceanography, working as an oceanographer in its research series since 1987 and as a senior lecturer since 1997. My research interests have remained observation based but have evolved toward observing phenomena of larger spatial and longer time scales. An overall goal is to identify, describe, and quantify the ocean's role in Earth's energy balance and its response to change. Ten years ago, I was just beginning to make observations in the Southern Ocean; today, my time series of Drake Passage current measurements is entering its sixteenth year, and the recently completed cDrake experiment that I co-led is providing a rich data set for examining the dynamics of the Antarctic Circumpolar Current.

The biggest challenge that I have faced is continued funding, especially for sustained observations, which have been difficult to maintain despite the community support for such measurements. When I was a graduate student, most oceanographers that I knew were on soft money, but now the paradigm has shifted. Today, when I advise students and postdocs, I tell them that the basis for a long and satisfying career is a permanent position.

Sanae Chiba

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Sanae rocks in an August blizzard at Klein Matterhorn during a holiday ski trip in 2014.

I am a biological oceanographer who studies marine ecosystem responses to climate and anthropogenic changes. Since beginning my career at a university in the United States, I have enjoyed fieldwork in a variety of places: chasing baleen whales in the Gulf of Maine, collecting plankton in the Arctic and Southern Oceans, joining biogeochemical research cruises in the sub-Arctic North Pacific, and many others. Throughout my career, I have been interested in the interactions among organisms and the mechanisms that induce spatio-temporal variations in ecosystems.

For me, the perquisites of being an ocean scientist range from numerous encounters with ocean life to breathtaking scenes during a research voyage—gigantic fin whales swimming beside our small fishing boat, blue icebergs turning from pink to purple during a white night. Since 2009, my research has mostly been analyzing long-term data sets of the North Pacific Continuous Plankton Recorder survey. Instead of going out to the ocean, I currently enjoy traveling around the world, expanding my network by meeting with excellent oceanographers from many countries. Because a global study of marine ecosystem change cannot be done by any single country, I have participated in several international projects over the years. The international network and friendships that I have built through these research collaborations are my greatest assets, not only for my professional career but also for my personal life.

My childhood experience probably influenced my choice to be a biological oceanographer. Having grown up in a coastal city, I naturally became fascinated by bugs and plants in the ocean and was never bored by observing these creatures for hours. At the same time, I was inspired by the arts, and even wished to be an artist when I was a child. But now, I clearly know why I am doing science. It is because natural science is more romantic than any other academic field. When I think about the connectivity of life, from prokaryotes to *Homo sapiens*, the fundamental rules governing the structures of living and even nonliving things from the tiniest to the largest scales, and "reincarnation" (recycling of materials) as a fact of the Earth system, my spirit soars. I believe the most important aptitudes shared by scientists and artists are the gifts of imagination and creativity.

For my next challenge, I plan to expand my career in a more interdisciplinary direction. I strongly believe that communication and networking are the keys to global change science. Today, the world ocean and its ecosystems are facing multiple environmental pressures, and global change is impacting several marine ecosystem services. The ocean sciences community is increasingly called upon to explain the societal benefits of our scientific outcomes, and I believe the role that facilitators can play in linking scientists and non-scientists—the public, policymakers, and the media—will be increasingly important. I have come to think that this intersection of science and other sectors might be my cup of tea.

In the 2005 special issue on "Women in Oceanography," I ended my essay by saying that "I hope more Japanese women join, agitate, and rock the community." I am happy to say that we have seen a great improvement over the past 10 years. Now, women comprise nearly half of my research team, and many mom-oceanographers are happily working at my institution and benefiting from childcare leave. Although only a few reach the higher positions today, I am quite optimistic about the future. Let's see how far we will go in the next 10 years!

Mireille Chinain

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I am a research scientist at the Institut Louis Malardé (ILM) of Tahiti (French Polynesia), where I serve as the head of the Laboratory of Toxic Micro-Algae. I received my doctoral degree from the Université des Sciences et Techniques du Languedoc of Montpellier (France). Since 1990, I have been working on ciguatera, a seafood-borne intoxication with significant social and economic consequences in endemic areas. I pioneered the in vitro culturing of the ciguatera-causing dinoflagellate *Gambierdiscus* at ILM and the use of highly toxic strains of this dinoflagellate for the mass-production of algal ciguatoxins so that we can study them in detail in the lab. My current research focuses on the ecotoxicology, taxonomy, and biogeographic diversity of *Gambierdiscus*, as well as the development of various methods for toxin detection. Over the last decade, my laboratory has also specialized in algal and toxin-based field monitoring programs throughout French Polynesian lagoons and the Pacific for ciguatera risk assessment and management purposes. Currently, my laboratory also manages the ciguatera epidemiological database of French Polynesia.

Working on ciguatera was not an option but rather an obvious choice for me, given the dramatically high incidence rates of this disease in my country and its strong public health impacts. However, getting to work and live in close contact with local populations, and learning about their traditional knowledge and practices, are among the most rewarding aspects of my work as an ocean scientist. This experience has contributed new insights into what might be the one of the most pressing research needs to be met in the coming years. Indeed, having confronted on several occasions the distress this disease causes in island communities, particularly in very remote places where ciguatera often seems inevitable, and faced with the gradual decline of the medical community's interest in this somewhat neglected disease, I feel that one of the greatest challenges in ciguatera research is promoting closer interactions among biologists, epidemiologists, physicians, and sociologists to implement more efficient control and prevention programs to reduce the risk of this disease. In this regard, studies aiming at an early diagnosis of ciguatera in patients, a better understanding of its chronic forms, and the promotion of traditional remedies for ciguatera treatment are a few of the promising research avenues currently under consideration by my laboratory (http://www.ciguatera-online.com).

A colorful and flowery farewell in the finest Polynesian tradition for Mireille Chinain and the scientific team at the airport of Raivavae, following a field campaign for ciguatera risk assessment in this remote island of the Australes archipelago (French Polynesia).

Also, as a mother of a young boy keen on outdoor activities, one of my main concerns is to make him aware of the exceptional beauty of the underwater scenery that is still accessible in many French Polynesian lagoons—and the importance of preserving this heritage.

Sallie (Penny) Chisholm

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When I wrote for this issue 10 years ago I was a full professor at MIT, teaching ecology and studying *Prochlorococcus*. That much is still the same. This tiny microbe has been an endless source of inspiration for my research. I feel extraordinarily lucky to be able to study it and to work with the fantastic people who have passed through my lab. When I wrote 10 years ago, my lab had just caught the wave of the genomics revolution in oceanography. I had no expertise in genomics and I was nervous about pursuing this direction because I was accustomed to being totally on top of everything we did. Convinced that this was the way to go, however, I let go of my fears and jumped in. The people in my lab who were well versed in genomics tutored me patiently until I learned enough to have a modicum of credibility. One genome led to two, and then two to 12, and now we have hundreds of genomes of different *Prochlorococcus* strains. Each one has a story. Each one tells us where to look for the next idea. It's no wonder I love this little creature!

One new development in my professional life in the past decade is my publishing a series of picture books for children with Molly Bang: The Sunlight Series[1]. Narrated by the Sun, the books are an outlet for my frustration that most people are completely ignorant of the process of photosynthesis and its role on Earth. What better place to start raising awareness than through children's books? There was a time when publishing children's books would put a damper on the career of a research scientist. Luckily those days are long gone. On the contrary, publishing these books has enriched my career in ways I never would have expected. More importantly, creating them has made me think deeply about life on Earth. Condensing everything you think is important into a thousand words is an amazing challenge. It focuses the mind like nothing else.

Ten years ago I wrote about the challenges of remaining authentic as a woman while participating in a profession designed by men. The challenge remains but significant progress has been made. There are more women in all ranks of oceanography now, and the more the numbers grow, the more the climate shifts. But the tenure clock still overlaps with women's decline in fertility and more young women than men feel they have to make choices between family and career as they move through the ranks. Until that changes we will not have parity.

The picture I chose to go with my profile 10 years ago was of me with my partner, Don Sisson, and our two Burmese cats, Jack and Gus. Since then, Don and I married and Jack moved on to cat heaven. But Gus (aka "Mr. Handsome") lives on. At the ripe old age of 19 he is still going strong, and he sits purring in my lap as I write this.

[1] The Sunlight Series. Scholastic, Blue Sky Press, www.thesunlightseries.com

Here I am in my office with one of the children's books in our "Sunlight Series[1]." This one is close to my heart. It gives phytoplankton their due credit for helping maintain the planet and feeding the seas. *Photo credit: Jim Long*

Gail Christeson

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I am a marine seismologist currently employed as a senior research scientist at the University of Texas Institute for Geophysics (UTIG). I grew up in Maryland, received my BS from Texas A&M University and my PhD from the MIT/WHOI Joint Program. My primary scientific and research interests are to use geophysical data (mostly seismic) to better understand processes related to plate tectonics. I have been fortunate to have the opportunity to participate in more than 10 research cruises as far north as the Gulf of Alaska and as far south as Bransfield Strait offshore the Antarctic Peninsula. I especially enjoy collaborative projects that allow me to work with experts in other fields towards a common goal.

My career path hasn't changed in the past 20 years, but I have tried to look for opportunities to diversify my research. I have always been impressed with scientific ocean drilling and recently sailed as a scientist on my first drilling expedition. It was a great opportunity to meet and interact with scientists from many different countries, and to get out of my comfort zone (a geophysicist surrounded by geochemists and petrologists for two months!). I encourage scientists at all career levels to participate in this program.

I receive tremendous support from my husband, John Goff, and my parents. John is also a marine geophysicist at UTIG, and we have two children, Megan and Cameron. Both John and I participate in research cruises and attend out-of-town meetings throughout the year. We have learned how to electronically share calendars to minimize conflicts. Fortunately, my parents moved nearby after our children were born and are willing to stay with their grandchildren when both of us need to be out of town. This allows us both to attend the annual fall AGU meetings, and let John carry out a rapid response survey following Hurricane Ike while I was at sea in the Gulf of Alaska. More recently, I conducted an entire meeting via Skype when John was doing fieldwork related to Superstorm Sandy and my mom was recovering from surgery.

My advice for young women oceanographers is to give a research career a chance. The battle for funding is stressful, but how many other jobs let you travel the world doing the job that you love? My second piece of advice is to pursue community service. Apply for committee positions, chair an AGU session, volunteer to be an associate editor. My third piece of advice is to attend several scientific meetings a year even if it is difficult to juggle family and work obligations. Getting your name out to the community will be a big benefit when promotion evaluations come around. My final piece of advice is to make time for personal activities—play soccer, go to movies, play golf, take the family trip to Europe. I often find that some of my best insights come when I am doing something totally non-work related.

Gail standing in a fleet of ocean bottom seismometers ready for deployment in the Gulf of Mexico.

Joan S. Cleveland

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Office of Naval Research Program Manager Joan Cleveland overseeing the Surf Zone Optics experiment at the US Army Corps of Engineers Field Research Facility in Duck, North Carolina. *Photo credit: Jeff Hanson*

I manage a basic and applied research program aimed at four-dimensional characterization of the coastal shallow water environment through in situ measurements, four-dimensional modeling, and remote sensing. We prioritize areas of investment based on Navy and Marine Corps needs for operations in nearshore, estuarine, and riverine environments.

Ever since I was young, I've enjoyed being in and around the water. When I was a child in Connecticut, my mom took us to the beach as often as possible. One afternoon, there was a sand bar a short distance from the beach. My brother and sister were tall enough to wade out to it, but my dad had to carry me. At three years old, I could not understand how the water could get deep and then shallow again. I started collecting shells at the age of eight, and in sixth grade, three other students and I filmed, edited, and narrated a film on tide pool life that reached the semifinals in a film contest.

In my junior high and high school science classes, I found it fascinating to learn how things worked, how chemicals combined, how ecosystems functioned. As a lover of the ocean and collector of shells, it was an easy decision to major in aquatic biology. At UC Santa Barbara, I had the opportunity to learn about seaweed, phytoplankton, fish, marine mammals, and physical and chemical oceanography. Plant physiology, and especially the process and biochemistry of photosynthesis, intrigued me, so I studied photosynthesis in phytoplankton during graduate school at the University of Washington, then moved into the study of underwater light.

Now, as a program manager at the Office of Naval Research (ONR), I enjoy helping the research community identify new research directions that advance our understanding of the coastal ocean, and I share the researchers' excitement at new discoveries. Fostering collaborations between researchers and institutions has proved to be a valuable approach to moving the field forward. I'm currently working on an interesting collaboration with researchers in Vietnam, investigating how tides, rainfall, channel characteristics, and vegetation affect sediment erosion and deposition and salt water intrusion near the mouth of the Mekong River. Results will inform planning for storm surges, rises in sea level, and changes in river flow.

Early in my career when I was a grant-supported research oceanographer at a university, balancing career and personal life was a struggle because of the pressing need to obtain salary support. That struggle eased significantly when I came to ONR because of the attitude of ONR management: family first (even if that family is composed of three border collies). My supervisors have always allowed flexibility and choice in selecting working hours and taking leave as needed—to take a dog to the veterinarian in the middle of the workday or take Friday off to drive to a competition. (Of course, I may also need to travel on Sunday to attend a Monday meeting.)

Over the years, I have seen wider acceptance of women in the field of oceanography, but it has not translated into higher percentages of women holding full professorships or upper management positions. A 2009 survey by Mentoring Physical Oceanography Women to Increase Retention shows approximately 10 women and more than 100 men hold full professorships in physical oceanography at 31 American institutions.* And at ONR, although we have more women in management overall across the agency now than when I arrived, there are fewer female program managers in my department. So there is still progress to be made in our field.

*Coles, V., L. Gerber, S. Legg, and S. Lozier. 2011. Mentoring groups: A nonexit strategy for women in physical oceanography. *Oceanography* 24(2):17–20, http://dx.doi.org/10.5670/oceanog.2011.43

Paula Coble

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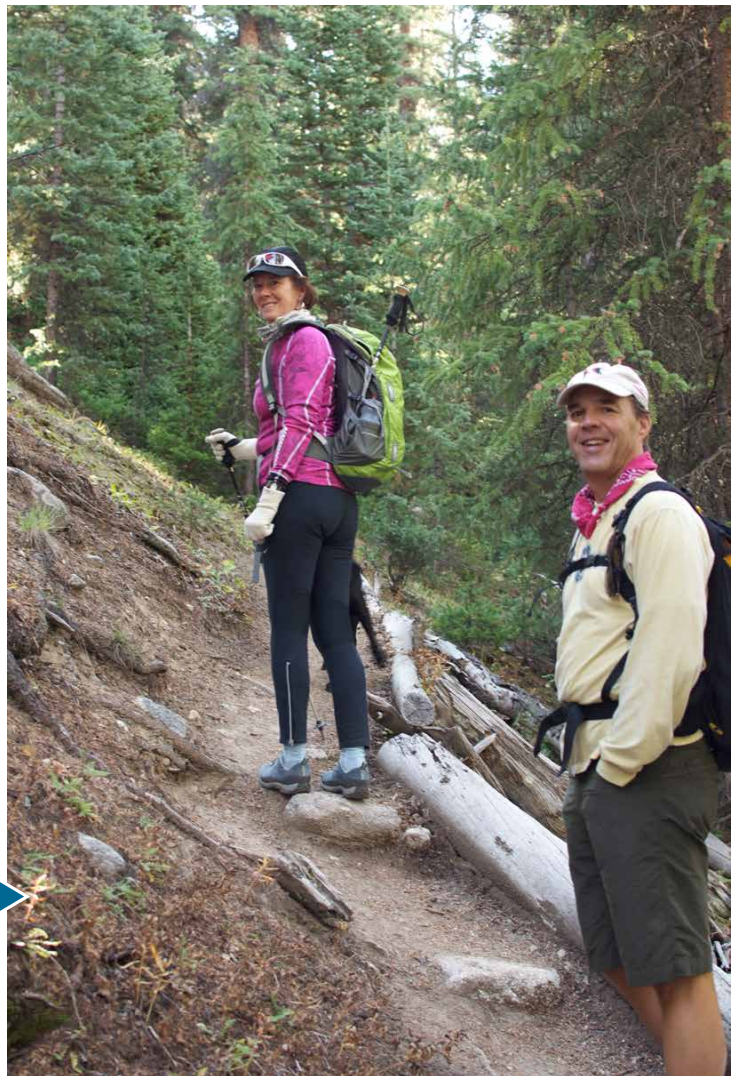
As I write this update to my career, I am in the process of transitioning into retirement. This move has led to significant introspection but likely no words of wisdom for the next generation. I can only share with you what has brought me satisfaction and a sense of accomplishment.

One of things I have most enjoyed has been working collaboratively with colleagues, either on interdisciplinary projects where we all had a lot to learn from each other or, more recently, on improving our discipline and communicating best practices to the larger community: brainstorming over data, working on collaborative papers, and experiencing a sense of family in the mixture of senior and junior scientists and graduate students. My experience is that it is more fun to work collaboratively than competitively, so find colleagues you both enjoy and can trust.

The second most rewarding aspect of my career has been my focus on community building and fostering the success of younger colleagues. I spent two years at NASA headquarters helping manage the Earth science education program. Though ocean science is only a small part of the agency's effort, getting to know the larger NASA community was truly an awe-inspiring experience—so many excellent research scientists excited about engaging students and the public in the wonders of science. It also gave me insight into the agency side of the grant proposal process, something I would recommend that everyone pursue. That experience translated into working to build a shared science community in order to bring together multiple disciplines to better understand archived data and to plan for future funding. It also led me to work toward organizing the first-ever science festival in my community. It has been a great joy to watch the festival grow in size and to see the success of adding a day when school groups can come and learn from our faculty and students. I encourage all scientists to get involved in science education in their communities. People are so appreciative of your efforts—you truly can feel like a science superhero!

Although I am very proud of my science education programs, especially one known as Project Oceanography, these efforts are seldom given the credit they are due, making my bid to become a full professor one of the more unhappy experiences of my career. Although I succeeded in the end, it was largely due to a wonderful Dean (also female) really fighting for me. We are encouraged to engage in science education by the funding agencies, but the value system in place for promotion and tenure has not adapted. Maybe in the next decade…

I am surprised that at this stage I have a profound sense of fulfillment. Living in a community of mostly retirees (it is Florida, after all), I find that I am not alone in this. We are all learning to play like kids again, and life is a lot of fun! Enjoy every minute of yours.



Paula Coble hiking in Colorado with her husband and favorite hiking partner.

Robyn N. Conmy

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Growing up in Staten Island, New York, the sea has always been a part of my life. My earliest memories are of boats, fishing, and playing with horseshoe crabs outside my aunt and uncle's fish market. My love of science began early with a fourth grade holography project. I was captivated by the mechanics of light—the balance of science, art, and what seemed to be magic. If this is what it felt like to be a scientist, then I was in! At 16, I felt the calling to pursue oceanography as a career when I became scuba certified and took my first dive near Coney Island with my dad (best dive buddy I've ever had). Seeing all of the biota, watching small particles drifting in the current, feeling the thermocline, observing how the light changed with depth—I was hooked. There had to be a way to do this for a living!

Robyn Conmy conducting oil and dispersant tests at the Ohmsett National Oil Spill Response Research & Renewable Energy Test Facility in Leonardo, NJ, in 2014.

I earned my bachelor's degree in marine science at Coastal Carolina University, where small class sizes afforded budding scientists tremendous amounts of hands on experience. My first research cruise was aboard R/V *Ferrel* in the mid-Atlantic Ocean. I felt at home at sea, and still do to this day. What was born out of blood, sweat, and tears during an organic chemistry course (never worked so hard for a B) was a quest to know more about carbon in the ocean, which I pursued at the University of South Florida, College of Marine Science.

Upon completing my master's degree, I worked as a lab technician and on science education projects before starting a doctoral program. It was important to me to fund my own research at this stage and submitted proposals. While at sea in the Indian Ocean, news came that I was awarded a NASA Earth Systems Science and US Geological Survey Cooperative fellowship to conduct research in optics and organic chemistry in the ocean, rivers, and groundwater. All together, I spent more than 35 weeks at sea. Serving as a principle investigator taught me a great deal about independence and leadership. I was also fortunate to have an advisor who was an excellent mentor and a strong female role model. Her endless support was critical, encouraging me to grow as a scientist, yet helping me maintain balance as the mother of young girls and wife of a fellow oceanographer.

When I joined the US Environmental Protection Agency (US EPA) in 2009 to conduct applied water quality research, I could have never predicted the sharp turn in my career in the wake of the Deepwater Horizon oil spill. My background and expertise were well suited for oil detection, which landed me aboard response vessels and at the spill Unified Command. Thereafter, I joined the US EPA Oil Research Program, where I currently serve as the program lead. It is a perfect blend of research and policymaking for me. One day I am in the field, the next in the lab, the next in Washington, DC, for regulatory purposes. The interdisciplinary nature of oceanography was great preparation for my current job. It is rewarding to conduct research that helps set policy for environmental protection. My biggest hope is that the pride I feel for this work is contagious, and that I can instill its importance in my three daughters. They attend the Children's School of Science in Woods Hole, MA, each summer and love science, too!

Sarah Cooley

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I'll never forget the moment I figured out I should be an oceanographer. In college, I wasn't sure what to do with the chemistry degree I was earning, but I felt my formal education wouldn't be complete after that. Problem was, I didn't want to specialize and close doors on different topics. I rolled these thoughts around as I sat on the beach one summer day, enviously watching a sailboat tack back and forth. All of a sudden, it hit me: there is a lot of interesting chemistry in the ocean, and to study it, I'd have to spend a lot more time on boats!

Becoming an oceanographer turned out to be a great fit. After two National Science Foundation Research Experiences for Undergraduates summer internships, I was sure that carbon biogeochemistry was for me. To solve puzzles about the carbon cycle, I'd have know a lot about chemistry, physics, biology, and geology. I began by studying the ocean's uptake of carbon dioxide, which led to thinking about the ways ocean acidification affects human communities by changing ecosystem services. Most recently, I've become interested in how people can plan ahead for these changes using new policies and ingenuity that take full advantage of scientific findings.

Watching the waves roll in with my son Miles during my first Mothers' Day, in 2012.

My biggest challenge has been to find my professional niche. In addition to carbon biogeochemistry, I've always been interested in communicating effectively about science so that people use it to make better decisions. Previously, I've worked as a researcher, science writer, and technical editor—jobs focused mostly on generating and communicating science. My current position now also focuses on bringing science into policy to improve decision making. Not having formal marine policy training, this new role has involved a leap into the unknown.

Through all this professional searching, I've been lucky to have a partner who understands exactly where I'm coming from. I met my husband on my first research cruise in graduate school, and since then we've seen each other off to countless research trips and meetings. We talk about science at the breakfast table, and now our three-year-old son does too! Clear and open communication helps us keep our work and personal lives balanced, as well as thinking carefully about how we want the "big picture" of our family's life to look.

Since I started graduate school, more women have advanced into senior positions, and there are more examples of women who have followed unique paths through science. As someone who has never been sure that the "traditional" academic path was the best fit for me, it helps to see the variety of ways these women ahead of me have made an impact on oceanography.

By now I can see there's a good fit for everyone's talents and interests, but it might take more searching for some to find their perfect fit than others. It's important to have confidence in the process, and enjoy that as well rather than being impatient that things aren't settled yet. It's in our nature as scientists to keep questioning and looking ahead to the next scientific challenge, so why should I be so impatient that my career journey is not fully resolved?

Marie-Helene Cormier

Marine Research Scientist, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, USA, milenecormier@gmail.com

My research interest is with the geological processes that shape the ocean floor. The seafloor carries a particular appeal to me because it uniquely exposes the effects of plate tectonics—and because it remains one of the last frontiers for exploration. As a marine geophysicist, I enjoy mapping new territory and developing methodologies to investigate volcanic, seismic, sedimentological, and hydrological processes. Oceanography is a multidisciplinary science, and I also enjoy collaborating with colleagues of different backgrounds and different countries, opening up new scientific insights from our combined expertise.

My graduate studies and early research activities focused on studying the mid-ocean ridge. Using shipboard data, my colleagues and I documented the changing geometries of mid-ocean ridges and investigated their possible causes. We also examined recent volcanic eruptions at their axes using an autonomous underwater vehicle and produced the first microbathymetric maps that highlighted eruptive vents, lava flow boundaries, fissures, and minor faults. In other projects, we assessed the timing of eruptions along the ridges by measuring the magnetic paleointensity recorded in basaltic samples.

Since then, I have expanded my research to other types of plate boundaries, including continental transform faults that extend into the sea along continental margins, and also subduction trenches. There, we are assessing the seismic hazards posed by nearshore faults, an emerging field of research that appeals to me because of its societal relevance. To date, we have examined the North Anatolian Fault beneath the Marmara Sea and the Enriquillo-Plantain Garden Fault offshore Haiti, and we are now studying the Japan Trench. I am also venturing away from plate boundaries to investigate gas and fluid seeps. Seeps, under some form or another, have now been detected across every continental margin. Understanding their potential significance in terms of climate change, ecosystems, natural hazards, and economical resources is a new, exciting field of research.

Marie-Helene Cormier standing on ancient oceanic crust now exposed high in the French Alps and holding a chunk of it—after having spent years investigating the seafloor with ships and deep-submergence vehicles.

My passion for marine geophysics has sustained my efforts to "make it" in the field, even though my career path has meant relocating between institutions and across continents. I completed my engineering studies in applied geophysics in France, moved to the United States for a master's degree at the University of Rhode Island, worked as a research geophysicist with Royal Dutch/Shell in the Netherlands, moved back to the United States for a PhD at the University of California, Santa Barbara, worked as a postdoc and as a research scientist at the Lamont-Doherty Earth Observatory in New York, moved to the University of Missouri for a stint at a tenure-track teaching position, and am presently a research scientist at the University of Rhode Island—supported solely through research grants. Relocating for professional opportunities was exciting at first, but has become quite stressful.

As it is for all my female colleagues, juggling personal and professional life along with the requirements of a scientific career (including meetings, workshops, and long cruises) is a challenge, and the fiercely competitive nature of US research funding is an added stressor. A passion for science is a must for pursuing a career in research, and I now find myself advising some students that rewarding career paths in oceanography are also accessible with a master's degree.

Meghan F. Cronin

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I lead the Ocean Climate Stations project at NOAA Pacific Marine Environmental Laboratory. Ocean Climate Stations are surface moorings that carry suites of sensors to monitor air-sea exchanges of heat, moisture, momentum; upper ocean temperature, salinity, and currents; and ocean bottom temperature and salinity. Co-principal investigators also add other sensors to monitor carbon dioxide uptake, ocean acidification, and aspects of the carbon cycle. With these data, I study how the atmosphere affects and is affected by the ocean. I am also fascinated by the dynamics of fronts and currents—my thesis (in 1993) was on eddy-mean flow interaction in the Gulf Stream. Most of the literature for my thesis was based on the Jet Stream, thus beginning my interest in "weather" (both in the atmosphere and ocean), climate, and air-sea interaction.

Going back further, as a college student, I considered physics to be a language, but how should it be used? I talked to everyone I met who had a science degree. What do you do? Where do you work? Do you like it? When I heard about physical oceanography from a family acquaintance, something clicked. That was what I wanted to do. She suggested I call her professor at the University of Rhode Island to see if he had a summer job available. I followed up, and this eventually led to a fabulous summer involving a research cruise and a window to another world. That summer was a turning point for me. I knew what I wanted to do. There have been few times in my life when I have had such clarity of purpose.

I have never regretted it. There are many things about this career that I really enjoy: it is very satisfying to figure things out, to make the connections, and see how to express our natural world in terms of mathematical equations. I work for those "Ah hah!" moments. I also work very closely with colleagues in Japan, Canada, South Africa, and other parts of the world, and we now have many very close friends scattered around the globe. While being a scientist has meant being somewhat of a nomad and living plane rides away from family, the world feels smaller and more accessible.

My husband has always been highly supportive of my career. When our daughter was young, we realized that it would not be possible to do everything we wanted to do with both of us working full time, particularly as our work travel increased. Brian opted to leave his "day job" and embrace the "homemaker" role (volunteering at our daughter's school, soccer dad carpool), which also gave him more opportunity to pursue his musical interests. While we didn't know any stay-at-home dads at the time, we have since met a growing number. Being now the sole breadwinner in our family, I am very grateful for having a hard-money position at NOAA. Overall, I feel very fortunate to be able to work on important scientific problems that will help us better understand weather, climate, and our changing world.

Kendra L. Daly

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My research interests focus on the ecology and physiology of planktonic organisms. Research themes include understanding the impacts of climate variability and human activities on marine food webs and biogeochemical cycles. I also am interested in the development of new technologies and instruments needed to advance understanding of marine systems. In the last 10 years, I have worked with multidisciplinary groups to investigate such diverse topics as the impact of oxygen minimum zones on the marine food web in the eastern tropical North Pacific, how the Deepwater Horizon oil spill affected plankton, the role of marine snow in the sedimentation of oil to the seafloor, and how McMurdo fast ice influences the distribution of predators and prey in the Ross Sea. Challenges include completing 22 cruises in the Gulf of Mexico since the oil spill in 2010, spending 40 days at sea in the North Pacific this summer, and looking forward to five weeks in the Antarctic this December and January.

Kendra Daly cooking dinner for participants in a survival training course, McMurdo ice shelf, Antarctica, November 2012.

Two of the most rewarding aspects of being an ocean scientist are the diversity of ocean environments that we can work in and the enduring friendships that develop while working with colleagues at sea. Another advantage for me has been the flexibility to follow an alternative career path beyond academia. I spent four years as a program director for biological oceanography in the Division of Ocean Sciences at the National Science Foundation (NSF). Then, several years ago, I went back to Washington, DC, to be the interim director of the Ocean Observatory Initiative (OOI), which is funded by NSF. Both experiences were rewarding and allowed me to work for the ocean community, not just within it.

My association with OOI for more than 15 years has been a unique experience. It has been interesting to participate in the planning and construction of this remarkable large ocean facility with hundreds of other ocean scientists, engineers, and technology experts. Scientists worked with engineers to develop novel technologies, such as profiling moorings, that the community requested during planning workshops. At this time, most of the platforms and instruments have been deployed and are sending data ashore. It has been a privilege to participate in this process.

Conditions have improved for women in ocean sciences. The closest I came to having a mentor was Dora Henry, the "barnacle lady," as John Steinbeck called her. Even though I was not working with her, she took an interest in me and urged me to publish. Because she believed in me, I did. I also was in the first group of women (two to three of us) allowed on three Coast Guard icebreakers, but only after some rigorous negotiations. Today, young women often make up more than 50% of the science parties. While discrimination is not as openly prevalent in the workplace today, it is still present, evidenced by the disparity in gender salaries being noted around the country in all disciplines. Most of my graduate students have been women who have all gone on to interesting careers. I look forward to working with new students, both male and female, and hope that they find their careers in ocean science as rewarding as I have.

Kate Darling

Honorary Professor, University of St Andrews, and Honorary Fellow, University of Edinburgh, UK,
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My last 10 years as an oceanographer have proved immensely challenging, yet deeply satisfying. I take pride in the fact that I have managed to achieve the majority of the goals I set for myself when I initially undertook the challenge of carrying out a phylogeographical project on a global scale. I had naively set myself the daunting task of sampling the global ocean to determine the extent of genetic diversity in the planktonic foraminifera used in past climate reconstructions. Because the field was still in its infancy, this work generated several significant publications, resulting in an extension to my Natural Environment Research Council (NERC) Advanced Research Fellowship in 2006.

This fellowship provided the luxury of working full time on my extended research project, which focused on the cryptic genotypes of foraminiferal morphospecies within the low latitude upwelling regions. Having spent most of my past research in high latitude waters, this project took me to the tropical and subtropical water masses of the Indian Ocean. I initially had mixed feelings about this challenge because my first cruise in the tropics in 2003 had been blighted by extreme seasickness. Going to sea during the summer monsoon is not to be recommended, and it was a lesson learned the hard way. However, the challenge changed to pirate-dodging off the Oman and Tanzania margins. I was particularly fortunate to complete my sampling program in these oceanographically complex regions before the risk of entering these waters was considered too high. The luxury of full-time research was not to last, however, as I came down to Earth with a thump when I became a tenured senior lecturer within the Grant Institute of Earth Science at the University of Edinburgh in 2009.

It is at this later stage of my career that the problems of taking a 12-year career break to raise two children have really become evident. I found myself reaching retirement age at the peak of my scientific output and decided to "pseudo-retire" at the end of 2013 to provide the time to work on the enormous amount of unpublished data and papers still to write. I am just as busy now with research as I was when fully employed, but I am doing it all for love again, as I did as a volunteer many years ago. In contrast, however, the pace of my work is now being set by others. As a principal investigator, I have research fellows and PhD students all relying on me to produce and work on manuscripts. In addition, this is the age of open access, and data have to be logged and compiled for release into the public domain. There will be no managed retirement for me it seems, but does it concern me? Of course not, because it is part of what I have become. I have had the privilege of traveling to the most inaccessible regions on Earth, and I have met and worked with quite remarkable people. What more could I want, though I can only recommend my career path if you are as crazy as I am! The rest of me is reserved for being an eccentric granny to my lovely grandchildren.

Sailing off the Western Isles of Scotland. No plankton net in sight!

Xujing Jia Davis

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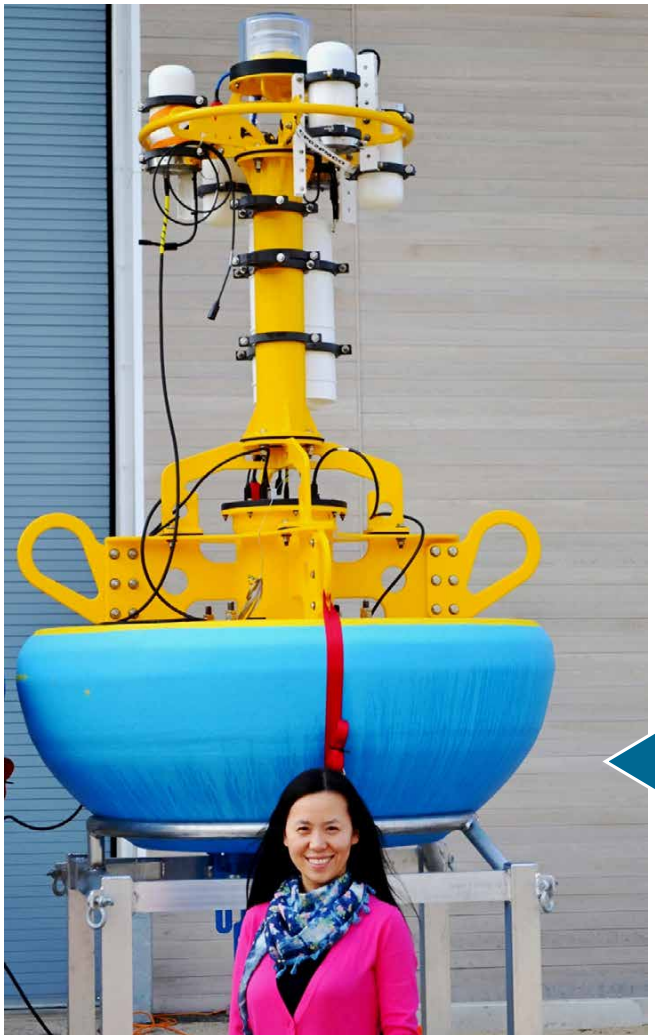
I had never seen an ocean at all until I started my college studies at Ocean University of China (OUC), the only university in China offering an undergraduate degree in physical oceanography at the time. My major was marine meteorology, although I attended lectures with students majoring in physical oceanography more than half of the time. There are so many similar principles for both the atmosphere and ocean, and their interactions with each other have a direct impact on our daily lives and on long-term climate variability. Initially, as a senior undergraduate and also as a graduate student at OUC, I studied air-sea interactions in the South China Sea. For my first research project, I was fortunate to be able to use observations from the South China Sea Monsoon Experiment (SCSMEX) and a one-dimensional turbulent kinetic energy model to study mixed layer dynamics during monsoon onset. Since then, air-sea interaction has been a central theme in my research, both in the coastal region of the Gulf of Mexico and in open-ocean regions of the North Pacific and the North Atlantic.

Upon completion of my studies in China, I followed my air-sea interests with further graduate work in oceanography at Florida State University (FSU). My work focused on the oceanic response to atmospheric forcing in the Gulf of Mexico—and I also met my husband. Together, we moved to New England where I finished my doctoral work at the University of Rhode Island, earning my PhD degree in 2008. I started work at Woods Hole Oceanographic Institution (WHOI) as a postdoc in 2009, then as a research associate beginning in 2013. For both my PhD and postdoctoral work, I have focused mainly on the role of air-sea interactions in western boundary current (WBC) regions and the important links that exist among mode water formation, WBC variability, biological productivity, and climate-scale processes. I have approached my scientific questions through analysis of in situ and satellite observations, GCM simulations, and idealized model experiments.

There have been many challenges along my career path, including the one my husband and I are facing right now: advancing two careers in Earth science in a financially challenging research environment and also balancing career and family. I have been fortunate, though, to have so many amazing mentors/colleagues along the way (including those at WHOI right now) who have offered invaluable advice and enormous support. My family in China, my husband, and my daughter are my biggest supporters, as always. I am grateful that I have a profession that I am passionate about, so many great scientists to work along with, and a family that I love more than anything. I am proud to be one of the female oceanographers in our society.



Xujing Jia Davis in front of a surface mooring at WHOI. One important part of her postdoctoral research is based on surface-mooring measurements in the Gulf Stream region.

Marie de Angelis

Professor, Department of Science, State University of New York (SUNY) Maritime College, Bronx, NY, USA, mdeangelis@sunymaritime.edu

Ten years ago, I moved from Humboldt State University, where I was teaching oceanography and doing research on methane hydrates and environmental controls on aquatic methane oxidation, to SUNY Maritime College to join the faculty of a marine environmental science program. I made the move based not on a professional motive but a personal one—I wished to spend more time with my mother, who was then in her late eighties. Maritime College is primarily an undergraduate teaching institution and one at which I discovered it was extremely difficult to do research, although I did continue to work on methane hydrates with colleagues at Oregon State University for several years. As it became too difficult to maintain an active research program, I concentrated on teaching, both expanding my range of courses and improving the quality of my teaching—with good results: in 2010, I received a SUNY Chancellor's Award for Excellence in Teaching. I also became active in curriculum development and currently serve as the Marine Environmental Sciences Curriculum Supervisor at Maritime College.

Besides working at becoming a better teacher, I compensated for the loss of serious research by becoming involved in K–12 science education, especially in middle schools, including a three-year collaboration with a New York City inner-city school environmental class. I visited the school to give lectures to the students, who then visited Maritime College and performed oceanographic experiments designed to strengthen concepts included in the New York City science standard for middle schools. I also conducted STEM teacher workshops during the summer in which I introduced science teachers from New York City public schools to oceanography and presented exercises in density that they could bring back to their classrooms. I currently serve as chair of the New York Marine Sciences Consortium, which seeks to provide policymakers with reliable and current scientific information on coastal ocean issues in the New York area.

In 2009, I was diagnosed with ALS (Lou Gehrig's disease), which effectively eliminated my ability to go to sea and presented me with a series of challenges to remain independent as long as possible. The resourcefulness and skills I learned as a seagoing oceanographer helped me address these challenges and adapt to my changing physical abilities. Oceanographer friends from abroad and from the West Coast came to New York and helped make my house handicap-friendly. I adapted my lecture and lab teaching methods to teach and supervise from a scooter. I continue to enjoy teaching students about the environment and the ocean.

My advice to young women oceanographers is to be flexible and grab interesting opportunities that come your way even if they do not coincide with your career plans. Take something positive from every professional experience—you don't know what skills will come in handy down the road. Don't forget to feed your personal life as well as your professional life. Remember that life is good—live it to the fullest while you are able.

Although my sampling is now restricted to the extreme nearshore, I still enjoy teaching oceanography and environmental science, being near the water, and living in New York City. With the aid of my trusty scooter, I continue to get around and enjoy life.

Agatha de Boer

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I happened upon the academic world quite by chance. After completing a bachelor's degree in physics and mathematics, I worked as a nuclear safety scientist at a large electricity utility company in South Africa. It was while rather aimlessly browsing the Internet that an online advertisement to do a PhD in physical oceanography at Florida State University caught my eye. The promise of personal and professional adventure appealed to me at the time, and off I went.

The unifying research interest across my career has been the control and variability of the global scale overturning circulation. From it, I branched out to study the role of the ocean in the carbon cycle, the circulation in the Arctic and Southern Oceans, the role of continental distribution in climate, and other areas. I primarily use theory and models to address the questions I am curious about.

The biggest academic challenges I've faced were a couple of times when I've had to struggle for a year or more to get a model to function and produce realistic simulations. At the early stages of my career, the years that went by without results felt like persistent downward trends toward ultimate failure. Only with the passage of enough time did I understand that it was just variability. During the period when I didn't have enough accomplishments under my belt to put the down times in proper perspective, I benefited greatly from council provided by supportive supervisors and more experienced colleagues. I'm deeply grateful for that and try to pass the favor on to more junior colleagues.

I've also encountered more subtle career obstacles throughout my career, but it was only over the course of time that I recognized them. One example is bias. As a younger person, I had blind faith in a fair and objective scientific system. Now, I realize that no pure objective measures exist nor do objective scientists. Biases are deeply ingrained in all of us, whether it is against a gender, seniority level, institutional background, sexual orientation, personality, race, or something else. Prejudices can be reduced by being aware that we have them, but concrete steps, for example, double-blind reviewing, will go a much longer way toward leveling the playing field. The importance of networking also became apparent later in my career as did the realization that it can be more challenging for minorities.

I am now at the fortunate stage where I quite often walk to the office in the morning and reflect on how much I enjoy my work and how lucky I am to have found my dream job. I have the freedom to pursue my research interests, great colleagues and collaborators, and a very supportive working environment. The 20 years leading up to my current employment were quite challenging at times, but they have also constituted a fulfilling and enriching period of my life, and I have, for the most part, enjoyed every step along the way. I would say that to succeed in our field certainly requires talent and an inquiring mind but also a thick skin, a supportive network, and, as in all aspects of life, a good deal of luck.

Christina L. De La Rocha

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Exploring life beyond oceanography, aka, making like a cow pie and hitting the dusty trail.

I was never going to win a Nobel Prize (there being none in oceanography being the least of the reasons), but I wasn't bad either. I was a professor (no front qualifier) before the end of my mid-30s. I worked hard and I loved the science (the links and feedbacks between biogeochemical cycles and climate over various time scales). After two and a half decades of research, writing, teaching, reading, discussing, and pondering, I had a formidable and continually deepening understanding of the ocean, climate, and Earth.

But somehow the main point of being a scientist—expanding the perimeters of human knowledge by designing experiments/expeditions/techniques, making exquisite measurements, grappling with results, and communicating findings—had fallen out the bottom of the list of things for which I was hounded. Workdays were a trudge through petty politics and email, forms, deliverables, and other tick boxes. Facilities were decrepit and oversubscribed. For these and other reasons, no one in the department was producing work anywhere near the caliber they could (and should) have been. I'd given all my life and time to science but wasn't accomplishing anything I felt proud of.

You can't carry on when your faith is gone, but I tried, slogging for six years past the point where dying in my sleep sounded better than getting up and going to work. When my other half finally landed a long-lasting position, I quit. Yay! I was free, and we could finally both live in the same country. I didn't even try to negotiate something for one of us or the other at one place or the other.

Several months on, I am shocked at how awful it feels to be a housewife in the eyes of the world. It is also so…*weird*…not to have independent means. And I let down the team. I was the only "lady professor" in my department and one of not so many here in Europe. Somehow, I *must* make throwing away the career I pursued for more than half my life a step forward, not curling up and raising a small white flag.

At least in middle age, you do wake up panicked about the little time left for trying all the other interesting things. Writing tops my list. I'd hate to look back from the end without having given it a go. So here it is: my spouse gets to support me while I take aim at my big breakthrough. Will I succeed? Probably not, but right now I'm agog with mastering this challenge—one, where my scientific knowledge, thinking, experience, and ideas are not flotsam but resources to draw upon.

As with many who've left, my disillusionment wasn't with science but with academia and the meaningfulness of my own contribution. Do I have advice? Be a pragmatist, work where people appreciate you and you can get stuff done, and somehow never waver in your conviction. When you no longer believe in what you are doing, that's when the burnout begins.

Laura de Steur

Physical Oceanographer, Norwegian Polar Institute, Tromsø, Norway, and the Netherlands Institute for Sea Research, Texel, The Netherlands, laura.desteur@npolar.no

Cold regions—that is what I like and where I do my research most of the time. Why? I don't really know. Mere fascination? Perhaps it has to do with the fact that as a child I went to the Fridtjof Nansen elementary school, or that I went to visit the Fram Museum in Oslo with my parents, sister, and brother when I was six?

I earned my PhD from Utrecht University where I studied the decay and mixing of Agulhas Rings with the numerical model MICOM. After my studies in the Netherlands, I spent 18 months at New York University and the University of Washington where I combined numerical modeling with field observations from around Maud Seamount in the Weddell Sea. During that period, I spent two months on an icebreaker in the Antarctic in winter. It was great experience, and ever since, I've been fascinated by ice-covered regions. I enjoyed staying in the United States, and that period has been very important for the rest of my career. However, I wanted to be closer to "home," so I accepted a postdoc position in Norway, where I did research on the East Greenland Current in Fram Strait and on Arctic freshwater, followed by a tenure-track position at the Netherlands Institute for Sea Research. Here, I was involved in several large programs measuring different elements that contribute to large-scale ocean circulation in the subpolar North Atlantic. I mostly work with data obtained from moorings, and preparing for and carrying out fieldwork is a substantial part of my job. Just recently, I moved back to Norway, together with my Norwegian fella, and am back working more in the polar regions again. Finally settled down?

I feel very fortunate to be in a position where I am involved in new observational programs designed to unravel the complexity of ocean circulation, and I conduct research in the polar regions, where climate change is hitting hard. It is a challenge to develop new programs and obtain new funding, while at the same time there is still a great deal of data to be processed from ongoing projects. There are many more women in oceanography than 10 to 15 years ago. Although I have never experienced any inequities myself, I believe things are more balanced now.

It has been difficult to move so many times for my job, but I realize I should no longer ask myself whether I feel at home here or there, but rather create a home where I can be with my partner and where we can do our research and enjoy life. One of the great things about my job is that I get to travel to special places not so easily accessible to others. Friends and family sometimes remind me of that privilege—especially when I tell them I feel frustrated that I do not have enough time to be with them.

Making breakfast in the parking lot before a day of climbing with my partner Geir in Red Rocks, NV, USA.

Petra S. Dekens

Associate Professor, Department of Earth & Climate Sciences, San Francisco State University, San Francisco, CA, USA, dekens@sfsu.edu

When I was nine years old, my family moved from Belgium, where the North Sea is cold and scary, to Southern California, where the waters are warm, calm, and inviting. My father bought a sailboat and, despite my tendency for seasickness, I was hooked.

A first generation college student, I earned a BS in marine biology at the University of California, Santa Cruz (UCSC), where intertidal ecology fieldwork prompted my interest in climate change. I then completed a master's degree in environmental science and management at the University of California, Santa Barbara. While there, I attended a course taught by David Lea, whose enthusiasm for carbonate chemistry was contagious. When I learned there is an entire field devoted to reconstructing past climate using geochemical tools, it was my "ah-hah" moment. What I enjoy most about paleoceanography is that it brings together biology, chemistry, physics, and geology to answer questions about our planet's climate.

My husband and kids are my number one supporters! Barry, Tila, and Liliana made signs and cheered me on during a half-marathon run in northern California wine country last August. I started running quite recently and it has been a great stress management strategy.

David Lea mentored my MS work in marine science, teaching me the importance of excellent analytical techniques and to critically evaluate data. My PhD advisor at UCSC, Christina Ravelo, taught me to think deeply about the climate system, how to ask important questions, and how to write. Perhaps most importantly, she taught me that it's possible to be an oceanographer, an academic, *and* a mother, and not just survive, but thrive.

I am interested in understanding early Pliocene warmth because of the insight it can provide about important climate feedbacks in a warmer world. My work focuses on reconstructing sea surface temperature to answer questions about ocean-atmosphere interactions and how they helped to sustain Pliocene warmth. The fact that we can estimate sea surface temperatures from millions of years ago using geochemical tools preserved in tiny fossils still amazes me.

I am fortunate to have found a partner in life who values my career as much as his own. We are raising two strong-willed girls (three and nine years old) who benefit from having parents committed to them, to each other, and to their careers. For the elder girl, having a scientist mom who shows up with microscopes and fossils at parties, in a lab coat to judge the science fair, and who will soon have a live chat with her class while at sea, earns her a surprising amount of street cred.

But having an academic career and a family is challenging! Gender bias still exists. Society's (and my extended family's) expectation is that I will be the primary caregiver to our children, and our efforts to split household responsibilities 50/50 (which we do quite effectively) are met with high praise for my husband and questioning eyebrow raises for me.

Support from my mentors, my spouse, and my friends has been critical. I am part of a group of four women who hold "retreats" semi-annually to share our strategies both professionally and personally. This group has been so essential that I am not sure I could have achieved tenure and maintained my sanity without them. My most important piece of advice to women (and men) just beginning their professional journey is to build a support system.

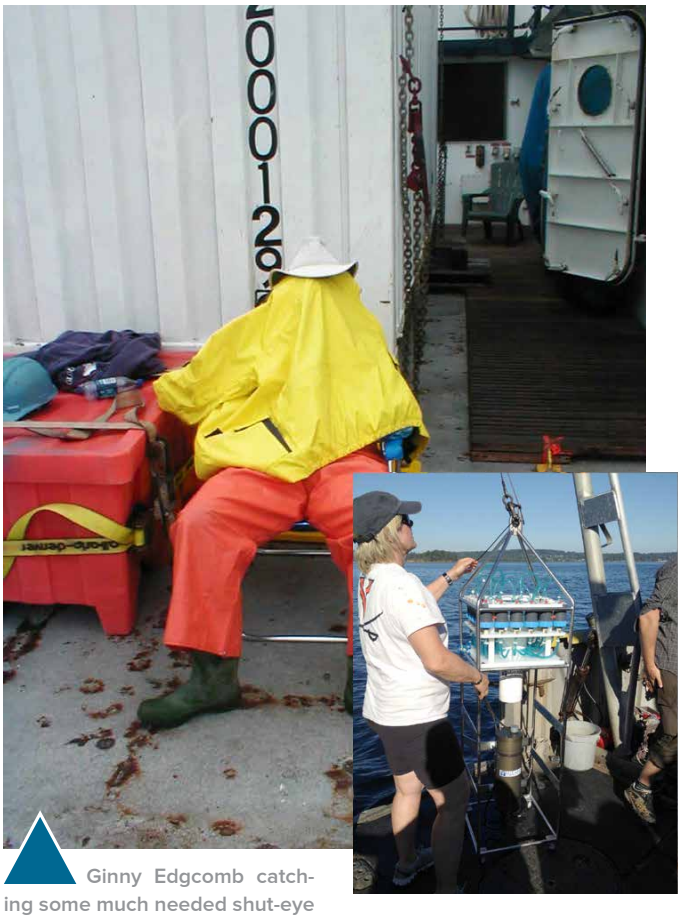
Virginia P. Edgcomb

Associate Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, vedgcomb@whoi.edu

My research program focuses on understanding the microbiology of marine chemocline sediments and water columns, with special emphasis on studies of microbial eukaryote populations (protists and fungi), using comparative and functional genomics and culture- and microscopy-based approaches. I emphasize the study of oxygen-depleted to anoxic/sulfidic water columns and sediments, including oxygen minimum zones, because these are areas of intensive biogeochemical cycling—and the extent of oxygen depletion in water columns appears to be expanding in response to global climate change. My work aims to better describe the diversity and impact of microbial eukaryotes in these habitats through (1) studies of eukaryotic grazing on key bacterial and archaeal communities along redoxclines, (2) studies of symbioses between protists and bacteria and/or archaea, and "omics" (metagenomics and metatranscriptomics), and (3) examination of in situ activities. Data derived from these investigations are used to better inform our understanding (and eventually our models) of carbon and other major nutrient cycling in these environments.

I am also actively engaged in helping to advance the technologies that oceanographers use to study microorganisms and their activities in order to obtain more accurate data on in situ processes and their rates. I ended up in my field of study because of the influences of two great mentors during my postdoctoral years, Mitch Sogin and Andreas Teske, who made possible my first research cruises and, thus, captivated my interest in oceanography, particularly in marine microbial diversity, ecology, and evolution.

The most rewarding aspect of being an ocean scientist is the feeling that I am studying something incredibly important to the future of our planet and the human race. It is very exciting when field data yield new discoveries or new insights into ocean processes. The time spent at sea is both exhausting and exhilarating. Working with a great scientific team is the most wonderful experience, though dealing with a problematic team member, little sleep, and/or the stresses of sampling operations can be challenging.



Ginny Edgcomb catching some much needed shut-eye between sampling stations on R/V *Gordon Sproul* (Santa Barbara Basin, CA). Inset: Sampling with University of British Columbia colleagues in Saanich Inlet, Vancouver, BC, on R/V *Strickland*.

My biggest career challenges, however, have come from an unexpected direction. They are associated with obtaining funding under the current climate in Washington, DC. I have had to learn how to find smaller amounts of funding from a wider variety of sources outside of the National Science Foundation to try to fill gaps. These challenges often lead to long hours at home spent writing proposals. Luckily, I am married to someone who is patient. Young oceanographers who have research interests and skills that can be attractive to private industries may benefit from pursuing some of those opportunities to apply their skills while we wait for funding for basic research on ocean ecosystem health and climate change impacts to become a national priority.

Henrietta N. Edmonds

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Ten years ago, when I submitted a similar profile to *Oceanography*, I was a chemical oceanographer at the University of Texas (UT) at Austin's Marine Science Institute, awaiting both a tenure decision and the birth of my first child. The following year was a particularly eventful one. Professionally, I was awarded both tenure and an honorary fellowship through the university, and my first PhD student successfully defended his thesis and found gainful employment. Personally, I welcomed my son Nick, and my life changed in ways I could barely have imagined.

Today, I am a program director at the National Science Foundation (NSF) and a mother of two. Why the big move, professionally? Part of it was just a matter of timing. I was interested in some sort of change—when I came to NSF, I had been at UT for 10 years, and in oceanography for nearly 20—and this opportunity appeared. Part of the specific appeal was an opportunity to "give back" and to serve a broader community. A mentor and good friend of mine wrote in the 2005 "Women in Oceanography" issue that "life is just a series of opportunities taken and opportunities lost." One string of opportunities led me to oceanography in 1990; another brought me here.

What's different? I don't teach classes, I don't give talks, I don't work in a lab, and I don't go to sea. I do use my oceanographic education every day. I write a lot. I read as many papers as I can, but it's fewer than I'd like. I still go to meetings. I do miss being at the front of those rooms, but I take satisfaction in seeing work that we fund come to fruition, especially when the findings are unexpected. I constantly learn new things. I still enjoy opportunities to mentor early career scientists. In place of formal lectures, I try to teach Nick and his sister Eugénie about the natural world and about approaching life with an open and inquisitive mind.

I used to roll my eyes when my father would say, "I still don't know what I want to be when I grow up." I thought he wasn't focused enough, but now I see the wisdom in his words. I have been incredibly fortunate to have the experiences and the career that I have had to date, but I hope not to let past choices and experiences limit what might come next, and I don't presume to know what opportunities may yet present themselves.

Hedy Edmonds and her daughter, Eugénie, in 2012.

Katherine B. Emery

Project Scientist, Marine Science Institute, University of California, Santa Barbara, and Adjunct Faculty, Department of Biological Sciences, Santa Barbara City College, Santa Barbara, CA, USA, katherine.emery@lifesci.ucsb.edu

I began PhD studies in marine science at the University of California, Santa Barbara (UCSB), in 2006 after completing my master's in marine science, studying marine hydrocarbon seeps. I wanted to continue with scientific research, but also wanted to work with people and their immediate needs (e.g., livelihood and food). My first research projects investigated the ecology, economics, and oceanography of sustainable management of a spiny lobster fishery. I also pursued international research opportunities, working with fishermen at local and Mexican docks to collect genetic samples, and investigating Atlantic bluefin tuna sustainability issues in the Mediterranean on a Fulbright. Based on this work, the first chapter of my thesis highlighted the need for increased education, environmental science literacy, and responsible decision making about social and ecological issues, such as fishery management. As a consequence of lessons learned in fisheries research about communicating with fishermen, scientists, and others—and becoming a mother—I refocused my dissertation on environmental literacy, science education, and decision making about water and marine issues.

Katherine Emery, husband Brian Emery, son Cormick, and daughter Eliza enjoying Katherine's PhD graduation.

Since completing the PhD in 2013, I have been working as a project scientist at UCSB and teaching biology labs at Santa Barbara City College (SBCC). Some rewarding aspects of being a female scientist and teacher are taking my research directly into the classroom, being an enthusiastic role model for young scientists, mentoring students, and sharing lessons I continue to learn to succeed academically and professionally.

I faced two challenges in graduate school. The first was deciding whether to start a family. I had two children as a doctoral student. They require attention and energy, and they also motivated me to focus my time, to meet deadlines, and to graduate. The second challenge was choosing to change the initial direction of my PhD from fisheries management to science education. I was fortunate to find positive mentors who provided invaluable support as I juggled being a mom and scientist and pursued my intellectual interests.

Ten years ago I wrote that "being in such a dynamic field as marine science, there are many qualified graduate students vying for limited grants and advisors, but that being a determined and open-minded person uncovers many opportunities…[and] that being organized, curious, and fun-seeking is critical to becoming a good ocean scientist." I now add, you need to be persistent, independent, proactive, and more persistent.

Support and encouragement from thoughtful mentors are also critical. I had several outstanding female science mentors who were priceless and fun advocates, and who provided encouragement and the know-how to dive into this new career adventure (Genny Anderson, Danielle Harlow, and Ali Whitmer). I am also grateful to real and pseudo PhD committee members at UCSB (Steve Gaines, Milton Love, Jon Snyder, and Libe Washburn) and to my husband and children for their help. I am excited about future opportunities to teach, write, and attain highly competitive jobs in marine and science education fields.

Gemma Ercilla

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Many interesting changes have taken place in both my professional life and my personal life since this magazine's 2005 special issue on women in oceanography. My wide-ranging interests in marine geology, from shallow to deep-sea environments, has led me to investigate new topics and driven me to combine my marine geology objectives with other oceanographic disciplines such as physics and biology. This interdisciplinarity has allowed me to explore new perspectives and to better understand the sedimentary outbuilding of continental margins. Some of my previous ideas have changed as I have become aware of how little we still know about our ocean and seas. I am looking for evidence of the action of along-slope bottom currents in shaping the seafloor; I am also intrigued by their interaction with downslope sedimentary instability processes, tectonics, and local morphology, as well as the roles they play in the variability of the stratigraphic architecture of continental margins. This new focus allows me to make interesting observations on paleoceanography as well as to identify potential geological hazards.

Other career challenges have stemmed from seeking stronger relationships with national and international scientific institutions, colleagues, and businesses in order to promote multidisciplinary research. Over the last 10 years, I have also enjoyed teaching oceanographic master's courses at the Spanish Universities of Cádiz and Vigo. Being in contact with young people is very rewarding. My participation in outreach has also been very fulfilling, bringing scientific results to the general public, writing comics, giving talks in my village school and library, and taking part in social rehabilitation programs.

One of the least exciting things I have done during the last 10 years is dedicate more time to administrative tasks. Even so, I have to admit that this experience has given me the opportunity to explore new funding sources, convey some of my ideas to legislators, and appreciate the work of administrators.

My many trips around the world, cruises in different seas, and new scientific projects over this decade lead me to say that the presence of women has changed in a positive way. In

Photographing operational procedures onboard.

