An Examination of Gender Differences in the American Fisheries Society Peer-Review Process

Grace Handley, Cynthia M. Frantz, Patrick M. Kocovsky, Dennis R. DeVries, Steven J. Cooke & Julie Claussen

Published online: 11 Sep 2015.

Submit your article to this journal ↗

View related articles ↗

View Crossmark data ↗

An Examination of Gender Differences in the American Fisheries Society Peer-Review Process

Grace Handley
Oberlin College Department of Psychology, Oberlin, OH

Cynthia M. Frantz
Oberlin College Department of Psychology, 175 W. Lorain St., Oberlin, OH 44047. E-mail: cindy.frantz@oberlin.edu

Patrick M. Kocovsky
U.S. Geological Survey Lake Erie Biological Station, Sandusky, OH

Dennis R. DeVries
School of Fisheries, Aquaculture, and Aquatic Sciences, Auburn University, Auburn, AL

Steven J. Cooke
Fish Ecology and Conservation Physiology Laboratory, Department of Biology, Carleton University, Ottawa, ON, Canada

Julie Claussen
Illinois Natural History Survey, University of Illinois, Champaign, IL

This study investigated the possibility of gender differences in outcomes throughout the peer review process of American Fisheries Society (AFS) journals. For each manuscript submitted to four AFS journals between January 2003 and December 2010, we collated information regarding the gender and nationality of authors, gender of associate editor, gender of reviewers, reviewer recommendations, associate editor's decision, and publication status of the manuscript. We used hierarchical linear modeling to test for differences in manuscript decision outcomes associated with author, reviewer, and associate editor gender. Gender differences were present at some but not every stage of the review process and were not equal among the four journals. Although there was a small gender difference in decision outcomes, we found no evidence of bias in editors' and reviewers' recommendations. Our results support the conclusion that the current single-blind review system does not result in bias against female authors within AFS journals.

Diferencias de género en el proceso de revisión por pares en la Sociedad Americana de Pesquerías

En este trabajo se investiga la posibilidad de que existan diferencias de género en los productos del proceso de revisión por pares en las revistas de la Sociedad Americana de Pesquerías (SAP). En cada manuscrito sometido a cuatro de las revistas de la SAP entre enero de 2003 y diciembre de 2010, se ordenó la información referente al género y nacionalidad de los autores, el género del editor asociado, el género de los revisores, las recomendaciones de los árbitros, la decisión del editor asociado y el estado de la publicación del manuscrito. Se utilizó modelación lineal jerárquica para probar diferencias en el veredicto de la publicación en relación al género del autor, del revisor y del editor asociado. Las diferencias de género se hicieron presentes en algunos, pero no en cada etapa del proceso de revisión; y los resultados no fueron los mismos entre revistas. Si bien hubo una pequeña diferencia ligada a género en el resultado de la decisión, no se encontraron sesgos en las recomendaciones hechas por parte del editor o de los revisores. Nuestros resultados apoyan la conclusión de que el sistema actual de revisión por pares tipo sencillo-ciego que impera en las revistas de la SAP, no existen sesgos en contra de las autoras.

Une analyse des différences entre les sexes dans le processus de relecture par les pairs de l'American Fisheries Society (Société américaine de la Pêche)

Cette étude a examiné la possibilité de différences entre les sexes dans les résultats du processus de relecture par les pairs des revues de l'American Fisheries Society (AFS [Société américaine de la Pêche]). Pour chaque manuscrit soumis à quatre revues de l'AFS entre janvier 2003 et décembre 2010, nous avons collecté les informations concernant le sexe et la nationalité des auteurs, le sexe du rédacteur en chef adjoint, celui des relecteurs, les recommandations des relecteurs, la décision de rédacteur en chef adjoint, et l'état de la publication du manuscrit. Nous avons utilisé la modélisation linéaire hiérarchique pour tester les différences dans les résultats des décisions manuscrites associées avec le sexe de l'auteur, du relecteur, et du rédacteur en chef adjoint. Les différences entre les sexes étaient présentes à certains endroits, mais pas à tous les stades du processus de relecture, et n'étaient pas égales entre les quatre revues. Bien qu'il y ait une petite différence entre les sexes dans les résultats des décisions, nous n'avons trouvé aucune preuve de partialité dans les recommandations des éditeurs et des relecteurs. Nos résultats appuient la conclusion que le système de relecture en simple aveugle actuel ne se traduit pas par un parti pris contre les auteurs féminins au sein de revues de l'AFS.

INTRODUCTION

Publication in peer-review journals is one of the major avenues through which knowledge is disseminated in scientific communities. Peer reviewers and editors serve as the "gatekeepers" of science (Hojat et al. 2003; Bornmann 2011) by influencing publication outcomes and the direction of future research. Peer reviewers strive to exercise impartial judgment to determine what information warrants publication, but objectivity may be hard to consistently achieve (Hojat et al. 2003; DeVries et al. 2009; Aarssen 2012; Duch et al. 2012; Heidari and Babor 2013). Single-blind review models have the potential to be problematic when authors are not anonymous because author characteristics may influence reviews (e.g., Blank 1991). Indeed, given issues with reviewer (and editor) bias, some have gone so far as to suggest that peer review is a crude (Kassirer and Campion 1994) and flawed process (Smith 2006).

