Overcoming barriers that limit the impact of ecological research

Running head: Overcoming barriers in ecology

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Abstract

Ecology and conservation researchers have diverse goals often including both personal career aspirations and enhancing the well-being of the natural world and its inhabitants. Perception of ecological research by ecologists typically involves a triad linking goals, research and impact. Yet the realities of scientific practice are substantially more complicated due to numerous constraints limiting researchers' ability to conduct ecological research and to have genuine impact. Many of these barriers can be mitigated, leading to more effective contributions to society and biodiversity conservation. Here, we outline frequently encountered constraints in ecological research institutions and, drawing upon many practices used internationally, identify feasible mitigations and highlight examples of negative consequences that can occur in the absence of effective mitigations strategies. We propose changes to aspects of the culture and reward systems that would allow ecological research as a discipline to more effectively achieve societal, environmental and personal goals.

In a nutshell

- Ecological researchers pursue goals encompassing personal, environmental, and societal aims.
- Constraints, perverse incentives and unexpected events can limit the translation of research activities into impactful outcomes and personal achievements.
- Here, researchers from different countries and career stages propose mitigation strategies and identify examples of negative consequences that can arise when these mitigations are not adopted.

- Changes to the prevailing culture and reward system in ecological research can foster effectiveness in achieving both environmental and personal goals within this discipline.

1. Introduction

Individuals choose academic research careers in ecology and conservation biology for numerous reasons, and unlike many other disciplines in biology, ecological research seldom yields direct and immediate financial benefits to researchers. Instead, ecologists' research motivations are often rooted in a combination of personal interests and the desire to achieve a fundamental understanding of the relationships between living organisms and their environment (Reiners *et al.* 2013). Moreover, many feel an imperative to develop practical solutions to current major environmental challenges and to train highly qualified professionals. However, the effectiveness of ecological research in achieving these objectives is often questionable (e.g. Butchart *et al.* 2010). Research progress is frequently hindered by both internal and external constraints. Internal constraints refer to those arising within the research and institutional environments, while external constraints are imposed from outside academia—most notably by governments and funding agencies. These external pressures may include national and international political agendas and research funders' priorities (see e.g. Kozlov and Ryan 2025). They are often influenced by the interests of ruling parties, and while we acknowledge the detrimental impact of these higher-level political barriers, they often remain beyond the direct control of individual researchers. Here, we focus instead on internal academic constraints that exert an ongoing influence on research practices, but can be mitigated through individual or institutional action.

Academic life can be competitive, precarious and sometimes financially unrewarding (Hamermesh 2018). This, together with significant mental health issues such as stress, anxiety and burn-out, leads many researchers to leave academia (Nicholls *et al.* 2022; Kis *et al.* 2022). Of those who stay, many compromise their original goals or pursue them with the time left from their daily responsibilities, driven by the belief that science is worth personal sacrifices (Kucirkova 2023).

Casual conversations with colleagues suggest common feelings of disconnection between aspirations and true research impact, yet few discussions in the literature focus on identifying common barriers nor mitigations (but see Receveur *et al.* 2024). These impressions are supported by reduced job satisfaction in academia compared to industry-employed researchers (Woolston 2021). Here, we aim to provide a preliminary toolkit to help researchers realign their personal and scientific goals with the outcome and impact of their research by providing mitigation measures across three categories (Figure 1): (1) evaluating research for hiring and career progression; (2) supporting impactful training and mentorship; and (3) addressing administration and bureaucratic obstacles. This subset of topics may not apply to everyone's experience, but they may offer a foundation for adaptation relevant to other circumstances. While researchers, especially in early career, may feel powerless to change the academic system at large, we suggest implementing a best-practice framework to identify constraints, highlight their consequences, and invoke mitigations at both individual and institutional levels. Thus, we can enact modest changes that will enable more effective ecological research, and ultimately help achieve personal, professional, and societal goals. Although some recommended mitigations may lack universality at a global scale due to macro-level political constraints, the ideas presented here are intended to serve as a starting point to shape more meaningful and effective ecological careers.

