OXFORD

BioScience, 2023, **73**, 376–387
https://doi.org/10.1093/biosci/biad032
Professional biologist

Sexual harassment disproportionately affects ecology and evolution graduate students with multiple marginalized identities in the United States

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Abstract

Sexual harassment within academic institutions has profound impacts that may lead to the attrition of groups historically excluded from the biological sciences and related disciplines. To understand sexual harassment's effects on vulnerable communities within academia, we examined graduate student experiences with sexual harassment. In a survey of ecology and evolutionary biology programs across the United States, we found that 38% of the graduate student respondents were sexually harassed during their time in these programs. Sexual harassment disproportionately affected graduate students with multiple intersecting marginalized identities, and these experiences led to delays in completing graduate programs and shifts away from their desired careers. Our research highlights the need for academic institutions, and science more broadly, to make widespread changes to sexual harassment policies, including treating sexual harassment as scientific misconduct and creating resources for individuals within students' informal support networks, in tandem with efforts to dismantle barriers to advancing diversity, equity, and inclusion.

El acoso sexual dentro de las instituciones académicas tiene impactos profundos que pueden conducir al abandono de grupos históricamente excluidos de las ciencias biológicas y disciplinas afines. Para comprender los efectos del acoso sexual en las comunidades vulnerables dentro de la academia, examinamos las experiencias de los estudiantes de posgrado con el acoso sexual. En una encuesta de programas de ecología y biología evolutiva en los Estados Unidos, encontramos que el 38% de los estudiantes graduados que respondieron fueron acosados sexualmente durante el tiempo que estuvieron en estos programas. El acoso sexual afectó de manera desproporcionada a los estudiantes de posgrado con múltiples identidades marginadas que se entrecruzaban, y estas experiencias provocaron retrasos en la finalización de los programas de posgrado y el alejamiento de las carreras deseadas. Nuestra investigación destaca la necesidad de que las instituciones académicas, y la ciencia en general, realicen cambios generalizados en las políticas de acoso sexual, incluido el tratamiento del acoso sexual como una mala conducta científica y la creación de recursos para las personas dentro de las redes informales de apoyo de los estudiantes, junto con los esfuerzos para desmantelar las barreras a la promover la diversidad, la equidad y la inclusión.

Keywords: ecology and evolutionary biology, equity and inclusion, intersectionality, #MeToo movement, sexual harassment

Palabras clave: ecología y biología evolutiva, equidad e inclusión, interseccionalidad, movimiento #MeToo, acoso sexual

Sexual harassment is pervasive across diverse scientific fields (Clancy et al. 2017, Gialopsos 2017, NASEM 2018) and within academic institutions (de Heer and Jones 2017, Wood et al. 2018, Tenbrunsel et al. 2019, Aguilar and Baek 2020, Clancy et al. 2020). A meta-analysis showed 58% of the women in academic faculty or staff positions have been sexually harassed, which is higher than in government and private-sector workplaces (Ilies et al. 2003, NASEM 2018). Even amid these high rates, academic institutions have largely failed to use information on prevalence and effects of sexual harassment to guide antiharassment initiatives across their campuses (Clancy et al. 2020). This inaction could prove more problematic for vulnerable groups, such as graduate students. However, the effects of sexual harassment on graduate students are not well understood, especially when considering differential effects at the intersection of gender, race, ethnicity, and sexual orientation. Graduate students may experience long-lasting impacts from sexual harassment that can affect their careers in science, technology, engineering, and mathematics (STEM). These impacts could exacerbate existing race and gender disparities among mid- and late-career professionals as these individuals

Received: June 10, 2022. **Revised:** February 19, 2023. **Accepted:** April 4, 2023

traverse the gauntlet of an academic program (Caproni and Finley 2012).

Sexual harassment is often rooted in a broader culture of disrespect (Lim and Cortina 2005) that helps to maintain existing social power structures (Holland and Cipriano 2021) and perpetuates a cycle of oppression for marginalized groups (e.g., women, people of color; Cortina et al. 2013). For example, harassment can be aimed at women in male-dominated spaces (Gutek and Cohen 1987, Dresden et al. 2018) and at students who challenge heterosexist ideals of gender roles and sexuality (Silverschanz et al. 2008). The negative consequences of sexual harassment for survivors can be exacerbated when the harassment is more pervasive (Langhout et al. 2005), especially in cases in which the perpetrator has more power (Cortina et al. 2002, Langhout et al. 2005). In addition, greater power discrepancies between perpetrators and survivors can lead to more retaliation against survivors who voice their mistreatment (Cortina and Magley 2003). Therefore, graduate students are vulnerable to sexual harassment's effects and may be less likely to speak up because of their relative lack of power within an academic setting.

Although the power dynamics and negative consequences of reporting can amplify the effects of sexual harassment, these effects may be further magnified for survivors from certain genders, races, ethnicities, and sexual orientations (Cortina et al. 2002, Silverschanz et al. 2008) and could intensify existing disparities in STEM (Crenshaw 1991, Cho et al. 2013, Ireland et al. 2018). Research has shown that more than 70% of graduate students across disciplines were harassed during their program, but the people most at risk of harassment included students identifying as women, lesbian, and/or bisexual (Cortina et al. 1998). Similarly, women who identify as Black, Indigenous, or People of Color (BIPOC) and people who identify as lesbian, gay, bisexual, transgender, questioning, intersex, and/or asexual (LGBTQIA+) face increased risk of harassment (Wood et al. 2018). Despite this evidence, research into intersectional experiences and harassment in academia remains uncommon (NASEM 2018). This may be attributed to many STEM fields historically being dominated by a heteronormative, racist, and misogynistic culture that created barriers to inclusion for BIPOC communities, people in the LGBTQIA+ community, and cisgender women (Miriti et al. 2020, Cronin et al. 2021). This lack of representation remains pronounced in ecology and evolutionary biology, particularly for BIPOC communities (O'Brien et al. 2020, Cronin et al. 2021).

The need to understand the impacts of sexual harassment on future professionals in ecology is underscored by recent findings that fieldwork, a common requirement of this discipline, can increase the risk of harassment (Clancy et al. 2014, Cronin et al. 2018, Rinkus et al. 2018). Furthermore, sexual harassment still poses a major barrier for women in science (Settles et al. 2006, James et al. 2023). Efforts to understand the prevalence and impacts of sexual harassment across scientific disciplines have increased following 2017's global #MeToo movement (Jagsi 2018, Nash and Nielsen 2020). However, few studies have been focused on graduate students, and none have explicitly used an intersectional lens to investigate how sexual harassment affects graduate students as they navigate degrees in the biological sciences (Rosenthal et al. 2016).

