

Policy analysis

The impact factor of engaged research: Metrics for conservation outcomes

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ABSTRACT

Will this paper lead to any measurable impact on biodiversity conservation? In this essay, we examine the relevance of scientific publications for conservation outcomes and propose specific recommendations to encourage procedural reforms in academia. While many conservation scientists dedicate significant effort to making their research accessible and actionable for conservation outcomes, academia often doesn't reward these efforts and can even inhibit them. Universities increasingly promote engaged scholarship, yet few institutions have established formal mechanisms that promote and reward such work. We suggest a new framework to support engaged universities and propose three recommendations for research institutions. Our recommendations are based on 71 interviews of conservation scientists producing actionable science. We recommend that universities: (1) actively support faculty engagement in boundary-spanning work, providing an interface between research and society; (2) meaningfully reward faculty work that makes a genuine impact on efforts to solve real-world problems, beyond academic publications; and (3) use appropriate metrics to recognize the value of impacts on society and contributions to practical conservation outcomes. Universities supporting engaged scholarship have the potential to excel in attracting talented scholars, securing funding, and fostering impactful change.

1. Introduction

Conservation scientists strive to produce research that has an impact. Conservation biology, or more explicitly the interdisciplinary field understood as conservation science (Williams et al., 2020), is an impact-oriented discipline. As 'use-inspired basic researchers' (Stokes, 1997), conservation scientists both address real-world problems and advance scientific discovery. Yet what it means to make an impact has changed over time. Measuring scientific impact by the publication of high impact factor journal articles has overshadowed scholarship that addresses pressing real-world problems (Barge and Shockley-Zalabak, 2008). Universities continue to predominantly reward researchers based on publishing metrics such as the number of articles they publish, the number of citations of their papers, or their H-index. This evaluation system results in 'publish or perish' pressures, often leading academic conservation scientists to prioritize publishing over other outcomes. Yet

publishing in high impact journals was not the primary intention of early conservation science; instead, it endeavored to solve real-world environmental challenges.

Conservation science is fundamentally a mission-oriented crisis discipline (Soulé and Wilcox, 1980; Kareiva and Marvier, 2012). The earliest aim of conservation biology was to provide scientific research that would slow global biodiversity loss (Soulé and Wilcox, 1980). However, the unprecedented global rate of extinction suggests that existing models have been inadequate – for both biodiversity conservation and knowledge use for evidence-based actions (Sutherland et al., 2021). In response, conservationists have recognized the need to collaborate with other disciplines, decision-makers, and users of research products (Lubchenco, 2017) to address rapidly escalating, interconnected, and seemingly intractable environmental issues in the 21st century.

A key insight from the social study of science (or science and

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technology studies), is that science is an activity which involves humans at every juncture and is therefore subject to the same social forces as any other human activity (Latour, 1983; Haraway, 1988; Cetina, 1999; Harding, 2008; Latour and Woolgar, 2013). Historically, research in the natural sciences has sought to distance itself from these forces and strive for ‘objectivity’, a goal which is not only a historically contingent goal (Latour, 1993; Daston and Galison, 2007), but one which many philosophers and historians of science believe is also a quixotic one (Haraway, 1988; Stokes, 1997). In pursuit of objectivity, many scientists seek to distance themselves from the real-world concerns of decision-makers and instead prefer to conduct their work in the isolated realm of pure theory and ‘basic’ research. However, an academic focus on basic science is not true of all scientists.

Recent work in the social study of science suggests an evolving perception of the interrelationship between science and society. Due to exposure to this literature, younger researchers may be more comfortable with the idea that science is not entirely objective and neutral, leading to a greater willingness to engage with practitioners’ real-world concerns (Hoffman, 2016). This is especially true for conservation researchers on the ground, who, due to the field’s focus on biodiversity loss in real time, are more exposed to the ways in which society and science are interrelated (Kareiva and Marvier, 2012; Carr Kelman et al., 2023). Conservation fits into the realm of what is called “post-normal science” due to an urgent need for action, which simultaneously faces uncertainties at multiple levels (Francis and Goodman, 2010). Still, decisions regarding conservation policy, funding, and implementation are often made by non-scientists despite extensive research conducted by the global scientific community. Additionally, the physical execution of conservation practices, typically at a local level, is often carried out by an ‘extended peer community’ not directly involved in research. For these reasons, methods and processes in conservation research are undergoing a shift (Lubchenco et al., 2015). New institutional models such as *engaged scholarship* are also needed to better connect scientists with conservation practitioners (Gerber and Raik, 2018).

