

Gender in Aquaculture and Fisheries: Engendering Security in Fisheries and Aquaculture

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Technical Paper

Towards Assessing Gender Authorship in Aquaculture Publications

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Abstract

While gender disparities are decreasing in some areas of academia, studies have shown that gender inequities in scholarly literature still persist. A review of more than eight million papers across disciplines found that men predominate in the first and last author positions and women are underrepresented in single-authored papers.

The present study applies the vetted methodology of assigning authorship gender in peer-reviewed literature, according to the U.S. Social Security Database of names, to the broad discipline of aquaculture in peer-reviewed journals in the complete JSTOR database archive, and compares these results to authorship by gender in the International Aquaculture Curated Database (IACD). The International Aquaculture Curated Database (IACD) is a compilation of over 500 peer-reviewed publications supported by four international aquaculture programs developed by Oregon State University researchers. Preliminary findings reveal that the percentage of women authors was similar to that for the JSTOR aquaculture journals subsample (13.8 %) and the journals in the IACD (15.7 %). Women, therefore, are not well represented in either database. The next steps for this work include comparing and contrasting the proportion of women authors in aquaculture journals to women working in the aquaculture discipline and to women graduates in the discipline. Learning how gender authorship has changed in the aquaculture discipline is a critical component for promoting gender equity in the academic discipline and broader field of aquaculture.

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Introduction

Studies have revealed that gender inequities still persist in scholarly literature (West et al. 2013; Breuning and Sanders 2007; Jagsi et al. 2006; Dubey et al. 2016; Arismendi and Penaluna 2016). From examining authorship of more than 8 million papers across disciplines in natural sciences, social sciences, and humanities, West et al. (2013) found that men dominate in the first and last authorship positions and that women are underrepresented as single authors. These numbers are important because most university systems judge a researcher's proficiency according to the number and quality of peer-reviewed papers, and on authorship position. This criterion is then used in determining promotions, assessments for tenure-track positions, attainment of research funding, and so on. Therefore, authorship can also be a measure of the status of gender and diversity in academia.

Generally, studies have found that women are underrepresented in science, publish less (Martin 2012; Conti and Visentin 2015), and receive less grant funding than their male counterparts (Vernos 2013). Other studies have assessed women's authorship in disciplines including political science and medicine, and found that not only does a gender gap in published literature still remain, but women's authorship has been levelling off in recent years (Breuning and Sanders 2007; Jagsi et al. 2006; and Dubey et al. 2016). This trend makes a closer evaluation of the status of gender authorship in peer-reviewed literature within aquaculture, one of the world's fastest growing food production sectors, highly relevant.

The academic discipline of aquaculture is relatively new and interdisciplinary, and many aquaculture degrees are granted from fisheries departments. Our analysis of the discipline, therefore, is embedded within the broader domain of fisheries. In more than 50 academic institutions, a study by Arismendi and Penaluna (2016) found that women and minorities are still a small portion of tenure-track faculty in the discipline of fisheries. Over the past three decades, they found only a slight increase in the inclusion of women among the academic community of fisheries science. This suggests a perpetuation of the "leaky pipeline" in fisheries science as, in recent years, women have received more than half of the doctoral degrees in the biological sciences (Miller and Wai 2015; Eгна et al. 2012; Blickenstaff 2005). These

trends and a study by Perna (2005) reveal that women are less likely to be promoted than men in academia, and the unlikelihood of a promotion can be linked to the status of gender authorship in peer-reviewed literature. Ignoring these inequities or allowing them to persist limits the development of the scholarly field of aquaculture.

To evaluate gender authorship within a discipline, it is first important to understand that the process of assigning authorship position varies across academic institutions, disciplines, and sub-cultures within research groups. Furthermore, most disciplines do not have a standardized protocol for determining authorship order, or determining each author's contribution to a paper. This is partly because it can be difficult to ascertain how much work each contributor has put into a paper (Laurance 2006; Tschardt et al. 2007). Traditionally, the first author has contributed the most to the paper and receives the most credit, and the positions of the subsequent authors are determined according to contribution, alphabetical order, or reverse seniority (Tschardt et al. 2007). The last author often gets as much credit as the first author as he or she is assumed to be the intellectual and financial driving force (Tschardt et al. 2007). Subtle biases and other factors can influence how authorship is assigned. Increasingly, "gift authorships" are given, i.e., an author is added for courtesy reasons because of their academic status, particularly in biomedical journals. This trend further confuses the actual contribution of each author listed on a publication. Because of the unclear process by which the set of authors for a paper is determined, identifying the amount of work each author contributed is challenging.

