

An early career perspective on encouraging collaborative and interdisciplinary research in ecology

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Abstract. There is a growing need for collaborative and interdisciplinary research in addressing global ecological challenges, and early career researchers (ECRs) often play a vital role in such ventures. But despite the desire for such approaches, forming new and interdisciplinary collaborations is risky, and disproportionately so for ECRs, whose perspectives on this topic are rarely heard. Here, we present common perceptions among ECRs regarding opportunities for intra- and interdisciplinary collaboration, and barriers preventing such collaboration from taking place. We also discuss possible solutions, and the ecological outcomes of fostering more collaboration. The perceptions discussed have been distilled from a two-day workshop in New Zealand, aiming to investigate the potential for collaboration between 34 ECRs in distinct ecological disciplines across ten research institutes. Commonality in methodology or research aims was vital for potential collaborations to be considered worthwhile, but differences in spatial or temporal scales were a key disconnect that hindered numerous potential crossovers. Individual connectivity and institutional structures were commonly perceived as barriers to acting collaboratively in general. Specifically, barriers included having a small peer network, lack of access to funding, and concerns over the risk/reward ratio of forming new collaborations. Overcoming barriers will require active, practical support from institutions, funding bodies and mentors, and participants commonly called for specific funding support and the creation of ECR-focused spaces to better foster collaborative behavior. Fostering interdisciplinary ECR collaborations in ecology was perceived to be useful in creating larger and more useful datasets and tools, and more scalable and transferable models and outcomes. Adopting practices that facilitate more ECR-led interdisciplinary collaboration will help generate a more integrative understanding of ecological systems globally.

Key words: collaboration; early career; interdisciplinary; networking; New Zealand; research; workshop.

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INTRODUCTION

Forming interdisciplinary teams is an increasingly important component of ecological research, due to the complex social, economic, and environmental factors that underpin global ecological problems (Brewer 1999, Carpenter and Folke 2006, Eigenbrode et al. 2007). The term interdisciplinary is sometimes incorrectly used interchangeably with other terms such as multidisciplinary, but here it specifically refers to distinct fields of research working together toward a common goal (Tress et al. 2003, White et al. 2015). Interdisciplinary research is therefore intrinsically linked with the concept of collaboration (John-Steiner et al. 1998, Sonnenwald 2007), although collaboration also commonly occurs within disciplines. Adopting such approaches can help improve the quality of ecological research: Diverse interdisciplinary collaborations in both academia and industry have been linked to better problem-solving and novel thinking (Goring et al. 2014). Collaborations also provide benefits for the researchers themselves: Publications with multiple authors are cited more frequently than single-author papers (Persson et al. 2004), and by dividing labor between more people with a greater combined skill set, interdisciplinary collaborations should also help individual researchers to keep up with the demands placed on them by an increasingly competitive job market (van den Besselaar et al. 2012, Bellotti et al. 2016).

In part due to the numerous benefits of interdisciplinary collaborative approaches, many funding bodies now expect them to be at the core of grant proposals (Lyall et al. 2013). For example, the Ecological Society of America (ESA) has centered such approaches in their Strategies for Ecology, Education, Development, and Sustainability program, by making action ecology a flagship objective (Rivera et al. 2010). Action ecology involves broad-scale, applied, technology-driven research that must be inclusive, collaborative, and interdisciplinary, and is increasingly recognized as crucial if we are to rapidly solve the many ecological crises faced globally. As collaboration has become almost a prerequisite for high-quality research, the composition of research teams has had to adapt. Modern teams are often large (Wuchty et al. 2007) and geographically dispersed, and rely on a growing suite of digital

collaboration tools, such as cloud storage (Kouzes et al. 1996, Kozlowski and Ilgen 2006, Cummings and Kiesler 2008). Online academic communities also allow emerging researchers to more easily connect with other like-minded scientists all over the world (Giglia 2011, Ferguson and Wheat 2015). However, there is still work to be done to enhance inclusion, access, and ease-of-use of these online spaces.

