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Data justice and biodiversity conservation

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Article Impact Statement: Data should advance socially just and ecologically effective conservation, not reinforce an unjust status quo or create new marginalizations.

Abstract

Increases in data availability coupled with enhanced computational capacities are revolutionizing conservation. But in the excitement over the opportunities afforded by new data, there has been less discussion of the justice implications of data used in conservation, that is, how people and environments are represented through data, the conservation choices made based on data, and the distribution of benefits and harms arising from these choices. We propose a framework for understanding the justice dimensions of conservation data composed of five elements: data composition, data control, data access, data processing and use, and data consequences. For each element, we suggest a set of guiding questions that conservationists could use to think through their collection and use of data and to identify potential data injustices. The need for such a framework is illustrated by a synthesis of recent critiques of global conservation prioritization analyses. These critiques demonstrate the range of ways data could serve to produce social and ecological harms due to the choice of underlying data sets, assumptions made in the analysis, oversimplification of real-world conservation practice, and crowding out of other forms of knowledge. We conclude by arguing that there are ways to mitigate risks of conservation data injustices, through formal ethical and legal frameworks and by promoting a more inclusive and more reflexive conservation research ethos. These will help ensure that data contribute to conservation strategies that are both socially just and ecologically effective.

KEYWORDS
big data, critical data studies, data justice, datification, equity, global analyses, political ecology, remote sensing

Justicia Informativa y Conservación de la Biodiversidad

Resumen: El incremento en la disponibilidad de datos acoplado con las capacidades computacionales mejoradas está revolucionando la conservación. Sin embargo, debido a la emoción generada por las oportunidades proporcionadas por los datos nuevos, ha habido menos discusiones sobre las implicaciones de justicia de los datos que se usan en la conservación, es decir, cómo las personas y los ecosistemas están representados por los datos, las opciones de conservación basadas en estos datos y la distribución de los daños y beneficios que surgen de estas opciones. Proponemos un marco de trabajo para entender las dimensiones de justicia de los datos de conservación compuestos por cinco elementos: composición de los datos, control de datos, acceso a los datos, procesamiento y uso de los datos, y consecuencias de los datos. Diseñamos un conjunto de preguntas guía para cada elemento, el cual los conservacionistas podrían usar para analizar

detalladamente la recolección y uso de los datos y así identificar posibles injusticias informativas. La necesidad de tener este marco de trabajo está ilustrada por una síntesis de críticas recientes a los análisis de priorización de la conservación global. Estas críticas demuestran la gama de formas en la que podrían usarse los datos para producir daño ecológico y social debido a la elección de los conjuntos de datos subyacentes, las suposiciones hechas en el análisis, la sobresimplificación de las prácticas de conservación reales y la exclusión de otras formas de conocimiento. Existen maneras de mitigar los riesgos de injustica informativa en la conservación por medio de los marcos de trabajo éticos y legales y mediante la promoción de una ética de investigación de la conservación más incluyente y reflexiva. Todo lo anterior ayudará a asegurar que los datos contribuyan a las estrategias de conservación que son socialmente justas y ecológicamente efectivas.

PALABRAS CLAVE
análisis globales, big data, datificación, ecología política, estudios críticos de datos, justicia informativa, teledetección

【摘要】
数据可用性的增加与计算能力的提升正在彻底改变保护工作。但是, 在对新数据带来的机遇感到兴奋的同时, 对保护中使用数据的公正性的讨论仍欠缺, 即数据如何代表人和环境, 基于数据如何做出保护选择, 以及这些选择带来的利益和伤害如何分配等问题。我们提出了一个理解保护数据公正性的框架, 该框架由5个要素组成:数据构成、数据控制、数据访问、数据处理与使用, 以及数据的结果。我们为每个要素设计了一套指导性的问题, 保护实践者可以用这些问题来反思他们对数据的收集和使用情况, 并确定潜在的数据不公正性。最近一篇对全球保护优先分析的评论的综述说明了这一框架的必要性。这些评论表明, 由于基础数据集的选择、分析中的假设、对现实世界保护实践的过度简化以及对其他形式知识的排挤, 可能会导致数据的使用产生一系列社会及生态伤害。通过规范的伦理和法律框架, 以及通过促进更具包容性和更具反思性的保护研究精神, 我们可以减轻保护数据不公正的风险。这将有助于确保数据为社会公正和生态有效的保护战略做出贡献。**【翻译: 胡怡思; 审校: 聂永刚】**

