Examining Diversity Inequities in Fisheries Science: A Call to Action

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A diverse workforce in science can bring about competitive advantages, innovation, and new knowledge, skills, and experiences for understanding complex problems involving the science and management of natural resources. In particular, fisheries sciences confronts exceptional challenges because of complicated societal-level problems from the overexploitation and degradation of aquatic ecosystems worldwide. Here, we examine the status of gender and race or ethnicity among the US fisheries science workforce on the basis of a survey of 498 faculty members from 56 institutions of higher education and 1717 federal employees. Our findings show that women and minorities are still a small portion of tenure-track faculty and federal-government professionals, likely because of systemic biases and cultural barriers. This forum provides a starting point for discussions about how the disparities of diversity in fisheries compares with other disciplines and what might be done to improve the climate and conditions for the successful inclusion of diverse scientists.

Keywords: education, tenure track, environmental sciences, aquaculture, academia

In fisheries science, we often celebrate the biodiversity of species. That celebration, however, exists in tension with the low diversity of gender and race or ethnicity in our workforce. Although the broader natural resources community recognizes the lack of gender and racial diversity as a general problem, progress toward a more diverse workforce has been slow (Brouha 1994, Keefe and Young-Dubovsky 1996, Pierotti 1996, Baker 2000).

The structural inequity of gender and race or ethnicity in the sciences (Vernos 2013, Reuben et al. 2014, EU 2015) and biases against women and minorities exist in some circles (Ginther et al. 2011, Moss-Racusin et al. 2012, Vernos 2013, Reuben et al. 2014). Women are underrepresented in science, publish fewer scientific articles (Martin 2012, Conti and Visentin 2015), and receive less grant funding than men (Vernos 2013). Men who are nonwhite minorities also have low representation in science and less grant success (Ginther et al. 2011). Allowing these inequities to continue may impede the advancement of fisheries science and the development of management practices. Previous research has shown that a diverse workforce generates new ideas, promotes innovation, leads to better problem-solving (Østergaard et al. 2011), enhances scientific productivity (Horta 2013), and increases the chances that the science will be high impact (Freeman and Huang 2015).

Fisheries science faces unprecedented challenges because of complex human–environmental issues from overexploitation and the degradation of both freshwater and marine ecosystems worldwide (Worm et al. 2009, FAO 2014). These challenges demand a collaborative team of professionals (Wuchty et al. 2007) with a broad array of knowledge, skills, and experiences (Keefe and Young-Dubovsky 1996, Pierotti 1996, Cheruvelil et al. 2014). This is particularly important in natural resources, such as fisheries, because diversity in the workforce may be most effective in generating transdisciplinary scientific approaches (Paterson et al. 2010, Cheruvelil et al. 2014) and multifaceted management strategies (Worm et al. 2009).

Here, we examine the status of gender and racial or ethnic diversity in fisheries science in the United States, focusing on academia, with reference to the US government fisheries science. We compiled information about the gender, the race or ethnicity, the graduating and employing institution, and the academic appointment of faculty members (n = 498) from 56 US institutions of higher education (supplemental table S1) by searching faculty webpages (details in the supplemental materials). In addition, we obtained information about gender and race or ethnicity from the federal government fisheries science workforce (white-collar GS-11 to GS-15; n = 1,717) using a Freedom of Information Act Request (details in the supplemental materials). We used the proportion of tenure-track faculty appointments by gender and race or ethnicity as a metric of the changes over time in the inclusion of diversity in fisheries science. We assumed that full professors represent the hiring decisions from two to three decades ago, associate professors from one to two decades ago, and assistant professors from the last 7 years (Tien and Blackburn 1996).

