

# Gender and early career status: variables of participation at an international marine science conference

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Conference participation is an important part of academic practice and contributes to building scientific careers. Investigating demographic differences in conference participation may reveal factors contributing to the continued under-representation of women in marine and ocean science. To explore the gender and career stage dimensions of participation in an international marine science conference, preferences of presentation type (oral/poster) as well as acceptance and rejection decisions were investigated using 5-years of data (2015–2019) from an International Marine Science Conference. It was found that early career scientists were more likely to be women, while established scientists were more likely to be men. Although overall, gender did not show a significant effect on the decisions to “downgrade” requests for oral presentations to poster presentations, early career scientists were significantly more likely to be downgraded than established scientists. Given that more women were often early career scientists, more women than men had their presentations downgraded. Other indicators and evidence from conference prize-giving and recognition awards point to a gender gap remaining at senior levels, highlighting the need for further actions as well as monitoring and researching conference participation from a gender perspective.

**Keywords:** abstract acceptance, early career, gender, marine science, ocean science, oral, poster, presentation, science conference participation, scientists.

## Introduction

### Gender

Science has been historically dominated by men (Jones, 2019), although with important advances for women achieved over the past 100 years (Saini, 2017; Horrocks, 2019). Despite these positive trends, women continue to be under-represented in sciences, including marine and ocean sciences (UNESCO, 2015; Huang *et al.*, 2019; IOC-UNESCO, 2020; Giakoumi *et al.*, 2021), and face a multitude of challenges for career progression and in leadership positions (Shellock *et al.*, 2022). Such challenges may be observed in a variety of scientific opportunities that women may access during their careers, such as scientific conferences. Scientific conferences are an important part of academic practice, with a tradition dating back at least to the 17th century (Hauss, 2020). Conferences can provide the venue for communication processes that have been shown to lead to the production of scientific knowledge [Lamour *et al.*, 2013, and can provide participants with increased visibility, new skills, ideas, and contacts (Cherrstrom, 2012; Oester *et al.*, 2017)]. Conferences bring scientific communities together, facilitate networking with others working in the discipline or field, and provide opportunities for the initiation of new collaborations and career development (Walters *et al.*, 2019). International conferences provide opportunities to engage with a more geographically and/or culturally diverse group of people than in a local setting. They therefore have a multitude of scientific and societal implications (Hauss, 2020).

### Early career

People in early career stages also face discrimination and bias [Implicit or unconscious bias is a phenomenon that recognizes behaviours and attitudes may not always operate consciously, and can lead to discrimination of specific groups, with negative stereotypes unknowingly influencing associations with e.g. gender, race, or age (Greenwald and Banaji, 1995).] in marine and ocean science. A survey of Early Career Ocean Professionals (ECOPs) (Here we adopt the term Early Career Ocean Professional in an effort to be as inclusive as possible, recognizing people in early career stages may be pursuing various career paths and in the literature are variously referred to as Early Career Scientist, or Early Career Researcher.) reports major economic barriers, including unpaid work and harassment, contributing to mental health issues (Osiecka *et al.*, 2022). These types of structural challenges faced by ECOPs have been exacerbated by the COVID-19 pandemic, and access to networking opportunities is an important part of ECOP well-being (Schadeberg *et al.*, 2022). Conference attendance for early career participants may be influenced by demographics, where participants from minoritized groups may face systemic or other types of bias and discrimination, as well as issues related to accessibility and the purpose or value of attending (Timperley *et al.*, 2020). ECOPs help to develop marine and fisheries science, with important contributions to the peer-reviewed literature (Smoliński *et al.*, 2022). Valuing and ensuring ECOP representation in scientific societies is important, given their important contributions and

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volume of work; their views should be included in shaping future research directions (Bankston *et al.*, 2020). Conference participation can be an important first exposure and engagement of ECOPs in a scientific society.

### Gender representation at conferences

Conference participation should be open to all members of scientific communities to participate on an equal footing (Tulloch, 2020). For people in early career stages, participation at conferences is an important part of building an academic career, though if conferences have not explicitly considered how to cater for and include ECOPs, the experience of participating can leave them with the feeling of having invested a greater amount of energy than benefit gained (Ridde and Mohindra, 2009). Academic science conference attendance can help establish reputations and bolster careers (Leon and McQuillin, 2020), and balanced gender representation at conferences is important both as a matter of equality, but also as a measure working against the implicit bias prevalent in science (Calaza *et al.*, 2021). Balanced gender representation at conferences also positively influences the social climate and ultimately the perception of the scientific community, which may influence the retention of women (Biggs *et al.*, 2018).

### Women in marine science conferences

A balance of genders in conference participation may not automatically translate into equal outcomes in terms of visibility or voice. There are examples in North American contexts that document that even in academic societies where women are well represented, there is evidence of continuing bias towards male contributions, with men giving more oral than poster presentations and women giving more poster than oral presentations (Isbell *et al.*, 2012). A study of verbal contributions at German sociological conferences found gender differences in word density, with the length of women's contributions increasing when a majority of women are present and decreasing word density with age. No such effect is present for men, highlighting "...the importance of social context for gender-related features of communication" (Kriwy *et al.*, 2012, p. 1). Women are also frequently underrepresented in highly visible and coveted conference roles, such as distinguished or keynote speakers, as demonstrated by Farr *et al.* (2017) in their study of the gender gap at professional ecology conferences. The gender of the organizers of symposia can also influence the gender balance of participants (Isbell *et al.*, 2012). Where conference participation is gender-balanced by attendance, equal visibility of women at conferences is not guaranteed; some studies have shown that women are self-selecting less visible presentation styles (Jones *et al.*, 2014) and more likely to reject invitations to speak (Schroeder *et al.*, 2013).

### Downgrading to posters

Given the high-volume of scientific information available at an international science conference, poster presentations are often associated with lower levels of prestige, as they compete for attention among conference participants, and with low-visibility constrain opportunities for networking (Rowe and Dragan, 2015), which is an important reason for ECOPs and all participants to attend international science conferences (Oester *et al.*, 2017). While posters may suffer from a lack of prestige in the conference setting, they are an important part of social academic practice. Accepted posters provide access

to the conference experience, allowing new researchers to develop presentation skills, and can meet the threshold for an employer to provide travel funding for physical participation at the conference (MacIntosh-Murray, 2007).