We define ‘engaged scholarship’ as the practice of collaboration among academics and practitioners to co-produce knowledge, which includes various perspectives and competencies, to solve our most complex and pressing conservation challenges (Barge and Shockley-Zalabak, 2008; *Beyond the Academy* 2022). Socially engaged models of scientific enterprise suggest that knowledge produced collaboratively with practitioners has a much greater likelihood of having real impact on policy and practice (Beier et al., 2017; Arnott et al., 2020). This process, often called knowledge co-production, involves knowledge users and knowledge producers collaborating at every stage of a project’s development, and has emerged as a promising approach to both resolving environmental issues and producing knowledge about those issues (Lemos et al., 2018). However, managing co-production activities can be difficult and time-consuming. Scientists often lack the institutional support necessary to engage in the co-production process that is so essential to achieving visible outcomes (Goodrich et al., 2020).

An academic culture in which tenure and promotion criteria recognize and reward engaged, impactful scholarship not only advances conservation as a field, it also positions the institution to better attract and retain cutting-edge scientists who aim to serve society in tangible ways (Lubchenco, 2017). Many conservation scientists recognize the limits of seeking impact via publishing in academic journals, and see the importance of creating other types of knowledge products, such as maps, tools, software, and datasets, for use by organizations, agencies, and communities (Wyborn et al., 2019). Such research products are often called ‘actionable science’: those “data, analyses, insights, predictive models, or planning tools based on scientific research that support decision-making in biodiversity conservation” (Beier et al., 2017; Gerber et al., 2020; Carr Kelman et al., 2023).

Engaged scholarship has been shown to produce impactful results, and therefore funding organizations are increasingly requiring this sort of partnership (see the [Transforming Evidence Funders Network](#), or the

[Partnership to Advance Conservation Science and Practice \(PACSP\)](#) and the [Directorate for Technology, Innovation and Partnerships within the US National Science Foundation](#)). In some cases, funding organizations partner with one another to increase impact, such as the NSF Partnership to Advance Conservation Science and Practice which partnered with the Paul G. Allen Family Foundation. As a result, the funding decisions gave as much weight to conservation outcomes as pure science. While the NSF always requires broader impacts, they could shift even more of their funds to work with projects of greater public value.

In this paper, we describe a framework for promoting academia’s engagement as a bridge between conservation research and real-world impacts. We illustrate the need for engaged scholarship by citing ten selected quotes from 71 interviews with conservation scientists conducting actionable science, through three specific fellowship programs (dataset presented in Gerber et al., 2020). We argue that academic institutions should: (i) recognize their role as highly effective boundary organizations that can support engaged scholarship across disciplines, (ii) determine how to incentivize and reward faculty work that makes a genuine impact on efforts to address real-world problems, and (iii) generate appropriate metrics to value the contributions of faculty and staff who aim to solve major conservation issues.

2. Challenges to real-world impact

There are numerous structural barriers that inhibit the ability of academic conservation scientists to engage with stakeholders and decision-makers. A primary barrier is that engaged scholarship is rarely recognized within the university system (Cvitanovic et al., 2015; *Beyond the Academy* 2022), and even less often rewarded. The motivations and aspirations of researchers and funders have progressed faster than the incentives universities provide for engaged scholarship. When scholars strive for real-world impact, many of their efforts in this area are often not valued or rewarded as scholarship, and therefore do not contribute to the advancement of their careers. In many cases, the pursuit of societal impacts is considered “service” instead of scholarship. Many junior scholars are advised not to sink time into engaged scholarship, since it may not directly benefit their academic career (Barge and Shockley-Zalabak, 2008). Thus, scholars who aspire to engage in impactful work can find their efforts foiled by the very institutions that purport to care about ‘impactful’ research.

Only a small minority of scholars find time to engage with non-academic stakeholders in boundary-spanning work (Quote 1 in Table 1). It is therefore unreasonable to expect most academics to engage in this work without additional incentives. Instead, universities must adjust their organizational and incentive structures to recognize, value, encourage, facilitate, and reward impactful research to train the next generation of leaders in this sort of work (*Beyond the Academy* 2022). Such a change will allow universities to provide real public value in the form of actionable knowledge that directly addresses conservation problems.