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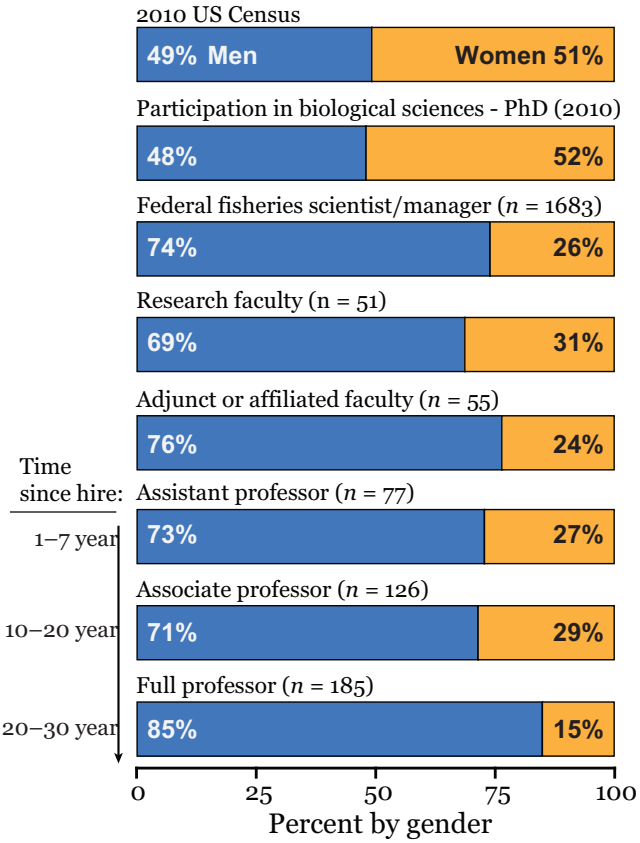

Figure 1. Participation by gender in the US fisheries science workforce. The data for academia came from a webpage search; the federal government data were obtained using a FOIA request. We included information about the participation by gender in biological sciences and population demography as a reference (see details in supplemental material).

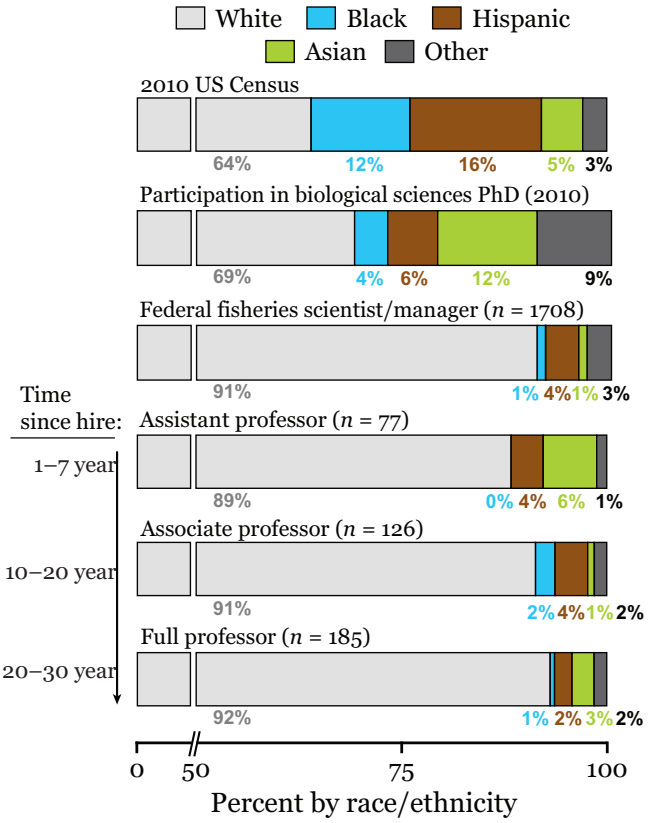

Figure 2. Participation by race or ethnicity in the US fisheries science workforce. The data for academia came from a webpage search; the federal government data were obtained using a FOIA request. We included information about the participation by race or ethnicity in biological sciences and population demography as a reference (see details in supplemental material).

Limited active recruitment and lack of career advancement of diversity in fisheries science

During the past three decades, there has been only a slight improvement in the inclusion of women and those of nonwhite race or ethnicity among the academic fisheries science community (figures 1 and 2). We found that more than 70% of tenure-track faculty in fisheries are men, and over 88% are white (figures 1 and 2, supplemental table S2). The lack of inclusion of both gender and racial minorities in fisheries science academia is remarkably similar to the lack of diversity among fisheries scientists and professionals in the US government (figures 1 and 2, supplemental tables S2 and S3), illustrating the pervasiveness of gender and minority inequality in the US fisheries science workforce. This suggests that this disparity is the result of more than the differences in organizational structure between academia and the federal government. Although many universities and the federal government have recently been limited in their hiring (Stephan 2012), arguably making each hire more significant, our results highlight a continuing gender and race or ethnicity gap, with little or no recent progress toward proportions reflective of the larger US population demography.

