SHORT COMMUNICATION

Is there gender bias in reviewer selection and publication success rates for the *New Zealand Journal of Ecology*?

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Abstract: Gender bias in the sciences is a prominent issue. Evidence suggests that more equal involvement of women in science, technology, engineering and mathematics fields leads to a diversity of working styles that can contribute to multiple measures of workplace success, such as better student outcomes in university settings and improved managerial approaches. One of the main ways we can combat gender bias is by increasing awareness. Thus, to directly draw attention to this issue for New Zealand ecologists, we performed a gender analysis of the publication process in the *New Zealand Journal of Ecology* (*NZJE*) for manuscripts reviewed between 2003 and 2012. First, we compared the frequencies of publication success between female and male authors. Second, we compared the frequencies of female and male reviewers selected by both female and male associate editors on the journal's editorial board from 2010 to 2012. Results show that publication success was not biased by gender, nor was it related to the gender of the editor. However, editors selected more male reviewers and this pattern was slightly more pronounced for male editors, suggesting that there is potential for at least some associate editors to reduce gender bias in their reviewer selections. We believe this will become easier with the development of the new reviewer database and mentoring scheme recently launched by the *NZJE*. It is important that publication of ecological research in New Zealand is unbiased so that the growing numbers of women in this field are not disadvantaged, and our results show that the *NZJE* is doing a good job at this. However, it is also important that women's contributions to the field are encouraged and recognised. We believe that reviewer selection is one way to enhance this and we strongly encourage early-career female ecologists to enrol in the *NZJE* mentoring scheme.

Keywords: authorship; discrimination; editorial bias; sexism; women in science

Introduction

Fostering diversity in the sciences is imperative. The nature of the discipline requires that problems and questions be challenged with multiple perspectives, which requires a variety of scientists with diverse backgrounds and experience. Despite the intrinsic need for diversification, as well as the establishment of initiatives to increase gender and race diversity in science, technology, engineering and mathematics (STEM) fields, there are still vast disparities in the representation of women and other minorities in STEM fields (Larivière et al. 2013; Shen 2013).

Though women play an invaluable role in science and the workplace, inequalities between women and men exist for a variety of success measures including representation, salaries, publication rates, promotions and seniority (Symonds et al. 2006; Ledin et al. 2007; Burrelli 2008; Dunstone & Williamson 2012; Larivière et al. 2013). Gender bias against women is consistent within the STEM disciplines. Nearly half of STEM PhDs in the United States are currently held by women (49.5% across all STEM fields and 52.9% in biological sciences; National Science Foundation 2013). However, the dramatic attrition of women after obtaining a PhD or postdoctoral fellowship in science results in women representing only 20% of full professor positions in the United States (Shen 2013) and 18% in Europe (Vernos 2013). Although some institutions around the world have set hiring quotas for women in science, females remain significantly under-represented. According to the US Census Bureau report (Landivar 2013), men are hired into STEM occupations at twice the rate of women and 20% of recent female graduates are out of the labour force compared with only 10% of recent male graduates. In 2009, the US census revealed that while women represented almost half of the work force across all jobs (48% women, 52% men), they only made up 25% of the work force in science-related jobs (Beede et al. 2011). Those women who do hold a STEM position on average earn 14% less than their male counterparts (Beede et al. 2011).

The importance of supporting the presence of women in higher ranked positions in science has recently become increasingly studied, published on, and talked about in the workplace (e.g. see http://www.nature.com/news/specials/

women/index.html). Women offer unique perspectives in the exploration of scientific topics. Furthermore, the presence of women in the workplace has been shown to improve managerial style and generosity (Dahl et al. 2012), influence thinking in organisations (Dezsö & Ross 2012), and improve outcomes for students and workplaces by filling mentor roles (Denmark & Klara 2010). With increasing numbers of female undergraduates (Snyder & Dillow 2012) and women in the workplace (Beede et al. 2011) is it important that women in higher positions of science be available to serve as role models and mentors to increase the success of female students and employees (Chesler & Chesler 2002).

