

Women in freshwater science: challenges and solutions for achieving equity

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The 70th anniversary of *Marine and Freshwater Research* affords the opportunity to reflect on the substantive contribution of women to freshwater science in the past and contemporaneously. This Special Issue complements a similar reflection on the significant contribution made by women to marine science (Gillanders and Heupel 2019). The reflections are timely, given the multinational commitment to the Athena Swan Initiative (see www.ecu.ac.uk/equality-charters/athena-swan) and strategies such as the Women in STEM Decadal Plan (Australian Academy of Science 2019) that are being developed by governments and granting bodies in all regions.

In compiling this special issue, we invited contributions from women freshwater scientists from around the globe. We targeted a range of early-, mid- and late-career researchers and encouraged both male and female co-authors. We left the scope of contributions open, and, as a result, they range from perspective pieces reflecting on the challenges of being a woman in freshwater science to more-traditional research articles. Within the issue, we include research papers reporting findings from experimental studies investigating the effect of land use, first on carbon and nutrient releases associated with floodplain inundation to assess the likely effect on hypoxic blackwater events (Liu *et al.* 2020), and second on propagule banks down the soil-depth profile (Dawson *et al.* 2020). Research papers also explore the timing of, and appropriate methods of sampling to detect, spawning of freshwater fish in the wet–dry tropics (King *et al.* 2020) and whether changes in prey composition have the capacity to affect efficiency of protein synthesis and nitrogen wastage in freshwater fish (Dwyer *et al.* 2020). Two papers develop new conceptual frameworks: one a model of the effect of mass fish-kills on consumers of fish in aquatic streams (McGinness *et al.* 2020) and the other developing a method to place individual management actions (here, environmental watering actions) in a broader spatial and temporal context to identify possible barriers to achieving long-term objectives (Lester *et al.* 2020). Finally, four other pieces explore broader aspects of women in freshwater science: the challenges associated with being a woman in tropical peatland research (Thornton *et al.* 2020), highlight past contributions to freshwater science by women that have been largely overlooked (Downes and Lancaster 2020; Waterton *et al.* 2020), explore the gender bias in measures of research quality and output (Downes and Lancaster

2020), and raise awareness of the risk of avian botulism and identify appropriate management strategies (Brandis *et al.* 2020). As a whole, this Special Issue highlights the breadth and quality of current and past research by women in freshwater science at all stages of their careers.

In this editorial, we take stock of the current state of gender equality in science, as applicable to freshwater science, and provide suggestions for how individuals (both men and women) can proactively contribute to enhance gender equality.

Is the playing field not level now?

In some circles, there is a perception that gender inequality is a thing of the past and that, given time, female representation will catch up. This, sadly, is a myth: it has been widely documented that women encounter gender-specific barriers that often hinder their progression in research careers (Greider *et al.* 2019). Although, in many cases, there is a positive trend towards gender balance (e.g. European Commission 2019), at the current rate it will take decades for women to be equally represented (Holman *et al.* 2018).

There is clear inequality in the career progression and remuneration of women compared with men. Women continue to have a slower average progression through the academic ranks, and are more likely to leave STEM careers (Shaw and Stanton 2012). Furthermore, although men and women are equally represented at an undergraduate level (and have been since the 1990s), the proportion of women declines with increasing seniority. For example, 39% of doctoral graduates in science, technology, engineering and mathematics (STEM) disciplines in the 28 European Union member states are women, declining to 15% of Grade A (full professor level) and 22% of heads of institute (European Commission 2019). Women are also typically paid less than their male counterparts at each level (Joëls and Mason 2014; European Commission 2019), with an 18% average gender pay-gap in European universities in 2017 (Salinas and Bagni 2017). This pattern is reflected throughout the international scientific community and remains stubbornly unchanged: the issue is clearly not a lack of time for change to propagate (Diezmann and Grieshaber 2019).