关键词: 公平, 大数据, 遥感, 数据化, 全球分析, 关键数据研究, 政治生态学, 数据公正性

INTRODUCTION

The nature and use of data in conservation have changed profoundly in recent years (Bakker & Ritts, 2018). Advances in digital technologies, such as satellite remote sensing, drones, camera traps, and their combination with social media data, are making certain kinds of data available at spatial and temporal scales and resolutions that would be impossible with ground-based survey methods alone. Technological advances are also transforming capacities to combine, share, store, and analyze conservation-related data. Many celebrate the revolutionary potential of data-driven sustainability approaches (Runting et al., 2020), particularly because large data sets are increasingly freely available to anyone with an adequate internet connection.

But some scholars fear that enthusiasm over the possibilities has led to neglect of potential harms (e.g., Adams, 2019; Sandbrook et al., 2021; Simlai & Sandbrook, 2021). These concerns arise because some actions taken in the name of conservation have caused and continue to cause harm (e.g., displacement and loss of livelihoods) to marginalized people, and these problems are exacerbated by increasingly militarized conservation strategies (Duffy et al., 2019; Kashwan et al., 2021; Tauli-Corpuz et al., 2020). Advancing justice and equity in conservation efforts is essential from both moral and instrumental perspectives, in that forms of conservation perceived as equitable are seen as more likely to succeed (Schreckenberg et al., 2016).

Therefore, conservation researchers and practitioners need to apply a more critical lens to the nature and use of data in conservation and question the justice benefits and risks associated with data. Such a lens would allow identification of the circumstances in which data use in conservation advances socially just and ecologically effective conservation practices, reinforces an unjust status quo, or creates new patterns of marginalization.

We argue for bringing theories of data justice to bear on the use of data in conservation. In this essay, we reflect on the urgent need for more critical perspectives on conservation data, review theories of data justice developed for other contexts, and consider how these theories could be applied to the context of conservation. We then explore the risks that could arise from neglecting data justice concerns by examining recent debates over global conservation prioritization analyses as an example. Finally, we discuss strategies to reduce the injustices arising from data use in conservation.

THE NEED FOR CRITICAL PERSPECTIVES ON CONSERVATION DATA

Data, conservation data included, are never neutral because they are derived and used by people (Dencik et al., 2019). A data set may be a relatively accurate representation of a particular environmental issue, such as fire frequency or species distribution. But the things deemed worthy of collecting data about—and the decisions made based on those data—are shaped by different sets of interests and beliefs about what is and is not important (Dalton & Thatcher, 2014; Jasanoff, 2017).

Kitchin and Lauriault (2014) argue for seeing data as part of complex assemblages, which include not only the data themselves but all the technical, political, and socioeconomic relations shaping data composition, use, and impact. Nost and Goldstein (2021:5) propose the parallel concept of "data infrastructures"—"place- and time-specific networks of funding, standards, rules, technologies and environments [that] structure data…, its organization, analysis, and dissemination, and, ultimately, its use in governing people and nature." In both conceptualizations, data are not objective truths waiting to be unearthed, but are inextricable from the sociopolitical systems in which they are produced and used (see also Power [2004] and Cooper [2015]).

Taking a critical approach to data is essential because biases and distortion in data sets have very real impacts on people and ecosystems. Biodiversity data demonstrate this issue well. Bowker (2000) and Hudson et al. (2014) discuss how global biodiversity data are biased toward particular locations and more charismatic taxa and the implications of this for distribution of conservation resources. Also important is who captures the data and the choices they make based on those data. Use of drone-derived data for state actors to surveil local people (Massé, 2018) is distinct from local people using the same kind of data to strengthen their claims over land and resources (Radjawali et al., 2017; Millner, 2020).