The culture of peer-reviewed publications is also changing and this also affects how changes in gender authorship over time are assessed. In particular, over the last several decades, the amount of collaborative and cross-disciplinary research has grown, as has the pressure to publish. Both of these factors have led to growth in the number of authors listed per paper (Wren et al. 2007). The growing number of authors per paper makes it even more difficult to adequately and fairly assert authorship order.

Because of the complex nature of assigning authorship position and the importance associated with publishing as a first author, examining gender authorship can help understand the advancement of the discipline because it is

inevitably a critical component of an individual's success in academia. For this reason, our study begins to evaluate the status of gender authorship in aquaculture by comparing authorships across the JSTOR Corpus database archive to, first, a subsample of JSTOR with aquaculture journals, and, second, a smaller, curated database, compiled by the AquaFish Innovation lab, of aquaculture peer-reviewed publications. The second database, the International Aquaculture Curated Database (IACD), was created in order to have a very rich data source of aquaculture publications from around the world that have been published throughout the entirety of the existence of the modern era of aquaculture for scholarly analysis. The richness of an international curated database lends itself to factoring in additional variables such as funding and faculty rank, along with other social metrics when assessing authorship.

The present paper shares preliminary findings that the percentage of women authors across the aquaculture discipline is significantly lower than women's apparent presence in the discipline. Since women have received more than half of the doctoral degrees in the biological sciences, it is plausible that women represent more than 16 % of researchers working in the discipline, while this is the rate at which women are authoring papers. This number is corroborated across two completely disparate, yet valuable sources within the aquaculture discipline. Although the results are not yet final and work is continuing to contextualize these authorships across the changing discipline, our findings represent the first time gender authorship in aquaculture has been calculated.

Materials and Methods

Datasets

Building on the work of West et al. (2013) and other studies conducted on gender authorship in the peer-reviewed literature within and across research disciplines, we compared multiple data sets from journals with publications in the aquaculture discipline. The International Aquaculture Curated Database (IACD), created by the AquaFish Innovation Lab, consists of 542 articles, written by 1706 authors in 121 journals, all of which were published between 1983-2016. The IACD draws from peer-reviewed papers whose research was supported by 4 separate international aquaculture programs, which were

developed by Hillary Egna including: (1) Pond Dynamics/Aquaculture Collaborative Research Special Program (CRSP) (1982-1996); (2) Aquaculture CRSP (1996-2008); (3) AquaFish CRSP (2006-2013); and (4) AquaFish Innovation Lab (2013-Present). The IACD was compiled by AquaFish Innovation Lab staff who reviewed both electronic and hard copies of journal articles. Every publication since 1983 was recorded with publication information, including full names, gender of authors, and author position, with the percentage of unknowns being less than 1 %. Gender of authors was recorded by Egna from having a personal connection to the author or by the lead authors themselves.

The IACD was analyzed for comparison to two separate JSTOR collections: (1) Recalibrated JSTOR dataset; and (2) JSTOR aquaculture subsample. The JSTOR is an expansive database of publications organized according to broad topics, and contains publications dating back to 1665. Similar online databases include but are not limited to: Academic Search Premier, Web of Science (WoS), Scopus and Microsoft Academic Graph (MAG). Each of these, however, has their proprietary strengths and weaknesses. For example, JSTOR has far more time depth than any of the other databases and it has full text for all their articles whereas most of the others have only bibliographic data. Some are freely available like MAG; others have decades of data (WoS). Hundreds of databases have been created, but many of them are specific to certain disciplines or types of publications, whereas those listed above are more comprehensive across the literature.