If women are disproportionately self-selecting less prestigious poster presentations at conferences and engaging differently than male counterparts in other aspects of academic practice, this may contribute to the "Matilda effect" (the systematic undervaluation of the scientific contributions of women; Rossiter, 1993) with potential implications for funding and other metrics of academic success (Jones *et al.*, 2014).

### Objectives of this study

To explore the different kinds of involvement of women and men in scientific conferences, this paper reports on research that explores the gender and early career dimensions of participation in the ICES ASC, investigating preferences of presentation type as well as acceptance and rejection decisions. Using anonymized data from the ICES ASC submissions over a 5-year period from 2015 to 2019, we investigate whether the fate (reject/accept—oral/poster) of the abstracts is influenced by whether the submitter is an early career professional and their gender. We discuss the results in light of the notion that, for many conference participants, an oral presentation has more prestige than a poster presentation (MacIntosh-Murray, 2007).

### Case study: ICES annual science conference 2015–2019

The International Council for the Exploration of the Sea (ICES) is an intergovernmental marine science body with a focus on the North Atlantic Ocean and adjacent seas. Each year ICES organizes an annual science conference (ASC) with an open call for abstracts across a wide-range of up to 18 parallel marine science themes. The annual conference attracts 500–700 participants; three keynote presentations are given, and participants share their research findings through posters or oral presentations. Recognition of scientific merit is awarded for the best presentation, the best poster, the two best early career presentations, and the one early career best poster (Merit Awards Section).

When submitting abstracts to the ICES ASC via an online submission system, submitters can express their preference for an oral or poster presentation. Theme sessions are proposed by conveners, and following acceptance of that theme session by the scientific committee, conveners have the responsibility to decide whether to reject or accept an abstract submitted to their session and, when accepted, whether it is for an oral presentation or a poster\*. When time slots for oral presentations are limited, conveners may decide to accept abstracts as posters, despite the submitter's preference for an oral presentation. In other cases, decisions to "downgrade" a requested oral presentation to a poster, may reflect that an abstract is evaluated as not communicating sufficient quality to be awarded an oral presentation slot.

### Method

Data were extracted from the ICES database on ASC abstract submissions for the years 2015–2019. The period of study was

\* 2020 ICES Annual Science Conference Guide for Conveners. Unpublished guidelines.

chosen to match the implementation of the fully online digital submission system, including the associated decisions on acceptance and rejection.

The data extracted included the abstract submitter's name, self-identified early career scientist status (yes/no), abstract submitter presentation preference (poster/oral), convener decision (accepted/rejected), and presentation preference received (yes/no). The analysis focused on the individual submitter (presenter) of the presentation, although the majority of submissions represent multiple author contributions. Assignment of gender based on first name was conducted *post hoc*, using the software *genderize.io*. This method of gender inference limits gender to the binary (male/female), excluding other gender identities, and can potentially misidentify gender for unisex names, introducing additional potential bias (Lockhart *et al.*, 2023). However, in the absence of self-identified gender data, *genderize.io* is an accessible tool suitable for this context (Santamaría and Mihaljević, 2018). Country/regional information was collected in the abstract submission database by use of a free text field, with a high variation in the type of information provided by submitters. With high-researcher mobility, and the data collected not necessarily intended to reflect county of origin, this parameter was not utilized in the gender inference process. Each record and the associated gender inference by first name receive a value calculated by the tool that indicates the confidence of the inferred gender. Records that resulted in a confidence value of >80% (37 records) were checked by internet searches with gender identity inferred from publicly available images on the internet (e.g. Research Gate).

A randomized validation exercise was conducted to compare the results of the gender inference of the *genderize.io* package with manual searches (see Supplementary Materials). Given 1952 unique persons in the dataset, we used a random number generator (<https://stattrek.com/statistics/random-number-generator>) to select IDs to verify inferred gender manually through internet searches. We checked 100 IDs, equivalent to ~5% of the unique IDs. A table of 100 numbers was produced according to the following specifications: Numbers were randomly selected from within the range of 1–1952, and duplicate numbers were not allowed. Manual internet searches used all available information, including both first and last name and, in one case, looking back to the original abstract to find the full name, resulting in 100% verification of inferred genders for all IDs checked. Where gender could not be inferred, records were excluded from the analysis (three records were removed). Following the assignment of gender (limited to male/female), unique identification numbers were assigned to individual persons, prior to removal of the names from the dataset as part of the anonymization process in advance of the analysis.

The data were analysed in R version 4.0.2. (R Core Team, 2020). We used generalized linear mixed effects models (GLMM) and the *lme4* package (Bates *et al.*, 2015) to explore if the covariates gender or career stage [i.e. Early Career (EC) or Established Scientist (ES) (Established scientist used as a label here, but recognizing not all professionals attending the conference may be scientists.)] showed a significant effect on abstract acceptance or rejection, presentation preference (poster/oral), or presentation type allocated, with random intercept of unique identification number, to account for those who attend the conference regularly, and/or submit more than one abstract in a given year.

After an initial review of the data, it was decided to analyse all 5-years of data as a single sample, identifying a major increase in rejection rates for 2018–2019 and limiting comparability between years. This increase in rejection rates was the result of a policy change implemented by conference organizers in 2018, mid-way through the sample period, to limit the length of theme sessions, restricting available time slots for oral presentations.

## Results

There were 1242 female (46%) and 1510 male (54%) abstract submissions ( $n = 2752$ ), comprising 1952 unique persons/unique identities (the same individual may have attended more than one conference or submitted more than one abstract). On average 148 posters [ $\pm 4.4$  (SE)] and 330 oral presentations [ $\pm 10.6$  (SE)] are given, each year (2015–2019)].

### Gender and career stage of submissions

Focusing first on the career stage (of all submissions), we found that EC were more likely to be female (687 females and 558 males) and ES were significantly more likely to be male (555 females and 952 males) [GLMM ( $p < 0.01$ ) see Supplementary Materials for model outputs].