Science in New Zealand is no exception to the global gender bias patterns. For example, we tallied the genders of 110 ecologists across New Zealand universities in 2013 and observed that only 30 (27%) were women. According to the New Zealand Ecological Society (www.newzealandecology.org), only a very small proportion of invited speakers at the society's annual meetings or senior award recipients are women (between 2003 and 2012, only 10 out of 41 invited speakers were women), despite a large majority of student awards for papers, posters and talks being awarded to women. Since being recorded in the 1990s, 77% of the 'best student presentation' awards, 72% of 'best student poster' awards, and 64% of 'best paper by a new researcher' awards went to women. In contrast, over the same period, only 11% of the more prestigious awards for ecological excellence went to women. The 2010 New Zealand Census of Women's Participation (New Zealand Human Rights Commission 2010[1]) also reveals stark gender bias across a range of fields. For example, only c. 22% of university professors and associate professors were women. In addition, the gender pay gap in New Zealand STEM fields was determined to be greater than that in the United States, at c. 15%, and only 9% of company directors in New Zealand were women. This bias extends beyond hire and pay discrepancies. For example, in 2010, of the number of fellowships awarded by the Royal Society that we tallied, fewer than 10% were awarded to women (www.royalsociety.org.nz).

Reasons for gender bias patterns have been offered in a multitude of publications and reports (see review by Ceci & Williams 2011) and it is argued that one of the main causes is subtle, unconscious bias by men and women alike (for ecology-specific examples, see Holt & Webb 2007; McGuire et al. 2012; Cameron et al. 2013). An experiment conducted by Moss-Raucusin et al. (2012) showed that both male and female faculty members rated female students as less hirable, less competent, and less deserving of pay and mentorship. Knobloch-Westerwick et al. (2013) expanded on empirical work by examining the perception of research quality on the basis of the gender of the work's author and the research topic. They used 'role congruity theory' and a survey of 243 participants to show how scientist attributes associated with men are more mathematical and objective ('hard' science), while those associated with women are more communal and humanities-based ('soft' science). Therefore, the perception of the quality of work is dependent on the interaction of the research topic and the gender of the author. For example, a 'hard' science topic researched by a woman was ranked lower in quality than a 'soft' science topic. An important finding of this work is that gender bias against women was more pronounced in men who held more traditional, senior roles, stressing the importance of supporting more women to hold those higher science positions.

Since higher scientific positions are primarily held by men, it is likely that there are more male journal editors (see Gilbert et al. 1994; Grod et al. 2008). If these men tend to rank the quality of women's research as lower in STEM fields, then it would be reasonable to conclude that there should be gender bias in manuscript acceptance rates in favour of male authors. This hypothesis has been examined and debated fervently. Budden et al. (2008b) concluded that gender bias results in lower publication rates for women. They found that after a double-blind review process (both author and reviewer names are withheld) was established for a journal that previously used a single-blind review (where only the reviewer name is withheld), the success rate for women increased. However, this finding was directly challenged by several authors because similar changes occurred in the same period for journals that kept using a single-blind review system (Hammerschmidt et al. 2008; Webb et al. 2008; Whittaker 2008). Indeed, multiple examinations have revealed no gender bias in the success rate of female first authors compared with male (Tregenza 2002; De Vries et al. 2009; Valkonen & Brooks 2011; Lee et al. 2013). Some argue that, in addition to similar acceptance rates between women and men, the publication process may be on the right track when the proportion of articles published by women approximates the proportion of women in the science pool (Hammerschmidt et al. 2008). However, a recent study of several million journal articles showed that papers for which the sole, first or last author of a paper was identifiably female were cited fewer times than if a male was in these authorship positions (Larivière et al. 2013).

Addressing the recently revealed disproportionality of male to female editors and first authors of accepted papers in the journal *Nature* (14% of editors and 19% of first authors were female; Conley & Stadmark 2012), a call was made to all scientific journal editors to assess gender equity in their publication process (Heidari & Babor 2013). In response to this call, we present a gender analysis for the publication process for the *New Zealand Journal of Ecology* (*NZJE*) between 2003 and 2012. Specifically, we asked: (1) Is the rate of publication success biased by the gender of either the first, or corresponding, author? (2) Is the gender ratio of selected reviewers biased? (3) Does the gender of the associate editor, who directly handled the editorial process for each paper, including selecting the reviewers, bias either the publication success or reviewer selection frequencies by gender?

