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Mismatch between conservation higher education skills training and contemporary conservation needs

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Abstract
Scholars have detailed the range of skills required for conservation and voiced concerns that training is not fit for purpose. Still, we have little understanding of what skills conservation education aims to teach. This study uses survey data and content analysis of online module descriptions to examine skills and methods teaching in conservation higher education across the United Kingdom and Australia. We found most conservation-specific modules aimed to develop disciplinary and communication skills, but fewer than half aimed to develop interpersonal or project management skills. Social science methods training was absent from the core offering of over half of the conservation degrees reviewed. To prepare students for conservation careers and the complex problems they will encounter, the conservation education sector should further focus on building essential nonacademic skills and provide training on the breadth of methods that contribute to effective conservation science. This analysis can help educators to reflect on teaching aims and forge a curriculum that will best prepare students for contemporary conservation challenges.

KEYWORDS
higher education, interdisciplinarity, skills training, social science methods, teaching

1 | INTRODUCTION

Calls to change conservation training are nothing new. There have been repeated critiques of conservation higher education and suggestions of a mismatch between conservation teaching and the skills required for conservation careers (Blickley et al., 2013; Langholz & Abeles, 2014; Muir & Schwartz, 2009; Pérez, 2005). Most conservation jobs lie outside academia (Lucas et al., 2017), but scholars have argued that degrees remain narrowly focused on teaching technical and academic skills required for research careers (Noss, 1999). Despite these critiques, there has been little empirical research that addresses what skills conservation education aims to teach. Without this information, it is difficult to identify what training gaps exist or implement actions to best prepare students for contemporary conservation challenges.

Today's conservation graduates require a broad skill set and knowledge base. Reviews of job advertisements (Blickley et al., 2013; Lucas et al., 2017), surveys of alumni (Muir & Schwartz, 2009), and interviews with professionals (Blickley et al., 2013; Lucas et al., 2017) have built a clear understanding of the skills graduates need to signal to conservation employers. Not only do graduates require strong disciplinary understanding of key concepts in conservation, but they also need to hone a range of nonacademic skills, such as networking and project management, to succeed in conservation roles (Blickley et al., 2013; Lucas et al., 2017).

Although the skills required for conservation professions vary by sector, certain nonacademic skills, including interpersonal skills and project management, have been highlighted as important across sectors (Blickley et al., 2013; Lucas et al., 2017). Project management plays a crucial role in bridging the research-implementation gap and there appears to be demand for project management training (Barlow et al., 2016). Meanwhile, interpersonal skills are essential for collaborative conservation (Elliott et al., 2018) and effective leadership (Englefield et al., 2019). It is essential that we understand whether conservation education teaches such skills because without them the effectiveness of conservation is diminished. Concerns have also been raised that academics may not be best placed to teach nonacademic skills and scholars have recommended that help be sought from those with experience in non-research roles (Muir & Schwartz, 2009; Noss, 1997, 1999; Parsons & MacPherson, 2016). It remains unclear what skills are being targeted in conservation training and whether recommendations to include nonacademic practitioners have been implemented.

While there have been efforts to understand the provision of skills training (Cannon et al., 1996; Elliott et al., 2018), many reviews have focused solely on postgraduate studies (Elliott et al., 2018; Van Heezik & Seddon, 2005) or a subset of skills (e.g., human interaction skills—Cannon et al., 1996). The literature on conservation skills training has predominantly focused on teaching for employability purposes (Blickley et al., 2013; Lucas et al., 2017; Muir & Schwartz, 2009). This is unsurprising given the trend toward "skilling up" students so that they graduate ready for employment (Higdon, 2016: 177). However, adequately preparing students to deal with the messy reality of conservation imposes additional requirements. Conservation challenges are wicked problems: they have no clear end point, no simple definition, involve multiple stakeholders with differing values (Rittel & Webber, 1973), and require adaptive approaches that account for complexity and uncertainty (Game et al., 2014).

Within higher education studies, there is increasing interest in how best to prepare students for wicked problems (Hanstedt, 2018). A common feature of such research is the emphasis on enabling students to work across boundaries and integrate different perspectives (McCune et al., 2021; Veltman et al., 2019). Integrating insights from multiple fields of study is widely recognized as crucial for effective, inclusive, and rigorous conservation practice (Bennett, Roth, Klain, Chan, Christie, et al., 2017; Dick et al., 2017) and boundary-crossing skills are arguably a foundational skill set for conservation (Elliott et al., 2018). Developing interdisciplinary skills requires deliberate and well-designed teaching (Reich & Reich, 2006). Given the significance of integrating diverse disciplinary insights to address wicked problems, it is essential to understand whether conservation teaching sets out to develop students' interdisciplinary skills.

So far, interdisciplinarity (defined here broadly as possessing skills needed to cross different academic disciplines or schools of thought) has typically been discussed in relation to the extent of social science content offered in conservation degrees (Newing, 2010). The importance of the social sciences to conservation has been well documented (Bennett, Roth, Klain, Chan, Christie, et al., 2017; Pooley et al., 2014) and there have been recommendations to increase the provision of social science training (Dayer & Mengak, 2020; Newing, 2010). Following their review of interdisciplinarity in conservation education, Newing et al. (2010) proposed that conservation students should, at minimum, receive introductory-level training in social science methods and research design. Despite these recommendations, Gardner (2021) identified only one degree offering a module in social science methods in a study of 29 undergraduate UK conservation degrees. Methods from within the social sciences are vital for creating more ethical and effective conservation practices (Bennett, Roth, Klain, Chan, Clark, et al., 2017; Sanborn & Jung, 2021). If conservation students are not receiving formal training in social sciences methods, there could be serious implications for the quality of conservation research and effectiveness of conservation actions.