Spain, many of the graduate students applying for jobs in scientific institutes are women, and I see more female faces on cruises. I have also realized that many of these women come from marine sciences faculties, although the numbers of both male and female geology students interested in marine geology have decreased. On the flip side, I have to admit that the Spanish economic crisis has been difficult. Its most dramatic aspect is the human factor, because members of my group have had to leave not only the institute but also their country and their families. They have primarily been the youngest women with interesting talents and abilities. My advice to is to hold on just a little longer and keep enjoying the work, because I am sure these efforts will be rewarded.

Balancing my career and personal life, I feel fortunate because my 14-year-old daughter supports and understands my lifestyle, in spite of the fact that my job demands many hours of dedication, and trips involving days or weeks at a time away from home. We have had to learn to combine our activities, although to be honest, she has put in a lot more effort than I.

Carlota Escutia

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For the past 10 years, I have been a research scientist at the Instituto Andaluz de Ciencias de la Tierra in Granada, one of the institutes of the Spanish National Research Council. In addition, during 2009, I enjoyed a Blaustein Visiting Professorship from the School of Earth Sciences at Stanford University in California.

During the past decade, my research has focused on understanding how the Antarctic ice sheet has responded in the past to elevated temperatures and CO_2 concentrations in order to provide information for models of future ice sheet behavior. I count as my most important research activity drilling on the Antarctic Wilkes Land margin in 2010 during Expedition 318 of the Integrated Ocean Drilling Program (IODP). This expedition culminated many years of work and development based on a proposal that I first submitted as an early career postdoc in 1999. I had the privilege of being invited to be co-chief scientist, a responsibility I shared with my colleague Henk Brinkhuis. Marine geologists know that even when you prepare well, nature and technology can greatly affect the success of your endeavors, and this is especially true when working on the frozen continental margins of Antarctica. Although we faced challenges, we captured a 55 million year sediment record from which Expedition 318 scientists have already produced numerous papers in highly ranked journals. For me, it has been a great feeling of accomplishment and a valuable use of my research time.

In parallel with my scientific career, I continued to be involved in IODP, serving as a member of the Site Survey Panel (2004–2007) and as chair of ESSAC (European Consortium for Ocean Research Drilling Science Support and Advisory Committee; 2011–2013). In addition, I had the chance to propose and chair two SCAR (Scientific Committee for Antarctic Research) programs: the Antarctic Climate Evolution Program (2008–2012) and its successor Past Antarctic Ice Sheet Dynamics (2013–2020). These positions provided the opportunities to serve the ocean drilling and the Antarctic Earth science communities and to be involved in science management and science policy. These activities resulted in my presentations at the XXXVII Antarctic Treaty Consultative Meeting, the United Nations COP19, and the SCAR HorizonScan 2020.

Along with other female ocean scientists, I continue to face the challenge of juggling family (first with young children and later with elder parents) and work. I also faced the challenge of maintaining a balance between keeping up with my scientific activities and outputs and serving the scientific community. It would probably be far easier to focus on my scientific career, but for me it has always been important to serve the community as a way of paying back all the assistance I have received from other scientists throughout my career. I do not think there is a recipe for how to handle every challenge we experience, but prioritizing, persistence, hard work, and patience are important in confronting these challenges.

Marta Estrada

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During the last 10 years, I have remained in my position as research professor at the Institute of Marine Sciences (CSIC) of Barcelona. This period has brought some career highlights, but also some disappointments, not at a personal level, but because the ascending path that scientific activity seemed to be taking in Spain was once again interrupted by drastic budget cuts resulting from the recent economic crisis. In addition, although there have been attempts to improve the flexibility and efficacy of Spain's scientific enterprise, they have largely failed, mostly because of insufficient allocation of resources. Nowadays, while people in tenured positions have a reasonable expectation that they can keep working, it is very hard for young scientists to find employment. Fortunately, research is more and more a global enterprise, and there are opportunities for international mobility and collaborations.

On the scientific side, I have continued with my interest in physical-biological interactions, and, in collaboration with graduate students and other colleagues, I have expanded my field of work toward ecosystem modeling and the application of a systems approach to ecological problems. I was privileged to participate in two Arctic cruises and in one of the legs of the "Malaspina 2010 Expedition," an around-the-world oceanographic survey commemorating the expedition of Alessandro Malaspina and José Bustamante to America, Asia, and Oceania about 200 years ago. Looking back, I see enormous advances in science, particularly in oceanography, since I started my career, and I feel fortunate to have had an opportunity to contribute to it.

As I wrote in my 2005 sketch, I have never observed any direct discrimination against women in official situations such as committee selection. However, the finding that the proportion of women becomes lower up the ladder toward top positions indicates that discrimination must persist. Balancing scientific activity (or any other outside work, for that matter) and family needs (be it for the care of young children or of elder parents) continues to be a challenge that falls disproportionately on women. However, the situation is improving, and I would say that for an overwhelming majority of women scientists, a research career has been a worthwhile path that they would choose again if given the opportunity.

I am now nearing retirement (mandatory in Spain at 70), but so long as there is good health, one never really retires from creative activities such as research. I am looking forward to continued scientific collaboration with my younger colleagues (although, I hope, without the bureaucratic part). To any aspiring oceanographer, women or man, I would say "just go ahead." There will be difficulties but also rewards—and the satisfaction of contributing to the world's scientific knowledge.

In the wet laboratory of the Spanish research vessel *Hespérides* during Leg 3 (South Africa to Australia) of the globe-circling Malaspina 2010 Expedition.

Kelly Kenison Falkner

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Ten years ago in 2005, I was enjoying my role as full professor at Oregon State University (OSU). The College of Oceanic & Atmospheric Sciences (COAS) was an exciting and forward-looking place to be, but we realized in the early 2000s that we needed to address our aging demographic and refresh our mission; by 2005, we were benefiting from fresh perspectives of new younger faculty. It was a lesson to me just how important a demographic spread is to keep an institution vibrant. My children were six and 10. Our family was reasonably settled into the rhythms of mom at work and dad tending the home front, as I juggled research and teaching and took on more leadership roles in the science community. It certainly was not easy, but Corvallis proved to be a wonderful place to raise a young family.

I relished challenging fieldwork and creating new knowledge at the extreme north of our planet, and my experiences there naturally led me toward serving the larger polar research community. The first major opportunity came when I held a temporary position at the National Science Foundation (NSF) as the founding program director for Antarctic Integrated System Science. I returned to OSU with an expanded perspective and enthusiasm to get back to my professorship and personal research. COAS continued to be forward thinking and I was happy to be entrained in a process that lead to merger with the Geosciences Department to form the College of Earth, Ocean and Atmospheric Sciences (CEOAS). Somewhat unexpectedly, the opportunity arose to return in a senior executive role to help lead the polar team at NSF. The choice put me into a real dilemma. In the end, I realized that my departure from CEOAS presented an opening for a new young faculty member, and my students were well positioned in their careers to carry on with our lines of inquiry. I was ready to tackle the bigger challenges in Washington on behalf of a cause that I believe in. So, the family packed up and headed back to Arlington, Virginia, in 2011, where I now serve as Director for Polar Programs at NSF. Our kids made new friends and benefited from an excellent school system as well as a diverse community.

I think the most important advice I could give to young female oceanographers is to carefully consider whether you are taking yourself out of the running for career advances.

Kelly Kenison Falkner on her way to view subglacier ice caves being studied on Svalbard in April 2010. *Photo taken by student-researcher Kiya Riverman*

The same commitment to family or other non-career factors that leads young women to decline the next career step often propels young men to take it. We need women leaders, and if it helps to reach out to a seasoned ear, don't hesitate to do so! It is my experience that if you are motivated enough to be reading this, you are likely to work hard at whatever you do. Why not do so up the ladder?

Kristina Faul

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Ten years ago, I was a new assistant professor at Mills College, hired to teach in the Environmental Sciences Program in the Chemistry and Physics Department. My research interests focused on using chemical techniques to determine nutrient (e.g., phosphorus) dynamics and biological productivity of the past ocean, with the goal of understanding how they might affect global biogeochemical cycles throughout Earth history. I continue to be interested in these questions. However, I soon realized that because of changes in my institution and my role, the types of research questions I tackled would also have to evolve.

I completed my undergraduate degree in Earth, atmospheric, and planetary sciences at the Massachusetts Institute of Technology, my graduate degree in Earth sciences at the University of California, Santa Cruz, and my postdoctoral work at Stanford University. Therefore, shifting from doing research at large research universities to doing research at a small liberal arts college for women was a big adjustment. I had to find projects that undergraduates would be interested in working on and were capable of doing, projects that were relatively inexpensive to implement and required less specialized and expensive instrumentation, and projects that could be accomplished within the time constraints of teaching five courses per year. Additionally, my role had changed, shifting from aspiring researcher to teacher and mentor for a new generation of women and other underrepresented groups in science.

Fortunately, a great project emerged through being introduced to a geochemist/hydrologist by a mutual friend. And my research has evolved to focus on understanding biogeochemical cycles in the "urban ecosystem" of San Francisco Bay watersheds. This project allows me to engage undergraduates in fieldwork and research that they feel has real-world implications for the environment around them. The other major role change in my life over the last 10 years has been becoming mom to two wonderful boys currently aged one and three! My children have made teaching and mentoring students all the more important to me because I hope I am modeling for my sons a life of service to others.

Kristina and her students pause in the field for a contemplative moment.

Because I'm the only oceanographer/geologist on campus, another major challenge I faced, and continue to face, is intellectual isolation. To combat this problem, I have sought out structures such as writing groups, collaborations, and a sabbatical project that allow me to interact intellectually with colleagues from other disciplines at Mills and other institutions nationally and internationally. In particular, I have a small group of other geoscience professor moms with whom I have been meeting for seven years for biannual retreats to discuss issues in research, teaching, service, and parenting. The group has truly been a lifeline for me. I'm happy to report that I was recently promoted to full professor at Mills. It's been an exciting journey thus far, and I look forward to being stretched in new ways during the next stage of my career!

Helena L. Filipsson

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As an undergraduate and graduate student at the University of Gothenburg, Sweden, I thought that all men and women were treated equally, and as long as I worked hard, nothing or no one would try to block me. My mantra was: it's all about being good at what you do and you will be recognized for the work you are doing. Now, 10 years after my PhD, I often hear young female students saying the exact same thing. I wish I could tell them that they are right. I wish that things had changed more, but they have not. Research shows over and over again that women and men are judged differently and are not given the same opportunities. The reasons are many and sometimes complex, but it can change if we want it to. Until then, this is the advice I give my female students:

1. Choose a subject that you are passionate about but that is also relevant—and fundable. Consider which fields are developing quickly versus shrinking. My interests lie in combining studies of past and current marine environments with proxy development. We use proxies when we can't measure an environmental variable directly, for instance, bottom water temperature 100,000 years ago, but we can measure Mg/Ca in bottom-dwelling foraminifera, a proxy for temperature.

2. If you marry, choose a supportive person. After finishing my PhD, I moved to the University of Bremen, Germany, for a two-year postdoc. It was tremendously important to my career—I can't stress the value of an international postdoc enough. My husband left his well-paid job in Sweden to come along—and was regarded almost as a saint for doing so.

3. Be flexible, seize opportunities. After Bremen, I moved back to Sweden to accept a four-year research grant from the Swedish Research Council. However, I also received a Fulbright Scholarship, so I decided to do both by going to Woods Hole Oceanographic Institution for a year. This time, my husband didn't come along; instead, we commuted.

4. Have a family if that's something you want. Thriving academically in the USA, I concluded that I wanted to build my own research group, and I also wanted kids. I knew I had to live in a country where it's financially possible and socially acceptable to have a long and shareable parental leave and have access to good, affordable day care/preschools. We were lucky. Scandinavian countries are famous for their gender equality, even though there is still much work to do. Today, I'm an associate professor, with my own research group.

5. Dual careers are tough, but worth it. We have two boys who learned to pull a suitcase from an early age and know that sometimes mom is away on a boat for quite a long time, but she always comes back. I'm convinced that even though dual careers can be difficult, they are absolutely necessary for a healthy relationship. Our work is so much more than a job: it is part of our identity and gives us independence.

Traditions and norms influence how we act, interact, and judge each other. The lion's share of the responsibility for kids and family life is still often regarded as the woman's. It is completely doable for female academics to combine work and family life, but it requires support, and we need to be aware that the rules we play by are different.

To increase the number of women in academia, more of us have to stay, and we have to find ways to enable other women to stay. We must actively support each other, change leadership, and choose to work with male colleagues who also see the need for change. Many highly qualified women are leaving science and academia; it is a waste of resources and potential. We can change the system if we want to.

Photo credit: Helena Bergqvist

Rana A. Fine

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It has been 10 years, yet I still enjoy being a professor of ocean sciences, discovering new things, working with colleagues from diverse disciplines and backgrounds, and viewing new information from the world ocean. Guiding the development of graduate students is even more rewarding. The main focus of my research involves using tracers to investigate physical processes, determining how these processes affect the capacity of the ocean to take up atmospheric constituents and how long it takes them to get into the interior, and observing changes in their ventilation time scales. I have been involved in several international global change programs over the years. Our contributions have included the analysis of transient tracers, chlorofluorocarbons, and, recently, sulfur hexafluoride. Tracers function like dyes, identifying pathways of newly ventilated waters. Their seawater concentrations relative to their atmospheric histories provide time scale information in the context of models. This research has contributed to estimates of the ages of oceanic layers, their transport pathways, and their renewal rates, as well as rates of biogeochemical processes.

Rana Fine fishing with friends in Florida Bay, her first pompano, March 2013.

In my biography for the *Oceanography* special issue a decade ago, I noted the challenges that I had as the only woman at a meeting or on a research vessel. When I took the opportunity to work as a rotator at the National Science Foundation in the early 1980s, I was one of only four women considered to be physical oceanographers at academic institutions in the United States. Today, the increase in numbers of women in the geosciences has made a difference; it makes me feel more comfortable in a professional environment. As the numbers of women have increased, we have developed some close friendships. About a decade ago, Mentoring Physical Oceanography Women to Increase Retention (MPOWIR) started as a formal commitment, with sponsorship from funding agencies. The MPOWIR meetings, workshops, and mentoring groups have meant a lot, giving women in physical oceanography a feeling of belonging to our community.

Needless to say, as older challenges fade, new ones always emerge. Over the years at my school, I have enjoyed huge support from the administration. About five years ago, the administration—and the way the school was run—changed. My personal challenge has been learning to work in the new environment that is perceived to be less friendly to women. However, focusing on the positive aspects of my career, like research, students, and community activities, has helped get me through these times. Over the past decade, I have been often asked to lead activities for the scientific community. For example, I was elected to the AGU Board of Directors, I have chaired the UCAR Board of Trustees and committees for AMS, and I have served as chair, vice-chair and participant in several National Research Council studies, experiences that have been enriching and rewarding. The challenges these activities have brought require balancing my scientific commitments, along with getting results published in a timely manner. My advice to women scientists at any career stage—and particularly in the early years—is to *publish*, and to *network* with scientists outside of your institution.

Jessica Fitzsimmons

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I am a biogeochemist focusing on the cycles of trace metals in the modern ocean. While I am interested in the "chemical personalities" of many metals, most of my research is focused on those used as nutrients by marine phytoplankton. Micronutrients are not only the metals with the largest impact on the global carbon cycle and climate, but they also have the most complex and elusive chemical speciation and reactivity of any metal—and it is this chemical complexity that keeps me coming back with new questions and ideas every day.

Growing up in Miami, Florida, with public school teachers for parents, science and mathematics were a large part of my life from a young age. I spent many weekends at local aquariums, on boats, or at the beach, so not surprisingly my childhood dream was to be a marine biologist. However, after my high school chemistry teacher showed me the powerful simplicity of the periodic table, I was hooked on chemistry for life. While I chose an undergraduate program in marine biology at Boston University, I remained focused on chemical applications, and during my junior year I participated in a chemical oceanography Research Experience for Undergraduates program at the Woods Hole Oceanographic Institution that sealed my fate as an oceanographer. Soon after, I pursued a PhD in the MIT/WHOI Joint Program in trace metal geochemistry, and I have been dedicated to an academic career in oceanography ever since.

I am fortunate that my oceanographic life has occurred during a time rich in female role models. Although I have received advice from countless female advisors, I am proud to admit that my most influential mentors have been males with a vested interest in enriching the careers of female scientists. Rick Murray and Ken Bruland both offered me fountains of advice from their own experiences balancing family life and professional development, and when I had concerns they couldn't address themselves, they would go out of their way to align me with female mentors fully prepared to answer my questions. It was the example and reassurance of these men that most encouraged me to pursue both an academic career and a family.

This past year, my husband, a sociologist, and I have been applying for academic positions. We have been positively overwhelmed by the numerous resources available to us to solve our "two-body problem." The Texas A&M (TAMU) Department of Oceanography, the institution where I will be starting my tenure-track faculty position next summer, was fully accommodating to both my career and that of my husband. That my professional success also depended on my husband's professional stability was not only transparent during my hiring process, but it was a priority during our negotiations. The family-friendly attitude shown at TAMU is a big step forward for academia, with effects that will hopefully trickle down through my students, my teaching, and my science.

The tides are changing. Women dominate my cohort of early career chemical oceanographers, and there are more and more women in leadership positions in oceanography each year. As for me: I look forward to being the example female oceanographer I hope to see more and more of during my own academic career.

Kathryn H. Ford

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I fell in love with the ocean in sixth grade at a New England Aquarium dolphin show, and my first dream was to be a dolphin trainer. A brief experience as a trainer convinced me to focus my energy on other marine passions, such as geology and ecology. My second dream was to live in a shack by the ocean. After graduating from the University of Rochester with a BS in geology and biology, which included a summer at the Isles of Shoals and a semester on the Great Barrier Reef, I headed to Forfar Field Station in the Bahamas. After enjoying several years of teaching marine ecology and scuba diving to a wide variety of students there, I chose to return to New England for graduate school to be close to family.

At the University of Rhode Island Graduate School of Oceanography, I studied coastal ecosystems. I was very interested in fieldwork, so on top of my thesis research I also spent a month on a Woods Hole Oceanographic Institution vessel in the Gulf of Mexico, participated in a two-month Ocean Drilling Program cruise in the Pacific (Leg 201), and spent a month collecting cores from a lake in Africa. As is more typical in other fields, I viewed a PhD as a stepping stone to a nonacademic job; both applied research and management or policy were interesting to me. I ended up seeking positions with fairly limited travel to ease the complications associated with having a partner who at the time traveled six months a year. A colleague encouraged me to apply for a technical position with a state fisheries agency, which has proven to be an excellent fit for me.

In some career studies, I am classified as having opted out of science or having dropped out of my career. However, this job has afforded me great challenges, very interesting research, and the opportunity to be influential in policy discussions. My primary research is mapping and classifying shallow seafloor habitats with acoustics and video (I spent last summer on a Jet Ski!). I also represent my agency on several committees. Being a state scientist has been extremely interesting and certainly very applied, especially as we grapple with offshore wind farms, offshore mining, and ocean planning. Success is judged differently than in the academic system and, in fact, publications are sometimes discouraged! So it has been important to me to take the time to consider my goals (not someone else's) and recognize when I have achieved them.

My two boys have added wonderful depth to life, which has helped me appreciate that my life and career will have many chapters. I have to be conscientious not to overreact when missing a big meeting due to a sick child or missing certain milestones the children are reaching due to a cruise. I try to give myself credit for the small wins—having a snack together after school, laughing while waiting for the bus, reading before bed—which clearly outnumber the losses associated with colliding work and family life.

With a 10-month-old at home and three months pregnant, I am headed out to a week at sea to map Georges Bank with a Focus-2 (at the stern) and HabCam (on the right). Neither child remembers this.

Eleanor Frajka-Williams

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Eleanor Frajka-Williams attaching styrofoam cups from her kids' classes on RRS *James Cook* in spring 2014. (The real work of the cruise was refurbishing the RAPID [Rapid Climate Change] moorings that monitor the meridional overturning circulation at 26°N in the Atlantic.)

Despite growing up in Southern California enjoying the beach, tide pools, and scuba diving, I never knew that "oceanography" existed as a science. And having three science-loving sisters and some great teachers (male and female), I also didn't realize that women in science were unusual. As an undergrad in math at Harvard, female peers were scarce, and I learned that the physics building had only recently added a women's bathroom. Around the same time, I started to look for ways to use math in the real world and spent a summer at Scripps Institution of Oceanography. Almost by accident, I found myself on a two-week research cruise—using math to address environmental problems, with the added thrill of fieldwork. I was hooked!

Fourteen years later, I still love it. My research now focuses on large-scale ocean circulation and its effect on and response to climate change. I make and use ocean observations and enjoy combining two or more data types (satellite, in situ hydrography, moorings, or autonomous platforms) to better understand ocean dynamics than would otherwise be possible.

It hasn't been all smooth sailing. At one particularly challenging period in my graduate degree, I had serious doubts about my future. My daughter was months old, and upon returning from unpaid maternity leave, I found my computer's hard drive had failed (back up your work!). I was four years into the PhD, with a new advisor (previous one had moved), my first paper rejected, and my general exam not yet undertaken. Exhausted, and not sure where I was headed, I participated in a training workshop at the University of Washington. There, I met Kate, a coach, who helped me rediscover what I enjoyed and was good at doing, and I knew I was still meant to be in this work.

There were still rough patches, as any parent of very young children can attest (breastfeeding, constant sleep deprivation, or a child home with chicken pox make my list). Now, I have two school-aged kids, a husband who also travels for work, and a work environment with occasionally conflicting priorities: teach, go to conferences, research, prepare lectures, write proposals. I still go to sea, thanks to my husband's ability to manage at home, and I help the kids feel involved by visiting their classes (giving a talk to three-year-olds is a new experience!), then taking their 80+ styrofoam cups to shrink. In creating solutions to the work-life dilemmas that continuously arise, I have relied on both practical and moral support from a variety of sources: my husband, an understanding boss, several incredible mentors in the department and in MPOWIR (Mentoring Physical Oceanographers to Increase Retention; see MPOWIR article in this issue), and now a critical mass of young female colleagues in Earth sciences at Southampton.

From looking at the last issue of *Oceanography* on women, it's clear that things are looking up. More institutions now recognize the value of investing in their staffs by enabling solutions to diverse work-life situations. I look forward to when these accommodations are as routine and natural as including a women's bathroom in a building.

Marga García

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My mother says that when I was about seven years old, we passed by a marine science institute close to Murcia. When I learned what it was, I said, very seriously, that I would work there one day. I don't really remember it, but it has become true. I am a marine geologist, focusing on the study of recent sedimentary processes in continental margins. During my career, I have investigated a wide range of topics in several geologic settings, including turbidite and contourite depositional systems in mid-latitude margins (Southwest Mediterranean, Gulf of Cádiz, Atlantic Iberian margin), glacial and subglacial sedimentary processes in high-latitude margins and basins (Antarctica, Greenland Basin), and the impact of the Messinian event in the Catalan margin. These projects provided opportunities to work at several research institutes and universities in six countries and to collaborate with numerous colleagues. I have learned a lot from them and I keep learning every day.

In my few years of research experience, I have been fortunate, and pleased, to work with many women whom I have always found to be both courageous and encouraging. The first paper I published was co-authored by four women. This experience made me feel very proud, as it is quite rare in the field of marine geology. Choosing research as a career can be an act of faith—when you realize that it is not just a job, but a way of life. Your personal life is sometimes the victim of your professional life, especially when you have to spend several years moving from one temporary position to the next. At the same time, you are meeting amazing people, having extraordinary experiences, and visiting places that very few people have reached. I would say that oceanographic cruises have been my most rewarding professional experiences, where researchers, technical staff, and crew coexist in a limited space in sometimes difficult conditions, with the only motivation of doing science. Antarctic cruises have been especially gratifying, as they represent the fulfillment of my dreamed-about scientific experience.

On board RV *Belgica* in 2013, during the COMIC (Comparative study of Plio-Pleistocene contourite drift evolution along the Moroccan and Iberian margins of the Gulf of Cadiz) cruise (Ghent University). Matching colors, when safety meets glamour.

Now I am facing the start of my career as an independent researcher, leading my own research projects. It is scary and exciting at the same time. The most challenging part is the increasing difficulty in getting funding for research because public investment is being dramatically cut in my country. Mobility has become an obligation, rather than an option, for many researchers who should be able to settle down and start their own research line. Besides, policies to help researchers (or any other workers) to balance their family and professional lives are not sufficiently supportive in many countries. In any case, I feel encouraged by the example of so many women in research who have managed, through huge effort, to succeed in both aspects of their lives. I have observed during recent years that women are progressively reaching more responsible positions in research, and although this process seems (too) slow, I am confident that we are going in the right direction.

Carmen García-Comas

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I am a plankton ecologist trying to understand community structure and its dynamics. Until now, I have specialized in plankton community size structure, analyzing field data to describe underlying mechanisms. But I hope to broaden my knowledge of different research areas and techniques as my career goes on. After all, my main motivation for conducting research is to gain knowledge and learn new skills so that I can apply them to unveiling the mechanisms that drive observed patterns.

I think I have been an ecologist since my early childhood when I would be mesmerized by ants marching around, street cats interacting, or a flock of migrating birds stopping at our beach on their way south. At that time, I didn't realize I was the only one around interested in those "weird" things.

Although I lived by the shore with a large beach and the sea has always been present in my life, I do not recall thinking about being an oceanographer. Perhaps that is because in Spain, at the time, only two universities offered a degree in marine sciences, and none in my region. Thus, I earned a degree in biology instead, which I did not enjoy much until I was able to choose ecology as specialization. Then, it rocked!

Exploring Taiwan (Green Island, 2012).

My journey to becoming a researcher involved a sequence of chance events, opportunities that I seized. It took me from Spain to England, France, and Italy. Between France and Italy, I did my PhD. Those years were the toughest and the most fun in equal parts! I learned a great deal about computer programming, oceanography, and piles of other stuff that was missing from my background. I also learned a lot in terms of culture and language. On top of it, I made very good friends with whom I still keep in touch long distance.

Now, I have been in East Asia for four years—Taiwan for the first three, and since then, Japan. My experience in Asia has been very enriching, too. In terms of science, I get inspired every day, learning complementary ways of doing and thinking from such different schools. Despite the mental and cultural difficulty of being so far from home, I am enjoying the experience to the utmost and trying to see it as an opportunity to broaden my mind.

Personal challenges in research mainly have to do with the precarious nomadic life we lead early in our careers, which makes it difficult to juggle personal relationships. These challenges are not gender specific. Women may have a bit more difficulty than men because of the shorter time we have to create a family and the rarer case in which a man follows a woman for her career. But I think we all face the same problems, and it is just a matter of society adapting. For example, it is easier for my female French friends to have children and pursue scientific careers than it is for my fewer Japanese female colleagues, who may still be less supported by their society and their government. It is clear that I love my job, but I would not give up my life for it. I hope in the near future I can settle and better balance life and work.

I encourage new generations to join if they feel it is right for them. Research is a great environment where you can collaborate with other curiosity-driven people in order to gain a better understanding of how the world works.

Marisol García-Reyes

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Oceanography was not my first career choice, but only because at the time, I didn't know it existed. I was a student at the National University of Mexico, thinking of becoming an astrophysicist, when I learned how fascinating, adventurous, and rewarding the life of an oceanographer could be. Oceanography seemed all that I was looking for, so I came to the United States to pursue a PhD at the University of California, Davis. Some years and many adventures later, I'm now a scientist at the Farallon Institute for Advanced Ecosystem Research, a young research institute based in Northern California. I study how variability in climate, from interannual to multidecadal scales, impacts coastal upwelling and, consequently, the marine ecosystem. There is something captivating about the interplay among the atmosphere (winds and pressure systems), land (coastal topography), climate, ocean (temperature, stratification, transport, and chemistry), biology, and ecology in upwelling systems. Better yet, I get to explore and learn about new research topics all the time.

Marisol and her dog, Keshi, having a relaxing afternoon at the beach.

Like any other career, mine came with many challenges: taking and teaching classes in a language I was just learning because my school was now in another country, always being one foot out the door because my visa would soon expire, or being on a remote African island in an old boat trying to make an acoustic Doppler current profiler work with few tools, no help, and no second chances. On the other hand, I was on an idyllic, exotic, and remote island in East Africa, living in a different culture, trying and learning new things, facing and overcoming challenges, doing research, and traveling at the same time—and I was getting paid for it. It doesn't get much more exciting than that. This career path has had its sacrifices too, though. Living far away from my family and leaving behind my home, my culture, and my country have been the hardest. However, I have the flexibility to visit them as much as I want, and technology does the rest.

Often, people ask me how I feel about being a Latina woman in a white-male-dominated field. When I was younger, I sometimes felt proud, I suppose. But now I don't really think about it. As different as I look from my colleagues, I feel that I belong in that group. It has nothing to do with race, nationality, culture, or gender. It is about our common interest in science and the fun we have working together. I am different, it is true. But I don't feel different, because everybody is. Some differences are more obvious than others, but we all have our own personal challenges and advantages; they give us unique perspectives. When discussing some analysis or planning a project, those differences are not divisive or adverse—they are, in fact, what make us a good team. I'm not naive, though; I know that I am able to feel and think this way now because many people before me (and some still today) have had to fight many gender and racial stereotypes. For them, I am thankful.

Joan M. Gardner

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Ten years ago, I outlined my career as a marine geologist for the Naval Research Lab (NRL). Today, I continue to be gainfully employed by NRL in the study of Earth but have dropped the word "marine" from my job description, as my career has taken me from sea-going-based research to airborne-based research.

I have bachelor of science and PhD degrees in geology and a master of science degree in geological oceanography. My career as a geologist with NRL began in the early 1990s when I was hired to do seafloor mapping and characterization research. These studies occupied me for the first 10 years of my employment as a civilian research scientist, but, as the conflicts in Iraq and Afghanistan began, the research that I was doing was refocused to address the emerging needs of our military. My background and experience with remotely mapping the seafloor was called upon for a multisensor airborne terrestrial mapping project. I suspect you are scratching your head trying to figure out why a research scientist for the Navy would be doing terrestrial mapping to support the Army?

The short answer is that NRL had the perfect airborne platform (P3 Orion) in which to mount the sensors, and the research group I work with at NRL had extensive experience with mapping. So, off I went to learn how to survive if my aircraft crashed in hostile territory, how to manage a firearm, and, most importantly, how to operate a bunch of sensors on a platform that was moving at hundreds of knots rather than tens of knots. The airborne fieldwork took me, and continues to take me, to remote places just like my ocean-going work, but I am now frequently embedded with the military I am supporting. Daunting? Yes! Challenging? Absolutely! Rewarding? Totally!

I am now considered a senior research scientist at NRL, so I've had to add project management to my plate on top of the fieldwork. Budget shortfalls, government furloughs, personnel issues, and logistics challenges keep me occupied when I'm not in the field. Not my favorite part of the job, but an essential rite of passage in the world of soft-money science.

The workhorse of our multisensor mapping missions in Iraq and Afghanistan was the Navy P-3 Orion shown here. I've logged over 600 research flight hours in both civilian and military aircraft conducting airborne research projects for NRL over the past 10 years.

The fieldwork continues to take me away from home for months at a time, and the questions regarding whether I feel like I'm shirking my responsibilities as a mother and wife are just as frequently asked now as they were in my earlier sea-going career. But the answers remain the same: I do the job because I'm inspired by it, I'm good at it, and I love it.

Silvia L. Garzoli

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When I read the biographical sketch that I wrote 10 years ago, I can only smile with satisfaction at how far away the gender problems that I faced at the beginning of my career are from the situation of today's women in science (even though not all of them are solved yet).

The last 10 years have been years of big changes. I went from being the Director of the Physical Oceanography Division at NOAA's Atlantic Oceanographic and Meteorological Laboratory (PhOD/AOML) in Miami, to being the Chief Scientist of AOML, to retirement from the federal government, and finally to a part-time position as a scientist at the Cooperative Institute for Marine and Atmospheric Studies (CIMAS), a joint institute between NOAA and the University of Miami (UM).

The journey to my positions as division director and chief scientist, even though it was not free of obstacles, was very rewarding. I think that my main achievement during those years—in addition to carrying out the administrative duties associated with the job—was to continue my career as a scientist, obtaining funds, directing scientific projects, and publishing scientific results, as well as remaining an involved mother and spouse.

As PhOD director, I was pushed to expand my scientific horizons, not only regarding my own projects, but also the various projects of the entire division. I also faced, for the first time, important administrative challenges, including being responsible for managing big budgets, writing performance reviews, hiring and firing personnel, and being a "woman boss" (which, in a few cases, presented some problems). At the end of my 10-year tenure in that position, the laboratory went through an intensive external review. It was of great personal satisfaction to learn that the division came out of that process with excellent reviews. At that time, I decided that I had closed one cycle, and it was now time for someone new to take my place. I stepped out of the position of division director and accepted the position of AOML Chief Scientist. Freed from my previous managerial responsibilities, my new career efforts were directed toward science policy and strategic planning at NOAA, particularly in the area of ocean and climate.

On December 31, 2012, I took one of the most difficult steps of my career: I retired. This was an extremely difficult decision for me to make, even though as I retired from the federal government, I accepted a part-time position at CIMAS/UM. The idea behind this most recent change was that now I was going to be free to direct my energies only toward writing those papers that I always wanted to write but never had enough time to do. Or, to have the luxury of being able to get away from the office for extended periods of time to participate in interesting research cruises. Although retired, I am still highly involved in scientific projects of my preference. But after the initial shock, and after two good years, I can say that I am enjoying the change.

My advice for young women: Change is good. It is difficult, and scary, but good!

Deidre M. Gibson

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(top) Doliolid *Dolioletta gegenbauri*, gonozooid stage of lifecycle. *Photo credit: G.A. Pafenhoffer.* (bottom) Deidre Gibson and her female science crew investigate "Doliolid Blooms: What are the Driving Variables? Investigations of Trophic Interactions." Left to right: Christy Pavel, Tina Walters (Co-chief Scientist), Stephanie Chiang, LaGina Frazier, Deidre Gibson (Chief Scientist), Maryse Leandre, Gibson's graduate student. *Photo credit: John Bichy.*

Though I was exposed to marine science while taking undergraduate courses at the University of New Orleans, I never imagined a career in oceanography. I was just searching, having some fun, when I took a scuba diving class that opened my eyes to a whole new world. My path to a research career in oceanography was not straightforward.

I earned both an associate's degree in science and an applied associate's degree in marine biology and oceanography in New Orleans, then moved on to the University of Washington to earn a BS in oceanography in 1991. For the next step, I worked as a research technician at Louisiana University's Marine Consortium for five years, investigating harmful algal blooms in the marshes of Louisiana and the effects of nutrients from the Mississippi River on the zooplankton community in the Gulf of Mexico. While I found the work meaningful, my female boss did not encourage my aspirations; in fact, she actively discouraged me from going to graduate school, stating that I was "not good enough." Fortunately, I did not listen: I earned my PhD in 2000 in marine science from the University of Georgia, conducting research on pelagic tunicates at Skidaway Institute of Oceanography in Savannah. I secured two postdoc positions, at Savannah State University and the University of Connecticut-Avery Point, continuing my work on doliolids and salps.

I began my research and academic career at Hampton University in 2002 as an assistant research professor in the NOAA Living Marine Resources Cooperative Science Center. In 2004, I became a tenure-track assistant professor in both the Biological Sciences and the Marine and Environmental Science Departments. Because of a freeze in the tenure process, it was in 2012 that I received tenure and was promoted to Associate Professor and to the Chair of the Department of Marine and Environmental Science. Being the department chair allows me to focus on research, writing grants and directing a number of research, mentorship, and professional development programs to bring more minorities into the field of oceanography. I have benefited from the guidance of many mentors throughout my academic career, and I would have not made it this far on my own. For that reason, I take my role as a mentor very seriously and have been involved in or directed a number of diversity programs throughout my research career. These range from the Diversity in Research in Environmental and Marine Sciences (DREAMS I and II) projects, which exposed under-represented minority marine science students to research, to the Hall-Bonner fellowship program for minority PhD students and the COSEE-Coastal Trends programs that introduced college and K–12 students and teachers to the marine sciences.

The highlight of my career so far was serving as chief scientist on R/V *Savannah* with a "diverse" all-female scientific crew (see photo) to conduct feeding experiments with large gonozooids of the doliolid *Dolioletta gegenbauri* in order to understand the ecological role and significance of doliolids in continental shelf pelagic ecosystems. As for that scuba course, I recently co-facilitated a coral reef research experience for my students in Mo'orea, French Polynesia, using the diving skills learned more than 30 years ago.

Sarah N. Giddings

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I grew up near the beach, near an estuary—coastal environments have played an important role in my life for as long as I can remember. I became interested in hydrodynamics as an undergraduate researcher, babysitting a time-lapse camera that was imaging San Francisco Bay. I found myself mesmerized watching the water surface. Fronts (confluences of different water masses) formed repeatedly along the estuary, made visible to the naked eye by foam. But these fronts did not just accumulate debris; I watched as birds dove along them and marine mammals aggregated to feed. It was fascinating to see first hand the role fluid dynamics can play in driving a biological response. At the time, I certainly did not envision an academic career in coastal oceanography, but this experience and my love for these environments motivate me to this day.

In an attempt to better understand and protect estuaries and the coastal ocean, my research examines the physical transport processes in these systems and their implications for biology and chemistry. I employ a variety of scientific approaches, ranging from field experiments to numerical simulations. My current research directions are focused on linking estuaries and the coastal ocean: how do estuaries impact the coast (via plumes) and how does the coastal ocean influence estuaries?

I find this work rewarding, as it has real implications for coastal environments and how humans relate to them. These systems provide valuable ecological functions and contribute to myriad human services, yet they are significantly degraded and remain threatened by pollution and a changing climate. The most rewarding aspect of my job, though, is extending my passion for estuaries and coasts to the community and students through outreach, teaching, and mentoring. I am engaged in a variety of scientific outreach projects, am excited to be at the stage in my career that I am advising students, and love integrating teaching with my research.

The greatest challenge I have encountered thus far in my career is creating a work-life balance that is fulfilling, enjoyable, and sustainable. This includes balance *between* work and life (e.g., how many hours I spend at work, how to say no), but also balance *at* work. As a new assistant professor, I find a constant push and pull among the variety of tasks that need to get done (e.g., writing proposals, teaching, advising students, attending meetings, research).

While it does not affect my day-to-day work, I certainly recognize the lack of women in my specialty (specifically, in permanent positions—the leaky pipeline). In some ways, this atmosphere is quite challenging, as it leaves a dearth of mentors and can sneak its way into my own confidence. For example, was I invited to talk just because I am a female? In other ways, it can feel rewarding to be forging a new path. I think the culture of academia is slowly changing and heading in a positive direction, not only for women but also for society as a whole.

Sarah taking a snack break while doing one of her favorite activities, hiking. This beautiful scene is from Skyline Divide in the North Cascades, taken by her husband, Robert Driscoll.

Sarah Gille

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When I started graduate school 25 years ago, I was excited about the scientific challenges of physical oceanography and hopeful that the field would provide a more hospitable environment for women than I had found as a physics undergraduate. While oceanography definitely felt more hospitable, that doesn't mean that it was always fully welcoming, and I sometimes felt like a small voice in a room full of bearded men. Over time, the demographics have changed. My hallway at Scripps Institution of Oceanography is now packed with women faculty and researchers. When my mind wanders in meetings, I routinely calculate the ratio of women to men in the room. Now, as often as not, women outnumber men, and the issues that concern us are more readily heard. Nonetheless, puzzles remain: for a recent faculty search, the ratio of male to female job applicants was about four to one, and I wondered how that could be, given that women comprise roughly half of our students and postdocs.

I'm fortunate to have a supportive husband. He is also a UC-San Diego professor (in mechanical and aerospace engineering), so we both have complicated schedules and also flexibility. We share responsibilities for our two boys (ages eight and 11), and we often lament the inefficiency and duplication associated with sharing responsibilities. Both of us need to know what goes in the kids' lunch boxes and who has soccer practice on Friday. We routinely remind the kids' school and sports teams to include both of us on e-mail distribution lists: "Things run more smoothly in our household if both of us our notified about events." That's code for saying that we travel more than we care to admit.

My research group focuses largely on the Southern Ocean, where research cruises can test the duration limits of the research fleet, sometimes running 50 to 60 days. Although I've been involved in recent seagoing projects (including the Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean, DIMES), I've dodged the cruises in order to stay home with my family. This can get me into trouble, because shipboard data fundamentally "belong" to the principal investigators who are on the ship getting knocked over by big waves. However, there's no shortage of science questions,

and my group makes extensive use of satellite data, autonomous floats, and numerical models, and we stray over a broad latitude range.

One direction we've taken is examination of diurnal variability of winds and temperatures in the upper ocean. Diurnal effects are largest in the tropics, equatorward of 30° latitude. My initial work on diurnal winds was with my husband. Working with someone I know so well is tremendous fun—but also difficult, because he and I tend to lose any remnant veneer of politeness when we collaborate. Our initial husband-wife project has grown in scope, and my research group is excited about the recent launch of the RapidScat ocean vector wind instrument aboard the International Space Station, because its orbit will give us new perspective on diurnal wind variability.

When I started 25 years ago, I could not have predicted the future trajectory of my life in oceanography with any accuracy. So I won't conjecture what the future might bring, but I hope oceanography continues to provide as much satisfaction as it has so far.

Mirjam Sophia Glessmer

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Mirjam Glessmer onboard R/V *Knorr* in 2011. *Photo credit: Rob McGregor*

When, as a teenager, I discovered that physical oceanography existed as a profession, it was instantly clear to me that was the path I wanted to take. I was fascinated by popular science articles about the ocean "conveyor belt," I loved traveling and being at/on/in the sea, I was excited whenever the chance to explore something presented itself, and I could not imagine anything else would make me more happy and fulfilled. So I dived into the world of ocean sciences, did my PhD and a postdoc, and went on adventures I always had dreamt of, including research cruises at least once every year. We stayed at sea for a month or two at a time, and when we saw land, it would be Greenland, Jan Mayen, Cape Verde, or other exotic places. We spotted the abundance of sea life, ranging from whales, polar bears, penguins, to flying fish; saw the northern lights and witnessed the green flash. Most importantly, I did exciting research with great people on topics I am passionate about: double-diffusive mixing, tropical oxygen minimum zones, and freshwater in the Nordic Seas. I traveled to conferences to meet the most amazing and inspiring people to discuss my work and share findings with a wider audience, and most recently I published in *Nature Geoscience*.

My interest in ocean education began during my PhD years, and I decided to enhance my teaching skills by studying for a master's degree in higher education. Several years of teaching oceanography at the university level and being involved in many outreach activities have only intensified my interest in how people learn about the ocean. Whether to the general public or to students of oceanography, conveying the knowledge, skills, and wonder, and also the open questions, of the ocean sciences is a very important task. However, spending a substantial amount of time communicating science left less time for actual research, and at some point I had to decide between research and teaching. I chose teaching.

I now work at a Center for Teaching and Learning at a German university, where I support teaching staff in mechanical and ocean engineering by developing new methods, discussing student misconceptions, or collaborating on the redesign of curricula. I also document my "adventures in oceanography and teaching" on my blog, where I share instructions for hands-on experiments, information about how education research can help us improve our teaching of oceanography, and other useful tidbits I pick up along the way. Investigating how people learn, especially how they learn about the physical processes governing the ocean, and empowering the oceanographic community to do an even better job at supporting others to learn about the ocean we care so deeply about—that is what I do now and what makes me feel happy and fulfilled as an oceanographer.

Patricia M. Glibert

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I am so lucky. Can there be a better career than that of phytoplankton ecologist? I don't think so, and these are certainly interesting times for this profession. Harmful algal blooms as well as nutrient pollution and eutrophication are increasing everywhere, and the science we do is not just ivory tower. It used to be difficult to explain what I studied to my non-scientist friends and relatives; now, they read headlines about water quality issues and algal blooms frequently.

I began my career as a "blue water" oceanographer, studying the question of how phytoplankton can obtain enough nitrogen for their growth in an ocean with vanishingly low nitrogen levels. In some regions of the ocean, nitrogen remains impoverished. However, our coasts and estuaries have become increasingly nutrient enriched, and proliferation of algal blooms is a consequence. My work ranges from the global to the physiological, addressing such questions as how are nutrient loads changing with changing practices in land and fertilizer use? And, how do different species of phytoplankton respond to different forms and loads of nitrogen and why? I have had incredible opportunities to study these questions and processes in many estuaries of the United States and in many other parts of the world, from Australia to the Baltic, from Kuwait to China.

Although we hope that what we do is making a difference, the challenges are many. Not every experiment follows the expectation, and not every system follows the "rules" we think we know. Why did this bloom happen here? Happen now? Why are systems changing over time? How can we bring new hypotheses, tools, and technologies to help us think and measure in new ways? Surprises in data are opportunities to explore new ideas, new hypotheses. If I have learned one thing, it is: "When life throws you a curveball, hit it out of the park."

As I stated in my biography in *Oceanography* 10 years ago, I am also one-half of a dual career couple, mother of three, professor, and advisor. My academic position is the same as that of 10 years ago, although my husband's work has evolved from academia to instrument application. Our children are grown now, so the days of scheduling sampling around school and sports schedules is past. Although none of our children are scientists, all have taken an aquatic path of one form or another: one is a captain with her own charter business; one is pursuing a PhD in naval engineering; and one is an artist incorporating inspirations from nature and the marine world in much of his work.

As proud as I am of the paths my children have taken, I am equally proud of the successes of my students. Seeing them blossom in their careers is very gratifying. Having the opportunity to help women, especially those from historically underrepresented backgrounds, has been especially rewarding. Science is hard, but research is fun. And nothing we do is a single effort. It is collectively that we can challenge ideas, share enthusiasm, and enjoy continual learning.

Shana Goffredi

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I have been exploring the deep ocean for 20 years. I absolutely love oceanic research expeditions—miles from land, with only the sky and the ocean surface in view. It smells and looks like no other place on Earth. Using submersibles, both manned and unmanned, has been one of the most exciting aspects of my research. I'm humbled by the privilege of these experiences and fascinated by the alien life that exists in the deep ocean. A quote from one of my heroes, William Beebe, captures the awe-inspiring experience perfectly: "There came a moment which stands out clearly: with my forehead pressed close to the cold glass—that transparent bit of old earth which so sturdily held back 9 tons of water from my face—there came to me at the that instant a tremendous wave of emotion, a real appreciation of human beings sealed tight in our lonely sphere peering into the abyssal darkness as we dangled in mid water."

I earned my BS in biology/marine science from the University of San Diego (USD) in 1993 and my PhD in ecology, evolution, and marine biology from the University of California, Santa Barbara, in 1998. Since then, most of my career has been devoted to the study of beneficial associations between bacteria and deep-sea invertebrates, including marine polychaetes (the fascinating worms *Riftia* and *Osedax*), chemosynthetic clams (*Calyptogena*), the bizarre hairy "yeti" crabs (*Kiwa*), and bloodletting leeches. Symbiotic bacteria are fundamental to the survival of most, if not all, multicellular organisms, yet we are only now beginning to fully appreciate the diversity and pervasiveness of beneficial microbial partnerships. At the heart of my research program, these symbioses represent the ways microbes profoundly affect higher organisms. Many symbiotic partnerships allow animals to exploit unusual or "extreme" environments—including deep-sea hydrothermal vents and whale falls. The majority of bacterial symbionts cannot be grown in the laboratory; thus, their study benefits greatly from the application of culture-independent molecular and microscopic techniques, such as ribotyping, gene expression analysis, and whole genome sequencing. Over the past 10 years, I have integrated these emerging techniques into my research program in order to gain a better understanding of the diversity, physiological functioning, and metabolic capabilities of beneficial symbionts, as well as the overall molecular ecological significance of microbial symbioses in the ocean.

In 2005, I joined the faculty at Occidental College, a small liberal arts institution in Los Angeles, because of its philosophy founded on close working relationships between students and faculty. I am greatly fulfilled by both of my roles as a researcher and as a teacher. My own career as a scientist began as an undergraduate with the opportunity to do research at USD with Hugh Ellis, an animal physiologist with a great devotion to side-by-side research with undergraduates. This past experience introduced me to the world of environmental biology and launched an enduring commitment to scientific discovery and involving the next generation of undergraduate scientists, particularly women, in contemporary research. Together, my students help me unravel the many mysteries of deep-sea animal-bacterial symbioses.

Jennifer A. Graham

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My research interests focus on the ocean's role in climate variability and the impact of interactions between ocean, ice, and atmosphere. Recently, I have been investigating ocean processes around the Antarctic continent. This region is vital for understanding the global climate system and how it will evolve in the future. For example, ocean temperatures determine the melt rate of ice shelves, which affects global sea level change.

My oceanography career started with earning a PhD at the University of East Anglia. Prior to this, I studied astrophysics at St Andrews University. Physics and math were always my strengths at school; however, I knew I wanted to apply my skills to understanding the natural world. Having perhaps a typically British fascination with the weather, I began looking into a career in meteorology toward the end of my undergraduate degree. As I stumbled upon PhD projects focusing on oceanography and climate variability, I was then drawn towards this area of research instead.

The majority of my work involves the use of numerical models, but I also enjoy working with observational data, and have been lucky enough to take part in a couple of research cruises. Every oceanographer should have the opportunity to go to sea. It puts every data point into perspective, making you appreciate the challenges faced in obtaining them, especially in harsh environments like the Southern Ocean. A trip to the Weddell Sea has been a highlight of my career, seeing sea ice and icebergs in various shapes and sizes. I also found that research cruises are a great place to get to know oceanographers from other institutions.

Throughout my career, I have enjoyed working in multidisciplinary departments. While the number of female physical oceanographers has been increasing, the female proportion is still much lower than it is in biological or chemical oceanography. This disparity is something that needs to be addressed from the high school level, if not before. In my final year of high school, I remember that only a quarter of the physics class was female, and I was the only one to consider pursuing it further (others went on to study medicine or psychology). Unless we change attitudes in younger generations, we cannot expect to fix gender discrepancy in their future career paths.

On board RRS *James Clark Ross* in the Weddell Sea.

One of the greatest challenges of my career has been the uncertainty in long-term employment. When looking for employment, you are also limited geographically to institutions that have relevant research departments. This is a concern for anyone considering an academic career. Unfortunately, I cannot see an easy way of avoiding this issue, aside from having an understanding group of family and friends. I am still in the early stage of my career, and have fortunately been relatively flexible so far. I took the opportunity to move to the United States for my current position, and have since worked with an excellent group of people. I look forward to seeing where my next position will take me.

Hazel Grant

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While studying mathematics at the University of East Anglia, I knew I wanted to move into a more applied field. With a meteorologist father, I had always had an interest in the physical and natural world around me. A final year project investigating the approximations made to the Navier-Stokes equations for equatorial models and then a PhD in Antarctic oceanography, ably supervised and encouraged by Karen Heywood, Alberto Naveira Garabato, and David Stevens, confirmed an interest in combining maths, physics, geography, and drawing "pretty pictures"!

As part of the consultancy service line at Fugro GEOS, I currently provide metocean (meteorological and oceanographic) criteria to the offshore industry, including the oil and gas sector, offshore wind farms, and shipping, at locations all over the world. We combine in situ measurements, models, and satellite data to derive extremes and operational statistics, and we conduct research for joint industry projects (JIP).

Much of my most interesting work involves problem solving—how can we use the very limited measured information we have as well as models to understand the physics at a particular location, for particular seasons or throughout the year. With this information, we can provide clients with their required numbers so they can calculate how much steel or concrete their structure needs or how and when they can conduct their operations with minimal risk to life and investment. For example, a fascinating, long running, and at times frustrating project was the West Africa Gust JIP where we used measured data to characterize squalls in vertical and horizontal, seasonal, and regional dimensions in this otherwise benign climate.

One of the reasons I enjoy my work so much is the constant challenge—we are often learning about complex processes so that we can characterize them fully through modeling and splitting them into their component processes. I have had to develop my understanding of the clients' requirements so we can fully meet their needs, and my work has led me into the challenges of technical review, line management, and auditing. The group of people I work with is also an important part of enjoying my career: the team at GEOS is a good bunch to learn from and to pass on learning. Far from the days of being the only girl in my physics class at school, my department is now more than 50% female!

Work-life balance is extremely important to me, so a few years ago I reduced my working hours slightly to ensure my health as well as fit in my other interests of craft, church life, and community. In these areas, it seems the same skills of problem solving, working, and sharing with others and passing on the joy of finding out how things work are often required.

Delighting in the wildflower meadows of Heidiland, Switzerland, last summer.

Cheryl Greengrove

Interim Dean, School of Interdisciplinary Arts & Sciences, and Associate Professor of Geoscience, University of Washington Tacoma, WA, USA, cgreen@uw.edu

Since writing my autobiography 10 years ago in the previous "Women in Oceanography" volume, I have taken on more of an administrative leadership role as I continue to help build a relatively young university. During that time, University of Washington Tacoma has more than doubled in size, from 2,000 to over 4,000 students, and expanded the undergraduate curriculum from just the upper-division coursework required for a degree (where all students were transfers), to a full four-year campus with the admission of the first freshmen class in 2006.

Getting ready to sample in Commencement Bay, Puget Sound, WA, with undergraduate research students. Left to right: Mitch Schatz, Ben Shetterly, Katherine Tran, Kelly Scholting, Ashley Nepela, Cheryl Greengrove, Audrey Hackett, Laura Nokes, and Julie Masura (Researcher).

Along the way, I remained active in research by teaming with other scientists on larger scientific projects that continued to investigate harmful algal blooms and sediment and water properties in Puget Sound and the fjords along the west coast of Vancouver Island. Writing proposals to a diverse set of funding sources, from federal agencies to local foundations, increased our chances for success and allowed us to develop projects that scaled up and built on one another. Undergraduates continue to be an integral part of all these research programs, gaining hands-on experiences in the field and lab that often serve as foundations for student capstones. Integrating my teaching and research has been key in allowing me to do both more efficiently and effectively, while providing real-world opportunities for students to study marine science.

The organizational and data analysis skills, as well as the scientific reasoning, that are so critical to being a scientist continue to serve me well in my administrative capacity. Having data to make decisions is always helpful. In addition, the ability to communicate, both orally and in writing, are essential to success as both a scientist and administrator. People skills are also extremely important, as almost everything we do involves teamwork. Understanding the big picture and context, as well as the processes that drive a system, whether it be an ecosystem or a university, are essential in being able to interpret observations and make predictions. The one thing to remember as you advance through a career is not to underestimate your capability and always negotiate for what you believe will make you and those around you more successful in achieving your goals. Also—don't ever stop doing what you love…

Silvia B. Gremes-Cordero

Assistant Professor/Research, Department of Physics, The University of New Orleans, LA, and Resident at Naval Research Laboratory, Stennis Space Center, MS, USA, sgremesc@uno.edu

I have felt a special connection with the ocean since my childhood. I would stay hours playing in the waves, with my grandma watching me, as she shared that passion, too. I learned about ocean movements and basic biology, searching for any type of information I could understand. Then, when I was 15, I read an article about the first woman oceanographer to go to Antarctica—and I knew at that moment what would I do in life.

When I was finishing high school, I heard that my neighbor was studying oceanography. After a long chat with her, I signed up at the only Argentinian university teaching it, ITBA (Technological Institute of Buenos Aires). To give you an idea of the environment there, my class had 120 men and only six women (including both oceanographers and engineers) in it. I was the only woman in my class to graduate, and I did it with a thesis in coastal engineering.

Once I graduated, local research jobs weren't easily available in my field. I realized that I had to confront my first and most important challenge: looking for a scientific job abroad. It was with no little sacrifice, leaving my family and friends, but I set out upon my own path, step by step.

I lived in Italy for 10 years, where I had the opportunity to work with researchers at the University of Rome. In my last year there, I took part in a collaborative project between Italy and the United States, and I had the chance to live in California for six months. That experience changed my life, and I wanted to come back. This wish, together with my insatiable need for new knowledge, resulted in the decision to apply to PhD programs in the United States.

I earned my master in science degree in coastal oceanography, particularly the study of plumes and shelf dynamics, at the University of Miami, where I also completed my PhD on air-sea interaction, turbulence, and the oceanic boundary layer. My research has always been observational, so I am happy today to be working in a place where I can apply that knowledge, and also work on two of my passions: satellite oceanography and numerical modeling.

Silvia, her mom, and Rocky, doing what Silvia enjoys the most—sailing.

The challenges at the beginning of my career were more related to being recognized as capable as a woman oceanographer; in later years, the challenge was to follow the career path I chose, with no gender biases. I am extremely grateful to the women who opened doors for all of us, and I hope we can all open gates for the next generation.

My conviction about what I wanted to do in my career sometimes interfered with my personal life, but I keep close communication with my family and friends, as I think they are part of my identity. I am very happy with all my decisions, which allowed me not only to increase my knowledge as a scientist but also to enjoy the rewards of collaborating and interacting with other women scientists and sharing our exciting experiences.

Annalisa Griffa

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I am a physical oceanographer whose main interest is transport and dispersion of pollutants and biological elements by ocean currents. My work involves analysis of data from drifters (floating buoys passively advected by the currents) and from HF radars (instruments that provide maps of surface velocity at intervals on the order of one hour), and complementing these data with numerical model results. Even now, after many years of doing this work, I am often mesmerized by looking at drifter trajectories in the ocean and wondering about the paths they have followed and what they can tell us, for instance, about larval dispersal in the sea. I have always been fascinated by the question of where things go and where they come from in the ocean as they follow the complex and highly variable roads of the currents.

Ours is a fantastic job—it allows us to combine scientific curiosity and a love of the ocean. Indeed, this is what drew me to oceanography from the beginning, after finishing my undergraduate degree in physics. I had the great opportunity to carry out a dual career between Italy, my country of origin and where I presently work, and the United States, where I earned my PhD at Scripps Institution of Oceanography and then worked for many years as a University of Miami (RSMAS) faculty member. In both places, I met a number of great colleagues and students.

I have encountered two main challenges during my career. The first one, which I think is very common for women, is how to combine work and personal and family life. It is very hard, and the challenges keep changing, from kids to parents and my husband. I did not always do a very good job of keeping the balance, even though I put all my soul into my family and into my work. The other great challenge for me is how to deal with the bureaucratic, administrative, and managerial part of the work. This might be another common women's issue, wanting to be a "good girl," working hard, and trying to please everybody—with the result of spending too much emotional energy and often being ineffective. It gets a bit better with age, but not a lot.

Things have changed a lot since the beginning of my career. Now, there are many more young women in oceanography, and this has brought a very positive change in the work environment, even though the situation today is in many respects harder, with fewer job opportunities and greater funding struggles. What I would like to tell young women (and men) entering oceanography is that the good part is that the excitement and fun never stop, and this cannot be said about many other jobs.

Annalisa Griffa at her favorite lunchtime spot: beside the ocean near her CNR laboratory in La Spezia (Italy).

Cécile Guieu

Senior Scientist, Centre National de la Recherche Scientifique (CNRS), Laboratoire d'Océanographie de Villefranche, Pierre and Marie Curie University, Villefranche-sur-Mer, France, guieu@obs-vlfr.fr

I was lucky that my parents were naturalists. As a kid, I spent a lot of time with them discovering nature and traveling to many different places. I've always looked at nature by observing first and then trying to understand how the different pieces work and are linked. Going to university to learn environmental sciences was thus quite natural for me. I started to learn geology like my father, enjoying the fieldwork a lot. The path from geology to marine biogeochemistry was a succession of chance, opportunities, and meetings with a few key people. I did my PhD in Paris, earning it in 1991, working in a quite new field at that time: the significance of the atmospheric deposition of nutrients in ocean biogeochemical cycles. I like multidisciplinarity in research and also practical work. Going to sea, setting up new experiments and devising new methods in situ or in the lab, developing new devices to describe key processes—all of these aspects of research make my career and everyday life diverse, exciting, and sometimes challenging. For example, when I proposed the idea, and then got funding, to set up large, new, all-plastic in situ mesocosms, it was fantastic—but at the same time, it involved coordinating a large project, with many people and some level of risk.

The human aspect has always been very important to me, and it has been very rewarding to supervise excellent young scientists who are now my colleagues and friends. It is also very rewarding to have a project funded to carry out a scientific idea, be successful with it, and publish interesting results to share with the scientific community and the public. Responses of my kids, who are very receptive and curious about my work, make me realize that I would like to do more outreach activities. Their generation needs to be educated about environmental issues.