Despite their benefits, there are also significant costs involved in creating interdisciplinary collaborations. From a team perspective, building good communication across interdisciplinary projects takes skill and patience, and setting up and maintaining these collaborative ventures is time-consuming (Cummings and Kiesler 2007, Bozeman et al. 2016). Developing such ventures may be a risky investment as, despite the widespread acknowledgment of the importance of interdisciplinary research, funding is often less likely to be granted (Bromham et al. 2016). This has been dubbed the paradox of interdisciplinarity (Woelert and Millar 2013) and is often explained by the difficulties in selecting review panels that are adequately qualified to review all parts of an interdisciplinary proposal (Boix Mansilla et al. 2006, Record et al. 2016). From an individual perspective, researchers may risk burnout trying to juggle the demands of large, globalized peer networks (Caretta et al. 2018), as well as isolating themselves from their core field, jeopardizing their career prospects (Jones 2010).

As interdisciplinary research continues to grow and evolve, it often falls on early career researchers (ECRs) to lead the way in this space (Rhoten and Parker 2004, Haider et al. 2018). While researchers were once specialists in narrow fields, as the research landscape has shifted the ECRs now supervised by these specialists learn not simply to work in interdisciplinary teams, but to be interdisciplinary individuals from the outset (Haider et al. 2018). This happens early on through formal interdisciplinary training and programs from undergraduate level onwards (e.g., Nielsen-Pincus et al. 2007), or through being immersed in diverse research teams before they are fully intellectually committed to a specific field (Rhoten and Parker 2004). Yet, ECRs are simultaneously less likely to receive adequate recognition for their contributions compared with more senior collaborators (Goring et al. 2014).

This is problematic as the system tends to undervalue the alternative research outputs that often result from highly interdisciplinary research (Schuitema and Sintov 2017, Singh et al. 2019), such as outreach, policy briefs, co-production, and team-building, as well as publications outside of the researcher's main discipline. In response, ECRs often prioritize traditional research outputs in order to build a reputation within their discipline and get ahead (Bridle et al. 2013). Discussion of the challenges and solutions to building interdisciplinary collaborations is therefore disproportionately relevant to ECRs, but their voices have, so far, been largely absent from this debate (Bridle et al. 2013).

Here, we discuss ECR perspectives on opportunities and barriers to intra- and interdisciplinary collaboration, as well as potential solutions and outcomes to increased collaboration, as identified during a two-day workshop intended to unpack this topic. Designed, led, and attended by ECRs, the New Zealand's Biological Heritage Early Career Workshop was held in July 2018 in Lincoln, New Zealand, funded by New Zealand's Biological Heritage National Science Challenge (BHNSC, <https://bioheritage.nz>). Thirty-four ECRs across various ecological and socio-ecological disciplines, and across ten research institutes, attended. To avoid exclusionary labels, researchers were considered early career through self-identification (Bosanquet et al. 2017) and ranged from MSc students to principal investigators, with the majority at doctoral level. All participants gave an oral presentation of their research, grouped into five sessions based on common themes. After each session, participants split into breakout groups and discussed: (1) specific opportunities for collaboration (commonalities and disconnects between the research projects presented), (2) barriers preventing collaboration in general (both individual and institutional), and (3) the way forward (how to overcome barriers and what research outcomes might result). After the workshop, responses were digitized and classified into common themes, which were counted and used to infer relative importance or consensus. Finally, in line with the theme of this workshop, all participants were given the opportunity to lead and co-author the resulting article.

By sharing our findings, we aim to increase awareness of the issues preventing better

collaboration between ECRs in ecology, and encourage the support of interdisciplinary collaborative approaches to ecological research. While our workshop comprised mainly ecologists, social scientists, and those in the life sciences, we acknowledge that solving ecological problems increasingly relies on collaboration with those in wider disciplines such as mathematics, economics, physics, and the humanities (Roy et al. 2013). In addition, collaboration with non-academics, politicians, and public stakeholders is vital in implementing ecological research effectively. These important issues were beyond the scope of our workshop, but we expect that many of the same barriers and opportunities that we identify will be relevant to broader interdisciplinary collaborations. We also believe that our findings are not only relevant in New Zealand, but are globally translatable due to the similar structure of academic research around the world, and the fact that ECRs often collaborate and compete in an international market. However, we note that in areas where there is reduced access to funding, research materials, and academic opportunities, different incentives or barriers to collaboration may arise.