Conservation science also confronts another major issue - the loading-dock problem (Cash et al., 2006): scientists publish their results in a massive continuous flow of literature that is then left on a proverbial loading dock (Quote 2), assuming practitioners will pick it up and use it readily (Feldman and Ingram, 2009). However, publishing research does not necessarily imply its use, and potential knowledge users are often excluded from the overall research process (Fig. 1). Various questions are implied by the traditional loading-dock approach: Whose responsibility is the pick-up? Can conservation practitioners access the literature on the dock? What does it cost them to access it? How would they know where to look for it? Is the published literature in an appropriate format to be used by practitioners? By involving both knowledge producers and users in co-production, research and action can be linked at their roots (Bednarek et al., 2018; Lemos et al., 2018). Institutions can play a pivotal role in making connections between research and action, by synchronizing the logic of inquiry with the logic

Table 1

Ten illustrative quotes selected from 71 interviews with conservation scientists engaged in the generation of actionable science through three specific fellowship programs (dataset presented in [Gerber et al., 2020](#)).

Quote 1	"To be directly involved in applying your research or even communicating it in non-academic settings becomes sort of an extra activity."
Quote 2	"There's a term - the loading dock problem. You can produce a lot of research and stick it out there on the university's loading dock and there's all sorts of reasons society never can never use what you put on there. So, that gap is a multifaceted gap."
Quote 3	"[...] the work we produce is not going to get used on its own. You can't just sort of put it out there and then expect that someone will pick it up and do things with it. And I do try to publish in journals that are read by managers... but in the end, there's just... a major, huge river of literature and it's constantly rushing back. And if there are key results that are likely to generate very direct recommendations, the only way to make sure that happens is to directly hand them to those people that you think can implement them. It becomes necessary to take that extra step and connect directly with people and say, 'here's some results that I think you may find interesting.'"
Quote 4	"To make your work actionable, it usually has to be very specific and local, and that's not going to get you a Nature paper."
Quote 5	"Some of the most impactful work we've done has been quite focused, quite targeted, and quite hard to get published actually, in good journals, because it is so topic driven and so focused and yeah, you know, you get the reviews back and they're like, well, this doesn't matter at a national level or international level. And sometimes it doesn't even get sent out for review. And yet these papers are having big impact, they're getting submitted as evidence by first nations groups. They're determining the course of action for environmental NGOs, and yet they're barely squeaking into peer reviewed papers... I have published some higher tier journal papers, and in my experience, those don't have any impact. And so in my mind, there's a disconnect between the review process and what is favored by sort of top level conservation or general journal, and their impact."
Quote 6	"Universities need to be much more stakeholder engaged and need to be much more solutions driven. All of the problems are multifaceted, wicked problems that I feel like we should be working on. And those by definition require interdisciplinary approaches."
Quote 7	"We are scientists. And we lack the people who are the bridge people that take this to the managers. And I think that there ought to be an agency whose job is solely to communicate the science to the practitioners."
Quote 8	"There is a net change toward actionability and recognition of actionability across the U.S., even in traditional 'ivory tower' places, with more openness to actionability. It really depends on the local environment and the institutions/departments."
Quote 9	"We've got a lot of early career scientists who are very hungry to have an impact. [...] There's much more enthusiasm and commitment among younger scientists, early career scientists, whether they're graduate students, postdocs, or tenured faculty, to doing something besides just assembling publications and academic prestige and satisfying their curiosity and all the kinds of things that we would normally do in science."
Quote 10	"It can double the work to try to publish gray literature in the academic literature. The problem is that the gray literature doesn't count for anything in the academic setting because it isn't in a peer reviewed journal. We need metrics to show the impact of this sort of publication as well."

of action ([Barton et al., 2021](#)). A proactive community of scholars engaged in boundary-spanning work is critical to supporting the pick-up of literature by conservation practitioners (Quote 3).

Another issue is the tension between globally relevant, generalizable research and research which attends to the nuances of specific cases. Most research aiming for real-world impact is focused on the issues felt by specific communities and is therefore not always 'generalizable'. This makes it less attractive to prestigious journals that privilege data of global relevance for an international audience (Quote 4). Publishing in prestigious journals may not be the most effective way to achieve real-world impacts (Quote 5). The idea of relevance (and excellence) in academia is generally focused on theory and novelty of ideas or concepts, often prioritizing basic science over more applied research. However, not all research outcomes can be turned into concrete recommendations or actions, calling for the need to reconsider how the

'impact' of research is recognized across basic and applied research communities. Transforming the root causes of biodiversity loss requires more than peer-review publications to bring about real political and structural changes.