The politics and partiality of data merit greater attention now because of wider trends in the availability and use of so-called big data. First, there is the scale of "datification" occurring as more of peoples' activities are captured in different forms of data (Newell & Marabelli, 2015). Second, those collecting and using data are increasingly distant from the people or environments represented in the data (Sarkar & Chapman, 2021). And third, this distance combined with the increasing complexity of the analytical techniques applied to data means it is harder for data subjects to understand data use, recognize when there is bias, and challenge harmful misrepresentations (Taylor, 2017). People are, therefore, increasingly observed without being aware that they are observed, and their lives increasingly affected by choices made based on big data, even as they become less able to understand and challenge the ways data are composed, processed, and used.

Although there are rich literatures on the nature and consequences of data in some fields, such as criminology, public health, and urban planning, and scholars in political ecology and critical Geographic Information Systems (GIS) have long engaged with the politics of knowledge and the politics of maps, there is less conservation research turning a critical lens on data itself (with notable early exceptions cf. *People and Pixels* produced by the National Research Council in 1998). However, concerns over representation, bias, surveillance, and accountability are equally relevant to the use of data in conservation, as indicated by recent and developing bodies of research on the social dimensions of conservation monitoring technologies (Sandbrook et al., 2018; Millner, 2020; Simlai & Sandbrook, 2021) and political ecologies of environmental data (Gabrys, 2016; Nost & Goldstein, 2021). But conservation research still prioritizes the technical opportunities and challenges of data over the sociopolitical ones. In some ways, this continues a tendency in parts of the conservation community to neglect conservation social science and the questions of justice it asks. But these omissions gain new urgency now that the evolving risks associated with large-scale digitally derived data are being coupled with the ongoing harms from and justice issues associated with conservation. This is why conservation research needs to engage with theories of data justice.

DATA JUSTICE AND CONSERVATION

Taylor (2017) defines *data justice* as "fairness in the way people are made visible, represented and treated as a result of their production of digital data." Taylor posits three pillars of data justice: "(in)visibility, (dis)engagement with technology, and antidiscrimination." This clearly maps onto the traditional distinctions of the procedural, distributional, and recognition aspects of environmental justice (Schlosberg, 2004). Pushing the concept further, Dencik et al. (2019) argue that a data justice approach means going beyond relatively narrow concerns about privacy and data security and seeking to understand data "in a way that engages more explicitly with questions of power, politics, inclusion and interests." Heeks and Shekhar (2019) provide empirical evidence of the distributive consequences of data use, demonstrating in an urban development context how data-driven initiatives can magnify inequalities.

Existing work on data justice and environmental concerns has produced a body of scholarship known as environmental data justice (Vera et al., 2019). Developed initially through the work of the Environmental Data and Governance Initiative, which emerged in the United States in response to threats to environmental data during the Trump Administration, the aim of those pursuing environmental data justice is to challenge the extractive logics of much data collection and to promote decolonial, participatory, and community-centered approaches to data capture and management. But as Vera et al. (2019) argue, there is an important tension between the concerns of data justice and environmental justice. Data justice advocates oppose the use of data to surveil data subjects and uphold the matrix of domination (i.e., the existing imbalances of power) and argue that data subjects should have the right to be forgotten. Environmental justice activists, in contrast, often draw on data to

TABLE 1 A framework, in the form of guiding questions, for evaluating the justice dimensions of conservation data

Element[a]	Questions
Data composition	Who or what is made visible through data? What is hidden by these data; how do they omit or disguise people, species, land uses, or land covers? Are there biases and distortion in the ways that people, places, or species are made visible through data?
Data control	Who funds the collection of the data? Who has the power to determine the content of the data—either by shaping collection strategies, or being able to challenge biases and distortion? Who has the power to determine how data are shared and used?
Data access	Who has the right to access the data, and in what form? Who has the ability to benefit from the data?
Data processing and use	Who actually uses the data? How do they use it? When data sets are combined, which data sets are included and which omitted? How are data analyzed and presented in information products? What assumptions are made when data sets are combined, and does this have implications for the recognition or invisibility of particular people or places?
Data consequences	Who can make what choices based on the data and resulting information products? What impacts on people and ecosystems arise from how data are produced and the choices made based on data? Who benefits—and who pays the costs—as a result of how data are produced, managed and used?