This study builds on previous reviews of conservation education (Gardner, 2021; Van Heezik & Seddon, 2005) to provide a deeper understanding of skills and methods training across universities. We focus on two countries with prominent conservation sectors: the United Kingdom and Australia. Our main objectives were to assess what skills conservation modules and degrees aimed to develop, and to examine the prevalence of teaching on different types of methods. We also investigated the association between conservation module characteristics (country, department, education level, involvement of individuals working primarily outside academia, and social science staff presence) and the teaching of specific skills or methods. Our study is the most comprehensive to date, collecting empirical data on 368 conservation-specific modules, across 95 universities, and 62 conservation degrees in 29 universities.

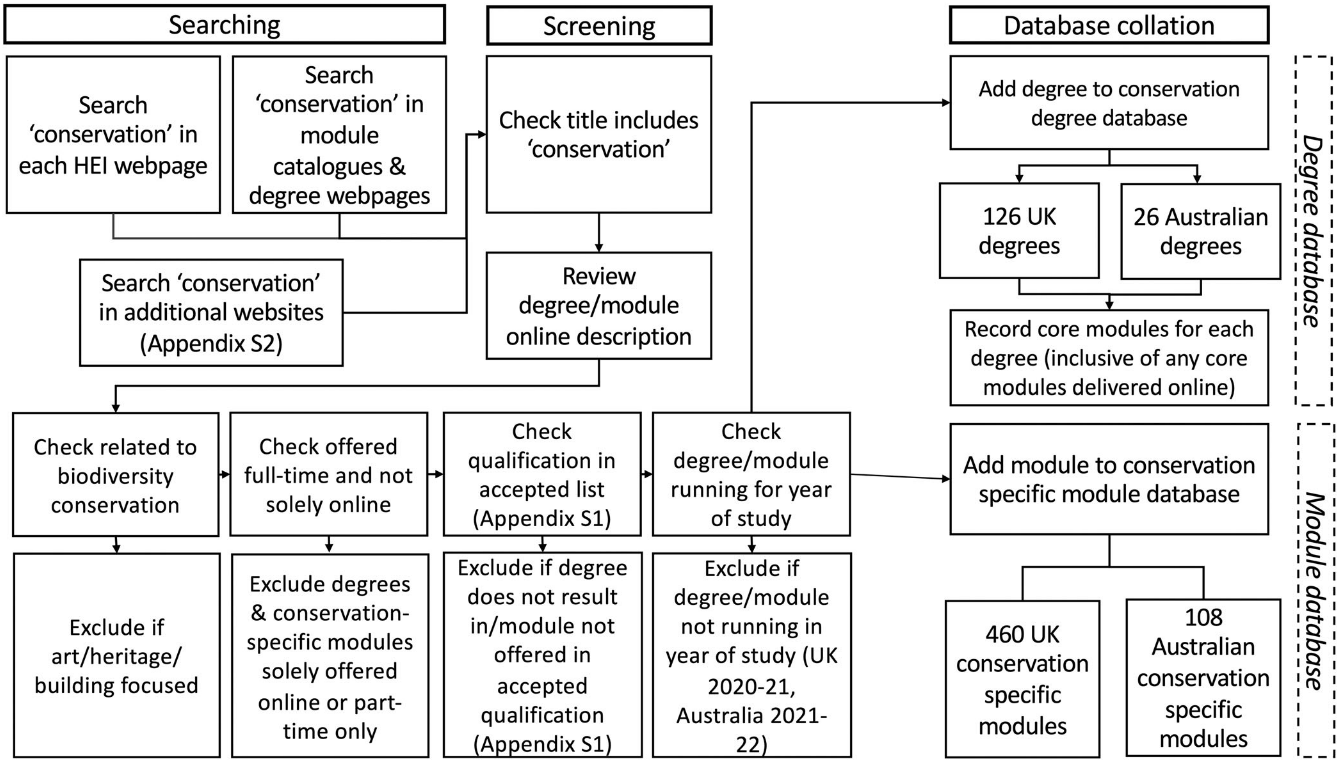

FIGURE 1 Process for collating conservation degree database and conservation-specific module database. HEI refers to Higher Education Institution.

Overall, the study provides new insights into the skills and methods that conservation higher education aims to teach.

2 | METHODS

2.1 | Scope and key terms

This study investigates conservation higher education in the United Kingdom and Australia. While differing in the conservation challenges they face, and social-ecological context, both countries have prominent conservation sectors and offer an array of conservation teaching. They share similarities in their higher education infrastructures, likely due to the historical roots of the Australian system in the Victorian British era (Wellings, 2015). The funding models of their universities have followed similar trajectories, with a long history of comparisons. Both countries have similar degree length and the use of modularization is common, making the data more easily comparable. In this paper, "module" refers to a credit bearing course that is typically taken as an optional or core aspect of a degree. A module is typically referred to as a "unit" in Australian higher education degrees.

Our analysis explores teaching at two levels: within conservation-specific modules and conservation degrees. We define conservation-specific modules as modules that have "conservation" in their title and a thematic focus on biodiversity conservation. Our sample includes both modules which form part of a conservation-focused degree and those offered in nonconservation-specific degrees (e.g., Biology BSc). We also investigate teaching in a sample of conservation degrees by collecting data on all listed core modules in each degree. By exploring both standalone conservation-specific modules, which may be the only time some students encounter conservation-focused teaching, and the core offering of a sample of conservation degrees we aim to provide a more detailed understanding of skills training than previous studies that have predominantly focused on degrees or relied on syllabus description data (such as Van Heezik & Seddon, 2005; Gardner, 2021).

2.2 | Database collation

We collated two databases: one for conservation degrees and a second for conservation-specific modules (Figure 1). We searched "conservation" in university webpages and online module catalogs. Degree search results were reviewed against predefined criteria

(Table S1). We also searched degree search engines (List S2) and new degrees were reviewed against the same criteria. A similar process was used to collate the conservation-specific module database. Module search results were scanned to ensure they were running for the relevant academic year of study (UK 2020–21, Australia 2021–22) and were not exclusively offered in a part-time or distance learning degree. The decision to exclude exclusively online and part-time conservation-specific modules and degrees was taken as our wider research project that uses the same sample required at least some students to be taught in person, and on a full-time basis. All core modules were listed for each degree in the final database, including any core modules taught online. This search took place during the COVID-19 pandemic and while several modules moved to online delivery in response to restrictions, our criteria relied on filtering out conservation-specific modules and degrees that were explicitly advertised in online materials as exclusively distance learning modules and degrees.