Recalibration was done in order to revisit the gender findings from West et al. (2013) and compare the findings to authorship data in the present study. The JSTOR aquaculture subsample separated the aquaculture journals from others within the broad database. It begins in 1913 as that was the year one of the first aquaculture-related journals began. Both the IACD and JSTOR comprise journals in the biotechnical domain of aquaculture more so than in the social or management domains of the discipline. JSTOR journal areas include: cultural studies, arts, business and economics, history, humanities, law, medicine and health, science and mathematics, and the social sciences. Aquaculture journals are located within the science and mathematics category. The Recalibrated JSTOR Corpus covers all major realms of scientific publications; the aquaculture subsample of the JSTOR Corpus includes a large

number of articles from a select few aquaculture journals; and the IACD is a substantiated aquaculture-specific database containing fewer journal articles. Together, the 3 data sources allow for a stronger understanding of gender representation in journal authorship.

Results

Women's authorships in the three databases

In the entire JSTOR Corpus, recalibrated for this study and comprising nearly 2 million papers, women represent 21.9 % of total authorships for papers published between 1665-2011 (West et al. 2013). This timeframe represents the existence of JSTOR publications.

For fisheries-related fields such as Ichthyology and Aquatic Ecology, women represent 21.0 % and 9.0 % of total authors, respectively. In the JSTOR, authorships are defined as an author-paper relationship, and does not count unique authors. This requires author disambiguation for the full corpus, which is an ongoing challenge in the field of bibliometrics and scientometrics. Also, in this preliminary stage of the current research, authorship by gender was not explicitly calculated for the interdisciplinary field of aquaculture. Because of the large number of authorships in JSTOR, gender was inferred by looking up the frequency of first names in the U.S. Social Security Database. For example, if "James" appears 99 % of the time as a boy, we assume that an author with the name "James" is male. For androgynous names such as "Andrea" and first names written as initials, we could not infer gender so we do not include these authors in the analysis. Therefore, the gender labels are self-identified and determined by only looking at the names and the frequency of gender for a given name. Unidentifiable names account for about one in every five authors in the Recalibrated JSTOR dataset (Table 1).

In the JSTOR aquaculture subsample, 23,381 articles and 43,146 authorships within 8 aquaculture journals (since 1913) were extracted and assessed for authorship gender in multiple positions to compare to the Recalibrated JSTOR dataset. The JSTOR recalibration adjusted for the period in which the first aquaculture journal in our subsample was initiated. The process for extracting authorship gender for the subsample was the same as for the

recalibrated entire JSTOR. The following eight journals were selected because they are highly ranked in the aquaculture discipline: *Ambio*, *Copeia*, *Estuaries and Coasts*, *Journal of Coastal Conservation*, *Journal of the North American Benthological Society*, *Limnology and Oceanography*, and *Water and Environment Research*. We recognize that these journals do not comprise a representative sample of all aquaculture journals, and are skewed towards biotechnical domains of aquaculture. However, these journals are consistent with the journals available in JSTOR. Future work will include a greater variety of aquaculture journals in the JSTOR subsample.

Table 1. Comparison of journal databases used for this study.

Dataset	Number of Journals	Number of Articles	Authors/ authorships	Timeframe	% Genders Unknown
IACD	121	543	1,706	1983-2016	<1 %
Recalibrated JSTOR	2227	1.8 million	2.8 million	1665-2011	26.7 %
JSTOR Subsample	8	23,381	43,146	1913-2016	23.7 %

Aquaculture Discipline

As well as recent changes in the publication process for peer-reviewed literature, the history of aquaculture was considered for this analysis. To understand the evolution of gender in the aquaculture discipline, it is important to first recognize that the discipline of aquaculture has changed substantially over the past 30 years (FAO 2016). Global aquaculture production started increasing in the early 1980s, rapidly expanding in the 1990s to the present to accommodate a growing global population with its changing diets and preferences. Development was especially expansive in the 1980s, with pond culture predominating total aquaculture production. The fisheries discipline has also grown in both scope and geographic range. There has been a global scale expansion of marine fisheries from the North Atlantic and West Pacific to the Southern Hemisphere. The southward expansion of intense industrial fisheries exploitation occurred at a rate of almost one degree latitude per year with the greatest expansion occurring in the mid-1980s and early 1990s (Swartz et al. 2010).