Understanding how sexual harassment affects academic disciplines at the intersection of student identities is fundamental to guiding future directions and developing effective actions for diversity, equity, inclusion, and justice. Therefore, in our research, we investigate how sexual harassment may contribute to the attrition (e.g., switching programs, leaving STEM and/or academia) of people historically and currently excluded from the disciplines of ecology and evolutionary biology in the United States (US). Specifically, we used an intersectional lens to investigate the following: 1) the prevalence and likelihood of graduate students being harassed; 2) the most common effects of sexual harassment on graduate student academic experiences and career trajectories, as well as the associations between these effects and the academic power or affiliations of the harasser(s); 3) to whom students did or would disclose being sexually harassed and their experience navigating this disclosure; and 4) the #MeToo movement's influence on perceptions of sexual harassment. We predicted 1) heterosexual, white (non-Hispanic), cisgender men would be the least likely demographic group to experience sexual harassment; 2) sexual harassment would delay graduation or professional engagement, particularly when the harasser held a position of greater authority; 3) graduate students would be more likely to disclose their experience(s) of sexual harassment with people close to them (e.g., advisors) than with other groups; and 4) students would agree that the #MeToo movement increased their awareness of and likelihood to intervene to stop sexual harassment. By improving our understanding of how sexual harassment affects graduate students, we aim to illuminate strategies to combat the harmful consequences of sexual harassment on the next generation of scientists.

Terminology

Because transgender identities correspond to gender rather than sexual orientation, we use LGBQ+ (lesbian, gay, bisexual, queer, and other groups) in reference to sexual orientation. Our use of the term BIPOC includes respondents who identified as Black and/or African American, Hispanic and/or Latinx, American Indian and/or Native American, Asian, Pacific Islander, and mixed race. However, we acknowledge that language to describe identity—especially gender, sexuality, race, and ethnicity—is continually evolving. We refer to students who identify as cisgender women, BIPOC, LGBQ+, transgender, and/or gender nonbinary as historically excluded from STEM fields, although we recognize that some groups may be overrepresented in subdisciplines (e.g., cisgender women in health-related fields; Fry et al. 2021) and that many groups continue to face barriers to inclusion in these fields.

We define sexual harassment as unwanted attempts to establish a romantic relationship; unwanted sexual comments; the display, use, or distribution of sexually suggestive or explicit materials that the recipient found offensive; suggested or implied rewards or special treatment in exchange for sexual behavior; feeling at risk of retaliation for not being sexually cooperative; unwanted physical contact; or other unwanted attention. We created our survey and definition of sexual harassment on the basis of published survey instruments (e.g., Clancy et al. 2014, Sapiro and Campbell 2018, Cabrera et al. 2019) and with the input of the Women and Gender Advocacy Center at Colorado State University (CSU). In this research, the experiences of harassment come from self-reported data, and we refer to sexual harassment, harassers, and students who were sexually harassed without use of the word *alleged*, because we believe students who disclosed their experiences.

Survey instrument

We used the National Research Council's list of graduate programs to identify 94 US–based graduate programs

related to ecology and evolutionary biology (Chronicle of Higher Education 2010). We collected the individual email addresses of all master's and PhD graduate students listed on these programs' websites in March 2019, omitting CSU's Graduate Degree Program in Ecology, with whom we piloted this study. This resulted in 3843 valid emails. These emails likely belonged to current students or recent graduates.

We distributed a structured survey instrument through Qualtrics (Seattle, Washington, United States) between 21 May and 26 June 2020 to the list of valid emails, sending up to three reminders 1 week apart. We did not offer financial incentives to the respondents for completing the survey, and all of the responses were collected anonymously. The respondents needed to consent to participate and could stop the survey at any time. Because of the sensitive nature of the research topic, we assured our respondents that individualized survey data would not be made publicly available to protect their privacy and anonymity. Resources for survivors of sexual harassment and assault were provided at the bottom of each page and at the end of the survey.

The survey (supplemental survey S1) included Likert multiple-choice questions and open-ended questions (Bernard 2017) to determine the following: whether the participants had been sexually harassed; the nature, frequency, and location of the harassment; the harassers' job positions; the harassment's impacts on the participants' academic experience and career trajectory; whether and to whom the participants disclosed the harassment; their satisfaction with how their disclosure was handled; how the #MeToo movement influenced our respondents' perceptions of sexual harassment; and demographic information. We assumed that these incidents occurred during the students' time enrolled in graduate school, because our survey stated, "During my time enrolled in any ecology, evolutionary biology, or related graduate program, I experienced… [list of options]" (supplemental survey S1). Every section provided an open-ended question to allow the respondents to share responses and experiences not encompassed by a priori options. By asking a mix of quantitative and qualitative questions, we could better quantify the prevalence and effects of harassment while also gaining a deeper understanding of the students' lived experiences. Our survey was approved by CSU's Institutional Review Board (protocol no. 19–9659H).

Respondents included in data analyses

To ensure that we captured the experiences of graduate students enrolled in programs related to ecology and evolutionary biology, we limited our analysis to 782 respondents currently or formerly enrolled in graduate programs related to ecology or evolutionary biology who also indicated the years that they were enrolled in those programs (1–11 years). Because our survey was only sent to email addresses that we could gather for current or former graduate students on department or lab webpages, we could not quantify the percentage of graduate students who left their programs because of sexual harassment. Our response rate of 20% matches those of similar online surveys that rely on email to recruit respondents and do not provide incentives (Bennett et al. 2018, Jimenez et al. 2019, Cantor et al. 2020).

We analyzed the respondents' experiences with sexual harassment with respect to gender, race/ethnicity, and sexual orientation to understand potential intersectional differences in incidents and impacts (supplemental table S1). All of the sample sizes in our results reflect the number of people who answered a given question, because the respondents could refuse to answer any question. In addition, we used a skip-logic framework that led some respondents to different sets of questions on the basis of their answers. However, all of the respondents were asked questions regarding the #MeToo movement.

Thematic coding of open-ended responses

We conducted a thematic analysis (Braun and Clarke 2012; supplemental table S2) on the qualitative responses using MaxQDA (version 20.4.0). We used analytical categories (e.g., type of harassment, effect of harassment; Saldaña 2009) to guide an initial round of free coding in which potential subcategories were simultaneously documented through the comment function on each coded segment. For example, write-in responses for the types of harassment experienced were reviewed and coded under a priori categories where appropriate, emergent categories, or were categorized as *not harassment*. This latter group included witnessing harassment of others and experiencing gender discrimination that was not sexual in nature. From a review of the codes, comments, and memos, we identified the final codes and subcodes for the responses (supplemental table S2).