2.3 | Survey design and distribution

We designed an online survey as part of a wider research project. We specified in the introductory information that this survey was to be completed by module leaders. The survey consisted of six sections, two of which were of particular relevance to this study. In one section, respondents selected any methods covered in their module (options included: field-based methods, lab-based methods, quantitative social science methods, qualitative social science methods, remote sensing and GIS, statistics and modeling). Respondents could specify any methods in an "other" text box. Each option included a description that was visible when respondents hovered over the option (Table S3). Another section asked respondents to select, from 16 options, any skills that the module aimed to develop. The skills options were created by reviewing skills included in peer-reviewed studies on skills required for conservation careers (Blickley et al., 2013; Lucas et al., 2017). The list included skills considered to be disciplinary specific/academic and skills often referred to as soft skills (Survey S4). We followed Blickley et al.'s (2013: 26) definition of specific disciplinary skills as "knowledge of specific ecosystems, conservation issues or analytical tools" and general disciplinary skills as "knowledge of general scientific and conservation principles." Other sections collected data on staffing configuration and summative assessments (Figure S5 and Table S6). Ethical approval was granted by the University of Edinburgh School of Geosciences Ethics Committee.

The survey was piloted with conservation educators at the University of Edinburgh and minor word changes were implemented following feedback. The final version of the survey was distributed via email to relevant educators who were identified by searching university webpages, contacting administration teams, and via the authors' networks. It was not possible to identify module leaders for all modules and, as a result, degree coordinators were asked to forward the survey to relevant educators. The survey was emailed directly to identified module leaders of 334 UK conservation-specific modules and 90 Australian conservation-specific modules. We received survey responses for 117 UK conservation-specific modules and 29 Australian conservation-specific modules (corresponding to 25% of the UK and 27% of the Australian conservation-specific modules in our database).

2.4 | Content analyses of module descriptions

Alongside the online survey, we used a second data collection method: content analysis of online module descriptions. This data collection method was particularly crucial for collecting data on core modules in conservation degrees. Using a predefined protocol, we reviewed module descriptions for conservation-specific modules and core modules in conservation degrees for which we did not receive a survey response. We checked that the description included a section on content and another on skills/learning objectives. We classed descriptions that met this criterion as "full module descriptions" and included in a content analyses spreadsheet. We only included full module descriptions, as many descriptions lacked sufficient detail. We reviewed descriptions for mentions of the skills/methods included in the survey. For each module, any method or skill mentioned in the description was assigned a point (i.e., 1 indicated evidence of teaching on field-based methods).

We compared the data collected through the content analysis method to the survey instrument for a sample of modules (Table S7) and identified some differences. On average, survey respondents selected a higher number of items than identified using the content analysis method. Despite these differences, there were similarities in the most and least frequently recorded items across both data collection sources (Figure S8 and Figure S9).

2.5 | Data preparation and descriptive statistics

We cleaned our dataset to remove entries that did not meet the study criteria, such as entries that stated the module was not running in the year of study or were

TABLE 1 Selected explanatory variables for generalized linear mixed effect model to examine the predicted probability of conservation-specific modules aiming to teach a skill/method.

Explanatory variables	Variable description	Variable type
Department	The department a module belonged to, following sorting of "Other" responses (Natural sciences, interdisciplinary, social sciences)	Categorical
Education level	Whether a module was exclusive to postgraduates or open to undergraduate students (1 = Yes, exclusive to postgraduate, 0 = No, not exclusive to postgraduates)	Binary
Social science staff presence	Whether a module included at least one academic staff member from the social sciences (1 = Yes, 0 = No)	Binary
Country	Whether a module was taught at a UK or Australian higher education institution (UK, Australia)	Binary
Involvement of individuals working primarily outside of academia	Whether the module involved at least one individual working primarily outside academia (1 = Yes, 0 = No)	Binary

offered within an exclusively online or part-time degree. For analyses, we only included conservation degrees that we were able to collect either survey or content analysis data on all core modules. Descriptive statistics were completed R 4.2.1 (R Core Team, 2022).

2.6 | Statistical modeling

As part of our exploratory analysis, we fitted a binomial generalized linear mixed effects model to investigate the effect of module characteristics on the probability of a module aiming to teach a particular skill or method. For this model, we used solely survey response data for conservation-specific modules because staffing information was not typically available in module descriptions. The model was fitted in R 4.2.1 (R Core Team, 2022) using the glmer function in the lme4 package (Bates et al., 2015).

We created a binary response variable that indicated whether a module aimed to teach a particular skill/method (1 = Yes, 0 = No). Five fixed explanatory variables were included in the model: department, education level, social science staff presence, involvement of individuals outside academia and country (Table 1).

Most respondents selected an option that best represented the department their module was housed in (biological sciences, non-biological sciences, social sciences, interdisciplinary, or humanities). We sorted "Other" department responses by reviewing any text provided, checking responses of modules in the same department, and reviewing online department descriptions for each case. In cases where the department description stated a combination of subject areas from the different disciplinary categories, the module department was classified as interdisciplinary. For analysis, we combined biological sciences and non-biological sciences into a category named natural sciences. We also sorted "other" staff discipline responses on a case-by-case basis (Table S10).

To account for variation in the number of skills/methods modules aimed to teach, we included module code as a random intercept term. We included an interaction term between the method/skill variable and the fixed predictors. Multicollinearity checks were performed in R using the check_collinearity function in the performance package (Lüdecke et al., 2021) and the results indicated no multicollinearity issues.