Being a scientist and a woman with a family makes my life very busy. I am very lucky to be married to a scientist. He is well aware that a scientific career means a chaotic schedule, a lot of traveling, regular month-long fieldwork, and other challenges. We take care of the children equally and they are used to my frequent (and sometimes long) trips. This said, the challenge for us is that my husband has a job far from France right now. We both have to make some compromises to make it work!

I am happy to see that more female students want to pursue scientific careers. I'd like to encourage them, as being a woman in science is not in itself a challenge. I am also happy to see more and more women offering and accepting invitations to be scientific experts on international panels and committees that used to be exclusively male. The biggest challenge I see for scientists—of whatever gender—may be that our jobs are becoming more and more about pursuing new funding.

Cécile Guieu in October 2013 sampling in the Bay of Villefranche-sur-Mer in the Mediterranean Sea.

Naomi Harada

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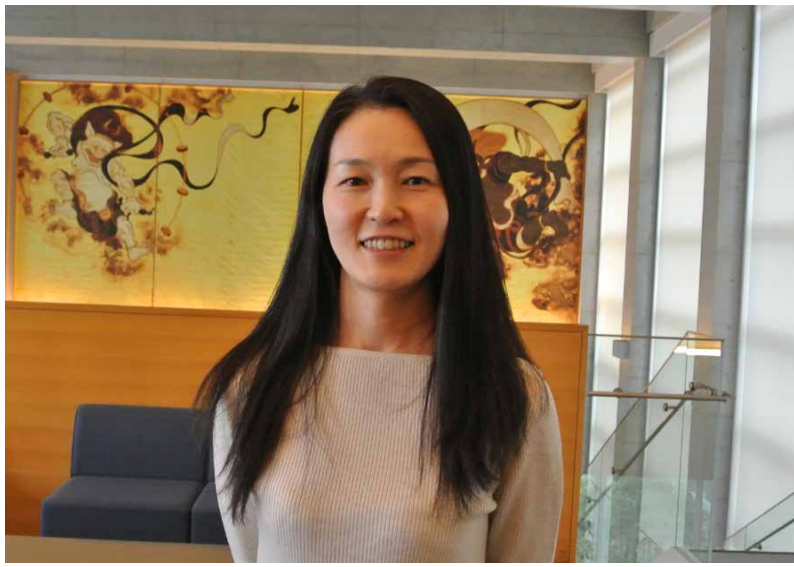
In 2005, when I last wrote my autobiography for this magazine, I was a research scientist in the fields of paleoceanography and biogeochemistry and deputy group leader of the paleoceanography and paleoclimate group, Global Warming Observational Research Program, Japan Agency for Marine-Earth Science and Technology (JAMSTEC). In 2006, I organized and served as principal investigator of a research cruise on R/V *Mirai*, in the Okhotsk and Bering Seas and the western Arctic Ocean. The purpose of the cruise was to collect sediment cores for the reconstruction of paleoenvironmental changes in sea surface temperature, productivity, and water circulation associated with centennial and millennial time scale climate change. Thanks to the dedication and effort of all crews and participants, the research cruise was a success: many paleoceanographic, paleoclimatological, biogeochemical, and geochemical results from this cruise were published in a special 2012 issue of *Deep Sea Research Part II* (vols. 61–64), for which I was one of four guest editors.

JAMSTEC research activity is based on medium-term (five-year) research plans. Thus, programs and groups are reorganized every five years. When JAMSTEC's second medium-term plan began in April 2009, I became team leader of the Paleoceanography Research Team, Environmental Biogeochemical Cycle Research Program (EBCRP). Five years later, I was promoted to senior technical scientist, and since April 2014, I have served as Deputy Director of the Research and Development Center for Global Change (RCGC). I also lead the RCGC Marine Ecosystem Dynamics Research Group.

In 2013, I faced the largest challenge of the last 10 years when I was asked to manage the EBCRP for Toshiro (Toshi) Saino, whose declining health prevented him from fulfilling his duties as program director. As fiscal year 2013 was the final year of the second medium-term research plan, it fell to me to report on the research achievements of the program and its success in meeting its goals for that period. The EBCRP is composed of six teams with a total of 80 scientists whose research activities are broad, encompassing atmospheric, terrestrial, and marine sciences. Moreover, JAMSTEC team leaders are expected to continue their research activities



(e.g., they are expected to be a lead author of at least one published paper each year) while simultaneously managing their teams. Therefore, to assume the responsibilities of program director, in addition to my responsibilities as team leader for JAMSTEC's largest program, was really tough for me. Fortunately, with Toshi's guidance as well as the efforts and assistance of the other five team leaders (M. Honda, M. Takigawa, S. Chiba, R. Suzuki, and Y. Kanaya), the evaluation committee fully accepted our presentation and report. Unfortunately, Toshi passed away before he knew the results of the evaluation.

During this period, I frequently met with Toshi at the hospital in order to learn how to lead and manage the program. Each time, we enjoyed a very short chat, only 10 minutes; however, I felt privileged to have that 10 minutes while he was fighting for his life against his enemy (cancer). He never second-guessed my decisions as acting director, but he taught me the importance of putting forth one's best effort at any given time. Now, I continue to ask myself every day, "Did you do your best today?" So, my advice to young women oceanographers, and indeed to all young people starting their careers, is to accept challenges that come your way, no matter how daunting, and, whatever the task, always do your best."

Lois Harwood

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It was 1980, and I was working on isopods and chemically dispersed oil in a lab in Vancouver. One day my boss asked me, "Do you know where the Beaufort Sea is?" "Not really," I replied. So he showed me on a wall map. The firm had just been successful in getting a large, long-term project to assess the potential impacts of oil and gas exploration on Beaufort Sea species and habitats. Months turned into years, and years into decades, and for more than 30 years I have been working on all things Beaufort. This includes my start in the private sector, two years at graduate school, and finally, current work in the public sector with Canada's Department of Fisheries and Oceans. All projects have been done in close collaboration with local hunters, trappers, and fishers—we strive to blend western science and local ecological knowledge in the delivery of all programs. I have had the benefit of positive, energizing, and insightful working relationships with local experts in small communities throughout the Western Arctic, as well as with eminent international Arctic scientists.

Work has mainly included assessing status and trends of fish and marine mammal populations in the Beaufort Sea, while living and raising a family in Canada's Arctic. We have focused on the health, habits, movements, and trends in fish, seal, and whales of the Beaufort Sea, a relatively "simple" ecosystem—yet unique, challenging, and vulnerable. It's a cliché to say that "change is the only constant," but in the North it is true: there have been changes in the environment; changes in the way government operates and in how scientists do, and can do, their work; changes in technology; and changes in climate. The interest of the oil and gas industry in the Arctic and Beaufort regions fluctuates, influenced by markets, issues, prices, and technology, all far from the Arctic. Of all the changes, the most difficult to mitigate and assess is a changing climate, and with it emerging, obvious, and consequential impacts on all inhabitants of northern ecosystems, including people.

Subsistence harvests by indigenous northerners have supplied us over many decades with large sample sizes and regular access to samples as well as competent field technicians and project co-leaders. We count, tag, track, and survey marine mammals and fish, as these methods are used to inform us about the location and integrity of "biological hot spots." We have done extensive work using satellite-linked transmitters deployed on ringed seals, and we have collaborated with our Alaskan counterparts to tag bowhead whales. All of these studies are designed to establish baselines and to monitor movements and behavior, especially as they relate to industrial underwater noise. Finally, our studies of the tissues of seals and whales reveal information about their lives. Their reproductive fluctuations and the thickness of their fat are excellent indicators of marine ecosystem productivity and temporal trends. With our indigenous partners, we have set the stage for the next generation of scientists, and encourage collaborative studies with holders of local knowledge and with physical, chemical, and biological oceanographers.

The ocean is changing. Species and ecosystems are responding to change. I have seen and lived the strengths, weaknesses, weather, and social problems of life in Canada's North as a resident. The sad legacy of the residential schools for aboriginal people and their communities permeates everything. The climate is warmer but, most noticeably, more variable. Hearts are warm, and remain kind and generous. Best for last: I am a grandmother now.

Rachel Haymon

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(left) White microbial mats cover lava pillars after a 1991 eruption on the East Pacific Rise crest at 9°50'N. (right) Rachel Haymon entering DSRV *Alvin* in 2008.

I was born in Louisiana in 1953. In my youth, the only woman scientist that I knew of was Marie Curie. When I entered graduate school in oceanography in 1976, a few pioneer women had left some blazes on trees for young women to follow, but there were still only one or two women at sea with 50 men on a ship, and women at sea were still considered "bad luck" and subjected to harassment. We female proto-oceanographers understood that the future of women in the field depended on whether we could measure up and earn respect. We endured, worked hard, and transformed a faint trail into a paved road for the women that came after us. After graduate school, bigger challenges arose. Nationally, there were few secure jobs in marine science, and a small pool of women competed against a large pool of men. Also, it was tough to get credit for our own accomplishments with so many male colleagues and social myths surrounding us. Meanwhile, our mothers asked when were we going to get married and produce grandchildren. Our own self-doubts did not help. Yet somehow, enough of us succeeded, and I am grateful to be one of those who survived and thrived.

In grad school, I was hooked on studying mid-ocean ridge hydrothermal systems during the 1979 expedition that first discovered "black smoker" hot springs blasting from the seafloor amid exotic fauna fed by chemicals in the hot springs. My PhD dissertation described minerals deposited by these hot springs. Later, over many years as a researcher and professor at UC Santa Barbara, I explored, wrote, and taught about the unknown deep-sea floor with my colleagues and students, leading and helping teams of women and men to reveal the great expanse of Earth hidden beneath the sea. Together we discovered extensive hydrothermal vent fields, witnessed an eruption of the mid-ocean ridge for the first time, and were astonished by the extraordinary bloom of microbial life and rapid faunal succession that transpired during and after deep-sea eruptions. Together we began envisioning how the chemistry of a planet can originate life. Together we began unlocking the mysteries of how enormous hydrothermal heat loss takes place on the vast flanks of the mid-ocean ridge, and supports life on and under huge regions of the ocean floor.

We entered a new millennium inspired by these novel ideas and discoveries. And then—there was a drastic collapse of funding for deep-sea exploration, particularly for investigators relying on core NSF support. Meanwhile, much more than excellent research productivity and teaching was added to the workload of university scientists ("broader impacts" requirements, extensive data sharing and reporting requirements, among others). Reduced funding and increased demands coincided with decreases in staff and other support at all institutional levels, and with problems at NSF. After 30 productive and exciting years, I realized that in my field it had become nearly impossible to support and train new graduate students at sea. Many of my colleagues bailed out of active research, or switched fields. Some of our brightest and best students struggled to get jobs and switched fields to survive. Though it was all I had ever wanted to do, I accepted the heartbreaking truth that being a seagoing oceanographer exploring the deep-ocean floor, and training the next generation to do it, was no longer viable for me.

These late-stage career challenges overlapped with caring for my dying parents and with my own health issues as I aged. After much thought, I retired in 2010 from being a full professor at UCSB. I continue to do non-seagoing research, publish, and mentor students. I also have redirected into volunteer activities where I can make a positive difference, including writing successful proposals for two nonprofits to fund their excellent projects. I am feeling productive and happy these days. I am immensely grateful for all of the terrific years of exploring the deep, and if the opportunity arose to conduct useful seagoing research, I would happily do it.

Kate Hendry

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I like to wear many different scientific hats: chemical oceanographer, biogeochemist, marine biologist, paleoceanographer…to name the main ones! I study the cycling of nutrients in seawater today and in the past, in particular, that of dissolved silicon and trace elements that are essential for diatom growth. Diatoms are microscopic algae that make their shells from glassy amorphous silica ("opal"), and they are responsible for about half of the carbon that sinks in dead biological material from the sea surface to the sediments—making them an essential component of the marine carbon cycle.

I encountered the wonderfully multifaceted field of marine sciences at a young age, and studied natural sciences at Cambridge University to get a good grounding in various sciences. My final-year dissertation was on marine ecology and paleoecology, and I worked that summer at the Natural History Museum in London and at the British Antarctic Survey in Cambridge. I completely fell for the idea of working in Antarctica and found an exciting biogeochemistry project at Oxford University that involved fieldwork and an ideal combination of Earth sciences, biology, and chemistry. Near the end of my PhD, I was invited to go on a research cruise to the Southern Ocean with a group of scientists from Wood Hole Oceanographic Institution (WHOI) to study another group of silicon-loving organisms, deep-sea sponges. That work led to a postdoctoral scholarship at WHOI, where I spent two-and-a-half years before returning to the UK. Last year, I was awarded a Royal Society University Research Fellowship, which I took to the University of Bristol.

My greatest career challenge has been making the important decisions about where to go and what to pursue. There are so many different ideas, approaches, and activities (research, policy, outreach…) that it can be difficult to keep grounded.

The most rewarding aspect about being a marine scientist is going to sea. You get to see stunning places and wildlife, and you become part of a team where you can make some very firm friendships. However, it is challenging to be away from home for long stretches of time.

Kate on R/V *Laurence M. Gould* off the West Antarctic Peninsula.

The balance between my academic career and my home life is relatively good, but it takes work. As a postdoc, I pulled very long hours in the lab. With time, I've come to realize the importance of perspective and of spending time with the people you care about. This has driven some of my decisions in life: when you have to think about other people, you naturally ask different questions. For example, when I was considering jobs, I needed to know: would my husband like living there? Is it far away from my parents and sisters? I'm happy to have ended up in Bristol, where we are both in good places for our careers and also near both of our families.

As a (relatively) early career scientist, I've found the number of men and women in my field *at my level* to be fairly balanced and that—with only a few exceptions—the conditions for women and men have been equal. However, since I started my PhD, I've seen a slow rise in the number of female scientists in senior positions such as readers and professors. When I started my thesis, there was one female professor in my school. Now there are six—which, although an improvement, means there is still some way to go.

Stephanie Henson

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My research focuses on how the physical environment affects phytoplankton and carbon fluxes. I use a combination of satellite, ship, and model data to understand how variability on seasonal, interannual, and longer time scales arises in phytoplankton.

I got into oceanography mostly by accident. I did an undergraduate degree in physics but wanted to do a master's in something more applied. Meteorology was a possibility, but I was attracted to oceanography by seeing the University of Southampton's inshore research vessel during an open-house day. After completing an MSc in oceanography followed by a couple of years doing a "real job," I realized that academia was the life for me, and I haven't looked back since.

One of the fun things about being an oceanographer is that (almost) everyone you meet outside the office is really excited about what you do, even after you've explained that it's not about swimming with dolphins. We have opportunities that are available to so few people—to do something important and that we love, and in amazing places, too. My favorite parts of the job are the feelings brought on by making a discovery or mentoring the next generation of marine scientists. I want them to feel the same sense of excitement and endless possibility about their science as I do.

Of course, every job has its downsides, and for me those center around the long hours, huge investment of energy that being successful takes, and high expectations that we have of ourselves. Having said that, for me, a really important part of trying to maintain a work-life balance is working hard—but not too hard. I find that to be productive and creative, I need to step away from my computer regularly. I suspect the same is true for most people, so although it's tempting to put in crazy hours when things get tough, I try going for a long walk and having an early night instead—I always work more efficiently the next day.

Having started out as a physicist, where I was one of only eight women in a class of more than 100, I was amazed to find during my PhD studies that there were so many female oceanography students. However, the higher up the food chain I progress, the more I notice the lack of women at senior levels, and thus of role models and support networks. Although everybody is aware of the need to ensure gender balance in departments, on committees, and for other professional activities, these good intentions aren't always borne out. Things must be improving, though—I remember attending an oceanography conference as a postdoc and ending up in a long queue for the ladies bathroom. The senior scientist next to me commented that it had never been a problem when she was a young scientist because she'd been virtually the only woman.

Overall, I thoroughly enjoy my job and am proud to tell everyone I meet that I'm an oceanographer, especially because the inevitable puzzled look I get is an opportunity to tell them about how important the ocean is to our lives.

Karen J. Heywood

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I can't believe it is 10 years since the TOS celebratory issue. I am still at UEA with no desire to move anywhere else. At that time, I was a reader; now, I am a professor. In the UK, there is a clear promotion pyramid in academia, from lecturer, through senior lecturer, reader, to professor. So promotion to professor was hugely satisfying and a great honor; all that hard work had finally paid off. I was the UK's first female physical oceanography professor, and to the best of my knowledge, I am still the only one. I try to be a role model to younger scientists (both women and men). Family-wise, our three boys are now off at university and beyond, which means that work hours can be more flexible (though I still seem to end up working on weekends!). A new challenge is caring for elderly parents.

Science-wise, the last 10 years have been great fun, and perhaps the most enjoyable of my career. I have become involved with ocean gliders. Initially, when I heard talks about gliders, I couldn't see the point. Then, in 2008, I attended a talk by Peter Rhines about Seagliders, and the scales fell from my eyes. It was inspirational, and I could finally see their potential. I returned to UEA and began badgering the university to buy some, which they did in 2009. (Lesson one for younger scientists: never give up!) Like many converts, I am now evangelical about using them. We currently have a fleet of four, and have deployed them all over the world. If there's an opportunity, we try to seize it and worry about the funding afterward. (Lesson two: say yes to all exciting science opportunities! You never know what doors they will subsequently open.)

One of the things I have especially enjoyed about the gliders is the resulting collaborations, especially with biologists and chemists. It's always fun to learn new things, and the gliders give me an opportunity to be involved at the coal face of science. As I wrote 10 years ago and still applies, finding time to do my own science is difficult; most of my time is spent in keeping the plates spinning—the plates being my PhD students and postdocs. The gliders give me a chance to get involved in the piloting, watch the data come in, and be actively involved.

One of the most useful pieces of advice that I was given by a colleague was "do what is important, not what is urgent." Will the world actually end if you don't get those exam questions set this week? Do the administrators really need that form back today or will tomorrow do? (Lesson three: be careful about saying yes to more things than you can cope with! It's good to be collegiate, but don't trying to do so many tasks that you feel stressed or frustrated.)

Ocean science has changed greatly in the last 10 years. Look around the conference room and you see many more women scientists; we now have more female than male PhD students; one of my male researchers is just taking six months paternity leave to care for his baby daughter. It's a great time to be an oceanographer, whether you are female or male.

Enjoying life on a calm day at sea in the Southern Ocean, having just deployed an ocean drifter off the stern.

Barbara Hickey

Professor, School of Oceanography, University of Washington, Seattle, WA, USA, bhickey@u.washington.edu

Barb and her favorite mountain.

I have now successfully weathered 40 years of a primarily soft-money-supported career in the exciting arena of physical coastal oceanography. Times have changed since the days when I was not allowed to go on a month-long cruise because I would have been the only woman, and when women boycotted a meeting because no women speakers had been invited. In fact, recently, all the women students and postdocs associated with our team have obtained academic positions, while the equally talented men struggle to do so.

What I have learned toward the end point of my career is that if you outlast most of your colleagues, you gather breadth, and also, fortuitously, there are few folks left with sufficient background knowledge to dispute your great ideas! I have been lucky in that regard, winning three large and exciting interdisciplinary grants in my last decade that have kept me in the game much longer than I anticipated. Interestingly, I had arrived at a state where I thought that nothing new lived under the sun—I was dead wrong as it turns out. Happy day—what an exciting turnabout! These last three projects enabled me to learn more about the oceanography of my regional coast than I had learned in the preceding three decades. Also, I was able to participate in the development of cutting-edge ecosystem, physical, and chemical models of an upwelling system laced with my favorite features: riverine input, submarine canyons, and remotely trapped waves.

In retrospect, my last decade has been the most enjoyable of all. I have been blessed with marvelous graduate students, exciting science discoveries, and a renewed ability to go to sea once again, as my children were grown and well launched. On the topic of children, my two girls have both inherited my organizational gene, as well as curiosity, writing skills, and self-reliance, and have put these gifts to good use. I believe seeing their mother working on proposals and papers (much work done at home) was a good thing in this regard. I have never considered my children a burden—but as other women have written in this womens' anthology and the prior one—I have been blessed with a husband (non academic, but professional) who cheerfully took on at least half of the household load. The only times I considered leaving the field for my (then enticingly adorable) small children were each time that I initiated a new proposal and was struggling with developing the next salable "big idea." After I got over that proposal hump, however, I never looked back. Knowing this struggle is normal might be helpful to those women just beginning their careers.

At the present time, I am continuing to write proposals and papers, with a focus on assisting young people to carry on our coastal studies at the University of Washington. In parting, I would like to thank all my supporters who were instrumental in helping me grab the "gold ring" last year, when I became a Fellow of the American Geophysical Union.

Jenna C. Hill

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I have loved rocks as long as I can remember, and decided I wanted to be a geologist at an early age. Alongside my traditional toys and dolls, I had rock collections and read children's science magazines like *3-2-1 Contact*. Piecing together a jigsaw puzzle of construction paper continents in second grade sealed the deal for me. While I entertained plenty of other career ideas, I kept coming back to geology. Somewhere along the way, I decided that marine geology sounded fascinating—what could be better than rocks under water? With this in mind, I majored in geology and environmental studies at Oberlin College, a small liberal arts school in Ohio, an unconventional choice for marine science, but one that helped set my course.

With help from my undergraduate advisor and an Oberlin alum, I landed an internship with the Seafloor Mapping Group at the US Geological Survey in Woods Hole, Massachusetts, during my junior year. I returned my senior year and was hired on full-time once I graduated. It was here that I really fell in love with oceanography and began to imagine reconstructing past landscapes and studying how the earth around us has changed over time. From there, I went on to earn my PhD at Scripps Institution of Oceanography, studying the evolution of continental margins, from submarine landslides and gas venting on the US Atlantic margin to climate and sea level reconstructions in Arctic Alaska. I have stuck to my seafloor mapping roots over the years, applying geophysical tools and sediment sampling to a range of topics, from delving deeper into paleoceanography to tackling coastal geomorphology and dabbling in fluvial systems. Cumulatively, I have spent more than a year of my life at sea and love the flexibility of a job that allows me to travel the world on some days and work from home on others.

Lucky to have had many inspiring teachers throughout my education, I was drawn to undergraduate teaching, but did not want to give up having a strong research component. I found just the right combination in my current position at CCU, which has flagship undergraduate and graduate programs in marine science. Now, as a recently tenured professor who teaches three undergraduate classes a semester, I can say that it has been challenging, but also rewarding, to maintain a strong research program. I can see my own success reflected in the dreams and aspirations of my students as they too realize that they can achieve more than they ever expected.

Throughout my career, I have been incredibly fortunate to have been inspired, encouraged, and mentored by so many talented people, both male and female. Although I have been keenly aware of being one of few women in many situations, especially on research vessels, I have never let myself feel that I was less qualified or would not succeed simply because of my gender. I look back at the incredibly successful generation of career women before me and am grateful for the work they have done to make my path that much easier.

Tessa M. Hill

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I like to think that I became an oceanographer the first day that my toes touched the waters of Puget Sound, probably before I could walk. These words began my autobiographical sketch in *Oceanography* 10 years ago. As an oceanographer, I wear many hats—sometimes describing myself as a biogeochemist, on other days a paleoceanographer or an Earth scientist—but always with my toes in the ocean.

While earning a BS in marine science from Eckerd College, I had early experiences in research with several professors, most notably Gregg Brooks, who supervised my senior thesis and encouraged me to think big about science and an academic career. In 1999, I began my PhD studies at the University of California, Santa Barbara, working with James Kennett, investigating the role of Late Quaternary oceanic methane release. I learned many things from Jim, including the value of curiosity in motivating scientific discovery. In 2004, I began a UC President's Postdoctoral Fellowship at UC Davis, working with Howard Spero on deep-sea coral climate archives. In Howie, I found an enduring advocate for my career, and a collaborator with high expectations for what I might achieve. In 2006, when I began a tenure-track position at UC Davis, I felt as if I had won the lottery.

One of the best parts of being an academic scientist is the freedom to follow your interests and inspirations. I have become deeply engaged in integrative work with ecologists, oceanographers, and geochemists on the impacts of ocean acidification. The "paleo" side of my research is now driven toward answering questions relevant to anthropogenic climate change. Other notable events of the past 10 years include achieving tenure and, with my husband, welcoming two kids into our family. These children live the charmed life of scientists' kids—traveling for fieldwork and conferences, talking about research results over dinner, and sharing our enthusiasm for the ocean, microscopes, museums, and shells. They make me a better, more thoughtful scientist. They challenge me to do work that will leave the world slightly improved for them.

A repeating thread through this history is the value of mentors and role models. Equally important has been the steady support from a group of women scientists who have seen me through many ups and downs. This "network" formally meets every six months but is at times in daily communication about the challenges and joys of our lives. My other secret weapon is my husband, who shares in my commitment to a 50/50 split in house and child duties, and in making decisions that support both of our academic careers.

I did not think deeply about "women in science" until I was in graduate school. Over the years since then, thinking about women in science has practically become a daily meditation. What does it mean to be a woman, mother, and mentor in science today? Many of the women in this volume carved the path that I now follow. I do so in a community of women and men who believe that for science to reach its full potential, we need the contributions and perspectives of everyone.

Tessa Hill in the field in Northern California with two helpful field assistants, investigating coastal ocean geochemistry.

Penny Holliday

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The joy and camaraderie of fieldwork is clear in this photo taken on *RRS James Clark Ross* at the end of a seven-week cruise in the North Atlantic in 2014. Scientists from many different countries worked closely together, developing strong friendships and new working partnerships. Penny is second from the left in the second row from the front. *Photo credit: Sinhue Torres-Valdes*

I am a physical oceanographer who has made her way into this wonderful job by a somewhat circuitous route. I developed an interest in the natural world and science as a teenager, along with a strong desire to do the opposite of what society seemed to expect us girls to do. A teacher inspired me to become an enthusiastic landscape detective fond of smashing rocks looking for fossils, and that experience propelled me into a degree in geology. In my class of 35 students at university in 1985, there were five women, and there were no female lecturers in the department—quite a change from my all-girls school.

After graduating, I came across an ad for a position at the Institute of Oceanographic Sciences. It was to serve as a junior science administrator for an international project with the ambitious aim to measure the entire world ocean circulation over the course of five years (WOCE). I was 22 years old, knew nothing about oceanography, something about databases, and had bundles of enthusiasm for science and fieldwork; luckily, they offered me the job.

In 1993, I was asked to go to sea, and my gradual transformation into a physical oceanographer began. On my first cruise, there were just two women in the 25-strong science team, and none in the ship's personnel. A couple of years and two more cruises later, I decided to work toward a PhD on the topic of interannual variability of physical properties and circulation in the subpolar North Atlantic, and it has continued to be my main area of interest. So, my job morphed in two part-time ones: three days per week coordinating WOCE, and two days doing research. I earned my PhD in early 2002, having worked on it part time for six years.

The WOCE office closed at the end of 2002, coinciding with the start of my first maternity leave. I returned as a three-day-a-week physical oceanographer, leaving behind the staff scientist role. Working part time and looking after two young children meant that I had to give up seagoing for eight years, and that was hard for me. It also meant attending few conferences and meetings, not going to social events, and missing all those key meetings that went on after 5 p.m. Most significantly, being primary caregiver meant that for a number of years, I had less mental energy to give to work. This situation has had a significant impact on some aspects of my career, but I have always found great satisfaction in my research, working with many colleagues from around the world, writing papers, and mentoring graduate students.

Now that my children are older, I have returned to my favorite part of the job, being at sea making measurements. I still work part time and I still miss important meetings, but the most challenging years have passed and will have lasted for less than a fifth of my career. Cruises are very different now: on my 2014 cruise, half the scientists were women, and on a cruise in 2011, five of the six-member physics team were women. Oceanography is a fantastic career choice—one of my greatest achievements may be that my daughter plans to be an oceanographer when she grows up.

Bärbel Hönisch

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I have always loved the ocean, swimming in the waves, observing creatures in rock pools, digging my feet in beach sand. When I decided to study biology, I flipped through an encyclopedia, found an entry on the Max Planck Institute for Marine Microbiology, and saw dolphins and whales in my future. I must have been so misty eyed at this prospect that I did not even notice the "micro" in the institute's name. Off I went to study marine biology at the Universities of Bielefeld and Bremen, learned that there is so much more to the ocean than just dolphins and whales, and began to develop a passion for geology and microfossils in particular. During my PhD under the mentorship of Jelle Bijma at the Alfred-Wegener Institute for Polar and Marine Research, I learned about marine carbonate chemistry and how to culture planktic foraminifers. Abhijit Sanyal was a recently minted PhD from Columbia University who had explored the potential of measuring boron isotopes in foraminifer shells for reconstructing seawater pH and atmospheric pCO_2. He introduced me to these analyses, and when I saw my first boron isotope signal appear on the computer screen, he called me the Queen of Boron—I was hooked.

Little did I know then that I had chosen one of the most difficult elements to measure, but Abhijit told me about a seemingly magical mass spectrometer at Stony Brook University, and I had to get to it. So I sent my first publication to Gary Hemming at Lamont-Doherty Earth Observatory, and half a year later he asked me if I wanted to do a postdoc with him. What was meant to be one year in New York became two, followed by another postdoc at Bremen University, and then I was fortunate to be offered a faculty position at Columbia University.

I now have my own not-so magical but very capable mass spectrometer, and over the years I have continued to validate paleo-proxies in laboratory culture experiments and applied those findings to reconstruct pH and pCO_2 on thousands to millions of years time scales. There have been major challenges, in particular when an alternative analytical technique was developed, and I was accused of doing everything wrong and told that I should no longer publish my data. There were times when I just wanted to quit, but the support and confidence of wonderful colleagues and friends at LDEO and elsewhere spurred me to do the experiments that verified my analyses.

I am glad that I did not quit. Even though I am still struggling to overcome the mental toll this dispute has taken on me, I do love my work and all the opportunities that come with it. Now that I am tenured, I am preparing for my first sabbatical, which will take me to Australia and to more fieldwork in Puerto Rico, where we will test foraminifer geochemistry under simulated early Cenozoic seawater conditions. What other job allows you to work in beautiful places and make friends all over the world?

Happy finale of a field season in Puerto Rico with my favorite colleagues Steve Eggins (middle) and former graduate student Kat Allen (right).

Emilie Hooft

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I just received tenure this fall and am now associate professor! My older daughter is and inch and a half taller than I am. She is a freshman on the high school rowing team and loves being out on the water. My other daughter prefers frozen water—figure skating. Her twin brother will do any activity with great enthusiasm. In this busy time of life, my husband and I continue to enjoy spending time together.

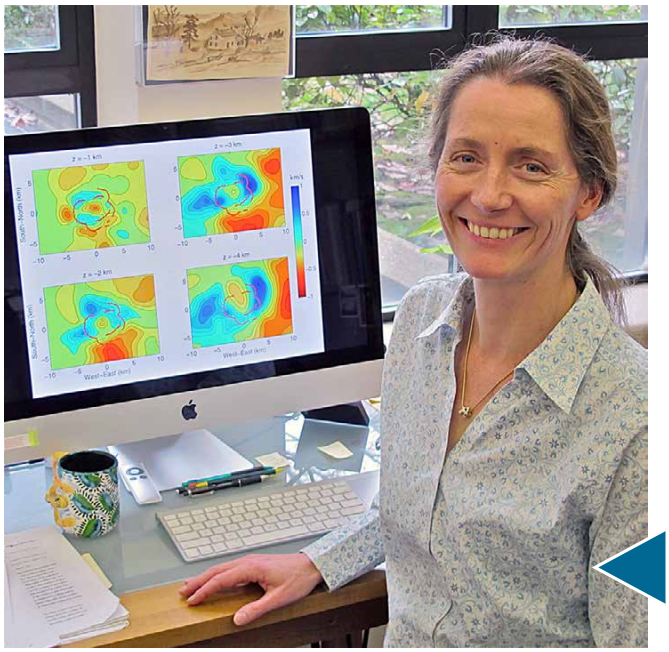
Ten years ago I was Courtesy Research Assistant in the Department of Geological Sciences at the University of Oregon (UO). I was working half time and my oldest was four, while the twins were two. After doing a strong PhD under Robert Detrick in the MIT/WHOI Joint Program in Oceanography and a prestigious postdoc at the Carnegie Institution of Washington, DC, with Sea Solomon, I moved to Oregon in late 1999 to be with my husband, who was a tenured professor at UO. We had our first child shortly after this and the twins 22 months later. Through the first seven years at UO, my career status remained unchanged.

Two years after my autobiographical sketch was first published in this journal, and after some pressure on the UO administration, I received the half-time tenure track position that I had hoped for. I enjoyed the new challenge of teaching in addition to continuing an active research program. I also started working more closely with graduate students, which has greatly enriched my research. Now, after eight years, I received tenure and feel that my file was strong because of the extra years of experience that I accumulated.

Over these years, I have been involved in a number of exciting research projects, including several large at-sea programs and an on-land seismic study of Newberry Volcano. The research on Newberry's magmatic structure and our accompanying YouTube video (http://youtu.be/VbErlYAfWKI) have had considerable impact on my career. I really enjoy going to sea and the challenge of leadership and teamwork under difficult conditions. I was co-chief scientist on a multi-scale seismic imaging experiment on R/V *Langseth*, ETOMO (http://pages.uoregon.edu/drt/MGL0910_Science_Report). I also led a number of cruises for the Cascadia Initiative (http://cascadia.uoregon.edu).

As with most of life, balancing is the most difficult part: balancing work travel with children and family time, and balancing several research projects that currently involve five graduate students and teaching, all in a half-time job. In addition, I lead the growth and development of our children and family and work hard at this undertaking in addition to my career.

All this balance is more straightforward when you keep in perspective that a career is long. Having good colleagues with whom I enjoy working and a husband who greatly admires my abilities have been essential. Lastly, having the courage to take on different challenges makes creative work and continued intellectual growth possible.



Emilie Hooft showing slices of seismic velocity from a tomographic study at Newberry volcano located in Oregon east of the Cascade Mountains. *Photo by Jim Barlow*

Meredith D.A. Howard

Senior Scientist, Southern California Coastal Water Research Project, Costa Mesa, CA, USA, mhoward@sccwrp.org

As a young child, I spent most summer weekends on a boat on Long Island Sound with my family, and there I developed a love of the ocean. By my teenage years, I spent as much time as possible scuba diving in the Florida Keys, and I attended Seacamp during the summers. While the ocean seemed like a natural calling for a career, the marine biologists I interacted with discouraged me due to employment and funding struggles. I listened, and instead chose a more practical and secure career path in finance, earning a BS in business and economics from Lehigh University.

I worked in New York City for several years, and spent all of my vacation days diving. I often wondered whether I had made the wrong career choice. Would I be happy if I woke up in 10 years and still worked in finance? The answer was no. So I changed my life. I went back to school and completed a BS in biology at Rutgers University. My first time in a lab setting was to earn research credits, and I loved it. I was exposed to a number of topics, but I was particularly fascinated with phytoplankton—so small you can't see them but such powerful and influential organisms. I especially loved the harmful ones. I attended the University of California, Santa Cruz, for my PhD, where I focused my research on harmful algal blooms. UCSC had an unusually large number of women faculty in the Ocean Science Department, and they were extremely influential and encouraging. There were many conversations about the challenges of balancing a career in oceanography with family, even with my male advisor. I was given the opportunity to do a joint postdoc between the University of Southern California and the Southern California Coastal Water Research Project, which turned into a permanent position at the end. While this path was rather unconventional, it has allowed me to continue to examine the effects of anthropogenic nutrients on coastal systems, particularly algal blooms (and harmful algal blooms), but on a much broader, more regional scale. It has been extremely rewarding to interact with coastal managers in order to change their misperceptions and to influence their management of the coastal ocean. This work has pushed me to be a better scientist.

I have felt an incredible sense of support and encouragement throughout my oceanographic journey, from both males and females alike. I credit those women who have smoothed the path, and those who have encouraged me to stay on it, despite the challenges. The births of my three boys (including twins!) forced me to create balance in my life. Central to the balancing act of career and family is my extraordinarily supportive husband, especially on the days when I feel both are being shortchanged. The challenges come with large rewards, such as working in an "office" surrounded by water, constantly learning, and being around the contagious enthusiasm that seems to be a personality trademark of most oceanographers. While oceanography may not be the easiest career path, it is certainly the most gratifying.

Julia M. Hummon

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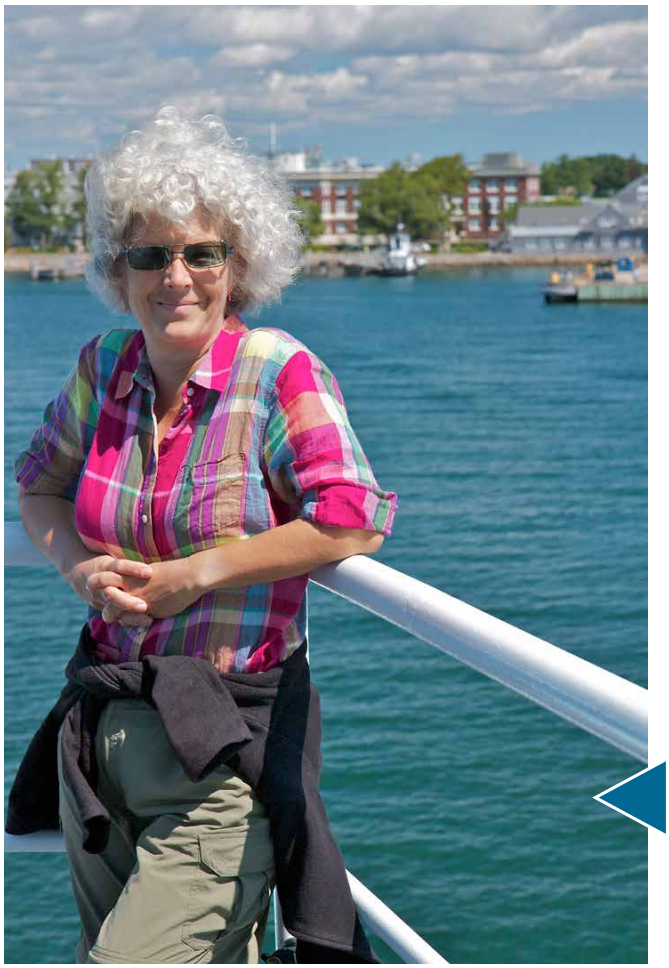
I work at the University of Hawaii for a member of the physical oceanography faculty. We are interested in ocean currents, with an emphasis on the equatorial and polar regions, and rely on measurements collected by acoustic Doppler current profilers (ADCP) as our primary data source. These instruments use the Doppler frequency shift in two pairs of opposing beams to calculate ocean velocities. We use them in one of two modes: mounted to the hull of a ship or mounted on a rosette frame (for full-depth profiling). In the last 10 years, my focus has shifted from seagoing cruises and data processing of lowered and shipboard ADCPs to development, maintenance, and support of a shipboard ADCP data acquisition and processing system, (the University of Hawaii Data Acquisition System [UHDAS]).



Julia Hummon on board R/V *Sikuliaq* as it approached Woods Hole, MA, during the ship's science shakedown cruises in August 2014.

UHDAS is running now on most of the large US research ships, and it will be installed on the NOAA Fisheries ships over the next few years. My work is mostly focused on this project, which involves data processing and interpretation, developing and improving processing algorithms, improving documentation and tutorials for processing, teaching people how to use the processing software (via email and workshops), and troubleshooting and debugging live systems at sea. I help ship operators and seagoing techs keep their ADCP systems running well, and help scientists get the most out of their data.

I knew I wanted to be a scientist when I was in high school, and always assumed I would be a professor in a small college somewhere. I switched majors, trying to find a good fit, and ended up with minors in biology and chemistry, a BS in math, and a master's in math. I wanted to find an appropriate and relevant application for my math background, and decided to go into physical oceanography. After earning my PhD, it became clear that I enjoyed the technical aspects of the work but did not want to be a grant-writing academic. When the opportunity arose to apply for a technical position as opposed to a postdoc, I decided the technical position was a better match for me.

I am happy to be part of the greater scientific endeavor, encouraging the use of ADCPs and improving the potential for good data sets. I love my job: the challenges and the variety, the people I get to work with, the travel and the programming, and I love looking at the data. The ocean is never boring, and I get to interact with it daily, observing ocean currents through UHDAS emails as I monitor the systems that are collecting data at sea.

Susan E. Humphris

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Ten years ago, I was completing a four-year term as chair of the Geology and Geophysics Department at Woods Hole Oceanographic Institution (WHOI). My plan was to return to full-time research studying water-rock reactions in seafloor hydrothermal systems. However, throughout my career, things have rarely turned out the way I planned, and this transition proved to be no exception!

In 2008, I was asked to assume the role of Vice President of Marine Facilities and Operations. While not wanting to commit to this position permanently, I agreed to take it on while a search was conducted to find a replacement. In this role, I had responsibility for ship operations, the National Deep Submergence Facility, and all marine-related activities at WHOI. Although I am a seagoing scientist, my technical knowledge of ships and deep-sea vehicles was limited. I was particularly challenged by two projects: first, submitting a proposal for WHOI to operate one of two new research vessels being built by the US Navy; and second, inheriting a project already in the early stages: to complete a major upgrade of the deep-diving submersible *Alvin*. The new ship proposal was successful, and WHOI will become the operator of R/V *Neil Armstrong* in 2015.

The second—the *Alvin* upgrade project—was not only to occupy the next five years of my life, but would also prove to be the most challenging undertaking of my career. As a scientist responsible for this large engineering project, I was on a steep learning curve regarding the technical aspects of a deep diving, human-occupied submersible, and I was unfamiliar with the project management requirements for such a large undertaking. Although we had numerous issues and were constantly challenged in terms of meeting deadlines and certification requirements within budget, the upgraded *Alvin* has been back in service for the US scientific community since April 2014. Even though it was a very difficult time, I learned a lot from working with a large group of incredibly talented, creative, and dedicated engineers who were responsible for the success of the project.

During that same time, I was heavily involved in leading a small team to engage the US scientific community in supporting a new scientific ocean drilling program. Our role was to develop resources and opportunities for the scientific community to communicate, engage, and educate our peers, university and college senior administrators, and community and national leaders about the importance of maintaining a scientific ocean drilling program to address exciting, urgent, and societally relevant scientific problems.

After loading the newly upgraded *Alvin* onto R/V *Atlantis* in May 2013, I take a last look inside the submersible prior to its departure for the West Coast and sea trials. *Photo credit: Tom Kleindinst, WHOI*

These wide-ranging experiences have immersed me in large technical projects, upper level management, and scientific administration and policymaking. They have broadened my understanding of, and given me a greater appreciation for, the diverse considerations that go into decision making. I now feel better prepared to provide leadership—something I am currently doing in my volunteer role as the chair of the Board of Trustees of the Sea Education Association. But returning to full-time basic scientific research after 10 years of administration is proving a challenge, and one that I am working on in the last stages of my career.

Deborah R. Hutchinson

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This year, 2014, marks the beginning of my fifth decade of marine research with the US Geological Survey. Ten years ago, I was returning to research after six-plus years in management as center director of the USGS Woods Hole office. Happily, I weathered the transition from short tasks/fire drills on personnel, budget, and space (and too rarely science planning), to the longer-term challenges of data analysis and synthesis. While my research time was initially split between gas hydrates and Law of the Sea studies, I followed Law of the Sea opportunities to the Arctic in collaboration with Canadian colleagues, and have spent much of the last seven years working on this frontier area, including three remarkable field seasons on two-icebreaker expeditions, one that came within 90 nautical miles of the North Pole.

I've always felt people can influence their own destinies by the choices they make, whether intentional or not. Some colleagues questioned the scientific opportunities offered by Law of the Sea work, dull as it may sound: using the formulae in the Law of the Sea Convention to define the outer limits of the seafloor beyond 200 nautical miles where a nation can exert sovereign rights. However, while the data are collected for the specific purpose of identifying these outer limits, they can also be used for fundamental studies of the hazards, tectonics, evolution, and stratigraphy of the continental margins of the United States—research opportunities do abound.

The scientific rewards of this work are many, beginning with exploring one of the least known ocean basins on Earth (Canada Basin of the Arctic Ocean) with international collaborators in some of the most difficult, remote field conditions in order to collect marine geophysical (seismic) data. As head of the USGS project, I've had to become familiar with US margins that I've never studied, mostly in the Pacific. I've had to dust the cobwebs off my long-ago graduate studies on global marine geology to understand how the outer limits defined by other nations might change how the US defines its outer limits, which entails finding, reading, and understanding the geology of continental margins from around the world.

It has not all been a piece of cake—just permitting marine seismic work takes so much time now, and sometimes has such stringent restrictions, that it is hard to recommend to a younger scientist that such effort early in one's career is really worth the reward of the data. Working in a multi-agency, multinational arena can also tax one's patience. Language barriers are many, and here I mean lawyers and geologists use the same words to describe different and sometimes incompatible concepts. The learning curve can be long and steep. But, we pursue research because of a certain drive to learn. So far, the frustrations have not won!

My work wouldn't be possible without the support of my family. While I don't routinely take geological vacations, a trip to the Grand Canyon with husband Lee, son Matt, and daughter Abby was a way to share the marvel and grandeur of this remarkable Earth.

Alexandra Isern

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Since I submitted a piece for the first "Women in Oceanography" 10 years ago, my career has taken a number of unexpected turns. These opportunities provided me with a chance to do interesting things at a time when I was ready for a change in direction. In 2005, I was in my third year as a Program Officer at the National Science Foundation (NSF), working on developing new initiatives and managing an interdisciplinary research program as well as the Ocean Technology Program. Although I didn't appreciate it at the time, the variety of professional experiences I had accumulated up to that time helped me frame my current career.

After six years in the Division of Ocean Sciences, I felt that I needed to broaden my project management skills, so I moved to the Office of Polar Programs to manage science support logistics as part of the US Antarctic Program, and subsequently I was the program officer for the Antarctic Earth Sciences Program. A big challenge in moving to the Antarctic Program, other than being a South Floridian learning to deal with the cold, was the steep learning curve needed to understand Antarctic logistics. However, my biggest challenge was learning how to promote change in an environment that embraces tradition and where I was, at least at the start, an outsider. This experience taught me how important tenacity can be in effecting change. You cannot just give up when someone tells you no. You need to keep reframing and honing your arguments until you make progress. This experience also taught me the importance of patience and listening, which helped me determine where new ideas would best take root and be worthwhile.

After seven years in the US Antarctic Program, I was presented with an opportunity to move into a leadership role in NSF's Division of Earth Sciences Surface Earth Process Section. Although this has moved me a bit farther from my oceanographic roots, it again demonstrated to me how important the varied training I received as an oceanographer has been to my ability to move into new disciplinary areas. I am really enjoying working with a growing research community that is focused on societally relevant research into areas such as the impact of climate change and anthropogenic activity on water resources and the critical zone, where rock, soil, water, air, and living organisms interact.

A day in the field visiting research sites in the McMurdo Dry Valleys of Antarctica. *Photo credit: Mark Kurz*

So, what have I learned in the past 10 years? One of the most important lessons is that it is important to continually look for opportunities to broaden your experience. It takes effort and some courage to move outside your comfort zone. But without this effort, you limit your possibilities and your creativity. I have also learned to be more deliberate about developing my career. Seek out mentors to help you navigate in the direction you want to go. They can be a great help in building a career roadmap that is realistic and achievable. Most importantly, seek out activities that help you gain self-awareness. This will help you make better decisions and be more successful at whatever you do.

Libby (Elizabeth) Johns

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In 2005, when the previous "Women in Oceanography" issue was published, I was back to working full-time after spending 11 years in a part-time status while my three children were young. I had moved from strictly blue water physical oceanography, studying western boundary currents and inflow patterns into the Caribbean Sea, to interdisciplinary oceanography focused primarily on South Florida coastal waters and the effects of the Everglades Restoration.

Since that time, I have continued with my research in South Florida coastal oceanography, and have expended my interests to include fisheries oceanography, specifically, collaborating with scientists from NOAA's Southeast Fisheries Science Center's Early Life History group. We go to sea approximately once per year for several weeks and collect physical, chemical, and biological data, including net tows for larval fish. Our areas of interest have focused on the Florida Keys/Dry Tortugas, the Mexican and Belizean Yucatán, and the Northeast Caribbean Sea from Puerto Rico and the Virgin Islands to the Lesser Antilles. The goal of this project is to better understand how regional circulation and water properties affect the abundance, distribution, and variety of larval reef fish, with an emphasis on economically important fish species. This information is then made available to resource managers who need to make decisions about such things as Marine Protected Areas (MPAs) and other fisheries-related topics. We are presently in the early staging process for a spring 2015 cruise that includes a chance of obtaining clearance to expand this work into Cuban coastal waters. This would be a significant advancement for our group and would fill a geographical gap in our knowledge of this area of the Caribbean and its connectivity with South Florida coastal waters.

I would say that one of the biggest challenges I have faced has been trying to be a caring, involved mother while pursuing a professional career. I think the key to this conundrum is to continually reassess how all of the components of life fit together and to be willing to make changes as the need arises. For example, my children are now young adults pursuing their careers and their lives with great enthusiasm, so I find that I have more time to concentrate on my research goals. But I am very happy that I was able to be there for them when they were younger and needed more of my time. (It also didn't hurt that I have an understanding husband who has always been willing to accept change.)

The other challenge that I faced in my career was making the transition from strictly physical oceanography to the kind of interdisciplinary, applied oceanography that I find most rewarding now. To be able to make this change took a bit of convincing and "salesmanship," but I am thankful that my laboratory was able to see the value in this type of research and has been highly supportive of my various endeavors.

I think that my story makes a case for the value of not settling for the status quo, but rather to maintain a mindset that is constantly evaluating how the various parts of a happy and successful life can best complement each other. There are many choices available to women at all stages of life, and it is of great importance to make decisions purposefully and not be afraid of changing direction when necessary.

Libby is shown offshore of the island of Great Inagua, Bahamas, riding on the ship's tender to join the NOAA Ship *Ronald H. Brown* for an interdisciplinary research cruise in the northern Caribbean Sea.

Ashanti Johnson

Assistant Vice Provost for Faculty Recruitment and Associate Professor of Environmental Science, The University of Texas at Arlington, TX, USA, and Executive Director, Institute for Broadening Participation, ashanti@uta.edu, ajohnson@ibparticipation.org

As one of just a handful of female African American oceanographers, I recognize the benefit of having a strong support system comprised of my family, colleagues, mentors, and friends. These individuals often provide encouragement during tough times and sound advice at periods of transition in both my professional career and my personal life. My scientific research focus began while examining sediment cores collected from the Lena River estuary in northern Siberia. Since then, I have conducted radiogeochemistry investigations in the Savannah River estuary (Georgia), Tampa Bay (Florida), and Puerto Rico. Now, as an established chemical oceanographer and environmental scientist who utilizes radiogeochemistry tools and techniques to examine the behavior and transport of anthropogenic material in aquatic systems, I devote myself to conducting scientific research and facilitating the advancement of other members of under-represented minorities (URMs) who are committed to achieving successful STEM (science, technology, engineering, and mathematics) careers.

Zig Ziglar once said "True joy comes when you inspire, encourage, and guide someone else on a path that benefits him or her." Most of the projects I engage in involve this principle. They include various activities designed to facilitate research and professional development experiences for students from diverse socioeconomic, cultural, gender, racial, and academic backgrounds. My other current endeavors are directing the NASA and National Science Foundation (NSF)-funded Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S®) initiative (http://www.msphds.org), the NSF-funded University of Texas System's Louis Stokes Alliances for Minority Participation (LSAMP) Bridge to the Doctorate Graduate Fellowship Program at the University of Texas at Arlington (http://www.uta.edu/admissions/lsamp/bridge-program/index.php), and the NASA One Stop Shopping Initiative Broker-Facilitator Corps (https://intern.nasa.gov). I have been fortunate to offer professional service through my participation in the White House Forum on Minorities in Energy, the National Academy of Science's Advisory Group for the Gulf Research Program, the Human Capital Executive Research Board for the magazines *Diversity Executive* and *Talent Management*, the White House Workshop on STEM Minority Inclusion, the American Geophysics Union Waldo E. Smith Award Committee, and the Association of Universities for Research in Astronomy Committee on Workforce and Diversity. In recognition of this service and for my commitment to support advancing URMs in STEM, I have received numerous honors and awards, including a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring; recognition by NBC's TheGrio.com as one of "100 History Makers in The Making"; and being profiled in the "Women In STEM" feature story in *Black Enterprise Magazine*.

I am able to support many people because my own support system helps me balance research, teaching, and various professional and personal activities. When life becomes challenging, you need people who will help and encourage you. I am known to work hard and long hours, but sometimes you may catch me at the movies in the middle of the day, smiling over something funny that one of my children said, or even dancing in the office. With my extended circle of love and support, I stay positive, upbeat, and committed to the spirit of giving.

Elizabeth (Libby) Jones

Postdoctoral Researcher, Centre for Energy and Environmental Sciences, University of Groningen, Groningen, The Netherlands, e.m.jones@rug.nl

I grew up in Ashby de-la Zouch in the middle of England, the furthest point from the sea in the UK. Travels across the seven continents over the last 30 years have given me a sense of wonderment about the planet. More recently, diving in Asia, Australia, the Caribbean, and the Middle East left me with a fascination with the ocean. I pursued an organic chemistry degree at Durham University, following my interests in the natural world by working as a conservation volunteer at Heron Island Research Station (Great Barrier Reef), studying lesser flamingos at Lake Bogoria (Kenya), and supporting the River Otter Project (Brazil) and Sea Turtle Protection Society of Greece (Crete). In 2005, the Royal Society report on ocean acidification brought my natural science and conservation interests together. This led me to the University of East Anglia and the British Antarctic Survey for a PhD, with Dorothee Bakker and Andy Watson, investigating the marine carbon dioxide (CO_2) cycle of the Scotia Sea, Southern Ocean. Here, a new life in carbonate chemistry and ocean acidification of the polar oceans began.

Following my PhD, I had two postdoctoral positions, first with Hein de Baar at the Royal Netherlands Institute for Sea Research, and then with Mario Hoppema at the Alfred Wegener Institute for Polar and Marine Research in Germany. Both gave me fantastic new experiences; stepping onto the Antarctic ice shelf (71°S) and flying over the Weddell Sea pack ice absolutely captivated me. In 2013, I returned to the Netherlands to work at the University of Groningen with Hein de Baar and Henk Moll on a project of the New Netherlands Polar Program. Setting up CO_2 time series sampling at Rothera Research Station with the British Antarctic Survey core program was the chance to achieve a life's dream. A major challenge is understanding the role of sea ice in the oceanic CO_2 system and how climate change affects the CO_2 system of the polar oceans. This rewarding position is giving exciting new results in very challenging and inspiring conditions. Furthermore, this work is set within the context of CO_2 and climate policy, allowing me to find a niche in the field of polar CO_2 chemistry and climate change.

I have happily found my "equilibrium" in the Netherlands and would like to build my future here. The path I've taken has been challenging, often moving house and sometimes feeling a long way from home. Keeping focused on exciting new experiences has helped as has the ability to carry my office with me on the road, sitting with my laptop at numerous interesting locations. Fantastic support from my English and Dutch family has made all this possible (thank you very much, dankjewel). To me, the following quote sums up my oceanography journey nicely: "Life is like the ocean. It can be calm or still, and rough or rigid, but in the end, it is always beautiful."

Enjoying the sun with a resident Adélie penguin at Rothera Research Station, Antarctica. The photo was taken during the first season setting up the new CO_2 time series in Marguerite Bay as part of the core sampling program of the British Antarctic Survey and a new project of the New Netherlands Polar Program.

Ellen Kappel

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Ellen in Iceland, September 2012

In the last decade since I shared my autobiographical sketch, my two kids have grown up and gone off to college—and one has already graduated. My two English Pointers grew old and died, and a set of three dogs of the same breed now keeps me fit. Professionally, I have kept up my Geo Prose work, editing *Oceanography* and working with the geosciences community on polishing documents in support of research programs large and small. I remain a generalist, enjoying the constant stimulation of learning new science with every project that I tackle.

Along with maintaining a diverse and interesting workload, running a home-based business was a perfect way to be available when my kids got home from school or to watch them participate in their sporting events. I haven't had to battle rush hour traffic around Washington, DC, for years, and I can walk my dogs and run my errands on my own schedule. Importantly, working from home gave me the flexibility to visit my elderly mother nearly daily as she declined. But working from a home office every day of the week has its drawbacks. As a social person who thrives on working in teams—whether going out to sea, collaborating on research in the lab, or working in an office full of dedicated people—the loneliness and isolation of a home office can be tough. You really have to work at remaining networked, or colleagues will forget to invite you to participate in professional activities. It's difficult to be your creative best when you don't have a colleague down the hall to trade ideas with at the drop of a hat. Simply sending emails all day without talking to colleagues in person can also chip away at your social skills.

I am confident that the new generation of women scientists will be more adept at navigating a working world where they can work productively from home (should they wish to) without penalties to their advancement. There are many tools available now to allow that to happen. A laptop and software permit participation in review panels and workshops without stepping on a plane. Nimble software and the cloud allow easy collaborations on papers, data sharing, and a host of other ways to participate in research, wherever you are located. If you are a user of social media—and the variety of outlets is ever expanding—they can keep you constantly connected. Few of these collaborative tools existed in the first decade that I worked from home.

I haven't had any new and entertaining sea stories to tell for a couple of decades at least, and I haven't won any awards for outstanding research (or anything, for that matter). What I have is a bookcase full of *Oceanography* magazines and science plans and brochures in which my graphic designer Johanna Adams and I helped the geoscience community articulate its successes and challenges. They remind me daily that I've had at least some small part in helping to promote and sustain our community's dreams.

Miriam Kastner

Distinguished Professor, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, mkastner@ucsd.edu

I have spent most of my career at Scripps Institution of Oceanography—a great place to work. I particularly enjoyed working with the bright Scripps students and the wonderful interdisciplinary faculty, using its top-tier facilities, and taking advantage of seagoing opportunities.

Early in my career, I was often the first and/or only woman serving on most national and international committees. In that capacity, I encountered many interesting and curious situations. At that time, it was rather difficult for women scientists to get support for research from funding agencies; some of the program directors regarded funding women a waste of resources. I am delighted to see the significant progress over the past ~ 30 years in how women are perceived, in the support young women scientists receive, and in the scientific impact women have on their fields of research.

Although gender issues have not fully disappeared, women are now encouraged to pursue their careers and are given resources to do so. For at least the past 15 to 20 years in the Earth sciences and oceanography at all of the leading universities and research institutions, close to 50% of the PhD degree recipients have been women. What concerns me, however, is that at the same universities and research institutions, women faculty members in these fields comprise only a maximum of ~ 20%. The universities and research institutions are not the only ones to be blamed; women scientists are also responsible for this situation. Unfortunately, when faculty positions are advertised, only ~ 20% of the applicants are female. It seems that many women scientists drop out after their PhD and postdoctoral work. For some reason, they become discouraged from pursuing research and/or teaching careers. The reasons for this significant dropout among young women scientists need to be clearly identified and urgently and properly addressed.

Many of today's young women scientists do not realize that the present support system for them is much better than it used to be. They need to appreciate that improvements did not just happen without many of their mentors working hard and enduring many difficulties over the years; yet, there is still much to be desired. Young women scientists will still have to work hard to improve the situation for their students until one day the gender problem may disappear. Aspiring young women scientists will succeed by doing the best they can and not expecting special favors. Self-confidence is most important.

