Received: 11 May 2024 | Revised: 17 January 2025 | Accepted: 23 January 2025

DOI: 10.1111/cobi.70005

Conservation Biology

ESSAY

Navigating scale and interdisciplinary dynamics in conservation social science

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Article impact statement: Improving conservation natural and social science collaboration requires scrutinizing the relationship between interdisciplinarity and scale.

Funding information
Fulbright Program; Cornell Migrations Initiative; Cornell Office of the Vice Provost for International Affairs; Cornell Center for Social Sciences

Abstract

To better understand and address global human–environment crises, interdisciplinary collaborations across the natural and social sciences have become increasingly common in conservation. Within such collaborations, the question of scale can cause tensions: how to agree on the unit of measurement and analysis? We contend there is value in scrutinizing the relationship between interdisciplinarity and scale more closely. Drawing on 2 research projects in Indonesia that integrate cultural anthropology and conservation biology, we focused on how these collaborations navigated questions of scale. We sought to illustrate that the relationship between interdisciplinarity and scale choices should be understood as situated in the context of the accelerating drive to scale up conservation science and practice impact. Current conservation discourse around scale deeply affects 3 interconnected factors: ethical and strategic considerations, epistemological parity, and institutional structures. However, interdisciplinary efforts can engage these factors in different ways that have implications for how research unfolds and responds to the push to scale up conservation. To cultivate more robust and resilient interdisciplinary collaborations between the natural and the social sciences, we recommend centering reflexive practices, recognizing the value of rescaling methods and goals, and reforming funding structures.

KEYWORDS
anthropology, bioacoustics, biodiversity, conservation technology, Indonesia, multispecies, orangutan, scaling up

INTRODUCTION

The last decades have seen a growing movement toward mainstreaming the social sciences in conservation (Bennett et al., 2017). This trend reflects an increasing recognition that conservation is intimately connected to, indeed inseparable from, social and political contexts (Hirsch & Brosius, 2013; Miller et al., 2023; Sanborn & Jung, 2021). Interdisciplinary collaborations between natural and social sciences are increasingly promoted as ways to better understand and navigate sustainability and equity challenges, such as climate change and biodiversity loss (Cairns et al., 2020; Leach et al., 2018). Such collaborations can help address analytical blind spots of individual disciplines (Hirsch & Brosius, 2013; Knigge & Cope, 2006; Ostrom &

Nagendra, 2006) and reveal nuanced dynamics within systems (Hardin & Remis, 2006; Nightingale, 2016; Velásquez Runk et al., 2010).

Although calls for interdisciplinarity emphasize these benefits for both theory and practice (Barry & Born, 2013; Graff, 2016; Mahajan et al., 2023), there remain conceptual, professional, and practical challenges to pursuing interdisciplinary conservation research (Bennett et al., 2017). Different normative, epistemological, and methodological assumptions across disciplines can hinder mutual understanding, valuation, or implementation (e.g., Chua et al., 2020; Mascia et al., 2003; Moon & Blackman, 2014). Furthermore, interdisciplinary research more broadly can be hard to fit into traditional academic categories and requires more time to design, implement, and publish, affecting its perceived productivity (Graff, 2016; Leahey et al., 2017).

Within collaborations between natural and social sciences in conservation, scale remains a particularly vexing problem, with researchers often disagreeing on appropriate units of measurement and analysis (Friis et al., 2023; Gibson et al., 2000; Levin, 1992). As a first step to reaching consensus on scale questions, scholars propose that conceptual clarity be reached by restricting the concept of scale to the "spatial, temporal, quantitative, or analytical dimensions used by scientists to measure and study objects and processes" (Gibson et al., 2000, p. 218) and reserving the concept of level to indicate the size of the unit of analysis within that dimension. In practice, however, scale is more commonly used in a fuzzy way: sometimes to indicate an analytical dimension, sometimes to denote a level on that dimension. We followed this fuzzier usage to align with many of the sources we cite here.