2.7 | Calculating average predictive comparisons

To facilitate interpretation of the average effect of each explanatory variable on the probability scale we calculated average predictive comparisons (Gelman & Pardoe, 2007). Average predictive comparisons were calculated by simulating data based on a fitted model and systematically varying each focal variable at a time, while holding all other variables constant (Gelman & Pardoe, 2007). For instance, one set of simulations was produced for a dataset where all modules belonged to a natural sciences department while all other variables retained their original values. We then fitted the model to each modified dataset and simulated every scenario 1000 times. The mean predicted probabilities across the simulations were then calculated for each skill/method within each scenario. The final outputs were predictions of the average probabilities of each skill/method being taught depending on each level of a focal variable, including all modeled uncertainty.

2.8 | Data summary

We collated a degree database of 126 UK (53 undergraduate and 73 postgraduate) and 26 Australian conservation degrees (14 undergraduate and 12 postgraduate), Data S11. Our conservation-specific module database included 460 UK and 108 Australian modules (Data S12). Following cleaning, the UK survey response dataset included 195 module responses. A total of 117 of these responses were conservation-specific and the remaining 78 were core or optional modules offered in a conservation degree. The cleaned Australian survey response dataset included 32 responses: 29 conservation-specific modules and three core modules that did not contain the word "conservation" in their title. We were able to collect content analysis data for a further 159 UK conservation-specific modules and 63 Australian conservation-specific modules about which we did not receive a survey response. We collected survey or content analysis data for all core modules in 42 UK conservation degrees (12 undergraduate, 30 postgraduate) and 20 Australian conservation degrees (nine undergraduate and 11 postgraduate).

In this paper we use a combination of data collected using the online survey instrument and content analysis method. Where possible, we display data sources in figures to show differences in frequencies recorded using the two data collection methods. Some core modules were collected through the survey response data, while information on other core modules was collected through the content analysis of module descriptions. As we aggregated core modules into conservation degrees, we did not split conservation degree results by data source.

Sections 1 and 2 use a combination of survey and content analysis data for conservation-specific modules and conservation degrees. Due to limited information on staffing within online module descriptions, the results in Sections 3 and 4 use solely survey response data for conservation-specific modules.

3 | RESULTS

3.1 | Section 1: Skills conservation modules and degrees aim to develop

On average, UK conservation-specific modules selected six skills options and Australian modules selected seven skills options. Most conservation-specific modules in the survey dataset aimed to develop written communication (UK 91%, Australia 100%) and general disciplinary skills (UK 81%, Australia 79%; Figure 2). These trends were similar in the degrees reviewed. 70% of Australian conservation degrees included a core module that aimed to develop inter- and multidisciplinary skills. 21% of UK conservation degrees included a core module that aimed to develop inter- and multidisciplinary skills. 66% of the Australian conservation-specific module survey responses aimed to develop inter- and multidisciplinary skills, while only 31% of UK conservation-specific module survey responses selected this skill option.

Three skills appeared least frequently in conservation-specific modules across both countries: personnel leadership, program leadership, and cultural and international experience. Less than half of all conservation-specific modules aimed to develop students' project management skills. 38% of UK and 35% of Australian conservation degrees did not include any core modules aiming to develop interpersonal skills.

The survey responses also revealed a range of summative assessment types, including assessments related to nonacademic roles (Figure S5 and Table S6). For example, several modules included creating a management plan or stakeholder negotiation as a summative assessment.

3.2 | Section 2: Disciplinary specific and research methods teaching

Most modules covered at least one type of disciplinary specific and research method. Over half of the conservation-specific modules included teaching on field-based methods (Figure 3). Less than a quarter of the conservation-specific modules included teaching on quantitative or qualitative social science methods. A similar trend was found in conservation degrees: below 50% of the degrees included a core module covering quantitative or qualitative social science methods. Further results grouped by data source or education level are shown in S8, S9, S13, and S14.

3.3 | Section 3: Departments and staff configurations

Following reclassification of "other" responses, most conservation-specific modules belonged to natural science departments (UK = 77, Australia = 18). 21% of the conservation-specific modules belonged to interdisciplinary departments (UK = 20, Australia = 10), while a further 14 belonged to social science departments (UK = 20, Australia = 1).

Many conservation-specific modules were team taught and included staff from the biological sciences. 21% of UK and 17% of Australian conservation-specific