Determining prevalence and likelihood of sexual harassment with respect to gender, race/ethnicity, and sexual orientation

We presented the survey respondents with a series of statements that mentioned actions we defined as sexually harassing behavior (supplemental survey S1). The respondents could select any statement that included actions they experienced during their time in graduate school. We then counted all of the respondents who selected at least one of the statements and classified them as experiencing sexual harassment, unless the only statement they chose was "I have not experienced any of the above as a graduate student," "unsure," or "prefer not to respond." We then summarized information on the prevalence of sexual harassment perpetrated against students at the intersection of gender, race/ethnicity, and sexual orientation. We present prevalence as the number of people within a group (e.g., people who identified as BIPOC, heterosexual, cisgender women) who were harassed divided by the total number of respondents in that group. To test how the interaction of gender, race/ethnicity, and sexual orientation affected the likelihood of being sexually harassed during graduate school, we fit a binomial logistic regression model in R (version 4.0.2; R Core Team 2021). All group likelihoods are in comparison to white (non-Hispanic), heterosexual, cisgender men, because this group has historically been shown to experience lower levels of harassment (Cortina et al. 1998, 2013).

Revealing sexual harassment's effects and the association with harassers' power levels and affiliations

To understand the effects of sexual harassment on graduate student experiences in graduate school and student career trajectories, we counted all of the respondents who selected at least one effect and divided the count by the total number of respondents who answered the question. We tracked counts of each individual effect to compare frequencies among them. The students were also asked to indicate what role their harasser held at the university (e.g., department head, dean, professor) and whether the harasser worked in ecology or evolutionary biology or was affiliated

with a university. We did not collect demographic data for the harassers, but we recognize that power asymmetries may also be affected by the harassers' identities. We classified department heads, deans, professors, and postdoctoral fellows as having more power than graduate students and classified graduate student harassers as having equal power (supplemental table S3). Our survey instrument did not ascertain whether peer harassers (i.e., other graduate students) held other types of power (e.g., leadership roles or further along in their degree programs). Undergraduate students were classified as less powerful. If the respondents identified multiple harassers of different levels, the power level classification was determined by the harasser of greatest power relative to the respondent. Because of uncertainty in their power levels, we excluded lab or field administrative staff, lab or field technicians, "prefer not to respond," "unsure," and "other" text responses that did not fall into the categories previously mentioned. For the respondents who indicated an effect and answered questions about their harasser's role, we used a Pearson's chi-square test in R to assess whether the apparent power level of the harassers (relative to the graduate students) and the harasser's affiliation in ecology or with a university was associated with effects on graduate school experiences or career trajectories.

Identifying to whom respondents disclosed incidents of sexual harassment

We also wanted to understand to whom graduate students disclosed or would disclose incidents of sexual harassment and whether or not they were harassed to understand any gaps in actual disclosures to certain entities versus the perception of disclosing to these entities. Therefore, we presented all of the respondents (i.e., the students who were harassed and disclosed, the students who were harassed and had yet to disclose, and the students who were not harassed) with a list of common individuals or entities that we anticipated they might speak with (e.g., advisors, campus police, Title IX), as well as an "other" option in which they were prompted to describe the other individuals in a text box. The respondents could choose all individuals or entities that applied. We used binomial logistic regression to test for demographic differences in whether the survivors disclosed incidents of sexual harassment with someone and whether they told only colleagues, friends, or family. For the respondents who experienced sexual harassment and provided the power level of their harasser, we used a Pearson's chi-square test in R to assess whether the harasser's power level was associated with disclosing their experiences only to colleagues, friends, and family.

Documenting perspectives on the #MeToo movement

In the wake of 2017's global #MeToo movement, we explored how this movement influenced the graduate student respondents' perceptions of sexual harassment. Specifically, we aimed to understand how the intersection of gender, race/ethnicity, and sexual orientation shaped these perceptions. We fit a binomial logistic regression model in R to test how the interaction of gender, race/ethnicity, and sexual orientation affected the likelihood of selecting statements on the efficacy of the #MeToo movement (e.g., #MeToo increasing the willingness of victims or witnesses to report).

Intersectional differences in the prevalence and likelihood of sexual harassment

Of 782 respondents, 38% reported being sexually harassed while they were in graduate school (supplemental table S4). Unwanted sexual comments (55.7%), unwanted physical contact (43.7%), and unwanted attempts to establish a romantic relationship (43.0%) were the most commonly experienced forms of harassment (supplemental figure S1). Over 80% of the students who cited the frequency of sexual harassment ($n = 294$) were harassed more than once. The respondents who disclosed where they were sexually harassed ($n = 286$) reported that incidents occurred off-campus (i.e., locations not related to academic activities; 75.2%), on-campus (59.8%), or off-campus in academic contexts (53.2%; e.g., conference or fieldwork; supplemental figure S2). In addition, a majority (96.0%) of the respondents who experienced sexual harassment also provided information on their gender, race/ethnicity, and sexual orientation.

For four groups, 50% or more of the respondents were sexually harassed (figure 1, supplemental table S5): 1) white (non-Hispanic), transgender or gender nonbinary students (6 of 11 respondents); 2) BIPOC, transgender or gender nonbinary students (4 of 8 respondents); 3) white (non-Hispanic), LGBQ+, cisgender women (58 of 111 respondents); and 4) BIPOC, heterosexual, cisgender women (39 of 77 respondents). In addition, we found strong evidence ($p < .001$) that the following groups were more likely to be harassed than white (non-Hispanic), heterosexual, cisgender men (supplemental table S6): 1) BIPOC, heterosexual, cisgender women; 2) white (non-Hispanic), LGBQ+, cisgender women; and 3) white (non-Hispanic), heterosexual, cisgender women. We note, however, that the number of respondents at certain intersections of gender, racial or ethnic identity, and sexual orientation were particularly low, including respondents identifying as BIPOC and transgender or gender nonbinary ($n = 8$) and respondents that were white (non-Hispanic) and transgender or gender nonbinary ($n = 11$).

Effects of sexual harassment and the association with harassers' power levels and affiliations

Across identities, 61.9% of the students who responded about how sexual harassment affected them acknowledged that sexual harassment affected their graduate school experience (169 of 273 respondents), whereas 22% of the respondents said it affected their career trajectory (64 of 287 respondents; supplemental figure S3, supplemental table S7). Proportionally, the largest group who indicated effects on their graduate school experience included transgender or gender nonbinary, BIPOC, LGBQ+ students (supplemental figure S3). When citing effects of sexual harassment on graduate school experiences, the most commonly reported effect was limiting or ceasing professional engagement (36.3%; figure 2). The largest proportion of students who indicated impacts on their career trajectories identified as white (non-Hispanic), LGBQ+, cisgender women (supplemental figure S3). Of the students who indicated how sexual harassment affected their career trajectories ($n = 60$), 41.7% indicated that they planned to no longer pursue a career in academia (figure 2).