A "leaky pipeline" in fisheries science exists at various levels, showing the limited recruitment of women and minorities (figures 1 and 2). The number of doctoral degrees in the biological sciences awarded to women (52%) and nonwhite minorities (31%) has improved in recent decades (Miller and Wai 2015, NSF 2015). This suggests that there are a sufficient number of potential candidates from the changing pool of talent, except for blacks and Hispanics, whose recruitment to the doctoral level appears to have issues. But our findings expose a disparity between men and women and for nonwhite minorities in both tenure-track and federal government positions, suggesting that there is a bottleneck from PhD to employment for these groups. Similar results have been shown for forestry-related sciences, in which women remain underrepresented in academia and the US Forest Service (Kern et al. 2015). The limited recruitment of women and minorities in academia may also be affected by traditional faculty-hiring processes. These processes are

driven by a voting procedure that is most likely controlled by the dominant gender or race or ethnicity of the tenure-track faculty; therefore, it may lead to a disadvantage for diverse applicants and candidates. Ironically, advanced tenure-track faculty are also less likely to have to live with the consequences of their voting decisions over the long term because they are nearer to retirement.

Our results reveal a considerable increase (14%) in women associate professors compared with women full professors that could be a result of multiple initiatives that promoted the inclusion of diversity in fisheries sciences during the 1990s (Brouha 1994, Keefe and Young-Dubovsky 1996, Pierotti 1996). During the most recent decade, however, increases in diversity did not continue, and women and minorities who were already in academia seemed to stall out at entry- or intermediate-level positions. For example, we show that there are 2% fewer women assistant professors compared with women associate professors, and there are only 2% and 3% more nonwhite assistant professors compared with associate and full professors. The biggest gap for women, however, occurs between associate and full professor (14%). After accounting for productivity, educational background, institution type, race or ethnicity, and nationality, women are still 10% less likely to be promoted to full professor than men (Perna 2005). Vague criteria, unclear timelines, lack of good mentoring, and overcommitments to service may result in women and minorities being less promotable toward advanced tenure-track faculty positions. In addition, women also have lifestyle choices related to childrearing that are unavailable to men (Ceci and Williams 2011). The biological phase of decreasing fertility overlaps with a crucial time for any scientist—the formative years of building a work portfolio and launching a career—potentially making promotion more difficult for women (Ceci and Williams 2011).

Across the fisheries science workforce, our findings show that only one in four fisheries faculty or scientists is a woman and one in ten is nonwhite. By region, the Northeast has shown the most progress in the inclusion of women in both the federal government and academia, whereas in the South and Midwest, women remain poorly represented (figures 3 and 4; tables S2 and S3). The greatest gap in the racial or ethnic composition between regional population demography and the fisheries science workforce (figures 3 and 4) exists in the West for both the federal government (38%) and academia (41%), whereas the smallest occurs in the Midwest (15%). Such differential rates of improvement may be due to discrimination and bias, as well as cultural and socioeconomic factors that are barriers to entry. Furthermore, the American Fisheries Society—the oldest and largest professional society in the world representing fisheries scientists—has increased its percentage of nonwhite membership only from 5.5% to 8% in the last 20 years (Brouha 1994, Eva Przygodzki [AFS, Bethesda, MD], personal communication, 1 December, 2015). The representation of women in the Society shows improvement from 9% to 25% (Brouha 1994, Eva Przygodzki [AFS, Bethesda, MD], personal communication, 1 December, 2015).

Cultural barriers to the inclusion of diversity in fisheries science

The desire to build social networks of individuals who are more similar to each other is termed *homophily* (McPherson et al. 2001). In faculty job searches, hiring someone "like them" can come out in discussions of which candidate is the best "fit" for the department or university. Our results show a fisheries science academic network emerging as regionally distinctive clusters in which most of the tenure-track faculty obtained their PhD degrees from the same or nearby institutions (figure 5, supplemental figure S1, supplemental tables S4 and S5). The need for specific expertise of faculty on regional issues, such as Pacific salmon in the West, inland fisheries in the Midwest, or aquaculture in the South, could be one factor that explains this pattern. In fact, the rate of academic institutions hiring their own PhD graduates (academic inbreeding) in fisheries is between 11% and 16% (figure 6), which is four times greater than in mathematics (Stewart 1992) and comparable to levels found during the 1950s for physical and biological sciences (Hargens 1969). In addition, the median distance between graduating and employing institutions is similar across tenure-track appointments (about one-fourth of the distance between San Francisco and New York), suggesting no change in faculty mobility over time (figure 7).