OPPORTUNITIES FOR COLLABORATION

Commonalities between participants' research projects

Participants discussed commonalities among their research projects to identify what might foster potential collaborations (Fig. 1). Research projects having similar overarching goals and/or similar methodologies were identified as the major common ground that would enable collaboration. Commonalities were also observed between projects working on the same ecosystem or model species. This is in line with previous studies, which have noted that successful collaborations often have similar overarching goals, end users, and research methodologies (van Rijnsoever and Hessels 2011, de Bruin and Fischhoff 2017). Inclusion of a social perspective in the research, and/or research having social implications that would benefit from a socio-ecological perspective, was also identified as an important potential area for collaboration. This is perhaps reflective of the interwoven nature of social and ecological systems, and the importance of

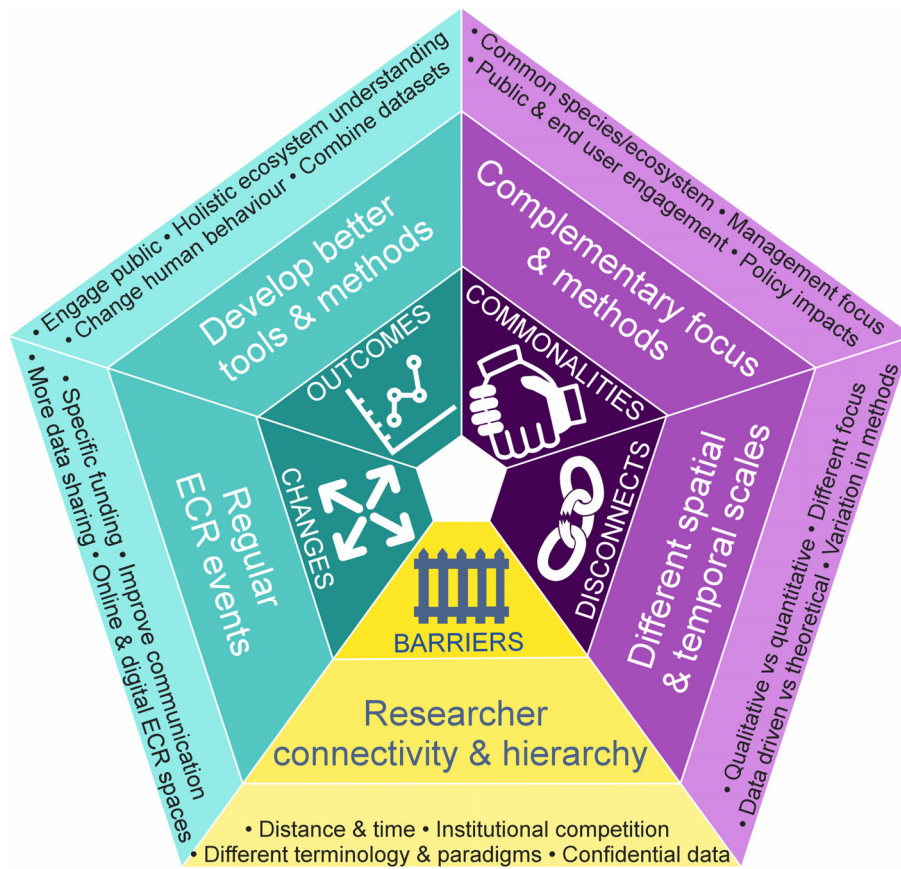


Fig. 1. A summary of participant responses in breakout discussion divided into themes (1) sources of commonalities and disconnects between projects (right), (2) common barriers to collaboration (bottom), (3) changes needed to facilitate future collaboration and potential outcomes for New Zealand biodiversity if more collaboration could be achieved (left). Most common participant response shown in large font near center, with other main responses in smaller bullet points around the edges.

understanding human behavior in solving ecological problems (Scoones 1999, Berkes et al. 2000, Carpenter and Folke 2006, Liu et al. 2007). It was encouraging to note that participants identified even purely scientific or theoretical projects as having potential to be enriched by collaborations with complementary socio-ecological research.

Disconnects between participants’ research projects

In some cases, the commonalities described above were identified as sources of disconnect between otherwise similar projects, and that might therefore hinder collaboration. For example, while many researchers with backgrounds in the natural sciences wanted to work with social

scientists and noted opportunities for collaboration, differences in common language and research methods were often seen as a roadblock to knowledge sharing, as has been noted in previous studies (de Bruin and Fischhoff 2017). Further disconnects were apparent where different methods or study systems were being used to answer similar overarching research questions. For example, potential collaboration between otherwise complementary projects was sometimes hindered by different spatial and temporal scales; while the underlying questions or techniques were similar, these scale differences were enough to make knowledge sharing impractical.

