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Addressing the Gender Gap in Distinguished Speakers at Professional Ecology Conferences

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Keynote and plenary speakers at professional conferences serve as highly visible role models for early-career scientists and provide recognition of scientific excellence. This recognition may be particularly important for women, who are underrepresented in senior positions in the biological sciences. To evaluate whether conferences fulfill this potential, we examined distinguished speakers at North American ecology conferences between 2000 and 2015 and compared these data with the percentage of women ecologists at diverse career stages. We found that 15%–35% ($\bar{x} = 28\%$, $n = 809$) of the distinguished speakers were women, which is significantly lower than the percentage of female ecology graduate students ($\bar{x} = 55\%$, $n = 26,802$) but consistent with the percentage of women in assistant- and associate-faculty positions. We recommend that conference organizers institute policies to enhance speaker gender balance, to provide support for speakers with family responsibilities, and to actively monitor gender-related trends in their societies to achieve the equitable representation of women in distinguished speaking roles.

Keywords: gender balance, plenary speaker, role model, women in science, career advancement

Distinguished speakers and the gender gap in ecology

Despite recent increases in the number of female students pursuing careers in science, women remain poorly represented in the biological sciences at the level of full professor or senior research scientist (Nelson and Rogers 2005, Hill et al. 2010). This imbalance has negative consequences for the field given the evidence that mixed-gender groups of scientists conduct higher-quality research and produce more well-received publications (Campbell et al. 2013). The underrepresentation of women in senior positions relative to in earlier career stages is frequently referred to as the “leaky pipeline” (Pell 1996). Previous investigators have suggested that women in science are disadvantaged by institutional barriers (Schroeder et al. 2013) and by both explicit and implicit biases (Steinpreis et al. 1999, Moss-Racusin et al. 2012). For example, childbearing years often correspond with the time frame in which biologists must be highly productive to compete for limited jobs (Adamo 2013); therefore, women with children may be hindered in this academic tenure system (Ceci et al. 2009).

Increasingly, inadequate mentoring and a lack of role models are also recognized as important factors contributing

to gender imbalances in the sciences (Downing et al. 2005, Casadevall and Handelsman 2014, Martin LJ 2014). For example, over 90% of female undergraduate science majors at three liberal arts colleges identified a female role model or mentor as an important driver of their decision to pursue a career in science (Downing et al. 2005). Although both men and women can be excellent mentors, there is evidence that female role models on average are more effective than male role models at retaining women in scientific fields (Drury et al. 2011). Furthermore, exposure to successful female role models can boost both academic performance and the self-evaluation of success-related traits (Lockwood 2006) and could be especially important in combatting the “impostor phenomenon,” in which women in science, technology, engineering, and mathematics (STEM) doubt their ability to perform well (Stout et al. 2011).

As a group of early-career ecologists, we chose to examine the gender gap in ecology, a subfield of the biological sciences that has seen recent improvements and achievements in gender equality (McGuire et al. 2012) but continues to experience issues with pay gaps and the underrepresentation of women in top positions (Lawrence et al. 1993, Damschen

et al. 2005). We became interested in the prevalence of female role models in ecology after observing trends in the invited ecologist speaker series at our institution. During recent years (2010–2015), only 4 of the 19 (21.1%) speakers were women. On the basis of this observation, we expected that gender ratio patterns of invited plenary and keynote speakers at national professional conferences may also be skewed toward male ecologists. These meetings provide a platform for many undergraduate and graduate students and early-career scientists to listen to and interact with highly acclaimed scientists. In addition, content from plenary talks is publicized through social media far more frequently than that from any other conference session type (Bombaci et al. 2015), amplifying the potential impact of distinguished speakers at professional conferences. Besides the important acclaim plenary speakers themselves receive, male and female scientists in these highly visible speaking roles have great potential for modeling success to early-career ecologists.

Our objective was to assess the gender ratio of plenary and keynote speakers (henceforth *distinguished speakers*) at ecological conferences in North America (the United States, Canada, and Mexico) and to investigate the factors that influenced speaker gender ratios. Specifically, we quantified the percentage of female distinguished speakers relative to the percentage of female ecologists at several career stages, and we evaluated how characteristics of speakers and their institutions influenced the probability that a distinguished speaker would be a woman in order to provide insight for strategies to combat gender inequality. We predicted that (a) the representation of women in distinguished-speaker roles at ecological conferences would be lower relative to that of ecology graduate students and faculty but would increase over time and (b) speaker characteristics such as career stage, field of expertise, and institution type would strongly correlate with the probability that a distinguished speaker was a woman.