Suzan Kholeif

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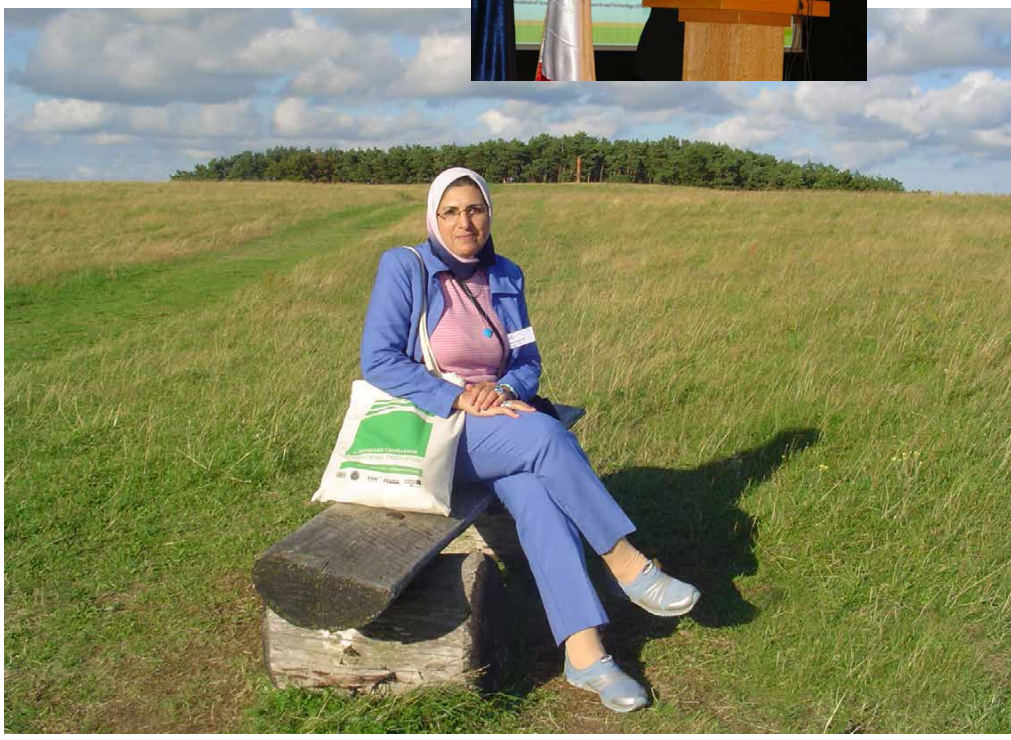
I am an oceanographer, marine geologist, and ecologist. Since 1994, I have been working at the National Institute of Oceanography and Fisheries (NIOF), Alexandria, Egypt, as researcher, professor, and consultant. My research includes assessment of coastal waters, shore protection, climate and sea level changes, and Environmental Impact Assessments (IEAs). I have also had many opportunities to collaborate with scientists outside of Egypt. I have used my skills in developing and managing both managerial and technical tasks through my roles as Director of the Scientific Documentation and Media Unit and Head of the Marine Geology and Geophysics Lab at NIOF, as well as across several national and international projects relating to the marine environment. These have included monitoring of marine waters and promoting integrated coastal zone management. I have participated in many international programs such as assessing and predicting changes in the Mediterranean and Black Seas ecosystems (SESAME, 2007–2011); the Quaternary Climate Fluctuations Study on the Nile Continental Margin and the Mediterranean Nile Deep Sea Fan (2008–2010); evaluation of chemical contamination in the Eastern Mediterranean through transplanted mussels (MYTIOR project, 2009–2010); the multi-nation AQUAMED project regarding the future of aquaculture research in the Mediterranean (2010–2014); the Fisheries and aquaculture Oriented Research Capacity in Egypt (FORCE) project (2011–2014); and Marine Dynamic Indicators of North Africa (MEDINA, 2010–2014). I have also been on the advisory board of the current European Commission 7th Framework (FP7) project "Fostering sustainability and uptake of research results through Networking activities in Black Sea & Mediterranean areas" (IASON, 2013–214), and have served as an expert for the project Mediterranean Innovation (MIRA, an FP7 project, 2011–2013), and as national coordinator for the project People for Ecosystem Based Governance in Assessing Sustainable Development of Ocean and Coast (PEGASO, 2010–2013).

In the last 10 years, I have also acquired a reputation as an expert on the marine environment, both at national and international levels, especially in water resource monitoring and planning in Mediterranean countries (particularly in Egypt and other North African countries), by developing guidelines for sustainable use and innovative methodology for management of wild resources, focusing on the ecological cycles of Mediterranean aquatic resources.



Gail C. Kineke

Associate Professor, Boston College, Chestnut Hill, MA, USA, gail.kineke@bc.edu

A series of loosely connected opportunities and choices led me to where I find myself today. Spending summers at Nauset Beach on Cape Cod, enrolling in an oceanography course in college because the lab time did not conflict with soccer practice, a semester in Sea Education Association's program, and teaching ninth grade Earth science my first year out of college—these experiences nudged me toward applying to graduate school, even with no long-term plan in mind. I landed at the University of Washington School of Oceanography, with an awesome advisor and mentor, Dick Sternberg, and a phenomenal cohort of graduate students in the late '80s and early '90s. Initially, I only considered a master's degree, but I was in the right place at the right time when my advisor was asked to join a large interdisciplinary program on the Amazon shelf. He suggested it would be a great opportunity for PhD work. I didn't think twice, and I've been "stuck in the mud" ever since, studying fine sediment transport in shallow shelf and estuarine systems—the muddier the better.

I consider myself a coastal oceanographer and am currently an associate professor at Boston College and an adjunct scientist at Woods Hole Oceanographic Institution. I enjoy the best of both worlds, teaching at a great liberal arts university where undergraduate education is strongly valued, and a member of the research community at one of the best oceanographic institutions in the world. In the 2000s, I became the first woman tenured in my department and the first female department chair (perhaps the most demanding period of my career). Even though opportunities abound for young women, and have for some time, we still have work to do to see more women at all levels in research and academia.

I have always enjoyed working on boats, no matter the size, and I use a variety of instrumentation for field measurements to test sediment-transport models. Like many oceanographers, my research is my ticket to see the world, and I've studied sediment dispersal from muddy rivers and coastal processes on five continents. In addition to seeing firsthand the beauty and variety of some of the world's coastlines, I've been able to work with outstanding colleagues and develop lasting friendships.

Perhaps the most rewarding moments come when former students visit or I run into them at professional meetings, especially those I worked with as undergraduates. I feel a great sense of pride to see students, with whom I shared a brief time during their formative college years, in graduate programs, as new PhDs, and as postdocs, and I enjoy meeting their partners, spouses, and children. Teaching and doing scientific research would not be nearly as satisfying without the people along the way who make it fun.

Sailing on Vineyard Sound near Woods Hole, Massachusetts. I spend most of my free time sailing with my partner of 22 years, Dave, a professional seaman and former captain of a coastal research vessel.

Emily M. Klein

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One would think that by my 50s I would have a pretty good sense of the road ahead. After all, with 25 years as a scientist and professor at Duke University behind me, my career path would seem to be pretty set. My children—who occupied much of my attention as I worked to balance life as a seagoing scientist and a mother—are now young adults and building lives of their own. And yet, writing now 10 years after my first contribution to "Women in Oceanography," I feel anything but settled—rather, I feel ready to jump into something new and challenging, although exactly what form that will take is not yet clear.

Apparently, it is part of my genes that I periodically feel compelled to change direction. Just as I wrote 10 years ago about my crazy career path—from English major to oceanographer—the past 10 years have been similarly eclectic. On the one hand, I continued my passion for oceanographic exploration, and led the most ambitious and exciting multidisciplinary research cruise of my career. But at the same time, I accepted a position as a dean at Duke because I was curious to try my hand at running things. I confess that I was surprised at how much real satisfaction I got from helping to make big things happen in the university and that I considered moving up in administration. And yet, after six years, I found that I longed for the more contemplative life of a scholar and teacher. I particularly missed the rich sense of fulfillment that comes from being fully engaged with my community of colleagues and students. So, with that self-recognition, I doffed my many administrative hats, and with the benefit of a long-deferred sabbatical leave (thank you, Lamont!), I reconnected with long-standing colleagues and began to build what I hope will lead to promising new scientific collaborations. In some ways, I feel a bit like a graduate student again, delving into the literature on what are, for me at least, whole new fields of research as I try to figure out what scientific problems I'd most like to work on.

One great thing that came from my stint in administration, though, is that I have begun to think more systemically about barriers to women and under-represented minorities in science. When I was the first female faculty member hired in the department of geology at Duke, I thought: well, I'm the first but there will be many more after me. Fast forward 25 years, and there are now three of us—despite numerous hires in the interim and the fact that our doctoral population is more than half female. And this is true not only of geology, but all of the sciences, at Duke and elsewhere. So despite my promise to myself to shed administrative duties, I have nevertheless committed to a multiyear faculty-led effort of self-study to try to bring about real change. My hope is that if we write these contributions in another 10 years, there will be great progress to report.

Karen L. Knee

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All my life, I've been drawn to the water. Although neither of my parents ever really learned how to swim, they signed me up for lessons as a preschooler, and I moved quickly up through the ranks. By age four, I was jumping off the diving board into the deep end. Growing up in Charleston, South Carolina, I spent countless happy days at the beach, not only swimming but observing the waves, the varied marine life—including dinner-plate-sized jellyfish, bioluminescent zooplankton, and bottlenose dolphins—and the intricate patterns left by the interplay of water and sand.

When the time came for me to choose a career, it was important to me to be outside, preferably on the water, at least some of the time. I knew that I wanted to work on understanding and preserving the natural world. I had enjoyed my science classes in high school and college and read about various scientific topics in my spare time, so a research career seemed like a good fit. The variety and adventure inherent in field science were also major selling points. In my career, I get to travel to exotic and random places, challenge myself physically and intellectually, develop a deep sense of camaraderie with my co-workers, generate new knowledge in my scientific field, teach at the college level, and communicate my research to others through journal articles, posters, presentations, and outreach activities. I often feel overwhelmed, but I'm never bored, and mostly I feel incredibly lucky to have a job that is so much fun.

The overarching theme of my research is how human activities influence water quality. In particular, much of my work has focused on using the natural tracers radium and radon to measure submarine groundwater discharge and the pollutant fluxes associated with it. Recently, I've begun investigating how radon can be used to trace gas exchange at the water's surface. I am also looking at how urbanization and hydraulic fracturing can influence water quality in streams, estuaries, and Chesapeake Bay.

I just started my first "real" job a few years ago, so I think that the major challenges and rewards of my career probably lie ahead. So far, the biggest challenge for me has been learning to persevere in the face of doubt and disappointment. In science, you get a lot of criticism and relatively little encouragement, and it can be hard to get used to this if you've been an academic high achiever your whole life. Because there are few official goals and milestones, it's easy to feel like you're always behind. As a result, I've learned to take pride in my own small achievements and rely less on the praise of others for affirmation.

I'm also fairly new to parenthood—my daughter was born in September 2013. Saying that time management is a challenge would be a major understatement, and, to be honest, I feel a lot of uncertainty about whether it will all work out well in the end. But I love my daughter, and I love my work, and even though some days (and weeks, and months) are exhausting, they are also filled with discovery, accomplishment, and joy.

Karen Knee in her lab at American University with her daughter, Maggie. *Photo credit: Kevan Moffett*

Yoshimi Kubota

Researcher/Curator, Department of Geology and Paleontology, National Museum of Nature and Science, Tsukuba, Japan, yoshimi@kahaku.go.jp

My research interests focus on using microfossils found in marine sediments to understand the climate system, ocean circulation, and interactions of the two. I conduct stable isotope and trace element analyses of the fossil skeletons of foraminifers to reconstruct the Quaternary paleoenvironment.

My pathway to becoming a paleoceanographer was not direct. When I was a high school student, I had a variety of interests in science, including physics, history, and archeology, but never really thought about being a scientist. Although I did not have a chance to learn Earth science in high school, I found the Earth science I encountered at Kyoto University very interesting. After my undergraduate studies, I enrolled in a master's program at the University of Tokyo to study paleoceanography under the guidance of Ryuji Tada. I have always loved history and archeology, so paleoceanography, which involves aspects of both, fascinated me. Since then, I have been involved in investigating the history of the Asian monsoon and the evolution of the Kuroshio using marine sediment cores from the East China Sea and the western North Pacific.

The biggest challenge I faced was determining whether or not to pursue a career as a scientist. During my master's course, I struggled with anxiety about my abilities as a researcher. Surviving the highly competitive academic environment seemed too difficult, and anxiety drove me to spend as much time studying as possible. After completing the two-year master's course, I took one year off to think about different career options, such as becoming a science writer or communicator. In the end, a career as a scientist was more attractive because I felt there was more creativity in research. I also realized that paleoceanography is a field where much remains to be uncovered, and it is worth investing the rest my life trying to discover something new in the ocean.

Currently, I find my work as a full time researcher/curator at the National Museum of Nature and Science in Japan to be enjoyable and rewarding—especially when I have a "Eureka!" moment. Even though it may not be a major breakthrough, and does not occur often, these moments help sustain my passion for research. By taking advantage of my time as a museum curator, I hope to broaden my research interests in paleontology to include such topics as the influence of paleoenvironmental changes on biological evolution.

(top) Yoshimi Kubota searching for planktonic foraminifers on Integrated Ocean Drilling Program Expedition 346. Evolutionary changes in the foraminifers are used to determine the ages of the sediments recovered. (bottom) Yoshimi Kubota (forth from left) aboard the drilling vessel *JOIDES Resolution* with the micropaleontology team of Integrated Ocean Drilling Program Expedition 346. *Photos credit: William Crawford, IODP/TAMU*

The percentage of women who have full-time positions in science is still considerably low in Japan. Only five out of 61 full-time researchers at the museum are women. Increasing the number of female role models in science is crucial to encouraging younger women to become scientists. Therefore, I believe it is my duty to become a role model for future female scientists.

Elizabeth Kujawinski

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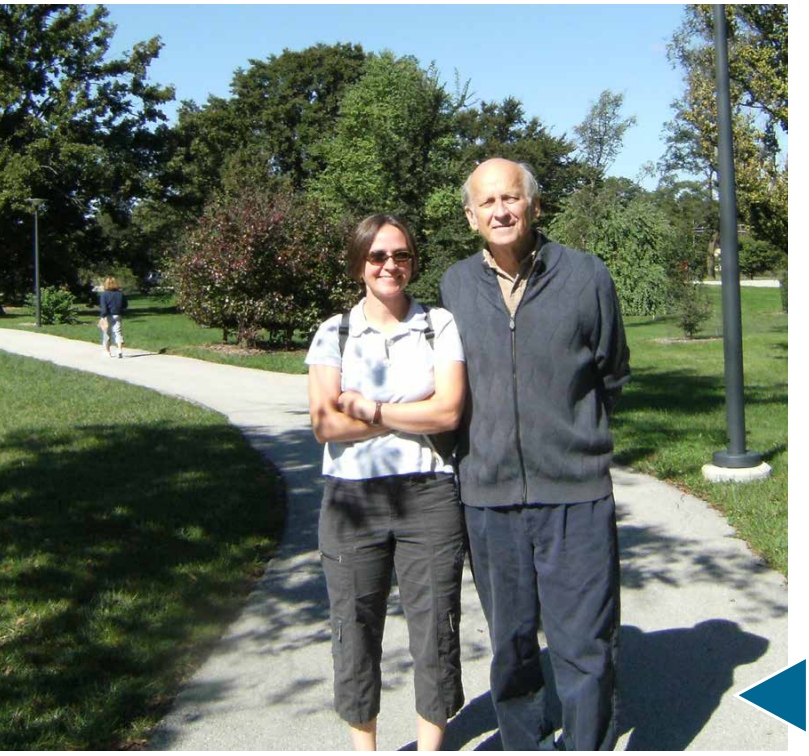
I am a chemical oceanographer because I like to ask questions about the world around me and then to participate in answering them. I find great beauty in the juxtaposition of simplicity and complexity within chemical structures, and I want to know how these chemicals are made and transformed in the environment. Chemical oceanography, therefore, is a natural marriage of chemical discovery and environmental exploration.

My research focuses on the role of microorganisms in chemical cycles. My group uses advanced analytical chemistry tools to detect, identify, and quantify new biomolecules in laboratory and field systems. We place our data within the context of biochemical pathways predicted by microbial gene sequences. Thus, we situate ourselves within an interdisciplinary network of fellow scientists, all of us striving to understand the mechanisms at the foundation of the carbon cycle. I find the intellectual puzzles of this work immensely satisfying, and I am fortunate to be joined in these endeavors by great colleagues within my lab and my broader oceanographic community.



Liz with her father in 2008.

I started the journey to this place in the midwestern United States, on the shores of Lake Michigan. Throughout my childhood, my parents encouraged my interests in math and science, pushing me to attend rigorous schools and to participate in extracurricular math and science programs. My father, in particular, had no patience with gender-based assumptions about math and science ability, and he held my grades and math/science activities to extremely high standards. His ever-present confidence and encouragement paid off when I was admitted to my first choice college in Boston.

As I look back on the 24 years since I left home, I see that the foundation he instilled has helped me recognize and take advantage of numerous scientific opportunities. While an undergraduate at MIT, I took an ecology course with Penny Chisholm, who introduced me to oceanography—and arranged my first oceanography research internship at Woods Hole Oceanographic Institution. From that point on, I shifted my chemical interests to environment-based questions, and I have never looked back. I went to graduate school in oceanography, did a postdoc in analytical chemistry, taught environmental chemistry at a liberal arts college, and now work at an oceanographic research institution. Through all these experiences, I have been blessed with many fine colleagues, friends, and mentors, culminating in a rich professional life.

As I move forward, my biggest challenges derive from a desire to balance my research career with my family life. I am one-half of a dual-career couple, and both of us travel to far-flung field locales. We have two children and extended families that deserve our attention and care. To date, we have managed these responsibilities with mostly good humor, but this balance remains delicate and requires mutual respect, humility, and a commitment to make it work. Nevertheless, I wouldn't trade this life for a different one. By example, I hope to show my son and daughter, not to mention my postdocs and graduate students, that this life of balancing oceanography and family is not only possible but also ultimately rewarding.

Kara Lavender Law

Research Professor, Sea Education Association, Woods Hole, MA, USA, klavender@sea.edu

Kara Lavender Law climbing the rigging of SSV *Corwith Cramer*, one of two tall ship sailing oceanographic research vessels operated by Sea Education Association (Woods Hole, MA).

I have always enjoyed math. As a kid, I completed math workbooks in the summer for fun. I loved the logic games and puzzles in *Games* magazine. I took an extracurricular course in Basic programming in third grade. But I didn't particularly like science, perhaps because of the focus on memorization rather than problem solving in K–12 science education at the time. It wasn't until a semester at the Duke University Marine Laboratory and a subsequent Intro to Physical Oceanography course as an undergraduate at Duke that my interest in science, and oceanography, was piqued. For the first time, I applied math skills to scientific problems. That, coupled with the notion of working in shorts and flip-flops with a view of the ocean, led me to pursue a career in oceanography.

I had always been one of only a few women in my math courses, and while numbers increased in my PhD program in physical oceanography, a disproportionately large number of women left the program before completing a PhD. I was involved in an informal study investigating this attrition and, while no firm conclusions were drawn, in the nearly two decades since, I have observed repeated themes such as work-life balance and challenges of working in a historically male-dominated field. I was honored to participate in a workshop to design the successful MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) program, which relies on active mentoring and support to overcome common career challenges that women (and often men) face. I have been very fortunate to have one exceptional female role model beginning with that first course in physical oceanography. Yet, I am also dismayed that there have not been more women scientists with a life and career I could envision for myself.

While my career path started out quite traditionally—PhD followed by a postdoc—I never had "traditional" career ambitions to become a tenured faculty member or a senior researcher. Instead, I longed to teach, and took a position on the oceanography faculty at Sea Education Association (SEA) in Woods Hole, Massachusetts, teaching undergraduates from schools around the country, on shore and at sea in the SEA Semester program. By teaching and leading student research projects in all fields of oceanography, I honed my research skills, broadened my knowledge base, and became interested in a broad suite of oceanographic questions. During this time, I also met and married my (nonscientist) husband, Jeremy Law.

After teaching and sailing for six years, my career curved in a new direction when I began thinking about plastic debris in the ocean during an analysis of SEA's 20+-year data set. At the same time, our family life curved as well, with the birth of our daughter, Kelsie (now 5). The timing, while coincidental, was an excellent twist of fate, allowing me to continue my plastics research part time, working from home with an infant, while moving 500 miles inland to follow my husband's career. Since then, we have moved back to the coast (of Maine), had a second baby, Sam (now one), and I continue to work from home, growing my career in the young field of marine debris. The work-life balance has been a struggle at times—trying to keep track of everything from laundry to kids' appointments, from lab work to paper deadlines, and still trying to go for a run in the midst of it all. It is a continual process of refining my goals and my boundaries, at home and at work, to maximize the richness of being both a scientist and a wife and mom.

Sonya Legg

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I am a physical oceanographer specializing in understanding turbulent mixing processes such as internal wave breaking and gravity current entrainment, primarily through the use of numerical simulations and theory, but strongly motivated by ongoing ocean observations made by my colleagues.

A multitude of accidents and opportunities determined my field of study rather than any concrete long-range plan. After studying physics as an undergraduate, I originally intended to pursue a PhD in dynamical meteorology. However, the idealized theoretical/computational model I was using at the beginning of my graduate study turned out to have more direct application to oceanic processes, particularly deep convection. I continued delving into deep convection processes as a postdoc, and became familiar with high-resolution numerical simulation as a result of involvement in a high-performance computing project. A few years later, when I wanted to broaden my interests beyond deep convection, exciting new observations inspired me to investigate mixing driven by internal waves, and now much of my work is focused on improving the parameterization of ocean mixing in climate models.

I love the way that oceanography requires the use of many different techniques—theory, numerical modeling, observations, and laboratory experiments. Even though we individual scientists usually specialize in a small subset, we need to collaborate closely with specialists in other areas to fully understand a problem. This variety of approaches keeps work interesting.

Since I met my husband as a fellow graduate student, we've had to continuously find ways to advance both of our careers simultaneously while keeping our relationship and life together intact. This meant spending most of our disposable income on air tickets as postdocs, then taking jobs 90 miles apart with the associated strain of commuting. When we had children, we realized that couldn't be sustained, so we looked for two good jobs close together, finally settling in Princeton 10 years ago. We've had to restrict our job choices to institutions with a big enough oceanography program to be able to include both of us, and now that our kids are in high school, we feel it would be very difficult to move, even if potentially exciting opportunities came along.

Unfortunately, I think conditions for women in oceanography haven't changed as much as I would have expected in the past 20 years. When I was a grad student, there were only about three women faculty in my department—now I'm the only woman faculty member in my program. I thought (hoped) women would be up to at least one-third by now, given our numbers when I was in grad school. This situation has not affected my research, but it definitely affects my enjoyment (or lack of it) of administrative tasks. I'm tired of being the only woman on almost every committee, and having to fight for our corner all the time.

Erika Lentz

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My introduction to geology happened in an amazing place to study it—the Sonoran desert. Participating in an unusual undergraduate semester studying Earth science at the Biosphere 2 facility—one rich with field experiences that stretched from the Sea of Cortez to the Santa Catalina mountains—made me reexamine my social science leanings and wrestle with how I could merge two very different passions, at least as far as research was concerned. Not finding an easy answer, I settled for a double major in sociology and geology, acknowledging at the same time a deep sense that to make my career personally fulfilling would require figuring out a way to integrate the two.

By emphasizing the importance of both physical and social science in my life, my coastal geology career, in many ways, found me. I began graduate school with a National Science Foundation IGERT (Integrative Graduate Education and Research Traineeship) focused on multidisciplinary problem solving in the management of coastal ecosystems. Working with mentors and students from a broad range of disciplines forced us to focus on our own communication and leadership styles through rigorous self-assessment; these were critical early lessons that, in turn, gave me courage to continue to pursue a less-traditional research path. When I found an opportunity to work on a project studying the geomorphology of a moderately developed barrier island, I found my multidisciplinary itch being scratched. In addition to physical science applications, my research had direct ties to policy issues and decision making for resource managers and homeowners.

My current project has been a fantastic opportunity to more fully merge my training and passions. Studying landscape change and adaptation in response to sea level rise has broadened my focus to regional issues, and now finds me working with a host of collaborators, from oceanographers and ecologists to resource managers; local, state, and government agencies; and nongovernmental organizations. More than anything, I find such collaboration rewarding because it ensures my research is both accessible and has meaning to decision makers.

Although it is deeply satisfying to have found a way to integrate my interests, doing so is not always easy. The breadth of my approach has made advising me challenging, and leaves some colleagues a bit wary as it extends beyond the scope of more traditional research tracks. I've had to learn to trust and lobby for my instincts frequently.

No challenge in my life, however, has been greater, or more grounding, than that of building our family. Yet, becoming a mother has introduced a surprising improvement in my ability to balance work and life. My toddler forces me to be fully present at home, which in turn makes my work hours intense, focused, and productive. I trust, too, that my son's watching me do both is important for him and by extension, his future relationships. And as I hear my husband boast about his wife "the scientist" in his professional circles, I'm keenly aware of how central our belief in each other is to this most incredible juggling act.

Collecting real-time kinematic GPS data in 2011 on one of many morphology surveys, Fire Island, New York.

Frances Lightsom

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When I was in college and graduate school, I never expected motherhood to be a big part of my life. The birth of my first child changed that, and I spent the next two decades focusing on the challenges of parenting instead of pursuing a research career. I had another baby, taught college part time, worked as a data specialist, then moved into supervision and management as the kids grew up. Ten years ago, my sketch in the "Women in Oceanography" issue focused on the life lessons of parenthood that are valuable preparation for work. The following year, my son left for college, I was left with an empty nest, and I was surprised by the upheaval of losing the purpose that had organized my days.

Since 2005, I have discovered a new sense of purpose in my work that is fully equal to what I felt as a mother. My calling is to promote the use of scientific information beyond the research community so humanity can live more wisely with the natural world. In the twenty-first century, the need for science-based decisions is critical, and the US Geological Survey is an excellent place to pursue my calling. I started by leading data management projects to develop new data services and make USGS research data available for future use. Then, I discovered the power to create change that comes from working with partners in other parts of the organization, so I applied myself to maintaining and coordinating the efforts of multiple agency-wide teams that are developing new approaches to data management and distribution. In my most recent role, USGS Ocean Data Ambassador, I work with an interagency team to support the data and information needs of the National Ocean Council, network with the marine planning and resource management communities to meet their data needs, and also network with data specialists within the USGS to make additional data available. These days my intellectual puzzle solving focuses on informatics and semantics; my professional tools are writing, facilitation, and use cases.

My work increasingly focuses on goals that I care about, and when I run into organizational roadblocks, I am motivated to achieve my immediate goals while also evolving the culture toward cooperation and public service. My approach to roadblocks is like research: develop a model for what is going on, use the model to choose actions that might achieve my goals, carry out some of the actions, pay attention to the results, improve my models, and try again. The hardest challenge is letting go of a project when I care strongly about its goal but the project is terminated. My young adult children still have something to teach me!

Since my children left home, I have time for a hobby and vacation travel. I am learning to play a bowed psaltery, and have been a regular at the annual Bowed Psaltery Symphony performance in Beckley, West Virginia. *Photo credit: Eb Werner*

My message to young women oceanographers is that there is a unique contribution that only you can make. Learn what that is. Take care of yourself so you will be fully able to contribute what only you can.

Susan Lozier

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Since I wrote that first biosketch for *Oceanography* 10 years ago, I have continued to conduct research, mentor graduate students, and teach undergraduates at Duke University. After all these years, I still do not think there is another job more suited to my interests and talents. I am now 25 years out of graduate school, which by my count gives me some license to look back over my career and wax philosophical. So, here goes. Before I left for graduate school, a good friend gave me one of those then-popular shellacked plaques with the following calligraphed quote: "It isn't the mountains ahead that wear you out; it's the grain of sand in your shoe." For whatever reason, this quote has stuck with me through these many years, as has the plaque, still tucked in a desk drawer at work. I always thought the point of this message was that you should take care to remove obstacles as you move toward a goal lest you wear out before you reach the summit.

In 2004, I was named a full professor at Duke. Despite having reached what might be considered the peak of my academic career, I soon came to the realization that my journey has actually been all about the grains, not the mountains. Sure, there have been achievements long sought—my PhD, a postdoctoral position, an academic post at a research university, and that thing called tenure—but, truth to tell, I have learned a lot more about myself, and, ironically, enjoyed the journey so much more, because of the "obstacles" in the way of those goals. When I first started at Duke, my chair told me to not spend so much time on my teaching, but rather keep my eye on the research needed for tenure. A colleague told me I would likely not make tenure if I did not spend more hours at work and fewer at home. And despite my best intentions, I would find myself at times fretting over how much time I spent mentoring graduate students, working with a struggling undergraduate in my class, writing proposals and reviewing papers, and serving on university committees. There seemed to be no end of obstacles keeping me from my work. It took a while, but I finally realized that the obstacles *were* my work, or at least a good part of it. And, in the end, the obstacles, not the mountains, made the journey.

My advice to young oceanographers starting their own journeys is: work on problems that keenly interest you, work with colleagues with whom you feel free to say something stupid or share a laugh, gather mentors, become a mentor yourself, build community, make commitments, keep commitments, and remember that there is more than one way to view obstacles. And, in contemplating how to manage a sustainable and enjoyable balance between your personal and professional lives, consider this: don't try fitting a family into your career; instead, fit your career into your family.

I am pictured here on a 2003 cruise in the Labrador Sea, finally happy after days of seasickness. I have, not surprisingly, been to sea only once since then. However, I have continued my interest in collecting new observations: I am currently the international lead for OSNAP (Overturning in the Subpolar North Atlantic)—and enjoy sending my graduate students on OSNAP cruises.

Allison Luengen

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When I finished graduate school, I was not sure what I would do with my MS in marine sciences and my PhD in environmental toxicology. I was moving on to a postdoctoral research position at the School of Marine and Atmospheric Sciences at Stony Brook University, inspired to continue in academia because I had discovered a passion for teaching late in graduate school. I also loved the marine environment and the interdisciplinary nature of the research. But despite my interest in teaching and research, I was not sure that I would pursue a career doing either.

Throughout my education, I had been at major research institutions, and they did not seem like a good fit. As a graduate student at the University of California, Santa Cruz, I had gotten to know the chancellor through my involvement in student government. She was an outspoken advocate for women in science and engineering at a time when Larry Summers, President of Harvard, was making news for saying that women had less aptitude than men for science. Her subsequent suicide, and especially some of the ensuing criticism of women in powerful positions, left me wondering if I had chosen the right field. Also, I knew that my job search would be restricted because my husband worked in high tech, an industry with few geographic hubs.

A colleague suggested that I apply for the position that I now hold, as an assistant professor at the University of San Francisco, a liberal arts institution. For the first time, my department has as many women on the faculty as men, and I feel comfortable having a life outside of science. My husband and I now have an eight-month-old son.

Part of finding my way has also been choosing the type of research that I do. I am glad that as a coastal oceanographer, I do not have to go to sea. My research focus is the biogeochemical cycling of mercury. I am particularly interested in how water chemistry influences the accumulation of methylmercury (the form that biomagnifies) at the base of aquatic food chains. Much of my research, including my postdoctoral work using radiotracers to look at the role of dissolved organic matter in methylmercury accumulation by phytoplankton, has been laboratory based. I really enjoy teasing apart processes with controlled experiments. The thrill of knowing something for the first time is one of the most exciting parts of being an oceanographer. I also find my research fulfilling because of the chance to reduce mercury pollution. High mercury levels have led to fish consumption advisories in many places, including where I work in San Francisco Bay.

Collecting a sediment core from Twitchell Island in the San Francisco Bay Delta to look at methylmercury concentrations. The work was a collaboration with colleagues at the US Geological Survey who were interested in mercury mobilization in rice paddies. *Photo credit: Brandon Oldham*

Choosing a local and lab-based research program has helped me balance my professional and personal life. It has also helped me adapt my research to a primarily undergraduate institution without a researched-based MS program. Training undergraduates has been one of the best parts of my job, and I am fortunate to have excellent local collaborators when I need to do fieldwork. Despite the challenges and uncertainty of pursuing this career, I am very happy that I ended up where I am.

Amy Maas

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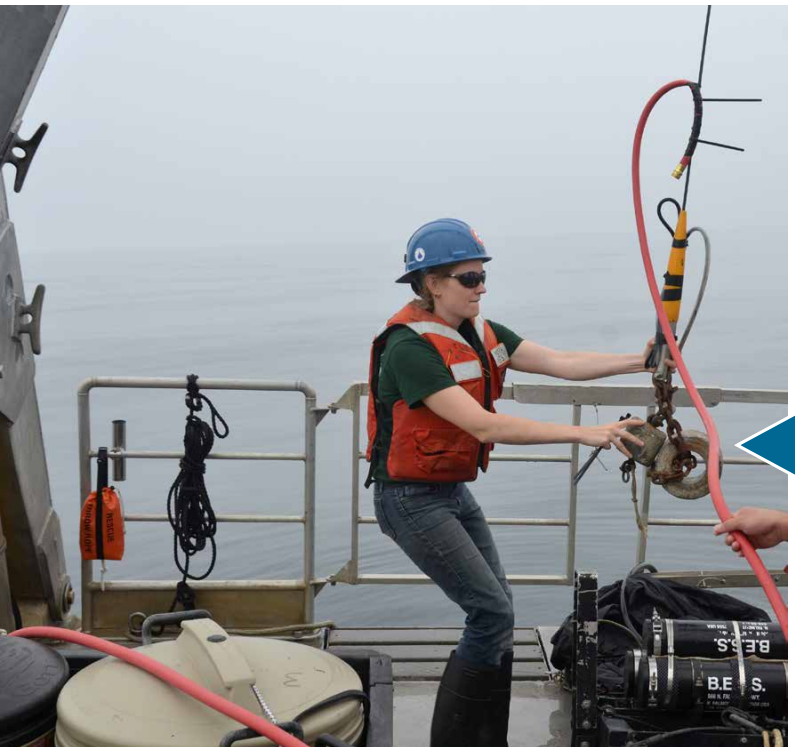
My research interests lie at the junction of comparative animal physiology, gene expression, ecology, and biological oceanography. I study how marine invertebrates function in response to environmental variables such as carbon dioxide (CO_2), oxygen (O_2), and temperature, generally in the context of climate change. My favorite part about this work is its interdisciplinary nature. I love that I can be wearing a white lab coat one day, a hardhat and steel-toed boots the following day, and then be fighting with computer code from my couch the next.

Growing up in Ohio, I originally thought I was going to be a librarian, but I kept making life decisions that led me farther and farther afield. The turning point was when I found myself, after my first year of graduate school as a master's student at the University of Rhode Island, in Antarctica and then only a few short months later on a boat in the eastern tropical Pacific studying a group of pelagic snails called pteropods. Although I had never considered a career as an academic, I decided to stay for the long haul, switch to the PhD track, and see where it went. My work focused on the effects of environmental stress in pteropods. When I came to Woods Hole Oceanographic Institution for a postdoc, I added transcriptomics to my physiological arsenal and was stunned to realize that, despite my concerns about work-life balance, I actually very much enjoy the intense research-driven life.

The difficulty for me has been choosing which compromises have to be made to pursue the work I love. My husband, who is Spanish, and I are both zooplankton biologists, so we are plagued with both a two-body problem and an international conundrum. He chose to remain in the United States far longer than he had ever intended so that we could stay together. I, at one point, turned down a wonderful and exciting postdoc in Europe during a time when my funding had almost dried up because it did not match with our long-term plans of establishing in the United States and both staying in science. Balancing our research aspirations and our goal of being together has not been easy, and many of the highest points of my career have resulted in difficulties in my personal life. The excitement of receiving my first National Science Foundation grant, for example, was tinged with the melancholy of committing to a big project at an institution two states away from where my husband lives and works. The balance seems to be paying off as we were offered dual-career positions for the coming year. Moving together to Bermuda is one of the personally scariest and scientifically most exciting things that has ever happened in my life, and I am thoroughly looking forward to our living and working in the same place.



Amy aboard R/V *Tioga* deploying a pump to collect water for pteropod culture in the Gulf of Maine, August 2013. "Learning how to lead as chief scientist has been another challenge of my career," she says. "My predilection is to lead by consensus, but sometimes you have to have a more "masculine" style and just tell people what to do. Striking the correct balance, particularly with a distinctly bubbly personality, has been a learning experience." *Photo credit: Peter Wiebe*

Jennifer MacKinnon

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My life as a mid-career scientist (when did that happen?) is one of mostly cheerful, barely controlled chaos. The balance between a seagoing research career, academic teaching responsibilities, and parenting two very energetic small boys is a challenge of time and energy management, to say the least! Yet, I am frequently and deeply awed at the incredible privilege of being able to spend my days doing something so intellectually engaging and fun. I truly love being at sea—the visceral sense of being an old-fashioned explorer, the excitement of on-the-fly decision making, and the comfort of being rocked to sleep at night by my subject matter make oceanography a really special science.

My research concerns small-scale turbulent processes in the ocean. Away from the surface and bottom boundary layers, most turbulent mixing is driven by breaking internal gravity waves, which in turn are largely forced by tides and winds. The net effect of this mixing is crucially important for everything from regional pollutant dispersal and nutrient budgets to global patterns of heat distribution, which is especially important in a changing climate.

I spend part of my time trying to understand the complex nonlinear dynamics that control where and how internal waves break and how much turbulence is produced. This often involves ship-based fieldwork because we can watch the actual process unfold. For example, colleagues and I are about to embark on an intensive multiship experiment off Tasmania, where we believe a focused beam of internal tide energy is shoaling and breaking on the Tasman slope. Our results should provide crucial insights into the life cycle of one of the most energetic phenomena in the ocean.

The second part of my research involves working to turn these sorts of basic physics insights into parameterizations of turbulent mixing for use in global climate models. For the last five years, I've been leading a national Climate Process Team that brings together two dozen scientists specializing in observations, theory, and modeling to do just that. It's been an interesting leadership experience, a combination of (the inevitable) cat herding with a genuinely rewarding feeling that we are collectively having an impact.

By and large, I've been lucky to feel welcomed and respected in my scientific community. I am often one of very few women at workshops, or at sea, which can be very lonely. For me, this has been largely compensated by the incredible good fortune of having many of my frequent colleagues also become close friends, and, crucially, a husband who is a fully equal co-parent and supportive of my absconding on boats for many weeks at a time. At the same time, it has been hard to watch many friends, especially but not exclusively women, struggle with everything from outright sexism to well-meaning but clueless ignorance and still-present significant institutional barriers against reasonable work-family accommodations. It is difficult at times not be angry that incredibly smart and talented people are still beaten down and leaked out of our field. But I am hopeful that the increasing awareness, good will, and hard work on these issues that I see from many of my colleagues will eventually create a more supportive climate for all of us.

Jennifer MacKinnon and one of her sons escaping the San Diego heat.

Maria Beatrice Magnani

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Although the ocean has always fascinated me, my career as a seismologist has often kept me on land. However, my love for the sea expressed itself early on through my passion for sailing with my dad on the family sailboat along the coast of the Mediterranean Sea, in my native Italy.

I think that the varied Italian landscape, combined with the influence of a key professor early in high school, helped to guide me toward geology and to kindle my interest in tectonics. I completed my PhD in Earth sciences in 2000 at the Universitá di Perugia in Italy, where I worked on the tectonics of the northern Apennine Mountains. Shortly after completing my PhD, I moved to the United States for a postdoc at Rice University. There, I learned that I could combine my interest in the formation and evolution of continents with my passion for the ocean by moving the perspective out to sea and studying the building blocks of a continent: volcanic island arcs. I began to work on onshore-offshore projects and became more and more involved with marine geophysics.

Beatrice during fieldwork on the Uppsala Glacier in the Argentinian Andes as part of a study of glacial isostatic adjustment triggered by the retreat of the Southern Patagonian Icefield glaciers.

I brought that insight with me when I joined the faculty of the Center for Earthquake Research and Information at the University of Memphis in 2006. The following year, I began studying the New Madrid seismic zone in the central United States through an innovative application of conventional marine reflection seismology to data acquisition along the Mississippi River. This new method allowed my colleagues and me to map known and unknown faults hidden beneath the river and to begin unmasking the network of faults that have been shaking the midcontinent. I am currently involved in an onshore-offshore project along the margin of the east coast of North America, continuing my quest to understand continental dynamics through marine and land investigations.

My career as a woman in science has been challenging, but very rewarding. My most difficult professional task is the demand to continuously find funds to support my research group and myself. I find that the best way to respond to that challenge is to remain engaged in the community and be flexible to the changes in our scientific field.

Balancing my personal life and my career has also been difficult. Being far from my family has been a high price to pay for the rewards and satisfaction my career brings me, and it has only been possible because I never stopped loving my job and the science I do every day with my students.

Briony Mamo

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Always keen on music and fine arts when I was younger, a senior high school trip to Tanzania saw me dumping paintbrushes for picking brushes. I completed a BABSc at Macquarie University majoring in geology and archaeology with palaeontology a prerequisite major. Warned by mentors that I would find it dry, I instead found my passion. Keen on many fossil groups, I settled on benthic foraminifera (unicellular eukaryotes with streaming pseudopodia and an agglutinated or carbonate test) for their beauty, their incredible diversity, and their applicability to a broad variety of research scenarios.

From there, my research interests have focused on the varying and novel application of foraminifera to both modern- and paleo-related problems, particularly where other types of data can be coupled and enhanced with taxonomic knowledge. I was lucky to join the University of the Sea with IFREMER and Geoscience Australia during my honors, reconstructing the environmental history of the New Caledonia Basin. My PhD involved several studies where the main focus concerned the biodiversity of southern Great Barrier Reef ecosystems. I also searched for paleotsunami in Australia and investigated ecosystem resilience to cyclones. Currently, I research the utility of foraminifera in natural hazard investigations, the surprisingly high biodiversity of submarine volcanoes off Japan, and benthic resistance to environmental change.

The most exciting element of my job is fieldwork, and I wouldn't be in academia without it—traipsing up a mountain to look at ancient reefs, diving to see living ones, getting covered in muck collecting samples in giant research vessels or a beat-up dingy. Thanks to being a researcher, I have made some amazing friends over the globe. The bonds you develop last a lifetime, and bringing students along for the ride makes it all the more enjoyable—especially when by the end of the trip, they're leading the charge.

Working in a new country with so many interesting things to see helps get me out of the office, but as an early career researcher, it's hard to get away. Elements of making a career in academia can rely on a variety of often uncontrollable factors, especially when first starting out. These include selecting an area of research that is uncommon and offers few collaborative opportunities, government funding cuts, being in the right place (usually a conference) at the right time, and knowing the right people. Even lab time impacts success when so much significance is placed on publication volume. It's challenging when new areas of research require very different methods and processing time. The dwindling number of tenure positions is a daunting issue, and as a single woman, I'm concerned about my future prospects in academia without long-term financial security.

Having fun earlier this year on a cruise through Doubtful Sound, New Zealand. Women in research are superheroes!

I was the only female in my first research lab after my bachelor's, so these days it's encouraging to see the female contingent equal to the male. Working in other countries where attitudes toward women in research are different has been challenging. Encouragement and inclusivity are important for building confidence in young female scientists, so I try to engage new colleagues and students wherever possible.

Clara Manno

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My main research interest is to understand the role of the zooplankton community in controlling the vertical export of carbon from the surface to the ocean sediment. I am also interested in the response of zooplankton organisms to anthropogenic environmental stressors (ocean acidification and global warming) and how this response can influence the ways carbon is exported to and sequestered in the deep ocean. I mainly focus on processes taking place in the Antarctic because this region is critical to control of the marine carbon cycle due to its interaction with the atmosphere and its role in producing deep water.

I dreamt about being a scientist as a child, watching wildlife documentaries set in amazing places. I have always been fascinated by the effects of extreme conditions in nature, and the polar oceans have inspired my spirit of adventure and exploration. During my university studies, I was attracted to the complexity of the biological, chemical, and physical processes driving the marine ecosystem, and I just followed my instincts on this topic. Determining how anthropogenic environmental stressors impact marine ecosystems is a vital challenge for both marine scientists and managers of ocean resources. For me, contributing knowledge toward understanding this global issue is one of the most rewarding aspects of being an ocean scientist. It is also rewarding to involve students in my research and to assist them in achieving their goals. They are always creative and stimulating.

My biggest career challenge was moving abroad to do science. Although I have faced enormous difficulties, on the positive side, I have had the privilege of working on my own projects. Another big career challenge has been to find the energy to manage both my scientific interests and my family. The balance between my career and my personal life is something I struggle with each day, especially because I am mother to two small children. My career has already caused me to live and work in three countries, which has been a huge compromise for all of my family.

Even though women are encouraged more and more to have the confidence to succeed in science, I think it is still difficult to simultaneously be a successful mother and a scientist. At the same time, I feel fortunate because my job gives me the flexibility to spend more time with my family, buffering the sacrifices made for long absences from home related to scientific cruises, conferences, and other professional activities. In addition, being a mother forces me to manage my time efficiently and to overcome most of the difficulties and frustrations that I face in my scientific life.

Nancy Marcus

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I've always believed it is important to have balance in one's life. Here I am (on the left) fishing in Costa Rica.

I had no idea when I wrote my original biographical piece 10 years ago that I would transition from a professor/researcher to a professor/administrator. I was chairperson of the Department of Oceanography at the time, and several months later became dean of the FSU Graduate School. I remember that I had just been awarded a grant from the State of Florida to set up a facility to cultivate copepods at a large scale, but I declined the funding because I did not think I could manage the new project along with my responsibilities as dean. I also had three doctoral students at the time, and one by one they completed their work during the ensuing three years. Because my role as dean was quite demanding of my time, I had decided to not accept any new students. Hence, it was not surprising when the department asked me to relinquish my lab space after my last student graduated. While it was difficult to give away and surplus my equipment, sort through files, and downsize to a single oceanography office, I have never regretted my decision to take on the responsibilities of dean of the Graduate School. As dean, I have gained a much greater appreciation for the university as a whole.

As professors, we tend to focus on our own narrow world of research and, unfortunately, are not always aware of the bigger picture. Universities are complex communities that have so much to offer. Students and faculty should learn to take advantage of those opportunities by interacting outside the confines of their units. In my current role, I advocate for the importance of graduate education to the university and to society. In the Graduate School, we are interested in enhancing the experience graduate students are exposed to in their individual programs, for example, through promoting interdisciplinary interactions, fostering international opportunities, and offering professional development workshops that focus on transferable skills.

I am often asked if I miss research. The fact is that I continue to engage in extensive research, but the topics are different. The oceanography and disciplinary specialty meetings I attended as a biological oceanographer have now been replaced by meetings of graduate deans and others engaged in all facets of graduate education all over the world. The community of graduate administrators is deeply committed to providing the best opportunities possible for the next generation of scholars and leaders, and our gatherings involve sharing best practices, helping new deans navigate their positions successfully, and discussing critical issues, for example, the impact of student loan debt on graduate education today.

I had a very fulfilling 28-year career as a scientist and professor, which is now being topped off by an equally fulfilling 10-year plus career in university administration. The various experiences I had as a student and then in the first 28 years of my professional life provided me with an invaluable perspective on higher education. Perhaps the biggest adjustment to life as a dean is the shift I experienced in daily activities. As a professor/scientist, I peered through microscopes a lot, read articles, reviewed and wrote manuscripts and grant proposals, and interacted with my lab group and departmental colleagues. As dean, my days are often consumed by meetings with students, faculty, and staff. These interactions can be energizing as well as draining, but in the end it is satisfying to help people find solutions to problems and ultimately be successful. Every day is a new day, and I continue to learn.

Irina Marinov

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After graduating from the old and prestigious Saint Sava high school in Bucharest, Romania, I came to the United States as an international student. I completed my BA in physics and mathematics at Middlebury College and my PhD in atmospheric and ocean sciences at Princeton University.

Following my 2005 graduation, I spent four years as a postdoctoral researcher at MIT and at the Woods Hole Oceanographic Institution. My career was most challenging during those years, partly because of the uncertainties associated with such temporary positions and the challenges of a three-year, long-distance relationship. I remember endless sleepless nights pondering the same questions again and again. Will I ever find a job in the same place with my partner? Will this relationship survive the distance? Am I good enough to ever get a faculty job? Should I quit the academic track to have a normal life? Will I ever have a child?

In 2009, after an intense job search, the difficulty of finding two tenure-track positions in the same university in different fields (oceanography and theoretical physics) became very clear. We found the best temporary solution at the University of Pennsylvania (Penn). My husband came in as an assistant professor in the Department of Physics and Astronomy, while I was offered a (non-tenure-track) lecturer position in Earth and Environmental Sciences—a small interdisciplinary department with no other oceanographers. After three years as a lecturer, and another intense job search (and almost leaving for another academic job), I was offered an assistant professorship at Penn.

Irina on the West Antarctic Peninsula, February 2014.

Life sometimes works out in unexpected ways. Despite the convoluted path I took to get and stay here, Penn turned out, somewhat unexpectedly, to be a good place for me. My colleagues are supportive, and because we are in such widely different fields, I do not feel internal competition or stress. I lead a small research group in oceanography, and we have great fun doing research. We run and analyze global climate models to predict future changes in climate, with a focus on the role of the ocean in global heat and carbon cycles and on global ocean ecology. My undergraduate students are brilliant, and I can teach and research whatever I want. I feel lucky every day to do research and teach in a field (climate science) that is important societally, and I hope to teach my students how to become better stewards of our planet in this process.

I have found myself thriving and happier as a scientist as I have became more and more independent scientifically, and also after having a child and enjoying a stable family life. I have a supportive family and husband, and a five-year-old son, who brings joy and excitement to my life every day. I am much happier now as a faculty member. Gradually, my anxieties related to the "impostor syndrome," which plagued me for all my student and postdoc years, subsided, and I understood that science is much more fun if you simply do not worry about what others think of you. To budding scientists, I would say: be persistent. Persistence trumps anything else in science. If you want a child, have one. A balanced family life will give you stability and happiness, and will help you be a better scientist. And finally, search for supportive mentors and ask for their help. I would have never made it so far if it were not for those caring mentors and advisors along the way who not only taught me science but also told me "yes, you can" when I was riddled with anxieties. I will always be indebted to them.

Marinna Martini

Electronics Engineer, US Geological Survey, Woods Hole Coastal and Marine Science Center, Woods Hole, MA, USA, mmartini@usgs.gov

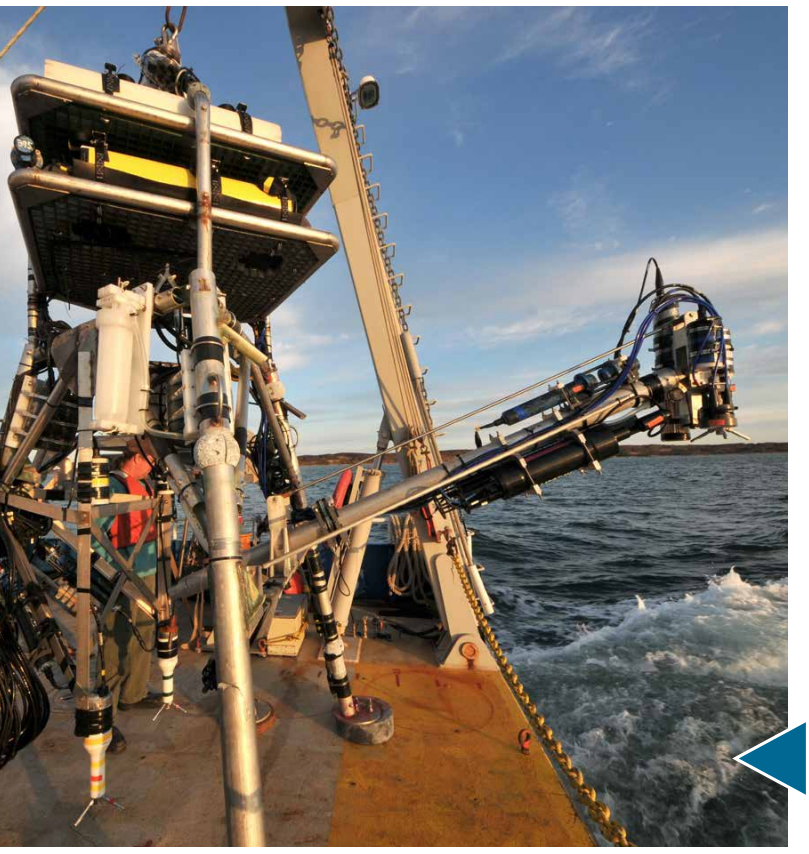
My vocation is engineering. For 24 years, I have provided services to USGS principal investigators in systems engineering, mooring design, field logistics and planning, personnel management, programming, and data processing. In today's lingo, I practice mechatronics.

I am in the same cubicle I was 10 years ago. Since then, instrumentation has changed, and not; people have changed, and not; and my role has changed, and not. Executing a plan to systematically grow in skills, pay, and responsibilities might have meant leaving federal service, Cape Cod, a world center of oceanographic excellence, and opening up the "two-body problem." So, I stayed in place. Growth came to me, and not always what I would have chosen. Now, I grapple with bureaucratic hurdles using skills I did not expect to have. Managing excellent people and having excellent benefits allowed me to attend to my dying mother during our busiest year at work. Is that a "career path"? Success, perhaps, is the wisdom to stay put where I have support and can, slowly and stumblingly, find balance.

In my previous essay, I credited male family members who introduced me to maritime traditions and opportunities. I was remiss in not crediting my mother for support and guidance: for help finding my vocation, making sure I had a well-rounded education, and developing valuable financial habits and knowledge. How could I forget my mother? But I did! It illustrates one of the greatest challenges for professional women: gender bias. Ten years ago, I thought bias I perceived was based on my lack of a PhD. Being older now, with many more data points, I find that gender bias is pervasive and subliminally practiced by both sexes. The behavior is cultural, and it has measurable impact, as demonstrated by many recent peer-reviewed papers on the subject. My advice is to assume good intent, remain professional at all times, achieve results, and network. Being a volunteer in a professional society (IEEE-Oceanic Engineering Society) has been an excellent experience for me. As more men become primary caregivers to their children and parents, I have hope for change.

Ten years ago, I also said that my greatest challenge was bridging the invisible divide between scientists and support staff. Today, as manager of many more people and projects, that challenge remains, and it is joined by the challenge of achieving results in spite of increasing bureaucracy. I now see consequences to science from this bureaucracy and the reduced funding that is limiting support staff for scientists.

These annoyances are balanced by blessings: a partner who also works with ocean technology, cooks, supports my travel, the capricious changes in schedule due to weather, and everything else that work in oceanography entails. We have been able to take long, far-away vacations together. I live in a beautiful vacation spot. I have a fantastic group of local, national, and international friends. I bike to work. My favorite sport (curling) is next door to my office. So to women I say, keep going. Yes, there are challenges, but aren't there always?



Aboard R/V *Connecticut* in October 2011 with a bottom tripod whose moving arm continuously profiles suspended sediment events at the seabed using acoustics, optics, and other methods simultaneously. *Photo credit: Dann Blackwood, USGS*

Patricia A. Matrai

Senior Research Scientist, Bigelow Laboratory for Ocean Sciences, East Boothbay, ME, USA,
pmatrai@bigelow.org

Ten years ago, I was a Senior Research Scientist (SRS) at Bigelow Laboratory for Ocean Sciences. Continuing in that position over the decade since, my research has centered on the polar regions, especially the Arctic Ocean, with NASA and National Science Foundation funding.

I investigate biological production and consumption of organic sulfur and halogenated compounds that are of climatic relevance, as well as their environmental controls, in various oceanic regimes. These studies led to research on the precursors of and controls on the production of new atmospheric particles in the Arctic, the role of the physiological ecology of phytoplankton and their associated food web in carbon and sulfur cycling, and the inclusion of such biogenic rates and controls in climate models. I interact with modelers who use both simpler one-dimensional ocean-color-based models and complex global or regional general circulation models (GCMs). I help to provide the field biogeochemical data they need to initialize and/or validate their outputs by rescuing historical data (e.g., on primary production and chlorophyll), creating/deploying new autonomous sampling systems to obtain time-series data (e.g., O Buoy Chemical Network), and collecting data from various instruments (e.g., bio-optical).

Hence, what I wrote 10 years ago still rings true: my interactions with the oceanographic and atmospheric chemistry communities challenge me every day to represent each in front of the other. I wrote: "I have been labeled a (marine) biologist, a (marine) chemist, a biochemist, an oceanographer, a gas person, a bug person and, as such, an expert in all topics within each discipline…" To this, I must now add that I am a buoy-and-float person and a "keep them true" observationalist.

As a way to give back to my institution, I've served as interim Co-Director and interim Co-Director of Finance and Administration. I've also engaged in the international research scene through involvement in international science advisory bodies such as IGAC (International Global Atmospheric Chemistry), SOLAS (Surface Ocean-Lower Atmosphere Study) and, most recently, the IGBP (International Geosphere Biosphere Programme) Steering Committee. I have learned, grown personally, and benefited tremendously scientifically by working with other talented geo- and social scientists. In order to learn how a scientific society functions, I joined the Association for the Sciences of Limnology and Oceanography board as a member-at-large and later served as treasurer, where one really sees how a society, or any institution for that matter, actually works! It was also a great way to meet a bunch of extremely dedicated colleagues.

Paty hanging incubations of atmospheric particle precursors in an Arctic lead at 87°N for possible UV environmental control during the Arctic Summer Cloud Ocean Study funded, in part, by the National Science Foundation's Office of Polar Programs.

These new activities offered even more exciting travel opportunities, but they continued to be the largest challenge in balancing my career and personal life, which includes a seagoing spouse and two wonderful young adults. Maintaining that balance implies negotiations, even stopping all travel for an entire year so that a parent was always on the premises.

As my children have grown to be college students and professionals, my educational activities have changed along with them. I now mentor more undergraduates in my lab and employ more recent, highly qualified graduates. It gives me great personal pleasure to see them bloom (always a plant person at heart!) and move on.

Erin McClymont

Senior Lecturer, Department of Geography, Durham University, Durham, UK, erin.mcclymont@durham.ac.uk

My research focuses on reconstructing past changes in ocean circulation and biological productivity by analyzing biomarkers (chemical fossils) preserved in marine sediments. I'm particularly interested in creating sea surface temperature histories over the last four million years of geological time and using them to explore the interaction between ocean circulation and ice sheet advance and retreat on glacial-interglacial and longer (million year) time scales. These interests probably first developed growing up in Northeast England, where I spent my weekends at the beach and enjoyed exploring the regional geology and the landscapes shaped by past glaciation.

Following my bachelor's degree at the University of St Andrews, I moved to Durham University where, in the early stages of my PhD, my advisor Antoni Rosell-Mele showed me some recent publications about a change in the pacing and amplitude of the glacial cycles about one million years ago. The challenge of investigating a debated and unexplained climate transition immediately captured my interest, and we rapidly developed a new project that allowed me to explore many different parts of the ocean in a search for answers. I'll always be grateful for the freedom and support that Toni gave me to take a chance on a new research area!

I feel privileged to analyze precious marine sediment sequences for the first time; it's exciting to reconstruct climates of tens of thousands or millions of year ago and to be the first to see what those past climates looked like. Although most of my work is laboratory based, I've been fortunate to participate in seagoing expeditions to some stunning and remote parts of the world, including eight weeks on *JOIDES Resolution* with the Integrated Ocean Drilling Program (IODP) in the Gulf of Alaska, and a trip to the Southern Ocean that included a stop in South Georgia. Working alongside scientists and crew with diverse backgrounds and interests has provided an unexpected but rewarding part of the job as friendships have developed that I would never have predicted.

My biggest career challenges have been securing funding and job security; learning that you need to convince others to be excited about your favorite topic isn't always easy. Mentoring from senior colleagues has been really important for navigating the system; my husband is also an academic so we often practice presentations or read each other's grant proposals. However, being a dual-career couple has delayed us settling down, because the system of short-term positions meant many years in a long-distance relationship while our careers developed. I returned to Durham as a member of faculty in 2011, and my husband has also secured a permanent position here. We're now looking forward to having a new addition to our family! During my career, I've seen increased visibility of women in my field, and I'm pleased that discussions about work-life balance and family life are no longer being seen as just "women's issues." I benefit from great support at work and at home, which means that I can continue to investigate the issues that excite me most in paleoceanography.