Different analytical approaches between projects were also seen as a potential hindrance to

data sharing and thus collaboration. Although there is increasing pressure on researchers to partake in data sharing and transparent research (Gewin 2016), we found that reluctance or inability to share data was common due to sensitive data (e.g., rare species locations or interview transcripts), as well as institutional or IP constraints on data sharing. Reluctance to work with data perceived as unreliable was also noted, including data collected by other scientists using unknown methods, or by non-experts for example via citizen science projects, or with methodological bias that rendered the data non-transferrable. In addition, some participants noted a general reluctance toward open data due to a perceived risk of being scooped. It is true that embracing open data is not without risk, but it has been argued that a shift in mindset from data ownership to data stewardship, as well as fostering a culture of openness and transparency, could help to bridge these gaps (Hampton et al. 2015). Some have even argued that data sharing is ethically imperative (Soranno et al. 2015); thus, it is vital that we address the valid practical hindrances to this practice.

BARRIERS PREVENTING COLLABORATION

Barriers to building interdisciplinary research projects

Barriers to collaboration, unlike disconnects, often had little to do with the research aims of projects (although difficulties sharing data and lacking common language between disciplines

were seen as general barriers as well as project-specific disconnects). Participants commonly cited physical distance, being in different institutions, and time constraints as being major barriers to forming new interdisciplinary collaborations (Table 1). Physical proximity is known to be key to idea exchange as, while long distance collaborations are common, they reduce opportunities for informal face-to-face discussions and require additional time and/or monetary investment for scheduling meetings (Cummins and Kiesler 2008). Further uncertainty about *who* and *how* to form a new collaboration was a major concern commonly voiced by participants. In particular, researchers felt their restricted professional network prevented them from knowing relevant collaborators (connectivity), compounded by insecurity about approaching highly accredited researchers (hierarchy), and we discuss each of these in turn.

Connectivity as a barrier for individual ECRs

Participants noted a distinct lack of knowledge of other researchers working on complementary projects, and they felt that this lack of knowledge was a key barrier to collaboration. Such disconnects were observed across otherwise similar projects, even where these projects were approved and run by a single grant (e.g., BHNSC). Connectivity was noted as being especially problematic for ECRs already working on interdisciplinary projects, who stated that it was sometimes difficult to find suitable spaces to share their research, they had trouble fitting in at

Table 1. Most common barriers to interdisciplinary collaboration identified by participants, divided into individual, research, and institutional barriers.

Category	Barrier	Potential solutions
Individual	Poor researcher connectivity	Regular events for ECRs Create databases of individual ECRs and their research Funding bodies and mentors make ECRs aware of complementary projects
	Time constraints and physical distance	Specific travel funds for ECR collaboration Support online forums and communities
Research	Practical difficulties sharing data	Create better tools and standards for data sharing Improve dialogue between overlapping projects to facilitate co-design
	Different terminology between disciplines	Facilitate knowledge sharing and normalize progress reporting between projects
Institutional	Hierarchy, competition	Supervisors, mentors to provide active support
	Lack of funding	Recognize alternative outputs and collaborations as research outputs Funding models to explicitly encourage interdisciplinary collaboration

Note: We also include commonly suggested solutions to overcome these barriers. ECRs, early career researchers.

conferences, and in some cases felt that aspects of their research were not represented by their supervisory team. Joint conferences by complementary societies could help to fill this gap, as noted by White et al. (2015), but such events remain relatively rare (Table 2). A restricted network is especially prevalent for ECRs, who often work alone a lot of the time, compounded by a lack of experience, and reduced opportunities to travel (Schäfer et al. 2011, Browning et al. 2017, Clark et al. 2018). This lack of connectivity between individual ECRs and to wider academic networks risks repeating work others are doing (reinventing the wheel), thus reducing research efficiency, and further exacerbates a lack of cohesiveness and complementarity in project outcomes (Anderson et al. 2007).