[a]Elements are not standalone, but rather part of the interacting processes through which data are used to produce conservation knowledge.

present counternarratives that support the pursuit of more just outcomes (Walker et al., 2018; Vera et al., 2019).

Although work on environmental data justice highlights interesting links and tensions between environmental and data justice, the main motivation behind that work is to challenge environmental harms, such as pollution, that disproportionately affect marginalized communities. Environmental data justice research is yet to engage fully with the kinds of injustices that can be associated with conservation. We drew on the environmental justice, data justice, and environmental data justice literatures to develop a framework for evaluating the justice dimensions of data use in conservation, presenting this in the form of guiding questions for conservation researchers and practitioners (Table 1). These questions are organized around five interacting elements: data composition, data access, data control, data processing and use, and data consequences.

The first element, data composition, reflects the emphasis placed in both environmental and data justice on who is seen and how. New data can make people or places visible that were previously neglected and so achieve the recognition seen as fundamental to equitable conservation (Massarella et al., 2020). Conversely, people, places, and species may be made visible in ways that increase susceptibility to harm, such as by revealing the locations of populations of threatened species (Sarkar & Chapman, 2021). We propose asking who or what is made visible or rendered invisible in individual data sets and whether biases or distortions in data representations could generate or perpetuate harms.

The second element of our framework, data control, involves asking who funds data collection, determines the content of the data, and has the power to influence how data are shared and used. In suggesting these questions, we drew from recent work on the political ecology of data (Nost & Goldstein, 2021). We were also inspired by work on Indigenous data sovereignty (Kukutai & Taylor, 2016), in which Indigenous scholars argue that Indigenous groups should control data about their people and lands. Our proposed questions would lead conservationists to consider whether patterns of data control follow the extractive logics critiqued by Vera et al. (2019) or adhere to more participatory or democratic models.

Data access is often reduced to whether data are freely available in digital form. Our framework draws on a broader view of access, following Ribot and Peluso's (2003) differentiation of the ability to benefit from a resource (in this case data) from the right to benefit. In this, we are aligned with the FAIR principles for data governance (http://www.go-fair.org/fair-principles), which stress the importance of factors, such as metadata and interoperability for enhancing data usability. This broader theorization of access also invokes work on digital divides (Tsatsou, 2011), in that data being freely available online is not the same as everyone having the technical capacities and expertise required to benefit.

The final two elements of our framework, data processing and use and data consequences, focus on the analysis of data and the impacts arising from the ways that data are produced, managed and used. This means asking who uses data, how are different data sets analyzed and combined, and how are results presented in information products. It also means considering the choices made based on data, the ways these choices remake the world, and how they alter the resulting distribution of costs and benefits. Posing these questions allows identification of the circumstances under which conservation data can be used to transformative effect and support equitable achievement of conservation goals, as well as when data serve to continue existing injustices or marginalize people or places in new ways.

Although we organized these questions into five categories, they overlap and interact; that is, the consequences of data are influenced by their composition, the composition of data is

influenced by who controls data collection, and so on. And while not repeated throughout the framework, each question could be enhanced by adding *and why*, a central question in the wider literatures on critical data studies, political ecologies of data, data infrastructures, and data assemblages (Kitchin & Lauriault, 2014; Nost & Goldstein, 2021). Asking why encourages conservation researchers to acknowledge and engage with the relationships of power surrounding conservation data.