### Rejection rate

Of the total submissions, 6% ( $n = 168$ ) of female submissions and 7% ( $n = 193$ ) of male submissions were rejected. Of the total submissions, 7% ( $n = 187$ ) of EC submissions were rejected (female  $n = 110$  or 8.9% of all female submissions, and male  $n = 77$  or 5% of all male submissions), and 6% ( $n = 174$ ) of ES submissions were rejected (female  $n = 58$  (4.6% of all female submissions) and male  $n = 116$  (7.7% of all male submissions)). When we looked at the effects of gender and career stage on the rejection rate we found the effect of gender was not significant, but the effect of career stage (EC) was significant [GLMM ( $p = 0.02$ ) see Supplementary Materials for model outputs].

### Presentation preference

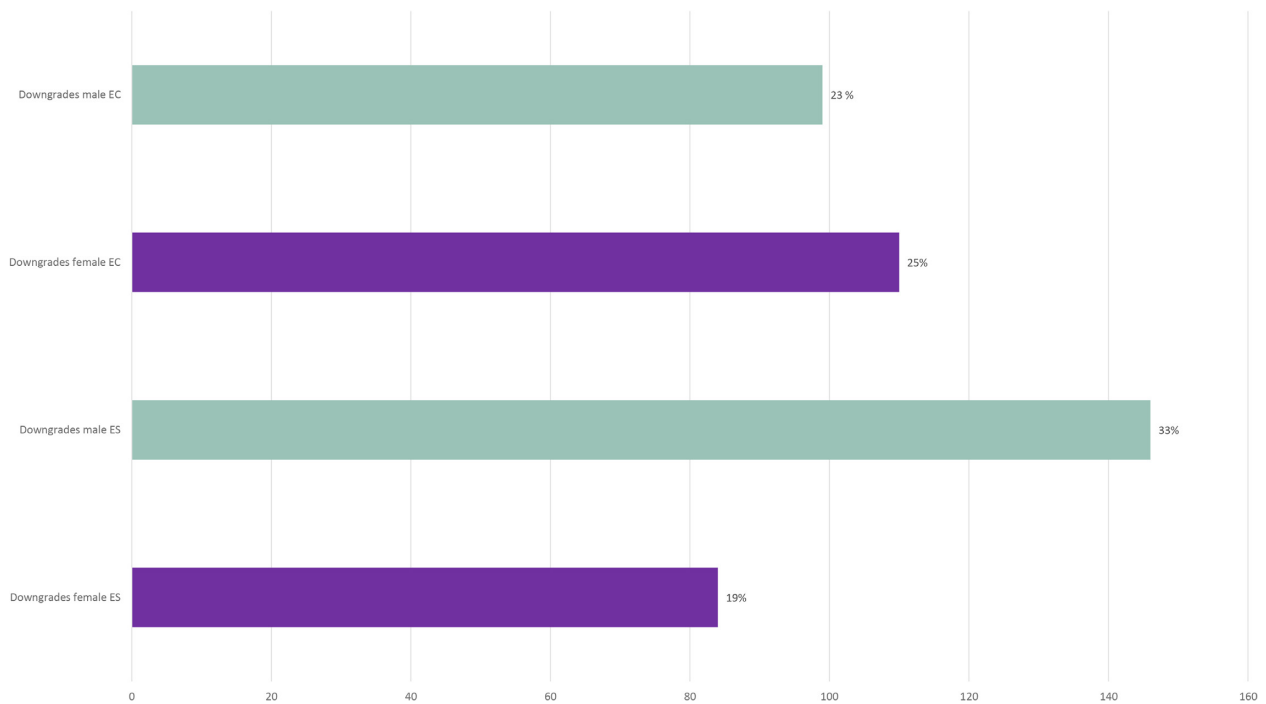
EC submitted requests for 1023 oral presentations and 222 poster presentations (45% of the total submission); of these submissions, 187 (144 oral presentations and 43 poster presentations) were rejected. ES submitted requests for 1325 oral presentations and 182 poster presentations (55% of total submissions); of these 174 abstracts (145 oral presentations and 29 posters), 29 were rejected.

### Downgrades

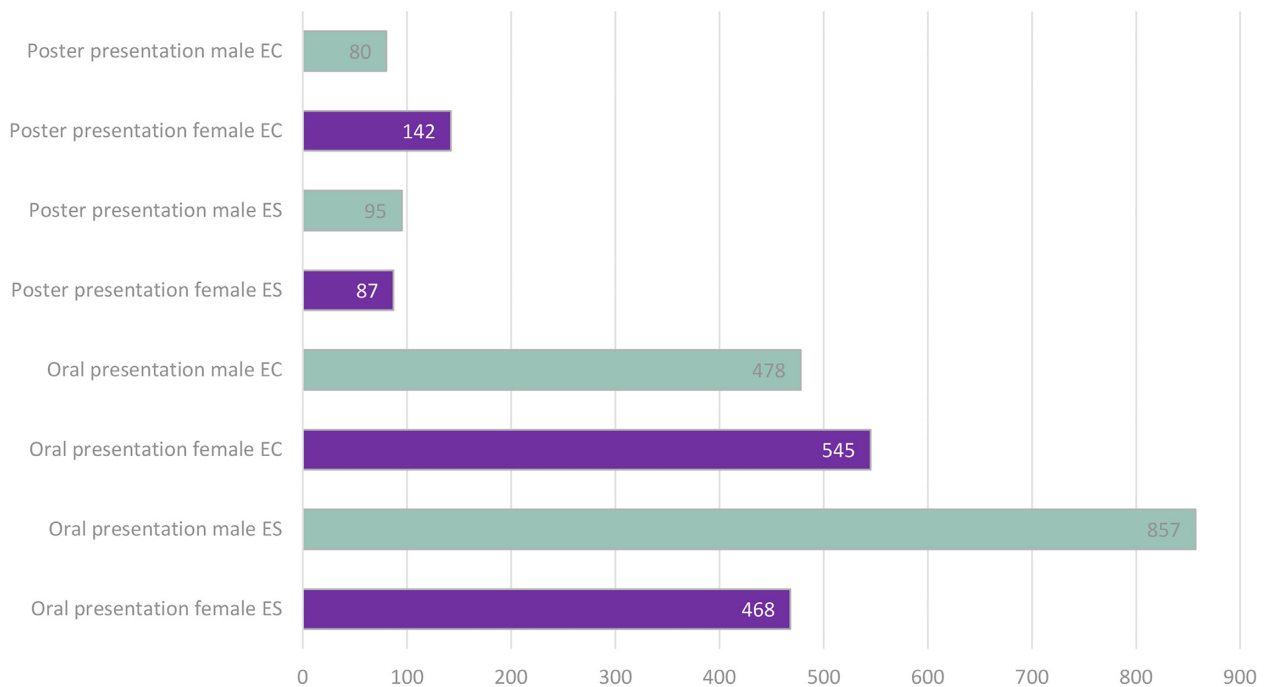
Some requests for oral presentations ( $n = 439$ ) were “downgraded” to poster presentations (see Figure 1).

