SPOTLIGHT

Fair Winds and Following Seas Remotely: Modifying Perceptions of Fieldwork as a Requirement in Marine Science to Aid in Diversifying the Discipline

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INTRODUCTION

Pursuing an academic career in marine science requires a range of skills that can be applied across different contexts, including experimental or computational proficiency, policy engagement, teaching, and seagoing fieldwork. The tendency to advertise careers in marine science with imagery of research expeditions results in the perception that it is a requirement for a career in marine science, an indicator of competitiveness in this discipline. Historically, those participating in remote fieldwork over extended periods of time were perceived as "adventurous explorers, with a strong bias towards western, able-bodied men" (Nash et al., 2019). Use of imagery reinforcing such notions for marine scientists fails to recognize that this perception can be discouraging to individuals from other backgrounds who may be excluded from the discipline by a range of real and perceived participatory barriers. Such exclusionary factors include: caring responsibilities, physical mobility, challenging social environments, isolating and physically uncomfortable working environments, mental health challenges, and access to opportunity (Giles et al., 2020). Such barriers disproportionately affect diverse, underrepresented, and marginalized groups, who may therefore struggle to identify with marine science as a potential discipline in which to pursue a successful career.

Current work toward achieving net zero targets within ocean research emphasizes the use of autonomous vehicles as alternatives to ocean-going ships (Storey, 2023), and the proposed concept of digital twinning would incorporate similar remote technology coupled with simulations and shore-based decision-making. The concept of digital twinning refers to the use of responsive autonomous platforms that can both collect data and be operated in response to that data, which could provide a non-field-based approach to delivering marine science while also potentially expanding the opportunities available for individuals not able or interested in working in the field. In distinguishing digital twinning from current approaches such as data assimilating models, Kritzinger et al. (2018) note the importance of a two-way data flow between the physical environment and its virtual representation, called a "digital twin," which, for example, may lead to changes in deployment strategy or data collection by researchers. Because these twins can be controlled and simulated anywhere with access to sufficient computing power, shore-based individuals can interact with a virtual version of the physical environment without being physically present at sea. The technology to support a fully realized digital twin of the ocean is still under development, but its use would require a broader range of skills and roles in the discipline, many of which are not accurately conveyed by the prevailing marketing of field-based disciplines (see Mol and Atchinson, 2019, regarding geosciences).

In order to fully integrate this new approach into marine science, employment of individuals with experience and training across a wide range of disciplines from software engineering to traditional field sampling is essential while also presenting the potential for making marine science more inclusive. Individuals for whom working at sea is not possible and/or desirable would be able to make equally valid contributions to such research projects via digital routes, without facing the many barriers fieldwork may present. This study explores the expectations of marine scientists, from both early and more established career stages, around the importance of field experience as a precursor or requirement for a successful marine science career, and also examines the advantages and disadvantages of using digital twinning as a complement to traditional field-based marine science.

METHODOLOGY

In January 2022, we hosted an exploratory interactive webinar for professionals working in marine science as part of a larger project designed to promote inclusivity in marine science. Participants were recruited through advertising on social media, which was then extended through research organizations and professional societies such as the Challenger Society for Marine Science. A short introductory presentation was given to define the aims of the session, and the web app Mentimeter was used to collect responses to the question: Do you think participating in fieldwork is a requirement for a career in marine sciences? Participants were then split into break-out groups, each moderated by a member of the research team. Individuals from each break-out group were asked to address the following questions by posting to a collaborative online whiteboard:

1. If you are early in your career, do you view fieldwork as a "requirement" for a career in marine science?
2. If you are later in your career, do you have fieldwork experience and was it crucial to your success?
3. Do you see a role for digital twinning to complement traditional marine science fieldwork?
4. Can you think of ways of utilizing digital twinning during fieldwork?
5. What advantages or disadvantages do you foresee in using digital twinning?