Approach

We generated a list of annual conferences in North America with a disciplinary focus on ecology or a subfield in ecology that listed distinguished speakers on their program (supplemental appendices S1 and S2). From the conferences that met our criteria, we collected publicly available conference programs from 2000 to 2015. We categorized each speaker on the basis of their gender (represented by pronouns used in their biography in the conference program or publicly available information online), their field of expertise, the type of institution (e.g., academia or government agency) they represented at the time of their presentation, and their career stage. Career stages were defined as follows: *Early-career professionals* were speakers with titles that included “assistant” or “junior” or those with 0–7 years of postdoctoral experience. *Midcareer professionals* were speakers with titles that included “associate” or those with 8–14 years of postdoctoral experience. *Late-career professionals* were

speakers with titles that included “full,” “director,” or “senior” or those with more than 15 years of postdoctoral experience. We also categorized presentation types as *keynote*, *plenary*, or *plenary panel moderator or member*.

To examine temporal trends in gender representation in academia, we collected information on the percentage of female graduate students enrolled in ecology programs in the United States from 2000 to 2013 (NSF 2013). To collect gender information for ecology faculty in assistant-, associate-, and full-professor roles in 2015, we looked at 36 department or program websites at US universities, which we randomly selected from the *Chronicle of Higher Education’s* (2010) list of doctoral programs in ecology and evolutionary biology (supplemental appendix S3).

We tested the prediction that individual or institutional characteristics (i.e., career stage, field of expertise, and institution type) influenced the probability that a distinguished speaker was female. Our response variable was a binary indicator of whether a speaker was female (1) or male (0). Therefore, to assess the influence of each predictor variable, we used a logistic regression model to estimate the probability of a distinguished speaker being female as a function of varying career stages, fields of expertise, and institution types. We also included a random effect (Gelman and Hill 2006) for the host professional society. To assess the influence of each level of the hypothesized predictors, we evaluated the direction and significance of each model coefficient.

The gender gap in distinguished speakers is consistent with the leaky-pipeline syndrome

Over the 15-year period from 2000 to 2015, women constituted only 15%–35% of distinguished speakers ($\bar{x} = 28\%$, $n = 809$) at North American ecology conferences ($n = 221$), with no consistent pattern of increasing female representation over time (figure 1, mean percentage across all years = 28.1%, SE = 1.6%, $\beta = 0.006$, 95% confidence intervals [CI] = -0.001 to 0.013). However, from 2000 to 2013, the percentage of female graduate students in ecology programs in the United States has remained above 50% ($\bar{x} = 55\%$, $n = 26,802$; NSF 2013). Our assessment of academic faculty in 36 ecology departments or groups across US universities in 2015 reveals underrepresentation of women at all professional levels, including assistant, associate, and full professor. Women made up approximately 30% of the faculty in our sample ($n = 1082$), and female representation was lowest at the level of full professor ($\bar{x} = 25\%$, $n = 551$; figure 2). The percentage of women distinguished speakers at ecology conferences in 2015 was approximately 35% ($n = 62$), which is similar to female representation at the assistant- and associate-professor levels in this year but significantly higher than female representation at the full-professor level (figure 2).

The gender ratio varies with individual and institutional characteristics

Gender representation varied with respect to the 16 sub-disciplines of ecology associated with the conferences we