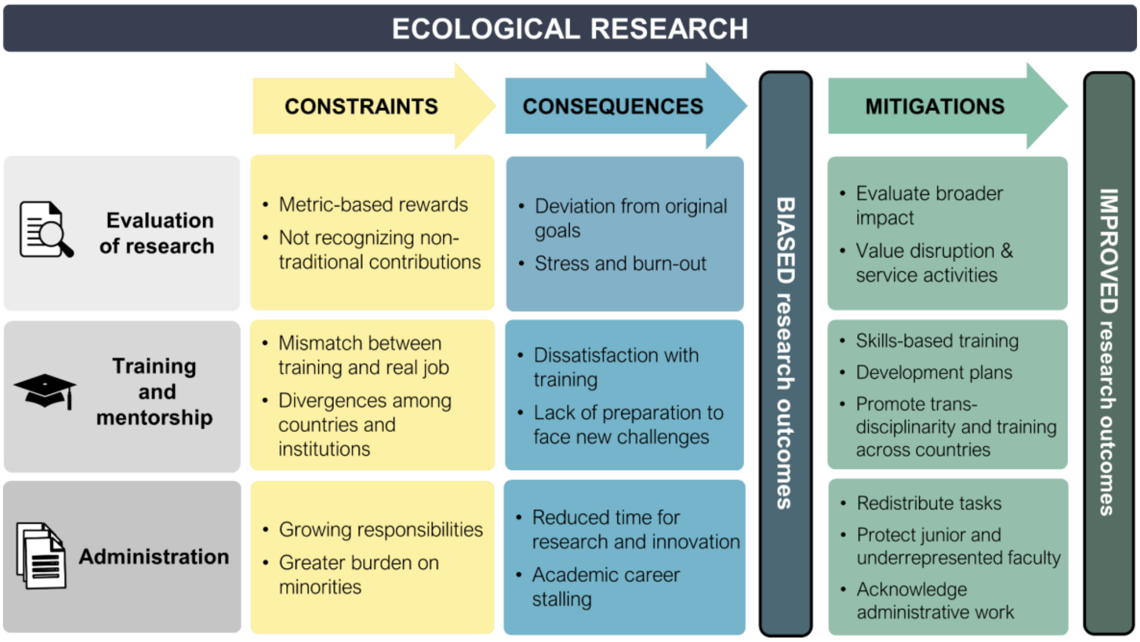

Figure 1. Overview of constraints influencing research in ecology and conservation biology, highlighting their consequences for ecological research, as well as for personal, professional and societal goals, and exploring potential measures to mitigate them. Figure created by ID and CCB with input from all authors using icons from Keynote, except for the "Evaluation of research" icon by Hilmy Abiyyu via Freeicon.io, licensed under CC BY 3.0.

2. Evaluating research for hiring and career progression

2.1. Constraints and consequences

Evaluation of research outputs is central to academia and influences decisions regarding hiring, career progression, institutional recognition, acquisition of grants and third-party awards. Reward decisions in research institutions are often based on individual researchers' performance, valuing predominantly peer-reviewed publications and grant activity (Lawrence 2016). However, in the evaluation of a researcher's contribution within and outside their specific research domain, it appears that the specific content, and direct impact and value of research outputs, are often overlooked. Instead, simple quantitative metrics, such as publication count and journal impact factors, often dominate evaluation processes, aiming to make candidate evaluation easier, faster and (presumably) more objective (Pontika *et al.* 2022). Thus, major career progression outcomes are strongly influenced by acceptance decisions of a particular set of journals, rather than extensive impact assessment (Neff 2018).