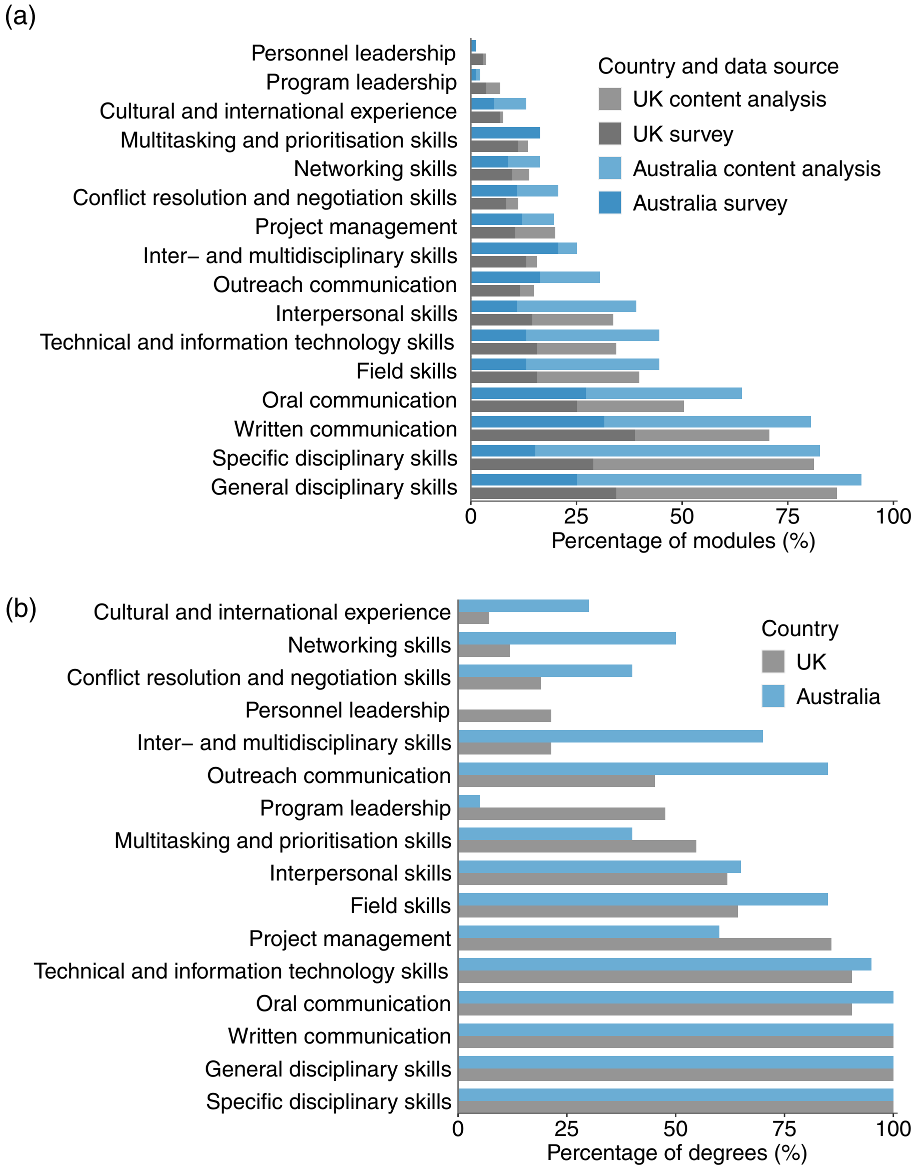

FIGURE 2 Prevalence of skills that conservation-specific modules and conservation degrees aimed to develop. Panel a: Percentage of conservation modules that aimed to develop each skill. Panel b: Percentage of conservation degrees with at least one core module that aimed to develop a given skill (UK degree n = 42, Australian degree n = 20). Panel a stacked bars represent the data source and percentages are calculated out of a combined survey and content analysis sample (UK module n = 276, Australian module n = 92).

modules involved at least one staff member from the social sciences. Over half of the conservation-specific modules surveyed (57% UK, 62% Australia) involved individuals working primarily outside of academia.

3.4 | Section 4: Average predictive comparisons for conservation-specific modules

Few differences were observed when systematically varying the department a module belonged to (Figure 4). Statistics and modeling and field-based methods were less likely to be taught in scenarios where modules belonged to a social science department compared with a natural science or interdisciplinary department. No notable differences were observed for social science methods when varying the department.

Varying the presence of social science staff resulted in some differences. In scenarios with at least one social science staff member, the average predictive probability of quantitative or qualitative social science methods being taught was higher than scenarios with no social science staff. In scenarios with no social science staff member, the average predicted probability of quantitative or qualitative social science methods being taught was approximately 10% (quantitative APC = 0.09, qualitative APC = 0.11).

Varying the education level had little effect on the average predicted probabilities. Modules exclusive to postgraduate students were less likely to include teaching on field-based methods than modules open to undergraduates. Modules exclusive to postgraduates were slightly