Many of the respondents ($n = 52$) wrote in experiences of making personal adjustments to address sexual harassment—an impact not explored in our a priori questions. These adjustments included investing time and energy in reporting their harassment; promoting a culture of antiharassment (including

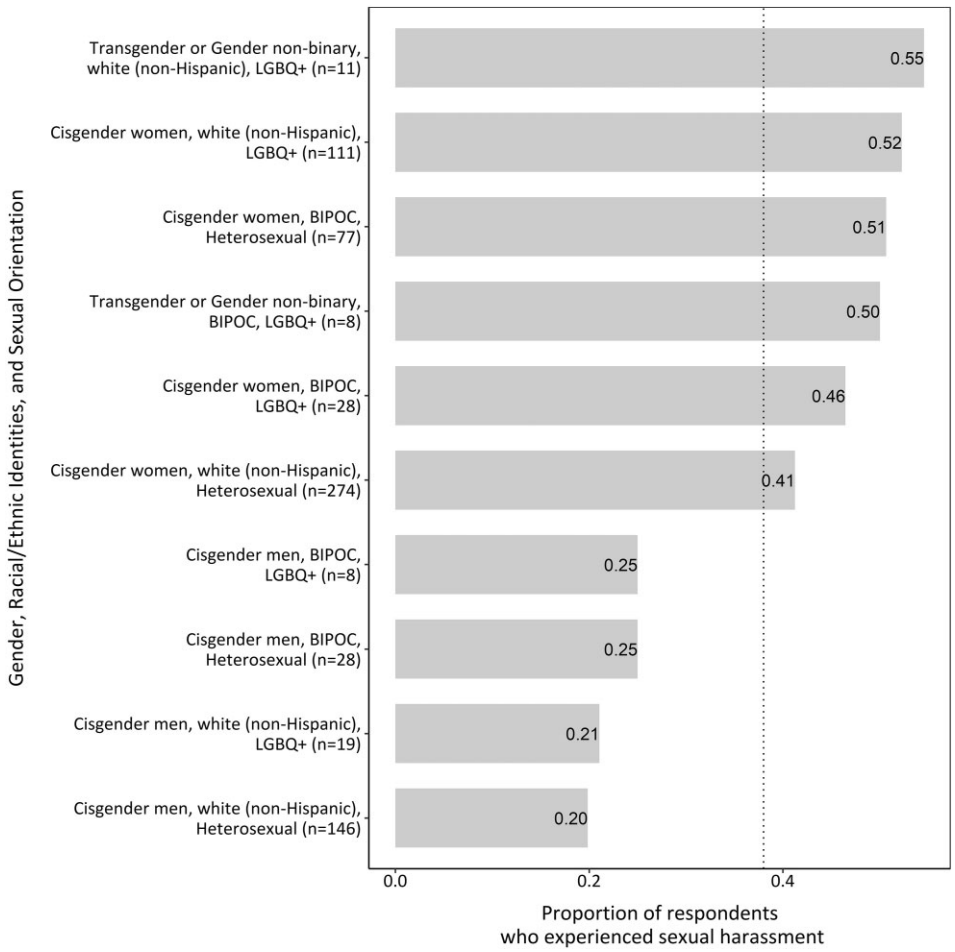

Figure 1. The proportion of respondents within intersections of gender, racial or ethnic identity, and sexual orientation (n = total number of respondents who answered the question) who experienced sexual harassment compared with the average proportion of all respondents who experienced harassment (0.38; the vertical dotted line). The average includes respondents who did not list intersecting identities.

educating their harassers); recovery (e.g., therapy); and, most commonly, measures to limit the likelihood of recurrence, reencounters with the harassers, or exposure to similar situations by avoiding their own offices, labs, and professional spaces (e.g., conferences).

Most of the participants identified other graduate students and professors as their harassers (54.6% and 38.5%, respectively, n = 286; supplemental figure S4), and more than 60% indicated that their harassers were in their field (i.e., ecology and evolutionary biology) at their university. A higher proportion of the graduate students whose harassers included people in positions of greater authority (p = .02; figure 3, supplemental table S8) or whose harassers were affiliated with ecology and evolutionary biology (p = .01, supplemental figure S5) cited impacts on their graduate school experiences compared to students harassed by fellow graduate students (peers) or students whose harassers were outside of their field.

Disclosing incidents of sexual harassment

Among the students who were sexually harassed and disclosed their experiences (n = 205), disclosures to colleagues, friends, and family members (59.0%) were more frequent than to official entities (e.g., Title IX Office, 15.1%; and Office of Equal Employment Opportunity [OEEO], 2.9%; figure 4a, supplemental table S9). In addition, 40% of the respondents only discussed their experience with colleagues, friends, and family members. By contrast, most of the respondents who had not been harassed (n = 440) or those who were harassed but did not disclose (n = 71) selected that they would speak to Title IX (64.3% and 39.4%, respectively; figure 4b–4c; supplemental table S10).

Although small sample sizes among many intersectional groups limits our interpretation (supplemental figure S6), we found that cisgender women were more than twice as likely to disclose being sexually harassed than cisgender men (supplemental table S11). The likelihood of telling only colleagues, friends, and family members or other groups (supplemental figure S6) was not affected by gender, race/ethnicity, or sexual orientation (supplemental table S11). Similarly, we did not find significant associations among the power level of the harasser and whether a respondent would tell someone about their experiences with sexual harassment (n = 221, $\chi^2(2) = 1.03$, p = .60; supplemental table S12) nor did we find an association between harasser power levels and whether the respondents told only colleagues, friends, and family members or other groups (n = 165, $\chi^2(2) = 3.82$, p = .15; supplemental table S12).