Cecilia M. Gonzalez-McHugh

Professor, Queens College, City University of New York, Flushing, NY, USA, cmchugh@qc.cuny.edu

I am a professor of oceanography at Queens College, where I teach undergraduate geology and environmental science majors as well as master's and doctoral students. For the past 10 years, I have also been one of the pioneers in the evolving field of submarine paleoseismology, developing methods for studying earthquakes and tsunamis from their sedimentary records and seafloor structural deformation. The goal of this research is to contribute to better hazard prediction and education of local populations. My work has taken me to the Marmara Sea, Turkey, after the 1999 Izmit and Duzce earthquakes; to offshore Haiti after the 2010 earthquake; and to the Japan Trench after the 2011 Tohoku earthquake. In Bangladesh, my students and I are beginning to document a large earthquake that occurred in 1762 by dating dead corals. With a population of 160 million and many living along the coast, if a large earthquake and tsunami were to occur there today, it would be devastating.

I have also participated in three ocean drilling expeditions to study eustasy (worldwide sea level change) offshore New Jersey, USA, and offshore South Island in Canterbury Basin, New Zealand. I soon will join a fourth drilling leg to study monsoon and climate change offshore Northwest Australia.

Along the local estuaries of the Hudson River and Long Island Sound, my students and I, along with collaborators from Lamont-Doherty Earth Observatory of Columbia University, Stony Brook University, and Adelphi University, are studying sediments to understand the impact of anthropogenic activities. With funding from a National Science Foundation (NSF) RAPID response grant in 2013, we surveyed the bays and inlets of Long Beach Barrier Island on the southern shore of Long Island, NY, to learn about the impacts of Superstorm Sandy. Involving students in local environmental problems is rewarding and facilitates their employment in local industry and/or state agencies.

One of my greatest challenges was leading an NSF RAPID response expedition aboard R/V *Endeavor* to study the 2010 Haiti earthquake less than two months after the event. Luckily, collaborators from the University of Texas at Austin, Missouri State University, and Lamont-Doherty Earth Observatory of Columbia University, together with the marine office of the University of Rhode Island and the captain and crew of R/V *Endeavor,* helped make this operation a success. Nothing like teamwork!

I tell my students to find the type of work or research they would love to do, set goals, and reach for them. You will achieve your dreams.

Fieldwork for McHugh and her students along the southeastern coast of Bangladesh is logistically challenging, but the scientific potential for better understanding the earthquake cycle and tectonics, thus contributing to diminish risk for the people of Bangladesh, is large.

Galen A. McKinley

Associate Professor of Atmospheric and Oceanic Sciences, University of Wisconsin–Madison, Madison, WI, USA, gamckinley@wisc.edu

I study the coupled mechanisms of large-scale ocean circulation and biogeochemistry that drive the modern ocean carbon sink and its temporal variability. My tools are numerical models and large data sets. Being a mid-continent oceanographer, I have also developed a research program on the circulation and biogeochemistry of the Laurentian Great Lakes. I chose oceanography because of the importance and the global scale of the field's scientific questions. The many huge unknowns in ocean science are at once frustrating and exciting, and there is opportunity for great discovery on the time scale of my career.

I have the honor being on the faculty at a great public university. I have many wonderful, supportive colleagues, and have the fortune to live in a fantastic small city. At the same time, being an oceanographer in Wisconsin has required flexibility and has shaped my career to be less purely oceanographic. In teaching, I instruct more on geophysical fluid dynamics and climate change than on the ocean. In research, I have come to appreciate that there is much we do not know about Great Lakes physics, ecology, and biogeochemistry, and have become an active member of the Great Lakes scientific community.

Balance between personal and professional life is, for me, a continually evolving pursuit. I have a supportive husband whom I met in graduate school. His decision to not pursue an academic career in oceanography has certainly reduced the constraints on my career. Even more important has been his willingness to be an equal partner in the parenting of our two children, now six and eight years old, with both having been born prior to my tenure.

One concern I have for women in oceanography, and across STEM academia, is the degree to which the issue of work-life balance appears to cause many women not to pursue a tenure-track or comparable PI-level position. The central worry seems to be "How could I possibly be successful in both the competitive world of science and the overwhelming task of motherhood?" Giving enough to one's family is critical, and everyone has a host of unique life circumstances that must be taken into account. But I do hope that the WORK side of this balance equation is not being overlooked. I ask: Do you love your work? Do you love the intellectual stimulation of learning and teaching? Raising a family is time consuming, exhausting, and overwhelming, and there are professional impacts from these realities. But a career is much longer than the years of childrearing. What do you want to do with your days and hours when your kids are at school, in college, and beyond? What do you want to look back on when you've retired? Is it worth struggling through some hectic years in order to have the long-term opportunity to be your own boss and to engage in the many wonders of scientific discovery and education? I encourage young women to think deeply about their whole careers, as well as the most intense years of motherhood, when they make this choice.

Here I am (bottom right) with my research group in May 2013. I have had the great fortune to work with many wonderful students and dedicated staff at Wisconsin.

Marcia McNutt

Editor-in-Chief, *Science* family of journals, Washington, DC, USA, mmcnutt@aaas.org

Ten years ago, when I first contributed an autobiographical sketch to *Oceanography*, I was President and CEO of the Monterey Bay Aquarium Research Institute (MBARI) in Moss Landing, California. Then, I thought had the best job in all of oceanography and that I would be at MBARI for the rest of my career. Looking back now, I could not have anticipated the interesting turns my career has taken.

In 2009, I was asked by President Obama to become the fifteenth Director of the US Geological Survey (USGS). I joined his "dream team" of science leaders in Washington, DC, including fellow ocean scientist Jane Lubchenco, who was Administrator of the National Oceanic and Atmospheric Administration (NOAA). During my tenure at the USGS, the agency responded to an unprecedented number of natural and man-made disasters, including the 2010 Haiti earthquake (death toll exceeding 230,000), the 2010 Chilean earthquake (a major M8.8 event), the 2010 Deepwater Horizon (DWH) oil spill (the largest marine oil spill in US waters), the 2011 Japan earthquake and tsunami (M9.0, the fourth largest ever recorded), and Superstorm Sandy in 2012 that ravaged the US Northeast.

Of all of these events, it was the DWH spill that engaged me most personally, as I spent more than three months in Houston as part of a government team working side-by-side with BP scientists and engineers to collect the oil and cap the well. I personally led the Flow Rate Technical Group that produced more accurate estimates of the rate of oil release from the well that guided improved strategies for well intervention. USGS personnel I brought to Houston to ensure the integrity of the well as it was shut in and to help direct the final well kill were important to the success of ending the oil spill and assuring government leaders of the safety and efficacy of our plans. USGS scientist Paul Hsieh was 2011 Federal Employee of the Year for his contributions. For my efforts, I was awarded the Coast Guard's Meritorious Service Medal, the noncombat equivalent to the Bronze Star.

My most enduring contribution to the USGS is likely to be adjusting its structure from a disciplinary-based organization to a mission-based organization, better reflecting the staff-generated strategic plan. This change better aligns leadership with mission, budget, strategic plan, and performance goals.

Marcia McNutt and daughters (left to right): Dana Hoffmann, founder of Silicon Valley startup Tenantopia; Ashley Corkery, attorney at San Francisco firm Drinker, Biddle, and Reath, LLC; and Meredith Scurci, Senior Manager at Apple Inc. *Photo credit: Stacey Pentland Photography*

In 2013, I became the nineteenth Editor-in-Chief of *Science*, the largest peer-reviewed general science magazine in the world, and the first woman to hold that post. I have enjoyed expanding my scientific horizons to include everything from astrophysics to microbiology. Since arriving at *Science*, we have updated the design of the print journal and of the website. We have also launched a new open-access journal, *Science Advances*, with a scope that includes science, engineering, and social sciences. The goal of the new journal is to bring *Science* standards to open-access publishing and to encourage broadly interdisciplinary research.

As I approach the end of what has been a very fulfilling scientific career, I count as my greatest accomplishment my three amazing daughters, all establishing their own fantastic careers and making a difference. I could not be prouder of their achievements and future promise.

Erika McPhee-Shaw

Director, Shannon Point Marine Center, Western Washington University, Bellingham and Anacortes, WA, USA, erika.mcphee-shaw@wwu.edu

I seem to have a lot of dreams about crashing waves and tumbling rivers, and my favorite college physics courses were those in electromagnetism, so perhaps it was inevitable that I would end up working in the science of waves and Earth's water systems. One focus of my research has been the physics of internal waves on continental margins and how they move sediment around on fairly vast scales. Over time, my interests widened to include more general coastal oceanographic dynamics, and my research became more interdisciplinary. My students and I have worked to understand how weather systems, upwelling, downwelling, surface waves, and internal waves all work together to move nutrients, oxygen, sediment, and low-pH water around to affect ecosystems in coastal waters.

In the 2005 "Women in Oceanography" issue, I described having just made the transition from postdoctoral researcher to faculty member. I was learning to juggle teaching, research, and the new demands of motherhood. In the decade since, I have had one more child, guided many amazing MS students successfully through the doors of my research group at Moss Landing Marine Laboratories, taught dozens of classes, obtained tenure and made full professor at San Jose State, worked with brilliant colleagues all over the country, and invested a great deal of time in state and national leadership toward stabilizing our integrated ocean observing systems (US IOOS and CeNCOOS). I obtained funding from the National Science Foundation, and had the great satisfaction of working at sea and ashore with a passionate and incredibly skilled set of scientists trying to figure out just what was going on out there on the continental slope and shelf.

Ten years later, this "Women in Oceanography" compendium finds me having just made another substantial career transition. I am now in Anacortes/Bellingham, WA, where I recently took over as the director of Shannon Point Marine Center at Western Washington University. I no longer teach day to day, but am still involved in mentoring students and faculty. An important difference between my previous job and the new one is that I no longer sell my own scientific ideas to program managers but rather spend a great deal of time selling the ideas and strengths of other talented faculty at WWU. I am finding the sales pitch efforts on behalf of the scientific work of others to be much more enjoyable. Much of my time now involves personnel and organizational management and formally includes strategic planning and vision setting in the context of state higher education. I thank the Leopold Leadership Fellowship program, which has trained many environmental scientists in leadership and public communication, for giving me confidence, as well as concrete guidance, in these skills.

Erika McPhee-Shaw and her children Ginny and Henry on a windy November day in Anacortes, Washington.

A dominant theme remains the same between my previous submission and this one, and that is the importance of mentorship. I am so very thankful to all of those who have helped me along the way. There are far too many to name here, the list would overfill these pages, but you all know who you are. We all share our stories and help each other through the bad times and the good. This is what the community of science is built upon, and we are a fantastic community. My main advice to young oceanographers is to remember to continuously lean on and gain strength from that community.

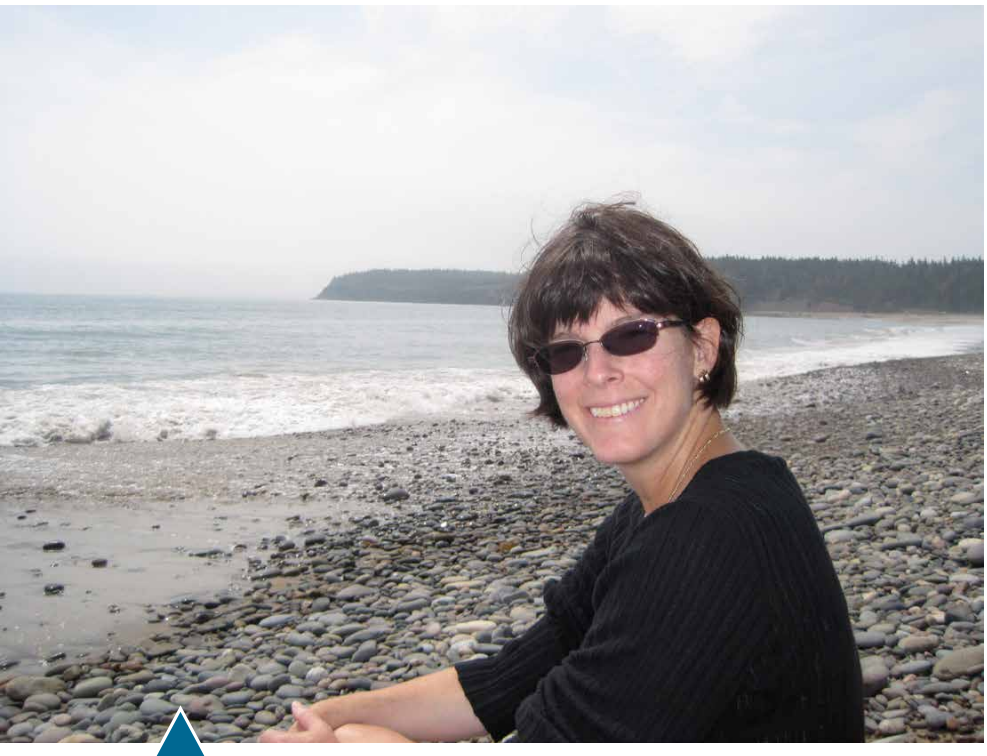
Ellen L. Mecray

Regional Climate Services Director—Eastern Region, National Oceanic and Atmospheric Administration, National Climatic Data Center, Taunton, MA, USA, ellen.l.mecray@noaa.gov

When I was a child, my family spent summers on an island off the coast of Maine. We sailed and explored, and one time I even tried to walk around a smaller island (it looked small on the nautical chart!). Every day was connected to the ocean through the tides, the winds, the weather, and the rocky coastline. In college, my advisors urged me to find courses that fit with my life interests (what great advice!). Paul Pinet's "oceanography" course in Colgate's geology department provided the critical thinking skills that formed the foundation of my science education. I petitioned the department in my final year to allow a research project based in geological oceanography instead of mapping rock formations. That summer of fieldwork on boats collecting sediment core samples, and then writing my first published research paper, brought science to life for me.

After a few years testing my interest in teaching and continuing my research over the summers, the perfect job opened up at the US Geological Survey. I spent nine years in the Coastal and Marine Geology program analyzing contaminated sediments from estuaries of the Northeast. A female mentor encouraged me to explore another agency to exercise my leadership skills. I moved to the National Oceanic and Atmospheric Administration to work in headquarters in Washington, DC. It was a great experience in a big city, surrounded by strategic thinkers advancing science. My current job blends my research training in paleoclimate with my extroverted love of teaching and communicating science. While I miss research cruises and black gooey mud, I now focus on public service and delivering climate science to real-world users. With each of my career moves, my method is: try it, explore your interests, and see if it translates to a job…then work hard and prove you can do it.

I've had some fabulous mentors, all strong women who pursued their goals with professionalism and grit. I rely on them when the going gets tough, and it still does get tough. Women notoriously understate our accomplishments when compared to men. We start by undervaluing our worth during salary negotiations, and we continue to spend a great deal of our time "balancing the needs of our families with the demands of our professions" (something rarely asked of men). My current work includes a lot of time on the road with customers, and I miss my family every second. I could not do this without my husband's commitment to our daughter and our home life. He is the glue that binds my heart with my head, our family with our career choices. My parents are also a big influence in my life. They adventured around the world with us so we could make educated choices about our interests. This gave us the courage to take risks and the confidence to know that working hard will lead to success. I try to pass that along to my daughter and those I mentor.



Ellen enjoying the signature rocky shorelines of the Gulf of Maine.

Sunshine Menezes

Executive Director, Metcalf Institute for Marine & Environmental Reporting, University of Rhode Island Graduate School of Oceanography, Narragansett, RI, USA, sunshine@mail.uri.edu

I studied species diversity and ecology of estuarine nanoplankton for my doctorate in biological oceanography at the University of Rhode Island Graduate School of Oceanography (URI GSO). I happened to come into the field at a time of transition from traditional, morphologically based phytoplankton taxonomy toward pigment-based and genetic approaches. My advisor's lab was firmly rooted in the morphological approach, which meant that, after collecting weekly samples along the salinity gradient of my target estuary, I spent long hours by myself in the lab, identifying, chasing, and counting flagellated nanoplankton. I could move the microscope stage control knobs so quickly that I fancied myself the world's fastest microscopist.

Several years into my studies, I had two important realizations: It was not my calling to work alone in dark rooms, and I needed to be able to draw a straight line from my work to knowledge or actions that would make the world a better place. (Yes, I am the child of hippies.)

These epiphanies led me to a less traditional career path that, nonetheless, is a direct outgrowth of my oceanographic training. I started with a NOAA Sea Grant John A. Knauss Marine Policy Fellowship in 2003, during which I managed the environmental policy portfolio for a New Jersey Congressman. This experience gave me an appreciation for how different US science and environmental policy might be if more Congressional staff had scientific expertise.

Sunshine on Louisiana Universities Marine Consortium's R/V *Pelican* during a Metcalf Institute Science Seminar for Journalists in 2011. The seminar, held in partnership with LUMCON, introduced reporters to researchers studying the effects of the Deepwater Horizon oil spill. Metcalf partners with a wide variety of academic institutions to provide science training for journalists.

I continued upon the road less traveled in 2006 when I was offered the opportunity to serve as executive director of URI GSO's Metcalf Institute for Marine & Environmental Reporting. The Metcalf Institute aims to expand accurate environmental news coverage by providing journalists with science training and resources and offering scientists training in communication. It has been my privilege to run Metcalf Institute for the past eight years, introducing journalists from around the world not only to marine and coastal research but also to the process and culture of science. Although I no longer conduct research, I apply my oceanographic training on a daily basis: informing the topics we choose to cover, the speakers we invite to our programs, and our complementary efforts to help scientists more effectively share their knowledge with lay audiences.

At first, I encountered some disappointment from more senior scientists for my nontraditional career choices. Most of my PhD committee members, for instance, begrudgingly supported my interest in another path, but made it clear that they wished I would "stay in science." An academic colleague lamented my choice to "work in public relations" when I took the Metcalf position. I'm proud to note that the intervening years have brought respect for my role at the interface of science, journalism, and environmental communication, even from those early detractors.

I have witnessed a dramatic shift over the past 10 years with regard to academics' acceptance of nonacademic careers. I relish opportunities to help young scientists identify mechanisms for accommodating research and science communication objectives within their own careers. The lingering barrier lies in the inflexible and outdated promotion and tenure process at most universities, which does not value talented science communicators. I feel fortunate to have found a niche where my entire suite of skills is both applicable and appreciated.

Amélie Meyer

Postdoctoral Fellow in Physical Oceanography, Norwegian Polar Institute, Tromsø, Norway, amelie.meyer@npolar.no

Amélie Meyer on Foa Island in the Ha'apai Polynesian Tonga archipelago in 2012.

When I first heard about "oceanography," it was clear that it was something for me: the perfect mix of science and the ocean. The undergraduate course at the National Oceanography Centre in Southampton only reinforced the idea that oceanography and research was the right career path; in a few years, you learn so much about so many different sciences and from such inspiring scientists. I traveled to the Gulf of St. Lawrence to study whales and stared straight into the eyes of a humpback whale, only a meter away. I spent four weeks onboard a research ship south of Greenland, with terrible weather and incredible aurora displays. Nobody had mentioned grant applications and funding at that stage, and I moved to Tasmania, Australia, to do a PhD. The project involved a cruise to the Kerguelen Plateau to collect observations. During that cruise, I got to spend time with people who not only influenced my career path but also became real mentors. Following the PhD, a postdoctoral position took me to Tromsø, in northern Norway. There, I now work on ocean-ice interactions. With climate change, the Arctic is warming and the sea ice cover is decreasing. Little is known about the dynamics of new first-year sea ice. Currently, a lot of resources are going into major observational campaigns in the Arctic to fill this gap, and ice dynamics is an exciting field.

Being an oceanographer has been incredibly rewarding. For someone who likes answering questions, there certainly is no lack of work. Everything about the job is stimulating: the science, fieldwork, people you work with, and questions you try to answer. Most importantly though, it allows me to combine my passion for the ocean and exploration with science and give it a purpose. The research we do today, understanding how our planet works, is a tool for present and future generations.

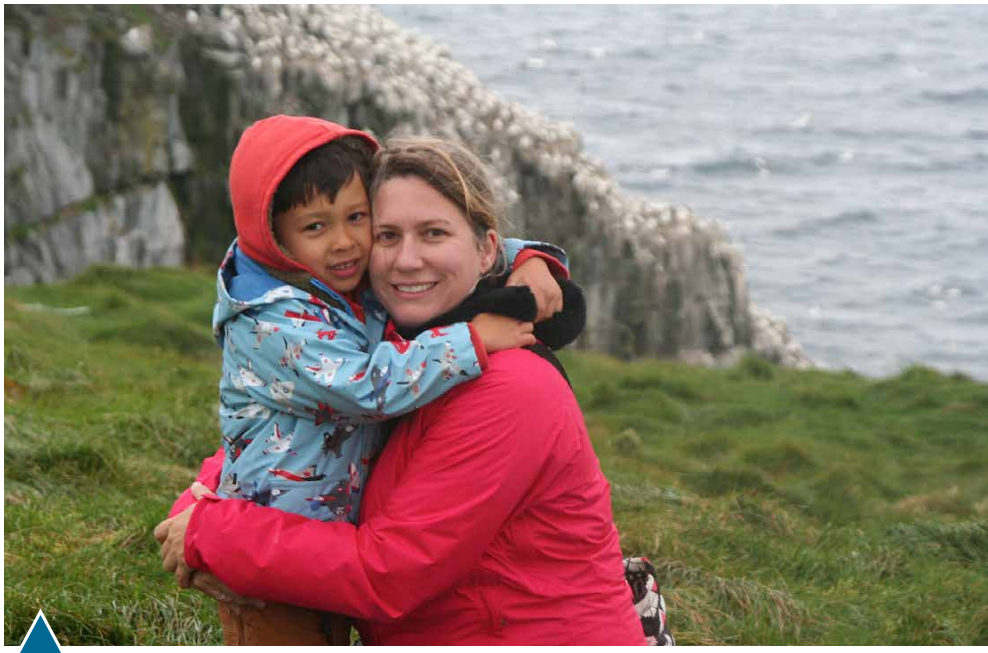
Being an oceanographer is challenging. It requires dedication and faith in your work. The real challenge for me, as for many other female scientists, was becoming a parent. Suddenly, my career choice was having a profound impact on my family. It is hard to reconcile going to sea, frequent traveling, and being a mother. Is a job really worth putting such pressure on your family and yourself? Part of the answer is passion. I would not be happy doing anything other than oceanography. However, without strong support from my spouse and friends, this passion would not be enough.

There is no denying that female researchers have it tough. The statistics are clear when it comes to gender differences in career progression and achievements. This subject is increasingly on the agendas of agencies and governments, and progressive policies are slowly making their way into the workplace. I encourage all female scientist to think of themselves as role models and mentors for younger female researchers.

Anna Michel

Assistant Scientist, Department of Applied Ocean Physics and Engineering, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, amichel@whoi.edu

My research interests focus on the development of in situ sensors for studying ocean chemistry in environments ranging from the deep sea to the atmosphere. I primarily use laser spectroscopy, and most of my work focuses on the measurement of gases. My interdisciplinary research lies at the interface of analytical chemistry and engineering.



Anna and her son in Newfoundland in 2014 where Anna traveled to give a talk on her research.

As a high school student, I had the amazing opportunity to join an oceanographic expedition to the Galápagos Islands to participate in Robert Ballard's JASON Project. During this cruise, I was able to drive a remotely operated vehicle around the seafloor and was hooked! I remember asking how I could do this for a career and was advised to study engineering. I knew that I loved math and science, and engineering gave me a way to couple the two. I double majored in chemical engineering and biology at MIT as an undergraduate. While at MIT, I found ways to be involved in oceanography by taking a field oceanography class and doing undergraduate research with Ed Boyle (MIT) and Lex van Geen (Lamont-Doherty Earth Observatory). I earned my PhD in mechanical and oceanographic engineering from the MIT/WHOI Joint Program. My research then left the ocean for the atmosphere for five years when I went to Princeton University to develop laser-based sensors for atmospheric gas sensing. I returned to WHOI two years ago to join the Department of Applied Ocean Physics and Engineering as an assistant scientist. Now, one area of my current research is to adapt techniques developed for atmospheric sensing to ocean sensing.

The greatest challenge I face is balancing my career with raising my son. I am the single mother of an energetic five-year-old, so every regular work/school day brings a challenge, and when I travel, arranging care for my son can be tricky. My wonderful parents have looked after him on countless occasions so that I could deploy a sensor at an Arctic field station or participate in a research cruise in the Caribbean. I have brought my son and my mother along to numerous conferences, and my frequent flyer son has already been to Brazil, France, Italy, and Canada, as well as all over the United States. Amazingly, in the constant balancing act, I recently arranged to do a live broadcast from a research ship to my son's school about the ocean explorations we were doing. Being at an institution where all of the women oceanographers face the challenge of balancing personal life with travel has made for a very positive experience in that there is a lot of support for one another.

Overall in the field of engineering, there are still very few women. As an undergraduate at MIT, I had many fellow female students. As I have moved along in my academic career, there were fewer and fewer women at each level. This trend has inspired me to put a lot of effort into outreach activities that focus on engineering for middle school girls. I hope more girls will pursue engineering, and especially oceanographic engineering!

Furu Mienis

Postdoctoral Researcher, NIOZ Royal Netherlands Institute for Sea Research, furu.mienis@nioz.nl

Growing up near the North Sea coast and hiking during long summer holidays in the mountains of Norway with my parents and sister triggered my interest in and love for plants, animals, and rocks. It was also during one of those hikes in Norway that I met a geologist who told me about his passion, which made me decide to study geology at VU University Amsterdam. During my MSc studies, I specialized in sedimentology and environmental analysis, and got the chance to participate in a research cruise on R/V *Pelagia*. That cruise convinced me that I preferred to be at sea rather than in the field with a hammer. I completed my PhD at NIOZ, studying environmental conditions that influence cold-water coral growth and mound formation. My colleagues and I were able to define which conditions are favorable for cold-water coral growth, and therefore reef development, and what the mechanisms are for (food) particle supply to the reefs.

After finishing my PhD, I worked for two years in Germany at the MARUM-Center for Marine Environmental Sciences, mainly studying cold-water coral reef systems along the US margin. In 2012, I received a grant from the Netherlands Organization for Scientific Research, which allowed me to return to NIOZ.

We use benthic landers that measure a large range of near-bed environmental parameters (e.g., temperature, current speed, amount and type of particles in the water column) for periods up to a year. These long-term data series allow us to observe hourly, daily, seasonal, and annual changes in the deep sea. More and more, I work at the interface between geology, biology, and physics, which advances my understanding of deep-ocean processes that drive vulnerable ecosystems. I also apply this knowledge of recent conditions to reconstruct conditions of past reef and mound formation.

I could not ask for a nicer and more challenging job. It is a great privilege to have the opportunity to learn and discover new things, cooperate with colleagues worldwide, guide students, and travel around the globe to participate in conferences and research cruises. Also, the technical aspect of developing and using equipment in the deep sea is challenging and exciting. On the other hand, being a soft money scientist creates periods of insecurity and sometimes stressful situations, especially during the months before a contract ends. It is a challenge to find a balance between writing proposals and making the most of the research projects you are working on. In the end, it is always a trade-off, because time can only be spent once.

Although the present NIOZ staff is mainly dominated by men, the number of female PhD students is increasing each year. I believe that this trend will also continue to evolve at staff level over the coming years.

Preparing a bottom lander during a cruise on R/V *Pelagia* near Rockall Bank.

Rachel Mills

Head, School of Ocean and Earth Science, University of Southampton, UK, rachel.mills@soton.ac.uk

Photo credit: Paul Tyler

Ten years on from the last "Women in Oceanography" issue, I am now head of the School of Ocean and Earth Science at the University of Southampton. The challenge I set myself a decade ago was "to generate an exciting environment that young graduates aspire to work within and that taps all of our potential." We have made great progress toward this goal. In the last five years, we have appointed 24 new faculty members, bringing the average age of the 70+ faculty down significantly. Our new hires come from centers of excellence from across the globe; the diversity and breadth of the staff now represents far more closely the student body that we educate. The next decade will be all about realizing this potential, developing the talent of these emerging leaders, and building strong links to place Southampton at the heart of knowledge generation in ocean and Earth science.

How did I get here? Ten years ago, I began the serious journey toward my current role. I served a four-year term as the deputy head of the school, working with the senior leadership team at the National Oceanography Centre Southampton, learning how to develop and deliver strategy and learning how to work effectively with people. I was then promoted to associate dean, and worked at faculty level for six years, through various periods of restructuring, before taking up my post as department chair this year. Faculty and university-wide project work has been an extraordinarily useful way to get a broader perspective on the issues and challenges that face all of us in higher education.

Throughout this period of carrying out administrative roles, I grew my research team, supervised over 20 PhD graduates, and got promoted to full professor in 2011. The PhD students and postdocs have made this possible: leading on expedition sampling, traveling the world to international meetings, and keeping our profile high during times when I had to focus on matters back home. Working with early career researchers is one of the pleasures of academia—it keeps us young.

My first seagoing expedition post children was to the waters around the volcanic island of Montserrat in 2007, and I realized that the pleasure of doing science at sea only increases with time. I now pick and choose my voyages carefully and have more recently explored the icy southern reaches of Bransfield Strait offshore Antarctica and the deepest hydrothermal vents in the Cayman Trough in the Caribbean. Working at sea is one way to carve out enough time to do research in a job with a lifestyle that has many demands on my time.

My journey here has not always been easy; luckily, I am wired to be optimistic, which helps weather the storms. I'm not in the business of giving advice, but if I had one tip for younger women scientists, it would be to find a mentor—better still, find several mentors and use them mercilessly in your times of need. And remember, what goes around, comes around, eventually.

Mary Ann Moran

Distinguished Research Professor, Department of Marine Sciences, University of Georgia, Athens, GA, USA, mmoran@uga.edu

My research focuses on the ecological genetics of bacterial sulfur and carbon cycling in the ocean, with the goal of understanding the role marine bacteria play in the productivity of the coastal ocean and the formation and flux of climatically active gases. We use molecular and ecological genomics approaches to explore bacterial processes and their regulation in seawater.

Although I grew up near the ocean on Long Island, my pathway to oceanography was surprisingly circuitous. I was drawn to botany early on, and spent a lot of time learning plant names and digging in our family garden. I then earned two degrees that focused on plant ecology: an undergraduate degree from Colgate University in Hamilton, New York, in 1977 and an MS from Cornell University in Ithaca, New York, in 1982. It was during my master's program that I was first exposed to the field of microbial ecology, and I was hooked. My husband landed a postdoc at the University of Georgia in 1983, and because it was also the home of several well-respected marine microbial ecologists in what was still a nascent field, we headed to Athens. Robert Hodson was my doctoral advisor and taught me how to think big about small organisms. What fascinates me most about studying the ecology of ocean microbes is that as soon as I can think of a question, these fast-growing and quickly responding microbes can answer it—it is experimental ecology without waiting for a tree to grow.

Thirty years after driving into Athens, I'm still at UGA. I broke the rule of never staying at the same institution where one receives her PhD, but my career path wasn't exactly typical in many other ways either. With my husband ensconced in a faculty position by the time I finished my degree, I stayed on in the Hodson lab on soft money. And then in the throes of depression over my stalled career, I happened to be in the right place at the right time: a new department of marine sciences was formed at UGA, and I snagged a faculty position.

Our second daughter was born one month after my tenure clock started in 1993, but as bad as that timing sounds, I've learned there is really no "good" time to have children in the career track of a female scientist. As a member of a marine sciences department in which one-third of our faculty are female, I know that things have changed for the better for female oceanographers. But we still faces challenges, including convincing ourselves that successful approaches to doing and managing science don't have to take us down the "typical" path.

Mary Ann in her microbial ecology lab at the University of Georgia.

Colleen Mouw

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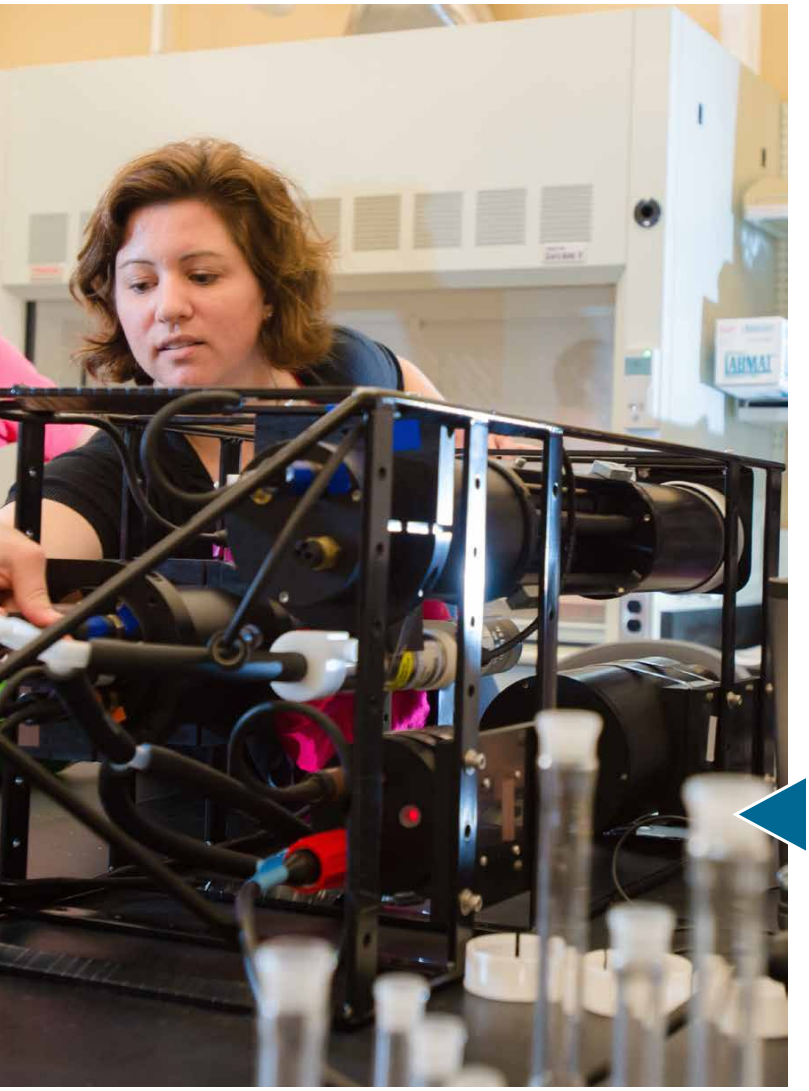
Partnering with numerical modelers, I use a variety of satellite products and in situ observations to understand how aquatic systems respond to environmental change. In particular, my research focuses on understanding the physical and chemical drivers of phytoplankton variability in the ocean, the Great Lakes, and inland lakes. I spend a lot of time evaluating, developing, and refining algorithms that lead to novel satellite products and improvement of product performance. I characterize optical variability in the field necessary for algorithm development and validation efforts.

Growing up on the eastern shores of Lake Michigan, I spent as much time as possible near the water, and it is still my favorite place to be. I clearly remember looking through a microscope for the first time and being astounded by the diversity of plankton in such a small volume of water. However, looking through the microscope was too narrow a view for me. I love maps and the big picture of how things work. Remote sensing provided a nice synergy for combining my curiosity about phytoplankton and the big picture.

Balancing career and personal life has been part of the picture from the beginning of graduate school. I was married just months before starting graduate school, and my son was born in my third semester of MS work, my daughter about two and a half years before completion of my PhD. I have always put family first and looked for flexibility in how I pursue work and what interests me. This is not always easy, but I know it is worth the creativity. My husband and I have leapfrogged, moving for his career and then mine many times over, and it does not seem that we have landed permanently yet. The balance between his work and mine has resulted in telecommuting in some cases and long commutes in others. I have found the practicality of being primarily computer oriented in my research allows for significant flexibility in how and when I work.

My favorite aspect of being an ocean/aquatic scientist is the flexibility to pursue what interests me and to work with colleagues and students who challenge and support me. The people have always been the most important aspect of the job, and I truly love mentoring students and building strong collaborative groups. I also love the opportunity to get out in the field occasionally, and it always serves as a reminder of why I chose ocean science as a career.



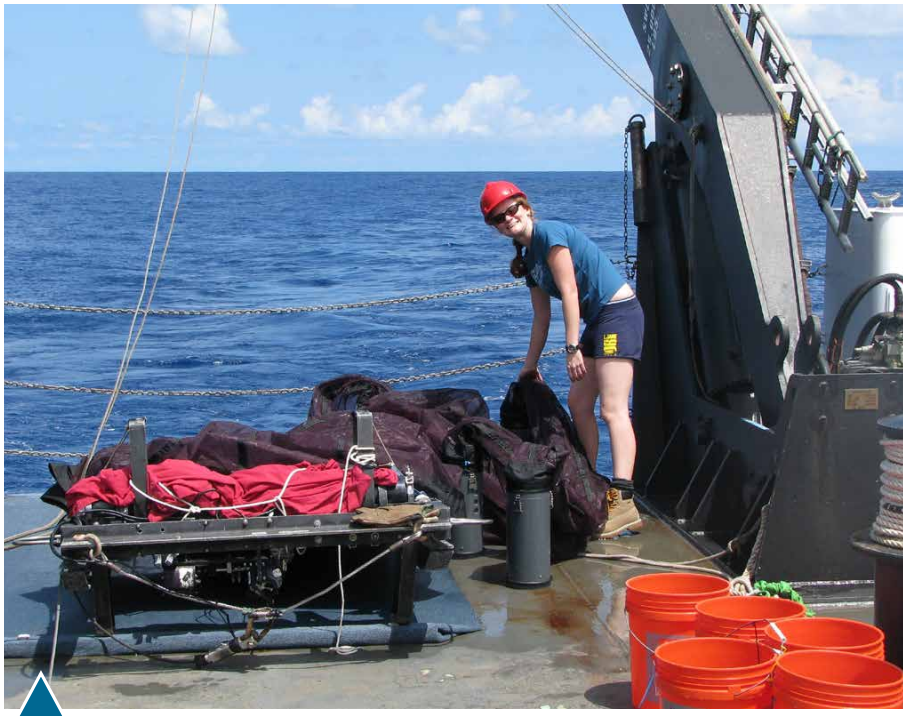
Colleen prepping equipment in the lab for deployment in the field. *Photo credit: Sarah Bird, Michigan Technological University*

Barbara Muhling

Associate Scientist, Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, FL, USA, barbara.muhling@noaa.gov

I grew up in southwestern Australia and was always close to the sea. My family spent many holidays near the beach, where the Southern and Indian Oceans meet. At the age of about 10, I remember my parents teaching my sister and me how to dive under the large breaking waves that pound that part of the coast for most of the year, and how to swim out past the surf zone to calmer waters.

Despite this upbringing, I never had much interest in oceanography at school. At 17, I was just another teenager staring down graduation, with no idea about what I wanted to do next. At 5'9", my childhood dreams of being a horseracing jockey were clearly off the table, and so I enrolled in a marine science course at the local university. The brochure showed pictures of scuba divers and coral reefs, which looked much more appealing than the photos of accounting students hard at work on their spreadsheets.



At work on the NOAA Ship *Nancy Foster*, during a 2008 biological oceanography cruise in the northeastern Caribbean Sea.

It was a fortuitous choice. By the end of my bachelor's degree, I knew that this was the field for me. During my PhD work, I moved further into biological oceanography, studying ichthyoplankton off the southwestern Australian coast. I worked with physical and chemical oceanographers who introduced me to satellite imagery, planktonic food webs, and the dynamics of the ocean on a regional scale.

After graduation, I knew I wanted to continue this type of multidisciplinary oceanographic research, but opportunities in my hometown were limited. Fortunately, I landed a National Research Council postdoctoral fellowship in Miami, Florida, in 2007, working on larval tuna in the Gulf of Mexico. I've been in Miami ever since. My current research uses environmental data from satellites and ocean models to predict adult and larval habitats of highly migratory tunas and billfishes in the Atlantic Ocean. We use these habitat models to benefit fisheries management and to predict impacts from stressors such as climate change and the 2010 Gulf of Mexico oil spill. So, I've moved from being a biologist to a modeler of sorts, which I think is quite a common experience. As technology advances, and funding for fieldwork diminishes, our work is increasingly focused on data mining and modeling, which requires us to constantly learn many new skills throughout our careers.

Perhaps I have been fortunate, but I haven't felt disadvantaged by being a woman in this field on very many occasions. I think that my experience has been very different to what it might have been 20 years earlier. My first research cruise as a graduate student (three weeks in the Southwest Indian Ocean in 2003) was led by two larger-than-life female biological oceanographers (Lynnath Beckley and Anya Waite). There was no question of their being intimidated by anyone on board, male or female. They gave me an inspiring, but rather tough, act to follow.

I have also been lucky to find a nonscientific but endlessly patient husband, who happily tolerates my obsession with things that float around in the ocean. We're excited to see what the future holds for us—for work and for every other part of life.

Lauren Mullineaux

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Photo credit: Peter White

I am a biological oceanographer interested in seafloor ecosystems. I investigate how larvae of benthic invertebrates disperse and how dispersal affects the structure and dynamics of benthic communities. These studies take me by foot into the intertidal zone and by submersible into the deep sea. The interdisciplinary nature of the work provides an opportunity to interact with many different kinds of scientists outside of my field, including physical oceanographers, chemists, and mathematical ecologists.

A decade ago when I wrote a bio sketch for *Oceanography*, I mentioned that one of the most rewarding parts of my career was teaching and advising students: "they are full of surprises, and keep my outlook fresh." Since then, I have dived further into science education at all levels. Developing a "Communicating Ocean Science" course to suit graduate students in the MIT/WHOI Joint Program has been particularly fun and has resulted in long-standing ties with local elementary schools and new partnerships with regional undergraduate universities.

Balancing life as a scientist and a parent is an adventure. With my sons now out of the house, I have more time to devote to research and education. But like many others, I find myself in a funding environment with tight resources. Keeping a research program afloat is a challenge that will require our lab to stay flexible and retool for important ecology problems of the future. I keep reminding myself to stay curious and be nimble. Perhaps that is good advice for newcomers to oceanography as well!

Sarah J. Norris

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From a very early age, I have been fascinated with how the world around us works. Initially, my interest was in severe weather, and in 2003, I completed a degree in meteorology at the University of Reading, UK. In 2006, I earned a PhD from the University of Leeds, developing instrumentation to investigate the formation of sea spray aerosols from the ocean surface. Further research has focused more on the upper ocean, processes that control the rate of the formation of sea spray aerosols, thus moving me closer into the world of oceanography.

I have been on numerous research cruises, from the Pacific to the Arctic and Antarctic, investigating whitecaps, bubbles, breaking waves, and the resulting flux of ocean spray. The number of women working on these research ships in the last eight years has varied widely, from a female-dominated science team to being the only female onboard the ship; however, every trip has been enjoyable in its own way.

The most interesting and rewarding aspect of my career has been exploring our beautiful world. I have been so lucky to travel from the very top to the very bottom of the planet for science. One of the best aspects of working at sea is meeting scientists from associated research areas and learning about their work. The combination of a wide range of subject areas all working together on one ship is fascinating, and you really get to see how interlinked everything on our planet is.

I have always loved my job and the variety of the work, both in the lab and the field, from data analysis to communicating our findings to the research community and the public. My greatest career challenges have come in the last couple of years. I now have a beautiful little boy, Logan, who is 14 months old. Starting a family has naturally changed some of my priorities and limited some of what I can do. Now it is not so easy to agree to that next trip, which inevitably will be going further into the ice or stopping at a new, remote island—part of me wants to carry on exploring. At times I have felt like I am letting my research team down: someone else goes to sea in my place, does extra fieldwork, and runs instruments to collect data for me. But fieldwork is only one part of my job, and one day I will return to the field; in the meantime, there is data analysis, papers to write, and instrument preparation to do.

Since earning my PhD, I have always worked on short contracts. This situation does not make for a very secure work environment, never knowing if there will be funding to extend my research and keep me in paid employment. I have been lucky with my line manager, who has been understanding and so far we have been able to find funding for our research.

The last year hasn't been easy, but with Logan now happily settled at nursery and a very supportive husband, I believe I have got to a place where I can push forward with my research and still be there for my family.

This photo was taken in August 2008 in front of the Swedish Icebreaker *Oden* at 87°N. We sailed from Svalbard and anchored to the pack ice for three weeks. A research camp was set up on the ice for the Arctic Summer Cloud-Ocean Study (ASCOS).

Joanne O'Callaghan

Research Scientist, National Institute of Water and Atmospheric Research, Wellington, New Zealand, joanne.ocallaghan@niwa.co.nz

My research focuses on understanding physical transport mechanisms in coastal ecosystems, specifically, how stratified flow regulates transport over a range of time scales. Typically, coastal system energy sources are transient in nature (seabreezes or freshwater flows from rivers), yet the role of transient processes is not clear from the mechanistic perspective for coastal-ocean coupling. I mainly use an observational approach in my science, but during my postdoc I adopted adaptive modeling techniques to explore stratified flows in idealized settings. One of the great things about observational oceanography is getting into the field. Just a few places that I have been fortunate to be able call my "office" are the New Zealand fjords, coral reefs in New Caledonia, and salmon farms in Marlborough Sound. Antarctica is on my list of places I would like to work in the future.

I have always loved being in or at the coast, from dinghy sailing to wild winter walks along the beach. But oceanography never occurred to me to as a career when I was making those tough decisions about what degree to do at university. After trying several different courses that did not inspire me, I reluctantly completed one of those career guidance questionnaires and the computer spat out "oceanographer." Amazing, really, that I walked out with my career aspirations on a scrappy piece of dot-matrix printer paper, but I have never looked back. I completed an undergraduate degree (in oceanography—this specialization is gone now!) at Flinders University, South Australia, in 1997, an honors degree at James Cook University, Queensland in 1999, and a doctoral degree at University of Western Australian in 2005.

Each stage of a science career brings a new challenge. Finishing the thesis, publishing papers, getting that hard-earned funding grant, the first student, establishing a relevant research theme. And this is about where I am up to in my career. Certainly, the first few years after finishing my doctorate were a struggle. Having a mentor during the early career years was an essential ingredient for making it through, for guidance and advice. I also helped establish a network for early career researchers and found meeting with others grappling with similar challenges a valuable resource. I expect there will be more challenges to come, but for now I am feeling happy that I get to come to work to do something I love.

Joe O'Callaghan deploying SCAMP (Self-Contained Autonomous Micro-Profiler) through the very thin buoyant surface water in Doubtful Sound, Fiordland, New Zealand. While the rain may look unpleasant, it did a great job of keeping the sand flies away! *Photo credit: Craig Stevens*

Balancing work and home life can be hard at times. Juggling the commitments of two professionals around voyages, conferences, or school concerts requires a fair amount of organization. Embracing chaos was necessary to achieve any sort of "balance" and has made life far more enjoyable. Sharing the excitement of science with my children and their peers more than makes up for the busyness. Being involved in a school system gives me an opportunity to show children that scientists don't all have white coats and beards! So perhaps when the kids from this generation go searching for career options, some will remember the experiments I did with them at school and that oceanography, or science at the very least, could be an exciting prospect.

Mónica V. Orellana

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Ten years after the last edition of "Women in Oceanography," I continue to be enchanted by the ocean, its beauty and vastness, as well as its mysteries. There are so many discoveries waiting to be made by the curious mind.

Today, I have dual research positions at the Institute for Systems Biology (ISB) and at the University of Washington's Polar Science Center in the Applied Physics Laboratory. They are very different places whose truly creative people complement one another, and both play leading roles in diverse fields. At ISB, I apply systems biology approaches to enhance understanding of the physiological and molecular responses of phytoplankton to environmental forcing (specifically, ocean acidification), while at the Polar Science Center, I develop approaches that will help determine how phytoplankton's influence on cloud formation affects climate, one of the biggest uncertainties in climate models. At these two institutions, I work on problems at vastly different scales. Examining a wide spectrum of issues brings enormous richness and a unique perspective on even bigger global processes, and working at the molecular scale leads to understanding of how the cumulative effects of single cells propagate to much larger scales, such as those influencing Earth's climate.

We live in a world where collaborations are increasingly important. They give us support, broaden our knowledge, and provide feedback at both fundamental and applied levels. I have been lucky to collaborate with brilliant women as well as men. These alliances that have taken me as far as the Arctic, where I was humbled by its beauty, expansiveness, and grandeur and experienced the thrill of discovery.

While I am very happy with the path I've taken in science, there is a downside to being 100% on soft money. It takes a great deal of energy to maintain several active grants to cover my own salary as well as that of the students, postdocs, and technicians who work in my lab. Sometimes I wonder if I will be able to come up with a new idea, a new observation, or a new process for that next proposal, but it almost always happens. It takes persistence and hard work, but it is also thrilling.

For the young scientist, I believe it is important not only to follow a dream but also to develop conceptual tools and experimental techniques. Be imaginative and open-minded; look at questions in different ways and learn cutting-edge techniques that can reveal new areas of thinking and research. It's also important to give back to the community through educating the next generation. While university professors do this all the time, it is more challenging for research scientists. One opportunity that I've enjoyed is bringing science concepts to high school and earlier grades through outreach programs. Teaching young students to understand our interactions with the environment will be of lasting benefit.

Tuba Özkan-Haller

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My work focuses on the nearshore ocean, the so-called "dirty rim around the bathtub," where water waves are important to just about anything that happens, contributing to its beauty, enabling recreational activities, and fueling dreams of renewable energy extraction. Waves are a major driver of long-term change to coastlines and of acute damage to cities and towns during storms. Waves also generate currents that are the leading cause for lifeguard rescues (and, unfortunately, also fatalities). So, as much as the nearshore ocean is beautiful and fun, it is also mysterious and dangerous. And I have had a fascination with it, and a healthy respect for it, since I was a child.

My approach to my work involves utilizing theoretical and numerical modeling along with observations from targeted laboratory or field experiments. I feel most satisfied with my work if the theory and modeling can elegantly help bring to light causal relationships and dominant dynamics, which then can help explain complex observations. Recently, I've worked on predicting properties of waves as they travel over the complicated bathymetry of the continental shelf, and their potential effect on oxygen cycling, or their interaction with ocean structures. I've also been studying surf zone currents generated by waves and the fascinating eddies and rips they form. And I've been working on ways to estimate the underlying bathymetry by combining information from remote sensors and skilled numerical models. These methods can potentially help us track beach change during storms when in situ equipment cannot be safely deployed. As part of my job, I also teach several courses and devote a significant amount of time to outreach. I thoroughly enjoy engaging students and the public not only because it might improve (or even save) lives, but also because I find joy in the fact that such engagement helps improve the research itself and the resulting products.

I was fortunate to be part of the first compilation of "Women in Oceanography" in 2005 when I was an assistant professor. The intervening years brought many adventures, some challenging (like a health issue that took some years to control), and some joyous (like the addition of a third son to our family). Along the way, I learned to balance my time better, to make things that keep me healthy and happy a priority, and to keep the joy in it all. I benefit daily from working with fantastic collaborators who help me remain curious and excited (and I try to stay away from people who don't). I also benefit from coming home to a supportive spouse, also an academic and an equal partner, and three active boys (now 14, 12, and 7) who keep me on my toes. Every year brings new and different challenges, and I often feel unprepared for them all. But I've learned that it is possible to make mistakes and recover from them: I might miss a wave, but there is another not far behind.

Tuba and family at her ancestral home, the village of Yörük near Safranbolu, Turkey. "Selfie" courtesy of her oldest son Atlas, while Bora and Korhan laugh, and husband Merrick Haller tries not to squint.

Jaime Palter

Assistant Professor, Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, QC, Canada, jaime.palter@mcgill.ca

During university, I had two realizations: I wanted to travel as much as possible and I wanted to understand more about how the Earth system worked. Going for a PhD in oceanography seemed like a ticket to fulfill both desires. Throughout the years since heading down that track, I have been rewarded by a career connecting ocean circulation to biogeochemistry and climate. Much of my work has focused on how water mass formation influences climate, carbon, nutrients, and sea level. It requires observations collected in targeted field campaigns and by the global oceanographic community via ships, through the Argo program, and by satellite, as well as climate models.

As I was considering graduate schools, an undergraduate mentor gave me the good advice to pay the most attention to the microenvironment of a PhD program. In other words: pick your advisor's lab with care. With this in mind, I returned to my undergraduate university, where the professor who had introduced me to the field was willing to mentor me in the PhD program. It was obvious that she was both an incredibly insightful scientist and a woman with a rich family life. Her example would help me navigate the path I aimed to walk in my own life. Combined with subsequent postdocs with excellent mentors, I am left with a huge debt to the oceanographic community, which I have tried to start paying back to the students I now advise in my role as an assistant professor.

To me, these relationships—with mentors, students, and colleagues—are the most rewarding parts of being an oceanographer. The travel, which I so desired as a student (and still love), recently became the most challenging aspect of this career, given the logistical and emotional toll of leaving two young children during these trips. I recognize this change as part of the journey from my time as an unencumbered student to a time when I am responsible for/to a research group, a classroom, and a family. Thanks to trailblazing women oceanographers and supportive men, this path has become wholly navigable.

Uta Passow

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I like my profession! Ten years ago, I had a motivating, tenured position as a lead oceanographer at the Alfred-Wegner Institute in Germany, where I worked with great facilities and fantastic colleagues. The decision to leave such a remarkable job and move back to California as a soft-money researcher was based on family considerations. The move was tough—as a major move always is. Being an oceanographer helped: as a member of this international "tribe," I never experienced the feeling of displacement that often accompanies large moves. Oceanographers "belong" no matter where they live.

Now, six years later, it is clear that my move to the United States has allowed me to thrive and succeed in new research arenas. I work on novel, stimulating topics, and have discovered a whole new "world" in collaborating with both recent colleagues and longstanding friends. To me, that is an essential aspect of being a scientist: embracing new insights and new experiences.

As I've matured, I've become more involved in mentoring, guiding, organizing, planning, and leading science efforts. I enjoy these new challenges: working on steering committees, and teaching, and communicating science. But I still spend time in the laboratory and make time to go to sea. Our profession allows us to change the daily work routine without having to change jobs, whether we physically move or not. Our profession is also one where we are continuously tested and evaluated. Every time we submit a manuscript for publication or a proposal, we get feedback. Dealing with this kind of input is challenging, but I feel it keeps my mind and my science active and flexible. I'd hate to remain on any type of treadmill.

Hiking in the Redwoods.

At the same time, there is consistency. I've worked on particle flux, for example, sinking of particles and marine snow, since my master's thesis. Currently, I look at the impacts of oil spills and global change on carbon flux. This expansion into new areas of research was paralleled by a shift in public awareness and interest. Whereas the sinking of particles once was a topic that interested only a few specialists, the consequences of global change, including ocean acidification, and of the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, have received ample media attention. This new interest has subtly changed my work as a scientist, increasingly emphasizing communicating science to the public. As active scientists, we continue to learn.

Adina Paytan

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It has been 10 years since the last volume—10 years ago I was an early career assistant professor starting my fifth year at Stanford, excited about my work and enthusiastic to share it with others. Now, 10 years older and a lot more savvy, my research is still focused on marine biogeochemical cycles in the present and past and on interactions among the solid Earth, the ocean, and the atmosphere. I am still very excited about my work, although now considerably less optimistic about the academic process.

I was quite naive 10 years ago and had no clue how opaque and unfair academic politics can be or how crucial mentorship is. So, what caused this transformation in my views? Despite my high research productivity as evidenced by funding, publication, and citation records, and the great teaching evaluations and vast student support I received, I did not get tenure at Stanford. The "official" reason was that my work was not likely to have the impact expected for this esteemed department/school (I am happy to say it was not a self-fulfilling prophecy). The real impact of this event, however, other than making me quite cynical and educating me about the pitfalls of the academic process, was that I moved to a workplace more compatible with my own values. To be honest, I would likely not have left Stanford had I gotten tenure, so a bad turn of events, in retrospect, resulted in a positive change. I am as productive in my science and education endeavors at my new location as I was in Palo Alto, and I'm a much happier person.

But it is not all rosy; decisions involve compromises. To balance family and career, I took a position that is 100% soft money (not even a dime of institutional support). Little did I know how close to impossible it is to convert such positions to tenured faculty positions, particularly for mid-career scientists engaged in interdisciplinary research. At times, I wonder if being a successful, assertive, and confident woman scientist makes things even harder, although I try not to focus on that. Another important outcome is that I devote a lot of time to mentoring students and early career scientists, particularly women. Specifically, I would advise early career scientists to seek a good mentor they trust and who has the ability to advance their cause and to negotiate tenure expectations or evaluations early on. I am also much more understanding of scientists who choose nonacademic careers to fit their life style and workload expectations.

Now, as a seasoned scientist and woman oceanographer, I tell my students and mentees that life is full of surprises, that they should not take anything for granted, that it is most important that they are happy with what they do and where they are. We all make choices, compromises, and decisions throughout our careers, many small ones on a daily basis (what to teach, how to respond to an email, should I accept this request to review) and some more substantial with broad and lasting implications (do I take this job, move, have another child). Sometimes, decisions will be made for you (as in my case), but whatever the consequences of the steps you take, it is important to remember to be happy that you have the opportunity to make your own decisions. Always be true to yourself, do not compromise your beliefs and values, and stay optimistic, maintain a positive attitude. After all, what a privilege it is to be able to wake up every morning and go to a job that you love; that keeps you curious, excited, and intellectually challenged; and in which you can truly make a difference.

Taking some time off work at the Galápagos.

Sara Pensieri

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As a child, I was fascinated by the development of new technologies to allow communication between people far away from one another, and this inspired me to study telecommunication engineering. At the end of my degree course, I investigated the world of research and became passionate about applied ocean engineering. This led me to collaborate with the environmental monitoring group of the Institute of Studies on Intelligent Systems for Automation of the National Research Council of Italy (CNR), and in 2005 I joined the Institute team that is dedicated to the scientific/technological development and enhancement of the W1M3A observing system, one of the oldest CNR meteo-oceanographic platforms.

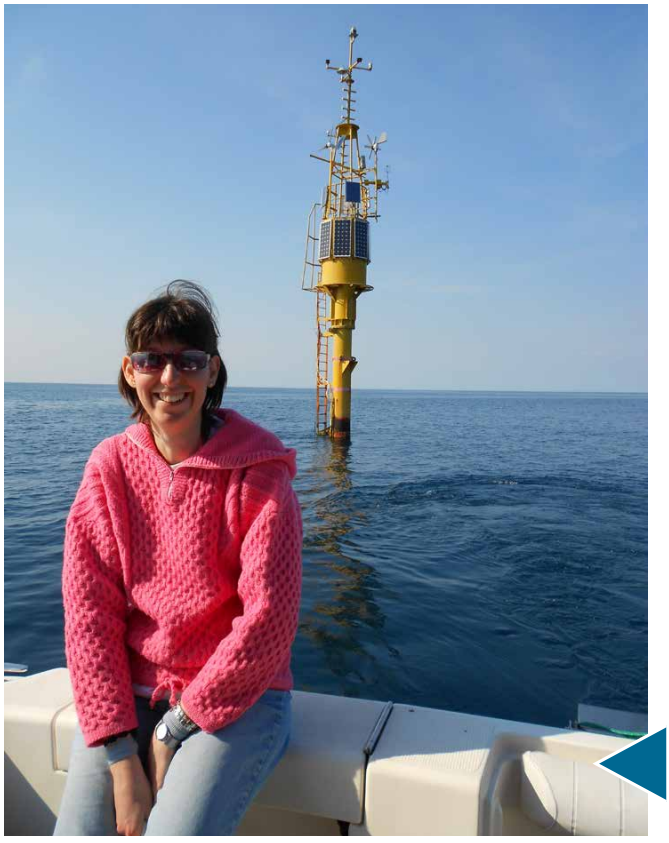
As a member of the W1M3A team, I am in contact with international programs dealing with a great variety of oceanographic applications and have the opportunity to work closely with researchers from all over the world. Indeed, my expertise now extends from marine technologies that support operational oceanography to underwater acoustics and analysis of physical processes at the air-sea interface. Interest in acoustic applications led me to get my PhD in electronic and computer engineering, robotics, and telecommunications with a thesis entitled *Analysis of Acoustic Signals for Measuring Oceanographic Parameters and Underwater Noise*.

Involvement in several European projects (MERSEA, EuroSITES, MyOCEAN, PERSEUS, FixO^3) that are developing innovative methodologies for marine environmental monitoring brings me experience in data management and in the design of field experiments for oceanographic cruises.

