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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.

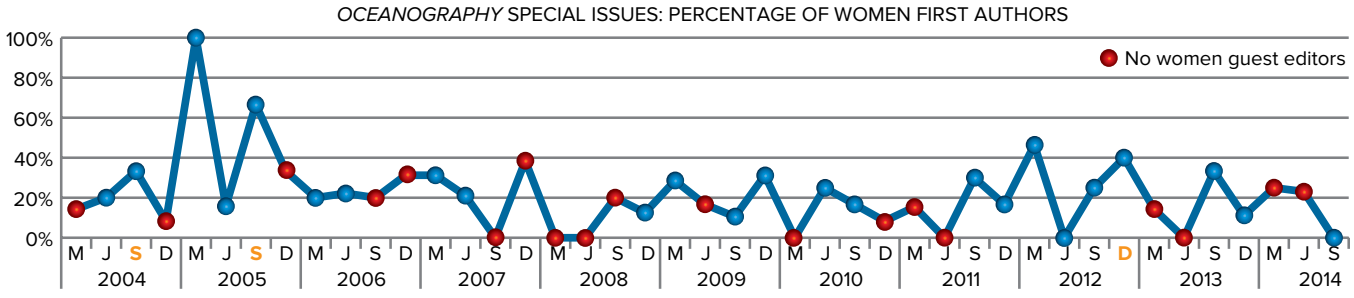

Figure 1. A decade of *Oceanography* special issue authorship as percentage of women first authors. The March 2005 issue that shows 100% women authorship was the previous special issue on "Women in Oceanography." The three issues that did not have a special issue section and were a mix of invited and 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

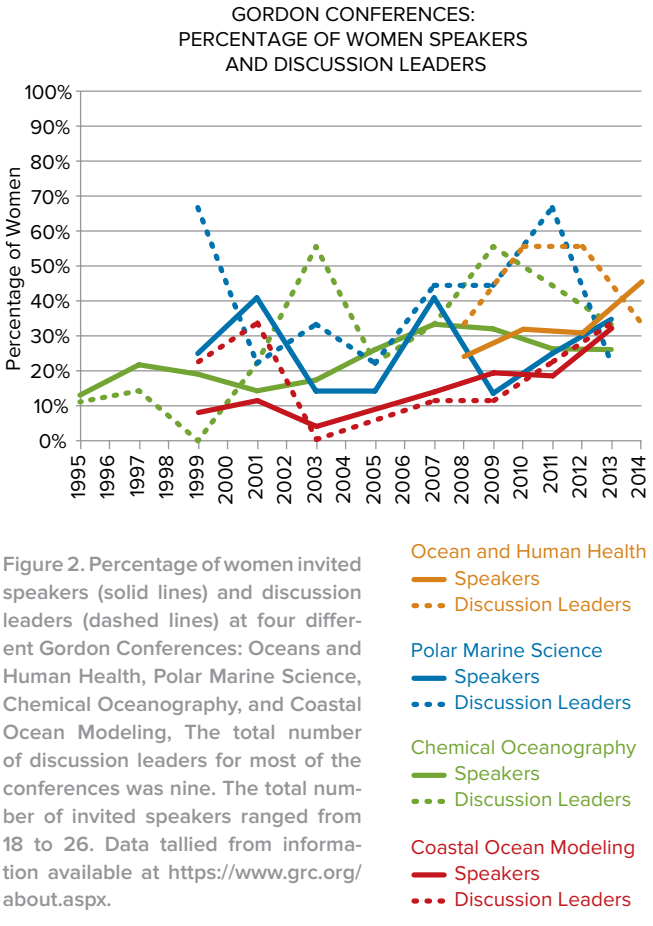

Figure 2. Percentage of women invited speakers (solid lines) and discussion leaders (dashed lines) at four different Gordon Conferences: Oceans and Human Health, Polar Marine Science, Chemical Oceanography, and Coastal Ocean Modeling, The total number of discussion leaders for most of the conferences 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,

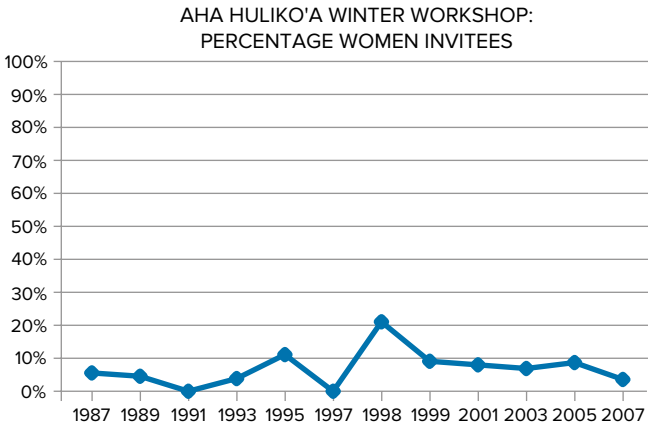

Figure 3. Percentage of women invited to participate in the Aha Huliko'a conferences, which covered specialized physical oceanography topics. Total number of participants in each conference ranged from 18 to 33. Data were tallied from the Aha Huliko'a website, http://www.soest.hawaii.edu/PubServices/AhaHulikoa.html.

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.

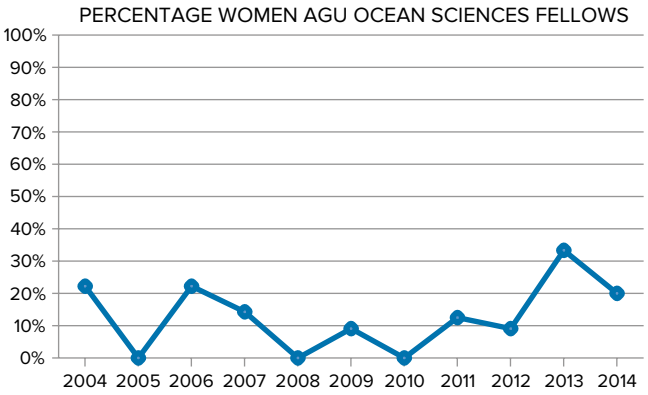

Figure 4. Percentage of women elected Fellows of the American Geophysical Union (AGU) in the Ocean Sciences section. Data for 2004–2010 from http://oceans.agu.org/honors. Data from 2011–2104 are the Fellows elected by the Ocean Sciences section, as provided to the authors by AGU for this study. Prior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

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