RESULTS

A total of 37 marine scientists from institutions across the UK attended this session, with 20 self-identifying as early-career researcher stage (EC) and 17 as later-career stage (LC); 31 individuals contributed to the break-out sessions. From the summary data, the largest portion of EC and LC participants indicated fieldwork was not essential (EC: 18.9%, LC: 24.3%; **Figure 1**); however, roughly 10% of both groups did say fieldwork was essential. LC participants were slightly less likely than EC participants to feel that fieldwork was not essential (EC: 10.8%, LC: 8.1%). Reasons for the importance of fieldwork related to either securing a position or progressing within one. One-third of participants noted that the importance of fieldwork was context or discipline

specific, particularly when working in a large team. Comments from ECs mentioned they felt fieldwork to be a "rite of passage" or that it was needed in order to "be taken seriously," indicating a strong perception of the importance of fieldwork. Among LC individuals, 63% indicated fieldwork was crucial to their success, highlighting benefits to transferable skills and networking with other researchers, and 21% mentioned that fieldwork was essential for collecting certain types of samples, although one LC participant acknowledged the role of teams in this regard (i.e., as long as the samples were collected from the field, it did not have to be done by any particular individual).

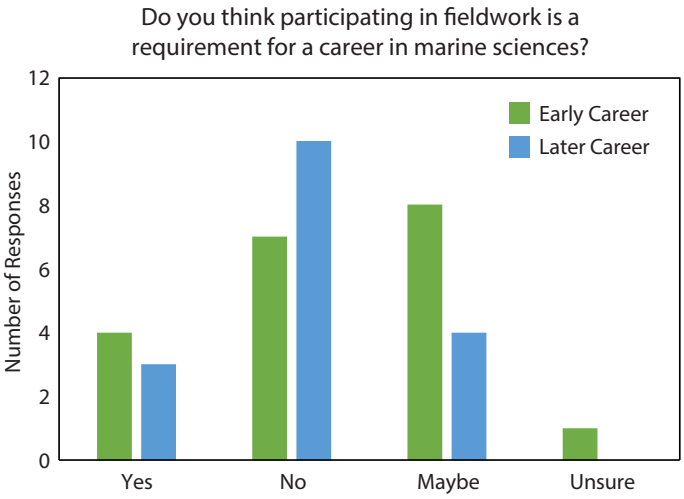

FIGURE 1. Participant responses (n = 37) to the question "Do you think participating in fieldwork is a requirement for a career in marine sciences?" are grouped here by career stage of workshop participants, self-defined as either Early Career (green, n = 20), including undergraduate and postgraduate, or Later Career (blue, n = 17), including mid- and senior-level individuals.

Most participants viewed digital twinning as beneficial (Figure 2), allowing either broader-scale research questions to be addressed or collection of larger data sets; however, quite a few individuals were initially unaware of the concept, as demonstrated by 14% of participants interpreting digital twinning as a standard modeling approach and being unaware of its two-way element. Several individuals mentioned the importance of digital twinning in reducing carbon emissions (10%) or improving accessibility for individuals (8%). A range of disadvantages were also suggested, including concerns about disconnecting from the actual environment, issues with technology and sensor quality, not having a qualified workforce to process the collected data, and, finally, that it could never completely replace fieldwork. Some also commented on digital twinning's potential for reinforcing a division between those working in the field versus those working on the data, while others commented that without students experiencing fieldwork early on, the discipline may lose a key aspect that inspires and motivates young scientists to enter and remain in the discipline. There was also a concern that organizations might automatically push those with disabilities into non-field-based roles rather than working to accommodate disabilities during fieldwork.

LESSONS LEARNED

From the responses of those who participated in this scoping workshop, we learned that fieldwork is typically considered an essential element of being successful in the discipline. However, participants also recognized that maintaining a field-based career is not necessary for long-term success. A range of different skills, and thus different roles in larger research teams, are necessary to answer global-scale research questions. Recognizing and valuing the contributions of individuals who do not participate in fieldwork, but who can contribute digital and data analysis skills, could encourage people who do not want to or cannot participate in fieldwork to consider careers in marine science. Although digital twinning is seen as a potential opportunity for addressing some of these issues, the