Clustered networks in fisheries due to the prevalence of less-mobile faculty as well as a high rate of academic institutions hiring their own graduates could affect the advancement of innovation in education, research, and management in fisheries. Under such settings, prevailing scientific ideas may be more narrow minded because of limited geographical and cultural boundaries (March 2005) and result in lower scientific productivity (Horta 2013). For example, an examination of 2.5 million scientific papers showed that researchers in the United States are more likely to co-author scientific articles with people of similar ethnicity, but these papers are published in lower-impact journals and receive fewer citations than when co-authors are from more diverse ethnicities (Freeman and Huang 2015). The challenges for faculty that come from academic inbreeding are similar to those for less-mobile faculty (Dutton 1980, Horta 2013).

Biases against the inclusion of gender and racial or ethnic diversity may intensify inequities initiated by a homophilous fisheries academic network. Negative preconceptions about women or minorities can create cognitive or unconscious bias against these underrepresented groups (Moss-Racusin et al. 2012, Reuben et al. 2014). For example, such bias could potentially contribute to women publishing fewer scientific articles than men during their PhDs (Conti and Visentin 2015) and underrepresented groups having less grant success (Ginther et al. 2011, Vernos 2013), leading to a disadvantage at their next career step when applying for employment or promotion. Similarly, scientific articles