Institutional structure and unconscious bias both contribute to inequality. Women encounter several obstacles that prevent or

delay them from reaching more senior positions compared with men. These include barriers to scientific productivity and recognition (e.g. lower rates of acceptance for papers, publishing in less-prestigious journals, less grant funding and fewer invitations to conferences due to gender bias) (Anon. 2017; Holman *et al.* 2018; Nittrouer *et al.* 2018; Sheltzer 2018; Astegiano *et al.* 2019, European Commission 2019; Fox and Paine 2019), gendered institutional cultures leading to bias at all stages of professional life (from recruitment and selection, to recommendation, evaluation, promotion, training, and compensation) (Heilman and Eagly 2008; Bohnet 2016; Botelho and Abraham 2017) and social cultures leading to imbalances in caring responsibilities (Howe-Walsh and Turnbull 2016) as well as incorrect and biased perceptions of reduced performance by mothers (Correll *et al.* 2007). Citation metrics, which are increasingly important in the allocation of grant funding, promotions and recruitment are also biased against women (Downes and Lancaster 2020). The playing field clearly remains uneven.

Most of the available statistics do not specifically include non-binary genders but it is safe to assume that the challenges and unconscious (as well as deliberate) bias facing non-binary scientists are likely greater than those identified here for women. In the following sections, we concentrate on the challenges faced by women, but we fully recognise that people of non-binary gender and other under-represented groups face similar challenges and would benefit from similar initiatives.

What can individual researchers (men and women) do to promote gender equity?

Being proactive is key to bringing about change. We all play a part in creating, supporting and, where necessary, changing the culture of our workplace. It is easy to assume that individual researchers can have little impact on the status quo. But institutional change, while necessary, is usually a slow process and, in the meantime, individuals can achieve much. Nurturing a culture of openness to change and gender equality can create a positive social climate for inclusion. A culture of approaching gender equality with both an open and scientific attitude, and the willingness to experiment and measure outcomes, creates the best climate for progress (Kang and Kaplan 2019). Thus, the challenge for individual researchers, whether men or women, is to recognise their role in maintaining (or changing) the status quo and to find motivation to offer a more-equitable environment for the women with whom they interact.

I am only one,
But still I am one.
I cannot do everything,
But still I can do something;
And because I cannot do everything,
I will not refuse to do the something that I can do [Edward Everett Hale, 1822–1909].

Taking action as an individual to provide a more-equitable environment often requires a more-deliberately thoughtful approach, rather than wholesale change. For many researchers, bias is unconscious, rather than deliberate, but this does not negate its impact. Recruitment, collaboration, mentoring and creating a culture of work–life balance are all areas in which meaningful change can be made reasonably easily.

Recruitment and job advertisements are an obvious starting point for individual academics. It is well established that writing numerous selection criteria in advertisements is likely to discourage women, who are more likely to respond when they are confident that they meet every criterion, whereas men are likely to apply if they consider they meet 60% or more (Mohr 2014). In many fields, female recruitment rates suggest that this caution is warranted. There is now a growing trend in recruitment to offer the opportunity to provide short video statements on an area of passion, instead of addressing numerous selection criteria. There are online tools to help identify unconscious bias in the workplace, which can assist, for example, by assessing the gendered nature of the language used in the wording of the advertisement (e.g. <http://successinstem.ca/resources/>; <https://biasinterrupters.org/>; Gaucher *et al.* 2011). Specifically advertising flexibility in work hours or fraction thereof can encourage more women to apply (Australian Human Rights Commission 2013). At the time of short-listing, an explicit assessment of the gender balance of that list is increasingly common practice. If there are no women able to be shortlisted, this should be recognised as a failing of the advertising or description of the position on behalf of the advertising institution, not a sign that there are no appointable women in that field. This failing should then be rectified by actively seeking appointable women and encouraging them to apply before filling the position.

Another area where individual researchers can implement change is to consider the gender balance of their collaborators. On a personal level, it can be instructive to calculate the proportions of female and male collaborators in your own publication history, or current list of collaborators. In many fields, the relative proportion of women to men is published (e.g. see Anon. 2018). How does your track record compare to the average? Are you offering a representative number of collaborative opportunities to women compared with that average? If not, how could you address that? It is a common justification that working with more senior academics will include a disproportionate number of males on publication lists – should that not mean that additional talented but more junior women should also be included? Such a comparison of collaborators can also be done during an interview process. Lists of co-authors are provided in most applications. The ratio of male to female co-authors for applicants can be calculated and compared. Applicants can be asked to justify any imbalance and identify mechanisms by which they could work to correct any bias. This sends a strong signal of commitment to gender equity and ensures that new personnel are aware of the issue and engaged to play their role to address it.