Although female authors have been represented better in some sciences (e.g., Bhattacharyya and Shapiro 2000; Jagsi et al. 2006), males continue to dominate scientific fields and the publishing processes (Rapoport 2004; Barres 2006; Ceci and Williams 2011; Shen 2013), and gender bias in peer-reviewed scientific journals remains a specific concern (Barres 2006; Ceci and Williams 2011). Currently, women encounter or perceive stereotyping and discrimination in traditionally male-dominated fields (Lloyd 1990; Steele et al. 2002; Duch et al. 2012; Kaminski and Geisler 2012; Knobloch-Westerwick et al. 2013; Shen 2013), leading many authors to promote changes to the review

process to minimize the potential for bias. The peer-review process warrants critical investigation to ensure that valuable research by all authors has an adequate opportunity to be published. In this study, we examine the potential for gender bias in the peer-review process in a traditionally male-dominated field: fisheries. We review research on gender bias in the peer-review process across multiple disciplines, and then describe a comprehensive investigation of the peer-review process of the American Fisheries Society's (AFS) editorial database.

Research on Gender Differences and Gender Bias in the Peer Review Process

A number of studies have shown gender differences throughout the peer-review process, but it remains uncertain whether these differences are the result of gender bias or whether female authors are disadvantaged in other ways, such as having less experience in their field or submitting to journals with higher rejection rates. In a study of five medical behavior journals, Lloyd (1990) determined that female reviewers showed a significant same-gender preference, although subsequent studies have failed to consistently replicate this finding (Borsuk et al. 2009; Knobloch-Westerwick et al. 2013). Studies that have manipulated author gender have also found inconsistent results. Borsuk et al. (2009) conducted an experiment in which the author of a published article was given either a male name, a female name, an initial, or no name (i.e., blind review). The authors found no change in acceptance rate among either experienced or inexperi-

enced reviewers. In contrast, Knobloch-Westerwick et al. (2013) reported that male authors were ranked higher in scientific quality for conference abstracts among male and female reviewers.

Several correlational studies have identified gender differences at multiple stages in the peer-review process. Gilbert et al. (1994) found that female editors handled female-authored manuscripts significantly more often than did male editors, female editors assigned more reviewers to each manuscript than did male editors, and male editors used male reviewers more often than did female editors. Although these differences emerged, no significant gender effect on publication outcome was found. In a study of the peer-review process in *Obstetrics and Gynecology*, Wing et al. (2010) reported that female reviewers were less likely to give manuscripts evaluations of "accept" or "accept with minor revisions" and took significantly longer to return reviews than male reviewers; however, editors graded female reviews as "very good" or "exceptional" more often than male reviews. Once again, no differences in publication outcome were observed. Thus, although the peer-review process may differ depending on author and reviewer gender, the decisions of editors regarding manuscript publication seem unaffected by author gender, at least for those journals and fields studied.

To strengthen the review process, several peer-reviewed journals have recently changed from single-blind review to double-blind review, providing an ideal opportunity to study the effects of author name disclosure. Ross et al. (2006) demonstrated that an open review favored authors affiliated with the United States, English-speaking countries outside the United States, and prestigious institutions; a change to a double-blind review significantly reduced some of this bias. However, there was no relationship between author gender and abstract acceptance under either peer-review process. In contrast, Budden et al. (2008) showed that acceptance rates for manuscripts submitted by women increased significantly during the four years following *Behavioral Ecology*'s change to double-blind peer review in 2001, but more rigorous statistical testing later revealed these differences to be nonsignificant (Engqvist and Frommen 2008).

Recently, Hilborn (2006) argued that high-impact journals in the fisheries field used a "faith-based" review process that published manuscripts based on publicity value instead of scientific merit. DeVries et al. (2009) responded to this criticism with a review of the literature surrounding the issues involved in peer review and suggested that AFS consider a double-blind review process. However, the literature from other fields offers mixed support for the necessity of double-blind review (Hill and Provost 2003; Snodgrass 2007; Budden et al. 2008; Primack et al. 2009). Differences due to author gender and reviewer gender have been found, but differences have not appeared to result in unequal publication outcomes.

A Case Study of the American Fisheries Society

Prompted by concerns about the potential for bias in the peer-review process of AFS journals, our current study focuses on AFS's peer-review process. The AFS's peer-reviewed journals use single-blind reviews in which manuscript author names are disclosed to reviewers, and reviewers are anonymous by default but may choose to sign their reviews. Gender differences that have the potential to impact publication outcome are possible throughout the review process: which journals authors choose to submit to, who are assigned as reviewers, and whether authors decide to revise and resubmit. Bias has the potential to influence the process primarily through reviews. Because reviewers know author names, it is possible that inferred gender influences reviewer judgments of the quality of the work.

This is of particular concern because the fisheries field has traditionally been male dominated (Moffitt 2012). In 2003, AFS began requesting gender identification on both their annual membership renewals and new membership forms. Of those members who identified their gender (AFS, unpublished data), women comprised 16.7% of regular members, 30.8% of young professionals, and 35.3% of students. By 2012 female regular members represented 19.8% of total membership, and female young professionals and students were 37.5% and 38.2%, respectively, demonstrating increasing gender diversity across all demographics. Although the field of fisheries has diversified considerably in recent years, concerns exist about the representation of female reviewers, associate editors, and editors in the peer-review process, as well as equitable publication outcomes for female authors. In response to these concerns, the AFS Publications Overview Committee accepted a proposal by the authors to conduct an independent investigation of the AFS peer-review process. This project began in 2010 with the goal of evaluating the peer-review process of four AFS journals in the electronic submission era between 2003 and 2010.

We examined the distribution of males and females as authors, reviewers, and associate editors in four peer-reviewed AFS journals: the *North American Journal of Aquaculture* (NAJA), the *Journal of Aquatic Animal Health* (JAAH), the *North American Journal of Fisheries Management* (NAJFM), and *Transactions of the American Fisheries Society* (TAFS). We sought to identify significant differences in outcomes throughout the peer-review process between male and female authors, particularly differences that influence ultimate publication outcomes. We did not attempt to independently assess the quality of submitted manuscripts as it related to gender.