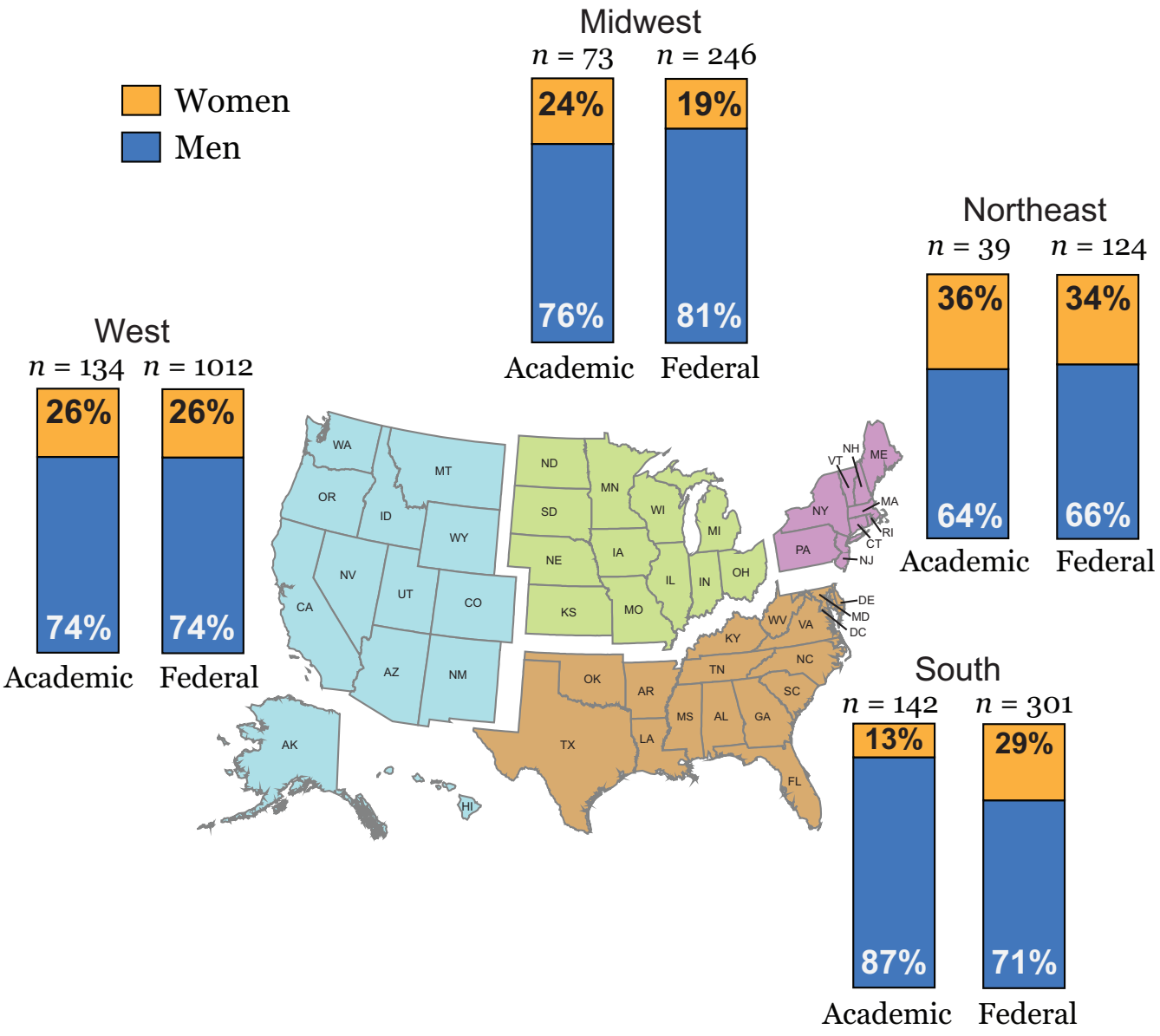

Figure 3. Participation by gender in the US fisheries science workforce by region. The data for academia came from a webpage search; the federal government data were obtained using a FOIA request (see details in supplemental material).

submitted to fisheries science journals with women as first authors are significantly (4%) less likely to be published than those with men as first authors (Handley et al. 2015). Overall, these biases against underrepresented groups are cumulative across the career of a diverse individual, leading to *minority stress*—difficult social situations that cause stress. Scientists and faculty who are women or minorities can feel stress from "being the only one." For example, he or she is the assumed role model for women and minority students, adding more work and time dedicated to mentoring. Therefore, identifying areas of bias and minority stress, independent of cause, is crucial if, as a society, we hope to evaluate and remedy policies and procedures resulting in gender and racial or ethnic inequalities.

Toward an active inclusion and retention of diversity in the fisheries workforce

Obviously, passively ignoring policies and procedures that perpetuate inequality in the fisheries science workforce does not solve the problem. We need to do more than just celebrate diversity. Privilege is often invisible to those who have it, and subtle but powerful biases may not even be noticed until they are eradicated (Meyerson and Fletcher 2000). Because diversity has been systematically underrepresented, we likely need to consider additional ways to systematically include it. We suggest that fisheries may need a top-down approach, in which the provision of diverse role models and mentors at varying levels of authority encourages the continued entry (e.g., strategic hiring) and retention of women and nonwhite minorities.