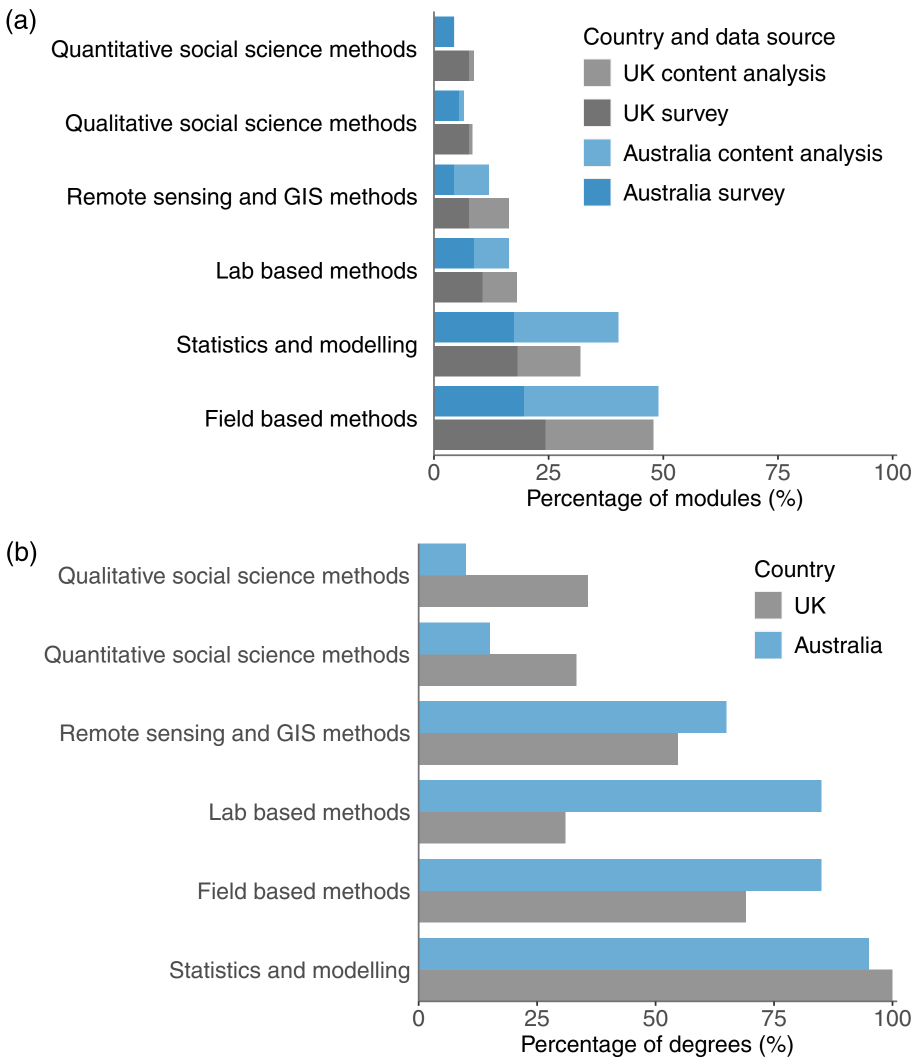

FIGURE 3 Disciplinary specific and research methods included in conservation-specific modules and the core module offering of conservation degrees. Panel a: Percentage of disciplinary specific and research methods taught in conservation-specific modules, using a combination of survey and content analyses data. Stacked bar percentages are calculated out of the total module sample size (UK module n = 276, Australian module n = 92). Respondents were able to select multiple options and "other" responses are excluded. Panel b: Percentage of conservation degrees that included at least one core module covering a given disciplinary specific and research method (UK degree n = 42, Australia degree n = 20).

less likely to aim to develop inter- and multidisciplinary skills than modules open to undergraduates.

We observed some differences when adjusting the presence of individuals working primarily outside of academia. Module scenarios involving individuals from outside academia had a higher probability, on average, of aiming to develop outreach and oral communication skills than scenarios with no individuals from outside academia. For both levels, the average predicted probabilities for program and personnel leadership remained low.

4 | DISCUSSION

This study provides the most extensive review of conservation higher education skills training across the United Kingdom and Australia. The results indicate that most conservation-specific modules and degrees aim to develop general disciplinary and communication skills. However, few conservation-specific modules aim to develop key nonacademic skills that have been repeatedly highlighted as important across conservation job sectors (Blickley et al., 2013; Lucas et al., 2017). In addition, several conservation degrees in our sample did not include a core module covering quantitative or qualitative social science methods. Such findings suggest that recommendations to increase nonacademic skills training and ensure conservation students receive formal social sciences methods teaching are yet to be fully implemented. To best prepare students for conservation careers and the complex problems they will encounter, conservation education needs to further focus on building students' nonacademic skills and provide teaching on the breadth of methods that contribute to conservation.

4.1 | Building nonacademic skills for effective conservation practice

It is reassuring that most conservation-specific modules and all conservation degrees in our sample aimed to develop general disciplinary and communication skills.

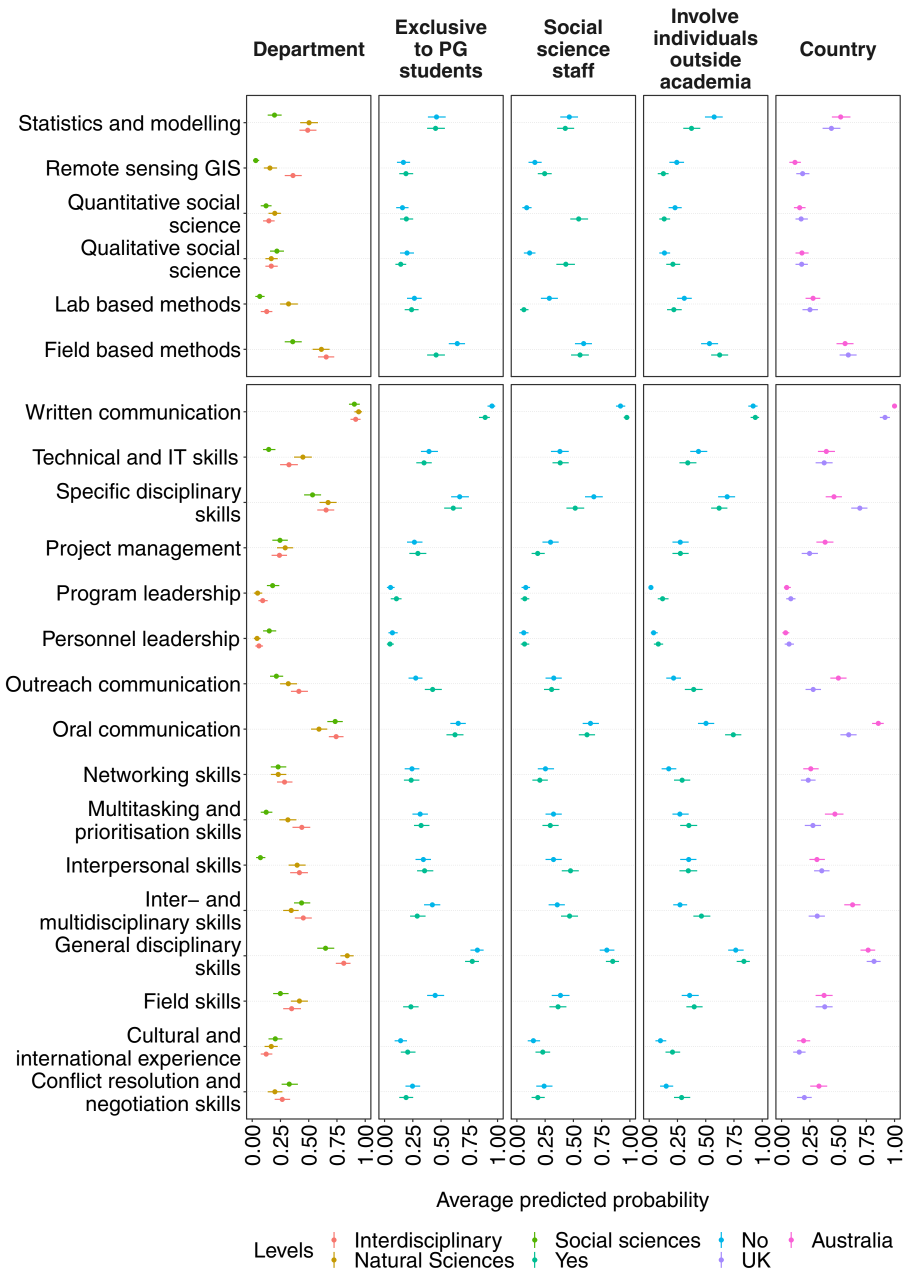

FIGURE 4 Average predictive comparisons for skills and methods. Model uses solely survey response data for conservation-specific modules (UK module n = 117, Australia module n = 29). The error bars indicate approximate 95% confidence intervals.