Methods

The *NZJE* uses an optional single-blind review process, where full names of authors are submitted with their manuscripts for review and reviewers have a choice to remain anonymous. The *NZJE* manuscript database was used to obtain a list of manuscripts submitted and sent out for review between 2003 and 2012. For each manuscript the genders of the first author and the corresponding author were obtained when possible (some names were not identified as gender specific and were removed from analysis). Thirteen out of a total 365 reviewed manuscripts were excluded from the dataset due to unknown author gender. Current associate editors of the journal were asked to provide data on the frequencies of female and male

[1] http://www.hrc.co.nz/hrc_new/hrc/cms/files/documents/05-Nov-2010_09-29-40_HRC_Womens_Census_2010_WEB.pdf

reviewers that they selected for all manuscripts handled between 2010 and 2012.

To assess if there was a bias in the frequency of publications by female first authors compared with male first authors, a 2 × 2 contingency table analysis was used to compare the frequencies of accepted and declined manuscripts by first author gender. This test was repeated using the gender of the corresponding author. We then tested if this pattern differed between female and male associate editors by splitting the dataset by gender of the associate editor and repeating the tests. Reviewer selection bias by associate editors was tested using a binomial generalised linear mixed-effects model (GLMM) accounting for clustering of manuscripts by editor. For this analysis we used the 'lmer' function in the 'lme4' package version 0.999999-2 (Bates et al. 2013). The number of female reviewers out of the total was modelled as a function of editor gender, and editor identity was included as a random effect. This model was compared with an intercept-only model using the small-size-corrected Akaike's information criterion (AICc; Anderson 2008) calculated in the package 'AICcmodavg' (Mazerolle 2013). All analyses were performed in R version 2.14 (R Core Team 2012).

Results

Of the 352 manuscripts analysed, 128 were submitted by female lead authors (Table 1). For 86% of the manuscripts, the lead author was also the corresponding author, but a slightly greater percentage of lead authors (36%) than corresponding authors (33%) were female. For manuscripts where the lead author differed from the corresponding author, females made up 37% of lead authors but only 16% of corresponding authors.

Rates of publication success were almost identical for manuscripts authored by women and men (Table 1, $\chi^2_{first} = 0.0001$, d.f. = 1, $P > 0.9$; $\chi^2_{corresponding} < 0.0001$, d.f. = 1, $P > 0.9$); during the study period, the *NZJE* had a 29% rejection rate for reviewed papers. This pattern did not change when female and male associate editors were treated as separate groups (data not shown). Though success rates of female versus male manuscript submissions were similar, the overall percentage of published articles by female authors was much lower than for male authors. Out of 249 published articles, 90 were first-authored by women (36%) and 159 were first-authored by men (64%; Table 1).

On average, the 8 female and 11 male current associate editors selected more male than female reviewers (Table 2); across 125 reviewed manuscripts handled by all 19 editors between 2010 and 2012, only 29% of reviewers selected were female. Although individual editors ranged widely in their mean rates of female selection from 0 to 60%, there was a trend for female editors to select more female reviewers than did male editors (Fig. 1; Table 2): female journal editors selected 31% female reviewers cf. male editors' 27%. However, the binomial GLMM model including editor gender as a predictor of the ratio of female to male reviewers had an AICc weight of only 0.57 and was less than two AICc points lower than the null, intercept-only model, which had a model weight of 0.43, indicating no difference between the two models and that editor gender did not significantly predict reviewer gender selection.

Discussion

Our analysis shows that there is not a gender bias in publication success rate for the *NZJE*. Publication success was not dependent on the gender of the first or corresponding author, the reviewer, or the associate editor handling the review process. These results concur with the majority of studies that have examined gender effects on publishing rates for other scientific journals (Tregenza 2002; De Vries et al. 2009; Valkonen & Brooks 2011; Lee et al. 2013; but see Budden et al. 2008a).

Although the effect of associate editor gender on the selection rate of female versus male reviewers was not strong, there was nonetheless a trend for female editors to select more female reviewers than did male editors, suggesting that editors could probably improve female selection rates on the whole. It could be argued that the overall percentage of female

Table 2. Gender breakdown of reviewer selections by the 19 associate editors for manuscripts submitted to the *New Zealand Journal of Ecology* between 2010 and 2012. Data are from a total of 125 reviewed manuscripts.

	Female editors ($N = 8$)	Male editors ($N = 11$)	Total
Number of female reviewers selected	39	37	76
Number of male reviewers selected	87	102	189
Total	126	139	265
Percent female reviewers selected	31.0	26.6	28.7

Table 1. Breakdown of publication success by gender for manuscripts sent for review by the *New Zealand Journal of Ecology* between 2003 and 2011. Note that four more manuscripts were excluded from the first-author analysis than the corresponding author analysis due to unknown author gender.