The conceptual fuzziness of scale also reflects deeper epistemological divides (Ahlborg & Nightingale, 2012; Sayre, 2015). Although natural sciences often adopt a realist approach that treats scale as an objective feature of the world, critical social sciences often utilize a constructionist approach that considers how political and moral considerations shape the categories, uses, and impacts of scale (Friis et al., 2023; Sayre, 2005). Researchers are often socialized within their disciplines to operate at particular geographic, spatial, temporal, or institutional levels and are influenced by interwoven epistemological, moral, and political dimensions. Collectively, these differences can create tensions when one attempts to bridge methods and translate findings (Friis et al., 2023), including efforts to establish causality or generalize results (Jagadish et al., 2024; Mills et al., 2019; Pienkowski et al., 2024).

In view of these challenges, we contend that there is value in scrutinizing the relationship between interdisciplinarity and scale more closely. Responding to calls to examine the diverse dynamics within interdisciplinary collaborations (e.g., Freeth & Vilsmaier, 2020; Hardin & Remis, 2012; MacMynowski, 2007), we analyzed 2 research projects that integrated cultural anthropology and conservation biology to enhance multispecies coexistence in Indonesia to explore how these collaborations navigated questions of scale (Friis et al., 2023; Gibson et al., 2000; Levin, 1992).

We found global conservation's increasing emphasis on scaling impact to be critical context to understand these case studies' scale choices (Mills et al., 2019; Pienkowski et al., 2024). A prevailing sense of planetary crisis has turned scale into a central concern for the conservation sector, and it is shaping the strategic and ethical considerations of conservation scientists, the relative voice and power of different kinds of knowledge and methods within interdisciplinary research (what we call epistemological parity), and the institutional structures supporting conservation research. Scale choices, therefore, are not just a matter of methodological and epistemological alignment across disciplines; rather, they are deeply situated within applied debates surrounding scale itself.

Crucially, the way in which scale choices are made is far from predetermined, and this contingency makes them highly consequential. The push to scale conservation impact up and out is itself a product of scientific practices, rife with internal contradictions and controversies. In comparing our case studies, we uncovered how collaborating researchers differently engage with, interpret, and negotiate the imperatives of scaling impact and how these differences can have significant repercussions for how collaboration unfolds. This is important not just because effectively dealing with scale can determine the success or failure of interdisciplinary collaborations but also because the outcomes of these collaborations, in turn, could reshape how conservationists understand and engage with scale.

We considered the challenges of scale in interdisciplinary conservation research and how they connect to the current push for—and pushback against—scaling up conservation impact. Based on our case studies highlighting the significance of this interplay between interdisciplinarity and scale, we offer recommendations for cultivating more robust and resilient interdisciplinary collaborations between the natural and the social sciences.

NEGOTIATING SCALE IN INTERDISCIPLINARY CONSERVATION RESEARCH

Disciplinary differences in orientation to scale pose both opportunities and challenges for interdisciplinary collaboration. This is not to say that scientific disciplines are internally homogeneous or necessarily incompatible in how they engage with and understand scale. Biological and social inquiries take place at many scales, from the study of genetic mutation at the cellular level to human and nonhuman migration patterns at the global level. Furthermore, the understanding that no one scale fits any single problem and that different processes are only visible at distinct levels is shared by social and natural sciences (Gibson et al., 2000; Noss, 1992; Reid, 2006; Sayre, 2005).

Nevertheless, different disciplines can complement each other by illuminating distinct relationships at and between different scales (Ostrom & Nagendra, 2006; Sayre, 2005; Velásquez Runk et al., 2010) and providing novel ways of framing both research questions and their answers (Ahlborg & Nightingale, 2012). Epistemological tensions can widen the lens of inquiry and produce new approaches to scale across conservation research portfolios (Hirsch & Brosius, 2013; Sayre, 2005). For example, cultural anthropology, known for its insights into

community-level dynamics, has in recent decades expanded its analytical scope to other species and landscape-level processes (Haraway, 2007; Tsing, 2015) and actively embraced interdisciplinary collaborations to study conservation landscapes and the systems that perpetuate social–ecological crises (Bubandt et al., 2022). Similarly, ecology and sustainability science are increasingly embracing social science methods and approaches to scale to understand the human dimensions of conservation, including the value of innovative participatory methods (Sanborn & Jung, 2021) and uncovering dynamics between livelihoods, property regimes, and environmental change (Unks, 2023).