Studies have highlighted that conservation graduates need strong disciplinary knowledge (Blickley et al., 2013; Lucas et al., 2017) and the ability to communicate complex information to a range of audiences (Kainer et al., 2006; Manolis et al., 2009). For Teel et al. (2022), disciplinary specific and communication skills are essential "technical capacities" that wildlife conservation degrees should teach. Our results indicate that developing disciplinary and communication skills is already an explicit aim for most conservation modules and degrees in the United Kingdom and Australia.

In contrast, few of the conservation-specific modules surveyed aimed to develop key nonacademic skills. Project management was a development aim for less than half of the conservation-specific modules, despite being ranked as important by conservation professionals (Blickley et al., 2013; Muir & Schwartz, 2009). 38% of UK and 35% of Australian degrees did not state interpersonal skills as a development aim in any of their core modules. Cannon et al. (1996) described a disconnect between the perceived importance of interpersonal training and the provision of interpersonal skills education in conservation biology degrees. Our results suggest that developing interpersonal skills is still not a priority for most conservation modules and remains absent from the core offering of several conservation degrees. This is concerning because effective conservation leadership demands well-developed interpersonal skills (Englefield et al., 2019). The ability to collaborate effectively is a foundational capacity for contemporary conservation (Elliott et al., 2018) and interpersonal skills are vital for addressing wicked problems (Davidson et al., 2021; Kawa et al., 2021).

In the context of constraints on the amount of content conservation teaching can cover, it has been argued that students should take responsibility of their skills development and seek opportunities to develop nonacademic skills (Blickley et al., 2013; Lucas et al., 2017). While we agree that it is important for students to play an active role in their professional development, the onus cannot be entirely on students to develop such skills independently. With calls to increase diversity and inclusion within conservation (Zavaleta et al., 2018), it is important that conservation education does not rely on students seeking out extracurricular (often unpaid) opportunities to develop nonacademic skills. Such an approach will likely be regressive, disadvantaging those with care responsibilities and socioeconomic barriers to undertaking unpaid work. Conservation education has a responsibility to prioritize and support students in developing skills that have been repeatedly highlighted as essential for conservation careers.

Much can be learnt from other applied disciplines that dedicate considerable time to developing nonacademic skills. Conservation is often compared with medicine as a mission-oriented discipline (Adams & Sandbrook, 2013; Soule, 1985). For medicine and allied health professions there is typically formal teaching on interpersonal skills (Daff, 2012; Skinner et al., 2016; Winter et al., 2023). These disciplines also have a vast amount of technical content to cover but place considerable effort into building and assessing students' interpersonal skills (including through Objective Structured Clinical Examinations—Lim et al., 2011). Likewise, engineering education is typically designed to build operational project logic and project management skills (Ballesteros-Sánchez et al., 2017; Battisti, 2018). Important insights can also be gained from neighboring fields of environmental management and sustainability, particularly research on the critical skills required for broader environmental professions (Thomas, 2019) and ideas around how best to signal nonacademic skills to employers (Miller & Jorre De St Jorre, 2022).

By basing our list of skills on studies about the conservation job market (Blickley et al., 2013; Lucas et al., 2017), we have developed an understanding of the prevalence of teaching of skills identified as important by conservation employers. Still, it would be useful for future research to explore whether and how teaching aims to develop other skills that are important for conservation, such as empathy and active listening, that may not appear in conservation job advertisements. This includes exploring the extent to which personal aptitudes needed for conservation, similar to those identified by Schwartz et al. (2017) for translational ecologists, are being fostered through formal education.

4.2 | Interdisciplinary skills are essential for addressing wicked problems

Although the need to integrate insights from different disciplines is widely recognized as important for conservation practice (Dick et al., 2017), few UK conservation modules and degrees aimed to develop students' inter- and multidisciplinary skills. In contrast, over half of the Australian conservation modules and degrees in our sample aimed to develop inter- and multidisciplinary skills. This difference could relate to a divergence in the ways universities are structured to promote interdisciplinary education. Despite much discourse around interdisciplinarity in both UK and Australian higher education documents (Lyall et al., 2015; Millar, 2016), several Australian universities have graduate attributes related to interdisciplinarity (Millar, 2016) while interdisciplinarity does not always feature in the educational goals of UK universities (Evis, 2022). The difference may also relate to varying interpretations of what interdisciplinary education involves (Lindvig & Ulriksen, 2019; Pharo & Bridle, 2012).

Overall, it is concerning that so few UK conservation modules and degrees set out to develop inter- and multidisciplinary skills. Conservation problems are socio-ecological in nature and their complexity demands approaches that transcend traditional academic disciplines (Beck et al., 2019; Kelly et al., 2019). Conservation graduates cannot be expected to integrate knowledge from different disciplines if they have not been taught the skills to do so. Interdisciplinary skills need to be cultivated over time. While there are different perspectives on the best timing to teach interdisciplinary skills (Schijf et al., 2022), over 50% of researchers working on human-environment topics stated that interdisciplinary training should begin during undergraduate degrees (Roy et al., 2013). It is crucial that conservation teaching makes an explicit effort to train agile graduates who are open to different disciplinary perspectives and have experience synthesizing information from diverse fields of study.