3. Recommendations for enabling real-world impact

We suggest a new framework for engaged universities that integrates knowledge co-production and boundary-spanning work in how researchers are evaluated and funded, moving beyond a reliance solely on academic publishing metrics (number of articles published in peer-review journals, journal impact factors, number of citations, H-index) ([Fig. 2](#)). Work that aims to make a genuine impact and solve real problems needs to be incentivized and valued, thereby supporting conservation academics who engage in research that matters to society. In that way, universities can help solve the loading-dock problem, enabling increased engagement and knowledge co-production between conservation scientists and practitioners ([Salomon et al., 2018](#)). These new institutional models ([Gerber and Raik, 2018](#)) actively support the connections between researchers, field managers, and decision-makers.

Recognizing the political dimensions of scientific practice includes an understanding that 'doing science' sometimes requires scientists to engage in politics – or potential conflict situations – which may be called for. Some researchers choose to engage in rebellious acts (e.g., [Scientist Rebellion](#)) or become whistleblowers. Other conservationists may have to address situations of violent extremism ([Lhoest et al., 2022](#)), and are in some cases exposed to intimidations or direct violence when they take strong positions on a political debate or take public actions. The question of what rights and protections scientists – or anyone – would have while engaging in politics is worth investigating. Universities and the scientific community should protect their engaged members as a state would its citizens. The broader relationship between the academy and the rest of society, the role of expertise in politics, and the relationship between a person's rights and responsibilities as a scholar and as a citizen of any society are all important questions for future research.

3.1. Recommendation #1 for universities: support and invest in boundary-spanning work

Universities need to play a stronger role in facilitating knowledge co-production by stepping into the role of boundary-spanning organizations that can draw upon deep expertise across multiple disciplines to facilitate real public value (Quotes 6 and 7). The gap between conservation science and practice remains a key space to develop new incentives for boundary-spanning work and actionable science within research institutions ([Toomey et al., 2017](#)). This may include hiring boundary-spanners and support staff, or training faculty in modes of creating more actionable science through science communication, boundary-spanning, and pluralist knowledge co-production ([Carr Kelman et al., 2023](#)). There are many NGOs, agencies, and governments that can greatly benefit from partnering with researchers to generate the conservation knowledge they need. Boundary-spanners help bridge the gap between sectors, facilitating the creation of partnerships and the coproduction of actionable knowledge. For example, the Central Arizona Conservation Alliance connects the expertise of university scientists with the work done by local city governments to protect and restore desert landscapes ([Raschke et al., 2022](#)).

Some universities are already beginning to recognize their role as neutral spaces of engaged scholarship that address societal issues (Quote 8). For example, Arizona State University promotes such initiatives through the President's [Award for Transdisciplinary Collaboration](#), which seeks to recognize multidisciplinary project teams undertaking exemplary trans-sectorial collaboration – including engaging participants from different sectors – to address complex and societally relevant issues. Other examples show the vast potential of universities to engage in boundary-spanning work ([Karlin et al., 2016](#); [Gerber and Raik, 2018](#)).