The AFS uses a model in which manuscripts are assigned to an associate editor (AE) by the AFS Editorial Office based on the paper's subject and the AE's area of expertise. The AEs solicit and obtain peer reviews, assess the manuscript themselves, and then pass that information to the editor, along with a recommendation concerning its publication. The editor then makes the final decision concerning the manuscript's disposition and communicates directly with the author. In addition, the editor provides oversight to assure consistency among manuscripts. In the majority of instances, the editorial recommendation provided by the AE is the one adopted by the editor. For these AFS journals, there were two to three editors and 10–20 AEs. For the purpose of this analysis, we excluded the editor given that AEs interact with the referees (e.g., select them) and make the initial editorial recommendation.

METHODS

The data set consisted of 4,663 manuscripts submitted between January 1, 2003, and December 31, 2010, to JAAH (*N* = 440), NAJA (*N* = 643), NAJFM (*N* = 1,744), and TAFS (*N* = 1,836).

Gender was coded for the first author based on their first name recorded in the database, the AE (AEs were identified by number in our data set to preserve anonymity), and up to five reviewers using the names provided to AFS. Gender was coded as male (e.g., Christopher, Patrick), female (e.g., Christine, Patricia), or indiscernible (e.g., Chris, Pat). Overall, 5% of first author and reviewer names fell into the indiscernible category; these manuscripts were eliminated from the data set. To confirm the reliability of assessing gender from author names, each co-author coded gender for a subset of 250 names randomly chosen

from electronically submitted manuscripts. Interrater agreement between raters was evaluated using Fleiss's kappa, which assesses the degree of agreement between multiple raters controlling for what would be expected by chance. Fleiss's κ was 0.61, which is considered to be "substantial interrater agreement" by Landis and Koch (1977). This suggests that coding gender based on author name was a valid procedure for determining author gender.

Because previous research in other fields has demonstrated that English-speaking ability affects publication outcomes (Kliewer et al. 2004; Ross et al. 2006), the country associated with the author's institutional address was recorded. The author's country of affiliation was coded as either English-speaking or not, based on whether English was listed as an official language in that country by the United Nations.

All reviewer and AE recommendations (reject, major revisions, minor revisions, accept) were recorded for each manuscript. Each decision was assigned a categorical numeric value (0 = reject, 1 = major revisions, 2 = minor revisions, 3 = accept), and the average of reviewer and AE recommendations was computed for each manuscript. The number of revisions of each manuscript was also recorded. Finally, the manuscript's outcome was recorded (rejected, still under review, in revision, published). Manuscripts that were under review or in revision were excluded, in addition to those manuscripts excluded because author gender was indeterminate, resulting in 4,264 manuscripts used for analysis. Manuscripts with indeterminate reviewers were retained, with the gender of indeterminate reviewers treated as missing data.

Below we present two sets of analyses. First, we present descriptive statistics depicting representation at various stages of the review process broken down by first author gender, presence of an author from an English-speaking country, and journal. Second, we conducted a series of hierarchical linear modeling (HLM; Raudenbush and Bryk 2002) analyses to examine the predictors of publication outcome. We first predicted publication outcome using only demographic variables to determine whether there were significant differences due to gender when controlling for other demographic variables. Then, we sequentially added variables related to each stage of the review process in a stepwise manner to observe how the model changed when controlling for each stage. All analyses controlled for differences in base rate representation of male and female AEs, reviewers, and first authors.

RESULTS

Descriptive Statistics

Females were best represented in every role in JAAH (Table 1). Submissions by female first authors and percentage of manuscripts with at least one female reviewer were lowest for NAJA, and NAJFM had the lowest percentage of manuscripts handled by female AEs. Linear trend analysis revealed no significant

change in the percentage of manuscripts submitted by female authors across all four AFS journals during this period (Figure 1). However, when examined separately, NAJA did show a significant increase in the percentage of manuscripts submitted by female authors ($P = 0.02$).

There was a significant difference among journals in the percentage of manuscripts submitted by female first authors ($\chi^2 = 32.4$, df = 3, $P < 0.001$; Table 1). Female first authors tended to submit more manuscripts than expected (assuming equal distribution of female authors) to JAAH and TAFS and fewer manuscripts than expected to NAJA and NAJFM.

Overall, there was no relationship between first author gender and the gender of the AE assigned to their manuscript ($\chi^2 = 0.79$, df = 1, $P = 0.37$). Across journals, male AEs were assigned to manuscripts with female first authors 18% of the time, and female AEs were assigned to manuscripts with female first authors 19% of the time.

There was a significant relationship between first author gender and the likelihood of their manuscript being assigned at least one female reviewer (Table 2). Manuscripts with female first authors were assigned at least one female reviewer more often than expected by chance, and manuscripts with male first authors were assigned at least one female reviewer less often than expected by chance. This pattern was observed in each journal but was only statistically significant in TAFS. Similarly, across journals, female AEs chose at least one female reviewer more often than expected (Table 2). This pattern was observed in each journal but was only statistically significant in NAJA.
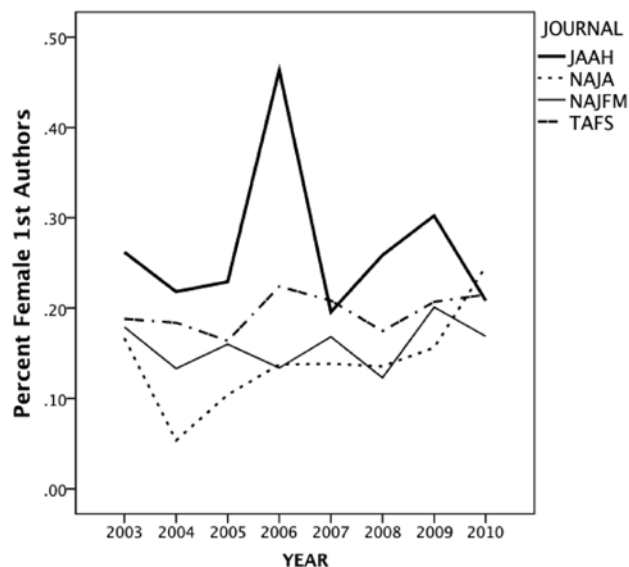

Figure 1. Proportion of submitted manuscripts with a female first author submitted to American Fisheries Society journals 2003–2010.