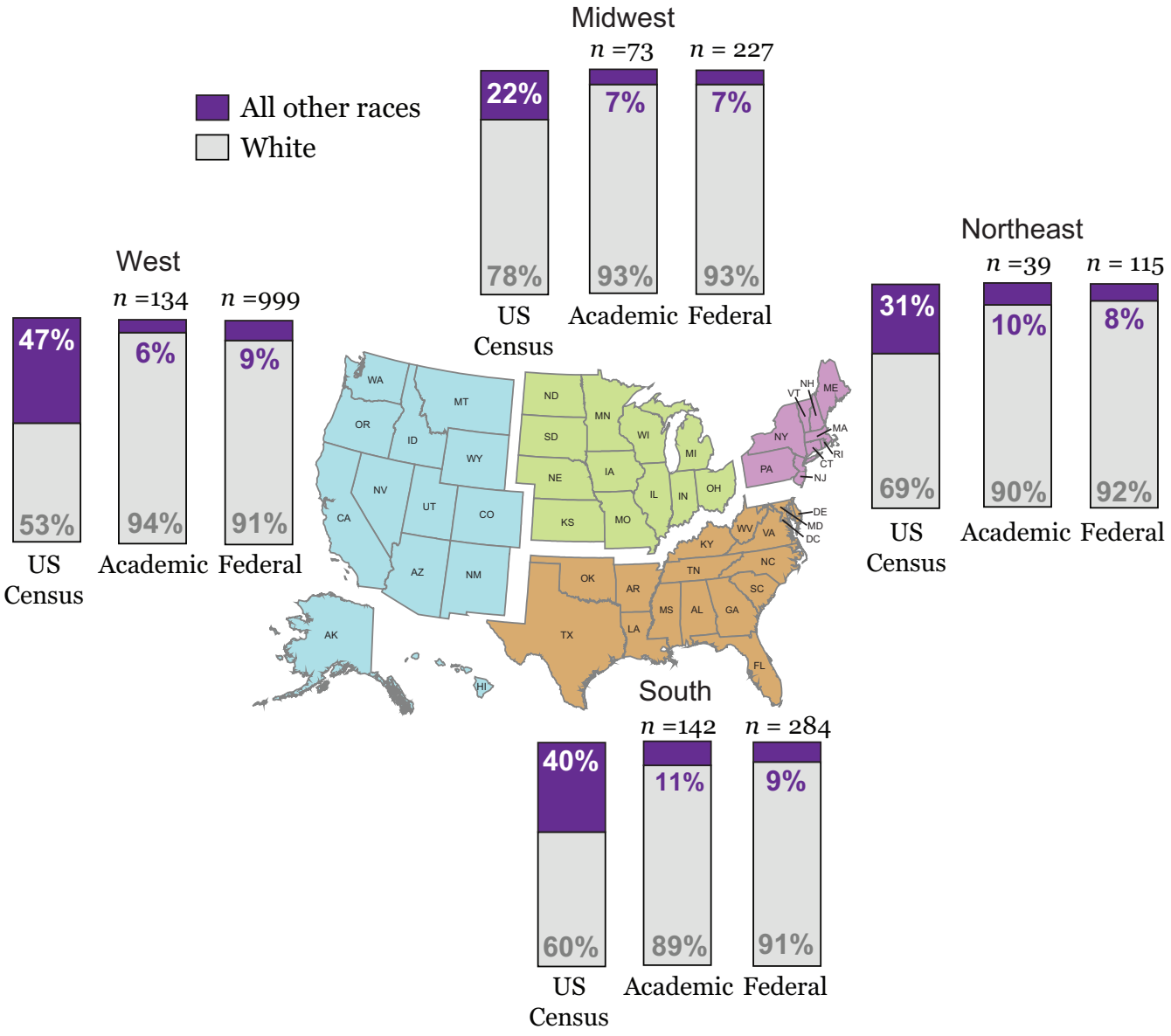

Figure 4. Participation by race or ethnicity in the US fisheries science workforce by region. Data for academia came from a webpage search; federal government data were obtained using a FOIA request. We included information about the race or ethnicity of the US population as a reference (see details in the supplemental materials).

In addition, intervention in the search process for faculty has produced higher numbers of women considered for and offered tenure-track positions compared with searches without this intervention (Smith et al. 2015). The intervention includes three steps: (1) training the search committee to improve their competence in conducting a broad applicant search, (2) increasing the autonomy of the search committee by providing training to avoid unintentional biases during the search process, and (3) providing a search advocate faculty member to the search committee during the entire search process.

Although some universities and agencies are already incorporating diversity in their workforce, the active inclusion of diverse people on an equitable basis will require full commitment from individuals, both in the majority and minority, and their institutions (Holmes et al. 2015). Individuals can learn to counter and eliminate biases and stereotypes that can otherwise lead to microaggressions and discrimination. Institutions may continue to provide clear policy guidelines and appropriate training on how to identify and conduct nontraditional hiring procedures (Smith et al. 2015). The values and practices of scientists and academics in the majority have set the pace, depth, and breadth of science in the past (Kern et al. 2015), and it will be crucial to incorporate them moving forward. New colleagues can be selected on the basis of their knowledge, skills, and experiences to address the disparities in opportunities for women