Satisfaction with the outcome of disclosing experiences varied by race/ethnicity. BIPOC respondents (n = 50) were more dissatisfied (42.0%) than satisfied (18.0%) with the outcomes, whereas white (non-Hispanic) respondents (n = 151) were more evenly

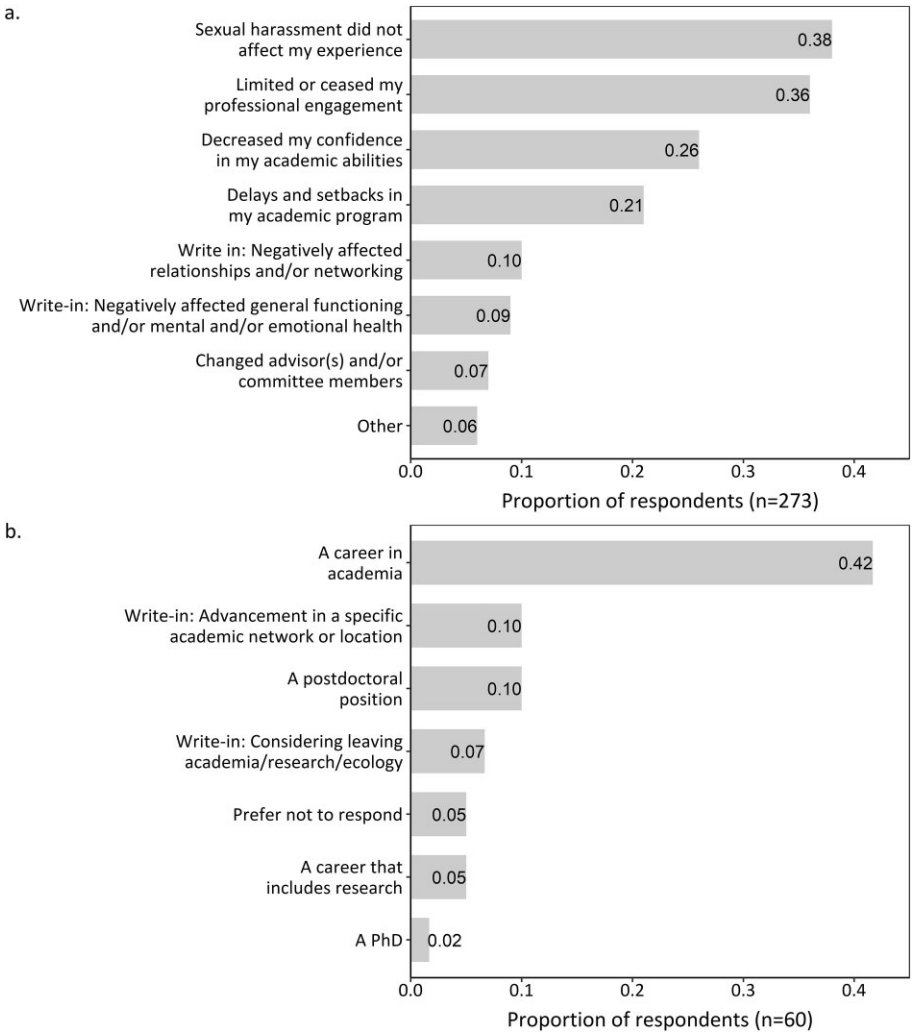

Figure 2. The effects of sexual harassment on (a) graduate school experiences (see supplemental table S19) and (b) educational and career choices. Panel (b) includes only respondents ($n = 60$) who said yes to harassment affecting their career trajectory and answered the follow-up question, "Because of the sexual harassment I experienced during my time enrolled in an ecology graduate program, I have decided not to pursue…" Our survey was limited to graduate students currently enrolled in ecology and evolutionary biology graduate programs; therefore, we could not capture the proportion of graduate students who left their programs because of sexual harassment.

divided (31.1% dissatisfied, 31.8% satisfied; supplemental figure S7). Altogether, 54.0% of the graduate students felt satisfied with how individuals (e.g., graduate advisors, deans, or other faculty and staff) responded, whereas 31.7% were satisfied with the response of larger entities (e.g., Title IX Office, OEEO, campus police, and others; supplemental figure S8). Most (80.3%) of the 71 respondents who did not disclose their experience to others perceived the incident as not serious enough to report (supplemental figure S9).

The qualitative responses demonstrated that some of the respondents felt their experiences were ignored, downplayed, or dismissed during the processes of disclosure, reporting, and resolution. The respondents noted that their institutions lacked transparent, consistent protocols between departments and universities and that personnel (e.g., faculty, departmental staff, university officials) were sometimes reluctant to act, resulting in little punishment to the harasser and little resolution for the student. Reporting was perceived to require time and energy (e.g., collecting evidence, following up), and some students felt they were expected to choose between reporting and academic progress.

Perspectives on the #MeToo movement

Nearly all of the respondents (99.5%) were familiar with the #MeToo movement and reported that the movement increased their understanding of the prevalence of sexual harassment and assault (78.5%) and how survivors are affected (55.5%; $n = 782$, supplemental table S13). Some felt the movement helped clarify what "counts" as sexual harassment or assault (45.2%). Far fewer (19.9%–22.9%) reported that this movement increased their understanding of how to navigate sexual harassment or assault when it occurs (e.g., how to intervene, where to report, university policies; supplemental table S13). In addition, whereas most of the respondents (76.1%) felt the #MeToo movement increased the willingness "of victims to report incidents of sexual harassment and/or assault," fewer felt that witnesses (60.6%) and universities (45.5%) would be more likely to report, support, and respond to a survivor's claims (supplemental table S14). We also found intersectional differences in perceptions of the #MeToo movement, with students historically and currently excluded in STEM being less likely than students traditionally in the majority (e.g., white, cisgender men or students identifying as heterosexual) to