Growth of the aquaculture discipline and industry have, not surprisingly, mirrored each other. Preliminary data from over 300 aquaculture-related publications shows the rapid inception of new journals from the late 1980s to the 2000s. Overall, the number of journals and publications has grown in all disciplines. In the recalibrated JSTOR set, we find that roughly half of all peer-reviewed publications were published after 1990. We think that this is consistent across other large scholarly article corpora. Scientific publishing, like many other industries, has faced many changes with the onset of the internet. Journal articles today are accessed online with increasing frequency, and retrieved in digital formats rather than through printed sources (Laakso et al. 2011). The way that journal articles are accessed online has also changed in recent years, particularly with the growth of Open Access publishing between 1993-2009. Since 2000, the annual growth rate for Open Access journals has been 18 %, and 30 % for the total number of published articles (Laakso et al. 2011). The evolving mechanisms for publishing peer-reviewed literature have consequences for researchers in the field, and their authorship track records.

Preliminary results reveal that women occur in low percentages as authors in any position in aquaculture journals, reinforcing results found by West et al. (2013) more generally in science. Women represent 16.1 % of authorship in all positions in the Recalibrated JSTOR Corpus, after correcting for unknowns. The percentage of women authors was comparable for the JSTOR aquaculture subsample (13.8 %) and the journals in the IACD (15.7 %). Women's authorship in aquaculture closely reflects the Recalibrated JSTOR Corpus covering many fields (Fig. 1).

For single-authored papers, the JSTOR Corpus shows an overall decline over time. However, there has been an increase in sole authorship by women. In the JSTOR aquaculture subsample, women represent 11.0 % of single-authored papers since 1913. In the IACD, women represent 11.1 % of all single authored papers since 1990.

Percentages of women in first and last authorship positions were comparable for the publications in the JSTOR Aquaculture subsample and IACD at 15.8 % and 14.4 %, respectively for first authors and 16.5 % and 14.0 % respectively for last authors. First and last author results from the overall

JSTOR Corpus for all fields were slightly higher than for the field of aquaculture at 19.2 % and 19.6 %, respectively.