At the same time, it can still be difficult to harmonize different disciplinary orientations to scale. This can be due to lack of common understanding (Ahlborg & Nightingale, 2012; Friis et al., 2023; Sayre, 2005) and persistent scale mismatches (Ahlborg & Nightingale, 2012; Cumming et al., 2006; Sayre, 2005; Unks et al., 2019). Moreover, choices about scale are inescapably political (Ahlborg & Nightingale, 2012) because they inevitably illuminate certain processes and obscure others (e.g., Lebel, 2006; Lebel et al., 2005; Swyngedouw, 1997). As Ahlborg and Nightingale (2012, p. 1) explain: "The choice of scale…influences what can be seen and the conclusions made, and therefore scale itself requires scrutiny."

THE PUSH FOR SCALING CONSERVATION

The loss of biodiversity is increasingly understood as a global crisis. With an average 69% decline in the relative abundance of wildlife populations worldwide since 1970 and more than 1 million species threatened with extinction (WWF, 2022), many conservationists call for expanding the scale of conservation work. Pointing to the inadequacy of current conservation actions to slow biodiversity loss (Neeson et al., 2022; Romero-de-Diego et al., 2021), some argue for enacting conservation initiatives "at a pace and scale that matches or exceeds environmental threats" (Mills et al., 2019, p. 939).

In the context of conservation, *scaling* can mean different things. Although *scaling up* means moving from lower to higher levels (e.g., targeting higher levels of governance) (Gibson et al., 2000; Tsing, 2012), *scaling out* refers to the replication or expansion of specific interventions to more locations (Dehgan & Hoffman, 2017; Mahajan et al., 2023). The push to scale up and out is connected to conservation science's identification as a "crisis discipline" (Soulé, 1985, p. 727) that emphasizes the moral need to work as quickly as possible to prevent species loss (Du Toit, 2010) and is reflected in efforts to define conservation targets at increasingly large and even global scales (CBD, 2022; Wilson, 2016).

The drive to work fast and go global has been facilitated by emerging technologies, from satellite imagery and drones to autonomous acoustic recorders and cameras to environmental DNA (Adams, 2018; Laurance et al., 2016; Speaker et al., 2022). Such advancements allow conservation biologists to monitor and evaluate biodiversity and habitat change at ever-finer and ever-broader spatial scales and over longer periods, potentially improving conservation planning and design (Arts et al., 2015; Berger-Tal & Lahoz-Monfort, 2018). The use of artificial intelligence (such as machine learning) additionally promises to automate certain time-intensive tasks, allowing for faster and cheaper data processing and analysis (Fang et al., 2019; Rasmussen et al., 2024).

However, the push to work at larger or higher scales has political and ethical repercussions. A bias toward so-called big science from funding agencies favors natural science models of research design and replicable, scalable outcomes that can disadvantage and devalue other more critical, humanist, or artistic forms of interdisciplinarity, including local and Indigenous collaborations and the organizational models to support them (Bennett et al., 2017; Graff, 2016). Social scientists worry that this disciplinary imbalance prioritizes research that simplifies multiscalar social–ecological relationships to more linear and decontextualized interactions that could misdiagnose the problems and be counterproductive (Adams & Sandbrook, 2013; Tsing, 2012; Turnhout & Boonman-Berson, 2011). Indeed, some argue that "delivering positive outcomes at scale remains a fundamental challenge for conservation practice" and that the push for scaling can incentivize exclusionary and coercive practices that hurt people, undermine trust building, and hinder attempts to transform conservation (Pienkowski et al., 2024, p. 1).

In response to these concerns, there are calls for scaling practices to follow rights-based approaches and seek integrated cobenefits to biodiversity, human well-being, and climate (Jagadish et al., 2024; Pienkowski et al., 2024). Instead of scaling out or up, this can mean being open to other rescaling methods or interventions, such as *scaling deep* or *scaling down*. Scaling deep implies focusing on changing groups' values, norms, and knowledge to "accelerate adoption and structural transformation," as seen in conservation organizations' adoption of rights-based agendas, training for industry actors regarding best practices for biodiversity, and the development of school curricula (Pienkowski et al., 2024, p. 3). It can mean pushing against dominant Western knowledge and value systems and focusing on the role of emotional and spiritual values in sustainable social–ecological change (Lam et al., 2020). Scaling deep may also initially require scaling down by focusing on smaller spatial units, such as communities, to account for local identities, geographies, and social relations, but with an eye to how such work might facilitate long-lasting impacts (Lam et al., 2020).