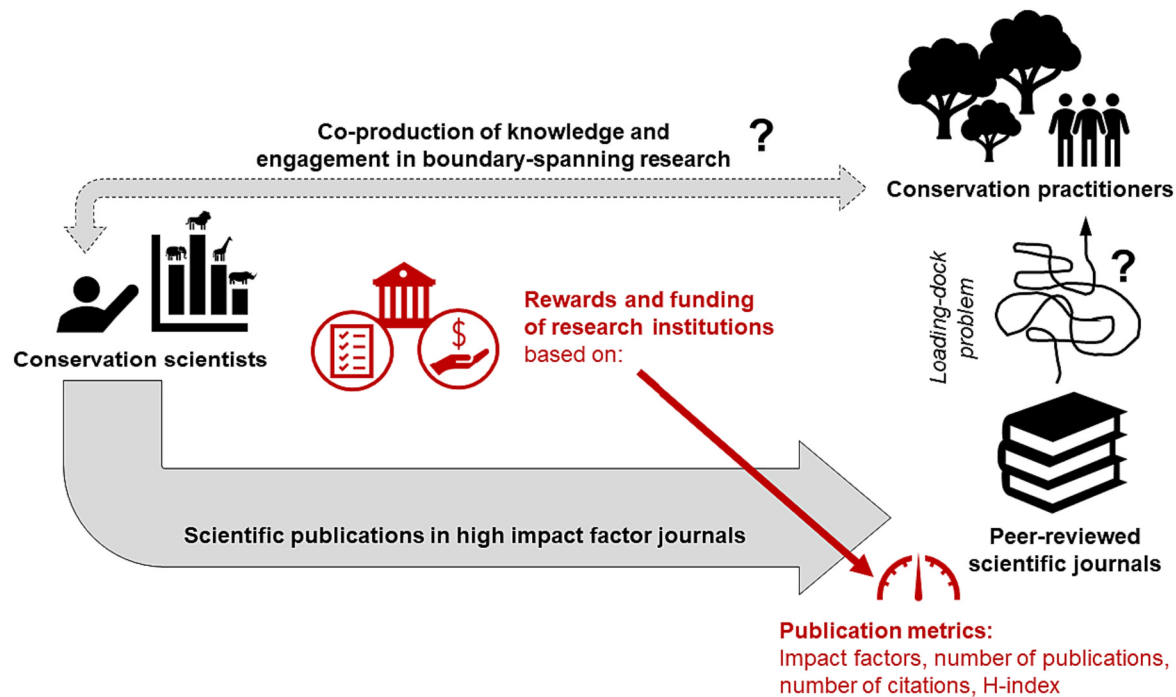


Fig. 1. Current problematic situation for research production, evaluation, and funding. The primary consideration of individual research metrics (journal impact factors, number of publications, number of citations, H-index) for the evaluation and funding of scientists by research institutions does not incentivize researchers to engage in boundary-spanning work. The width of gray arrows represents the research effort dedicated to publishing articles in peer-reviewed scientific journals (bottom arrow) and engaging in co-production of knowledge and boundary-spanning work (top arrow).

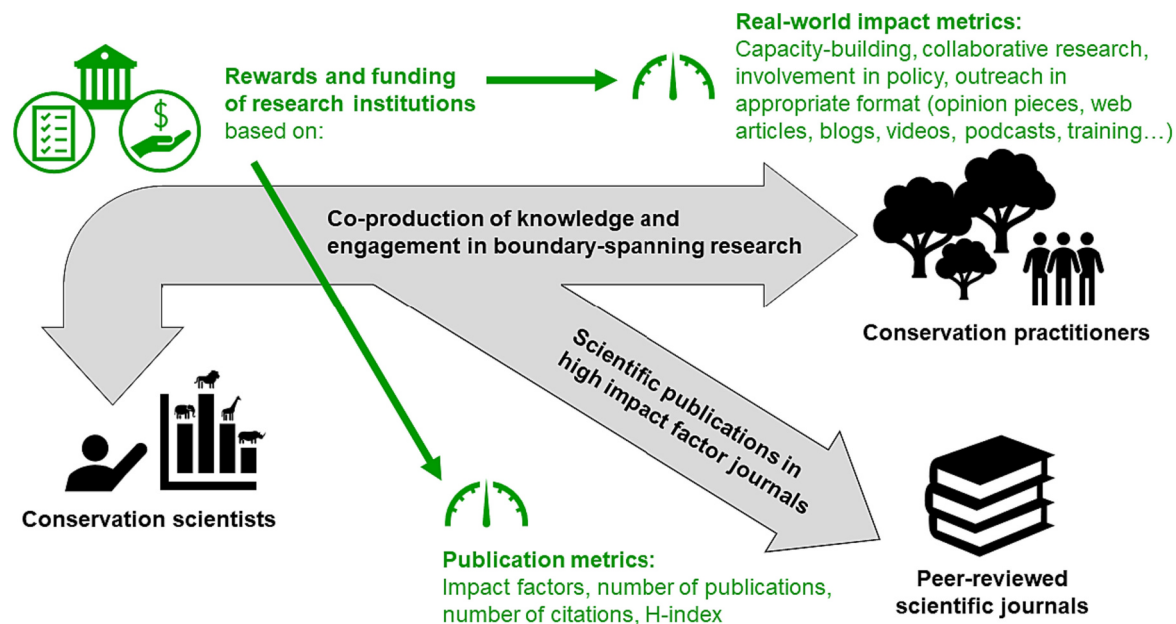


Fig. 2. Suggested framework for research production, evaluation, and funding of conservation scientists in academia. Beyond publication metrics, scientists' evaluation and funding criteria used by research institutions must also include the engagement in knowledge co-production and boundary-spanning research. The width of gray arrows represents the research effort dedicated to publishing articles in peer-reviewed scientific journals (bottom arrow) and engaging in co-production of knowledge and boundary-spanning work (top arrow).