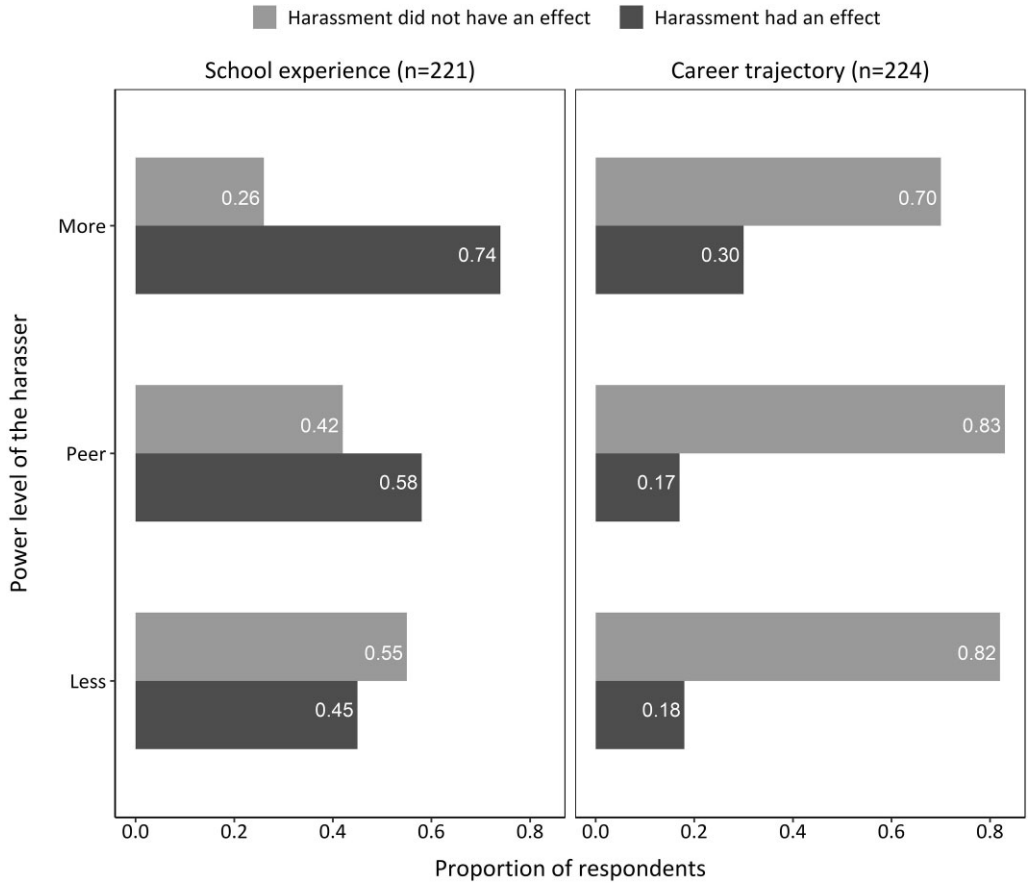

Figure 3. Intersection of respondents who identified the type of harasser (see supplemental table S3) and whether harassment affected the respondent's school experience ($n = 221$, $\chi^2 = 7.94$, $p = .02$) and career trajectory ($n = 224$, $\chi^2 = 4.89$, $p = .09$).

agree with many of the statements—suggesting that the #MeToo movement has not improved the climate for people most affected by sexual harassment (supplemental figures S10–S13, supplemental tables S15–S18).

Sexual harassment as a major barrier to equity and inclusion in US graduate programs

Our nationwide survey of graduate students demonstrates that sexual harassment is pervasive, impactful, and disproportionately affects students from communities that have historically been and continue to be excluded from the sciences (figure 1). Although most respondents in our survey were primarily harassed by peers, many were also harassed by perpetrators in positions of relative power. These power imbalances exacerbated the potentially long-lasting consequences of sexual harassment, including delayed graduation, curtailed engagement, and loss of self-confidence. When it came to disclosure of such experiences, 40% of the students who were harassed disclosed this information only to colleagues, friends, and family rather than to official entities that other respondents believed they would report to. When the students did report to official entities, they were less satisfied with the outcomes, and this was more pronounced for BIPOC students.

Our survey revealed substantial variation in experiences of sexual harassment among graduate students based on the intersection of gender, race/ethnicity, and sexual orientation (figure 1). As we had hypothesized, we found that heterosexual, white (non-Hispanic), cisgender men were the least likely group to be harassed during graduate school. The gender ratios within a workplace may play an important role in the levels of sexual harassment; for example, male-dominated workplaces can trend toward higher levels of harassment than those with more balanced gender ratios (Fitzgerald et al. 1997). However, gender equity does not always translate to equality, as demonstrated in recent research that showed women continue to face challenges in gender-balanced workplaces (James et al. 2023). The National Science Foundation's National Center for Science and Engineering Statistics 2020 report on doctoral recipients in ecology and evolutionary biology reveals gender balance in these fields (55% women in ecology and 56% women in evolutionary biology; NCSES 2021a), although the report failed to take into account transgender respondents or respondents' sexual orientations. Unfortunately, the race and ethnicity of doctoral recipients (NCSES 2021b) in ecology and evolutionary biology are wildly uneven, with only 11% of both ecology and evolutionary biology doctorate recipients identifying as BIPOC—a percentage that does not match the 2020 US census data in which around 33% of the population identified as BIPOC (Jones et al. 2021). This imbalance may help explain why BIPOC women who took our survey reported the second highest prevalence of sexual harassment, a result consistent with findings from a study of harassment in other science disciplines (Clancy et al. 2017).

In addition, our survey showed that a disproportionately high percentage of transgender and gender nonbinary graduate students were sexually harassed. This finding matches the results