Table 1. Descriptive statistics and frequency of female involvement in the review process for American Fisheries Society journals 2003–2010. Percentages in parentheses indicate the number in the column relative to the total number of submissions.

	Total submissions	Total published	Manuscripts submitted by female first authors	Manuscripts handled by female AEs	Manuscripts with at least one female reviewer
All journals combined	4,264	2,598 (60.9%)	749 (17.6%)	514 (12.1%)	1,311 (30.7%)
JAAH	361	228 (63.2%)	98 (27.1%)	210 (58.2%)	154 (42.7%)
NAJA	545	405 (74.3%)	73 (13.4%)	116 (21.4%)	138 (25.3%)
NAJFM	1,603	983 (61.3%)	242 (15.1%)	65 (4.1%)	460 (28.7%)
TAFS	1,755	982 (56.0%)	336 (19.1%)	123 (7.0%)	559 (31.9%)

Table 2. Relationship between author gender and reviewer gender for the four AFS journals. The χ^2 test compares whether the distribution of male and female first-authored manuscripts differs significantly from what would be expected by chance.

	Female first-authored manuscripts with at least one female reviewer	Male first-authored manuscripts with at least one female reviewer	χ^2	df	P
All journals combined	265 (35.4%)	1,046 (29.8%)	9.17	1	0.002
JAAH	48 (49.0%)	106 (40.3%)	2.20	1	0.14
NAJA	20 (27.4%)	118 (25.0%)	0.19	1	0.66
NAJFM	74 (30.6%)	386 (28.4)%	0.49	1	0.48
TAFS	123 (36.6%)	436 (30.7%)	4.33	1	0.04
	Manuscripts handled by female AE with at least one female reviewer	Manuscripts handled by male AE with at least one female reviewer			
All journals combined	214 (38.8%)	1,119 (29.9%)	17.55	1	<0.001
JAAH	104 (44.1%)	67 (37.6%)	1.73	1	0.19
NAJA	45 (33.1%)	106 (23.7%)	4.78	1	0.03
NAJFM	23 (32.4%)	440 (29.0%)	0.39	1	0.59
TAFS	42 (38.5%)	506 (31.7%)	2.17	1	0.17

There was an overall significant difference in publication outcomes for manuscripts with male and female first authors. Manuscripts with female first authors were published less often than expected by chance ($\chi^2 = 4.61$, df = 1, $P = 0.03$). This pattern held for all journals, but when analyzed separately, it was only statistically significant for NAJFM ($\chi^2 = 2.95$, df = 1, $P = 0.05$; Table 3). This overall difference in publication outcome could be the result of one or more of the differences already described (e.g., differences in the acceptance rates of the journals men and women tended to submit to or stylistic differences between male and female reviewers). It could also be the result of the number of revisions authors choose to submit or the biased judgments on the part of reviewers and AEs.

To tease apart these possibilities, we present below the results of HLM analyses that tested the effect of gender on publication outcome while controlling for other demographic variables and each stage of the review process.

HLM Analysis Predicting Publication Solely from Demographic Variables

This study used a nested design with two hierarchical levels. The manuscript was at the lowest level of the hierarchy. Associate Editor represented the next level of the hierarchy. Variables associated with the highest level were AE gender, journal, and submission year. Variables associated with the lower level of manuscript were reviewer gender, author gender, manuscript recommendations, number of rounds of revisions, publication outcome, and whether there was one author from an English-speaking country (although not of primary interest to our study, omitting a relevant variable from the HLM models would bias our regression estimates). We also included two-way interactions between first author gender and AE gender and first author gender and the presence of at least one female reviewer.

The first model predicted publication outcome from demographic variables *without* controlling for what happened during the review process. The main effect of journal was significant, reflecting that acceptance rates differ among journals (Table 4). Year was also a significant predictor; manuscripts submitted in later years were less likely to be published. There was also a significant main effect of presence of an author from an English-speaking country, with manuscripts with at least one author from an English-speaking country having better publication outcomes (63.1% published) than those with none (28.9% published). Finally, there was a marginally significant interaction of AE gender and first author gender. Associate Editor gender did not significantly affect publication for manuscripts with female first authors (57.1% publication rate with female AEs, 58.4% with male AEs). However, manuscripts with male first authors that were assigned to female AEs had significantly higher publication rates (69.9%) than those that were assigned to male AEs (61.7%, $t = 3.243$, df = 503.076, $P = 0.001$; Figure 2). The main effect of gender was not significant.

HLM Analysis Predicting Publication Using Demographic Variables and Manuscript Recommendations

In the next model, we included the scale computed from the average of reviewer and AE recommendations to control for perceived quality of the manuscript. The effects of journal, year, and English-speaking authorship did not change when controlling for recommendations (Table 5). In this model, having at least one female reviewer was a significant predictor of publication outcome. Controlling for recommendations, having no

Table 3. Relationship between author gender and publication outcome. χ^2 tests whether the difference between male and female publication rates differed significantly from what would be expected by chance.