This projection of assessment to journal acceptance has created a system where publications are viewed as supporting career progression, rather than primary research dissemination tools (Lawrence 2016). Combined with short-term funding and contracts, this shift in the role of scientific publication encourages researchers to undertake short and reliable projects instead of riskier, longer-term research (Park *et al.* 2023). The latter, however, is required to solve global challenges (Werner 2015). Thus, the current reward system unintentionally discourages trans-disciplinary research and collaborations with researchers from less wealthy countries, limiting the global relevance of scientific research (Nuñez *et al.* 2021). Instead, it favours meta-analyses or short studies known for yielding rapid and impactful results (Cadotte *et al.* 2012), evidenced by the increasing number of grant programs funding synthesis projects (e.g. calls from US National Science Foundation, iDiv, British Ecological Society). High publishing costs further exacerbate inequities by creating barriers for researchers with limited resources, especially those in less wealthy countries, constraining their research impact and potentially their career progression (Williams *et al.* 2023).

Moreover, reliance on simple metrics fails to recognize other valuable contributions which include teaching, public and policy engagement, relationships with local stakeholders, publishing datasets or analytical tools, or descriptive taxonomic work. This misrepresents the societal and economic outcomes of research when assessing its impact (Lawrence 2016).

2.2. Mitigations

Mitigating perverse career incentives requires fundamentally shifting research evaluation away from publisher-derived metrics towards societally—and scientifically—valuable work (Hicks *et al.* 2015). For instance, the San Francisco Declaration of Research Assessment (DORA) has called for a move away from metric-based evaluation of research output since 2012. Nevertheless, the number of published papers and journal impact factors still remain important determinants of many hiring and advancement decisions (Pontika *et al.* 2022). To address this issue, we propose three actions.

Firstly, institutions should be explicit in the types of impact they value and make this information easily accessible. To align the values of the institution with the impact of the candidate, researchers should explain how their work contributes to these values through narrative CVs. This approach would ensure mutual understanding between the researcher and the institution regarding what is valued, and it highlights impacts invisible to conventional citation metrics. Additionally, including external members with expertise in tangible impacts on evaluation committees can provide diverse and impartial perspectives. These external members could include academics from different disciplines and members from key sectors and local communities with expertise on the research topic.

Secondly, alternative metrics, beyond citations and impact factors, are needed to evaluate research. Recognizing a paper's "disruptiveness", which measures its integration of disciplines, could promote novel, risky and impactful research (Park *et al.* 2023). Though this may be more difficult to apply to early career researchers, it is likely helpful when making decisions about career progression. Encouraging science that engages in solving grand ecological challenges is also important. Metrics considering policy-impact or application can also encourage research addressing major ecological challenges.

Finally, evaluation processes should also recognize other service activities (Moher *et al.* 2020). Institutions often encourage these activities, but fail to reward them proportional to their impact. Fair evaluation could assign weightings for research, teaching, public engagement, policy impact and service activities, based on institutional mission and values. For example, the promotion criteria of University of Glasgow reward peer review and journal editing, while Macquarie University in Australia follows a five-category promotion policy, including broader contributions to university and community. Other merits include publishing software, data sets and analytical tools as “publications” or rewarding work beyond academic journals and conferences (Hicks *et al.* 2015; Moher *et al.* 2020).

3. Supporting and recognizing impactful training and mentorship

3.1. Constraints and consequences

Good scientific training and mentorship should help scientists to develop the skill sets needed to foster their research and fulfil their goals (Hund *et al.* 2018). However, many ecologists report dissatisfaction with their training, due to the mismatch between current (and future) requirements of an academic position (i.e. publishing, deep statistical knowledge, mentoring, lecturing, fundraising, team leadership, communication) and current training received (Touchon and McCoy 2016; Farrell *et al.* 2021). For instance, as ecological questions, databases and methodological approaches become increasingly complex and interdisciplinary, many early career ecologists feel that they do not have the technical and interpersonal skills required in large collaborative projects (Farrell *et al.* 2021). Additionally, the interests of early career—and even senior—researchers often clash with rigid university programs, which are often compartmentalised and modularised, hindering multidisciplinarity work, despite its benefits for student development and employability (Wang *et al.* 2022).