Using the GLMM model, we found no effect of gender on the “downgrading” decision; only the effect of EC was significant [GLMM ( $p = 0.05$ ) see Supplementary Materials for model outputs]. The interaction effect between the fixed effects was not significant [GLMM ( $p = 0.43$ ); see Supplementary Materials for model outputs].

Many more abstracts were submitted for oral presentations ( $n = 2348$ ) than poster presentations ( $n = 404$ ). The lme model was also used to explore if there was a preference for presentation type by gender or career stage (see Figure 2), and no evidence of a gender [GLMM, ( $p = 0.12$ ) see Supplemen-



**Figure 1.** Proportion by gender and career stage of accepted submissions that preferred oral presentations and were downgraded to poster presentations (ES = Established Scientist, EC = Early Career; x-axis = number of downgrades).



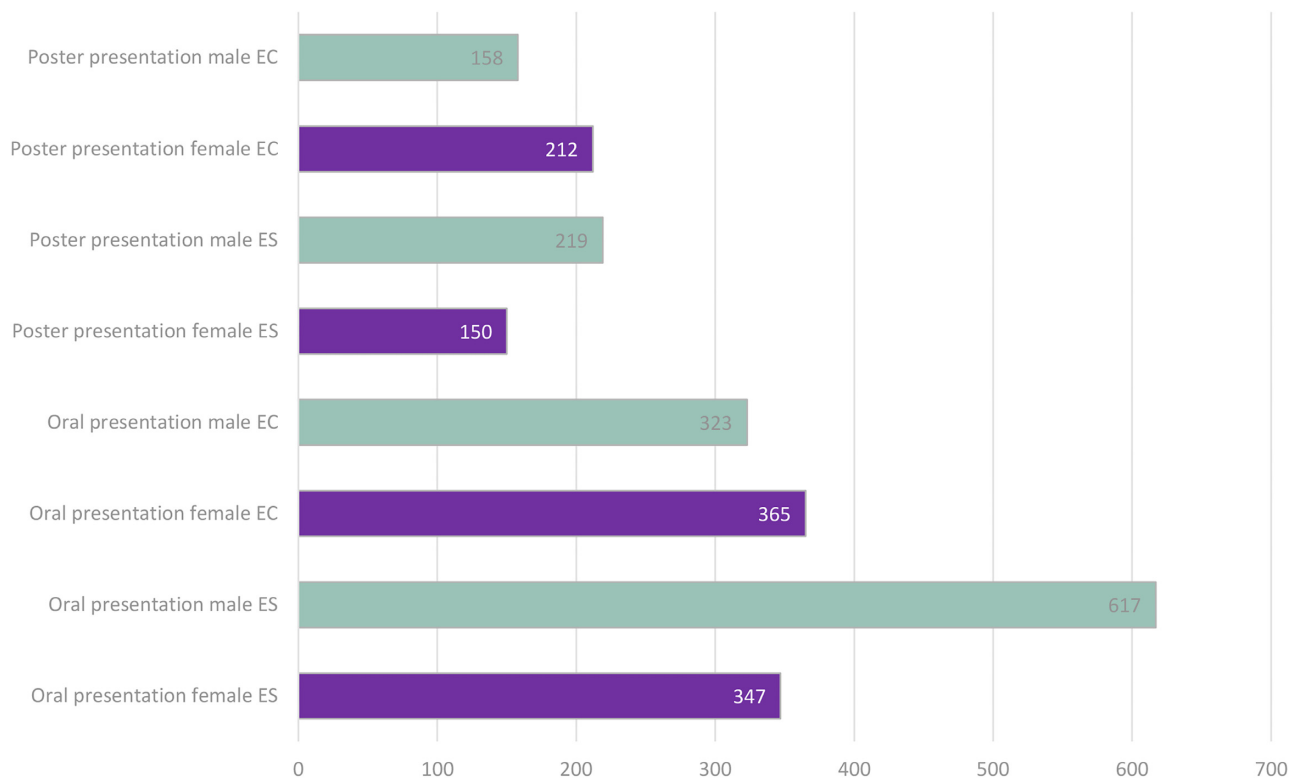
**Figure 2.** Presentation preference of abstracts by gender and career stage (ES = Established Scientist, EC = Early Career Scientist; x-axis = number of individuals).

tary Materials for model outputs] or career stage effect was found [GLMM ( $p = 0.12$ ) see Supplementary Materials for model outputs].

When we looked at the effect of gender and career stage on presentation types given (see Figure 3), we found career stage was significant [GLMM ( $p < 0.001$ ) see Supplementary Materials for model outputs], with ES giving more oral presenta-

tions, as well as gender was also significant [GLMM ( $p < 0.01$ ) see Supplementary Materials for model outputs] with a majority of male ES giving oral presentations (37% of all oral presentations, or 64% of oral presentations given by established scientists).

The ICES ASC event in 2019 was the first year that the organization began to collect self-identified gender disaggre-



**Figure 3.** Number of presentations given by type, gender, and career stage (ES = Established Scientist, EC = Early Career; x-axis = number of individuals).