	Female first-authored manuscripts accepted (%)	Male first-authored manuscripts accepted (%)	χ^2	df	P
All journals combined	58.2	62.5	4.61	1	0.03
JAAH	59.8	65.6	0.98	1	0.32
NAJA	73.2	74.4	0.05	1	0.83
NAJFM	57.5	63.5	2.95	1	0.05
TAFS	54.9	57.1	0.51	1	0.48

female reviewers was associated with higher rates of manuscript publication than having at least one female reviewer. Not surprisingly, recommendations significantly predicted publication outcomes. More positive recommendations were associated with better publication outcomes. First author gender became marginally significant in this model. That is, controlling for the recommendations received, manuscripts with female first authors were published more frequently.

The AE gender by first author gender interaction was no longer significant; however, the first author gender by reviewer gender interaction was significant and yielded a similar pattern of results (Figure 3). Whether a manuscript was assigned female reviewers did not affect publication of manuscripts with female first authors. For manuscripts with male first authors, however, having at least one female reviewer resulted in higher publication rates.

HLM Analysis Predicting Publication Outcome Controlling for the Number of Revisions

The next model controlled for the number of revisions a manuscript went through before being either published or not published. For this analysis, manuscripts that were immediately accepted ($N = 49$) and immediately rejected ($N = 1,290$) were omitted, because revisions were not required (39% of the original sample). Among manuscripts that received a recommendation to revise, those handled by female AEs were marginally more likely to be published (Table 6). Journal was no longer a significant predictor of publication among this subset of manuscripts; hence, publication rate was the same across journals. The effects of year, English-speaking authorship, and reviewer recommendations remained significant. The number of revisions had a large effect, with more revisions predicting greater likelihood of publication. Additionally, once we controlled for number of revisions, none of the variables related to first author or reviewer gender remained significant. This suggests that the number of revisions authors choose to pursue may explain the observed gender difference in publication outcome.

HLM Analysis Predicting Number of Revisions before Publication Decision

Because the number of revisions was an important predictor of publication success with potential to explain gender differences in publication rate, we predicted number of revisions from the main variables of interest. Manuscripts that were immediately accepted and immediately rejected were omitted. Lower mean number of revisions had at least two possible interpretations; the number could result from fewer revisions needed to be accepted, or it could result from authors choosing not to resubmit at all. There was a tendency for manuscripts handled by male AEs to be revised marginally more often (mean = 1.24, SD = 0.77) than manuscripts that were handled by female AEs (mean = 1.15, SD = 0.80; Table 7). Manuscripts with an author from an English-speaking country had lower mean number of revisions than manuscripts with all authors from non-English-speaking countries. Similarly, manuscripts that initially received more positive recommendations were revised significantly less often than manuscripts that initially received less positive recommendations. The main effect of gender was not significant. The interaction between first author gender and the presence of at least one female reviewer was significant (Figure 4). Papers with a female first author *and* at least one female reviewer were revised less often than all other manuscripts.

Table 4. Hierarchical linear modeling analysis predicting publication from demographic variables and their interaction terms.

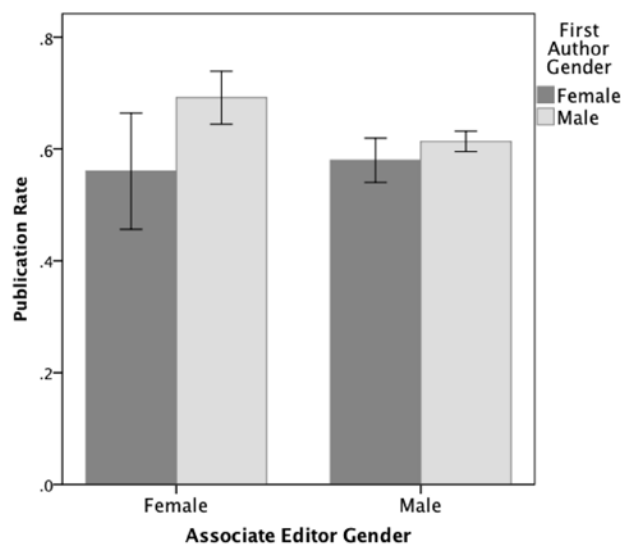|	b	P
Between-AE differences		
AE gender	−0.09	0.44
Journal	−0.25	<0.001
Between-manuscript differences		
Year	−0.12	<0.001
At least one author from English-speaking country	1.42	<0.001
At least one female reviewer	−0.05	0.75
First author gender	0.05	0.64
First author gender × AE gender	−0.47	0.08
First author gender × at least one female reviewer	0.31	0.10

Figure 2. Publication rate (mean + 95% confidence interval) as a function of first author gender and AE gender.

Table 5. Hierarchical linear modeling analysis predicting publication outcome from demographic variables and manuscript recommendations.

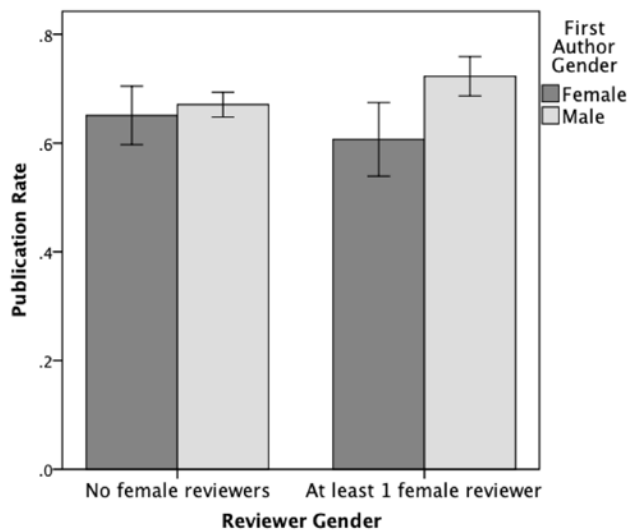|	b	P
Between-AE differences		
AE gender	−0.03	0.83
Journal	−0.24	<0.001
Between-manuscript differences		
Year	−0.10	<0.001
At least one author from English-speaking country	0.79	0.001
At least one female reviewer	−0.58	0.007
First author gender	−0.23	0.10
First author gender × AE gender	−0.07	0.83
First author gender × at least one female reviewer	0.62	0.009
Recommendations scale	2.97	<0.001

Figure 3. Interaction of reviewer gender by first author gender on publication outcome (mean + 95% confidence interval) of manuscripts submitted to four American Fisheries Society journals 2003–2010.