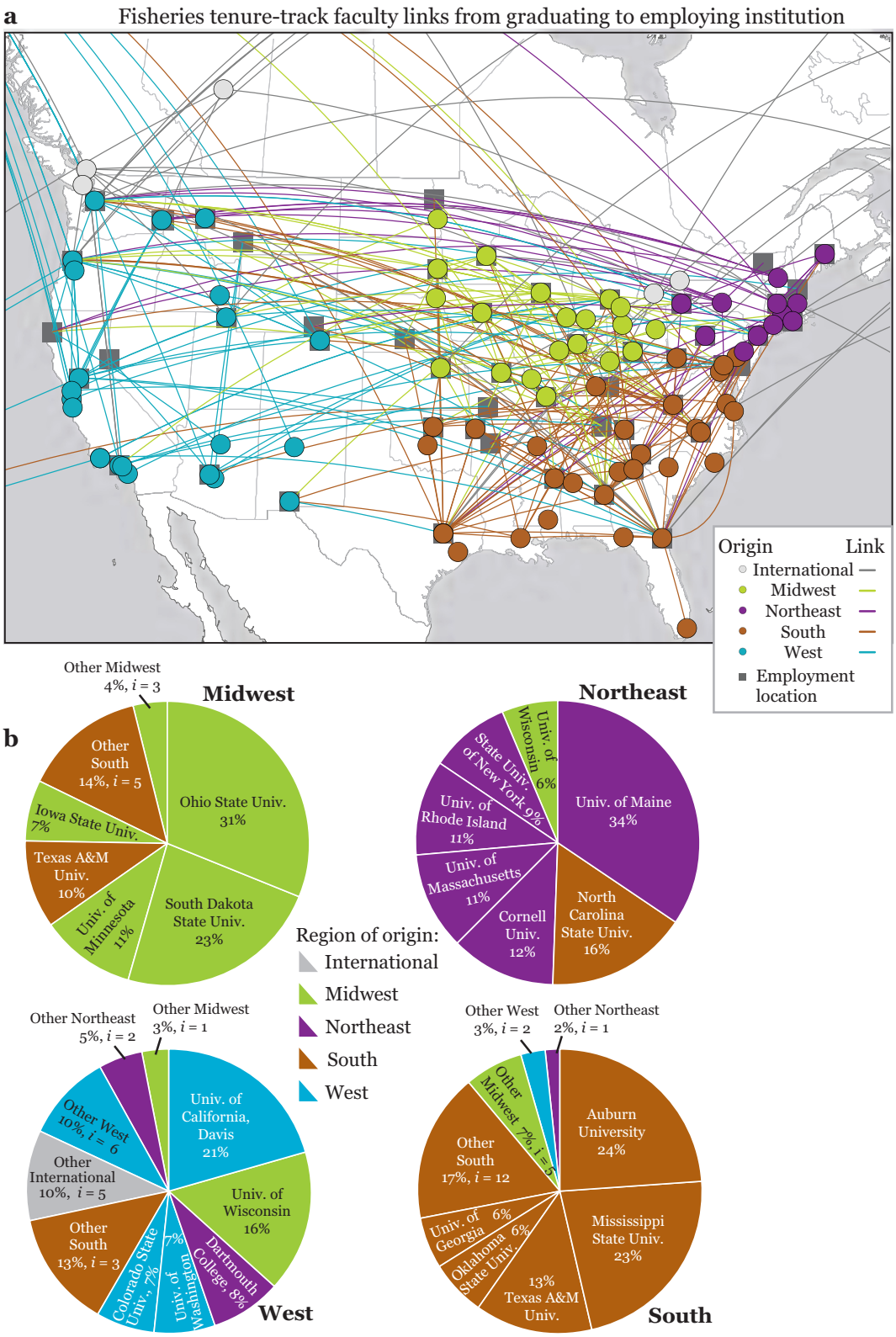

Figure 5. (a) The fisheries science tenure-track faculty network in the United States. Each line represents the link between the graduating (circle) and the employing (square) institution of each individual faculty member (n = 498; figure S1 includes a complete world map); (b) Pie charts highlight graduating institutions that contribute the most to the tenure-track faculty from employing institutions among regions (i = number of institutions). Each pie chart represents the region of employing institutions; the colors represent the region of graduating institutions. Detailed descriptions of the statistical analysis and results are provided in supplemental tables S4 and S5.