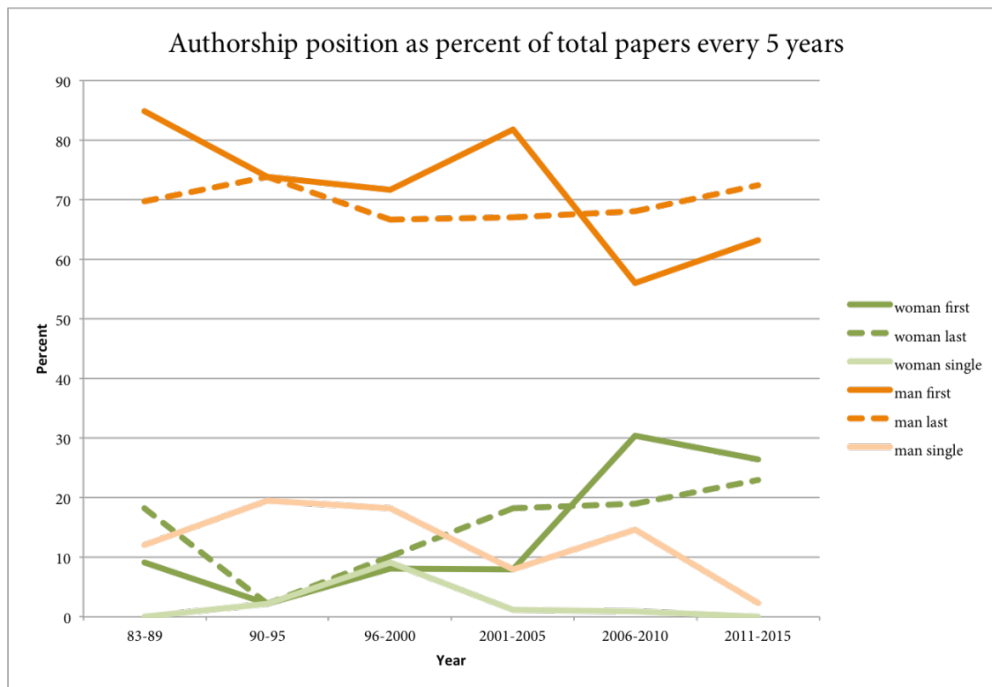


Fig. 1. Results from analysis of the IACD for the gender authorship by first, last, and single-author position as a percentage of the total papers published every five years. Note that only authorships for which gender could be assigned were included, and that gender was only assigned as a binary variable.

Discussion

Comparing the percentage of women authors across all 3 databases reveals a low percentage of women authors with between 13.8-16.1 % of all authorships. The 3 datasets, while skewed towards biological and technical domains of aquaculture, represent a wide range of aquaculture journals that are well regarded within the discipline. These preliminary results for aquaculture echo the findings of West et al. (2013) for women in many fields of science, as well as (Arismendi and Penaluna 2016) on the status of women publishing in the broader discipline of fisheries.

While there are many factors that may explain why women hold a low percentage of authorships across all fields of peer-reviewed literature and in aquaculture, in particular, these results do not reveal the cause. The data reflect

an end-result that is influenced by a number of factors that are not easily studied and have not yet been addressed in the project. One of the main factors is the proportion of women trained and actively working in the aquaculture discipline. Also, recognizing that gender is a social construction, our preliminary work was simplified by binary designations (man-woman; male-female); additional deeper analyses may reveal nuances for other underrepresented groups.

Although the data show a low share of women authors in all 3 datasets, in subsequent work we plan to contextualize these results within the datasets that reveal the population of women professionals in aquaculture worldwide across the time period of focus. Thus far it is known that women have been reported by the World Bank (2008) to comprise 47 % of the total workforce in fisheries yet this is a rough estimate confounded by a paucity of gender-disaggregated data in aquaculture and fisheries overall. Few data are available on the percentage of women in the fisheries discipline. One exception is the study by Arismendi and Penaluna (2016) for the United States of America. In that study, 26 % of federal fisheries scientists and managers, and 31 % of research faculty were women. Until adequate numbers for women in aquaculture and in the aquaculture discipline are obtained, it is useful to apply information from the greater field of fisheries to frame the research.

Next steps involve re-analyzing data from the IACD and JSTOR with the population of women graduates with aquaculture degrees over time, and of a curated population of international professional and student participants in the IACD. The timelines for the 3 data sources will be aligned to represent the time frame of the discipline. Further, the JSTOR subsample dataset will be expanded to include a larger set of aquaculture journals, as well as sub-areas within related disciplines. Additional analysis including comparison of the gender of authorship positions over time in the JSTOR Corpus and JSTOR aquaculture subsample with those in the IACD will also be conducted. These analyses will make the overall findings of the study more contextualized so that more significant conclusions can be made regarding the current status of women in aquaculture and how that status may have changed over time.

Conclusions

These results suggest that gender inequities in aquaculture, specifically in authorship of peer-reviewed literature, exist. While these are very preliminary conclusions, 15 % is a relatively low number for women authorships in aquaculture considering that the proportion of women authorships in the entire JSTOR corpus is 22 %. To understand some of the drivers propelling low authorship participation, we will add further context by examining data on the representation of women in the aquaculture discipline over time, and by geographic region. The IACD may prove a useful tool for social network analyses including assessments of unique very highly networked authors, and of subsequent generations of authorships. The richness of an international curated database lends itself to factoring in variables such as funding and faculty rank, along with other social metrics. The IACD will be further verified against the larger data sets from JSTOR, and the JSTOR conversely will be further examined as a proxy for the IACD. The information in these data sets can be used by other studies to assess the major influences on gender equity in the field of aquaculture. Increasing awareness of the equitable treatment of scientists in aquaculture remains essential for the sustainable growth of the discipline.

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