Table 6. Hierarchical linear modeling analysis predicting publication outcome from demographic variables, manuscript recommendations, and number of revisions.

	b	P
Between-AE differences		
AE gender	1.22	0.07
Journal	−0.30	0.17
Between-manuscript differences		
Year	0.20	0.003
At least one author from English-speaking country	1.38	0.03
At least one female reviewer	0.28	0.24
First author gender	−0.46	0.24
First author gender × AE gender	−0.13	0.88
First author gender × at least one female reviewer	0.27	0.26
Recommendations scale	1.90	<0.001
Revisions	3.69	<0.001

Table 7. Hierarchical linear modeling analysis predicting number of revisions before publication decision.

	b	P
Between-AE differences		
AE gender	0.26	0.08
Journal	−0.02	0.70
Between-manuscript differences		
Year	0.006	0.42
At least one author from English-speaking country	−0.09	0.002
At least one female reviewer	0.007	0.77
First author gender	−0.02	0.56
First author gender × AE gender	−0.05	0.62
First author gender × at least one female reviewer	0.06	0.03
Recommendations scale	−0.20	<0.001

HLM Analysis Predicting Reviewer Evaluations of Manuscript Quality

The previous analyses used the manuscript as the unit of analysis. These analyses showed that the recommendations a manuscript received and the number of revisions were both significant factors predicting publication. However, these analyses could not show which variables might account for differences in the initial recommendations a manuscript received. Of particular interest to the question of bias was whether manuscripts with female first authors received more negative evaluations by reviewers than manuscripts with male first authors. To address this question, we ran an HLM model predicting reviewer recommendations from author and reviewer demographics. Because the unit of analysis was the reviewer, we included each individual reviewer's gender in the model instead of using the overall variable of whether or not there was at least one female reviewer assigned to the manuscript. The only significant predictor of reviewer recommendations was whether or not the manuscript had at least one English-speaking author (Table 8). Manuscripts with at least one English-speaking author received higher reviewer recommendations than those with no English-speaking authors ($t = 4.79$, df = 8,928, $P < 0.001$). Neither first author gender nor the interaction between first author gender and reviewer gender were significant. Manuscripts first-authored by women did not receive more negative evaluations than those first-authored by men. This suggests that gender did not influence the perceived quality of the manuscript. Notably, the effect of year was nonsignificant, suggesting that reviewer recommendations have not changed over the time period studied.

DISCUSSION

The size and completeness of this data set provides a comprehensive analysis of how and where gender differences exist in the AFS peer-review process and whether these differences are the likely result of bias. Though there were differences attributable to gender at many stages of the review process, as well as in overall publication outcome, the presence of gender differences throughout the process does not, in itself, constitute evidence of gender bias. Rather, our overall assessment is that there was no evidence of bias on the part of reviewers or AEs for these AFS journals.
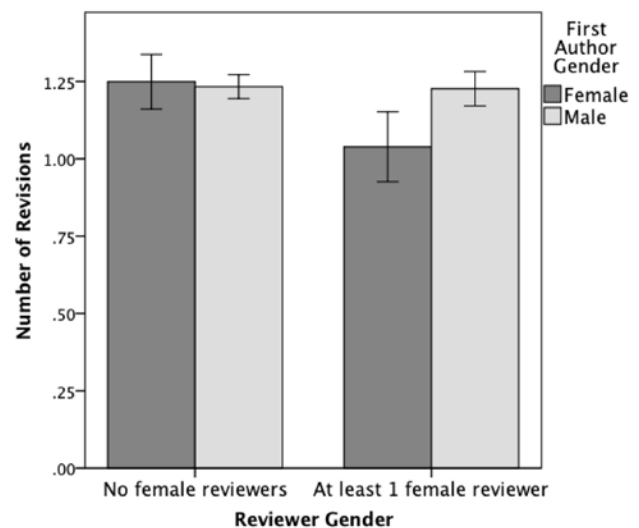

Figure 4. Mean number of revisions (mean + 95% confidence interval) by first author gender of manuscripts submitted to four American Fisheries Society journals 2003–2010, excluding manuscripts that received immediate accept or immediate reject decisions.

Overall, manuscripts with female first authors were less likely to be published than those with male first authors. Gender differences emerged at several stages of the review process that may explain this overall pattern. Female first authors tended to submit more manuscripts to TAFS (the journal with the highest rejection rate) and fewer manuscripts than expected to NAJA (the journal with the lowest rejection rate). These differences might reflect differences in representation of females in the subfields served by these journals, although AFS does not have detailed demographic data on representation of women in various fisheries subfields. Though first author gender did not predict gender of the AE assigned, manuscripts with male first authors assigned to female AEs were published at a significantly higher rate than other manuscripts in TAFS, and particularly in JAAH.

Manuscripts with female first authors were more likely to be assigned to at least one female reviewer, which suggests that AEs may attempt to create a "jury of peers" for female first authors. Female AEs were more likely to select female reviewers than were male AEs, which may be an attempt to provide professional opportunities to other women.

The HLM analyses provide the most complete test of which factors influence publication outcome, controlling for all other factors. In the HLM model, including only demographic variables and journal, the main effect of gender was nonsignificant. This provides strong evidence that differences in acceptance rates among journals, which were controlled for in this analysis, at least partially explain the gender differences in publication outcomes.