Mentoring, sponsorship and feedback is another area under the control of individuals. Women are less likely to be mentored, less likely to be sponsored and less likely to be asked to apply for positions than men (Sheltzer and Smith 2014; Schrouff *et al.* 2019). There is also evidence that the advice and feedback received by females in the workplace is less specific and less actionable than that received by males (Sanders *et al.* 2017). Programs can be set up within institutions to address this, but individual researchers can also consider their own practice. Whom do you mentor? Whom do you promote internally as an emerging talent (and so sponsor)? What feedback do you provide? Do you give detailed, constructive criticism where

appropriate to provide an avenue for extension and improvement? Actively encouraging women who may not have experienced such mentoring or sponsorship in the past and proactively offering that support, rather than waiting to be asked, may be a turning point for a talented scientist.

Finally, setting an example of work–life balance in the workplace can be incredibly important for early-career researchers (Australian Human Rights Commission 2013). Many freshwater scientists (and scientists more generally) work inordinately hard, often to the detriment of their family and personal lives, with many popular articles focusing on the need for better work–life balance (e.g. Fullman 2017). It can be very difficult for junior researchers to meet family and other commitments if the example set within the workplace is of myopic commitment to research. Setting an example to normalise work–life balance, along with family and personal duties, can signal to younger researchers, including women, that they can make an important contribution to science while balancing caring and other responsibilities, as well as mental, emotional and physical wellbeing. My (R. E. Lester) own personal experience of reducing my work hours for family reasons was actually of increased productivity and creativity. I found that having an additional day per week at home seemed to allow my subconscious the opportunity to mull problems and research questions, and I would return to work with a new perspective and new ideas in a way that I had not managed previously, or since my return to fulltime work. For me, that was wholly unexpected, but it is supported by the evidence (e.g. see Fullman 2017). But, seeing examples of successful researchers (especially women) who do achieve a balance in their lives can help younger researchers perceiving science as compatible with family life and encourage them to remain in the profession.

The surprising benefit of applying some (or all) of these techniques for the individual may be the benefit to that individual themselves (no matter their gender) – they may find that they work in a more-productive, better-balanced team that challenges them with new, exciting ideas and paradigms, leading to better quality science output overall.

How individual women in science can maximise their opportunities

Before providing advice on how individual women can maximise their opportunities, we must acknowledge that such advice can be hard to give without sounding condescending. Long-standing suggestions that women can individually address gender inequity (e.g. by ‘leaning in’; negotiating better, talking more in meetings, and being more assertive; Babcock and Laschever 2003; Moss-Racusin and Rudman 2010; Brescoll 2011; Sandberg and Scovell 2013) to create their own opportunities can underestimate the institutional and other barriers. Furthermore, many such solutions that attempt to ‘fix’ the women are themselves highly biased, in that they train women to act more like men because the actions of men are more valued and perceived as the ‘correct’ way to succeed (Kang and Kaplan 2019). This can result in a backlash because, while such behaviours are regarded as signs of strength in men, they violate expectations of warmth and so-called ‘feminine niceness’ in women and lead to women being perceived as aggressive or bossy (Butler and Geis 1990). Speaking out about perceived or

real injustices can, sadly, still be a career-limiting move. Thus, attempts to address the balance of power and influence at the individual level is challenging and may be counterproductive within a system that is systematically biased against women. But complying with the status quo negates the benefits of diversity and there are ways that individuals can incrementally influence the opportunities that are available to them. These include accepting offers of assistance, finding ways and places to ask for support, engaging in the gender-equality movement, recognising the power of being a role model for others and better celebrating successes.

A simple (perhaps simplistic) approach is to accept advice or assistance when it is offered. Women are typically less forthcoming than men when it comes to asking for help (Babcock and Laschever 2003). Individuals will be busy and may be perceived as important, but many are motivated to assist younger researchers, and women in particular, and are often keen to repay past assistance by paying it forward. So, if someone offers to look over a grant application, a manuscript, or whatever else, take them up on the offer. Recognise that mentors often derive as much benefit from the relationship as a mentee, in self-reflection, professional development and satisfaction in seeing a mentee grow (Kalpazidou Schmidt and Faber 2016). Formal recognition for mentoring and other support of junior academics is often available at an institutional level (e.g. recognition of service roles in promotions, funding applications) (Greider *et al.* 2019), so the benefits do not all flow towards the researcher assisted.