Hierarchy, and academic and institutional barriers

Numerous broader academic and institutional barriers to collaboration were cited by participants. In particular, the publish or perish nature of academia was perceived as putting pressure on ECRs to focus on their own outcomes and minimize the time and risk associated with building new collaborations. Experiences such as this may help explain the fact that while many ECRs are drawn to interdisciplinary collaborations as graduate students, most are later deterred by the professional risks (Rhoten and Parker 2004). Other barriers included the hierarchical and competitive nature of academia, institutional politics, lack of accountability, isolation of students, and competing interests between supervisors and potential collaborators. Concerns over a perceived competition between research groups were also commonly cited. Similar institutional obstacles have been noted by Roy et al. (2013) in a survey of more established academics in the natural and social sciences.

Unfortunately, such critiques of the culture of academia are not uncommon and the sometimes toxic nature of research teams is increasingly under scrutiny, especially given the mental health crisis in PhD students (Evans et al. 2018). Recent articles documenting the experiences of minority groups such as women (Howe-Walsh and Turnbull 2016), people of color (Burke 2017), and LGBTQ (Freeman 2018) in academia, as well as Twitter movements such as #MeTooSTEM

(Wadman 2019), demonstrate that there is still a long way to go before we create a truly open and inclusive research culture in our universities. However, inclusivity and diversity are now explicitly encouraged by most institutions, and some, such as the New Zealand Ecological Society, are actively reflecting on this issue (Wehi et al. 2019). Initiatives such as #KindnessInScience (Mehta et al. 2018) actively subvert the competitive norms of traditional academia and will be required in greater number if we are to create a culture shift that truly enables interdisciplinary collaboration for ECRs.

THE FUTURE OF INTERDISCIPLINARY RESEARCH

Creating spaces and opportunities for collaboration

Participants identified that new spaces, support, and opportunities for collaboration are needed to overcome the barriers and disconnects identified, at both individual and team levels. The majority of participants found the workshop highly beneficial (a mean rating of four out of five, where 1 = not useful at all and 5 = extremely useful) and called for more networking events of a similar nature designed specifically for ECRs. Such events provide new opportunities to build connectivity across ECRs, while creating a safe space for all participants to speak their mind, minimizing potential power dynamics that may otherwise prevent ECRs from having a strong voice in more hierarchical settings (Nokkala et al. 2017). Additionally, participants identified a need for practical solutions to facilitate collaboration, such as building interdisciplinary databases of researchers tackling similar problems, or developing online forums for ECRs within larger organizations and funding bodies, for example, BHNSC.

Platforms to connect ECRs do exist in limited forms, such as the global database ECR Central and within New Zealand, the ECR forum of the Royal Society (Table 2). However, the fact that even within a community as small as that represented by our workshop, most participants were not aware of each other's work, shows that there is still work to be done. Supporting online communities such as those found on Twitter and Instagram, for example, the #ECRchat community (Ferguson and Wheat 2015), may also help

Table 2. Examples of existing initiatives, events, and platforms for ecological interdisciplinary research, collaborations, and/or ECRs.

Category	Example	Purpose	Location	URL
Initiatives/ Organizations/ Funding	ESA Strategies for Ecology Education, Diversity, and Sustainability	Education program providing opportunities for underrepresented students in ecology	USA	https://esa.org/seeds
	National Collaborative Research Infrastructure Strategy	Government initiative to support cross-institutional research and capacity building	Australia	https://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris
	University of Cambridge Conservation Research Institute	Interdisciplinary research institute aiming to enhance collaboration and diverse research	UK	https://www.conservation.cam.ac.uk/about
	British Academy Knowledge Frontiers	Funding for interdisciplinary collaboration between humanities and STEM	UK	https://www.thebritishacademy.ac.uk/programme/s/knowledge-frontiers
Events	Association for the Advancement of Sustainability in Higher Education Mentorship Program	Connects staff with peers to collaborate on projects and advance the field of higher education sustainability	North America	https://www.aashe.org/get-involved/mentorship-program
	Alliance of Artist Communities' Arts and Ecology conference	Showcase creative work at intersection of art and ecology. Also offers residencies.	USA	https://www.artistcommunities.org/arts-ecology-residency-programs
	Conference on Language and Ecology	Provide a platform for interdisciplinary research on ecology and linguistics	Hong Kong	https://www.ecolinguistics2019.com
	Early Career Ecology section events at ESA	Networking, mentorship, and learning events at annual meetings for ECRs	USA	https://esa.org/earlycareer/early-career-ecology-events-at-esa-2018
Online Platforms/ Communities	Te Pūnaha Matatini Whānau	Trans-disciplinary ECR community holding regular events, a space for skill-sharing and collaboration.	NZ	https://www.tepunahamatatini.ac.nz/our-team/tpm-whanau
	#KindnessInScience (Twitter)	Collective led by ECRs creating a culture of kindness and collaboration	NZ	http://www.kindnessinscience.org
	#ECRChat (Twitter/Instagram)	Weekly advice/support discussions for ECRs	Global	https://ecrchat.wordpress.com/2012/07/15/ecrchat
	ECR Central	Platform for sharing funding, resources, and connecting with ECRs	Global	https://ecrcentral.org
	Interdisciplinary Marine Early Career Network	Network of ECRs working on topics related to the IMBeR Grand Challenges	Global	http://www.imber.info
	ECR Network of Networks	Network for connecting ECR organizations	Global	http://earlycareerresearchersnetwork.weebly.com
	International Network of Next-Generation Ecologists	Network for ECRs for connecting individual ecologists and societies, aligned with INTECOL	Global	http://innge.net
	ECR Forum of the Royal Society of New Zealand	Cross-disciplinary group representing the voice of ECRs	NZ	https://royalsociety.org.nz/early-career-researcher-forum
Conservation Connection	Social media for SCB members to encourage collaboration	Global	https://conbio.org/publications/scb-news-blog/conservation-connection	