Universities should employ boundary-spanners, including staff and faculty, such as extension faculty (Crow and Dabars, 2020; Goodrich et al., 2020), who can engage full-time in knowledge co-production and boundary-spanning research (Quote 7). This would include staff who can coordinate projects and maintain relationships and networks within and beyond academia. This can take some of the organizational burden off the tenure-track faculty involved in publicly engaged projects.

Research centers can explicitly serve as boundary-spanning portals that connect specific publics with experts within academia and the public sector to generate knowledge that aims to solve problems. Training programs for faculty on actionable science and knowledge co-production can be funded and promoted.

To actively contribute to achieving conservation goals, universities may also hire faculty and professionals dedicated to bridging the gap

between conservation science and practice, as it requires a special skillset to manage conservation partnerships and the process of knowledge co-production (Goodrich et al., 2020). If these profiles are non-tenure track, they may be called, for instance, professors of practice, program or center directors, extension agents or specialists, policy or research associates, outreach coordinators, or practitioner faculty (Beyond the Academy 2022). Importantly, any non-tenure track university scholars and staff need to be provided with career ladders that include clear promotion pathways equivalent to tenure-track faculty, equitable compensation, and the opportunity to lead grants and benefit from sabbatical opportunities.

Baseline internal funding could be provided by universities for the recruitment of engagement leaders, complemented by funding from governments, philanthropists and foundations, recognizing the public value of engaged conservation scholarship (Beyond the Academy 2022). Meanwhile, institutions should incentivize the integration of personnel budgeting that supports engaged scholarship work in grant requests. The collaboration of several university departments in mission-driven fundraising can also cooperatively raise resources to meet multiple missions of the institution.

Investing in engaged scholarship ultimately pays dividends for society and the university (Beyond the Academy 2022). Fostering a shared culture of engaged scholarship across different university positions can lead to a virtuous cycle of multifaceted benefits for both society and the institution. Collaboration between engaged scholars and their partner organizations amplifies the university's prestige and showcases the societal relevance of academic pursuits. This collaborative effort also yields experiential learning opportunities for students, unlocks novel funding avenues, and exerts a cross-disciplinary influence on scholarship and its practical applications.

3.2. Recommendation #2 for universities: incentivize and reward engaged scholarship

Engaged scholarship for achieving real-world impact requires incentives at the organizational level (Gerber et al., 2020; Association of Public & Land-grant Universities 2023). For many young scientists, the individual motivations for engaging in boundary-spanning work are already present and many of them are motivated to make social impacts beyond solely publishing articles (Quote 9). What is needed is for research organizations, including universities, to incentivize and provide resources for engaged scholarship with their communities. The faculty who are already engaged in knowledge co-production and boundary-spanning work should be adequately recognized and rewarded for their above-and-beyond service.

Tenure and promotion policies reflect institutional priorities: they have the power to encourage, support, incentivize and reward engaged scholars (Beyond the Academy 2022). A long-standing institutional commitment to engaged scholarship can embed administrative support, funding, hiring, and mentorship – from faculty recruitment to evaluation. Transparent tenure processes and clear definitions of ambiguous terms such as “service” and “engagement” are key at the institutional level for assessing engaged scholarship. Including representation from multiple disciplines in evaluation committees and making the peer review process more inclusive by inviting non-academic experts can help assess engaged scholarship beyond traditional research metrics. If a faculty is seeking promotion based on their coproduction of conservation outcomes, they should list the main agencies and NGOs they partnered with and explain how they are building these knowledge partnerships. Scientists under evaluation can even include in their CVs links to video testimonials from their partners, stating how their work contributes to real-world conservation action. Achieving conservation outcomes can be slow, and so projections of future impact by qualified experts from the ‘extended peer community’ (Francis and Goodman, 2010) may provide a way for promotion or tenure committees to assess the significance of these engagements.

Some institutions may not be prone to support engaged scientists due to their values and (clear or hidden) political orientations, representing major obstacles for researchers. In that case, engaged scholarship should be supported through civil society and the scientific community at large. Many resources focused on engaged scholarship and conservation practice are freely available in the conservation community, for example through Massive Open Online Courses (e.g., MOOC Conservation).