In short, global conservation is currently grappling with critical and complex questions around scale to improve conservation effectiveness. We compared our case studies to examine how these debates shape the processes and outcomes of interdisciplinary collaboration.

CASE STUDIES

Ethnographic survey of human–orangutan relations

The first project aimed to import anthropological methods and principles into orangutan (*Pongo spp.*) conservation research, which has long been dominated by natural science perspectives (Knott et al., 2021; Santika et al., 2022; Utami-Atmoko

et al., 2019). Historically, there has been limited engagement between orangutan research and cultural anthropology, perhaps because orangutans tend to be less culturally significant to local communities than other animals, such as hornbills or fish (Chua et al., 2021; Schreer, 2023). In recent decades, however, orangutan researchers have increasingly recognized the need to both protect orangutan populations in natural forests and foster human–orangutan coexistence in mixed-use landscapes (Ancrenaz et al., 2021; Massingham et al., 2023; Spehar et al., 2018). This has driven greater demand for insights from conservation social sciences (Meijaard et al., 2012).

In that context, a group of orangutan researchers invited 2 anthropologists to contribute to a funding application for a broader project aimed at identifying and implementing critical orangutan conservation actions. Through a series of online meetings and emails, the idea emerged for an ethnographic survey of human–orangutan relations across villages near wild orangutan populations in Indonesia. Ethnography, the primary method of cultural anthropology, emphasizes long-term immersion to understand the interconnections across social, economic, cultural, and political aspects of life (traditionally 1–2 years, but nowadays also shorter periods). By applying this method in different mixed-use landscapes, the team hoped to illuminate sociocultural dynamics of human–orangutan coexistence to inform development of context-specific interventions that would encourage communities to protect orangutans.

Despite alignment on this broad idea, questions of scale posed enduring challenges to the collaboration. Team members struggled to agree on the number of villages to survey, reflecting different disciplinary priorities and motivations. The biological researchers were concerned about the time required to conduct a small set of in-depth studies, given that there are thousands of villages in the orangutan range in Indonesia (Meijaard et al., 2011), and, as the managers of the grant, had to consider budget and time constraints. They thus favored the production of data that could inform urgent orangutan conservation actions at scale. An important requirement for this was to represent the diversity of orangutan habitats in terms of remoteness, ethnicity, and land uses. They therefore sought a village sample size that could optimize the balance between depth and breadth of information required.

In contrast, the anthropologists, V.S. and P.T., prioritized building strong connections between local researchers and village residents. Rather than developing scalable designs for conservation interventions, they hoped to promote an innovative methodology for in-depth study of human–orangutan relations that could be scaled out to different contexts. This priority also stemmed from a felt responsibility to uphold the disciplinary integrity of cultural anthropology by not letting its methods and principles become excessively diluted. Rushing the fieldwork, they feared, might lead to oversimplified representations and undermine the credibility of anthropologists (Fair et al., 2023; Ortner, 1995).

The funded proposal ultimately included an ambitious target of 30 villages, the limit of what seemed feasible within the constraints of the budget and timeframe. The team assumed that this number could be adjusted based on evaluation of early results of a pilot study.

For the pilot study, the anthropologists provided 2 weeks of in-person training in anthropological ethics, theory, and methods to 8 Indonesian nongovernmental organization (NGO) staff. Subsequently, teams of 2 staff members conducted 4 weeks of ethnographic fieldwork in 4 villages, combining participant observation, semistructured interviews, and participatory methods. V.S. and P.T. provided remote mentoring of 6 of the researchers, which ensured all research practices followed the human subjects ethical standards of the Association of Social Anthropologists of the United Kingdom.