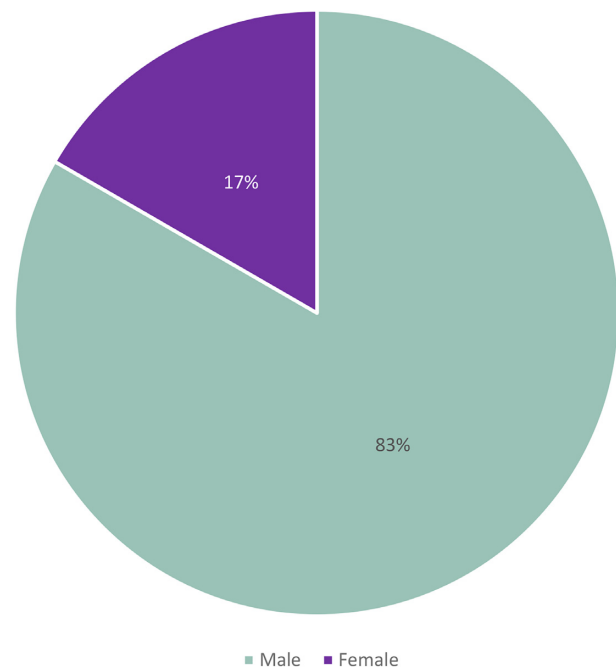
gated data at registration for participants. In that year, conference participants were 50% males, 48% females, and 2% preferred not to answer. Looking at total presentations in that year also shows a similar split, with female participants giving 49% of all presentations and male participants giving 51% of all presentations. Broken down by presentation type in 2019, women gave 46% of oral presentations and 54% of poster presentations.

## Results—prizes and awards

In ICES, there are also different recognition programmes that were developed to acknowledge the achievements of scientists spanning an entire career. The *Prix D'Excellence* “recognizes the highest level of achievement in marine sciences and important contributions to ICES vision”. All four recipients since 2008 were male. The *ICES Outstanding Achievement Award* has been awarded 13 times since 2005 and only twice to women (see Figure 4).

### Keynote presentations

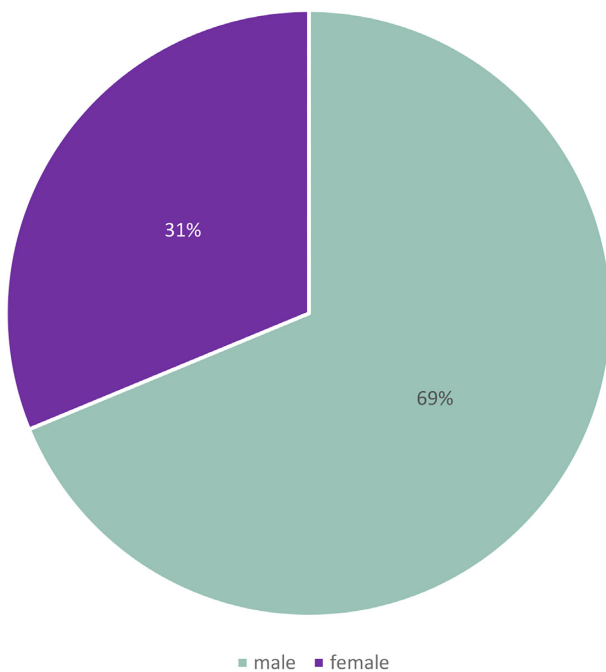
In the ICES ASC context, the Science Committee (The ICES Science Committee is made up of one representative from each of the 20 ICES member countries.) is responsible for the nomination and selection of keynote presentations. In the period of study 2015–2019, only 30% of keynote presentations were given by women ( $n = 5$ ), or 1 of 3 slots per year (see Figure 5). In one of the years (2018), two men were co-presenters in one of the three keynote slots (see Table 1).



**Figure 4.** Outstanding Achievement Award and *Prix D'Excellence* winners by gender 2015–2019.

### Merit Awards

The ICES ASC presents merit awards to recognize scientific contributions at the conference, and 70% of awards (all categories combined; see Figure 6) were awarded to women in the



**Figure 5.** ICES ASC Keynote presentations by gender 2015–2019.

period of study, highlighting that women are well recognized when judged on their specific scientific contribution.

## Discussion

### Individual scientific contributions and participation

In summary, we found no significant evidence of gender bias around (1) acceptance of abstracts and (2) presentation preference, while oral presentations were given mostly by men. Early career professionals were more likely to have their abstracts rejected and requests for oral presentations downgraded to presenting posters. While gender did not show a significant effect on the decisions to downgrade requests for oral presentations to poster presentations, women are more often early in their careers, and therefore overall more women had their presentations downgraded.

In-depth analysis of this conference participation dataset, including demographic information such as gender and career stage, reveals important information about participation in an international marine science conference, providing insights beyond registration data.

Our analysis focused on the abstract decisions, presentation preference, and presentation type awarded and demonstrates that career stage and gender are interconnected in complex ways and important factors in understanding potential sources of bias that may influence who participates in a conference. While our study did not identify significant gender bias in aspects of the submission of individual scientific contributions in conference participation, given the continued underrepresentation of women in marine and ocean science leadership roles (Arismendi and Penaluna, 2016; Giakoumi *et al.*, 2021), critical reflection and monitoring of sources of potential bias in institutional processes remain important. Corona-Sobrino *et al.* (2020) suggest a range of indicators should be used to monitor and track gender balance, assess progress, and implement corrective actions for a more holistic approach to