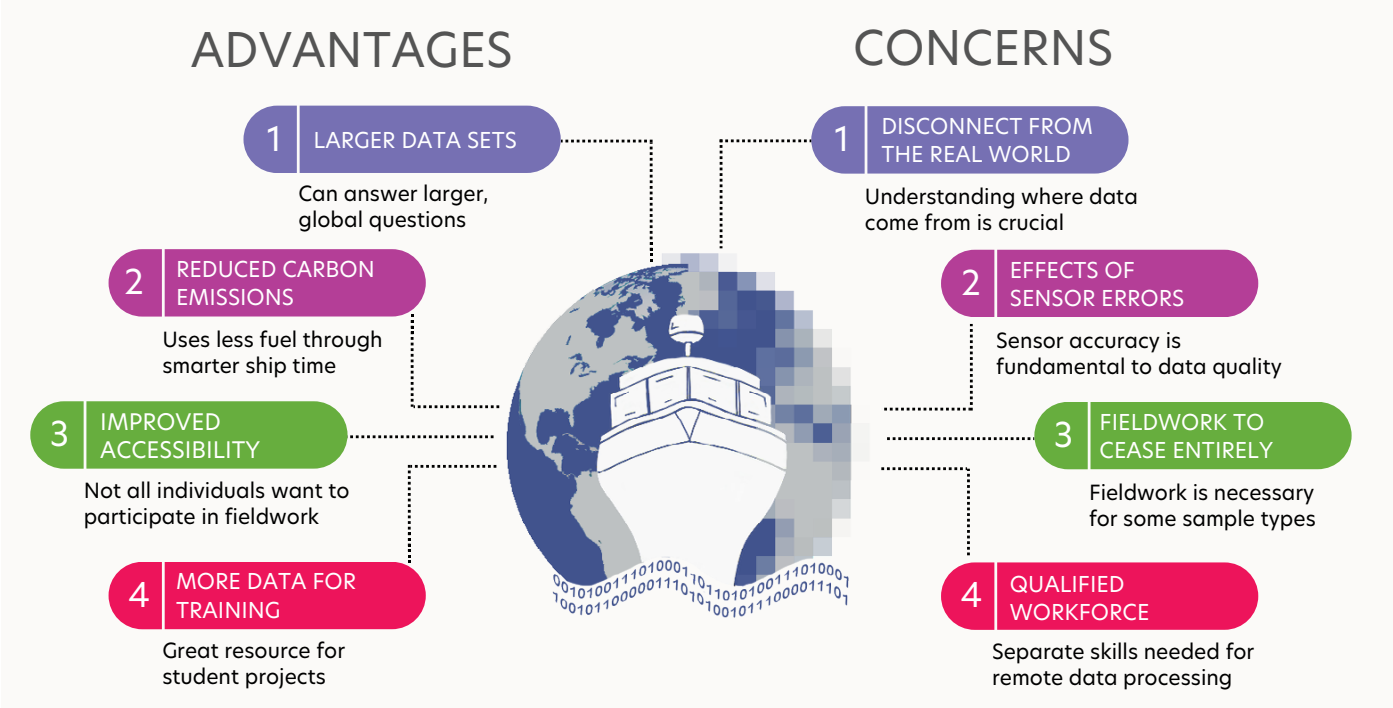

FIGURE 2. Key themes are identified from online whiteboard responses submitted by participants on the advantages and disadvantages of digital twinning.

marine science community is still grappling with digital twinning as an approach (Siddorn et al., 2022). Further education on and increased awareness of the concept itself, perhaps by scheduling workshops on the topic at marine science conferences, are needed along with technological advances.

Our workshop also highlighted that digital twinning must be included from the inception of a project, so raising awareness of the opportunities and advantages of digital twinning among principal investigators is crucial. Furthermore, for digital twinning to be utilized to support diversity and inclusion in marine science, the perceptions and field sampling strategies used by established researchers will need to undergo a cultural shift that moves away from the perception of fieldwork as a "rite of passage." Kintisch (2013) provides examples of increasing numbers of US postgraduates that never undertake fieldwork during their doctoral program training. Fernando et al. (2023) include diversifying advertising as a recommendation for encouraging wider postgraduate student entry into geoscience disciplines. Finally, approaches like digital twinning should never be used to negate the responsibility of institutions to tackle barriers to fieldwork.

Fieldwork will remain a key part of marine science, but emerging approaches such as digital twinning present opportunities to make marine science more inclusive. The equal importance of shore- and field-based roles could be recognized more fully by including both in imagery and text on websites and in knowledge exchange events with researchers. Many websites directed at individuals entering the field include researcher profiles or example job roles, which could be updated to highlight the key interaction between those working ashore and those in the field. In addition, incorporating synchronous interactions between field-based and non-field-based activities into undergraduate field courses could strengthen understanding of the importance of these two groups working together (Collins et al., 2023). Partnering through the use of technology during developmental career stages could make significant progress in shifting cultural perceptions of the importance of diverse roles. Ultimately, these steps may also help previously excluded groups engage with the discipline and enhance progress toward a more inclusive and diverse marine science workforce.

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