For the anthropologists, the results revealed the potential benefits of this experimental form of ethnography. Fieldworkers with limited anthropological training could gain context-rich understandings of individual villages and develop solid bases for long-term engagement after only 4 weeks, which in anthropological terms is relatively short. Moreover, rather than operating on a model of field teams collecting data followed by outside expert analysis, the pilot became a multivocal effort of knowledge production through a continuous process of joint discussion, reflection, and analysis. The researchers' field notes drew rich portraits of human–orangutan relations, confirming previous research findings that, for many communities sharing a landscape with orangutans, the apes are relatively unimportant and become important only through the current and historical mediation of companies, government agents, and conservation organizations (Schreer, 2023). Their findings also reiterated the need for conservation strategies to be based on long-term engagement with local practices and priorities—which implies that, to promote human–orangutan coexistence, it may be helpful to first understand and address other issues (Chua et al., 2020).

Unfortunately, the pilot also revealed that targeting 30 villages was unrealistic within the project's budget and timeframe. Initially, the local researchers expected to finish each village survey within 2 weeks. However, through experience, they learned to appreciate ethnography as an opportunity for relationship building rather than rapid data collection. Following discussions with the researchers, V.S. and P.T. advocated for a reduction of the number of villages. However, due to unexpected pressure from the funder to reach the original target of 30 villages, the orangutan researchers decided to discontinue the collaboration with the authors even before the pilot study was concluded. Although they allowed the pilot study to finish as planned, the orangutan researchers later noted disappointment with the results, which did not offer concrete conservation actions that they could implement. The authors have since not been involved in the overarching project, although they were pleased to hear that it has continued collaborations with Indonesian researchers, involving both ethnographic and other methods.

Collaborative human–environment study of Nusantara

In the second project, anthropologist W.D. and bioacoustician and ecologist W.M.E. developed a research project to investigate the impacts of Indonesia's new capital, Nusantara,

on the region's forests and surrounding human and more-than-human communities. The project was inspired by a university grant call for cross-disciplinary, multispecies, and systems-level research proposals. They compiled a team of social and natural scientists in the United States and Indonesia to design and plan the study. After a 2.5-year delay due to COVID-19, W.D. and W.M.E. initiated fieldwork with their local collaborators and identified 2 protected forest areas and 2 frontline communities with whom to jointly study their forest territories. The project sought to understand the twin threats of habitat fragmentation and community marginalization that threaten to damage human–environment connections across this landscape. The team applied participatory and integrative research practices to better comprehend these interdependent social–ecological processes, following university Institutional Review Board (IRB) protocol for all research involving human subjects.

Over the course of the project, W.D. and W.M.E. held regular meetings (online and in person) and actively studied each other's disciplines and methods. More than discussing research methods, goals, and scales of data collection and outputs, they centered reflexivity. The practice enabled them to critically interrogate the personal, social, political, and institutional conditions of their work and discuss their ethical commitments to local human and ecological communities, acknowledging that such commitments and research priorities are sometimes at odds.

The team approached the research sites as coupled systems, engaging bioacoustics to document spatiotemporal dynamics in soundscapes and biodiversity at the regional level and ethnography to uncover past, present, and possible future human–environment relationships at the local level. Bioacoustic methods (namely, passive acoustic monitoring [PAM]) are often used in conservation to monitor wildlife and their habitats and are touted for their broad spatial and temporal coverage (Rice et al., 2023). PAM relies on the deployment of autonomous recording units (ARUs) that can continuously collect acoustic data in remote places for weeks or months at a time (Owens et al., 2024; Sugai et al., 2019). By reducing research time in the field, PAM minimizes disturbance to wildlife and reduces labor costs. Conversely, ethnographic research is usually predicated on long-term social engagement, leaving little natural overlap for these methods of data collection. However, as conservation scientists grapple with humans as part of nature and anthropologists increasingly turn their attention to the more-than-human relations that sustain people, there is concurrent interest in experimental methods to explore multispecies landscapes (Bubandt et al., 2022).