Imposter syndrome, gendered conditioning of acceptable behaviours and many other factors can make difficult actively seeking help and mentoring, and network building and use. Asking for support (either time or financial) to attend training in these (or discipline-specific) areas is hard for the same reasons (e.g. Hewlett *et al.* 2010). Recognising one’s own strengths, particularly as a scientist, can be a starting point. Acknowledging the journey of others – that they too once needed mentors and others to help them reach their current position (and likely still rely on similar such support) – can make senior figures seem less imposing. Learning to accept that a refusal, or occasional ungracious response, is not personal, can make asking less intimidating. Finding safe, welcoming spaces to seek advice, support and encouragement, wherever those are, can make other situations more tolerable. Science can be incredibly challenging as a career choice – the competition and pressure are relentless, rejection is often the norm and feedback can be insensitive or downright rude. Ensuring that a love of the discipline (and a thick skin) outweighs the often-negative culture can help support individuals, but also motivate them to challenge the status quo to make science a more empathic pursuit.

It can also help to engage in the movement to address gender (and other) imbalance. Preparing this editorial has been enlightening for me (C. M. Rosten). Seeing that the obstacles that I have met during my career are typical for women in STEM careers empowers me to ‘battle on’ towards my scientific goals. Knowing that I am not alone and, indeed, engaging in what I have discovered to be a significant positive movement for change is inspiring. Many high-profile journals now have portals for promoting the contributions of women in science

(e.g. www.thelancet.com/lancet-women; www.springernature.com/gp/researchers/campaigns/women-in-science). Various fora exist to enhance networking and debate between women scientists (e.g. The European Platform of Women Scientists, see <https://epws.org/>; The International Network of Women Engineers and Scientists, INWES, see www.inwes.org/) or promote high-profile women scientists (e.g. AcademiaNet, see <https://www.academia-net.org/>; Wikipedia, cf. Wade and Zaringhalam 2018). Finding ways to connect with other women in science and contribute to addressing gender imbalance can provide individuals with support and improve networks, while simultaneously developing opportunities for other women.

As individual women progress through their careers, it can be surprising to be perceived as a role model. That perception should not be dismissed. It is an opportunity to encourage the next generation of women and try to make the pathway a little easier for those who follow. Sharing stories of past difficulties and challenges can be empowering for younger researchers who may have felt isolated attempting to deal with similar issues in their careers. It can also be an opportunity to reflect on your own achievements and journey so far.

Finally, we should celebrate each other! We have much to celebrate. Women typically do not engage in self-promotion of their science to the same degree as men (Lerchenmueller *et al.* 2019). By creating awareness of the behavioural differences between men and women in scientific self-promotion, perhaps it will be easier for women to take the plunge and promote their science. In the meantime, we (men and women) can make a point of actively promoting the research and successes of female colleagues and peers. This Special Issue is intended to act as such a celebration of women's contribution to freshwater science.

Conclusion

It is well established that the supposed meritocracy is a fallacy that leads to a lack of diversity in science, management and any number of other fields (Kang and Kaplan 2019). Unconscious bias continues to result in the promotion and nurturing of new entrants who resemble the existing practitioners, in appearance, outlook and ideas. Women continue to be under-represented in the senior ranks of science in general, and life sciences in particular, along with representatives of other cultures, sexualities and genders. This is to the detriment of science, with less diverse ideas explored and existing paradigms less likely to be challenged from a new perspective (e.g. see Warkentin 2018). Our challenge is to leverage the great contribution made by the women such as those featured in this Special Issue and to ensure that the 80th anniversary of *Marine and Freshwater Research* can be celebrated by acknowledging the great strides that have been made in increased gender and other diversity in science. We all have a role to play if we are to achieve that goal.

Conflicts of interest

R. E. Lester and C. M. Rosten are both guest editors of the Women in Freshwater Science special issue and are Associate Editors for *Marine and Freshwater Research*. Despite these relationships, they took no part in the review and acceptance of this or any other manuscript in this issue that they authored. The authors declare that they have no further conflicts of interest.

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