Today, I am the data manager of the W1M3A observatory. This position is extremely rewarding, combining my engineering background with operational oceanography issues. Daily activities involve responsibility for data acquisition, near-real-time data transmission, and data processing and product delivery. It is a real pleasure to know that my work is useful for operational oceanography and that the entire chain (from data acquisition to distribution) is successful every day!

Being a researcher is extremely exciting. Every day I use innovative technologies to enhance the monitoring capability of the W1M3A system and also analyze in situ data for studying air-sea interaction, ocean variability, and the biogeochemical properties of the water column.

On the other hand, fixed-term contracts limit perspectives and ideas…but being an ocean scientist allows me to participate in cruises, to attend national and international conferences where I am in contact with so many people, and to enjoy many experiences. It would be very hard to give that all up! As an ocean scientist, I travel a lot, am at sea for weeks, and sometimes have to miss holidays or cancel plans. But I like my job and I am very lucky, because my family always supports me even when I encounter difficulties. Nonetheless, to be a woman engineer working in operational oceanography is really a challenge in Italy, but there are so many things that I still want to accomplish that I am determined to continue this career.



Sara at the end of a day at sea working on the W1M3A observatory (in background).

Renellys C. Perez

Associate Scientist, Cooperative Institute for Marine and Atmospheric Sciences, University of Miami, and NOAA Atlantic Oceanographic and Meteorological Laboratory, Miami, FL, USA, renellys.c.perez@noaa.gov, rperez@rsmas.miami.edu

I am a physical oceanographer living and working in my hometown in South Florida. While I didn't always know I would be an oceanographer, the love of water was instilled in me at an early age growing up surrounded by swimming pools, the Florida Straits, and the Gulf of Mexico. My family moved from Cuba almost a decade before I was born, and the romanticized notion of my parents' homeland separated from the United States by just 90 miles of seawater may have also been a contributing factor.

I began to consider becoming an oceanographer near the end of high school—I really enjoyed math and physics, and oceanography seemed to be a perfect field to apply those skills. I studied applied marine physics at the University of Miami for my master's degree and then physical oceanography at Oregon State University for my doctorate. My path to getting my PhD was fairly linear in that I had a clear goal in mind from early on. But, I definitely took the scenic route and considered alternate paths. After finishing a postdoc in Seattle, I moved back to South Florida to take my current job. It is quite rare in our field to return to your hometown, and I am very grateful that my life and career worked out that way.

My current research is focused on developing a better understanding of the processes that influence ocean currents and their roles in ocean-atmosphere heat exchange on seasonal to decadal time scales. Recently, I have been working to understand the role of the South Atlantic Ocean in the global meridional overturning circulation, to characterize how upper ocean currents in the tropical Atlantic and Pacific vary, and to build a high resolution velocity data set from a network of global drifting buoys. This work is very broad in scope and requires strong collaboration with researchers from many national and international institutions. Going to science meetings and to sea in support of these projects is becoming a very important part of my job.

While work-related travel can be incredibly rewarding, it can also be personally challenging because it requires that I spend time away from my husband and our daughter. Those times away are far less difficult than they could be because of my superhero of a husband and our extensive network of family and friends. Technological advances, such as increased Internet access at sea, make it possible to stay in touch from very remote locations in the Atlantic Ocean.

Renellys with her husband, Bertrand, and their daughter, Viviane, on Miami's South Beach.

Until recently, my greatest career challenge was learning how to navigate the US science funding system. I have become more successful at getting research grants funded in the past few years, and now the new challenge will be learning how to make progress on multiple projects simultaneously. Basically, I will need to use the multitasking skills that I have honed being a woman in science and trying to balance family and a career.

Laetitia Pichevin

Senior Postdoctoral Researcher, Grant Institute, School of Geosciences, University of Edinburgh, UK, laetitiapichevin@ed.ac.uk

I am a marine biogeochemist whose research focuses on the role of the ocean's chemistry and biology in modulating past climate change, greenhouse gas concentrations in the atmosphere, and the carbon cycle.

My vocation as a paleoceanographer came somewhat late, in my early twenties, and is more the result of fortuitous events than a planned career path. However, looking back, I remember as a child being struck—while searching for shark teeth in the sandy pathway behind my garden—by the realization that our house stood on what was once the bottom of a tropical ocean. Earth dynamics and the unimaginably long time scales at which they shape our landscape and climate have always fascinated me.

Although my original path was to study anthropology and the Indonesian language, I became concerned with environmental issues and opted for a master's degree in applied environmental sciences. It was during my education at the Université de Strasbourg that I heard for the first time about the astronomical theory of climate change and the oceanic conveyor belt, and how they interact to pull our planet in and out of ice ages. I was captivated. Thereafter, I decided to do a second master's in marine geology and climate at the Université Bordeaux 1, followed by a PhD in paleoceanography working on the Benguela upwelling system and the role of marine nutrients and carbon preservation mechanisms in the oceanic biological carbon pump—one of the many ways by which the ocean modulates greenhouse gas concentration.

During my second year, I had the great opportunity to participate in one of the IMAGES research cruises aboard the French research vessel *Marion Dufresne*, renowned both for its great food (a definite bonus on a scientific ship) and its giant piston corer *Calypso.* During the month-long cruise in the North Pacific, I met inspirational marine researchers who have influenced and stimulated me ever since. Two of these researchers were based at the University of Edinburgh, and after a brief postdoc in France, I decided to apply for a Marie Curie intra-European fellowship to join the Edinburgh team. This was nearly 10 years ago.

Kayaking around Vancouver Island after the 2006 Goldschmidt Conference in British Columbia, Canada.

After spending years reconstructing the marine nitrogen cycle by measuring nitrogen isotopes in sediment cores from most of the tropical ocean, I have focused the last few years on measuring trace metals and silicon isotopes in sedimentary diatoms, a siliceous phytoplankton group that is particularly efficient at fixing carbon at the ocean's surface. Collectively, these studies have added to the emerging picture that the constraints imposed by marine nutrient (iron, nitrate, and silicate) limitations on the biological carbon pump were fundamentally different in the glacial ocean compared to the modern ocean. The broader implications are that changes in marine nutrient cycles are likely to occur in a warming world, with the potential for dramatic feedback effects on marine productivity and the biological carbon pump.

Moving to Edinburgh was probably one of the best decisions I have ever made. There, I found a family and a home, but also inspiration and support for pursuing demanding chemical analyses and cutting-edge research while looking after my two small children, Martin, four, and Fin, two. Understanding colleagues and flexible working hours have made it possible for me to have both a successful career and a fulfilling family life. I would not have sacrificed one for the other.

Helle Ploug

Professor of Marine Ecology, University of Gothenburg, Sweden, helle.ploug@bioenv.gu.se

My research focuses on small-scale processes occurring within and around suspended and sinking phytoplankton colonies and marine snow aggregates and how these processes drive carbon and nutrient cycles, food webs, and biogeochemical fluxes at a larger scale in the ocean.

I grew up in the northern part of Denmark, directly on Limfjord, about 25 km from both the North Sea and the east coast. As a child, I spent every summer at the North Sea, digging in the sand, collecting stones, seashells, and seaweed, or playing in the dunes with my sister. Being surrounded by the sea was a natural environment to me, but I never considered becoming an oceanographer or marine ecologist before well into my biology studies at university. I also did not consider working toward a PhD until after my MS thesis with Bo Barker Jørgensen, my mentor. He opened my eyes to the invisible mass transfer processes that we can measure using microsensors at interfaces between water and, for example, sediment, phytoplankton colonies, marine snow—and I am still doing this 25 years later! I remain fascinated by these small-scale processes, which are governed by physics, chemistry, and biology.

I met my spouse relatively late in life, and we had three children (one plus twins) 26 months apart during the 12 years that we lived in Germany. I was lucky to have supportive colleagues and mentors, and I found my way back to science after both maternity leaves. It was not easy with three small children, but we had great daycare, I had a lot of flexibility in my research, and, most importantly, I shared the housework with my husband, who is a professional geochemist. Later, his career opportunities took us to Stockholm. This was probably the biggest challenge in my career, but it turned out to be very fruitful. I applied for a Marie Curie fellowship for career development, which can be done at any stage of a career. Through collaboration with former colleagues, I began to use stable isotopes in combination with novel nanoscale secondary ion mass spectrometry to study the small-scale fluxes of carbon and nitrogen associated with N_2-fixing cyanobacteria colonies in the Baltic Sea.

Six months after my Marie Curie fellowship ended, I was appointed to a faculty position as an associate professor at the University of Gothenburg, where I could start up my own research group. With the support of my husband (and the University of Gothenburg), I am now commuting nearly 500 km between Stockholm and Gothenburg every week, while he is working as an associate professor at Stockholm University and taking care of our children and our household three to four days a week when I am away. We often have to solve the puzzle of accommodating our two schedules with those of our children who are now 10 and 12 years old. Most of the time, we find that all the pieces fit, and our way of living together is giving us all much in life.

Julie Pullen

Director, Department of Homeland Security National Center for Maritime Security Research, and
Research Associate Professor, Stevens Institute of Technology, Hoboken, NJ, USA, julie.pullen@stevens.edu

I apply coupled ocean-atmosphere modeling toward understanding and forecasting the dynamics of coastal urban regions throughout the world. My specific research interests encompass the ocean's response to atmospheric flows around island topography and sea-breeze interactions with city morphology during heat waves. My work synthesizes meteorology and oceanography as well as transport and dispersion modeling for research and also for national security applications relevant to groups such as the US Coast Guard and the Navy.

As a child, I often floated sticks down the rivulets that would form in the dirt road in front of our farmhouse. I spent hours mapping out the various paths, twists, and turns the sticks would make as they traveled down the incline toward the pond. As an undergraduate, I learned that my sticks had been showing me chaos theory, and I was eager to learn more. I wrote to the Santa Fe Institute and the staff invited me to join them as their first visiting undergraduate student. I was mentored by an evolutionary biologist, who guided me as I explored a variety of complex systems. After pursuing applied mathematics in graduate school, I transferred to oceanography, acknowledging my abiding passion for fluid dynamics.

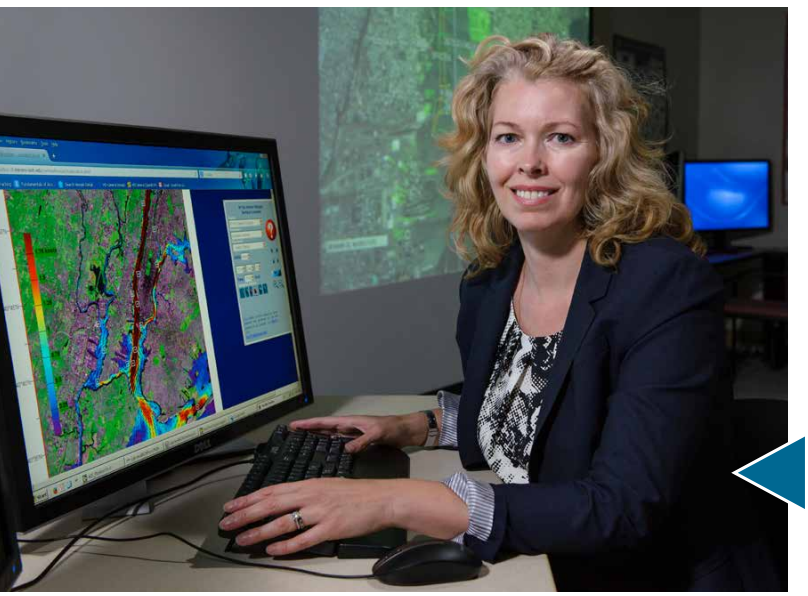
I thrive at the boundaries of disciplines, forging collaborations across multiple realms. I ground my modeling efforts with a healthy dose of field participation, so I work hard to include this key reality check in my schedule. I enjoy being part of research cruises where I can run high-resolution air/sea prediction models and verify the results in real time. Sometimes I can even influence the sampling because of what the forecasts are showing!

I enjoy seizing new opportunities like creating a graduate class on nuclear security and terrorism that I'm teaching for the first time this year. My interest in this area grew out of my time as a Science Fellow at Stanford's Center for International Security and Cooperation post-9/11, and being a principal investigator on the largest urban tracer release study in the United States (NYC Urban Dispersion Program).

One of my favorite things is sharing my interest in oceanography with my two young boys. They visit my lab on school field trips, and I bring science to their classrooms. I am collaborating with a local nonprofit, The River Project, to develop a curriculum that introduces Hudson River species into the schools and offers tabletop water experiments on salinity and temperature.

I travel for work, and that takes me away from my family. Often, however, we find ways to be together on my work trips. For example, my husband has brought the boys down to Puerto Rico after my meetings so we can all explore the island environment.

When I was a graduate student in oceanography, I remember being one of relatively few women at large national and international meetings. Happily, that seems to have changed throughout the Earth sciences. But biases, both subtle and overt, persist and have negative impacts on careers. I'm pleased to be on the steering committee of our Institute's National Science Foundation ADVANCE initiative that will address some of these issues.



Julie in her lab at the Stevens Institute looking at the New York Harbor Observing and Prediction System (NYHOPS) forecast.

Andrea M. Quattrini

Postdoctoral Researcher, Cherokee Nations Technology Solutions Contracted to the US Geological Survey, Southeast Ecological Science Center, Gainesville, FL, USA, aquattrini@usgs.gov

At 700 m below the ocean's surface, I fulfilled a lifelong dream in the *Johnson Sea Link* submersible, visiting a deep coral reef that no one else in the world had seen. It was a humbling experience. This moment in time both solidified my aspiration to become a deep-sea biologist and deepened my desire to understand the mechanisms that shape deep-sea biodiversity, with the ultimate goal of protecting these communities from anthropogenic disturbances.

Like many others, my interests in the marine sciences began when I was a child. Growing up in rural Pennsylvania, visits to the ocean (along the Jersey Shore) were few, but I was fortunate to grow up on the Susquehanna River. It sparked my attraction to the outdoors, and it is where I became fascinated by the diversity of fishes. Combining my attraction to the ocean with my love of the outdoors, I naturally decided to pursue a career in marine science.

I began my biology studies at Millersville University, Pennsylvania, before entering a master's program at the University of North Carolina, Wilmington. My first research project (directed by the late David G. Lindquist) introduced me to the open ocean and to life at sea, where I became interested in population connectivity of marine organisms. After graduating, I had the incredible opportunity to participate in numerous deep-sea cruises off the southeastern US coast. I gained immeasurable experience, logging over 100 days at sea and completing 10 *JSL* dives. However, this experience reinforced my need to further my education. Thus, in 2009, I began a PhD program under the mentorship of Erik Cordes at Temple University in Philadelphia. I never thought that 10 years after finishing my undergraduate degree, I would end up back in Pennsylvania to study deep-sea biology, but Temple turned out to be the ideal place to continue my investigations. Throughout my PhD, I continued to participate in research cruises, and I learned new genetic and bioinformatic techniques for investigating questions of connectivity. I have become particularly interested in the relative roles of dispersal, habitat heterogeneity, and bathymetry

Andrea in the ROV control van with Brendan Roark aboard the NOAA Ship *Okeanos Explorer*. *Photo Credit: NOAA Okeanos Explorer Program*

in shaping population and community structure in the deep sea. Understanding the evolutionary and ecological mechanisms that affect patterns of biological and genetic diversity will help guide effective conservation practices.

I feel privileged to have sailed over the past 14 years with many amazing women and men who have inspired me and taught me skills that have prepared me to lead my own research program in the future. I also feel very fortunate to continue my career during a time when there is more acceptance and encouragement of women in science and more programs available that assist women in becoming successful. My gratitude extends to the women all over the world who have worked hard for equality in science. Although I recognize there are obstacles still to overcome (some I have personally experienced), I believe that there is a bright future ahead. I hope to continue to follow in the footsteps of fellow women oceanographers and inspire other young women to study science, while investigating the wonders of the deep sea.

Berit Rabe

Research Scientist, Marine Laboratory, Marine Scotland Science, Aberdeen, UK, b.rabe@marlab.ac.uk

I am a seagoing physical oceanographer with education and work experience from Germany, Canada, the United States, and the UK. My research interests include observational dynamical oceanography, especially in high latitudes and coastal regions. My PhD work at the University of Delaware, USA, focused on the hydrography and fluxes in Nares Strait, one of the passages in the Canadian Arctic Archipelago between Ellesmere Island and Greenland at 80.5°N. I analyzed mooring data and was involved in fieldwork conducted from the Canadian Coast Guard Ship *Henry Larsen* (see photo). The ice conditions within Nares Strait vary between mobile and land-fast ice, and we found different amounts of freshwater flowing south depending on the ice conditions. Possible changing ice conditions in the strait in the future might affect the amount of freshwater exported from the Arctic to the Atlantic Ocean through this strait.

My recent research at the Marine Lab in Aberdeen, UK, focuses on dynamics in fjordic systems on the west coast of Scotland. This work is part of a larger multidisciplinary project that is investigating sea lice dispersal within one sea loch. My role in the project is to help understand the circulation in the sea loch, measure winds around the loch to force a hydrodynamic model, validate the model, and analyze current, temperature, and salinity data. The winds are funneled up and down the long, narrow loch by mountains on either side. The circulation is therefore influenced by the winds, but also by tides, freshwater input from rivers, and the Coriolis force.

How did I choose physical oceanography? I have always been interested in science and the ocean. When I learned that it was possible to study physical oceanography at the University of Hamburg, Germany, with a degree requirement of going to sea for at least six weeks, I was hooked. Seventeen years later, going to sea is still one of my favorite parts of the job, especially exploring and studying remote regions or dynamically interesting fjords.

The most rewarding part of being an oceanographer is working as part of a team, especially at sea. You build strong connections, exchange ideas, and learn about other disciplines.

One of the challenges during my career so far has been to finish my PhD. Having a life outside of graduate school, including friends and sports, and having a support network through MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) gave me the motivation to persevere. I am grateful for all the strong women in the field (many of them represented in this compendium) who helped me and other junior scientists get to where we are today.

Berit Rabe onboard the Canadian Coast Guard Ship *Henry Larsen* in Nares Strait, between northern Canada and Greenland, collecting data for her PhD.

Nicole Raineault

Director of Science Operations,
Ocean Exploration Trust, Old Lyme, CT, USA,
nicole@oceanexplorationtrust.com

Although I have always been interested in exploring the ocean's depths, I never would have predicted I would organize and lead deep-sea oceanographic exploration cruises. I grew up peering into tide pools and digging holes in the beach, reveling in the layers of fine and coarse sand, gravel, and shell. When I began to study physical oceanography and marine geology in college, I discovered my passion for researching coastal processes, which was a relief at the time due to my early experiences with seasickness.

I thoroughly enjoyed my early research projects mapping coastal geological hazards and understanding barrier island movement over time. I also had a wonderful mentor who provided me with the opportunity to scour the Gulf of Maine meteorological buoy data for climatological trends and subsequent comparisons to a forecasting model. My experiences with nearshore research made me content to keep my feet on nearly dry land.

My re-introduction to seafaring oceanography occurred during my PhD research, when I was encouraged to participate in numerous research cruises with our lab's autonomous underwater vehicle (AUV) in tow. At first, I was uncomfortable with both ships and advanced technology, but I soon discovered excitement and enrichment in both. Although both the environmental (at-sea) and technological aspects of my work provide constant challenges, the rewards for going where no one has been and using new tools to gather data are immense.

I now consider myself a marine geologist who uses acoustic technologies to study the seafloor. I spend a little more than two months a year exploring the deep sea aboard E/V *Nautilus*. Exploration is the essential first step in the scientific method before hypothesis-driven science can occur. The *Nautilus* team gathers the data to drive scientific research in previously unexplored regions. I work closely with scientists to devise a plan, targeting the areas that have the highest probability for new discoveries. First, we map the seafloor because much of the deep sea has never been charted. With a map in hand, I look for clues that point to something of interest (such as hard substrate, bubbles escaping from the seafloor, or rough terrain). I then plan dive tracks for remotely operated vehicles that use a suite of sensors and cameras to reveal new information about the deep sea. With these underwater robots, we can retrieve samples—rocks, short sediment cores, water, and organisms—to learn more about the geological history of the seafloor and life in extreme environments. The quick tempo of exploration and working with a dynamic, enthusiastic team are two of the reasons I love my work.

Nicole processing samples in the Wet Lab on E/V *Nautilus*.

It is rewarding to learn how to utilize technology, map and interpret acoustic data, and thrive in an at-sea environment. I enthusiastically encourage young scientists to delve into the challenging unknown. Take advantage of opportunities to help with research projects or cruises. Seek out mentors who provide you with these opportunities and encourage you to take risks. The ocean abounds with discoveries yet to be made!

Beatriz Reguera

Research Professor, Spanish Institute of Oceanography (IEO), Vigo, Spain, beatriz.reguera@vi.ieo.es

When I wrote for "Women in Oceanography" 10 years ago, I was a researcher (Científico Titular) focused on harmful algal blooms and working at the Spanish Institute of Oceanography (IEO) in Vigo, Spain. My main interest was the toxin-producing planktonic microalgae that pose a major threat to the sustainable exploitation of shellfish resources, specifically, their morphological and physiological variability in response to environmental conditions, their life history strategies, and their biological interactions. I also played an active role in international organizations (e.g., the International Council for the Exploration of the Sea [ICES] and the Intergovernmental Oceanographic Commission [IOC] of UNESCO), serving as chair of the ICES-IOC Working Group on Harmful Algal Bloom Dynamics (1991–1995) and the IOC Intergovernmental Panel on Harmful Algal Blooms (2002–2006).

During the last 10 years, my main focus on toxin-producing microalgae, particularly those of the genus *Dinophysis*, has not changed, but it has become more interdisciplinary. A major challenge in our field is to develop biophysical models for predicting harmful algae events based on operational oceanography. Thus, I continue to be a "microscope researcher" who enjoys examining field samples or cultures with my own eyes, with the clear objective of obtaining information that can be fed into predictive models. Though the ability to look at samples and identify cellular signals in response to physiological processes will always be needed, cooperation with researchers applying next-generation molecular biology and high-resolution sampling technologies is also essential. Helping young scientists to develop their PhD theses and to write good articles, and reviewing articles written by others, now occupies more of my time than writing my own articles.

I feel lucky because I have been able to work in a profession I like, following my own research interests. International cooperation and opportunities to visit different countries/cultures/people around the world are among the most rewarding activities. One recent challenge was serving as president of the International Society for the Study of Harmful Algae from 2008 to 2014 and working to make the society more visible and dynamic. Now, I am applying the same enthusiasm to the editorship of UNESCO's digital bulletin *Harmful Algae News*. Most recently, it has been extremely rewarding to be the first to obtain the title of Research Professor now offered by our institute in compliance with the new Spanish law on science.

Beatriz Reguera (in the middle with sunglasses) with students on board R/V *Navaz* during an IOC-IEO training course in June 2012. Mussel rafts surround the vessel in the Ria de Vigo.

Employment regulations concerning the protection of students' rights and reconciliation of maternity leave with ongoing grants and contracts have improved considerably in the last 10 years. My advice to young women: choose a companion who respects and understands your scientific passion and dedication. Be focused and always keep your priorities clear. Follow your intuition and be open to trying new things; remember that the happier you are, the more creative you will be. Do try to complete your PhD and your postdoctoral work before becoming a mother. Scientifically, keep in mind that advanced instruments and software are just tools that serve your hypotheses and your research, and do not let them overwhelm you and replace creative thinking and writing!

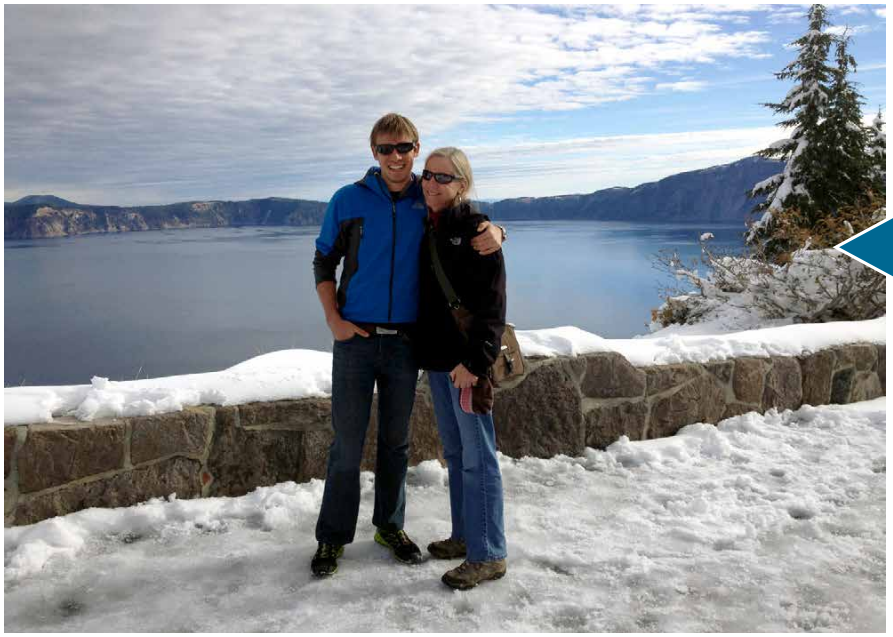
Clare E. Reimers

Professor, Ocean Ecology and Biogeochemistry Discipline, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, Oregon, USA, creimers@coas.oregonstate.edu

In the years since my autobiographical-scientific sketch appeared in the 2005 special issue of *Oceanography*, I have remained at Oregon State University as a professor in a college that has recently expanded and been renamed the College of Earth, Ocean, and Atmospheric Sciences. My research and teaching have continued to focus on areas of sediment biogeochemistry and applied electrochemistry, with a new direction that employs an approach called "eddy correlation" to derive benthic chemical fluxes from co-located velocity and chemical sensor measurements. My service activities have expanded, largely through contributions to the University-National Oceanographic Laboratory System (UNOLS). I guess it is fair to say that I have become passionate about the importance of modern research vessels for oceanography, and I am working as chair of the UNOLS Fleet Improvement Committee to ensure fleet renewal. In 2011, I initiated a "UNOLS Chief Scientist Training Program" to educate early career marine scientists on how to effectively plan for, acquire, utilize, and report on time at sea for multidisciplinary research and education. Young women in the program have especially appreciated this leadership training.

To round out my career, I am helping Oregon State University lead a project to finalize the design and coordinate the construction of as many as three new regional class research vessels to bolster the marine science capabilities of the United States. This means I am working with a team of scientists, marine technical advisors, naval architects, engineers, and administrative specialists to get a highly scrutinized job done within scope, budget, and schedule.

My advice to young women oceanographers is: your contributions are needed and persistence pays off. Have confidence in your talents and your abilities to advance the field while learning new skills, approaches, and better ways to face challenges.



Clare Reimers with her son Brian Wakefield at Crater Lake Oregon in 2013. Brian is currently in medical school at the University of Virginia, where Clare did her undergraduate studies.

Angelika Renner

Research Scientist, Institute of Marine Research, Tromsø, Norway, angelika.renner@imr.no

A marine environmental scientist by training, I am most fascinated by the physical environment of the polar oceans. I study processes in the upper ocean and at the sea ice/ocean interface and their impact on the state of the sea ice cover. I am also keen to work with marine biologists, chemical oceanographers, and others to bring our data together and learn more about the entire ocean system.

I ended up in science by chance, with a lot of luck and great supervisors along the way. Not being good enough to study what I really wanted (a ridiculously competitive music-related subject), I settled on environmental sciences: instead of having to choose between any of the natural sciences, I could do them all. I started my studies in Germany, but escaped to Finland for my diploma thesis work. With the diploma in hand, but no clue about what I wanted to do, I relocated to Tromsø, northern Norway, for an internship. This move proved to be pivotal for both choice of career and private life: I was sent on my very first proper research cruise to the Arctic to work with the sea ice team (that is, just me and one other!). Standing on the ice with the midnight sun above 3,000 m of water, I was hooked.

I left Tromsø to do a PhD at the British Antarctic Survey and the University of East Anglia on ocean currents near the Antarctic Peninsula. My fantastic supervisors, Sally Thorpe and Karen Heywood, encouraged my enthusiasm for fieldwork and let me go on various cruises, even if they went to the "wrong" hemisphere. Cruises are probably the best networking opportunities possible—how better to get to know people than sharing 12-hour night watches doing countless CTDs?

My love of sea ice and Tromsø brought me back to the Norwegian Polar Institute for a postdoc. I had many more opportunities to work in the field and get really cold hands and feet on the ice! I also met again my colleague from the sea ice team on that very first cruise—another couple of cruises and a dog-sledding trip later, we moved in together a couple of years ago. This summer, I started a new, permanent job at the Institute of Marine Research with new exciting challenges, such as learning all about fish and teaching at the university, and the incredibly comforting prospect of being able to stay in Tromsø.

All through my undergraduate and PhD studies and now in my job, I've made every effort to develop a group of friends outside science. While I am glad that my partner knows what it means to be a scientist, I am also glad that he is not a scientist and has no patience for my working late every night, and thus forces me to take time off. I still carry my notebook to the mountains or in the kayak, but getting away often and regularly helps me stay sane and continue to love science as much as I do.

Drilling holes through sea ice—one of my favorite pastimes... And still essential for measuring sea ice thickness.

Mariana Ribas Ribas

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I am a chemical oceanographer with research interests in carbon and carbonate cycling across aquatic systems. This work ranges from coastal ecosystems (estuaries and continental margins) to polar regions, with particular emphasis on the exchange of CO_2 with the atmosphere and on the coupling between inorganic carbon dynamics and biological processes. I chose to study marine science at the University of Cádiz (Spain) because I come from a fishing family on the Mediterranean island of Ibiza. The sea is all around—in the family business, hobbies (sailing), spare time (beaches)—in fact, being more than few days without the sea close by freaks me out: I miss the smell, I start to get disoriented…

For me, one of rewarding things about being an ocean scientist is visiting the places you have dreamed about. Being in the middle of the Arctic, seeing an amazing polar bear really close and realizing, "Oh my gosh, I get paid to do this and be here—I would have given all my savings to be here right now." You also get the opportunity to meet a lot of people and visit many new places. Another thing, now that I am just starting a new project from scratch, is that I feel like a little girl with a new toy every time I receive a new piece of equipment.

I consider myself to have been really lucky from the start in my oceanography studies. Since earning my PhD, I have only been without salary for three months (being a young Spanish person nowadays, this is a huge success!). My greatest career challenge has been finishing my PhD, because it happened while my mother was very ill and died. But I know in my heart that I finished because of her and her courage.

Speaking of balance, I have not been a good example. I was separated from my partner for two years during my first postdoc. The only way to find some "balance" was traveling a lot and not having real holidays together (we spent our days off visiting each other, but not when both of us were off). Now we live together in Germany, but it is difficult for him to find a job as a non-national.

In my previous work at the University of Southampton, I was involved in a program called "Women in Leadership and Management," where we discussed the many problems women encounter in academia. I learned two very important

things during this program. First, to say NO. Women are by nature kind and willing to help, so we tend to get involved in a lot of things that have no positive result for us. We really need to be selfish with our time in order to follow a premeditated career path. Second, take more risks, be bold about what you think, and express it (blog, Twitter, etc.). I'm not sure if conditions for women in oceanography have changed during my short career, but at least now I am more aware of the issues involved, such as unconscious bias.

Mary Jo Richardson

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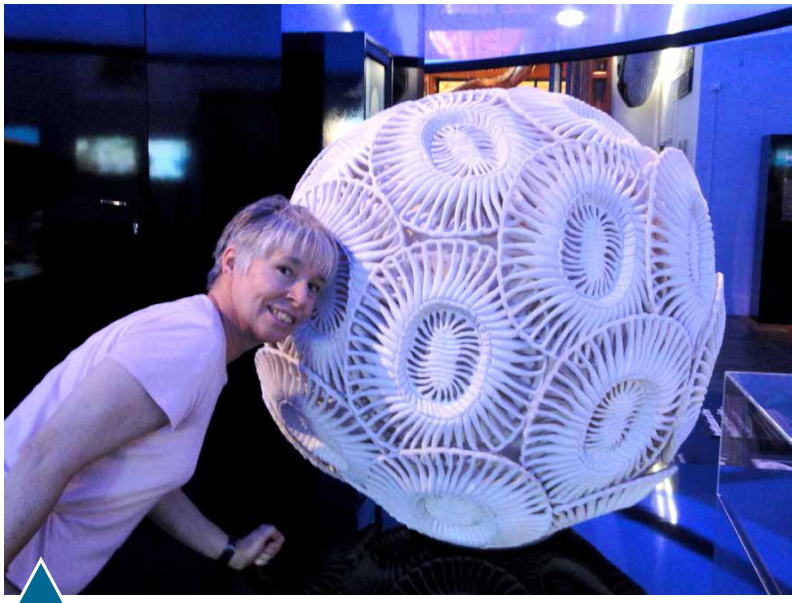
Here is my update 10 years later. In 2005, I was a full professor in the Department of Oceanography with a joint appointment in the Department of Geology and Geophysics. I had spent more than a decade in university administration as Associate Dean and Interim Dean of the College of Geosciences at Texas A&M University, leading change in advancing the College. I then chaired a university-wide task force commissioned by President Robert Gates to enhance the undergraduate experience. It is rewarding to see the transformative recommendations from that report implemented. I earned the title of Regents' Professor.

In fall of 2006, our youngest daughter reminded me of my goal from graduate student days: to run a marathon. After training through the fall and winter, in February of 2007 I ran a marathon and placed third in my age group.

Having needed scholarships and loans for my own undergraduate education, I sought funding through the National Science Foundation (NSF) Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program to acquire need-based scholarships for academically talented students. The first grant has financially aided more than 70 students in rigorous geoscience disciplines. Another two S-STEM grants on which I am co-principal investigator will provide financial assistance for more than 50 graduate students through completion of an MS or PhD degree.

In 2009, I was on faculty development leave at the Hellenic Centre for Marine Research in Anavyssos, Greece, along with my spouse and colleague, Wilf Gardner, who had a Fulbright Fellowship. It was a fantastic opportunity to do biogeochemical research with colleagues in Greece and live there for four and a half months. During that year via Skype meetings and shared documents, I co-wrote, with College Station colleagues in science, engineering, and psychology, a successful NSF ADVANCE proposal for creating a psychologically healthy workplace. I co-chair the "climate change" portion of this grant for improving university and departmental culture for female faculty advancement.



Musée océanographique de Monaco.

For the fall semester of 2011, Wilf and I taught field-based geology and oceanography at the Texas A&M Santa Chiara Study Center in Italy. I spent substantial time during the prior year developing the courses and integrating them with the Center's arts and civilization coursework. Having become intrigued with the concept of online teaching, in addition to the field-based courses in Italy, I taught an online physical geology course asynchronously to College Station. I also chaired the departmental tenure and promotion committee, which involved late-night Skype meetings to accommodate the working hours in College Station. The experience in Italy was life changing for our students—and thoroughly exhausting for us.

My service on the Ocean Observing Science Committee for NSF provides user perspectives to improve the quality of data collected under the OOI (Ocean Observing Initiative) as this extremely complex infrastructure is being built and commissioned.

The work-life balancing act is difficult, most especially when challenges arise in personal and professional life simultaneously. The frustrations and stresses do not decrease with time, they only morph. With our three daughters aged 27, 30, and 32, all employed in STEM fields, and a granddaughter approaching 2, we sympathetically share their joys and their sorrows.

In the last 10 years, I am pleased and proud to have been able to provide opportunities for students, junior colleagues, and peers that were not available to me.

Paola Malanotte-Rizzoli

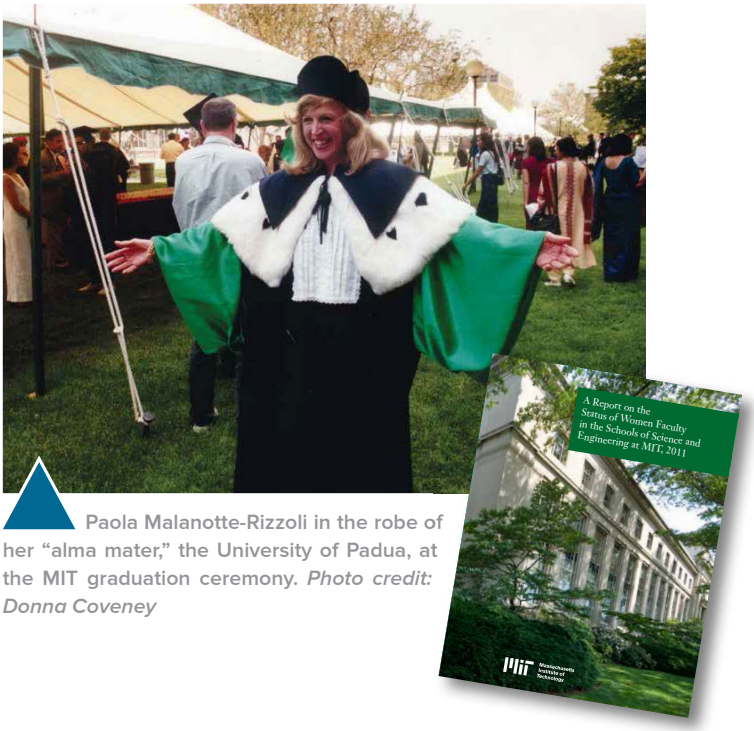
Professor of Physical Oceanography, Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, USA, rizzoli@mit.edu

The profile I wrote 10 years ago summarized the various stages of my career before and after joining MIT in 1981. I became full professor of physical oceanography in 1992 and continue full time on the faculty. Changes have occurred in my academic duties and research since 2005. In 2009, I stepped down from the position of MIT Director of the MIT/WHOI Joint Program in Oceanography, a position that I held for 12 years (1997–2009). In 2008, a major event at MIT was the establishment of the Singapore-MIT Alliance for Research and Technology (SMART), composed of five Interdisciplinary Research Groups (IRG) established over the course of five years. One of the first two IRGs was the Center for Environmental Sensing and Modeling (CENSAM), which I joined as Full Principal Investigator upon its initiation. This involvement led to a major evolution in my research interests, which have now two main foci:

1. Investigation of the present oceanographic climate of the Asian Maritime Continent, composed of the South China Sea and the Indonesian Throughflow, and of its evolution during the last five decades.
2. Establishment of a coupled atmosphere/ocean climate model of the Maritime Continent for the projection of future climate scenarios over the decadal time scale.

Under the CENSAM umbrella, I have formed multiple collaborations not only with MIT colleagues in other departments but also with colleagues at the National University of Singapore and the Nanyang Technological University.

This year, 2014, marks the 15th anniversary of the 1999 publication of the *Study on the Status of Women Faculty in Science at MIT*, which became famous in the United States and abroad for exposing discrimination against women working at the Institute. The comments made by then President Charles M. Vest were reported in *Oceanography* issue and in all the major US newspapers. This study resulted from a collaboration among tenured women scientists and produced indisputable data demonstrating gender inequalities at MIT. I am proud to state that I was one of the original group of women who produced the study. In 2011, I also participated in the writing of a follow-up report produced by women in the School of Science along with colleagues in the School of Engineering. This second report showed the enormous progress made by the MIT administration toward changing and improving academic and research conditions for MIT women faculty. But it also showed that much more work remains to be done to establish a fully gender-unbiased environment for women, not only at MIT, but, more generally, in academia. The 2011 report, which also summarizes the results of the 1999 study, can be found at http://web.mit.edu/faculty/reports/pdf/women_faculty.pdf. I urge all young women entering an academic or research career to read it.



Paola Malanotte-Rizzoli in the robe of her "alma mater," the University of Padua, at the MIT graduation ceremony. *Photo credit: Donna Coveney*

Robin Robertson

Senior Lecturer, University of New South Wales, Canberra, Australia, r.robertson@adfa.edu.au

The past 10 years have brought a lot of changes to my life: I changed countries, positions, and gained a stepdaughter. In 2005, I was a soft money research scientist at Lamont-Doherty Earth Observatory of Columbia University, living in Tuxedo, New York. I owned a house (or really, it owned me) and saw myself staying there for the rest of my career. However, with the encouragement of Robin Bell, I organized a Women's Forum. One of the speakers we had inspired many of us to really review our careers and our options for the future. Unfortunately for Lamont, several of us moved on.

In 2006, I accepted a tenured teaching position in oceanography at Australia's University of New South Wales (UNSW) Canberra in the School of Physical, Environmental, and Mathematical Sciences. This branch of UNSW is at the Australian Defence Force Academy. With 12 months of hard money, the offer was too good to pass up. We love living in Australia: no snow, no traffic, beautiful weather most of the year, great beaches, mountains close by, friendly kayakers. I also found I liked teaching and I am good at it (I've won two teaching awards). I recognize that teaching military cadets differs from a regular university both in that there are minimal disciplinary problems (the military is happy to take care of that) and that the students know they have jobs when they finish, so have little interest in postgraduate degrees. I found teaching expanded my knowledge base. In the research-only position, I was focusing on one topic, while teaching has broadened my perspective.

Although I do have less time for it, I continue to do research, which is still focused on internal tides and mixing, but now I investigate not only the Antarctic and Indonesian seas but also the waters around Australia. Additionally, I have been involved in glider operations as part of the Integrated Marine Observing System (IMOS). Since 2013, I have been a deputy node leader for the New South Wales IMOS node. I also serve as president of the Ocean Sciences section of the Asia-Oceania Geosciences Society, which is affiliated with both the American Geophysical and European Geophysical Unions.

My main challenges have been obtaining funding and being isolated. I have combated the latter by collaborating with other investigators and spending time at the Sydney Institute of Marine Science (and the main campus of UNSW in Sydney). Funding is a difficulty that many of us all over the world are facing, and I am fortunate that my salary is no longer dependent on grants.

My advice to young oceanographers, both women and men, is to work both smart and hard and to find mentors—multiple mentors for various facets of your career, not just the science. They will help you navigate the minefield of academic research, which has become so competitive with the present financial situation that I am very glad I am not starting out now.

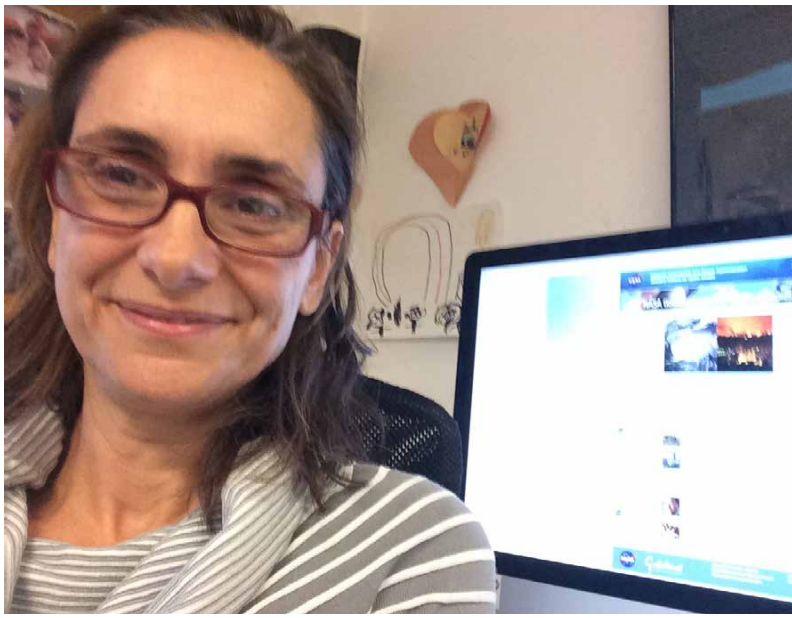
Anastasia Romanou

Associate Research Scientist, Applied Physics and Applied Mathematics, Columbia University, and National Aeronautics and Space Administration Goddard Institute for Space Studies, New York, NY, USA, ar2235@columbia.edu

As an undergraduate at the University of Athens, Greece, about 25 years ago, I studied basic physics, including classical mechanics, wave theory, and fluid dynamics. In preparing for graduation and a career, I knew I wanted to continue with graduate studies and delve into such areas of applied physics as meteorology or oceanography. The meteorology group had received some serious funding cuts that year, so I decided to do a master's degree in oceanography. I was thrilled to be working in a field where I could describe the drift of ocean currents with equations and then go out to sea and observe that my description was very close to the real thing! To continue my studies toward a PhD in physical oceanography and fluid dynamics meant I had to move to the United States, where I also gained an additional specialization in numerical modeling. A couple of postdoctoral positions later, I got to my present spot at Columbia University and the NASA Goddard Institute for Space Studies.

I was very lucky to have entered the field of oceanography while it was emerging as a prominent component of studies of Earth's climate system and while the ocean's role in climate and climate change was becoming more apparent. I witnessed the early controversies and their resolutions, from the time when ocean components in climate models were mere boundary conditions or q-flux subroutines, to modern times when ocean models are becoming more and more complex. I was one of the first people (as a graduate student) to analyze data from Argo float precursors. Today, I combine ocean processes, the effects of air-sea interactions, and characteristics of the carbon cycle in climate models to address issues related to climate change.

The cross-disciplinarity in our field never ceases to amaze me. Ocean modeling requires a combination of physics, numerical methods, chemistry, biology, and geophysics. This is both a major challenge and a blessing for me, as my research addresses a plethora of interesting topics. Keeping focused on just one of the many interesting questions in the field is a challenge.



Meeting my husband and starting a family brought another type of challenge and blessing. More than balancing career and family, the most difficult problem has been the "two-body problem," finding a job near where the spouse finds one. This has led to compromises, time off work, and redirection of research interests, which probably did impact my career in multiple ways. However, in the end, I became more flexible, gained perspectives in different areas of science, and am more appreciative of my own skills and workplace.

Although my experience in the field has been fulfilling and is still promising, I know that women still face many issues today in oceanography. Funding cuts and a decreasing number of quality jobs, as well as the high stakes in academia, are turning young women away from practicing science at research institutes and universities across the country. These matters should be addressed more seriously by the oceanographic community.

Leslie Rosenfeld

Retired, Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA, role@mbari.org

I just retired from my position as director of the Central and Northern California Ocean Observing System (CeNCOOS) after a 40-year career in oceanography. Because I worked in and studied oceanography almost right out of high school, those 40 years began well before earning my PhD. I started as a seagoing oceanographer and ended up managing one of the 11 regional coastal ocean observing systems of the US Integrated Ocean Observing System. Over the course of my career, I served as technician, researcher, educator, consultant, and executive director, working for universities, nonprofits, companies, and the federal government.

My research focused on physical oceanography off the coast of California, and my involvement in interdisciplinary studies, as well as experience with a broad suite of in situ, remotely sensed, and numerical model data, positioned me well for managing an integrated ocean observing system. But it was my role as consultant to government, industry, and public utility users of ocean data that allowed me to see the impact of those data outside the research realm.

My career started in 1973, at the age of 18, by sailing across the Atlantic aboard Sea Education Association's schooner *Westward*. (Prior to that year, SEA accepted boys from the age of 16 while girls had to be 21.) I then attended Florida Institute of Technology's Jensen Beach campus and completed an AS in oceanographic technology. In 1978, I earned a BS in physical oceanography from the University of Washington, barely noticing that I was one of only two or three females in my physics classes. During my undergraduate years, I worked summers at Lamont-Doherty Geological Observatory and Harbor Branch Oceanographic Institution. It took only a brief stint at the Naval Oceanographic Office in Mississippi in the late 1970s to realize that advancement opportunities for professional women there were limited. During that time, I was the sole woman aboard a USNS *Wilkes* cruise, and was told I was only the second woman ever to have sailed on that ship. I moved on to the Chesapeake Bay Institute and the Martin Marietta Laboratories. In 1980, I participated in an unsuccessful search for the *Titanic*, after which I entered the MIT/WHOI Joint Program in Oceanography, from which I received a PhD in 1987. I did my postdoc years at the

Leslie Rosenfeld, former director of the Central and Northern California Ocean Observing System (CeNCOOS).

Cooperative Institute for Marine and Atmospheric Studies in Miami before moving to Monterey, CA. From 1989 on, I went back and forth between a primary position as a scientist or manager at MBARI (home of the CeNCOOS Program Office) and as a member of the research faculty at the Naval Postgraduate School, where I also taught courses.

As I recount my career, the first couple of decades sound somewhat frenetic, but I was fortunate to be able to take advantage of a variety of enticing opportunities. I have tried to return the favor by taking students to sea as part of the Research Experiences for Undergraduates program, mentoring summer interns, advising graduate students, and helping recent graduates find employment. Based on both my personal experience and workforce development projects, my advice to women pursuing a career in oceanography would be to gain expertise in a technical field along with a strong science education—and having an androgynous first name may not hurt either. Imagine my delight when a young oceanographer approached me at a conference several years ago after he saw my name on the program and sought me out to tell me how much one of my papers had influenced his research—and how surprised he was to learn that I was a woman.

Carolyn Ruppel

Research Geophysicist, US Geological Survey, Woods Hole, MA, USA, cruppel@usgs.gov

The autobiographical vignette that I provided 10 years ago came during a period of career transition. I was then 13 years beyond my PhD, had completed a substantial disciplinary shift, and had been tenured at Georgia Tech for nearly five years. Back in 2005, I was simultaneously serving as a program officer/faculty rotator at the National Science Foundation (NSF) and maintaining my Georgia Tech research from afar. I was also a first-time, middle-aged mother of a newborn and starting my twelfth year of a commuting academic marriage.

In 2006, I finished my stint at NSF, left Georgia Tech, and joined the Gas Hydrates Project at the US Geological Survey (USGS) in Woods Hole. I had sailed with some Gas Hydrates Project scientists on Ocean Drilling Program Leg 164 in 1995 and knew others through collaborations. The return to Woods Hole, where I had done my postdoc at Woods Hole Oceanographic Institution years before, was intellectually invigorating, as was the luxury of focusing on full-time research for the first time in over a decade. Importantly, our family was finally together under one roof outside Boston.

I now formally lead the USGS Gas Hydrates Project, which focuses on energy resource issues, climate links, and geohazards. Since 2008, our group in Woods Hole has established the largest US program studying climate-hydrate interactions and conducted five Arctic cruises to map subsea permafrost, measure ocean-atmosphere methane fluxes, document the response of upper slope gas hydrates to ocean warming, and acquire data for potential International Ocean Discovery Program drilling. More recently, we have discovered widespread methane seepage on the upper slope of the US Atlantic margin, giving us a second study site and one closer to New England.

Moving to the USGS has been overwhelmingly positive. There are times when I miss teaching, close Georgia Tech colleagues, and the force-multiplier of PhD students. These losses are more than offset by outstanding operational support at the USGS and the capacity to do important, large-scale research divorced from the three-year academic grant cycle. More pragmatically, the USGS encourages telecommuting, allowing me to split my time between Woods Hole and a courtesy appointment at MIT. This affords me flexibility to work and write efficiently, to interact with a broad range of colleagues, and to prioritize family needs when necessary.

My husband is an aeronautical engineering professor and autonomous vehicle expert at MIT. Seniority has brought us increased flexibility in choosing among commitments, but we juggle mightily to sustain two demanding careers and to stagger our travel. From an early age, our daughter showed a strong interest in math, science, and engineering, and we are committed to providing an example of the value that we place on both parents' careers and career paths.

My choices—pursuing an academic career distant from a spouse, delaying motherhood, and leaving academia for government research—are not for everyone. For me, this path, which was enabled along the way by so many colleagues, has led to a degree of professional fulfillment and confidence that I never thought possible 25 years ago.

An early introduction to marine science for my daughter, shown with me during a kayaking adventure on Cape Cod in summer 2011.

Ann D. Russell

Associate Research Scientist, Department of Earth & Planetary Sciences, University of California, Davis, CA, USA, adrussell@ucdavis.edu

Almost 20 years ago, my husband and I started an experiment to see if we could raise our son and continue our oceanography careers with me as a research scientist. We reasoned that this strategy would allow me to be an active researcher and still have the flexibility needed to take care of our family.

So, as a research scientist at UC Davis since 1997, I've conducted research on the controls over metal incorporation into foraminiferal calcite, focusing on culture experiments that use living planktic foraminifera and testing hypotheses developed in the laboratory against down-core records. I've developed and tested the utility of foraminiferal U/Ca as a proxy for pH in past oceans, explored the role of light in U and Mg uptake into calcite, and tackled the problem of unraveling the primary U/Ca signal from possible diagenetic influences. I also expanded my research into other aspects of ocean biogeochemistry, including ocean and estuarine acidification. I was a founding member of the Bodega Ocean Acidification Research Group at UC Davis, examining the natural variability of pH in intertidal waters and in estuaries, as well as the effects of changing seawater pH on the growth and survival of oyster, mussel, and urchin larvae.

One of the most rewarding aspects of my career has been mentoring undergraduates doing research for senior theses. It has been a great pleasure to see a students develop what began as an interest in oceanography into a passion and a career. One of them is now an oceanography professor herself; another is working on a PhD and sends me small bottles of foraminifera from exotic places. I'm grateful for the opportunity to teach and work with them.

It's been harder than I expected to keep up a steady flow of funding and ideas. It was very useful in this regard to offer a graduate seminar in a promising new area of research; by stimulating discussions, each seminar led to a new collaboration and/or proposal. I didn't anticipate the impact of working in an institutional culture that celebrates, mentors, and promotes its state-funded faculty but ignores its soft-money scientists. I tackled this issue by developing contacts and friendships with my peers in the soft-money track, and by focusing on the rewards of the research itself. I didn't anticipate the stress that I would feel when I left my scientific work unfinished to be with my family, and when I put my family's needs on hold to delve into my science. During those early years, I lived with the daily reality that I wouldn't be able to give either of these spheres my full attention. Eventually, I became a bit more realistic about what defines a good scientist, mother, and wife.

What advice do I have for young women oceanographers? If you are considering a career as a research scientist, ask what resources will be available to you and what the institution does to promote the careers of its soft-money scientists. If you don't like the answer, keep looking for a position that suits your needs. Wherever you are, be fully involved in whatever you're doing. Be thoughtful, but don't question yourself too much. Communicate often with others in your department or group; don't work in isolation. Realize that all interesting careers (and lives) have challenges and will be hard in unexpected ways—and that you are where you are because challenges appeal to you.

Now, with our son off to college, my husband and I are starting a new experiment: can a woman scientist make even greater contributions later in life?

Ann prepares for a scuba dive to collect foraminifera for culture experiments. *Photo credit: Jennifer Fehrenbacher*

Grace Saba

Assistant Research Professor, Center for Ocean Observing Leadership, Department of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ, USA, saba@marine.rutgers.edu

I remember exactly where I was when I knew without a doubt that I wanted to be a marine scientist. At eight years old, I had never seen an ocean and rarely even ventured out of my home state of Kansas. But standing next to a small pond behind our farmhouse in Harveyville, observing crawdads and keeping tabs on a group of tadpoles metamorphosing into frogs, it hit me like a ton of bricks. I still can't explain why that experience affected me the way that it did. I must have been a convincing child because when I told my mom I was going to be a marine biologist, she supported me fully and bought me Jacques Cousteau's *The Ocean World* for my ninth birthday. It was the first new book I had ever owned, and it had that new book smell. I took in every word, every image with great reverence. And even now when I smell a new book, I am brought back to that time of my life, and I smile at the realization that I followed my dreams and have no regrets.

Interestingly enough, the most rewarding part about being an oceanographer is the people I work with and not necessarily the marine organisms I study. Along the way, I was fortunate to be supported by four inspiring academic "parents." Alice Alldredge opened her door to the farm girl from Kansas and shared with me experiences I had been dreaming of: blue water diving, nets full of zooplankton, and marine snow. These opportunities steered me toward a focus on plankton ecology. Deborah Bronk nurtured my appetite for biogeochemistry and taught me the importance of method development, experimental design, and organization (yes, this also includes color-coded tape). My PhD advisor, Deborah Steinberg, taught me how to think big and multidisciplinary. She gave me independence, which I think was the greatest gift. Because of that, I am able to confidently pave my own way. On a personal level, Debbie also became my role model for balancing work and family. She officiated at my wedding, and supported me when I had my son during grad school. My postdoctoral advisor, Oscar Schofield, welcomed me into the Antarctic Palmer Long Term Ecological Research (LTER) team, my second family. Furthermore, his encouragement to write grant proposals led me to my current position. These positive experiences with and lessons from my mentors have shielded me from many adversities that women in oceanography have faced, and I am grateful for that.

Grace Saba enjoying her time on the West Antarctic Peninsula with the Palmer Long Term Ecological Research project in January 2011.

As a soft-money scientist focused on plankton processes, physical-biological coupling, and climate change, the biggest challenge is sustaining financial support for my research. But this challenge has taught me to think creatively, be open-minded about nontraditional funding sources, and invest effort into networking. Additionally, I sometimes find it overwhelming to balance my time between writing grant proposals, doing fieldwork, analyzing data, writing papers, and mentoring students. But my extremely supportive husband, also a successful marine scientist, makes me take a step back and prioritize. This keeps me grounded and mostly sane in this job that I love so dearly.

Claudia Schmid

Oceanographer, National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML), Miami, FL, USA, claudia.schmid@noaa.gov

I always loved the ocean, and spent nearly every summer vacation in the Mediterranean region, mostly on or in the water. My biggest talents in school were physics and mathematics, which made the decision to combine my love for the ocean with a career in physical oceanography an easy one. I enrolled at the University of Kiel (Germany) in 1986 to study physical oceanography at the Institute of Marine Science. Throughout a large part of my time as a student, I had opportunities to go to sea and thereby learn a lot about data collection and analysis. Probably the most exciting cruise I have been a part of was one where we were chasing Mediterranean salt lenses. It involved plotting the data throughout the cruise and adjusting the cruise track to map out these features and find their center. We also seeded these eddies with RAFOS floats to track their movement over several years. The chief scientist for this cruise was Rolf Käse, a theoretical oceanographer who loved going to sea and who became my master's thesis advisor. The thesis involved performing model experiments to increase understanding of eddy movement in the ocean.

Once I had my master's degree, I went to work in the Marine Physics Division on a project lead by Walter Zenk. The goal was to measure the circulation of Antarctic Intermediate Water using RAFOS floats and hydrographic observations. During that time, I began working on my PhD, studying the dynamics of Antarctic Intermediate Water circulation with Gerold Siedler as my advisor. After finishing my PhD in 1998, I was interested in going abroad and had the opportunity to become a postdoctoral associate at the University of Miami Cooperative Institute for Marine and Atmospheric Studies, working at NOAA's Atlantic Oceanographic and Meteorological Laboratory in the Physical Oceanography Division led by Silvia Garzoli. During that time, I continued studying aspects of Antarctic Intermediate Water circulation using data from profiling floats. I also became involved in the Argo project, which was initiating an array of 3,000 profiling floats in the open ocean. Achieving global data coverage with regular sampling was a dream come true, and it motivated me to become involved in data management in addition to being a co-principal investigator for this project. I also joined the PIRATA (Prediction and Research Moored Array in the Tropical Atlantic) project to deploy Atlas moorings in the northeastern tropical Atlantic, a region where tropical storms form and where the measurements collected help to improve estimates of the heat balance. In addition to the scientific importance of this project, it gives me an opportunity to go to sea once in a while as chief scientist for mooring recovery and redeployment cruises. During these cruises, we also collect hydrographic data along a repeat section at 23°W that helps monitor the oxygen-minimum zone in the northeastern tropical Atlantic.

Claudia during small boat operations performed as part of the 2013 PIRATA (Prediction and Research Moored Array in the Tropical Atlantic) Northeast Extension cruise that serviced PIRATA moorings. NOAA's research vessel *Ronald H. Brown* can be seen in the background.

Astrid Schnetzer

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The fascinating world of phytoplankton and zooplankton.

I am a biological oceanographer interested in plankton diversity and ecology, food web dynamics, and harmful algal blooms. Though born and raised in landlocked Austria, I was exposed as a child to the Mediterranean Sea as my parents took my brother and me to spend the entire summer there every year. Studying at the University of Vienna and participating in field courses to the northern Adriatic, and later to Bermuda, further kindled my passion for oceanography.