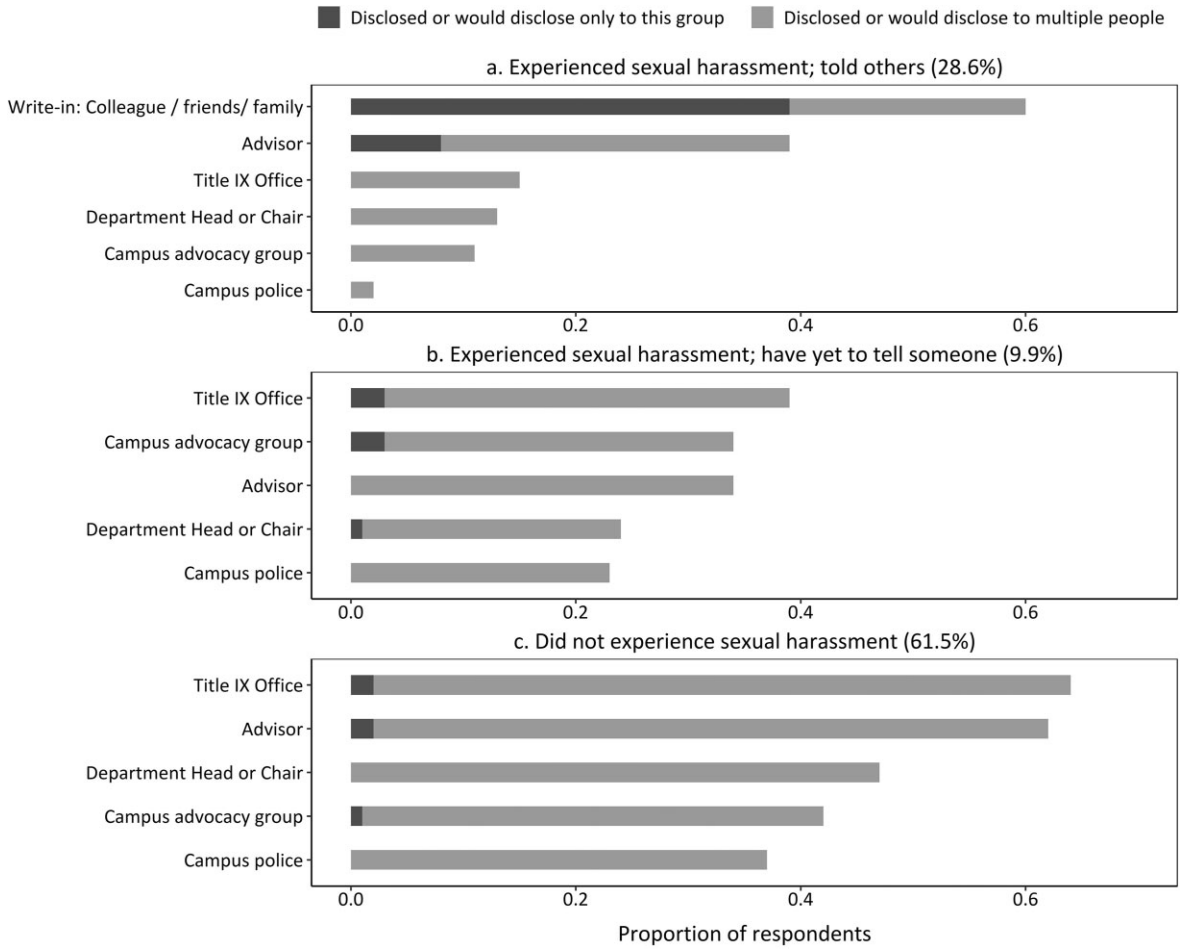

Figure 4. The most common categories of individuals or entities to whom respondents disclosed or would disclose incidents of sexual harassment, including (a) respondents who experienced and disclosed their experiences of sexual harassment ($n = 205$), (b) respondents who experienced sexual harassment but have yet to disclose their experiences ($n = 71$), and (c) respondents who did not experience sexual harassment but who selected which individuals or entities to whom they would consider disclosing ($n = 440$). The respondents could choose all individuals or entities that applied. In each section, we include the percentage of total respondents who provided responses for these questions ($n = 716$).

from a study of 33 universities that showed that transgender, nonbinary, genderqueer, or gender-questioning graduate students experienced the highest levels (53.4%) of sexual harassment compared with graduate students identifying as cisgender women or men (36.6% and 23.0%, respectively; Cantor et al. 2020). As well as the unwanted sexual comments or touching experienced by students of many identities, transgender women and men can also experience sexual harassment directly tied to their identities, including intentional misgendering (as identified by a respondent in our survey) and invasive questions or comments about their bodies (Nadal et al. 2012). Contrary to past research, we found that transgender and gender nonbinary students who also identify as white (non-Hispanic) had the highest proportion of individuals who were harassed. This diverges from extensive research on the disproportionate levels of violence, including sexual violence, perpetrated against transgender people of color (Stotzer 2009, Balzer and Hutta 2012). Further research specifically focused on the experiences of transgender and gender nonbinary students in ecology and other biological science disciplines is warranted.

For the LGBQ+ individuals in our study, we found that white (non-Hispanic), LGBQ+, cisgender women experienced more harassment than white (non-Hispanic), heterosexual, cisgender women, which matches research that assessed the prevalence of sexual harassment and other forms of sexual violence at universities (Wood et al. 2018, Cantor et al. 2020) and community colleges (Potter et al. 2020). Sexual harassment for people in the LGBQ+ community is also often tied to their sexual identity and can include unwanted comments or questions about their sexual preferences (D'Augelli 1992, Konik and Cortina 2008, Trades Union Congress 2019).

We found that most of the students in our survey were sexually harassed by fellow graduate students (i.e., potential colleagues) or professors (i.e., people with power relative to students) and that a similar proportion of students were harassed on campus and during fieldwork. Research demonstrates that people are more likely to experience harassment when they have less power or are more vulnerable (e.g., have fewer financial resources, are part of groups that have been historically excluded from certain spaces) or do not follow the standards of the group in power (Uggen and Blackstone 2004, Konik and Cortina 2008, Leskinen et al. 2015). Harassment from peers, who may or may not share equal privileges, could be particularly detrimental to groups historically excluded from STEM because strong peer networks are vital to the academic success and retention of these groups (Hurtado et al. 2010). However, some evidence suggests that harassment across power asymmetries may be more harmful than peer harassment in academia (NASEM 2018) because sexual harassment perpetrated

by faculty can lower STEM career aspirations for women (Leaper and Starr 2019). We found similar results that also supported our predictions that sexual harassment would have a greater negative impact on a survivor's graduate school experience when their harasser had relatively more power. Regarding where students were harassed, our results diverged from research that demonstrates fieldwork can be a risky environment for harassment (Clancy et al. 2014, Cronin et al. 2018, Rinkus et al. 2018). This result could stem from our survey's respondents not being primarily field-based ecologists and evolutionary biologists; regardless, it is important to bring attention to academic settings as places where harassment occurs.

As was revealed by our survey's open-ended responses, the respondents emphasized the time and energy spent on reporting or actions taken to avoid further harassment. Therefore, the people most affected were burdened with solving the problem—a phenomenon seen in other spaces, such as faculty from historically excluded backgrounds leading the charge on diversity, equity, and inclusion at their institutions (Jimenez et al. 2019). Our qualitative results also reflect findings from other studies that reveal the substantive, deleterious impact on the mental and physical health of people who have been harassed (Lim and Cortina 2005, Street et al. 2007, Houle et al. 2011), including feelings of alienation (Settles et al. 2013) and stress that persists beyond the incident of harassment (Stockdale et al. 2009). These effects may require longer-term support than is often given to targets of harassment (Stockdale et al. 2009, NASEM 2018). Because of these deleterious effects, we suggest that understanding how sexual harassment may contribute to students leaving graduate programs is an important research need. Because of how we collected graduate student email addresses, our analysis was necessarily limited to students currently or recently enrolled in graduate programs.

Access to proper support and resources for survivors can be hampered by barriers to reporting. Research on barriers to reporting sexual assault among college students demonstrates that women rate the fear of retaliation significantly higher than men do, whereas men are comparatively more influenced by feelings of shame, confidentiality concerns, and not being believed (Sable et al. 2006). When it came to gender discrepancies in reporting, we found that cisgender men were less likely to tell someone that they were sexually harassed than were cisgender women. The fears around reporting may have affected our survey respondents because 40% who experienced harassment told only informal support networks (e.g., friends, family members, and colleagues) instead of reporting to the formal entities charged with handling cases of sexual harassment (e.g., Title IX Office, OEEO)—a finding that matches our hypothesis and results from research on this topic in the physical sciences (47.2% did not report; Aguilar and Baek 2020) and marine sciences (39.0% did not report; Women in Ocean Science 2021). To help reduce these barriers, institutions could spread more awareness of how perpetrators may respond when confronted about sexual harassment (e.g., deny, attack, and reverse victim and offender-DARVO; Harsey et al. 2017). When survivors understand this reaction, it may decrease self-blame for the incident and possibly moderate the negative effects of reporting or confrontation (Harsey et al. 2017). Perhaps because of the small sample sizes of certain intersectional groups, we did not find differences among genders, races/ethnicities, or sexual orientations in the likelihood of respondents disclosing experiences of sexual harassment to individuals compared with entities associated with formal reporting mechanisms. Future studies may want to consider addressing how the decision to report may vary at the intersection of student identities.