ECRs, early career researchers; ESA, Ecological Society of America; SCB, Society for Conservation Biology; INTECOL, The International Association for Ecology; IMBeR, Integrated Marine Biosphere Research.

alleviate this problem. So-called Global Community Innovation Platforms, such as the International Network of Next-Generation Ecologists, have been leading the way in this space for nearly a decade (Jørgensen et al. 2015). These platforms differ from other online spaces aimed at ECRs by their non-hierarchical and open structures, which foster collaboration and innovation. However, some require society membership, such as the newly launched Conservation Connection, reducing their openness, and all rely on adequate uptake in order to function.

It is important that the burden of creating new spaces and opportunities does not fall on ECRs alone. Participants stated that senior academics and institutions are crucial for supporting ECR networking and collaboration, and setting an example of how interdisciplinary teamwork can be done well. Here, mentoring schemes such as those facilitated by the cross-institutional Collaborative Research Networks implemented in Australian universities (Fenton et al. 2016) could be useful in connecting ECRs to a wider network of peers via their mentor. Having support from more senior academics is particularly important because ECRs will not be able to challenge broader academic and institutional barriers on their own without a degree of professional risk (Oni et al. 2016, Gibson et al. 2019), and need their mentors to act as allies and advocate on their behalf. Helping mentees expand their networks often results in long-term relationships that ultimately facilitate future research (Boix Mansilla et al. 2016), and once researchers have some collaboration experience, future collaborations tend to be easier even in the face of barriers (Cummings and Kiesler 2008).

Participants also strongly advocated for active funding of ECR collaborations, for example, through funding networking events or specific travel grants for visiting collaborators. Changing competitive funding models is also pivotal to facilitating a more open and collaborative atmosphere in academia (Oni et al. 2016, Gläser and Velarde 2018), such as the encouragement of challenge-led research (Gibson et al. 2019); that is, interdisciplinary funding programs organized around pre-defined themes. Participants encouraged institutions to measure outputs and success on more than simply publications alone, thus also including non-traditional research outputs

such as developing tools and reports for end users, successful engagement with the public, or demonstrated behavior change. While the need for recognition of alternative research outputs is well known, debate is ongoing over how best to achieve this, and traditional reward structures still dominate the research landscape (Rau et al. 2018).

Impacts of interdisciplinary collaboration on ecological research

During the workshop, we envisaged a future where barriers to collaboration were removed, and what that would mean for the ecological research presented. Participants believed that interdisciplinary collaborations had potential to provide a more integrative understanding of their specific ecosystems and generate more knowledge than an individual researcher or team of singular discipline researchers could produce. Developing new tools and methods to bridge gaps between researchers, and sharing data and knowledge, was seen as a way to collect data more efficiently and to create stronger and larger datasets that could allow research to scale more effectively to other areas or time periods. Examples of how this could work in practice include the COMPADRE & COMADRE databases (<http://www.compadre-db.org>) and the PREDICTS project (<https://www.predicts.org.uk>).