The hierarchical linear models also support the idea that differences in resubmission may explain the gender difference in publication outcome: manuscripts with female first authors and at least one female reviewer were published at lower rates; these manuscripts were also revised at lower rates. Further, once we controlled for the number of revisions, none of the variables related to first author or reviewer gender remained significant. A lower mean number of revisions has at least two possible interpretations; it could result from high-quality manuscripts that require fewer revisions to be accepted or from authors choosing not to resubmit at all. It is possible that female first authors with at least one female reviewer are choosing not to resubmit at all.

The HLM model predicting reviewer recommendation from journal and demographic variables, simultaneously, is the most direct and complete test of whether gender bias occurs in the AFS review process. Neither the gender of the first author, the reviewer gender—nor the interaction between the two—significantly predicted reviewer recommendation, which argues against the hypothesis that biased judgments based on gender occur during the review process. Further, when perceived manuscript quality (as measured by reviewer and AE evaluations) was added to the model, gender became marginally significant but in the opposite direction than observed earlier. That is, controlling for demographic variables, journal, and perceived manuscript quality, manuscripts with female first authors were marginally more likely to be published. If anything, this suggests an opposing effect: given two manuscripts of equal quality, the one authored by a female is marginally more likely to be published.

Somewhat contrary to this finding, manuscripts with male first authors and at least one female reviewer were more likely to be published. However, this effect and all other author gender effects became nonsignificant once we controlled for the number of revisions. This suggests that the number of revisions may at least partially explain the observed gender difference in publication outcome. For all analyses performed, year was nonsignificant, suggesting that reviewer recommendations have not changed over the time period studied.

The most robust finding was the consistent disadvantage experienced by manuscripts with no author from an English-speaking country. Controlling for every stage of the review process—including manuscript quality as rated by reviewers and AEs—these manuscripts were less likely to be published than those with at least one author from an English-speaking country. In addition, manuscripts with an author from an English-speaking country had a lower mean number of revisions than manuscripts with all authors working in non-English-speaking countries. This variable is not a perfect proxy for having a native English speaker work on the manuscript, of course; the country of institutional address does not necessarily indicate that the person was from that country or spoke the language of that country. However, our findings are quite robust, suggesting that if anything the effect may be a bit stronger than what we have shown.

CONCLUSIONS AND RECOMMENDATIONS

We observed a small but statistically significant difference in publication rate between male and female first-authored manuscripts, but when background variables, other demographics, and stages in the review process were controlled, the difference became nonsignificant. Notably, manuscripts with female first authors did not receive more negative reviews than manuscripts with male first authors. We thus conclude that there is no evidence of gender bias in the review process.

Why is bias in publications not evident in the profession of fisheries? We cannot address this question with our data, but we can speculate based on AFS history and efforts to ensure equal opportunities. In the early 1900s, women leaders like J Frances Allen (White et al. 2013) and Emmeline Moore (Franzin and Alade 2009) opened doors for women in the field of fisheries. In 1991, the Equal Opportunities Section was formed to provide a voice, as well as to promote opportunities for females and minorities in the fisheries profession. On the whole, AFS has been a leader in promoting women in fisheries professions, as well as understanding how gender influences career development (e.g., Connelly et al. 2006) and publication success (this study).

A lower acceptance and publication rate among authors from non-English-speaking countries is consistent with results found in other professions (e.g., Kliewer et al. 2004; Ross et al. 2006).

Table 8. Hierarchical linear modeling analysis with reviewer as unit of analysis predicting reviewer recommendations.

	b	P
Between-AE differences		
AE gender	0.008	0.93
Journal	−0.007	0.84
Between-reviewer differences		
Year	0.005	0.26
Reviewer gender	0.01	0.85
At least one author from English-speaking country	0.25	<0.001
First author gender	0.07	0.23
First author gender × AE gender	−0.03	0.66
First author gender × at least one female reviewer	−0.03	0.68

Our data do not permit firm conclusions on mechanisms, but we can offer potential reasons. Manuscripts that are poorly prepared or not thoroughly edited for English grammar can be a significant time effort for reviewers, who might not be willing to make that effort and hence recommend rejection. Poorly prepared manuscripts might also create the perception of less than rigorous science, although Kliewer et al. (2004) found that reviewers focused more on science quality than lack of language skills.

DeVries et al. (2009) recommended AFS evaluate the pros and cons of a double-blind review system as a means of reducing potential for bias. Our study failed to identify evidence of gender bias; hence, our work does not provide further support for the implementation of a double-blind system for reducing gender bias (although there might be other reasons for doing so). The AFS already permits authors to remain unknown to reviewers, but few authors exercise this option. Significant differences in publication rates for international authors suggest an opportunity for the AFS's International Fisheries Section or other Units to address needs of these authors.

ACKNOWLEDGMENTS

FUNDING

REFERENCES

Aarssen, L. W. 2012. Are peer-review filters optimal for the progress of science in ecology and evolution? Ideas in Ecology and Evolution 5:9–12.

Barres, B. A. 2006. Does gender matter? Nature 442:133–136.

Bhattacharyya, N., and N. L. Shapiro. 2000. Increased female authorship in otolaryngology over the past three decades. The Laryngoscope 110:358–361.

Blank, R. M. 1991. The effects of double-blind versus single-blind reviewing: experimental evidence from the *American Economic Review*. The American Economic Review 81(5):1041–1067.

Bornmann, L. 2011. Scientific peer review. Annual Review of Information Science and Technology 45:199–245.

Borsuk, R. M., L. W. Aarssen, A. E. Budden, J. Koricheva, R. Leimu, T. Tregenza, and C. J. Lortie. 2009. To name or not to name: the effect of changing author gender on peer review. Bioscience 59:985–989.