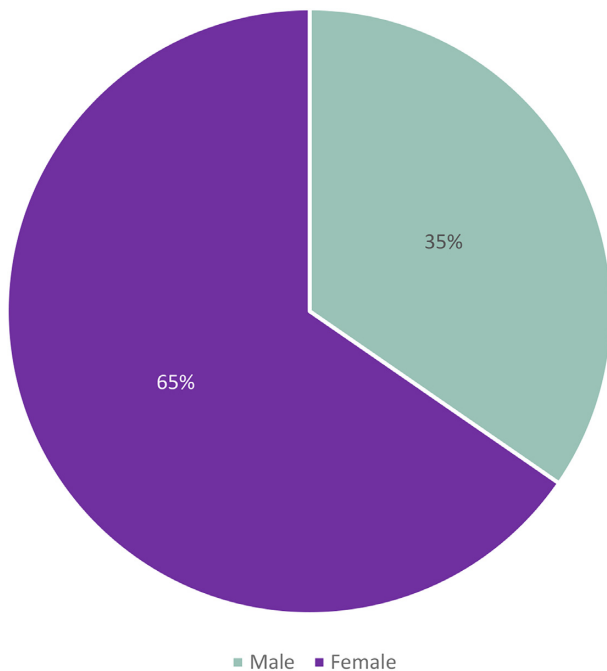
addressing the gender gap at academic conferences. In order to evaluate if the balance of conference participation is representative of the gender balance of ocean scientists overall, a baseline is required (Corona-Sobrino *et al.*, 2020). Defining the total number of people of different genders in international multi-disciplinary fields like marine and ocean science can be difficult compared to single-discipline fields where it may be easier to compare, for example, using numbers of graduates. To approach this question, the Global Ocean Science Report (GOSR; IOC-UNESCO, 2020) has developed an international conference participation indicator to assess the involvement of women in ocean science by region at the global level. The GOSR reports that women account for 39% of ocean scientists globally (IOC-UNESCO, 2020), which might be an overestimate given the massive range reported between countries (7–70%) and major institutional and country data gaps. At the same time, “Women represent 48% of the participants in conferences on ocean science in general” (IOC-UNESCO, 2020, p. 103). Comparing almost 50–50 male/female total participation in the ICES ASC 2019, suggests “good” status on this conference participation indicator (Corona-Sobrino *et al.*, 2020). Absolute numbers or percentages of participation in a conference provide a limited picture of the engagement of women in ocean science and overlook representation by career stage as an important indicator of the status and influence of women in the discipline. The results of this study are contributing to closing this knowledge gap and show what kind of analysis can be used to make biases towards gender or career stage explicit.

Our analysis suggests that overall, there was no gender bias influencing the decision-making process to accept or reject submitted abstracts. However, implicit gender bias can influence decision outcomes (Moss-Racusin *et al.*, 2012; Calaza *et al.*, 2021) and contribute to the barriers faced by women in STEM careers. Reviewing decision outcomes from a gender and career stage perspective is important to understanding potential sources of bias in institutional processes and systems. With only 6% of total abstracts rejected and no gender bias identified in the initial accept or reject decision, this finding supports the finding of Corona-Sobrino *et al.* (2020) in their development of an indicator framework, where acceptance and rejection were excluded as an indicator from their diagnostic tool in the final framework for evaluating gender roles and inequalities, given that there is generally a high acceptance rate for science conference submissions in general. However, our analysis found early career professionals were more often rejected. Given the importance of conference participation for networking building and career development and abstract acceptance as a barrier to entry, finding ways to support improved abstract quality for early career ocean professionals could be explored.

Our findings of greater numbers of women at early career stages with fewer women as established scientists is consistent with the findings of a recent study of European marine science research institutes identifying a persistent gender bias in marine science with a gender balance of PhD students and recent graduates but fewer women at higher-level positions (Giakoumi *et al.*, 2021), reflecting the “leaky pipe”, a metaphor that is often used to describe the under-representation of women in higher-levels of academia and in STEM fields (Berryman, 1983; UNESCO, 2015). While there are many career paths that are often not linear, new metaphors, such as “the vanishing box” (Etzkowitz and Ranga, 2011) or “the

**Table 1.** ICES ASC conference location, year, and gender of keynote presenters.

ASC year	2019	2018	2017	2016	2015
Location	Gothenburg, Sweden	Hamburg, Germany	Fort Lauderdale, USA	Riga, Latvia	Copenhagen, Denmark
Keynote presenters	1 woman, 2 men	1 woman, 3 men	1 woman, 2 men	1 woman, 2 men	1 woman, 2 men

**Figure 6.** ICES ASC merit award winners 2015–2019 (all categories combined).

braided river” (Batchelor *et al.*, 2021), may better describe the opportunities and challenges of fostering more inclusive scientific workplaces and recognize that there are multiple factors that can influence career progression. Systemic, institutional, and network changes are required to help foster the development of diverse and inclusive marine and ocean science leadership (Shellock *et al.*, 2023), and these changes can be supported by evidence-based analysis, e.g. analysis and critical reflection of institutional events like conferences.

We found no preference for specific presentation types influenced by gender or career stage. Female self-selection of less visible presentation types (shorter talks or poster presentations) has been identified in studies from other disciplines (Isbell *et al.*, 2012; Jones *et al.*, 2014; Schroeder *et al.*, 2013). But at the ASC, all genders and career stages prefer an oral presentation, supporting the assumption that oral presentations are associated with greater prestige. Here, the finding that early career professionals are more often downgraded to poster presentations and are more often women highlights the influence that decisions of theme session conveners can have on the visibility of conference participants (MacIntosh-Murray, 2007). Being allocated a poster presentation has implications for both the visibility of individual participants as well as the specific scientific contributions that they are presenting. The “Diversity–Innovation paradox in science” illustrates how novel scientific contributions from underrepresented groups have less uptake and are discounted

(Hofstra *et al.*, 2020). Strategies to create enabling conference environments for people in early career stages, women, and other under-represented groups are imperative for both equality and better science (Nielsen *et al.*, 2017; Calaza *et al.*, 2021). Specific guidelines and criteria could help session conveners foster greater inclusion, ensure a range of diversity, and tackle implicit bias through intentional consideration of gender and early career representation and the balance of allocation of oral and poster presentations in sessions (Tulloch, 2020).