W.D. and W.M.E. joined and coordinated teams comprising university students and community partners to conduct ARU maintenance (i.e., replacing batteries, exchanging SD cards, and checking and repairing ARUs) across the 4 protected and community forest sites. This maintenance occurred regularly on roughly 21-day intervals, when batteries were typically exhausted, enabling the researchers to mentor and employ a consistent team to assist with fieldwork and build relationships with community partners over the span of more than a year. At the same time, limited funding and personnel shaped decisions for when and how to conduct ethnographic research within the constraints of this schedule. W.D. adapted to the short maintenance periods (usually 2–4 days) in any one village by joining PAM maintenance trips with community members to conduct participant observation of bioacoustics science and study cultural geographies and perceptions of social–ecological impacts from Nusantara. During these visits, the team also conducted key informant interviews and focus group discussions with men and women throughout the communities.

Moreover, in contrast to the usual bioacoustic practice of targeting species and monitoring sites with high conservation value, the team centered the knowledge and interests of community partners. This emphasis led them to limit the project's geographic scale—pushing against the disciplinary impulses in bioacoustics to scale out data collection and scale up conservation impact (Roe et al., 2021; Wood et al., 2024). Instead, W.D. and W.M.E. experimented with methods at the intersection of bioacoustics and ethnography, such as community sound walks and ARU listening sessions, to elicit novel insights into landscape histories, biocultural values, and more-than-human relationships (Erb & DePuy, 2023). By focusing on sites and species of historical, cultural, and ecological significance for partner communities, they are curating locally appropriate acoustic indicators with potential wider regional relevance. Their goal of a landscape-level biodiversity assessment was supported through data-sharing agreements developed with community partners that permitted the team to analyze acoustic data from village sites together with protected forest sites to generate insights into biodiversity patterns at a wider geographic scale. Due to a lack of funding, field research is currently on pause. Collaboration, however, with the local university and community partners and the codevelopment of academic and community-centered outputs are ongoing.

DISCUSSION

Although both case studies explicitly sought to enhance multispecies coexistence, their engagement with scale choices differed. Although the Nusantara team decided to scale down and deep with bioacoustics research, V.S. and P.T.'s engagement was ended after pressure from the donor to cover the number of sites written in the proposal. We attribute these differences to 3 interrelated factors: ethical and strategic considerations, epistemological parity, and institutional structures.

First, interdisciplinary engagement requires reflexive discussion not just on research aims but also on the ethical and strategic considerations in getting there. The ethnographic survey revealed what happens when researchers from different disciplines disagree on those. Although team members broadly agreed on the intended end goal of human–orangutan coexistence, the question of how many villages to include in the study remained a source of tension throughout the collaboration. The Nusantara team, through an adaptive research process with university and community partners, prioritized the rights and histories of local counterparts and the building of trusting relationships. This meant limiting the geographical scale of bioacoustics data collection to 4 sites and created the opportunity

to comparatively study biodiversity across both protected and community lands.

Another factor, connected to reflexive interdisciplinary practice (Fair et al., 2023; Kaechele et al., 2024; Schreer et al., 2024), is how interdisciplinary collaborations hinder or promote epistemological parity between disciplines and different kinds of knowledge and methods. As described, integrating different disciplinary approaches to scale can be challenging (Friis et al., 2023; Hirsch & Brosius, 2013; Nightingale, 2016). In the ethnographic survey case, the need to work across a large spatial extent was prioritized over the more time-consuming, relationship-focused nature of ethnography. These dynamics are widespread in interdisciplinary engagement, where the assumptions and requirements of one discipline often dominate (MacMynowski, 2007). The Nusantara team leads jointly navigated these tensions through discussions on epistemology, developing research questions together at scales appropriate to their distinct methods, creating data-sharing agreements with community partners, and bringing the disciplines together through the medium of sound, which proved a new means for relationship building and considering more-than-human relations and social–ecological change.

Finally, the cases showed how institutional structures affect questions of scale. The decision of the project managers to abort their collaboration with V.S. and P.T. before the pilot study results were known reflects a problematic aspect of the project model, which can impede flexibility in adapting quantitative indicators of progress (Schreer et al., 2024). The Nusantara team dealt with these challenges by combining university funding and individual fellowships, which enabled them to push against certain disciplinary trends regarding scalability. This funding arrangement created a more equitable foundation on which to design research and gave the time to learn about disciplinary differences, emphasize reflexivity in the research process, adapt plans, and experiment with new methods and forms of collaboration.