Budden, A. E., T. Tregenza, L. W. Aarssen, J. Koricheva, R. Leimu, and C. J. Lortie. 2008. Double-blind review favours increased representation of female authors. Trends in Ecology and Evolution 23(1):4–6.

Ceci, S. J., and W. M. Williams. 2011. Understanding current causes of women's underrepresentation in science. Proceedings of the National Academy of Sciences 108:3157–3162.

Connelly, N. A., T. L. Brown, and J. M. Hardiman. 2006. AFS men and women differ most in their lifestyle choices. Fisheries 31(10):503–506.

DeVries, D., E. A. Marschall, and R. A. Stein. 2009. Exploring the peer review process: what is it, does it work, and can it be improved? Fisheries 34(6):270–279.

Duch, J., X. H. T. Zeng, M. Sales-Pardo, F. Radicchi, S. Otis, T. K. Woodruff, and L. A. N. Amaral. 2012. The possible role of resource requirements and academic career-choice risk on gender differences in publication rate and impact. Public Library of Science ONE 7(12):e51332. DOI:10.1371/journal.pone.0051332.

Engqvist, L., and J. G. Frommen. 2008. Double-blind peer review and gender publication bias. Animal Behaviour 76:E1-E2. DOI:10.1016/ j.anbehav.2008.05.023.

Franzin, W. G., and L. Alade. 2009. Recognizing diversity in AFS. Fisheries 34(2):56.

Gilbert, J. R., E. S. Williams, and G. D. Lundberg. 1994. Is there gender bias in JAMA's peer review process? Journal of the American Medical Association 272:139–142.

Heidari, S., and T. Babor. 2013. Science editors: evaluate gender equality in journals. Nature 495(7439):47.

Hilborn, R. 2006. Faith-based fisheries. Fisheries 31(11):554–555.

Hill, S., and F. Provost. 2003. The myth of the double-blind review?: author identification using only citations. ACM SIGKDD Explorations Newsletter 5(2):179–184.

Hojat, M., J. S. Gonnella, and A. S. Caelleigh. 2003. Impartial judgment by the "gatekeepers" of science: fallibility and accountability in the peer review process. Advances in Health Sciences Education 8:75–96.

Jagsi, R., E. A. Guancial, C. C. Worobey, L. E. Henault, Y. Chang, R. Starr, N. J. Tarbell, and E. M. Hylek. 2006. The "gender gap" in authorship of academic medical literature—a 35-year perspective. New England Journal of Medicine 355:281–287.

Kaminski, D., and C. Geisler. 2012. Survival analysis of faculty retention in science and engineering by gender. Science 335:864–866.

Kassirer, J. P., and E. W. Campion. 1994. Peer review: crude and understudied, but indispensable. JAMA - Journal of the American Medical Association - US Edition 272(2):96–97.

Kliewer, M. A., D. M. DeLong, K. Freed, C. B. Jenkins, E. K. Paulson, and J. M. Provenzale. 2004. Peer review at the *American Journal of Roentgenology*: how reviewer and manuscript characteristics affected editorial decisions on 196 major papers. American Journal of Roentgenology 183:1545–1550.

Knobloch-Westerwick, S., C. J. Glynn, and M. Huge. 2013. The Matilda effect in science communication: an experiment in gender bias in publication quality perceptions and collaboration interest. Science Communications 35:603–625.

Landis, J. R., and G. G. Koch. 1977. The measurement of observer agreement for categorical data. Biometrics 33:159–174.

Lloyd, M. E. 1990. Gender factors in reviewer recommendations for manuscript publication. Journal of Applied Behavior Analysis 23:539–543.

Moffitt, C. M. 2012. Diversity in natural resource science professions: using feminine attributes to broaden diversity. Fisheries 37(8):376–377.

Primack, R., E. Ellwood, A. J. Miller-Rushing, R. Marrs, and A. Mulligan. 2009. Do gender, nationality, or academic age affect review decisions? An analysis of submissions to the journal *Biological Conservation*. Biological Conservation 142(11):2415–2418.

Rapoport, A. 2004. Gender differences in the careers of academic scientists and engineers. National Science Foundation, Division of Science Resources Statistics, NSF 04-323, Arlington, Virginia.

Raudenbush, S. W., and A. S. Bryk. 2002. Hierarchical linear models: applications and data analysis methods, second edition. Sage Publications, Thousand Oaks, California.

Ross, J. S., C. P. Gross, M. M. Desai, Y. Hong, A. O. Grant, S. R. Daniels, V. C. Hachinski, R. J. Gibbons, T. J. Gardner, and H. M. Krumholz. 2006. Effect of blinded peer review on abstract acceptance. Journal of the American Medical Association 295(14):1675–1680. DOI:10.1001/jama.295.14.1675.

Shen, H. 2013. Inequality quantified: mind the gender gap. Nature 495(7439):22–24. DOI:10.1038/495022a.

Smith, R. 2006. Peer review: a flawed process at the heart of science and journals. Journal of the Royal Society of Medicine 99(4):178–182.

Snodgrass, R. 2007. Editorial: single- versus double-blind reviewing. ACM Transactions on Database Systems 32(1):1–29.

Steele, J., J. B. James, and R. C. Barnett. 2002. Learning in a man's world: examining the perceptions of undergraduate women in male-dominated academic areas. Psychology of Women Quarterly 26:46–50.

White, G., J. Claussen, C. Moffitt, B. Norcross, and D. Parrish. 2013. Dr. J Frances Allen: pioneer of women in fisheries. Fisheries 38(3):103–111.

Wing, D. A., R. S. Benner, R. Petersen, R. Newcomb, and J. R. Scott. 2010. Differences in editorial board reviewer behavior based on gender. Journal of Women's Health 19:1919–1923. **AFS**