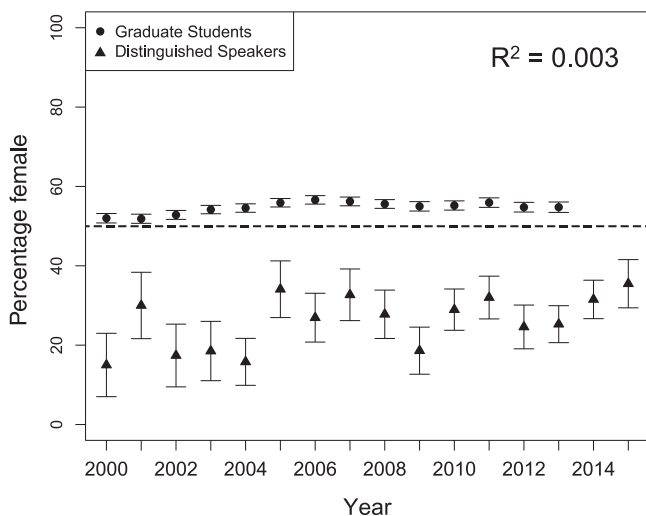


Figure 1. The percentage of female distinguished speakers at ecology conferences from 2000 to 2015 (triangles; data derived from conference data) and the percentage of female ecology graduate students from 2000 to 2013 (circles; data derived from the NSF/NIH graduate data set). R^2 indicates the percentage of variance in female speakers explained by variation over years. The error bars represent the standard error. The dashed line is drawn at 0.50.

assessed (appendix S1). Conferences associated with the subfields of animal behavior and restoration ecology had the highest female distinguished-speaker representation, with 42% and 40% women, respectively. The conference subfields with the lowest female distinguished-speaker representation included herpetology, ichthyology, entomology, landscape ecology, and range management, each with less than 20% women distinguished speakers.

Distinguished-speaker characteristics related to career stage and institution type were important predictors of the gender ratios in our data set, whereas field of expertise had less influence. Late career stages had a significant negative relationship with the probability of a distinguished speaker being female ($\beta = -1.066$, 95% CI = -1.636 to -0.495) relative to early career stages, and working in the private sector also had a significant negative relationship ($\beta = -1.096$, 95% CI = -2.016 to 0.175) relative to academia. Only 24% of the speakers in late career stages and 19% of speakers from private-sector institutions were women (appendix S1). Thirty-four percent of the distinguished speakers associated with nongovernmental organizations (NGOs), zoos, aquaria, and museums were women. Women constituted 29% of the speakers from academic institutions and 24% of the speakers from government agencies. The distinguished speakers were also less likely to be women if they specialized in the life and physical sciences (44% probability), but this trend was only marginally significant (90% confidence level; supplemental appendix S4). The gender ratios were relatively even for the distinguished speakers from the social sciences (49%

female) and the arts and humanities (45% female). The distinguished speakers in the life and physical sciences and in policy fields comprised 27% and 26% women, respectively. The random effect, which corresponded to the professional society that organized each conference ($n = 25$), explained about 10% of the variance in our regression model.

Achieving gender equity among distinguished speakers: Recommendations for research and practice

Distinguished talks at large conferences can elevate the careers of speakers, as well as providing important role models for early-career ecologists. Maintaining gender balance among speakers could also increase productivity by catalyzing an exchange of ideas among a broader and more diverse pool of scientists (Campbell et al. 2013). We found that the percentage of female distinguished speakers at ecology conferences was approximately equivalent to the percentage of women in early- and midlevel academic positions. However, the distinguished-speaker gender ratios were far from balanced and were not representative of the ecology graduate-student population. These results reinforce documented gender gaps in ecology (Martin LJ 2012) and emphasize the need to increase the representation of women as distinguished speakers who can serve as role models to aspiring female ecologists. Several studies of conference-speaker gender ratios in other STEM fields revealed similar patterns: A mathematics conference documented that 25.6% of the invited speakers were female (Martin G 2015), women constituted 25% to 43% of the invited speakers in a series of microbiology meetings (Casadevall and Handelsman 2014), and approximately 25% of the plenary speakers at a 2011 evolutionary biology conference were women (Schroeder et al. 2013). Our results also reflect patterns of other types of professional recognition. For example, men receive a higher proportion of awards and prizes for STEM scholarly research relative to their representation in the nomination pool (Lincoln et al. 2012, Cadwalader et al. 2014).