3.3. Recommendation #3 for universities: create metrics for valuing engaged scholarship equally

Impactful research that aims to solve urgent, real-world conservation problems needs to be valued alongside peer-reviewed journal articles and other academic publications. This shift will support scholars who make tangible impacts on conservation outcomes. Already existing alternative evaluation metrics for promotion and scholarship should be employed to properly reward scientists for investing in the production of actionable outreach products that catalyze the use of their research outcomes (Beyond the Academy 2022).

An institution should allow scholars to place themselves on an engaged scholarship continuum from traditional, basic research to engaged, co-produced research (Beyond the Academy 2022). Periodic evaluations and promotion criteria can be adapted to each level of such continuum, defining clear expectations for all scholars. Researchers' evaluation criteria should recognize the impact of research on decision-making and local practices. Researchers deserve to receive credit during promotion and tenure evaluations when their work has a demonstrated influence on concrete actions, policies, decisions, or laws. Reporting these impacts in their academic CVs in the form of narratives can complement quantitative metrics to demonstrate engaged scholarship and help value locally relevant impacts, which can be applied in all disciplines.

The evaluation of engaged scholarship can also consist of numerous scholarly products other than journal articles that can generate tremendous real-world impacts. These might include software, open-source code and datasets, websites, blogs, maps, technical reports, policy or planning documents, workshops, videos, podcasts, how-to guides, creative performances, and exhibits (Quote 10). If universities provide more support for networking, building relationships and partnering with organizations positioned to implement the knowledge produced by researchers, it will become easier to track and describe the development of such engagement. The publication of opinion papers addressed to practitioners is also a way to have greater real-world impact while still publishing in high impact factor journals. Considering non-academic products that demonstrate engaged scholarship can also be interpreted as “broadening the bar” rather than raising or lowering the bar for achieving tenure (Association of Public & Land-grant Universities 2023).

An example of a new complementary metric to measure a research product's outreach beyond academia is Altmetric, which measures an article's clicks and downloads, social media and blog shares, and media mentions. Although it is behind a paywall, Altmetric provides an informative view of the online activity surrounding one's scholarly content, collecting and collating all information related to a single research output across multiple websites and platforms.

New standardized metrics for valuing engaged scholarship have already emerged. For example, the Coalition for Advancing Research Assessment is an agreement signed by 608 organizations to set a common direction for reforming academic evaluations, based on the principles of quality, impact, diversity, inclusiveness, and collaboration. Another example is the United Kingdom Research Excellence Framework – an assessment tool that measures research quality and prioritizes impact, reach, and significance to ensure responsible and accountable allocation of public research funds.

4. Conclusions

To be societally relevant, universities must serve as boundary organizations, operating as a forum and convener; serving the public good by providing scientific expertise to solve global and local conservation challenges. Research organizations need to be much more stakeholder-engaged and solutions-driven. By embodying the position of official boundary-spanning organizations, universities will serve a vital role in bridging science and society through engaged scholarship. We encourage all institutions to value actionable science in equal measure with basic science. This is not solely about changing institutional norms in conservation science production; it is about prioritizing clear, applicable, and solution-based knowledge that users can effectively implement on the ground.

A transformation to more engaged universities requires a collective effort to redirect academia toward conservation outcomes. Our three recommendations underscore critical actions for success that can position engaged universities to outcompete traditional universities for the best students, researchers, and faculty, while also increasing public support and funding. Acknowledging the role of engaged scholarship is paramount, as these contributions drive impactful research that tackles pressing conservation challenges. Reforms in tenure and promotion criteria are essential to recognizing the true value of engaged scholarship, encouraging a culture of inclusivity, and aligning faculty incentives with institutional missions. A shift in research impact assessment metrics is imperative, one that balances qualitative and quantitative measures that better capture diverse forms of engagement and outreach activities. By fostering a culture of engagement and embracing innovative research assessment metrics, universities can serve as powerful catalysts of positive societal and conservation impacts.

CRedit authorship contribution statement

Simon Lhoest: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Candice Carr Kelman:** Writing – review & editing, Validation, Investigation, Formal analysis, Data curation, Conceptualization. **Chris J. Barton:** Writing – review & editing, Validation, Methodology, Investigation. **J.A. Beaudette:** Writing – review & editing, Validation. **Leah R. Gerber:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

Authors have no conflict of interest to declare.

Data availability

All data used for the research are presented in Table 1.

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