My research path has allowed me to study various topics in different, often very exciting, locations. I examined sediment-water exchange processes in the Mediterranean (MS thesis), investigated the role that vertically migrating zooplankton play in carbon export in the Sargasso Sea (PhD, Bermuda Institute of Ocean Sciences), and studied protistan diversity and harmful algal blooms in California coastal waters (postdoc and research associate professorship at the University of Southern California in Los Angeles). My decision to add molecular tools to my skill set during my postdoc years has greatly increased my ability to work on interdisciplinary science themes and approach key research questions from a new angle. It also taught me that keeping a flexible and open mind for dabbling in new directions can be highly rewarding. Trips to the Ross Sea and Antarctica, and diving to the seafloor in *Alvin* to study microbes at hydrothermal vents in the equatorial Pacific, count as the most exciting and humbling experiences I have had (so far!).

Recently, I joined North Carolina State University as an associate professor, and my research now includes the study of estuarine plankton dynamics along the North Carolina coast. Moving from a research to a tenure-track position means that I now spend considerable time teaching and advising undergraduates and graduate students, while also fulfilling administrative demands. Thankfully, through this process and throughout my career, I have had strong and inspiring mentors, mostly highly successful female colleagues. I truly enjoy the aspects of my job that allow me to work with students and observe their excitement as they discover marine science and oceanography.

Overall, the research questions I am most passionate about address how plankton communities, food webs, and coastal ecosystems are affected by environmental change, mainly in response to anthropogenic causes (i.e., eutrophication or ocean acidification). As a scientist and mother, I feel it is urgent to determine what a future ocean will look like. I feel very connected to the scientific community as a whole in the desire to examine, predict, and alert people to the changes that are taking place and impacting us all. The most challenging times for me were my years as a "soft money" researcher and single mother to a small child. I learned that chipping away little by little and sticking with it goes a long way. My research experiences, my relationships with peers and colleagues (many of whom I call friends), and freedom to investigate the ocean and its intricacies as my daily job are all enormously gratifying.

Magali Schweizer

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I work at the interface between biology and geosciences, focusing on the phylogenetics and phylogeography of benthic foraminifers. One of my aims is to study the genetic variation of these organisms, coupled with their morphology and ecology.

Although I was born and raised in the middle of Europe, I always liked going to the sea for holiday when I was a child. Then, I wanted to become an archaeologist. My interests broadened when I was a teenager, going from A-rchaeology to Z-oology and passing through astronomy, lichenology, and oceanography without knowing exactly what oceanography implied (geology, physics, biology?). At the time I went to university, I chose prehistorical archaeology because it was taught in the Faculty of Sciences, and there were courses in biology and geology, two fields that also interested me. During my studies, I realized that a balance between field and lab work was ideal for me. Also having discovered that I was more interested in natural sciences than in humanities, I completed a bachelor's degree in biology in parallel with my diploma and wrote a thesis on the osteometry of cave bears in the Jura mountains—hard to be further from the sea than that!

For my PhD thesis, I wanted a more biological subject, so I spoke to one of my lecturers at the University of Geneva who specialized in the molecular phylogeny of protists. Although I did not speak English and did not scuba dive, he still accepted me as a PhD student. There happened to be a position in the Netherlands to work on two genera of benthic foraminifers: I did not need to dive, and I would be forced to learn English (and Dutch eventually), two good points. For my postdocs, I first went back to Switzerland to study the DNA of coccolithophores. During that time, I also worked on planktonic filters and discovered the diversity of these organisms living at the sea surface. After that, I went to Edinburgh, back to working on benthic foraminifers, their DNA and biogeography, a field I continue to investigate now in Angers.

I always found fieldwork attractive. Although I am prone to motion sickness, I really enjoyed participating in sampling cruises. The ocean is often described as the final frontier, at least on Earth. It is very exciting to think about all that is still unknown in this ecosystem that covers 70% of the planet and also to play a role in its discovery.

Sampling benthic foraminifera in a western Iceland fjord in spring 2010. I arrived in Iceland the day the Eyjafjallajökull began to erupt and left when air traffic was finally perturbed in Iceland—lucky timing.

My partner Dario, who is not a scientist, helps me find the balance between career and personal life. Since the beginning of our relationship, he has been very supportive and open minded. He encouraged me to go abroad when needed, following me when possible. Now that we have a child, it is very helpful to share the childcare and other household tasks.

When I was an undergraduate and a graduate student, I was confronted with sexism several times, coming not only from men but also from women who were tenure-track faculty. Since then, I have also met very inspiring and supportive women in senior positions who were good mentors for me during my PhD thesis and my postdocs.

Presently, I feel that it is more difficult to be at the interface between two disciplines than to be a woman. Although everybody speaks about interdisciplinarity, being in between seems more often a weakness than a strength for many people.

Tiziana Sgroi

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I really don't know if I am an oceanographer, but I do know that I love geophysics and the sea. Since I was awarded a degree in geology from the University of Catania, and a PhD in geophysics from the University of Chieti-Pescara, I have been particularly interested in seismicity of both tectonic and volcanic origin. To be fair, my field of study chose me, mainly because of the geography of my homeland. I was born in Catania, Sicily. My hometown is both on the sea and at the base of Mt. Etna volcano. It is also near the tectonic structures that caused the most destructive earthquakes in Italy in the past and in recent times. I was an eyewitness to the 1990 "Santa Lucia earthquake" that affected eastern Sicily, and to many Etna eruptions that caused great destruction around the volcano. Through witnessing these events, I knew that I had to understand how tectonic and volcanic systems worked, and I started my studies as a seismologist. Recently, I have widened my field of scientific research from land to the offshore environment through a multidisciplinary geophysical and oceanographic approach. This has been my greatest challenge, as geophysical studies carried out at sea are still a new frontier for Italy, where the subject is hardly known.

At present, my work involves acquiring, managing, and analyzing both high- and low-frequency seismic signals recorded by marine and land stations and, through correlation among seismic, geophysical, and oceanographic data, identifying active tectonic structures of crustal origin as well as volcanic feeding systems. I have participated in several oceanographic cruises that deployed seafloor observatories and ocean bottom seismometer modules. During the cruises, multichannel seismic data and multibeam bathymetry were also acquired and processed.

In addition to my research activities, I tutor students and am an assistant supervisor of thesis writing (degree level) for several Italian universities. I lecture on various subjects, and I also consult on many Italian and European scientific initiatives.

The most difficult part of my work is balancing my career and my personal life. Following my inner voice and character, I have chosen to place more importance on my scientific research rather than on starting a family. In Italy, government policies regarding family welfare are far from ideal. This neglect has deeply discouraged me from forming my own family. Moreover, my field of research is not a simple task for a woman. Hostility and discrimination against women are still very common in our country, and we face them in our daily lives. However, the positive perspective is that I greatly enjoy what I do. Whenever I think I need a well-earned break, I pack my suitcase and set off for a journey around the world!

Tiziana Sgroi during an oceanographic cruise around Stromboli Island (southern Tyrrhenian Sea, Italy) on the *Urania* in December 2006.

Evelyn B. Sherr

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Snow-covered ice stretched to the horizon around US Coast Guard Cutter *Healy* at a 24-hour sampling site in the Chukchi Sea in spring 2004. The nighttime sun, low in the sky and occluded by clouds, still gave enough light for us to see the polar bear coming our way. A sediment trap, deployed at the edge of a nearby ice floe, was kept afloat by orange plastic spheres attached to a line. The bear, likely a young male, noticed this curious contraption and first toyed with the rope, then began dragging on it. One by one, orange balls came out of the water onto the ice. Entranced, the bear mouthed and batted the balls, having as much fun as a kitten with a ball of yarn. A technician and I left our chlorophyll sampling and joined the crew and scientists watching the spectacle. The crew yelled and shot off emergency flares, with no obvious effect. After a while, the balls lost their novelty, and the bear departed. The sediment trap, with its clawed and chewed float balls, was duly recovered.

This is one of many fond memories from a career in oceanography spanning more than 40 years. Growing up on the Atlantic coast of Florida, with an easy walk to a world-class beach, the ocean was woven into the fabric of my childhood. After completing my doctorate in 1974, I worked in southeastern US salt marsh estuaries at the University of Georgia Marine Institute on Sapelo Island. My husband, Barry, and I first met on a project to evaluate the fate of nitrogen in dried sewage sludge applied to the salt marsh. We married in 1979, then went to Israel for an 18-month research visit at the Kinneret Limnological Laboratory to study lake-ecosystem microbes. There, we became interested in the bacterivorous flagellates that grew during the decay of an annual dinoflagellate bloom in the lake. Investigating trophic roles of phagotrophic protists, from nanoflagellates to ciliates and non-pigmented dinoflagellates, occupied our research from then on.

After moving to Oregon State University in 1990, we had projects in the coastal Oregon upwelling system and in the western Arctic Ocean and Bering Sea. One of my most exciting adventures was participating in the historic 1994 Arctic Ocean Section in which US and Canadian icebreakers reached the North Pole—where we were surprised to learn that a Russian ship had beaten us to it. The large nuclear-powered vessel *Yamal* was there to produce a children's TV show. We were treated to a three-ship party, with the Russians offering us grilled reindeer meat and vodka-laced hot tea on the ice.

Working as a dual-career couple, Barry and I shared one faculty position at OSU. We were assigned separate offices, but put both desks in one office and used the other as a microscope room. We enjoyed traveling with our two sons for research in France and Israel, and vacationing around the Pacific Northwest. Since 1969, when I first started in oceanography, it is encouraging to see that many more women have come into the field and will have their own amazing experiences at sea.

Barry and Evelyn Sherr by the jawbones of a bowhead whale at the Barrow Arctic Science Consortium during a research project in 2005–2006 on the food web of the coastal ocean off the north slope of Alaska.

Amelia E. Shevenell

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Photo credit: Steffen Saustrup, UTIG

My research involves generating geochemical and micropaleontologic records from marine sediments and using these records to understand the evolution of Earth's high latitude climate systems. Ultimately, I hope my group will contribute to a greater understanding of ocean-ice sheet interactions in the context of ongoing climate change.

I am lucky to have grown up in a family of high achieving women. One of them was my "Great Aunt Mary from Woods Hole," who gave me book every Thanksgiving about children having great adventures. She inscribed each book with a message encouraging me to seek out big adventures and follow my passions. As a child, I didn't know that Aunt Mary was Mary Sears, an oceanographer described in 1985 by the then editors of *Deep Sea Research* (a journal that she founded and edited) as someone who "has probably played a greater role in the advancement of oceanographic studies than any other woman." Aunt Mary was a tiny woman, but her shoes are impossible to fill.

Given this legacy, my route to oceanography was rather circuitous, but I finally found my niche in paleoceanography, thanks to a series of supportive faculty mentors. As an undergraduate at Hamilton College, I majored in both geology and studio art. However, it was my love of big adventures that led me to Eugene Domack's undergraduate Antarctic research program. During my junior year, I participated in my first research cruise aboard RV/IB *Nathanial B Palmer* and fell in love with Antarctica, scientific discovery, and research.

After a year of adventure in Alaska working as an environmental consultant and analytical chemist, Gene Domack offered me a spot on an R/V *Laurence M. Gould* cruise to the western Antarctic Peninsula. My participation was conditional; it was time to apply to graduate school. I was accepted to the University of California, Santa Barbara, and, after graduating, I did a postdoc at the University of Washington. After three years, I left for my next big adventure as a new mom and permanent lecturer at University College London. After four years, I returned to the United States to begin my current position at the University of South Florida.

Like most working women, my biggest challenge is trying to balance career and family. Luckily, I have a supportive husband who understands the allure and requirements of seagoing oceanography and who has been able to move up his own career ladder as I moved up mine. We returned to the United States to be near family. Despite the usual short-term work-life balance difficulties, our quality of life has improved significantly. My mother lives a block away and is the foundation of our family's support system, often augmented by extended visits from my husband's family. This has enabled me to return to sea after a five-year hiatus and sail on three NSF-funded Antarctic research cruises, as chief and co-chief scientist as well as principal investigator.

My favorite part of being a seagoing oceanographer is watching the excitement of my students as they embark on their own big scientific adventures and make shipboard scientific discoveries that often translate to high-quality publications. I feel strongly that this positive feedback cycle is one of the ways we can increase the number of women in oceanography. As mother of a now seven-year-old daughter, I also want these young scientists to see that it is possible to have a well-adjusted family and a successful career, even pre-tenure. To this end, I try not to stress too much about my future. In my graduate school application, I wrote that if my planned academic career didn't pan out, I would become a potter and yoga instructor in Alaska. I think it is sensible to have an alternative career plan—fortunately, I have not had to use it.

Ingunn Skjelvan

Research Scientist, Uni Research AS, and Associate Professor, Geophysical Institute, University of Bergen, Bergen, Norway, ingunn.skjelvan@uni.no

During my childhood, there were no signs that I would become an oceanographer. In spite of being a Norwegian, I was not particularly fond of water, I lived far from the shore, and none of my ancestors were sailors, fishermen, or did any marine-related work. However, here I am, a chemical oceanographer who has spent months at sea, and even enjoyed it.

I graduated university with a master's degree in experimental physics, and responding to an enthusiastic supervisor who had a strong interest in Earth's carbon cycle, I became engaged in these topics. At that time, I joined a group that was among the very first in Norway to measure inorganic carbon in seawater, and it was certainly both inspiring and challenging to be a part of a development and research team.

During a cruise at one of the Norwegian fjords off Bergen, Norway, Ingunn Skjelvan (in blue T-shirt) doing one of the things she really enjoys—teaching students from upper secondary school about ocean science.

Later, I did my PhD and postdoc at the Geophysical Institute at the University in Bergen, and I continued my career in chemical oceanography at the Bjerknes Centre for Climate Research in Bergen, which, over the years, has become internationally acknowledged for its climate investigations. At present, I'm working with climate-related topics, such as air-sea gas exchange of carbon dioxide, anthropogenic carbon signal in the ocean, and seasonal and interannual changes in the carbon cycle. My primary source of information is long time series of carbon, nutrients, oxygen, and hydrography.

For me, working on climate-related issues is very inspiring and makes sense. My work represents a few pieces in the large "Climate on Earth" puzzle, and realizing this is probably one of the most rewarding things about being an ocean scientist. Further, it is, of course, rewarding when a manuscript is accepted or a proposal funded, as well as when one of my students graduates. I enjoy teaching, and if I manage to inspire some of the people around me, I'm happy.

There are certainly numerous challenges connected to being a researcher. I find it hard to allocate enough time to concentrate on my own research; too much time is spent on other issues, such as proposal writing, reports, meetings, planning, and operational work—all of which steal time from what I actually want to do: explore my data. It is difficult to maintain a balance between "own research" and "other stuff" as long as I'm on soft money, similar to the situations of most of my colleagues at Uni Research. I'm aware that this is an issue of prioritizing, and I believe that, until now, it was an exercise that men have been better at than women.

When I started conducting research, the number of women in ocean science was low, few women graduated with degrees in ocean science, and there were few female participants on cruises, at scientific meetings, and in research positions. This proportion has changed toward a more equal distribution, but the number of female professors in ocean science is still far too low—posing a challenge for the future.

Caroline Slomp

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I was born in Pakistan and moved to the Netherlands when I was nine. Inspired by what I had seen as a child, I initially wanted to become an agricultural engineer so I could help improve living conditions in developing countries. Three months into the engineering program at an Agricultural University, I realized I was not really interested in building dams, and I subsequently majored in soil chemistry and microbiology. It then was only a small step to studying the chemistry of the seafloor of the North Sea for my PhD.

My specialty is still marine geochemistry. Most of my current research focuses on the dynamics of carbon, nutrients, and trace metals in the past and present ocean. In addition to experimental analyses and modeling, I do a lot of seagoing work, frequently as chief scientist. These past few years, my group's fieldwork has concentrated on the Baltic Sea and the Black Sea. For example, I am currently organizing a research cruise to the Black Sea on the Dutch research vessel *Pelagia* that should take place next summer. Last year, I joined the International Ocean Discovery Program Expedition to the Baltic Sea as a geochemist.

What I really like about my current job is that it allows me to work on topics that I think are interesting. The work always brings challenges and exciting new things. It's a real voyage of discovery. I also very much enjoy the teamwork and the interaction with and mentoring of students and junior researchers. The teaching part of my job is great—besides being highly rewarding in itself, it has made me a much better researcher. Working at a university is also good for my personal life because it allows some flexibility at home—I have a husband who is also a scientist and a 12-year-old son.

What amazes me every day is how few of the women of my generation are represented in senior research positions. I had so many women of my own age as direct colleagues when I did my PhD and when I was a postdoc, and now practically all my senior colleagues are men. So much talent has been lost for science. This is not the place to discuss the mechanisms contributing to this under-representation of women, but it is important for young women to realize that those mechanisms exist and will impact their careers, and, thus, action is still needed.

When you are a PhD student, it usually looks like men and women have equal opportunities in science, but when you try to climb the ladder upward, you likely will start noticing subtle and less subtle differences. This especially holds when you have children. So where you can, you should act: make sure that women and men get the chance to raise a family, speak up when you see that women are being overlooked as plenary speakers at conferences, for awards and fellowships, as project partners and leaders, and for positions and for promotion.

Deborah K. Smith

Senior Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, dsmith@whoi.edu

I am a seagoing scientist in the field of marine geology and geophysics. I map the seafloor using several types of instruments, including hull-mounted sonar, remotely operated vehicles (ROVs), near-bottom imaging systems, and autonomous underwater vehicles (AUVs). I also collect gravity, magnetic, and earthquake data as well as rock samples. I have done fieldwork in Hawaii and Iceland to understand how volcanoes and faults work on land in order to use these insights to interpret the volcanoes and faults we map on the seafloor at mid-ocean ridges. My major research focus has been to understand the underlying forces that build the oceanic lithosphere and shape the seafloor.

Debbie Smith next to R/V *Knorr* in Barbados in 2013. The ship is about to depart to map and sample the Mid-Atlantic Ridge with Smith as chief scientist.

Having grown up in Illinois, far from the ocean, I only became interested in oceanography in the late 1970s when I agreed to join the crew of a 30-foot sailboat on a trip from San Francisco, CA, through the Panama Canal to Europe. During the two years on the sailboat, I fell in love with the sea. I already had an undergraduate degree in mathematics, but decided to go back to school to learn more about the ocean. I enrolled in City College of San Francisco, took classes in geology, biology, physics, and chemistry, and became very interested in marine geology. The next stop was San Francisco State University, where I obtained a second undergraduate degree, in geology. After that, I decided to get a PhD in marine geology and was accepted as a graduate student at Scripps Institution of Oceanography. Much of my time at Scripps was spent at sea on research expeditions learning from the chief scientists how to plan for an expedition, collect data, and interpret them.

After graduating from Scripps in 1985, I went to Woods Hole Oceanographic Institution (WHOI) as a postdoctoral scholar, then joined the WHOI scientific staff in the Department of Geology and Geophysics, where I have been ever since. I still love going to sea and making new discoveries. Every time we survey an unmapped section of the seafloor, we find something completely unexpected, and it changes the way we think about mid-ocean ridges and the construction of the oceanic lithosphere.

Heidi M. Sosik

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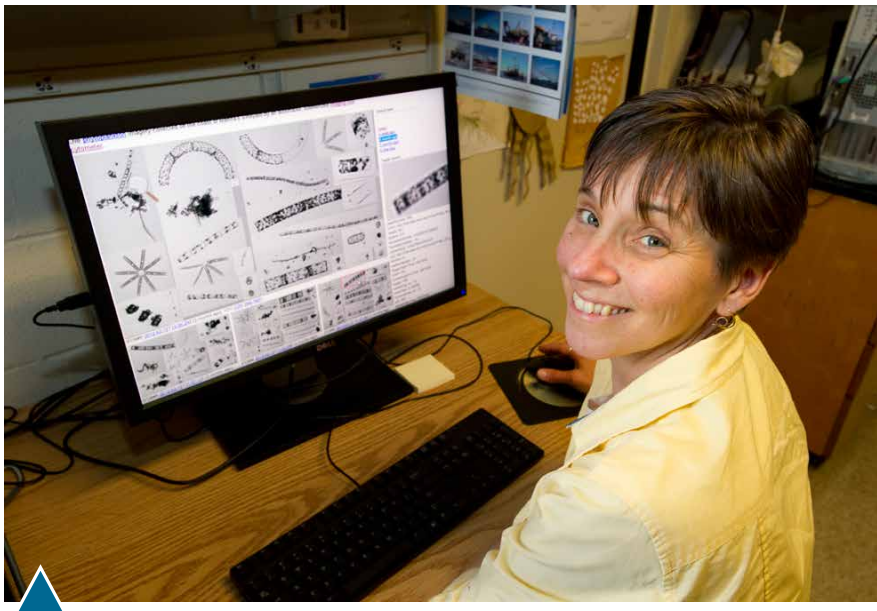
In the 2005 "Women in Oceanography" issue, I described myself as a biological oceanographer and phytoplankton ecologist. Ten years later, I still identify with and enjoy those roles, while other descriptions—teacher, advisor, wife, mother, daughter—feel just as prominent and rewarding. In 2005, I remember feelings of unease because I lacked a sense that I was in any competent way managing a strategic career trajectory—despite (or maybe because of!) having just been awarded tenure at the Woods Hole Oceanographic Institution (WHOI). Now, still at WHOI where I have since been promoted to Senior Scientist, I realize that elusive target would probably make me unhappy anyway. I find satisfaction in having the ups and downs of a research career interwoven with the demands and rewards of family life, and navigating the balancing act of shooting for goals while remaining flexible enough to respond to the unexpected, whether challenge or opportunity. Today, I find that feeling content and successful comes a little bit from deliberate planning and control and a whole lot from focusing on a few priorities and being adaptable.



Motivated by research needs for high-resolution observations, my colleagues and I have developed in situ instruments to count and image microscopic organisms. That success unexpectedly led me into new research directions involving image processing and classification and information science approaches for large data sets. *Photo credit: Tom Kleindinst*

On the surface, my career path appears straightforward, perhaps even predictably boring. I completed my PhD, transitioned into a postdoctoral position in my area of expertise, accepted a tenure-track appointment, and then moved through the ranks at a single institution. But that simplicity belies a wealth of twists and turns that have shaped my work and life on a day-to-day and year-to-year basis. For instance, I could never have predicted that my research activities would morph to encompass instrument development, commercial transition of inventions, development of new analysis and information flow techniques, and a deep passion for sustaining time series that are now leading to many intriguing insights. I feel incredibly fortunate to have the opportunity work at an institution and in a field where I have been encouraged to take risks and explore new avenues such as these—this is one of the central reasons I find oceanography so rewarding and stimulating.

Of course a number of challenges have come along the way. In hindsight, most seem overshadowed by the life-structuring demands of raising children in conjunction with managing a professional career. My perspective on this has changed remarkably little since 2005. At that time, I wrote about a strategy involving lots of shared responsibilities, especially hinging on my husband's dedication to involved parenting, and very mindful focus on a small set of simple priorities, both at home and work. As my children (now aged 24, 21, and 16 years) transition into their own adult lives and those ever-shifting parenting roles continue to evolve, I am struck by how consistently that strategy has been effective for me. In the face of so many demands at work and home, more than anything, it has been critical to repeatedly remind myself about the things that are *not* on my life's high priority list! This feels like energy well spent and a key to enjoying the rewards of both family and research work.

Kristen D. Splinter

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As a child, I was always fascinated with water—be it swimming, boating, or just playing in it. I grew up in Ontario, Canada, near Lake Ontario, and summered at our family cottage or the local pool. My first experience with the ocean was when my family moved to Nova Scotia. I remember playing with jellyfish on Prince Edward Island and the saltiness of the water and waves. As I grew older, I had a fascination with corals and dolphins (and perhaps warmer tropical islands). When it came time to apply for university, I looked at marine biology programs but also at engineering. Ultimately, I chose to do my undergrad work in civil and environmental engineering at Queen's University, but was always pulled back to the water and geology courses. Upon graduation, my interest in water continued, and I pursued an MSc in coastal and oceanographic engineering at the University of Florida. While my research focused on numerical modeling of surf-zone currents, I was able to get out and help in field experiments. Being involved in the multi-institutional Nearshore Canyon Experiment in San Diego, CA, might have been my game changer. I got to be outside, and my experience with the nearshore broadened. I wanted to learn more about the ocean. This ultimately led this "engineer" to Oregon State University for a PhD in oceanography. I learned about ocean chemistry, forams, benthic sediments, the oceans currents, and more—and I got to take part in research cruises in the Pacific. It was great. I became a better scientist and engineer with this new (broader) perspective.

Now, five years beyond the completion of my PhD, I still find myself blurring the lines of engineering and oceanography as I establish my career in a male-dominated field. My research interests focus on coastal change, specifically, understanding how coastlines are modified by changing wave heights and water levels. I also look at the nearshore morphology of sand bars and how they move and alter nearshore currents in a complex feedback system. Recently, I have been involved in research examining the impact of storms on coastal reef lagoons. When there's opportunity, I get involved in others' field research to broaden my horizons. (The best way to understand a rip current is to be stuck in one!) Every day I ask the questions: why do we see the things we see, and can we explain them? I live within walking distance of the beach and spend most mornings down there, walking, swimming, or occasionally surfing. Every day I learn or observe something about how this water world works. The nearshore/beach is never the same twice. I love it.

Kristen at Bondi Beach, NSW, Australia. She is carrying a drifter with a GPS that was being used to track currents as part of a rip current experiment.

This year involved big milestones for me. On the personal level, I got married, and the challenges ahead regarding family and work are inevitable. Professionally, I have taken on teaching roles and advising students and was awarded my first major grant. While this has all been challenging, I am enjoying being able to share my love of the ocean with the next generation.

Janet Sprintall

Research Oceanographer, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, jsprintall@ucsd.edu

As an observational and seagoing physical oceanographer, my interests lie in understanding the large-scale circulation of heat, freshwater, and mass and their roles in climate variability. I seem to have a focus on inter-basin exchanges in regions such as the Drake Passage in the Southern Ocean and the western Pacific marginal seas of Indonesia, the Philippines, and the Solomons. My pathway to study oceanography was a bit convoluted. As a math graduate, I worked in computer programming (a relatively new field then!) and soil physics before, in my late 20s, an unexpected and opportunistic occasion arose to do postgraduate work in physical oceanography. Until then, I hadn't really thought much about the possibility of studying the physics of the ocean—who knew such a field existed? But I loved the ocean—growing up in Australia I loved to swim, to dive, and to laze on its l-o-n-g sandy shoreline—and I was fairly good at math, so this would seem a perfect fit for me.

I still feel like I have the best job in the world, and one reason is that there are still so many things we don't understand about how and why the ocean moves—physical oceanography is such a relatively young science and so there are still lots of open questions to investigate and answer. I love going to sea and measuring the ocean properties right beneath my feet. How awesome is it that we have developed technology that can do that when we are in the field or even remotely when we are sitting in front of the computer in our offices? On my first cruise at sea as a student, many of the crew had never sailed with women before, and I vividly remember their shocked faces when we first went on board. Still, that cruise was successful, and there have been many, many more since then, and women at sea are no longer a novelty. Rather, we get the opportunity to contribute to the many facets of seagoing life, from the science questions, to the experimental design, to the implementation, and then through to the analysis. Personally, I've found the best way to deal with issues and challenges that arise at sea (and also just in the general work environment) is to surround yourself with good people and work and collaborate with those people whom you like and get on well with. That way, you're bound to get good honest advice that can help inform your own decision making. Luckily, we work in a field where I've been fortunate to find there are loads of good people. And don't forget that in the end, it's all about being happy—life should be fun!

Janet Sprintall (fourth from left, back row) and the women of the CLIVAR (Climate Variability and Predictability) I9N cruise on R/V *Revelle* in the Indian Ocean. *Photo credit: Geoffrey Lebon*

Rachel Stanley

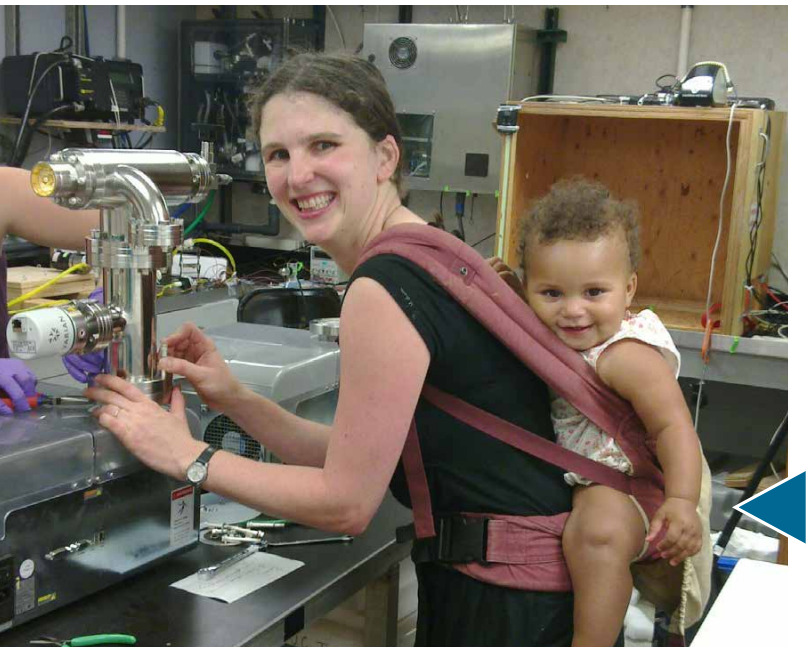
Until 12/31/14: Assistant Scientist, Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, rstanley@whoi.edu; From 1/1/15 on: Assistant Professor, Department of Chemistry, Wellesley College, Wellesley, MA, USA, rachel.stanley@wellesley.edu

I realized I wanted to be in oceanographer when I was a senior in high school, sitting in a dark auditorium after dinner one night at the National Academy of Sciences, listening to Sylvia Earle talk about the wonders of the ocean. I was there because I was a Westinghouse Science Talent Search Finalist, and I already knew I wanted to be a scientist of some kind. But I had never realized I could study the ocean for a living. As soon as I understood that I could, I was hooked on oceanography.

As an undergraduate at MIT, I majored in chemistry and took advantage of many oceanography and environmental classes. I then went to the MIT/WHOI Joint Program to get my PhD in chemical oceanography, and after a brief postdoc at Princeton, I returned to Woods Hole Oceanographic Institution (WHOI) as an assistant scientist. I have happily been pursuing research at WHOI for the past five years, but I am about to begin a new stage of my career. In two months, I will be starting as an assistant professor of chemistry at Wellesley College. I greatly look forward to teaching a lot more than I currently do, and still conducting the research I love. I am excited about incorporating oceanographic examples into regular undergraduate chemistry classes and perhaps making some students realize that oceanography is a career they, too, can pursue.

My research focuses on investigating the marine carbon cycle. To that end, I use inorganic chemicals as tracers of biological and physical processes. In particular, the tracers I study are the noble gases and the triple isotopic composition of oxygen. I have worked in many environments, ranging from a salt marsh 20 minutes away from my office to the Arctic Ocean and the equatorial Pacific. I love being in the field, but I equally love being in the lab, surrounded by my four mass spectrometers (one large, three small), or in my office looking at data on my computer screen. My two favorite parts of my job are (1) figuring out how something works—whether it is a facet of the carbon cycle, a piece of a mass spectrometer, or a line of MATLAB code, and (2) teaching and hopefully inspiring others.

The biggest challenge of my job has been balancing my work and family life. I have two daughters—ages 6 and 3—and it can be hard to find enough time to do the work I want to do and to spend the time I'd like with them. I manage in part by including them in a lot of what I do—my daughters have come to the field and conferences with me, and they routinely come to lab with me on weekends (when my older daughter was two, she asked if she could have a pink mass spectrometer when she grew up). While it can be challenging, it is fun to include my daughters in my scientific life and to watch them learn and love science and the ocean.



Rachel and one of her daughters on an impromptu trip to Bermuda to fix a broken mass spectrometer system.

Deborah K. Steinberg

CSX Professor of Marine Science, Department of Biological Sciences, Virginia Institute of Marine Science, The College of William & Mary, Gloucester Point, VA, USA, debbies@vims.edu

When I contributed an autobiographical sketch to the first special issue on "Women in Oceanography" 10 years ago, I was an associate professor at the Virginia Institute of Marine Science. I had recently been awarded tenure, my children were quite young, and I was in the midst of two large, interdisciplinary field projects in the North Pacific and Atlantic Oceans. Today, I am still at the same institution—which has been supportive of me and my research—and have advanced into more and varied leadership roles as this stage of my career has progressed. I now have students and postdocs who have moved on to their own careers, many now with their own young families. I have a sense of a job well done, and must say I am happy.

There have been challenges; some I have faced in these last 10 years are the same as they have always been, such as balancing work and family and making time for myself. Some simple schedule changes, like working at home a day a week to write, make a big difference—I can get out for a bike ride at lunch time, throw in a load of laundry, and be there for my kids when they get home from school. Like others in mid-career, I am asked to take on increasing administrative responsibilities and community service. I enjoy this, but keep an eye on how it might affect my productivity in science. I've handled it by saying yes to the kinds of things I know I will enjoy, and I try to be realistic about the travel that often comes with it (rule: no more than one trip a month). I still find myself one of only a few women on most boards or governance committees I serve on, and as I've gotten older have become braver about speaking my mind when I encounter gender-related issues.

What advice do I have for young women oceanographers? Reach out to other women inside and outside your institution, both senior women for advice, and those more junior to lend support. Be creative about how you do it, and remember it's okay to have fun—we have a holiday lunch with our women faculty that I look forward to all year! Surround yourself with excellent support staff and students; it will make your job much easier. If you want to have children, consider,

Deb at "science summer camp" in Antarctica aboard the research vessel *Laurence M. Gould* with the South Shetland Islands in background. *Photo credit: Sharon Stammerjohn*

but don't over think, the timing—do it when you feel ready, and make arrangements to accommodate (not the other way around). Be resilient. This is a rewarding profession, but you sometimes need a thick skin; take time to mourn an unsuccessful proposal, then lift your head and move on. If you find yourself adrift or feeling complacent, consciously do something to remind you why you got into oceanography in the first place. For me, an annual research cruise is like "science summer camp"—when else these days do I get to spend all my time in the lab and field for weeks straight (and not have to cook)? Collaborate with people you enjoy; it makes work a lot more fun. Pay it forward—we've all had colleagues who have helped us get a job or nominated us for an award, so take time to do the same for others. Oh yes, and bring a fancy, scented bar of soap on your next research cruise.

Fiamma Straneo

Senior Scientist, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, fstraneo@whoi.edu

These days, I spend much of my time trying to figure out how ice sheets, Greenland's in particular, interact with the ocean. I use helicopters, icebreakers, fishing vessels, and autonomous surface and underwater vehicles to collect data at the edge of Greenland's enormous marine-terminating glaciers. These data, complemented by numerical and laboratory models, are used to investigate how glaciers and the ocean exchange heat and freshwater, with the goal of understanding how ice sheets will respond to a warming climate. This work, and my broader research, seeks to document and understand climate change in the high latitudes of the North Atlantic. It is motivated by a deep curiosity and a sense of wonder for the natural world as well as a commitment to providing present and future generations with the scientific understanding of the polar regions needed for sustainable stewardship of our planet.

I have benefited from many significant opportunities, experiences, and interactions throughout my life. Growing up, I spent summers sailing (or cruising) around the Mediterranean (including hours staring below the surface), nurturing a passion for the natural world, and the ocean in particular. This passion helped pull me back when I was lost in the meanders of theoretical physics at the University of Milan, Italy, where I grew up, and eventually led to a (theoretical) PhD in physical oceanography at the University of Washington. Subsequently working at the Woods Hole Oceanographic Institution, my methodology evolved from theory to seagoing data collection (though seagoing seems a misnomer for fieldwork that involves helicopters or camping at the edge of glacier). I like to think it will keep evolving.

My work relies on other people. Research straddling multiple disciplines in the climate arena requires collaboration of colleagues from different fields. The fieldwork I do is only possible because I am supported by a cadre of engineers, technicians, ships' crews, helo pilots, and Greenlandic hunters and because the passion and excitement of the work is continuously fueled by students and postdocs.

How do I do it? I owe much to numerous mentors, both women and men, who looked out for me over the years and put my name forward at just the right times. Above all, I think their goal was to promote a diverse and healthy scientific community—and many of them were especially attentive to providing opportunities to junior women. Other necessary ingredients? A bag full of optimism, perseverance, and humor. Juggling work (especially fieldwork) and family (I have two young children) is a challenge, but it is also, quite simply, part of who I am today. Life in the office always seems calm after getting everyone fed, dressed, and out the door in the morning. On the other hand, improved (I dare not say good) organizational and crisis-averting skills from years of fieldwork come in very handy at home. Has it ever been easy? No. Is it easy now? No. But it is infinitely rewarding to unravel our climate system and imagine myself contributing to a better world.

Oceanography at the edge of a glacier from a hovering helicopter. *Photo credit: R. Jackson, WHOI*

Kathryn Sullivan

Under Secretary of Commerce for Oceans & Atmosphere and NOAA Administrator, Washington, DC, USA

Maps. We use them to plan road trips. We use them in classrooms to teach geography. We use them to understand economies and political boundaries.

As a young girl, I used maps to explore our planet. I would run to our mailbox each month to grab the latest issue of *National Geographic*, pull out the map insert, unfold it on my bedroom floor, and start studying. I was fascinated by the grand terrain of the Alps, the grandeur of the Serengeti, the mysteries of the Amazon, the limitlessness of our solar system, and the vastness of our world ocean. I wanted to understand how our planet "worked," and how all of these seemingly disparate systems were interconnected. I wanted to go to all these fascinating places to experience them myself.

I headed to college planning to study languages (a natural talent of mine), hoping this would translate somehow into world travel. Happily, I discovered the Earth sciences while fulfilling my freshman science requirements. Back then, we were advised to pick a subdiscipline and focus on one particular aspect of the earth. It was as if we were picking a color on a cartoon of the earth: brown if you wanted to study geology, green for ecology, white to study glaciers, and so forth. Today, we realize that all these Earth systems are interconnected. So Earth scientists nowadays work hand in hand with one another to study these connections and understand what they mean for the health and well-being of our planet.

My Earth science studies stoked my desire to explore even further: I wanted to explore the depths of the ocean floor and dreamed of seeing our planet from space—and I was privileged to do both. From a mile and half below the surface of the sea in the submersible *Alvin*, and, then, from 200 miles above as an astronaut, I had truly amazing views our remarkable planet, views that erased the lines and borders of the maps I studied as a child. Seeing our planet from these varied perspectives crystallized everything I learned through my studies and research into new and deeper understanding. The view from space triggered something else: a passion to not just bring back pretty pictures of Earth, but to bring the value of that transformative perspective and find ways to make it benefit society via policy and practice.

At the US National Oceanic and Atmospheric Administration, I'm proud to lead an agency of 12,000 dedicated employees who work on behalf of every American every day. Our observing networks take the pulse of the planet, and we transform those data into science-based, action-oriented information, or, as we call it, environmental intelligence, that aids decision makers around the country.

This environmental intelligence supports the economic vitality of our nation and lies at the core of what NOAA does. It provides us with foresight—the ability to look ahead, think ahead, analyze ahead, and make sense of alternative courses of action that lie before us.

It's come full circle for me. My childhood passion for maps led me to run an agency that is the legacy of the Survey of the Coast created by President Thomas Jefferson in 1807. Hundreds of years have passed, and we've come a long way in understanding our planet, but there's much more work to be done. I'm excited to see where the journey takes us.

Chaojiao Sun

Research Team Leader, Oceans and Atmosphere Flagship, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Perth, Australia, chaojiao.sun@csiro.au

I was born in Shanghai, China, when the Cultural Revolution was just about to start. Both of my parents were skilled mechanics working in a state-run factory, and they could never have imagined their little daughter would one day go to the United States and get a PhD in oceanography. I was the first one in my dad's family to go to college when I went to the University of Science and Technology of China. I majored in geophysics and became fascinated with the ocean, so I decided to study physical oceanography for my master's degree at the Institute of Oceanology of the Chinese Academy of Sciences (CAS) in Qingdao. My first year of graduate study was at the CAS Graduate School in Beijing, in 1988. While there, I took the Test of English as a Foreign Language and Graduate Record Examinations (GRE) to prepare to go to the United States for my PhD.

Chaojiao Sun and her two sons, Daniel and Justin van der Stelt.

I went to Oregon State University in 1990 on a research assistantship and worked with Jim Moum and Bill Smyth on the mechanism of deep cycle turbulence in the equatorial Pacific and its connection to shear instability. It was a long and difficult journey, but I persevered and was awarded my PhD in 1997.

Having become fascinated with data assimilation for its ability to bridge observations and numerical models to achieve something better than either observation or models alone, I went on to the University of California at Los Angeles to pursue a postdoc with Michael Ghil on coupled ocean-atmosphere data assimilation.

After my postdoc, I joined the Hydrological Sciences Branch at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center to develop the extended Kalman filter for a NASA catchment-based land surface model and to assimilate satellite snow observations. Next, I worked on ocean data assimilation methods to improve seasonal predictions at the Global Modeling and Assimilation Office at Goddard.

In 2008, I joined the CSIRO Marine and Atmospheric Research Division as a research scientist and moved from the east coast of the United States to the west coast of Australia, to the beautiful city of Perth. I have since worked on diverse topics, including ocean climate downscaling, hybrid ocean data assimilation, dredge plume modeling, and the Building with Nature Australia Initiative. I am now a research team leader in the CSIRO Oceans and Atmosphere Flagship.

My biggest challenge has been to learn to have confidence in myself. I have tried hard to be both a good mother and a good scientist, and sometimes have been disappointed and discouraged with myself. There have been many struggles, but the joy of doing science and raising kids is worth every pain. I have been inspired by some of the most brilliant, generous, and caring oceanographers as well as scientists from other fields. Now, the kids are older, and I can spend more time drawing and playing the piano. It has been a wonderful journey.

Kazuyo Tachikawa

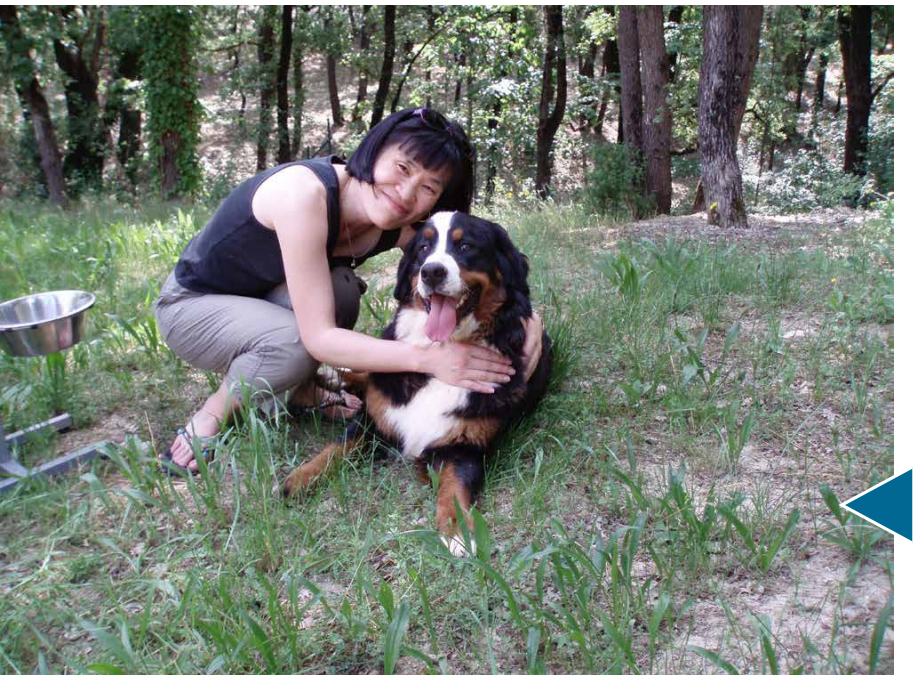
Research Scientist, Aix-Marseille Université, CNRS, IRD, CEREGE UM34, Aix-en-Provence, France, kazuyo@cerege.fr

When I wrote my short sketch 10 years ago, I was freshly recruited as a research scientist at CNRS (French National Centre for Scientific Research). I became a French civil servant while keeping my Japanese nationality. My career path was considered "original" because after four years' experience as a patent engineer at a Japanese company in Tokyo, I returned to academia, not in Japan but in Europe. First, I earned a PhD in France, where I met my future French husband. Then, during the next five years, I did postdocs in the UK and in France. During the final stage of my postdoctoral period, a Marie-Cure Individual Fellowship greatly helped me to integrate into the French scientific community.

My current research interest is marine biogeochemistry and paleoceanography using elemental compositions and radiogenic isotopes in bulk sediments and biogenic carbonates. Since I was recruited for my position, my career has been evolving gradually, but steadily. My great pleasure is that two of my PhD students have recently obtained academic positions. I also contributed to the construction of an inorganic geochemistry laboratory at my institute and have been responsible for installation of the instruments. Two years ago, I was promoted to research director of CNRS. Just like everyone else, as my career has progressed, my local and national responsibilities have increased.

Once I entered the French academic system, I did not confront any special difficulties related to my atypical path. Because the institute is big and well equipped, I benefited from collaborating with specialists in various fields and having a wide range of analytical facilities available. Of course, there are always some problems having to do with human relationships and conflicts between researchers, but they exist everywhere. My solution was not to bring these problems home but instead to adopt a dog, truly "man's best friend" (see photo).

Based on my own experience, I have two messages to young women oceanographers. The most important and difficult step in starting a career is figuring out what you want to accomplish in your professional life. You should try things that are completely different from research activities to examine your commitment. At first glance, it may seem like a waste of time. But, you actually gain future time because your hesitation disappears. The second message is, rather, a wish. I have been a member of a science committee for a French national program on biogeochemical cycles in the marine environment. Out of curiosity, I counted the proportion of female researchers who submitted proposals: women occupy 36%, which is not too bad. However, the proportion of female directors of the associated institutes is only 10%. Directing an institute requires specific skills that are distinct from research activities. If you recognize that you are talented in this domain, please do not hesitate to move into it if you have the opportunity—it will contribute to further improving the situation for younger generations.



Settling down in the south France after a long journey with my dog "Fuku" (happiness), who prematurely passed away this summer. Patting Fuku was the best tranquilizer for me.

Patricia Tester

Senior Scientist, Ocean Tester LLC, Beaufort, NC, USA, ocean.tester@gmail.com

For more than 30 years, my research has focused on phytoplankton-zooplankton interactions and effects of toxic or harmful phytoplankton on marine food webs. I helped pioneer the use of remote sensing in oceanography—a result of research at the US National Oceanic and Atmospheric Administration's (NOAA's) Beaufort (NC) Laboratory during the 1987–1988 red tide bloom off North Carolina. The need for real-time satellite imagery of coastal waters was clearly demonstrated by this event and led to establishment of a COASTWATCH program within NOAA that provides remotely sensed data on coastal regions throughout the United States, including Alaska and Hawaii (http://coastwatch.noaa.gov). As a follow-on to the 1987–1988 bloom, I presented testimony to the Small Business Administration (SBA) that helped change the definition of "disaster" to include red tides, allowing the SBA to render assistance when "customary fishing waters are closed due to red tides." Watermen from Maine to Florida have been able to apply for assistance from the SBA seven times since the legislation was changed. In March 2000, I briefed both US Senate and House staffs again on effects of red tides on marine mammals.

Over the years, it has been an honor to serve on many committees and receive awards that recognize career accomplishments. Being named to the International Organizing Committee on Harmful Algae from 2006 to 2008 and from 2012 to 2014 positioned me serve as president of the International Society for the Study of Harmful Algae from 2004 to 2008. Both the Provasoli Award from the Phycological Society of America in 2002 and the 2010 Tyge Christensen Prize from Phycologia recognized the efforts of our working group and colleagues for outstanding publications in the societies' journals. I received NOAA's Administrator Award in 2004 and the agency's Technology Transfer Award in 2007 for helping develop a rapid field test kit for algal toxins and transition it to market. In 2009, I was co-recipient of the Department of Commerce Gold Medal Award for design and implementation of a monitoring tool that safeguards marine resources. It was a privilege to be named to the GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) IOC-SCOR Open Science Meeting organizing committee in 2010, and we hope to successfully transition the GEOHAB program to Global HAB in the coming year. After working to initiate the National Research Council postdoctoral associate program at the Beaufort Laboratory, it was a pleasure to support five postdoctoral associates.

Field testing a *Ranger* autonomous underwater vehicle produced by Nekton Research (now iRobot) at Cape Lookout.

The past year has been a time of transition for me. After 33 years at NOAA's Beaufort Lab, I stepped aside from administrative tasks and returned to the lab and fieldwork. I am now consulting for NOAA part time while developing Ocean Tester LLC to provide opportunities for research partners and to facilitate marine research and education. The change of pace has been delightful. There is time to write, to consider data rescue projects, to conduct training workshops, and to become more active in international scientific issues. I plan to continue working on the biology and ecology of harmful algae, to consult and teach nationally and internationally, and to be inspired by the coming generation of women in oceanography.

Debbie Thomas

Associate Professor and Interim Department Head, Department of Oceanography, Texas A&M University, College Station, TX, USA, dthomas@ocean.tamu.edu

Wow—where did the past 10 years go?! In 2005, I was in the second year of my assistant professorship in the Department of Oceanography at Texas A&M University. Now, I'm serving as Department Head and going through the promotion process to full professor. The year 2015 is a significant milestone for me personally—I will be celebrating my tenth wedding anniversary to Brent Miller, who is an associate professor in the Department of Geology and Geophysics here at TAMU. Brent and I were hired together at TAMU in 2004, we built a lab together, we saw each other through tenure, and now we are navigating the ever-shifting currents of work-life balance with our amazing five-year-old son, Van.

Scientifically, the last 10 years have been very fulfilling. My research program has sought to understand climate dynamics during warm climate intervals of the geologic past as well as the causes of transitions between greenhouse and icehouse climate states. Much of this work has focused on understanding the role of deep ocean circulation in heat transport during the last major greenhouse climate interval in Earth's history (~ 100–40 million years ago). This is a particularly challenging (and fun!) interdisciplinary problem because the geographies, bathymetries, and thermal structures of the ocean basins were considerably different during the last major greenhouse climate interval than what we have now.

Over the past 10 years, my students and I have identified the primary mode of deep-sea ventilation during the Late Cretaceous and early Cenozoic (~ 100–40 million years ago) in the Atlantic, proto-Indian, and Pacific Ocean basins. Our work, using the neodymium and lead isotopic compositions of deep-sea sediments recovered by scientific ocean drilling (Deep Sea Drilling Project, Ocean Drilling Program, and Integrated Ocean Drilling Program cores), combined with numerical modeling, indicates that the deep-ocean circulation then was significantly different than the modern. Distinct, independent overturning circulations were operating in the Atlantic and Pacific, and there were numerous sites of deepwater sinking, including in the proto-Indian Ocean and the North Pacific (deep waters do not form in the modern North Pacific or Indian Oceans). Now, our team is focused on understanding when the ancient mode of circulation evolved into the modern, globally connected mode and how that was related to the climate evolution of the past ~ 20 million years.

I find it crazy to think that over the past 10 years I've evolved from an early career scientist into a leadership role. Now, I find myself in what is certainly the most challenging phase in my career so far, but at the same the most rewarding. I'm honored and humbled to be in a position to pay forward the efforts that my mentors made on my behalf, and to be in a position to better serve the ocean science community. And I now fully recognize that as women in the ocean sciences, we must all serve as mentors and leaders at every stage in our careers in order to broaden future opportunities for girls and women.

Debbie and son, Van Miller, pictured with a replica of the Texas A&M mascot, Reveille.

Anne Williford Thompson

Senior Research Scientist, Institute for Systems Biology, Seattle, WA, USA, anne.w.thompson@gmail.com

A college microbiology course kindled my interest in environmental microorganisms and the adventurous scientists who pursued them into caves, space, and the ocean. Initially, I wanted to become an astrobiologist. I fantasized about searching for microbial life on Mars. After learning more, I saw the ocean as a more accessible extreme environment, full of understudied microbial life, and I looked into oceanographic graduate programs. Penny Chisholm accepted me into the MIT/WHOI Joint Program to study *Prochlorococcus* alongside Mak Saito, a chemical oceanographer at Woods Hole Oceanographic Institution. The promise of oceanographic cruises to far off places enticed me. My research explored how the abundant cyanobacterium *Prochlorococcus* uses iron as a nutrient, and I discovered differences between how different *Prochlorococcus* ecotypes tolerate low iron concentrations. I loved being an oceanographer once I learned to manage my seasickness.

I then joined Jonathan Zehr at the University of California, Santa Cruz, to study an unusual marine nitrogen-fixing cyanobacterium, UCYN-A, for my postdoc. Colleagues and I discovered a symbiosis between UCYN-A and a unicellular alga through our fieldwork at Station ALOHA in the Pacific. This discovery revealed the reason for UCYN-A's small unusual genome and provided insight into the evolution of symbiosis in nitrogen-fixing cyanobacteria. The combination of flow cytometry and molecular analysis made this discovery possible, and I became interested in learning more about flow cytometry. I accepted an offer from Ger van den Engh to join his company, which had been recently acquired by BD Biosciences. Ger and I developed flow cytometry techniques for marine microbiology, with a focus on *Prochlorococcus* and other small pigmented cells. A changing marketplace shifted the company's interest away from environmental applications, and I missed the excitement of a research lab. After a year with BD, I joined the laboratory of Nitin Baliga at the Institute for Systems Biology, where I am now investigating the evolution and ecology of microbial systems, including *Prochlorococcus*, with the aim of understanding how microorganisms influence the Earth system.

The biggest challenges of my career have been the transitions from one job to the next. These transitions have been intense periods of uncertainty, but valuable for self-reflection. Notions of becoming a teacher, primary care physician, or paramedic would arise when the frustrations of failed experiments started to get the best of me. Despite these quandaries, my interest in the natural world and the thrill of discovery has kept me tied to oceanography.

My contentment with work depends strongly on making time for pursuits outside of research. I took multiple leaves of absence to sail with my father on passages from Virginia to Norway, Africa, and the Caribbean during my graduate and postdoc years. These expeditions gave me energy to draw upon later during long days in the lab or at the computer, and kept me awed by the vastness and mysteries of the ocean. I am grateful that my mentors, Penny, Mak, and Jon, understood this motivation.

My experiences as a female oceanographer have been positive. Ambitious and nurturing women have been my mentors, peers, and students. Though not a parent myself, colleagues who are mothers have worked at sea for extended periods, thanks to the support of their partners. Never have I felt that my ideas were rejected, or opportunities denied, because of being female. I hope these experiences are the budding of the equitable future referred to by women oceanographers in their 2005 autobiographies. It is surely their pioneering spirits that made my positive experiences possible.

Anne Thompson on her family's sailboat in Kobbefjorden, off the northwest coast of Spitsbergen, just before retreating to the south because of thick persistent sea ice farther north. *Photo credit: Audrey Thompson*

Diane Thompson

Advanced Study Program Postdoctoral Fellow, National Center for Atmospheric Research, Boulder, CO, USA, thompsod@ucar.edu

(above) A formative December 1998 snorkeling trip to Buck Island off St. Croix, US Virgin Islands, with my dad, who cultivated and encouraged my love of science and the natural world. (right) Coring a coral colony off Wolf Island, Galápagos in May 2010.

Although I grew up in Minnesota, I developed a deep passion for the ocean during childhood snorkeling trips to Buck Island Reef National Monument in the US Virgin Islands. These experiences, along with my natural curiosity and love of science, interested me in studying the marine environment from a young age. As a 2006 summer fellow for the National Marine Fisheries Service, I returned to the reefs at Buck Island and was devastated by the loss that had occurred over a few years' time. I realized then that management at the local level cannot protect reefs from threats that are occurring on a global scale, particularly temperature stress associated with El Niño events and global warming. This experience inspired me to study these global-scale climate phenomena and their effects on coral reef ecosystems. What excites me most about this research is the possibility that what I discover may lead to more informed management decisions to protect these critical marine ecosystems.

The most rewarding part of being an ocean scientist for me has been seeing firsthand the potential for recovery following catastrophic coral bleaching and mortality. I'll never forget pulling out my first core from a large coral colony off Wolf Island, Galápagos, and seeing a distinct death band riddled with capitalistic bivalves that took over the surface of the coral following the massive 1982/1983 El Niño bleaching event. But this coral, and many others I've cored since, regrew or recolonized on this surface and soldiered on! In a field dominated by stark projections of widespread mortality, these experiences remind me that corals are resilient creatures and give me hope that we can help protect them.

The most challenging part of being in ocean science for me thus far has been the difficulty of balancing my personal life with the frequent travel and moving associated with the early stages of my career. And I know I'm not alone in this—it's is a balance that I've seen many of my graduate student and postdoc friends and colleagues struggle to find as well. We call this the "one-body problem." Unwilling to sacrifice my career, yet striving to "have it all," I have found it very difficult to maintain relationships while moving every few years and traveling for fieldwork and conferences (not to mention the jealousy it can create—you get to go to a tropical island again?!?). So while the travel is one of the most rewarding parts of my career, it is also one of the most challenging. I look forward to landing a permanent position, getting real adult furniture, and (with any luck) finding my other half!

LuAnne Thompson

Professor of Oceanography, Adjunct Professor of Atmospheric Sciences and Physics, Director of the Program on Climate Change, University of Washington, Seattle, WA, USA, luanne@uw.edu

I am a physical oceanographer who studies the ocean's role in climate using models as well as satellite and in situ observations. My research group focuses on how the ocean stores and moves heat, freshwater, and geochemical tracers, and how it exchanges these quantities with the atmosphere. Like many physical oceanographers, I began my education with an undergraduate degree in physics. I was brought up in Northern California, hiking in the Sierra Nevada Mountains and going to the beach, but became enamored with astrophysics. After my first year of graduate school in physics, I discovered oceanography and moved from Harvard to MIT to begin working toward a PhD in oceanography. The field of physical oceanography appealed to me because I could apply math to solve real-world problems, and in retrospect, because it linked me to my childhood connection with the natural world. Joining the faculty of the School of Oceanography at the University of Washington forced me to become comfortable interacting with scientists who have a variety of approaches to studying the world ocean and to view math and physics as means to an end rather than as goals in themselves.

The broad interdisciplinary nature of oceanography has taught me how to value other scientific approaches. Over the past decade, I have become involved in efforts across the UW campus to build a community of researchers interested in studying climate change from a variety of perspectives. Three years ago, I became director of the UW Program on Climate Change (PCC) and now spend much of my time engaged in talking with faculty and students from across the campus about the challenges that climate change will bring to humanity. This is both a daunting and exciting time to be a geoscientist. The graduate students involved in the PCC have helped me to expand my perspective even further, and interacting with them is the best part of my job; I have served on over 80 graduate student committees and advised numerous climate communication projects.

I met my husband, Greg Johnson, in graduate school, and we were able to find permanent positions in the same town, with Greg working at the National Oceanic and Atmospheric Administration. This arrangement has allowed us to have someone who understands what we do and also to be able to keep work from dominating our lives. The demands of his seagoing research often kept me from traveling after we had our daughter, and we have had to negotiate participation in meetings such as the AGU/TOS/ASLO Ocean Sciences Meeting. I have taken advantage of the flexibility of an academic career to be involved in our daughter's life, including working part-time in the summer.

I am envious of women entering the field now, as there are so many more of them. For me, it was often lonely, and at times the isolation affected my confidence. In the department, I had to teach the chair about maternity leave and stopping the tenure clock policies. I am happy that these issues are dealt with more directly now, but I admit that I am often disappointed with the lack of progress on more subtle problems that women encounter in academic oceanography.

Greg, LuAnne, and Lucy (age 16) visiting Prague after the 2013 European Geophysical Union Meeting.

Kristen Thyng

Postdoctoral Research Associate, Texas A&M University, College Station, TX, USA, kthyng@tamu.edu

Kristen on a hike on Oahu before the Ocean Sciences Meeting in Honolulu in February 2014.