### Improving gender balance in keynote presentations

Recent studies of global conservation and ecology conferences have shown improved gender balance among keynote presenters over time, with women giving 47% of talks 2009–2020 (Tulloch, 2020), while earlier analysis found lower representation of 15–35% women keynote presentations 2000–2015 (Farr *et al.*, 2017). Keynote presentation slots in our analysis were not balanced by gender. The ICES Science Committee, which is responsible for organizing the ASC and selecting keynote presenters, includes a nationally appointed member from each of the 20-member countries. In 2019, women made up only 20% of members, although our analysis showed that, measured by conference participation, women are equally active in ICES-related science as men. Isbell *et al.* (2012) found that the gender make-up of organizing committees influences the composition of symposia, with fewer women invited to all-male-organized symposia as compared to symposia organized by women. With the data presented here documenting that women are well represented at the conference and the reference condition noted by the GOSR of 39% of ocean scientists being women, this is evidence of an under-representation of women in high-profile participation roles at the conference, such as keynote presentations. An intervention strategy to tackle this bias described in the journal *Nature* describes the implementation of a code of conduct and a pledge to eliminate all-male panels. Eliminating all-male panels improved the representation of women in keynote presentation slots from 29 to 48% over 6 years (Nature, 2021). A code of conduct for science conferences, setting expectations for behaviour and outlining consequences for violations, are important tools for fostering safe working conditions and signaling commitment to equity and inclusion, but are not yet standard practice (Favaro *et al.*, 2016; Foxx *et al.*, 2019; Tulloch, 2020). However, the presence of a code of conduct, may not directly influence improved gender balance in highly visible conference roles, such as keynote presenters (Tulloch, 2020). An in-depth review of the keynote selection process to identify and counteract potential sources of bias in the nominations, selection, or acceptance stage, could help to improve the diversity of profiles of keynote presenters. To attract a greater diversity of keynote presenters, offering more supportive conditions at conferences to facilitate the participation of women, and others with caring responsibilities, such as explicitly welcoming

children, and/or providing subsidies or grants for childcare, can also contribute, especially for those in early career stages (Calisi *et al.*, 2018).

### Recognition programmes

A gender bias has been observed in many scientific recognition programmes; a recent study of Nobel Prize nominations from 1901 to 1964 showed that of the 10818 nominations, only 98 were for women (Modgil *et al.*, 2018). These authors evaluate that the low number of nominations (and winners) is caused by a diverse set of social factors, including male dominance on selection committees. Another study found that all six scientific societies studied "...had twice as many women receiving awards for service, teaching, mentoring, and communication as those receiving awards that recognize senior scholarship and research" (Holmes *et al.*, 2011). A Canadian review of prestigious STEM awards found that women represented >25% of award winners (with the exception of one where female recipients were found to be 44% of winners; Baker and Vasseur, 2021). Bias can be introduced at the nomination or selection stage; therefore, gender mainstreaming strategies using evidence-based approaches (Grogan, 2019; Carnes *et al.*, 2005) should be implemented to reform prize and award processes to reduce bias. Nomination calls should be advertised broadly, and being transparent about the nominations process and publishing data about the gender of nominators and nominees can also help to improve diversity over time (Nature, 2022). Strategies for the selection stage should include improving diversity on the selection committee; having diversity, equity, and inclusion policies and training; raising awareness and providing training on implicit and explicit bias; increasing the visibility of women role-models; ensuring fair and equitable outreach efforts; training on gendered language implications; reforming letters of reference; and using specific and measurable evaluation and assessment criteria based on current achievements (Holmes *et al.*, 2011; Baker and Vasseur, 2021). ICES Awards currently lack specific criteria for the diversity of the awards committee; instead, the description of the committee focuses on representing organizational roles. Given the lack of gender diversity among the recipients of ICES Awards, consideration of strategies such as those proposed by Baker and Vasseur (2021) and Holmes *et al.* (2011) may be appropriate.

Although not all conferences allocate awards, where they are present, they provide additional documentation and evidence that should be used for institutional reflection on gender bias overall. They can also be used to review if the criteria and processes for award nomination and selection do not preferentially treat one gender over another and, therefore, continue to reinforce or exacerbate the gender gap in marine science. This is relevant in the ICES conference context as the awards ceremonies feature prominently in the plenary sessions, giving awardees visibility and building credibility. With "Gaining credibility" highlighted among the top-10 gendered challenges experienced by women leaders in interdisciplinary marine science (Shellock *et al.*, 2022), ensuring equality of opportunity for all types of awards is important for contributing to gender equality in marine and ocean science.

With at least one year of the ASC (2019) balanced by gender in terms of registration, our findings highlight that, while gender may not be significantly influencing decision out-

comes, men continue to dominate visible conference roles like keynotes and awards presented to honour an entire career of academic achievement, negatively reinforcing the gender gap in marine science. This in-depth analysis challenges the GOSR statements that use basic participation data from international conferences as an indicator and signal that "Female ocean scientists are increasingly talking to the world" (IOC-UNESCO, 2020, p. 29). We highlight that although the contributions of women are being recognized through merit awards specific to their contributions, this is not being translated into visibility as keynote presenters or career-level awards and recognition.

### Collecting gender disaggregated data

The need for greater attention to the collection of gender-disaggregated data in marine and ocean science is needed to monitor progress towards gender equality, especially in the context of the UN Decade of Ocean Science for Sustainable Development (2021–2030; Brooks and Déniz-González, 2021). Analysis of the gender gap in many fields has been advanced by the development of software that can infer gender based on name; however, this approach must be used with caution, recognizing its limitations (Lockhart *et al.*, 2023), and not replace a commitment to collecting self-identified gender data in an inclusive manner. On balance, these tools can provide a historical perspective valuable for making visible the continuing gender gap in science. Inferring gender based on name has helped to make previously gender-blind datasets useful for analysing the participation and contribution of women in fields that are considered male-dominated, like academia and fisheries (Elsevier, 2020; Szymkowiak, 2020), revealing new insights important for understanding the gender gap, career progression, and informing appropriate interventions. However, it also demonstrates the importance of the collection of gender-disaggregated data in support of fostering diverse and inclusive conferences with balanced representation and facilitating monitoring of the participation process. To bypass the limitations of such software, and comply with personal data collection best practices (Lindqvist *et al.*, 2018), data prompts must be voluntary, and facilitate that participants can report their own gender, beyond the binary, in support of a more inclusive setting. Institutional commitment to regular and systematic analysis of gender disaggregated data and conference participation can support further investigation of trends over time to determine if, (e.g using our data) this large cohort of female early career professionals increases recruitment of established scientists to the ICES community.