Finally, mentoring, though increasingly essential for career progression, is generally time consuming and challenging; especially since most academics lack formal training in mentorship (Emery *et al.* 2019). This is particularly the case when early career researchers advise undergraduate or new graduate students, or within small research groups and institutions where interactions with other senior and mid-career researchers are limited. These constraints are exacerbated in countries and institutions with reduced career development opportunities, and scarce qualified teachers, learning materials or even mentorship programmes, leading to an uneven playing field for job opportunities globally.

3.2. Mitigations

Addressing the challenges in ecological training requires a multifaceted approach. Firstly, shifting to skill-based learning can empower future ecologists with the necessary competencies needed for employment. Incorporating both hard (e.g. study design, statistical analysis) and soft skills (e.g. project, people and financial management) into the curriculum from an early stage is imperative. Courses should adopt a practical orientation, simulating real-world research scenarios rather than following traditional, theoretical approaches. For instance, “living labs”—i.e. user-centric innovation milieus built on everyday practice and research, aiming to create sustainable values—can serve as learning environments where students gain practical experience (Almirall and Wareham 2011), bridging the gap between theory and real-world application (Bergvall-Kareborn and Stahlbrost 2009).

Secondly, research institutions and mentors should embrace guiding standards, creating best practice guides in ecological mentoring and adopt “personal development plans” during the PhD, postdoc, and junior faculty stages. Embracing these practices, together with efforts to connect trainees and early-career researchers with collaborative opportunities, can advance professional capacity and reinforce cognitive synergy (Clegg and Bradley 2006). For example, the European Competence Framework for Researchers helps faculty to develop transversal skills, and higher education institutions to adapt their training offer to researchers. Similarly, some institutions like Columbia University have best practice guides for faculty mentoring. The implementation of these guidelines should be evaluated regularly, similar to undergraduate teaching assessments. Similarly to the reward system, metrics solely based on the number of PhD students or postdocs supervised do not adequately capture mentorship quality, as they fail to account for the diverse career trajectories pursued by these individuals, which can provide a more comprehensive evaluation of the mentor's impact and guidance.

Finally, universities should promote transdisciplinarity in both institution structures and ecological research itself (Scholz 2020). Environmental challenges are driven by different factors (ecological, but also social, political, physical, etc), traditionally examined separately through the lenses of different disciplines (Holm *et al.* 2013). Adopting holistic perspectives involving multiple stakeholders is necessary to address global challenges; thus, research institutions must reinforce interactions between traditionally separated disciplines and society (Hein *et al.* 2018). Some potential actions could include promoting institutes or networks across different faculties or mixing members within departments. The establishment of ecological societies beyond countries with established traditions can also promote transdisciplinarity and mitigate geographic disparity.

4. Administration, service and bureaucratic obstacles

4.1. Constraints and consequences

Administration and service involve managing research, teaching, organisational functions, and the formulation and execution of policy on university or research institutions. Administrative tasks are a key component of the expected duties of most academics and encompass a wide range of responsibilities including lab safety, curriculum development, hiring, misconduct oversight or research grant management. All of these are subject to evolving demands for compliance, reporting and cross-institutional collaboration, contributing to the growing administrative burden, taking significant time away from an academic position's core functions (Woelert 2023). For example, PIs in the United States spent 44% of their time performing administrative tasks mandated by federal funding agencies (Mosley *et al.* 2020). Institutional budget constraints also mean that tasks that were traditionally carried out by administrative staff now often fall to academics, reducing time for creative research—those aspects that academics were drawn to in the first place (Schneider 2020). Many institutions have introduced software for compliance and reporting, so-called “robotic bureaucracy”. While designed to streamline compliance accounting, they shift responsibility from administrators to researchers, further increasing administrative burden (Bozeman *et al.* 2020). Valuable time taken away from research and teaching leads to a reduction in research discovery and innovation, and an erosion of quality in education. Less time to train students, postdocs and other personnel leads to lost opportunity and unmet potential and innovation. It promotes a lack of desire for graduate students and postdocs, particularly those in under-represented groups, to pursue careers in academia, perpetuating bias as a “lifetime problem” (Llorens *et al.* 2021).