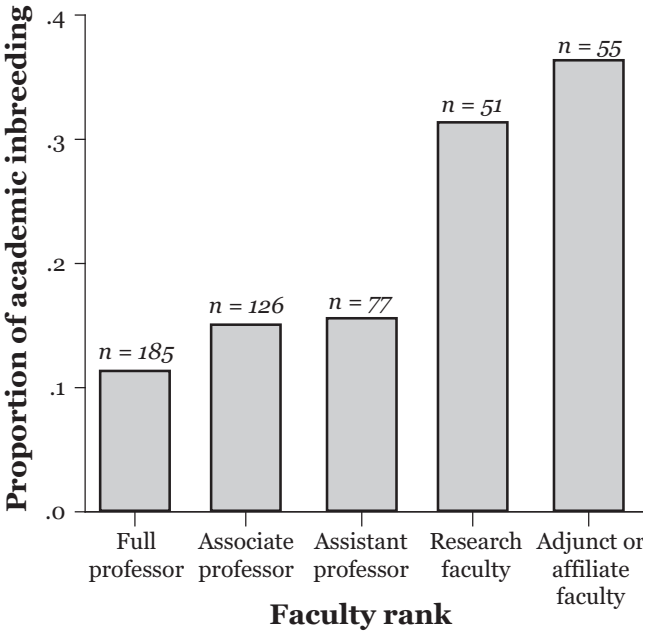

Figure 6. The academic inbreeding rate among tenure-track faculty positions in fisheries science in the United States. The data resulted from a webpage search (see details in the supplemental materials).

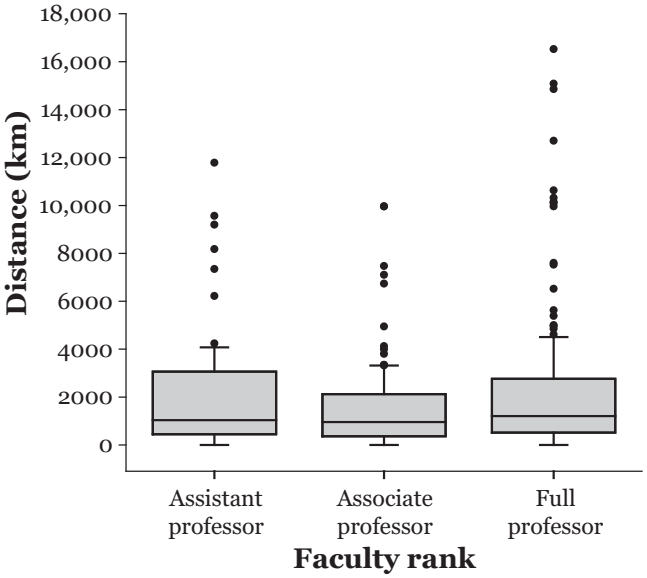

Figure 7. The distance in kilometers (km) from graduating to employing institutions for tenure-track faculty positions in fisheries science in the United States. The data resulted from a Web search. One-way ANOVA on ranks showed statistically nonsignificant differences among faculty positions ($H_{(2, 0.05)} = 4.221$; p = .12; see details in the supplemental materials). Abbreviation: km, kilometers.

and minorities, creating a fundamentally new workplace that is welcoming to diversity.

The promotion and retention of diversity hires is imperative to addressing inequities. Our current path emphasizes bottom-up strategies that have been successful in equalizing the gender disparity of PhD graduates in STEM fields (Miller and Wai 2015). Although these programs need to persist, they are not translating into equality in the fisheries science workforce. The "leaky pipeline" linking STEM graduates with gainful employment has been documented (NSF 2015) and appears to be present in fisheries science. Institutions may require policies that eliminate barriers to success and encourage equal opportunities, including paid family leave, extensions on key responsibilities (grants, tenure-track process, performance reviews), and flexibility in duties (meetings, committees; Holmes et al. 2015). Ultimately, creating a local climate that is welcoming and offers mentorship, opportunities for leadership, clear guidelines for tenure and promotion, and an open community may be important for the retention of diverse individuals.

Conclusions

The fisheries science workforce is strikingly not diverse. Although the enhancement of diversity has progressed, that progress has not been spontaneous. It has required critical self-reflection and overt efforts and appears to be at a standstill. To move forward as a truly diverse and cohesive society, talented women and minorities may need positive discrimination to increase opportunities for success. Simultaneously, we may consider the retention of diverse candidates by fostering a supportive workplace and community. Ultimately, complex human–environmental problems may best be approached with a wider variety of knowledge, skills, and experiences rooted in a truly diverse workforce.

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Supplemental material

The supplemental material is available online at *http://bioscience.oxfordjournals.org/lookup/suppl/doi:10.1093/biosci/biw041/-/DC1*.

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