The way these factors played out over the course of the projects informed our perceptions of success and failure. On the one hand, the training of local ethnographic teams was a success in the ethnographic survey case; the relationships developed enabled trust building and knowledge sharing. On the other hand, the need to reach the target scale of 30 villages meant that the project's collaboration with V.S. and P.T. ended prematurely. Regarding the Nusantara case, its data analysis and output production are ongoing, and thus, the impacts of its multiscalar contributions are unknown. However, as a case study of imperfect collaboration, it can cautiously be claimed a success in its practice of cocreating knowledge with community partners, Indonesian student mentorship, and methodological experimentation to capture and communicate biocultural relationships through sound.

CONCLUDING REMARKS

Corson and Campbell (2023, p. 2) argue that conservation "is at a crossroads—one that tests not only its ability to succeed in protecting the world's biodiversity but also its ability to transmute to meet the demands of a changing world." Both the push for scaling up conservation efforts and advancing conservation social science are promoted as strategies to deal with human–environment crises. However, as our cases demonstrated, interdisciplinary dynamics and choices of scale iteratively influence each other, with both generative and disruptive potential for conservation practice.

We suggest that such collaborations would benefit from paying attention to this interdependency. Doing so requires changes from the individual to the institutional level (Friis et al., 2023). First, to build critical yet constructive interdisciplinary engagements, researchers need to openly and reflexively discuss research goals, epistemological differences, associated scale choices, and how these are shaped by power relations, positionality, and ethical commitments. To foster reflexivity among conservation scientists, social science modules should become standard in conservation science curricula, and organizations and donors should invest in hiring social scientists to institutionalize reflexivity (Schreer et al., 2024).

Second, our cases revealed the value of rescaling for disciplinary innovation in conservation science and practice. One of the major strengths of bioacoustics research is its promise to scale out and up. At the same time, its potential as a participatory method when scaled down and deep should not be ignored. Similarly, team-based ethnography illustrated the potential to focus on both relationship building (scaling down) and expanding community coverage (scaling out) to better understand how forces of extractive and environmental governance (Berenschot et al., 2023; DePuy, 2023) shape multispecies landscapes.

Finally, we emphasize the need to refine interdisciplinary funding structures to avoid situations that led to the end of V.S. and P.T.'s collaboration on the ethnographic survey. Funders should reflect on their own underlying ethical and strategic logics and facilitate more inclusive research approaches. Such programs should support more genuinely equitable conservation collaborations (Graff, 2016; Lam et al., 2020) and allow researchers to experiment with methods and deliverables (Bubandt et al., 2022; Friis et al., 2023; Mahajan et al., 2023). Together with the explicit acknowledgment that not all projects can or should scale outward and upward (Tsing, 2012), such changes could promote a more robust model of science that centers adaptive collaboration, epistemological parity, and relationship building as key strategies for successful interdisciplinary conservation research.

ACKNOWLEDGMENTS

W.D. and W.M.E. thank their collaborators at the Forestry Faculty of Universitas Mulawarman (C. Boer, Rustam, E. Purwanti, H. M. Ghamalsa, M. K. Simone) and community partners from Pemaluan (Jubaen, Abidin, Ardim) and Mentawir (Sahnan, Lamale, Dorsat, Baco) for their partnership and support throughout research. They also thank S. Allred, V. Beard, C. J. P. Colfer, and H. Klinck for their help in designing the research plan and acknowledge funding from the Cornell Migrations Initiative, Cornell Office of the Vice Provost for International Affairs, Cornell Center for Conservation Social Sciences, and

Fulbright Program. P.T. and V.S. are grateful to the global project team for the opportunity to develop an ethnographic survey together with NGO staff in Indonesia, whom they thank for their enthusiasm and trust. Because this essay contains P.T. and V.S.'s personal reflections on the collaboration, they have chosen to protect the identities of everyone involved but hope to jointly publish the findings of the fieldwork in the future.

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How to cite this article: DePuy, W., Thung, P., Schreer, V., & Erb, W. M. (2025). Navigating scale and interdisciplinary dynamics in conservation social science. *Conservation Biology*, *39*, e70005. https://doi.org/10.1111/cobi.70005