The fact that many students who were harassed did not talk to formal entities indicates that US academic institutions are likely chronically underdocumenting sexual harassment, despite universal mandatory reporting policies, as has been highlighted in previous research (Bergman et al. 2002, Ilies et al. 2003, Aguilar and Baek 2020, Cantor et al. 2020, Kirkner et al. 2020). This underestimation can be pronounced for people of color, who are often failed by formal entities and therefore are not willing to report to them (Trachtenberg 2017). For example, recent research suggests that mandatory reporting policies that require university employees to report disclosed incidents to formal entities can harm survivors when those reports are made without the survivors' consent (Holland and Cipriano 2021, Holland et al. 2021). These harms, which can include posttraumatic stress and depression, stem from a loss of autonomy and may be exacerbated for students with marginalized racial or gender identities, because reporting brings survivors into contact with entities such as police that they may already mistrust because of past failings and traumatic experiences (Tillman et al. 2010, Trachtenberg 2017, Holland et al. 2021). In addition, cultural climates of perceived tolerance for sexual harassment can lead to fear that reporting or seeking support may negatively affect academic and career success or that institutions will do nothing in response (NASEM 2018, Tenbrunsel et al. 2019, Kirkner et al. 2020). Such cultural climates, including perceptions of how an organization will handle reports (e.g., dismissing them or not taking them seriously) and whether they discipline perpetrators, can affect reporting and are highly predictive of people committing sexual harassment (Hulin et al. 1996, Welsh 1999). Our survey showed more evidence for these trends, including that the predominant reason for not disclosing harassment was believing the incident was not serious enough to report in addition to concerns about social and career consequences. When the respondents did disclose their experiences, they were largely dissatisfied with the outcomes when reporting to formal entities. This result is possibly due to such entities being perceived as unaccommodating and unreliable (Webermann and Holland 2022) or as prioritizing prevention of institutional liability above providing effective support and justice for people who are harassed (NASEM 2018, Cantor et al. 2020). Negative perceptions of formal entities (e.g., Title IX) have also been documented elsewhere (Holland and Cipriano 2021).

We hypothesized that the high-profile #MeToo movement might serve as an empowering platform to increase awareness of sexual harassment's prevalence and tools for reporting and counteracting it. Although we found that the #MeToo movement changed perceptions for a small percentage of the students, perceptions were least likely to change among historically excluded groups in STEM fields and academia, such as BIPOC women, transgender men and women, gender nonbinary people, and LGBQ+ students (de Heer and Jones 2017, Onwuachi-Willig 2018, Brown 2020). This could be attributed to the #MeToo movement being dominated by the voices of white, cisgender women (Fileborn and Loney-Howes 2019), despite being initiated and championed by a Black woman, Tarana Burke (Burke 2017), and having roots in the Latinx feminist movement's *escraches*—demonstrations in which the protestors publicly condemn prominent figures for their misdeeds (Kaiser 2002).

Despite the awareness raised by the #MeToo movement, our survey revealed that sexual harassment perpetrated against graduate students is widespread and may contribute to the gauntlet of surviving and thriving in graduate programs in multiple

complex ways with the greatest impact on students historically excluded from STEM. Although we acknowledge the potential for response bias (i.e., respondents are more likely to respond if they have been harassed), research demonstrates little evidence for such selection bias; one study showed similar rates of sexual violence reported by undergraduate students who knew the survey topic beforehand ("self-selected") compared with students with no prior knowledge of the survey topic (Rosenthal and Freyd 2018).

Universities can combat sexual harassment by fostering a culture of zero tolerance through greater accountability, transparency, prevention, and support (NASEM 2020, Know Your IX 2021). To achieve accountability, universities should classify sexual harassment as scientific misconduct (Marín-Spiotta 2018), as some large scientific societies have begun to do (American Geophysical Union 2017). Academics who commit sexual harassment should not be shielded from consequences by institutions or funding agencies (Iversen and Bendixen 2018) to preserve their contributions to science or institutional reputation (Koren 2018, Nash and Nielsen 2020). To achieve transparency, institutions should publish clear policies on sexual harassment and assault and should collect and publish data on these incidents (Know Your IX 2021). For example, NASEM has distributed a rubric with guidelines aimed at institutional prevention, response, support for survivors, and evaluation (NASEM 2020). Prevention across campuses involves actions that include more substantially vetting the past behavior of new hires, setting clear guidelines for behavioral expectations, and creating a system that rewards those who improve the climate in their department (Clancy et al. 2020) or advance diversity, equity, inclusion, and justice in STEM (NASEM 2020). Universities can better support survivors by expanding confidential advocacy services and anonymous or third-party reporting options that students can access and control independently of Title IX offices (Holland et al. 2021).

To prevent harm and improve networks of support for survivors, institutions must end the normalization of rape culture that permits sexual harassment to persist. Universities can also create a safer climate by hosting in-person group continuing education sessions (Freyd and Smidt 2019). We strongly recommend continuing education programs in lieu of single training sessions, which imply an end point to learning as opposed to a constant process of understanding how to prevent incidents and best practices for supporting survivors (Freyd and Smidt 2019). Continuing education sessions should include trauma-informed training on how to respond to disclosures of sexual harassment with particular attention to racial and gender inclusivity (Barros-Lane et al. 2021, Holland et al. 2021). These sessions should also empower advisors, graduate students, and other support networks (Karjane et al. 2005) to speak out against the spectrum of sexual harassing behaviors (Cronin et al. 2018) with an emphasis on believing students who come forward. Universities could study the efficacy of continuing education programs, refine them, and scale them across other academic institutions.

Fundamentally, institutions must recognize that sexual harassment detrimentally affects students of all identities and has outsized, intersectional impacts on transgender women and men, gender nonbinary students, LGBQ+ students, and BIPOC cisgender women. Sexual harassment therefore remains a considerable barrier to advancing diversity, equity, and inclusion and could be a major driver of ongoing disparities in representation that disrupts the ability of students with multiple intersecting identities to thrive in the biological sciences.

Acknowledgments

We are grateful to the many students that responded to our survey and were willing to share their experiences. We also thank E. Amoa-Awuah, S. Petrita Bombaci, T. Gallo, P. Iranah., M. Jimenez, J. Lavallee, A. Mangan, C. Moss-Racusin, T. Pickering, and N. Van Lanen for providing feedback on our research questions and survey design. We appreciate M. Cronin and several anonymous reviewers for valuable comments that improved earlier versions of the manuscript.

Supplementary material

Supplementary material, including an infographic intended for distribution that summarizes data from this manuscript, is available at *BIOSCI* online.

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