A further perceived outcome of better collaboration was the generation of more transferrable tools and models for conservation by integrating across multiple species or scales, for example, to generate better nationwide monitoring statistics for native and pest organisms. These ideas are central to some existing National Science Challenges projects in New Zealand, for example, the Biosecurity network interventions project, which uses similar methodologies to investigate multiple species and systems (<https://bioheritage.nz/research/biosecurity-network/>). Many research projects and regional councils around New Zealand also make use of the Department of Conservation's monitoring protocols, which were designed for transferability and scalability (<https://www.doc.govt.nz/our-work/monitoring-and-reporting-system>).

Participants also perceived an improved ability to do effective public outreach and citizen science with increased collaboration, by teaming

up with other researchers with more experience in this area. If projects with similar goals could combine forces, it was thought that more effective outreach and data collection might be achievable. A working example of this approach is Wild for Taranaki, New Zealand's first regional biodiversity trust, formed as a collaboration between research institutes, environmental groups, government, and the local community (<https://www.wildfortaranaki.nz>).

Combining forces on outreach is important as while participants stated a desire to engage with the public, it is difficult for researchers to find willing citizen scientists, stakeholders, and interviewees when there are an increasing number of projects requesting public input. This competition for a limited pool of public attention can lead to participant fatigue (Clark 2008), so it makes sense for researchers with common goals to collaborate on public engagement where possible. Fortunately for New Zealand researchers, the public is interested and actively involved in the conservation of native biodiversity (Sullivan and Molles 2016), and participants recognized the opportunity for multiple projects to use existing conservation groups and citizen science data collection networks. Interdisciplinary collaborations may also help to spread the time investment and risk involved in creating the alternative research outputs such as infographics, blogs/vlogs, and social media engagement that are pivotal to effective public outreach (Yammine et al. 2018).

Encouraging ECR-led interdisciplinary collaboration has been critical to the success of projects elsewhere. For example, after the Gulf of Mexico oil spill, the ESA was able to mobilize a rapid and effective response coordinating data sharing and communicating with government, largely thanks to close collaboration between the Student Section and the Executive Board (Ramos et al. 2012). In other cases, close collaboration between ECRs is the driving force behind producing high-impact research, such as a study described by Cleland et al. (2013). In this study, seven of 11 authors were PhD students or post-doctoral researchers at the start of the collaboration, resulting in a paper that was cited over 100 times in the first six years following publication. The four senior authors were key to the success of this effort; they all had established research

careers in the U.S. Long-Term Ecological Research Network and were dedicated to training the next generation of leaders in the scientific community (S. Cleland, *personal communication*).

In fact, our own workshop itself is testament to the fruitful outcomes of supporting ECR collaboration. The workshop was designed and run by a committee of 12 PhD students and postdocs who had not previously met, brought together by the common goal of creating an event for ECRs like themselves to network and share their research with one another. The funders (BHNSC) allowed the committee complete freedom over the aims, design, and execution of the event, only stepping in to provide practical and financial support, which we believe was critical to authentically representing the vision of the ECRs involved. Given the demonstrated effectiveness of such approaches, if they became mainstream they could provide considerable benefits both in terms of producing better ecological research and in solving global biodiversity problems.

CONCLUSION

By encouraging ECRs to come together to share their research with the specific aim to foster collaboration, we identified important opportunities and barriers that play a part in determining whether such collaboration occurs. We also propose a number of key solutions to help overcome these barriers in the future, distilled from participants' responses. By focusing specifically on ECR perspectives, we have prioritized those who are often disproportionately invested in this debate, yet are also rarely heard. Perceived outcomes of increased collaboration included development of stronger networks between researchers, a greater awareness of the breadth of current research being undertaken, and the identification of potential spaces, opportunities, and pathways for collaborative interdisciplinary research going forward. Importantly, participants noted that the workshop provided a valuable, safe, and collaborative space for them to share their research and experiences, and they encouraged the development of similar ECR-led initiatives supported by funding bodies. Through harnessing the collective abilities of researchers, growing ecological datasets, and improving outreach potential, the removal of barriers to interdisciplinary

collaborations between ECRs will not only improve the quality and diversity of our research, but has the potential to secure better outcomes for biodiversity and conservation.

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