The individualistic nature of research labs and productivity-focused structure fosters an adversarial system with perverse incentives, creating inequities in administrative loads among colleagues. With the institutional desire to achieve diversity in administrative committees outpacing the recruitment of a diverse body of faculty, under-represented faculty, particularly women and visible minorities, tend to face greater administrative burdens earlier in their career than their counterparts (Llorens *et al.* 2021), hindering advancement and causing burn-out —the “minority tax” (Trejo 2020). These inequities in service expectations exacerbate an already challenging environment for under-represented faculty in which to succeed (Llorens *et al.* 2021; Cronin *et al.* 2021). Burn-out and erosion in quality of life associated with high administrative loads result in faculty failing to advance through the ranks and leaving academia.

4.2. Mitigations

Reducing the administrative burden to a level that lies within the expectations of the position and what is necessary for the function of the institution is largely determined by the upper administrative level (or above), as the constraints trickle down to researchers.

The first step should be to fully account for researchers' time spent on service activities, how service loads are allocated across academics within a unit, and the impact on the time devoted to other academic pursuits such as research, writing grant proposals, developing curricula and mentoring students (Woelert 2023). Institutions should perform cost-benefit analyses to ensure researchers' time aligns with institutional and governmental goals.

University administrators and researchers alike should be aware of how administrative burdens affect individuals' activities and the overall mission of the university or research institute. Researchers also should recognize that the benefits derived from shared-governance structures come with responsibilities that need equitable distribution (Curnalia and Mermer 2018). Hence, clear, equitable, and appropriate service expectations should be defined in hours per month or as a percentage of working hours. To reduce reporting and oversight time, institutions should hire, train, and retain more staff and coordinate efforts to avoid redundant reporting.

Measures should be put in place to ensure equitable administrative loads for established researchers, while protecting early and mid-career staff from excessive burdens, allowing them to build their research and teaching programs (Reese *et al.* 2021). Long-term mentoring of junior and under-represented faculty should be departmental and institutional priorities to reduce biases and overload. Regular department/institute chair training can foster a culture of shared accountability towards service that has collective benefits. Finally, reimagining reward and incentive structures to appropriately value service work according to the time invested would do much to recognize its importance to research functioning.

5. Conclusions

Ecologists often have high intrinsic motivation and chose the life sciences as a research topic because of its inherent attractiveness rather than for economic profits or fame.

However, barriers can generate perverse incentives which lead to sub-optimal working conditions and learning environments (e.g. extended working hours, greater workload, reduced work-life balance), and decreased quality of research outcomes. This reduces researchers' intrinsic motivation along their careers, making academia a high stress working environment (Nicholls *et al.* 2022). As a result, burn-out has become a significant issue, particularly among PhD students and early career researchers (Mattijssen *et al.* 2020; Forrester 2023).

The measures outlined here offer a starting framework to combat researcher burn-out, enabling more efficient work while maintaining high-quality research and mentorship. Institutions and administrators are urged to prioritise researchers' basic needs, minimise simultaneous activities and implement mental well-being tools. On an individual level, researchers should try to reconnect with their passion and prioritise activities that not only leads to the desired outcome but also offers immediate rewards or satisfaction along the way (Fishbach and Woolley 2022). By making the steps toward the goal enjoyable and personally fulfilling, individuals increase their likelihood of following through on their objectives. In conclusion, fostering an environment that promotes the well-being of researchers at all levels is crucial to combat burn-out and to catalyse disruptive and high-quality research.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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