There are factors that we were not able to measure that may play an important role in explaining the mechanisms behind gender ratios of distinguished speakers. Although it was beyond the scope of this article to examine how implicit bias affected the distinguished-speaker selection process, there is evidence that unconscious devaluation of women is widespread (e.g., Kaatz et al. 2014, Reuben et al. 2014), and the link between implicit bias and professional opportunities, such as speaking roles, should be investigated further. Other important factors include the gender ratios of invited speakers relative to confirmed speakers (e.g., women may disproportionately decline invitations to speak; Schroeder et al. 2013) and the speaker selection processes, which may vary among professional societies or individual conferences (e.g., some societies or organizing committees may have explicit guidelines in their bylaws to achieve gender equity among distinguished speakers). Furthermore, although we were unable to examine the race and ethnicity, sexual

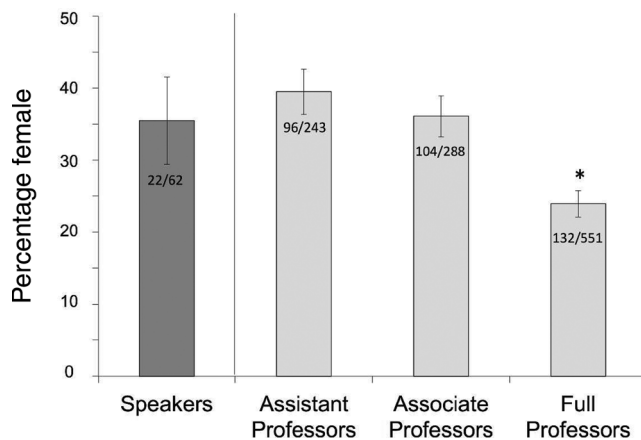


Figure 2. The percentage of female distinguished speakers at ecology conferences in 2015 (the dark gray bar indicates data derived from the conference data set) and the percentage of women at different professional levels in ecology careers at academic institutions in 2015 (the light gray bars indicate data derived from the academic status data set). The vertical line divides the separate data sets. The asterisk indicates that the percentage significantly differs from the percentage of distinguished speakers ($p < .05$; two-sample z-test of difference between proportions). The error bars represent the standard error.

identity, and physical or cognitive disabilities of the speakers, increasing diversity and inclusion beyond gender at ecology conferences are crucially important and should be a priority for future research and action. Finally, we were limited to the binary pronouns used by speakers and conference materials to determine gender, leaving us unable to explore other aspects of gender identity in this research.

We propose a suite of strategies for closing the gender gap among distinguished speakers at professional conferences. First, professional societies could institute policies requiring gender equality in distinguished-speaking roles. Several professional conferences outside the field of ecology (e.g., the Lorne Conference on Protein Structure and Function) have implemented this strategy and have made these policies and their results publically available (www.lorneproteins.org/policies). Although the efficacy of such policies remains unexplored, societies could implement similar policies and take steps to evaluate success. Second, conference organizers should consider taking measures to accommodate women with family responsibilities that might limit attendance and participation, such as providing onsite childcare and reimbursing distinguished speakers for other family obligations, such as the care of elderly or disabled dependents (Martin LJ 2014). A third strategy for achieving gender equality at conferences could be to include greater representation of women on selection committees (Martin LJ 2014). Although some research suggests that women are equally likely to exhibit gender bias against women (Moss-Racusin et al. 2012), other research suggests that this strategy can increase

the number of invited female speakers (Casadevall and Handelsman 2014, Sardelis and Drew 2016). Some professional societies are beginning to conduct their own internal research on gender-related trends in conference participation (e.g., the American Society of Mammologists), which may elucidate achievements and further opportunities for improvement (Martin LJ 2014).

Increasing the number of female distinguished speakers at professional conferences will not resolve all gender inequities in ecology, because there are many factors that contribute to this shortcoming (Blickenstaff 2005). However, evidence suggests female role models are important for women at early-career stages (Downing et al. 2005, Drury et al. 2011), and public recognition of scientific excellence is important at all career stages (Cole and Cole 1968). Encouragingly, female distinguished speakers in ecology are now proportional to the early- and midcareer faculty pool in the United States, but speaker gender ratios remain far less than 50% for most subdisciplines, with no improvement over the past 15 years. The lack of change over time suggests that collectively, professional ecological societies have fallen short of addressing gender disparity as awareness of this issue has grown. To help patch the leaky pipeline in institutions that train and mentor ecology professionals, we recommend that conferences adopt strategies with the explicit objective of increasing the number of women in distinguished-speaking roles.

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Supplemental material

Supplementary data are available at *BIOSCI* online.

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