	Number published	Number declined	Total submitted	Percent publication success
Number of female first authors	90	38	128	70.3
Number of male first authors	159	65	224	71.0
Total	249	103	352	71.7
Number of female corresponding authors	81	35	116	69.8
Number of male corresponding authors	168	72	240	70.0
Total	249	107	356	69.9

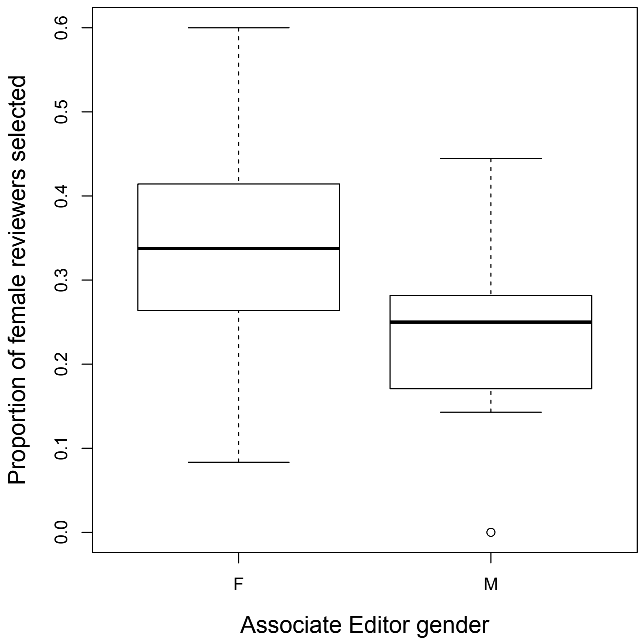

Figure 1. Boxplot showing the median proportion of female reviewers selected by female ($N_F = 8$) and male ($N_M = 11$) associate editors between 2010 and 2012 for 125 manuscripts submitted to the *New Zealand Journal of Ecology*.

reviewers (29%) selected was approximately the same as their proportional availability (27%). Indeed, in New Zealand the pool of senior female ecologists holding full-time, permanent positions from which editors can request peer reviewers is substantially smaller than the pool of men; the percentage of female ecologists in university departments in 2013 was 27% and at Landcare Research was 33% (www.landcareresearch.co.nz). It could be argued that this is the reason we observed a relatively low rate of selection of female reviewers by the majority of journal editors between 2010 and 2012. However, we did not tally postdoctoral researchers or PhD students, both of which pools contain a large source of potential female reviewers and so we argue that the lower female selection rate is more due to a lack of female 'visibility' than availability. Regardless, we do not believe that the gender ratio of selected reviewers needs to reflect the perceived gender ratio of the pool of potential reviewers. If, instead, associate editors selected a more equal number of female and male reviewers then this improved representation of women would increase the visibility and contribution of women to New Zealand ecology. This, then, would hopefully lead to better recruitment and retention of women in senior roles. Indeed, Leahey (2007) suggested that being selected as a reviewer increases visibility, which has a direct and significant impact on salary. A recent review by Ceci and Williams (2011) also suggests that, overall, there is little evidence of gender discrimination in the publication process and concludes that the under-representation of women in STEM fields in general is likely to be due to the tendency of women to hold positions with fewer resources. Indeed, if service, including peer review, is highly valued in the hiring and promotion process, then we should encourage the female reviewer selection rate to be higher.

Overall, although there is little evidence for gender bias in the *NZJE* publication process, we advocate for the use of the peer review process as a mechanism to enhance the retention and promotion of women into higher science positions. For example, actively seeking to include women in more junior roles, such as PhD students and postdocs, in the reviewing process might improve retention of women in science by boosting their confidence and improving the quality of their work. Participating in the peer-review process is an important way that early-career researchers can feel more involved with, and contribute to, the scientific community (Donaldson et al. 2010). This is something that the *NZJE* is trying to facilitate through its reviewer mentoring initiative (Curran et al. 2013), which is an excellent way for associate editors to improve the gender ratio of their reviewer selection through increased visibility of female potential reviewers, including both female mentees and mentors. In conclusion, spreading the responsibility of peer review across all experience levels, from junior to senior scientists, may reduce service demands for those in higher positions and concomitantly bolster the experience, confidence and visibility of those women who are more likely to fall out of STEM fields after postgraduate study.

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