I'm currently a postdoc at Texas A&M University in the oceanography department, but I've had an unconventional career path getting here. I started by studying physics for my BA at Whitman College, a small liberal arts school in Washington state. I then attended graduate school at the University of Washington in applied mathematics for a master's degree. There, in a fluid mechanics class, I met my PhD advisor, Jim Riley, a professor of mechanical engineering who is also adjunct in applied math. He had funding for a tidal-energy modeling project, which I had the background to work on, so I moved to mechanical engineering for my PhD. From graduate school, a postdoc in oceanography made the most sense based on my skill set—geophysical fluid dynamics and numerical modeling. Accordingly, I moved to the oceanography department where I am now.

Because I changed departments with each stage of my academic career, I have come into every department from the side. It has been hard always being an outsider. I often don't know the jargon and the assumptions that others take for granted, but I also have met a wide range of people doing all sorts of different research. I hope this diverse background will enable me to generate ideas that I might not have otherwise. I have found that when I introduce myself to people whose work I've studied, they respond willingly and positively, and that has helped me integrate into my research community.

My research is in coastal and estuarine physics. I did oceanographic modeling during my PhD work to help understand siting for tidal turbines, a renewable energy source being studied in the Puget Sound and other locations around the world. Currently, I am studying the transport of materials such as oil and phytoplankton in the coastal ocean.

Being in the minority as a woman is something that I am accustomed to—physics, applied math, and engineering all have their own difficulties with attracting and retaining women. Now that I am in an oceanography department, I interact with more women relative to other disciplines I've been in. However, while there are approximately equal numbers of women and men at the student and postdoc levels, there are still fewer female professors.

I came to work in oceanography largely by circumstance and by following paths as they opened for me; I never planned on it. However, I am very happy to be in this field and employed as a scientist. While it is hard work, I frequently remind myself that I get paid to figure out problems; talk with smart, interesting people; and travel to do more of the same. Coming to the oceanography community late, I have found it to be very welcoming—oceanographers are a fun and friendly bunch!

Masako Tominaga

Assistant Professor, Multiscale Applied Physics Lab for Earth Science, Department of Geological Sciences, Michigan State University, East Lansing, MI, USA, tominaga@msu.edu*

I am a marine geophysicist who uses remotely sensed physical signals from rock formations under the seafloor and from ancient seafloor that is now exposed in mountains to decipher how Earth's geological domain has formed and evolved. A core part of my research is devoted to deep submergence geophysics that utilizes underwater robotic vehicles to "nail down" the details of deep-sea geological processes. Just three months after my arrival at Texas A&M University in 2003, I was on a UNOLS vessel, logging my first 42 days of ship time to collect data for my master's thesis. Since then, I have kept my sea legs by spending 520 days at sea, with another month-long cruise to be added at the end of 2014.

My childhood surroundings and my paternal family's nomadic life inspired me to work close to the ocean and mountains. I grew up in Kamakura, a town south of Tokyo, Japan, where I had an incredible childhood exploring a historic town established in 1192, a beach on the western Pacific, and mountainside trails. When I had to choose a field of study in high school, anthropology and comparative literature were the first fields that came to mind. However, using math and physics and being outside were also important priorities—and hence, geophysics ultimately became my chosen field.

Masako, at 18 months, trying to see "what's out there" with her outfit ready for upcoming expeditions.

Today, I strive to keep conducting oceanography not only to advance our scientific knowledge and support societal needs but also to hand down what I have been given by the many people I have met throughout my career. Looking back on my days sailing on scientific research vessels across the world, exploring field sites on land, and even attending scientific workshops and meetings, I have met wonderful people, some of whom have become mentors and friends for life. Over time, we have come to share scientific curiosity, celebrate career milestones, and support one another in navigating new work responsibilities. But we also share a philosophy of humanity—most of us seem to try to "leave nothing unattempted." In our pursuits both at work and at home, we inspire one another, and learn from one another.

Through more than 12 years of living outside my home country, I have conducted my own personal anthropology and comparative literature study, and my curiosity in these realms has been more than satisfied. My friends, who include geologists, oceanographers, ships' crew members, engineers, and system architects of different ages, genders, nationalities, and ethnic groups, have shown me how to think, understand, and tackle challenging situations and choices to be made at work and in life. These individuals constitute my North Star, guiding, cheering, supporting, and inspiring me throughout my career.

Someday, I hope my life story will be cherished and inspire others—particularly students in my lab and in the field—and I hope they have the opportunity to establish their own North Star among their friends and colleagues as they explore our planet.

* As of July 1, 2015, Assistant Professor, Department of Geology and Geophysics, Texas A&M University, College Station, TX, USA.

Marta E. Torres

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Marta Torres onboard *Polarstern* offshore South Georgia in the southern Atlantic Ocean.

I have been extremely fortunate in finding my oceanographic career to be a truly rewarding life-long experience. I completed my bachelor's degree in chemistry in 1976 at the University of Costa Rica and was inspired by two visiting professors to pursue a career in oceanography. At Oregon State University (OSU), I earned my MS in chemical oceanography (1983) and PhD in marine geochemistry (1988). I then spent two years as a staff scientist for the Ocean Drilling Program and three years at GEOMAR in Kiel, Germany, before returning to OSU, where I have been on the faculty since 1993.

For what is now three decades, I have been applying state-of-the-art inorganic elemental and isotopic measurements toward understanding geochemical changes associated with fluid transport along plate boundaries. What began as the study of cold seeps in the Eastern Pacific has expanded to include a variety of topics in which fluid flow plays a fundamental role. I have pursued my research using a variety of tools, including conventional vessels and icebreakers, deep-sea drilling platforms, and remotely operated and deep submergence vehicles. Most recently, I have been involved in large scientific ocean drilling projects offshore Oregon, Washington, India, and Korea to increase understanding of how carbon sources, metabolic pathways, and fluid transport influence gas hydrate dynamics. As a member of large multidisciplinary projects offshore Costa Rica and Japan, I have used my understanding of geochemical processes to infer the impact of fluid flow on geochemical cycles, mineral and microbially mediated reactions, and earthquake generation at convergent margins. But for me, the most valuable aspect of my career, without a doubt, has been the collaborations and friendships I have been fortunate to forge with a broad range of researchers from all over the globe, all of whom I respect enormously as scientists and human beings. I continue to learn from these interactions and benefit from opportunities to visit many parts of the world to do fieldwork, attend international conferences, and collaborate as a visiting research fellow.

By serving on several national and international panels, I have had the opportunity to contribute to group efforts aimed at generating and promoting ideas for new research. In addition, it has been particularly rewarding to mentor young scientists and watch them develop, then see them go on to contribute to the advancement of the discipline in ways beyond anything I had imagined.

The opportunity to look for answers to the world's scientific questions is truly a privilege. The joy of discovery remains as fresh as when I started this journey. It has been a fascinating career, but not without its challenges. While my son was growing up, it was always very difficult to be there for him and also to be away in the field for long periods of time. It was not easy to balance the pressures of family and science, especially when having to continuously secure funding and maintain a productive research program at a soft-money institution. However, as I look back, now that my son is finishing college, I cannot imagine a better way to have spent my life. If you are beginning your career in this field, please do not be discouraged; this is a team effort, both scientifically and personally; you will find that there are colleagues willing to contribute to both parts of your life in a variety of ways. Personally, I owe a debt of gratitude to many, among them my doctoral advisor Erwin Suess, who launched me in this adventure; colleagues who lent me a hand along the way; and my husband, who supported me throughout the journey.

Elizabeth Turner

Oceanographer, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Durham, NH, USA, elizabeth.turner@noaa.gov

Most oceanographers don't start out as ballet majors. I was in a semi-professional ballet company all through high school, and when it came time for college, I wanted to continue to dance. At that time, very few schools offered a ballet major, but Texas Christian University was one of them. So I packed up my pointe shoes and got on the plane from Maine to Texas. I survived the culture shock, but eventually my dreams didn't survive the reality of trying to make it in the competitive world of professional dance. So when it came time to choose another major, I gravitated toward my favorite subject in high school, biology. And I found that my favorite college biology class was invertebrate zoology. I was amazed at the diversity of life history strategies, strange body plans, phylogenetic breadth, and just plain bizarre types of animals. Another favorite class was ecology. And these topics all tied into my childhood passion for tide pooling on the coast of Maine. A marine scientist was born.

An MS degree from Stony Brook followed, with a subsequent stint as a technician at the University of Maine, and finally a PhD from the University of Delaware. During a postdoc at Rutgers University, I met another marine scientist postdoc, and we are still married 23 years later. My husband was the first one of us to land a "real" job, but his job offer from NOAA required a move. Because I was not interested in a long-distance marriage, I moved to Maryland and worked out another postdoc at the University of Maryland. No academic job offer ever came, so I looked outside of academia. I found a job with the National Research Council's Ocean Studies Board and the Office of Naval Research and later joined NOAA as an oceanographer and program manager in the National Centers for Coastal Ocean Science. All of these experiences helped me to see the wide range of interesting things going on in areas other than my own subdiscipline.

I manage a number of competitive research projects that have spanned fisheries oceanography, limnology, ocean acidification, and various aspects of estuarine ecology. All of the projects have some link to coastal management and/or policy, which provides the satisfaction of serving environmental needs. Every time a new project starts, I learn a whole new field and get to work with a new set of ocean and coastal scientists, which is one of the most rewarding parts of my job. I also have been able to see students who were supported under a grant that I managed early in my career go on to become faculty members in their own right, which is tremendously gratifying. Through all the bureaucracy, red tape, government shutdowns, and budget shortfalls, I hope that I have made a difference to the field by playing a supporting role. I'll never be first author on a huge pile of publications, or get any awards for scientific achievement. But I've been able to enjoy a breadth of experiences that I would never have gained as an academic pursuing my own line of research.

Tina van de Flierdt

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I grew up on a dairy farm, and my parents always told me that if you follow your passion and are prepared to work hard, your dreams can come true. It really all started off with the pebbles in our backyard that I liked to break open to see what was inside and then try (with limited success) to sell. As for so many of us, it was one person, my geography teacher, who really opened the door to the big world out there. He taught us about mountain building, volcanoes, and plate tectonics, and soon I knew that I needed to become a geologist.

But where did oceanography come into play? I studied at a university where the Quaternary was not even on geological maps, and where we had no lectures on the ocean or climate. I was in love with proper rocks (crystalline rocks, that is), but also had discovered that by studying their chemical composition, we can learn so much more than what we can by simply observing them. It was my passion for geochemistry that got me into a PhD in paleoceanography. I soon realized that the ocean covers almost every possible aspect of geology. Who would have thought that by analyzing the chemistry of seawater and marine deposits, we can tell stories about ocean currents, mountain building, erosion and continental weathering, and even the waxing and waning of ice sheets?

For most of my research, I use big mass spectrometers to measure small variations in the isotopic compositions of particular elements in seawater, mud, or deep-sea corals. I feel very privileged to have had opportunities to work at some great universities and alongside some truly inspiring scientists over the years. The biggest reward for turning into a (paleo)oceanographer, however, came when I went to sea for the first time in 2008. I had no clue whether I would get seasick or not, and the test bed was Drake Passage—the roughest part of the global ocean. It turned out I did not get seasick. It also turned out that going to sea was the new love of my life. Aren't rocks much more exciting in dissolved form in the ocean, where they get into the skeletons of marine organisms, or where individual grains in the mud can tell us about the history of eroding continents?

The biggest question in this amazing journey of becoming a scientist was clearly whether the small girl from the countryside could survive in the big cities of this world and among eloquent people from more privileged backgrounds. To anybody out there: if I can do it, you can do it! What better career is there than one where you are paid for to search for answers to the questions you are curious about? I feel fortunate that my gender was never a hurdle in anything I tried to do, and I sincerely hope that my experience will apply to the next generation of young women scientists who are working hard to make their dreams come true.

The second time my friend and colleague Laura Robinson took me along on one of her expeditions to the Drake Passage, we had an amazing day of sailing through the sea ice in Bransfield Strait—there even were penguins around!

Diana E. Varela

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Then and now... (above) Diana participating on a research expedition to the South Atlantic in the late 1980s and (left) during a recent trip to the Antarctic base "Carlini" on King George Island in January 2014. Both photos were taken on the same research ship (formerly the Woods Hole Oceanographic Institution first research vessel *Atlantis*, known as *El Austral after* its transfer to Argentina in the 1960s, and later renamed *Dr. Bernardo Houssay*).

I have been interested in science for as long as I can remember. Although my first love was astronomy (thanks to Carl Sagan and his TV show, Cosmos), leaving home to pursue this passion wasn't an option at the time. Instead, I decided to study oceanography at the Universidad Nacional del Sur in my hometown of Bahía Blanca, Argentina. At that time, the ocean was as unexplored as outer space, which made them both equally fascinating to me. After obtaining my "licenciatura" (equivalent to an Honors BSc) in biological oceanography, I moved further south in Argentina to Puerto Madryn, where I worked on the biogeochemistry of marine sediments at a government institute. For the next four years, fieldwork in Patagonia was an integral part of my life. I participated on day-long trips on small boats and multi-day trips on a large research ship, and although I was often the only woman on board, it never bothered me, thanks to the support of my male colleagues.

A summer trip to Woods Hole to take a course at the Marine Biological Laboratory was a turning point in my life, because I was exposed to so much exciting science there. I returned to Woods Hole in 1989 as a master's student in the Boston University Marine Program. The University of British Columbia in Vancouver was my next stop, where I had a fabulous time learning everything I could about phytoplankton eco-physiology, and, as a bonus, earned my doctorate. Postdoctoral positions at universities and government labs took me back to the United States and then to Canada again. In particular, my postdoc at the University of California, Santa Barbara, was a defining point in my scientific career, although it came with some personal challenges. I moved to California on my own with my 10-month-old son because his dad had to stay in Vancouver for work. That experience made me a more compassionate person who has a huge amount of respect for single parents. Despite the change that a child brings to one's life, motherhood has given me a clear realization of what really matters, and what balancing a personal life and a career really means.

As a faculty member at the University of Victoria (Canada) since 2004, I have been involved in projects in warm and cold oceans, many of which took me away from home for several weeks at a time. I have participated in oceanographic cruises from the Arctic to the equator, conducted research at an Antarctic base, and traveled the world for conferences and workshops to gain and share knowledge about the role of phytoplankton in the world ocean and Earth's climate. All of this would have been impossible without my spouse's constant support for my career and sharing of parental duties, and without the help of my close family, mainly my parents, who at times also cared for my young child. Now that my son is a wonderful teenager, I have to thank him for putting up with a mom who is not much of a homemaker and who is always marking final exams instead of baking Christmas cookies.

Women have made huge strides in oceanography in the last few decades, often with the guidance and encouragement of wonderful male mentors. The mentorship I received from each of my supervisors and colleagues (male and female) made me a better scientist and increased my commitment to marine sciences, but most importantly, those interactions have enriched my personal life. Now I am trying to give this back to my own graduate students, who I consider "my own kids" and to those enthusiastic undergraduates who, in return, make me feel that I have indeed chosen the right career.

Lourdes Velo-Suárez

Marie Curie International Outgoing Fellow, French Research Institute for Exploitation of the Sea, IFREMER, Brest, France, lourdesvelo@gmail.com

Having grown up in a coastal town in southern Spain, I've always loved the sea and the mysteries it holds. Whales fascinated me when I was a kid, and I spent my youth dreaming of being a marine scientist. How did I end up working with tiny planktonic organisms instead of gigantic cetaceans? I must confess it was less than romantic. When I finished college, I decided to take a job as a lab assistant in a harmful algae (HAB) monitoring program in my hometown. While still dreaming about blue whales, diatoms and dinoflagellates grew on me. Two years later, I finally made the decision to pursue a PhD in phytoplankton ecology. I've never looked back. Planktonic organisms are the most amazing creatures. Every time I look at a live sample, I discover something new and wonderful.

In 2005, I applied for a research contract at the Instituto Español de Oceanografía (IEO). The time I spent at IEO working with Beatriz Reguera, my PhD supervisor, and Sonsoles González-Gil was truly joyful. I learned how to work with field data, combine information from several sources, and collaborate with multidisciplinary scientific partners. After my PhD, I was thrilled to receive a Marie Curie International Outgoing Fellowship. Working at Woods Hole Oceanographic Institution (WHOI) provided me an experience that has been fundamental to my work on plankton dynamics. As a WHOI postdoc, I was encouraged to try new approaches, and I benefited from interactions with interdisciplinary and enthusiastic scientists.

My research focuses on HAB population dynamics. Specifically, I am drawn to questions that provide insights into biological oceanography, molecular biology, and marine ecology. To answer these questions, I have developed a multidisciplinary approach, combining modeling techniques and laboratory/field studies to understand how physical (e.g., currents) and biological (e.g., growth, swimming behavior, parasites) factors affect plankton blooms.

The most rewarding part of being a marine biologist is the freedom to follow my own ideas (even the crazy ones). Science is fun, and I enjoy the spirit of discovery and innovation that is abundant in marine research.

The birth of my son in 2013 changed my whole perspective, redefining both my personal life and my professional career. Balancing work and home life is not always easy, but having the full support of my family is making this journey a great adventure.

My greatest challenge nowadays is struggling for funding. Being *determined*—or as my friends might say, stubborn—is the key to overcoming this challenge. However, I wonder at times if I will get enough grants and write enough papers and stay sane. I try not to stress myself planning for the future, but I cannot help thinking about some colleagues I have left behind. Will that happen to me? The 2008 global financial crisis has led to a huge decrease in funding for scientific research in European countries. I hope, for my own sake, that the situation will get better in the near future.

It is hard to be away from your family, but when you come back, they don't stop smiling. This photo was taken the first time I left my baby for more than a week. I was very happy to be back at home!

Penny Vlahos

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Ten years ago when I contributed an autobiographical sketch to the "Women in Oceanography" special issue, I was a research associate. I am still working in the same academic building but as an associate professor. In 2006, I applied and was short-listed for a faculty position at another academic institution, but I was offered a position to remain here at UConn and decided to stay. I received tenure two years ago, and I am very grateful for the way things have worked out.

Penny Vlahos with her kids.

Challenges? Hmmmmm…yes. One of the biggest was trying to navigate a career in a field for which I would have configured a different landscape. I often joked that I was playing a game for which I would have made different rules. Specifically, I found that though science is purely objective, the culture is not. Though I had two great male mentors, female mentors were nonexistent (there were no female faculty when I trained), and the subtleties are huge. A second challenge was the struggle to balance personal and career choices. It's just the conservation of energy—there is only so much to go around, and, honestly, people had to come first. I am thrilled to be doing what I love in both realms (professional and personal) though the two overlap significantly, if not completely.

One of the best parts of this career is the freedom to explore new ideas, to solve bits of a puzzle, and to do so in a self-governing manner. I have been able to work on a variety of projects that have spanned air-sea gas exchange, carbon geochemistry, and even developing new chemical sampling tools. There were many times along the way when I was very doubtful about being able to balance life and science. There were many times when it felt like I was trying to do too much, and nothing was going to work out right. And then there were the great times, when I could sit back and look at the people my kids were becoming or at the development of my students and really feel great pride and a sense of accomplishment.

Ten years later I'm part of a wonderful community (with special mention to Ann Bucklin). Now, when I look around the table at faculty meetings, I note that one-third of my colleagues are women, and there is a great sense of collegiality. There are probably as many ways to end up in this position as there are individuals who are oceanographers. Thus, there will be no one story in this compendium that could be applied to every young student looking to build a career in science, but this is my story: though engineering and science were second nature to me, the scientific culture I was entering was not. I'm glad to say the culture is changing, though we are not there yet. Change is inevitable, and entropy will always prevail! Advice? Build a community of peers, don't be shy about asking questions and seeking out colleagues, and don't let your perceptions of the field mold you, but instead redefine the scientist of the future.

Kathleen Wage and Lora Van Uffelen: The Able Sea Chicks

KATHLEEN E. WAGE | Associate Professor, Electrical and Computer Engineering Department, George Mason University, Fairfax, VA, USA, kwage@gmu.edu

LORA J. VAN UFFELEN | Assistant Researcher, Department of Ocean and Resources Engineering, School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa, HI, USA, loravu@hawaii.edu

We are scientists interested in how sound travels underwater and how we can use acoustics to study the deep ocean. We started a blog as a part of program called "Listen up and get involved" sponsored by the Acoustical Society of America to introduce young girls to STEM-related fields. The blog chronicled our day-to-day experiences onboard a research vessel in the Philippine Sea deploying moorings as part of an ocean acoustic tomography experiment.

We both have engineering backgrounds and are drawn to experimental work because it gives us the opportunity to use our design and problem-solving skills. This type of work also offers variety, incorporating elements of engineering, oceanography, signal processing, and adventurous travel. Here's a little bit about what we do and how we ended up as the Able Sea Chicks.

KATHLEEN WAGE

Several inspiring high school science classes and a book on careers in the biomedical field sparked my interest in engineering. At the University of Tennessee I started out in biomedical engineering, but eventually switched to electrical engineering. One of the professors who convinced me to switch also helped me find a summer internship at Oak Ridge National Laboratory. While the hills of Tennessee are far from the ocean, I ended up working on a sonar project, and it convinced me that I wanted to study signal processing in graduate school at MIT. My advisor recommended that I apply to the MIT/WHOI Joint Program. Since new Woods Hole Oceanographic Institution students get to go on a 10-day cruise in the Atlantic on a 125-foot sailboat, I immediately said yes!

Today, I am an associate professor in the Electrical and Computer Engineering Department at George Mason University. Currently, I am studying noise in the Philippine Sea and investigating better ways to design arrays of sensors to sample the deep ocean. I love working with students, going to sea, and analyzing experimental data. Being a professor is definitely my dream job.

LORA VAN UFFELEN

Growing up in West Michigan, the prospect of being an oceanographic researcher wasn't really on my radar (or sonar!). As an engineering student, I had plans to pursue architectural acoustics after graduation. On a whim, I did a summer internship in ocean acoustics at the Marine Physical Laboratory at Scripps Institution of Oceanography. I spent the summer running acoustic models and learning about how sound is used under water. I even had the opportunity to test my sea legs on two short research-cruises…that was all it took to get me hooked!

I earned my PhD at Scripps studying long-range acoustic propagation, and am now a researcher at the University of Hawaii at Manoa in the Department of Ocean and Resources Engineering. I use gliders equipped with recorders to study acoustic propagation and oceanography as well as for bio-acoustic sensing. I have spent cumulatively over a year at sea and have visited the ocean everywhere, from the tip of South America almost to the North Pole via a Norwegian icebreaker. The thrill of collecting data fuels my curiosity and keeps me excited about my research.

To read more about our seagoing adventures, check out our blog at ableseachicks@blogspot.com. We're planning to resume the blog the next time we go to sea, in 2015.

Photo credit: Lloyd Green, Scripps Institution of Oceanography

Angelicque E. White

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I am a biological oceanographer who dabbles in microbial ecology, marine biochemistry, and satellite oceanography. I look for stories to tell and systems to outline. Like many of the rest of you, I am curious by nature; I just happen to want to know about the lives of microbes. I want to know how nitrogen-fixing organisms compete for nutrients in the open ocean. I want to outline their habitats and understand the limits of their physiology. I want to know what controls community productivity in our seas. I want to know why the general public cares more about plastic pollution in the middle of the ocean than sea level rise or coastal eutrophication, for example. I want to know why there are subsurface maxima of methane throughout the oligotrophic ocean. I also want to ride my bike and run in the woods. I want to love and be loved. I want to learn.

My career is still young, but the rewards have been many: I have the freedom to develop my own research across disciplinary boundaries. I have had the opportunity to travel and explore, and I even have had a few rare and special moments of real discovery. I have worked in the Antarctic, the tropical Atlantic, the Gulf of Mexico, and the grande dame of them all—the Pacific. My research is largely collaborative, for example, as a part of the National Science Foundation (NSF) Center for Microbial Oceanography: Research and Education and more recently the Simons Collaboration on Ocean Processes and Ecology. In comparison to these joys, the challenges have been by and large related to the funding environment. Proposal success rates are currently low: less than 20% for NSF Ocean Sciences. It's such a common topic of concern among my colleagues that we've jokingly called the current vibe "assistant professor hunger games." We all want to be Katniss but know that rejection is an inevitable part of the game. The challenge has been to retain some semblance of self-confidence, optimism, and motivation despite the often toxic funding climate.

These complaints are small, though, particularly when viewed from a wider lens. I have not had to face the challenges of balancing work and children, although I see daily how hard that feat is for many of my colleagues (male and female). Loss was what shook me: cancer took my wife of 11 years in 2012. That journey brought everything else into sharp focus and revealed with a crisp clarity what matters most. Being an oceanographer is a great privilege; I've worked hard to get here and I love my job and my colleagues. In the end though, what matters more to me is the answer to these questions: Am I making the choices that allow me to be the best human I can be? Am I making a difference? Do my friends and family feel loved? Am I living a good life? Like proposal writing, I oscillate between failure and success in these endeavors. It's the trying that matters.

Angelicque White building rock cairns on the Oregon coast near Cape Perpetua. This site looks out over a marine reserve that happens to also be a local hot spot for seasonal hypoxia. It is not quite visible, but her T-shirt says "Antarctica: the farewell tour."

LeAnn Whitney

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LeAnn Whitney enjoys a visit with Darth Vader, a grouper at the Bermuda Aquarium.

I grew up in a very small town in down east Maine, where, despite its coastal location, I didn't appreciate the importance of the ocean—I just knew it was beautiful and cold! In high school, having taken every science class offered, I was encouraged to apply for and selected to attend a week-long hands-on marine research experience (the Keller BLOOM Program) at Bigelow Laboratory for Ocean Sciences. This experience is what piqued my interest in marine science. It was here that I first saw a seawater sample under the microscope; I was amazed by the diversity of shapes and sizes of natural phytoplankton communities. It was also where I met "card-carrying" scientists for the first time and saw that they were real people. This experience led me to pursue a bachelor's degree in marine biology at the University of Maine at Orono, followed by a PhD in cell and molecular biology at the University of Rhode Island (URI), where I used molecular tools to study iron limitation in diatoms. At URI, I was advised by and worked closely with exemplary women oceanographers who provided positive examples of what could be achieved with hard work and dedication. I also developed lifelong friends whose support and camaraderie helped me to persevere through the trials and tribulations associated with getting a PhD. My journey has come full circle. I have happily returned to my home state of Maine and Bigelow Laboratory, where I am currently a postdoctoral researcher. My research couples molecular tools with biogeochemical measurements to understand how future ocean conditions will affect phytoplankton growing in low nutrient environments.

The rewards of working in this field are many. It is a privilege to have a career where learning and exploration are not just encouraged, but are required. I have had many opportunities to travel, including spending time at sea, which is an indescribable experience few people are afforded. I also find mentoring young adults to be extremely rewarding. I am an oceanographer because of the many great experiences and mentors I've had throughout my education. In an effort to return the favor, I have sought out as many opportunities as possible to expose young people to the work that I do. To that end, I was recently awarded a National Science Foundation Postdoctoral Broadening Participation Fellowship, with which I look forward to developing an outreach program to work with Somali youths whose families have recently sought refuge in Maine.

This year has also brought great changes to my life outside of the lab, as my husband and I await the birth of our first child. While balancing a career and a family will undoubtedly be a challenge, it will be a far greater blessing! I look forward to sharing my love for the ocean with my daughter and, hopefully, teaching her that having a rewarding career doesn't have to come at the expense of having a family.

Gunda Wieczorek

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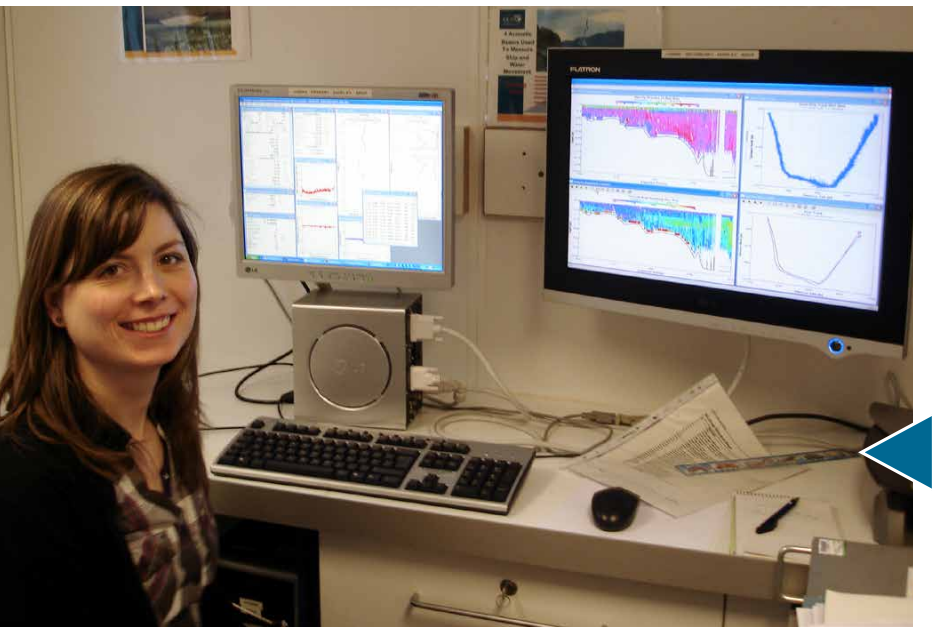
Although I grew up a couple of hours away from the sea, in Muenster, Germany, I was always fascinated by it. On summer holidays, my parents would take my siblings and me to the German coast (Baltic and North Sea), and I loved watching the crashing waves. After school, I began studying English and economics, but I wasn't happy with my choice. Between terms, I began looking for alternatives until I came across a course in physical oceanography at Hamburg University and realized that oceanography was what I wanted to do. For my master's, I looked at the seasonal variability within the East Greenland Current. In 2003, after my master's, my first post as a research assistant was with Klaus Peter Koltermann at the Federal Maritime and Hydrographic Agency (BSH) in Hamburg working on the CLIVAR (Climate Variability and Predictability) Marin-2 project. Using Argo float data, we investigated the exchanges and interactions between the North Atlantic subpolar and the subtropical gyres.

At the end of the project in 2005, I began PhD work in Rostock at the Leibniz Institute for Baltic Sea Research, with Eberhard Hagen. My studies focused on water mass exchanges and associated mixing processes in the Eastern Gotland Basin, which is the largest basin in the Baltic Sea with a permanent halocline. I also investigated changes in deepwater circulation with acoustic Doppler current profiler (ADCP) data and numerical model simulations. During my PhD studies, I was awarded a three-month research grant at the Sea Mammal Research Unit of St Andrews University, UK, studying pathways of the Southern Antarctic Circumpolar Front within the SEaOS (Southern Elephant Seals as Oceanographic Samplers) project, using hydrographic data collected by both southern elephant seals and Argo floats.

When my PhD funding ran out in 2009, I found a permanent position as an oceanographer/modeler at the Scottish Environment Protection Agency (SEPA) in Glasgow, UK. While working at SEPA, I continued to write up my dissertation and was awarded a PhD in 2012. At SEPA, I am part of the oceanography/meteorology unit, with very diverse tasks. I am primarily responsible for collecting ADCP and CTD data and looking after the instruments. I have been running our Delft 3D water quality model for the river Clyde, looking at changing oxygen levels. I also coordinated and carried out small internal research projects at the Clyde's tidal weir to investigate the influence of salt intrusions on the river. Furthermore, I assess fish farm applications.

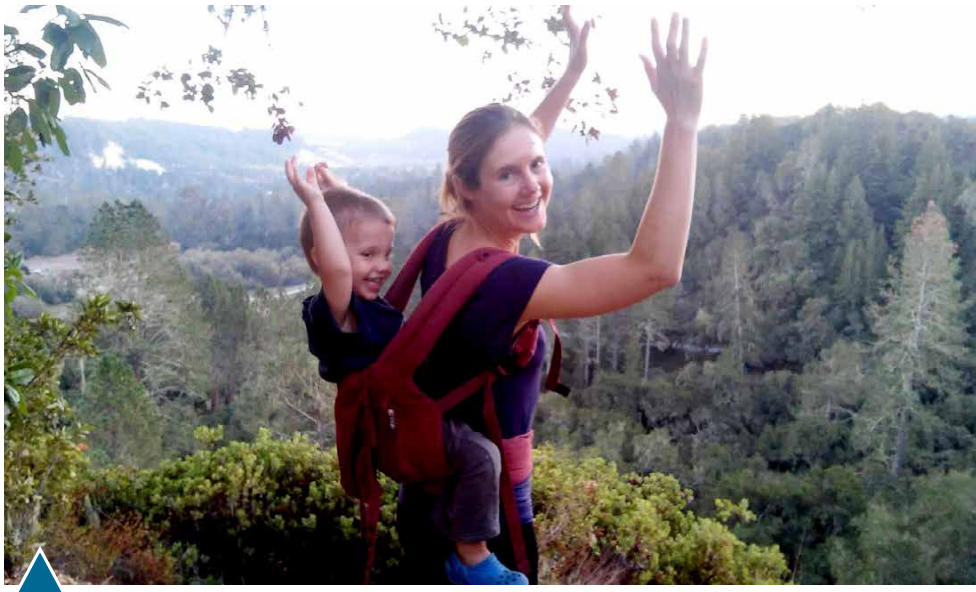
On a personal level, I am the only female member in our team, which seems normal to me. In all the places/teams I have worked to date, there were always fewer women than men. SEPA is very good to people with kids and family, but I am not married and don't have any kids myself. My second love (after the ocean) is the mountains, and I spend a lot of my free time walking and climbing with my partner and friends in the Scottish and European mountains.



Gunda Wieczorek on board the *Sir John Murray* looking at current meter measurements collected with the VM-ADCP.

Branwen Williams

Assistant Professor of Environmental Science, W.M. Keck Science Department, Claremont McKenna College, Pitzer College, and Scripps College, Claremont, CA, USA, bwilliams@keckscl.claremont.edu



Branwen and her son enjoying some time off while on sabbatical in Santa Cruz.

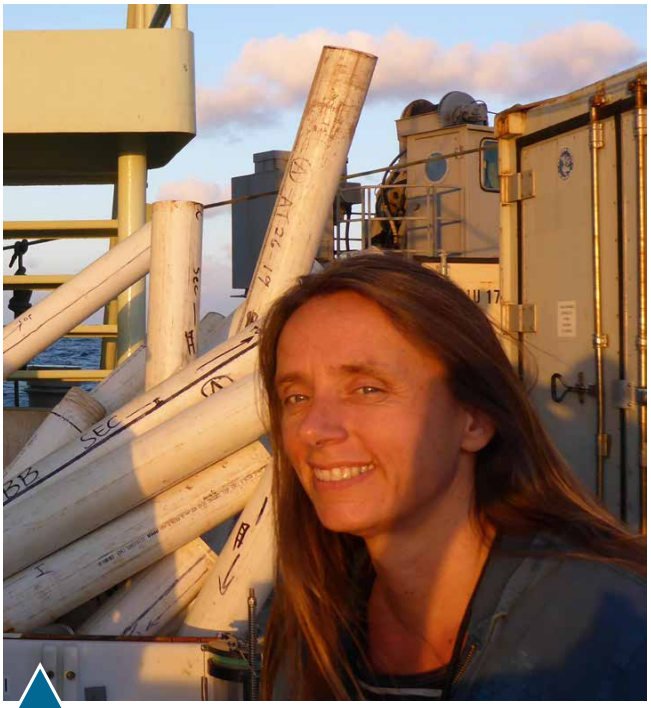
My love of the ocean first developed during a family vacation that took us from rural Ontario to Florida when I was 10 years old. Initially captivated by charismatic megafauna, I completed my bachelor of science degree at the University of Guelph, Canada, in marine and freshwater biology. During my BSc studies, I came to care about the health of the ocean, particularly the influence of human activities that were degrading it. This interest was spurred by research with Mike Risk. He introduced me to the geochemistry of deep-sea corals and taught me that measurements of their chemistry can trace changes in the ocean environment over time. Using records that I generated from deep-sea corals during my master's work at the University of Quebec at Montreal, I tracked the increase in land-based nutrients to the deep sea. For my PhD in geological sciences, my research shifted focus to changing oceanographic conditions in the western Pacific resulting from our warming atmosphere. My adviser, Andrea Grottoli, trained me to be an academic, once I realized that my dream job was to be a professor. I married my husband, Erik, during my PhD studies, and we had our first child a few months after I started my postdoctoral research at the University of Toronto. Now, I am a tenure-track scientist with two kids at a liberal arts college, in a position where teaching and research are both emphasized.

The most rewarding aspect of my career during my time as a student was fieldwork. From collecting corals as a diver using scuba in warm tropical waters to using a submersible in the dark, deep, cold ocean depths, the thrill of working outdoors constantly inspired and motivated me. Now, as a faculty member, I find the multifaceted nature of my job gratifying, particularly that no two days are the same. I benefit from the ability to focus my energy in pursuit of important research questions, specifically, understanding variability in our environment. I also get to decide how to run my classes to best educate undergraduates. It is very exciting that someday these undergraduate students may, in turn, become oceanographers.

Balancing my work with my personal life is a pleasure. I look forward to going to work every morning and am just as excited to leave at the end of the day to pick up my kids. In part, this works because I co-parent with my nonacademic husband. I think the greatest challenge is that I always want more time—time for my family and time for work, particularly my research program. This has led me, as a junior faculty member, to be very specific about activities that take me away from my family in order to ensure that I maximize the time I am at work to continue to build my career.

Gisela Winckler

Lamont Research Professor, Lamont-Doherty Earth Observatory, Columbia University, and Adjunct Professor, Department of Earth and Environmental Sciences, Columbia University, Palisades, NY, USA, winckler@ldeo.columbia.edu



On board R/V *Atlantis* in the Northeast Pacific in September 2014—back at sea after a 14-year hiatus.

Ten years? Really? It feels to me like a research cruise—it just started, but it also feels as though you have been on board forever…In 2004, I had just finished my postdoctoral fellowship at Lamont-Doherty Earth Observatory and been promoted to junior research scientist. I had just managed to get my first National Science Foundation proposal funded, and had a one-year-old baby. Ten years later, I still live in New York City and am still at the Lamont-Doherty Earth Observatory. Now, I'm a Lamont Research Professor and I teach undergraduates about the climate system. My husband and I now have two wonderful daughters (10 and six years old), and I spend my weekends on soccer pitches and baseball fields.

My planned two-year postdoctoral stint at Lamont has turned into a 13-year adventure. As for many of my peers, one of the biggest challenges of mapping out my career has been the "two-body problem." Throughout the past 10 years, my husband (who is also an Earth scientist at Lamont and teaches at Columbia) and I have thought a couple of times very seriously about moving back to Europe. We both had attractive offers for faculty positions in Norway, the UK, and Germany, but we decided to stay at Columbia. With the exception of the UK offer, the main challenge each time was the same—the limited understanding and appreciation for dual-career couples. The traditional academic system and mindset in Europe is moving on glacial time scales in adjusting to the reality that dual-career couples often represent a great opportunity for institutions and not a burden. Lamont is a competitive environment—but, more importantly, Lamont is a wonderful, intellectually amazing, vibrant place, and Lamont and Columbia have been great in supporting our dual-career situation, and giving both of us equivalent opportunities. Continuing our careers at Lamont has felt like the right choice for us.

Going to sea is still as fascinating as it was at the beginning of graduate school, even though the challenges now can be very different. Having cut back on longer field trips when our kids were little, I recently decided it was time to sail again and took advantage of an exciting opportunity to go on a cruise to the North Pacific. Just a few days into the cruise, my older daughter had an emergency appendectomy. It felt terrible to get an email from my very sick 10-year-old facing her first major surgery and not to be able to be there with her. But she and my husband handled the challenging situation amazingly, and everything turned out fine. Having faced this crisis, I am encouraged by my family and particularly my husband, who is my greatest source of support and who has been an amazing companion on this 13-year-plus adventure, to plan for future field work and cruises.

I am thrilled to see the many young women oceanographers in our field, but I also see so many of them opting out of the academic world during or soon after their postdocs. I don't have much sage advice; it is a struggle. The hurdles we face in advancing our careers may be subtler than in the past, and overt discrimination against women has receded. But negative impacts of institutional and individual prejudices remain tangible. Nonetheless, I hope that my experience, as well as that of many others, over the last 10 years indicates that women can have successful scientific careers, and also have rewarding personal (family) lives—without having super powers.

Karen Wishner

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A few months ago during a coffee break at a prestigious international meeting, I found myself chatting with five women colleagues I had known for many years, some since graduate school. I realized, in a reflective moment, that all of us had actually "made it" in our oceanographic research careers. We had survived the stresses and battles of the early days—graduate school, finding jobs, moving up the promotion and tenure ladder, dealing with university and departmental politics. Amazingly, we were still around and scientifically active—doing research, publishing papers, mentoring younger investigators, engaging in public outreach. There had been times when I almost left the field, in frustration at proposal or paper rejection or in anger at hostile academic situations. But here I was, at an intellectually stimulating meeting, appreciated by and comfortable with both new colleagues and long-term friends. It was a very positive and satisfying moment.

In the 10 years since I wrote my previous short biography for the 2005 "Women in Oceanography" issue, I have continued to do seagoing research. We had two cruises to the eastern tropical Pacific a few years ago to study oxygen minimum zone (OMZ) biology. I am especially proud of my 2013 paper on zooplankton distributions and the redistribution and layering of zooplankton biomass and trophic processes associated with the strong oxygen gradients at the upper and lower OMZ oxyclines. The changing depth of mesopelagic zooplankton biomass layers that follow a particular oxygen concentration has important implications for biogeochemical cycling, as climate change leads to the likely expansion of OMZs worldwide. This project was a collaborative effort, and the many discussions, publications, and presentations by all participants have been personally rewarding and have gained substantial recognition. I have co-chaired scientific sessions on OMZs at several recent international meetings and been invited as a keynote speaker to other events. Several of the students who received their PhDs as part of this project have gone on to faculty or research positions. The OMZ "theme" has been an important part of my research since the 1980s, and the friends and colleagues I have met and worked with along the way have been so essential to my own happiness and scientific success. Last summer, I was invited to be a co-mentor on the 2014 UNOLS chief scientist training cruise. It was very rewarding to help train junior colleagues to take over the leadership of future cruises and projects.

One piece of advice I would give to junior scientists is to take advantage of unexpected opportunities and serendipitous observations at sea. It is harder these days, with large complex seagoing projects and many people vying for limited wire time, but sometimes following up on a unique, intriguing observation may lead to big scientific rewards. The OMZ focus of my recent work developed from a serendipitous discovery during an *Alvin* cruise and the ability to redirect the entire dive plan on the last day on station to obtain samples and conduct experiments of a novel phenomenon.

Karen Wishner at sea during the 2014 UNOLS chief scientist training cruise. *Photo credit: Paul Suprenand*

Alexandra Z. Worden

Principal Investigator, Monterey Bay Aquarium Research Institute, Moss Landing, CA, USA, and Associate Professor Adjunct, University of California Santa Cruz, Santa Cruz, CA, USA, azworden@mbari.org

My lab investigates fundamental questions about the biology and regulation of unicellular photosynthetic eukaryotes and their roles in CO_2 uptake. We use a combination of traditional and novel genomic, evolutionary, and physiological studies to understand factors behind the distributions and functions of cultured and wild taxa. To this end, I also pursue technological innovations that advance oceanographic science.

I have enjoyed science from early on, not so much in school, but outside of it, thanks to my mother, who gave me books like *Botany Made Simple* and *Silent Spring* in elementary school, and always had the journal *Science* lying around. In college, I was interested in environmental engineering, but after taking "Fundamentals of Ecology" and realizing the dearth of knowledge on processes underlying natural systems, I instead immersed myself in the science of large systems (atmosphere, ocean). I planned to apply to chemical oceanography PhD programs, but something wasn't feeling quite right. Only after working as a technician in Penny Chisholm's lab at MIT did I realize that, for me, green life needed to be in the picture. I got hooked on phytoplankton in the smallest size fraction (picoplankton) and never looked back.

While my research passions center on mechanisms underlying organismal responses and interactions, teaching is also tremendously important to me as is each individual in my lab. Most rewarding are the light bulb moments with undergraduates and mentees when they experience the joy of discovery and understanding. I also love being at sea—it is an incredibly freeing place to focus on specific scientific questions.

Admittedly, the work-life balance discussion didn't strike a chord with me before having children. My partner and I both love our science, and (pre-children) were probably too accommodating of each other's careers. Now I often need to make very different choices than I would have prior to children, in order to be a truly present parent. This is a constant challenge because of external expectations, but in the end, my own expectations of what I should be capable of as a mother and as a scientist are the most serious to confront.

My girls talk a lot about "mama's ship." On this autumn day in 2014, they learned about deploying equipment, and they tested the captain's chair. *Photo credit: Todd Walsh ©2014 MBARI*

I am fortunate to have a partner willing to modify his career to support mine and not exhibit resentment about it. I am grateful for growing up with four exceptionally different but nerdy brothers, for MIT undergraduate professors and peers who didn't seem to notice gender during scholarly pursuits—and for having an inspirational female mentor early on, as well as supportive male PhD and postdoctoral advisors. These beginnings helped me gain solid footing and belief in my science while having fun with it.

Recently, the persistence of the leaky pipe has become glaringly obvious. At this stage, when my commitment to research has been questioned by less enlightened colleagues relating to family needs—for example, not going to sea—I am able to move on with confidence (it is surprising that some folks are, for instance, unaware of recommendations on breast feeding and how lactation works!). Nonetheless, I am disappointed and aware of how disparaging comments might affect those in earlier career stages. Independent of children, it is sometimes a struggle to be heard in a way that is true to what I feel is important scientifically, ethically, and societally (this is perhaps the case in any gender/generationally imbalanced department or field). I am excited for a time when there is a consistent plurality in types of successful scientists and more than a sprinkling of role models to inspire greater diversity and creativity.

Lindsay Lowe Worthington

Assistant Professor, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM, USA, lworthington@unm.edu

I am a marine geophysicist (though, sometimes I work on land, too) primarily interested in imaging faults below the seafloor and determining how these faults evolve with variable sediment input from nearby land sources. The interplay of different Earth systems fascinates me, and I enjoy thinking about how processes that occur on land can affect structures far away and deep beneath the ocean.

I always knew that I wanted to be a scientist when I grew up, and imagined life in a lab coat surrounded by lasers or test tubes. As an undergraduate at the University of California, Berkeley, I realized that, instead, I could join my love of science with my interest in the outdoors and the natural world by studying geology. My dissertation work at the University of Texas Institute for Geophysics allowed the opportunity to work in Alaska, both on land in the St. Elias Mountains and on a research cruise in the northern Gulf of Alaska.

The most rewarding thing about working in the ocean sciences, for me, is knowing I am one of the few people to get to see a particular subsurface structure for the very first time. I love the feeling of discovery and adventure. Also, in geology we are often looking at sediments and faults that are millions of years old, so there is an element of traveling through time and unraveling Earth's long history.

One of my greatest continuing challenges is balancing starting my career with starting and managing a family. Working in ocean and Earth science can involve a great deal of fieldwork, which takes time away from children and spouses. I am lucky to have a very supportive partner and an extended family to help run the household. I hope that, as they get older, my children will be proud of having a mother who gets to go on all these adventures for work, and I hope that they, in turn, will be inspired to follow their dreams. I am fortunate that life as an academic can be very flexible, so work can sometimes be planned around play groups or music classes. I have also been able to take advantage of university policies that encourage pursuit of family life, and I applaud the women and men who worked hard to put them in place. I am optimistic that the academic environment will continue to get friendlier for researchers with families.

I have also been blessed with many women role models and mentors who have inspired me with their dedication to excellence in the field and the classroom while still living a balanced life. I would like to encourage the next generation of scientists by showing them that you don't have to be a robot to be a successful academic. You can be a scientist and a mom—and even train for a triathalon on the side.

Lindsay as a shipboard scientist during Integrated Ocean Drilling Program Expedition 341 to the Gulf of Alaska in 2013. "I wrote my dissertation about faults in the sediments we collected, but previously had only seen them as 'wiggles' in seismic profiles. It was like meeting an old friend in person for the first time."

Şükran Yalçın Özdilek

Professor Doctor, Faculty of Science and Arts, Department of Biology, Çanakkale Onsekiz Mart University, Çanakkale, Turkey, syalcinozdilek@gmail.com

Ten years ego, I was an assistant professor at Mustafa Kemal University in southern Turkey. Because of difficulty with funding my fish biology research, I began to work on fish ecology instead, in particular, studying European eels, using my own money and with limited facilities. About that time, the survival of sea turtles became a hot topic. The lack of knowledge about sea turtle biology in my country led me to study this charismatic creature. Support from Sancar Ozaner of TUBITAK was a turning point for me and my students.

At that point, everything was going well in my life; however, my husband was not happy in his job. Hence, we decided to look elsewhere and moved to Çanakkale Onsekiz Mart University on the northern coast of Turkey. I was able to find a job on the education faculty because of my teaching experience, but it was difficult time for me. I felt that I lost three valuable years of my career, having to work on educational issues instead of sea turtles and fish ecology: I had no laboratory, no students, and no projects.

Science education was a new challenge for me because I had to learn new terminology—and I did. While carrying out educational studies with master's students, I assembled a file on my background and was promoted to associate professor. My goal, however, was to join the Biology Department, and in 2010, thanks to god, I was finally able to do so. There was strong competition for laboratory space and equipment in this department, so I started with limited working conditions. Another turning point in my career occurred when I was introduced to stable isotope analysis by Roger I. Jones of Jvaskyla University and was able to acquire enough funding to study the feeding ecology of fish using this method.

I currently study the freshwater ecology of fish, including the European eel. I have six ongoing projects with two PhD and six master's students. Laboratory conditions have improved, and I am a full professor. Though I faced many obstacles, including misunderstandings, gender bias, and lack of understanding, I never abandoned my dreams. However, I don't dwell on those challenging times. They were not important. The most important thing was my goal—to be a good scientist and to serve humanity and nature. I love nature and all of its components. If you love something enough, you are willing to do anything to pursue your passion, and this can be very powerful. My suggestion to young women is: never give up your dreams even though you may face difficult challenges. If you love your job, swallow your pride, and never stop pursuing your goals, success will be waiting for you.

Margaret Yelland

Principal Investigator, National Oceanography Centre, Southampton, UK, mjy@noc.ac.uk

I did my first degree in physics at Imperial College, London. I wanted to work in the environmental sciences and was keen to work for the British Antarctic Survey, but in those days (late 1980s), women were not allowed to over-winter in the Antarctic. Instead, I began work on a short-term contract at the Institute of Oceanographic Sciences in Wormley. The Institute moved to Southampton in the mid 1990s and became the National Oceanography Centre (NOC). I am now a Principal Investigator at NOC, and I am still pursuing the same research area that I began 25 years ago, that is, understanding the physics of how the atmosphere and ocean exchange momentum, heat, moisture, CO_2, and other constituents. The work involves making measurements at sea, using instruments that are mounted on the ship's foremast. To get the largest signals, we deliberately take a ship to windy regions, such as the Southern Ocean or the North Atlantic. Despite the bad weather, I absolutely love being at sea—it is a different world in so many ways.

The physics team (aka the "Valkyries") on *RRS James Clark Ross* in the Southern Ocean during November/December 2011. Margaret Yelland is third from the right.

I have worked on many different ships and have lost count of the number of research cruises that I have participated in, but they have covered the full length of the Atlantic and the width of the Indian Ocean. I have been privileged to do two long trips to the Arctic (polar bears!) and have had five trips to the Antarctic (albatross!). Being the Principal Scientist on the Antarctic cruises was particularly satisfying because they took place on a British Antarctic Survey ship.

Many things have changed since I began work. Twenty-five years ago, people assumed that I was my boss's secretary or his daughter. At sea, I was often the only woman on the ship. On one occasion, I was leading a very short (36 hours) instrument trial on a small navy support vessel and was told that I could not possibly go on the trial because the boat "had no facilities for women": the facilities for my male colleagues were simply sleeping bags under the mess table. With the support of my colleagues, I went on the trial and slept under the table alongside them.

These days, it would be unimaginable to be the only woman on a research ship. In 2011, I was particularly pleased to put together a small physics team for one of the Antarctic cruises that consisted of six women and just one man (see photo). Some of the women had not been to sea for some years while their children were very young: their excitement and enthusiasm at returning to sea made that cruise particularly enjoyable and hugely successful. In another advance, NOC recently appointed the UK's first female captain of a research ship (*RRS Discovery*).

Times are definitely changing for the better, but there is still a long way to go. At my institute, there are very few women of my seniority, and only one of them (not me) has children.

Xiaojun Yuan

Lamont Research Professor, Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY, USA, xyuan@ldeo.columbia.edu

When I was in high school, I was curious about the mysteries of the ocean and attracted to the beauty of tropical fish in the coral reef. Consequently, oceanography became my first choice for college. I completed a bachelor's degree in physical oceanography at Shangdon College of Oceanography, China, in 1982. After spending four years at the National Research Center for Environmental Forecast in Beijing, I came to the United States to work with Jerome Namias at Scripps Institution of Oceanography. We studied the persistence of sea surface temperature anomalies in the North Pacific and its influence on the climate variability of the Northern Hemisphere. A year later, I enrolled in the PhD program at Scripps under the supervision of Lynne Talley. I investigated oceanic fronts in the North Pacific using historical conductivity-temperature-depth (CTD) measurements together with surface fluxes. Upon completing my PhD in 1994, I moved to New York and started postdoctoral studies with Doug Martinson at Lamont-Doherty Earth Observatory of Columbia University. I then focused on Antarctic sea ice and its relationships with global climate.

My career path included promotion to Doherty Associate Research Scientist in 1998, Doherty Research Scientist in 2004, and Lamont Research Professor in 2013. Currently, I conduct a broad range of studies in polar regions. I have investigated Antarctic sea ice and its relationships with regional climate modes and remote forcing. My studies have identified a major climate mode, the Antarctic Dipole, in the atmosphere-ocean-sea ice system of the Southern Ocean and established its connection with El Niño–Southern Oscillation (ENSO) variability through diagnostic analyses and mechanistic studies. I also maintained long-term collaborative research activities with Chinese scientists, including carrying out a decade (1998–2008) of ship-of-opportunity sampling programs in the Southern Ocean with colleagues from the Polar Research Institute of China.

Xiaojun Yuan in the Amundsen Sea, Antarctica, in 2008.

Currently, I am the lead principal investigator of a US/Chinese collaborative program that is studying bottom water formation in Prydz Bay, Southern Indian Ocean. The team began with scientists from Lamont, First Institute of Oceanography (China), and Ocean University of China, and it has now expanded to include scientists from North Carolina State University and from Niels Bohr Institute, Denmark. I collaborated with Dake Chen (currently at the Second Institute of Oceanography, China) to develop the first generation Antarctic sea ice forecast model in 2004, and we are now expanding sea ice prediction to the Arctic.

The greatest challenge in my life is balancing career and family. As mother of two children, Thomas and Amy, and wife to Kaiyuan Zhang, family responsibilities can sometimes conflict with my job, particularly when I need to go to sea and travel to meetings. After years of juggling these two jobs, I sincerely appreciate the flexibility provided by this unique career. I enjoy working on my laptop outside my daughter's music lesson room or on the bleachers during my son's swim competition as much as working in my office or meeting with world renowned scientists at international conferences. Life is full of challenges and excitement.

LDEO contribution number 7857.

Patrizia Ziveri

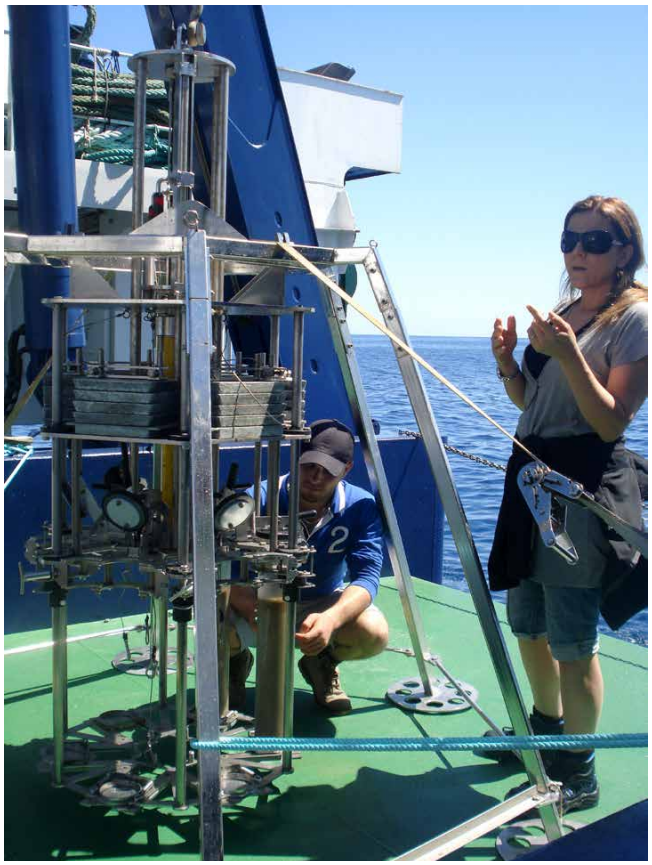
Research Professor, Catalan Institution for Research and Advanced Studies (ICREA), and Institute of Environmental Science and Technology, Universitat Autónomoma de Barcelona (UAB), Bellaterra, Barcelona, Catalunya, Spain, patrizia.ziveri@uab.cat

When I wrote my short biography 10 years ago, I was working at the Vrije Universiteit of Amsterdam (VU) as a senior researcher/associate professor, and I had one small child. Now, I am a research professor at the Universitat Autonoma de Barcelona at the Institute of Environmental Science and Technology, and I have two kids.

In recent years, my main research has evolved from planktonic calcifiers and their roles in marine biogeochemistry and climate and as paleoceanographic proxies to greater concentration on studies of anthropogenic CO_2 as a global driver of ocean warming, ocean acidification, and de-oxygenation, and how these changes are affecting marine life. My recent work has focused on the Southern and North Atlantic Oceans and the Mediterranean Sea. From 2011 to 2014, I was coordinator of a highly multidisciplinary European consortium on "Mediterranean Sea Acidification in a changing climate" (MedSeA, http://medsea-project.eu). The program's goal is to assess uncertainties, risks, and thresholds related to Mediterranean Sea acidification and warming at organism, ecosystem, and economic scales. In 2013, I was chief scientist of the first Mediterranean research cruise to study basin-wide impacts of elevated CO_2 on marine biogeochemistry and on potentially sensitive organisms.

Balancing career and personal life remains a challenge; however, when I became a mom, it was very clear that the kids had absolute priority. I have continued to do what I felt was right in this regard. Over the last several years, I have had intense work-related travel, which was not always easy. When my kids were very small, I used to travel with them. I believe that academia should get more used to motherhood and accept that during the first year of a child's life, it is almost unnatural for mother and child to be separated. I have always tried to reduce the number of days and nights away and to work hard to reduce the time apart, with significant help from my husband and extended family.

In European laboratories, there are still marked differences in how women in science (particularly those who are mothers) are perceived and supported. Though I see our world slowly changing, many mothers still have to choose between career and family.



The advice that I can provide to young women oceanographers is to maintain a strong sense of independence and to not give up. Help to make the changes that we would like to see and possibly even initiate and support important "women-friendly" options, including flexible working hours, allowing children in the office/university environment, and availability of daycare facilities on campus.

In countries like Italy (where I am from), in the Netherlands (where I worked for several years), and in Spain (where I live now), the general lifestyle is very family-oriented, but there is still too little effort made to support young women pursuing scientific careers. Improving conditions in these important aspects would encourage more women to travel farther in their scientific trajectories.

Integrated Ocean Drilling Program Expedition 336 in 2011 had one of the largest groups of female participants the program's history. FRONT ROW (L-R): Margaret Hastedt, Yumiko Harigane, Katrina Edwards, Lisa Crowder, Beth Orcutt. MIDDLE ROW (L-R): Louise Anderson, Victoria Rennie, Tania Lado Insua, Kristin Hillis, Kasumi Sakata, Hisako Hirayama. BACK ROW (L-R): Jennifer Magnusson, Gemma Barrett, Alyssa Stephens, Fengping Wang, Lisa Brandt, Amanda Haddad. *Photo credit: William Crawford, Texas A&M University*

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