### Intersectional approaches needed

While our data did not allow for investigation of how race, ethnicity, or (dis)ability intersects with gender, others have demonstrated that people at these different intersections experience greater levels of discrimination and harassment working in science (Clancy *et al.*, 2017; Bernard and Cooperdock, 2018; Eaton, Saunders, Jacobson *et al.*, 2020; Edge, 2020). Specific strategies for creating enabling conference conditions free from harassment are needed. Collecting diversity data and aiming to understand the experiences of participants could help to design appropriate interventions (Tulloch, 2020). Specific conference sessions on gender and diversity, equity, and inclusion (DEI) more broadly can help to influence attitudes and perceptions and can be an indicator of organiza-



tional commitment to closing inequities in the science system (Corona-Sobrinho *et al.*, 2020). With no conference events or sessions specifically addressed to gender or DEI in the period of study, this is another opportunity for the ICES ASC to improve, address the importance of critical gender awareness in science, and work towards fostering a more inclusive conference experience. The need for specific actions to create an enabling conference environment for women, as well as other under-represented groups, is highlighted by our analysis. A greater understanding of the demographics of conference participants can signal to organizers that further resources and efforts should be used to provide support to female early career professionals. Strategies for supporting early career women's advancement in their career, including "...early and equitable career development opportunities" (Shellock *et al.*, 2023) have been highlighted, and scientific communities must consider the opportunities provided by conference participation. Offering childcare, breastfeeding facilities, and other family friendly services is another way to help support the participation of women (across career levels) and others with caring responsibilities at conferences (Farr *et al.*, 2017). Hybrid conferences that facilitate remote participation may also help to improve accessibility and accommodate those with caring responsibilities or others who may not have the resources required to travel (Tulloch, 2020). At the same time, this intervention can be a double-edged sword. If conveners argue that a hybrid conference will allow, e.g. young parents to participate from home, there is a risk that they will overlook the importance of establishing a family friendly infrastructure at the actual conference. This could lead towards participation bias where only people with no caring responsibilities can profit from in-person peer networking.

### Future directions

A variety of additional institutional actions could be implemented, providing scope for further research and actions towards equitable conference conditions. Further development of conference participant experience forms could provide further information on participant motivation for presentation type (e.g. poster or oral presentation), as well as motivations for attending the conference or reflections on feelings of inclusiveness or belonging at the conference. Greater and improved demographic data collection for participants and abstract submitters, including participant country of origin, could provide the basis for monitoring changes in diversity as well as how inclusive conference conditions might influence participant experience, including if the gender of keynote presenters influences the gender balance of abstract submissions, or if conditions influence repeat attendees. The mechanisms that lead to the underrepresentation of women in keynote presenter roles as well as in recognition programmes should be further investigated. Qualitative information on the motivations of early career ocean professionals for participating in the ASC and presentation preferences could also provide insights into what role conferences play in career progression for people of all genders.

Continued monitoring of the gendered and early career dimensions of ASC participants could help to explore the female majority of early career professionals identified in the data. There might be factors which influence men to not specifically identify as early career, or other potential issues with relying on self-reported data. Expanded collection of demographic data over longer time periods can also be used to fur-

ther investigate gendered early career retention in the marine scientific community.

### Limitations

A limitation of our study was the necessary aggregation of data over 5-years, explained earlier by changes to the boundary conditions limiting the number of presentations mid-way through the period of analysis. However, this inevitably prevented comparisons between locations and over time. New approaches will be needed to assess how the online and hybrid conferences formats recently adopted (by ICES, but many other conferences as well) will influence gendered and early career dimensions of participation, and how to compare between years with different participation models. Another future direction could be to analyse if there is an influence of gender or career stage of theme session conveners on their decision outcomes.

Additional data and analysis should be used by organizers to better tailor interventions aimed at improving participant experience, thereby fostering greater diversity and inclusion in marine science. Improved collection of gender disaggregated data in inter-disciplinary marine science beyond conference participation is an opportunity for inter-governmental organizations like ICES to collect and publish, providing improved information on the baseline of gender representation in the field.

### Conclusions

Our results found no significant evidence of gender bias around (1) acceptance of abstracts or (2) presentation preference, while oral presentations were given mostly by men. However, early career professionals were more likely to have their abstracts rejected and have oral presentations downgraded to posters. While gender did not show a significant effect on the decisions to downgrade requests for oral presentations to poster presentations, women are more often in their early careers, and therefore more women than men have their presentations downgraded. Using additional indicators based on gender representation in keynote presentations and awards, evidence of a gender gap remains, highlighting the need for greater focus on institutional actions to reduce potential sources of bias as well as monitoring and research into conference participation from a rich, beyond binary, gender perspective at the ASC. To counteract implicit bias, carefully managed policies are needed to help realize a gender-diversity dividend in science, where more diverse teams have been shown to improve collective decision-making and strengthen science by including diverse perspectives and a wider frame of reference to support the development of new knowledge (Nielsen *et al.*, 2017; Saini, 2017; Schiebinger *et al.*, 2011–2020). Greater inclusivity in the marine science community requires ongoing critical reflection of both organizational and individual behaviours. Our findings underscore the importance of using data-driven approaches to gender-sensitive and career stage organizational policies that have the potential to influence scientific careers.

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## Supplementary data

Supplementary material is available at the *ICESJMS* online version of the manuscript.

## Conflict of interest statement

The authors declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

## Author contributions statement

E.J. conceptualization, data cleaning and preparation, data analysis and interpretation, writing the original draft, review, and editing. F.B. conceptualization, randomized data validation, writing, review, and editing. D.D. conceptualization, randomized data validation, writing, review, and editing. S.K. conceptualization, data analysis, and interpretation\*. All authors discussed the results and contributed to the final manuscript.

\*Sarah Kraak, who sadly passed away in January 2022, is the last author on this paper. Sarah was motivated to understand how her own decisions (as a regular theme session convener at the ICES Annual Science Conference) might be influencing representation and visibility, and she was inspired to analyse the ICES abstract submission database from a gender and career stage perspective. Sarah provided support and guidance to the early career researchers leading and conducting the research and analysis. Her guidance will be missed a lot.

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## Data availability statement

The data underlying this article will be shared on reasonable request to the corresponding author.

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