4.3 | Minimal difference between conservation-specific modules exclusive to postgraduates versus modules open to undergraduates

An interesting finding was the lack of difference between teaching aims in postgraduate exclusive and nonpostgraduate exclusive modules. Excluding field skills and field-based methods, we observed little variation in average predicted probabilities when varying the education level variable (Figure 4). While postgraduate modules may need to provide introductory training given students enter from different backgrounds, many postgraduate students are likely to have undertaken modules that aim to develop their disciplinary and written communication skills. This is supported by our supplementary analysis of a sample of degrees, where all undergraduate degrees reviewed included at least one core module on specific disciplinary skills, general disciplinary skills, and written communication (S13). Recognizing this, we suggest that postgraduate modules consider focusing on key nonacademic skills highlighted in previous studies. Building nonacademic skills will not only benefit those who wish to pursue research careers, of which spaces are limited, but also graduates who intend to enter directly into positions outside of academia.

4.4 | Teaching the breadth of methods in conservation science

A range of disciplinary specific and research methods were represented in our sample, but some appeared more frequently than others. Field-based methods were covered frequently, while less than a quarter of the conservation-specific modules included teaching on qualitative or quantitative social science methods. It could be argued that social science methods are taught elsewhere in the degree program. Yet, our analyses of core modules in a sample of conservation degrees indicate that there are several degrees where conservation students can graduate without receiving any formal teaching on social science methods. Our findings are in line with Gardner's (2021) review of UK undergraduate degrees, who identified one module on social science research methods. Our results suggest that recommendations to increase social science methods training are yet to be fully realized, at least within conservation teaching in the United Kingdom and Australia. Alongside others (Gardner, 2021; Newing, 2010; Teel et al., 2022), we reiterate that not all conservation graduates need to be experts in social science methods but providing students with at least foundational training in research methods used within the social sciences could benefit conservation in several ways.

Ensuring conservation students receive training in social science research methods could reduce communication barriers that often hinder interdisciplinary work (Pooley et al., 2014). An understanding of the terminology used in social science research designs could help students to communicate effectively in interdisciplinary teams (Newing et al., 2010). Social science methods teaching may also help students to appreciate the diverse range of fields and tools that contribute to conservation. Such training would reduce myths that social science methods are "easy" to conduct (Teel et al., 2022) and teach future conservationists that relevant social sciences expertise needs to be included in the early stages of project proposals (Kelly et al., 2019; Martin, 2020).

It is possible that our dependence on online module descriptions to collect data on core modules means we may have underrepresented some methods covered in conservation degrees. Future studies could make use of program specifications, handbooks, and interviews to better understand the training offered in conservation degrees. Still, our approach does provide an insight into the types of methods that are explicitly advertised in module descriptions.

4.5 | Training conservationists requires cross-disciplinary expertise

The teaching offered is likely to depend, in part, on the expertise available. Given most conservation-specific module faculty were from the biological sciences, it is unsurprising that we found social science methods to be taught less than lab or field-based methods. The average predictive comparisons indicated that modules including at least one member of social science staff were more likely to teach social science methods. Still, in scenarios with no social science staff the probabilities of teaching quantitative or qualitative social science methods were approximately 10%. This calls into question whether appropriate expertise is being involved in conservation education. There have been critiques of conservationists conducting social science research with no training or little effort to involve social science expertise (Martin, 2020). It is important that conservation education does not make similar mistakes but instead ensures that appropriate expertise is included in training future conservationists. This will require effort from universities to remove barriers preventing collaborations across departments and incentives for cross-disciplinary team teaching (Jacobson & Robinson, 1990).

Meanwhile, most conservation modules involved staff working primarily outside of academia. This suggests that calls to include professionals working in non-research roles (Noss, 1997, 1999) have been heeded. We found some nonacademic skills were more likely to be included as teaching aims in scenarios with individuals working primarily outside of academia. Due to the lack of staffing information in module descriptions, our staff analyses were limited to survey response data for conservation-specific modules. In future research, it would be useful to understand how nonacademic practitioners may shape students' skills development.

4.6 | Concluding discussion

Decisions around what to teach conservation students today will shape the field for coming decades. To equip students with the skills required to approach wicked conservation challenges, conservation higher education needs to place greater emphasis on developing the nonacademic skills that have been highlighted as essential in previous studies (Blickley et al., 2013; Lucas et al., 2017; Muir & Schwartz, 2009). Skills related to integrating insights from different disciplines and working as a team to achieve project goals need to be collaboratively learned and practiced in a supportive environment. Even a small degree of formal training on essential nonacademic skills could help to prepare graduates for the messy conservation problems they will face.

We argue that there is a need to increase the provision of social science methods training. It is important to ensure that graduates are aware of the breadth of methods required for contemporary conservation science. The SCB's social science working group is one of the most active sections in the society (Adams, 2007; Bennett, Roth, Klain, Chan, Clark, et al., 2017) and multiple articles detail the importance of incorporating the social sciences into conservation (Bennett, Roth, Klain, Chan, Clark, et al., 2017). Yet, our results indicate that conservation education is lagging behind and still to fully integrate social science methods into conservation training. It should be noted that our findings are limited to the United Kingdom and Australia. It would be useful to compare the trends identified with teaching offered in different geographic regions.

Overall, the pace of curriculum change in higher education is known to be slow (Cotton et al., 2009). Institution level changes are required to fully realize the interdisciplinary and collaborative teaching required for contemporary conservation. There needs to be greater flexibility and incentives for teaching across traditional departments and increased simplicity in connecting students with conservation practitioners. Such changes are necessary to ensure that students build the boundary-spanning skills required for wicked problems. In the short term, this study can assist conservation educators in reflecting on current teaching aims and in considering where changes may be implemented to better align skills training with contemporary conservation needs.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data are available from the University of Edinburgh DataShare service at the following address: https://doi.org/10.7488/ds/7692.

ETHICS STATEMENT

This research was reviewed and approved by the University of Edinburgh School of Geosciences Ethics Committee.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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