These groupings are intended to be broad enough to be applicable to all kinds of data used in conservation. They are also intended to be flexible enough for application at different scales and in different contexts. The justice risks attached to global-scale data will be different from those associated with data about specific landscapes. Key data justice concerns will also vary between conservation contexts because each landscape will have different existing power relationships and injustices related to factors such as gender, race, wealth, and colonial and conservation histories. As just one example, we used our framework to reframe recent debates over global conservation prioritization analyses.

RISKS OF GLOBAL PRIORITIZATION ANALYSES

Global-scale prioritization analyses have multiplied in recent years in the literatures on conservation and ecosystem restoration, particularly in high-impact scientific journals. Most of these prioritizations either outline optimal spatial distributions for conservation and restoration activities (e.g., Strassburg et al., 2020) or quantify the potential costs and benefits of particular approaches at global scales, such as increasing tree cover (e.g., Bastin et al., 2019) or designating certain proportions of terrestrial land as protected areas (e.g., Hannah et al., 2020). Although conservation and restoration may have slightly different practices and goals, we drew examples from debates in both fields because both are illustrative of the potential risk of data injustices.

Some of these analyses have proven contentious; the concerns (Table 2) reflect the different aspects of data justice we described above. Although the critiques reproduce a longstanding tension between human-centered and more-than-human justice paradigms (Celermajer et al., 2021), they share a theme: the nature or use of data could result in injustices and harms to life. Should the authors of these studies succeed in their objective of influencing global conservation policy and altering flows of funding and resources, then currently unrecognized justice implications of data may have large effects on human and nonhuman lives within and beyond conserved landscapes. We have brought together what have up to now been quite a disparate set of critiques to show how the new framework for thinking through conservation data we propose can advance conversations about the nature and politics of conservation knowledge and the justice dimensions of the technologically transformed conservation data landscape.

A first set of critiques focuses on the underlying data themselves and on how they render visible or invisible certain people, places, or species. Biases and omissions may arise from logistical constraints or variations in interest in different species and ecosystems, as in the case of biodiversity data. Or they may arise from simplifications, which means, for example, that data capture only one dimension of complex phenomena (such as poverty). An additional critique is that some forms of knowledge, particularly local and Indigenous knowledges, cannot be captured quantitatively or globally. Any global-scale representation of the world developed purely from quantitative data sets, therefore, renders invisible other forms of knowledge (Briggs et al., 2020).

The second set of critiques focuses on data access and control and reflects wider concerns about how digital technologies are altering the relationships of power between those observing and those observed. In the case of global prioritization analyses, this concern is compounded by the fact that authorship teams are often dominated by natural scientist researchers based at institutions in the Global North, resulting in analyses shaped by a limited range of perspectives and values. McCarthy and Thatcher (2019) are among those questioning what a combination of remotely derived data and inequities in access to that data could mean for downward accountability and democratic decision-making processes. In the case of the global prioritization analyses, the main forums for raising concern about an analysis are the letters and comments pages of academic journals—an environment inaccessible to many of those who might wish to disagree.

A third set of critiques focuses on data processing and use, particularly the ways that data sets are combined, analyzed, and presented in information products (the latter refers to outputs, such as maps and research articles). Critiques often focus on the data that were left out, including socioeconomic variables, such as population (Dutta et al., 2020; Zeng et al., 2020), and ecological parameters, such as data on the distribution of tropical grasslands (inadvertently justifying harmful tree planting efforts [Bond, 2016]). In some cases, exclusion of important parameters or unrealistic assumptions made during the analysis has resulted in overstated or misleading conclusions about the potential of a particular strategy (see Lewis et al., 2019 on Bastin et al., 2019). In other cases, critiques considered both the content of the analyses and how the results were reported, such as when results reported as large-scale aggregates obscure important distributive inequities in costs and benefits (Agrawal et al., 2021).

The final set of critiques focuses on data consequences, arising from these issues of composition, access, control, and use. Wyborn and Evans (2021) argue against "crowding out," where ascribing greater value to a particular form of data or kind of analysis excludes other ways of knowing about conservation. Fleischman et al. (2020) argue that oversimplified findings in global-scale analyses underplay the complexity of real-world environmental interventions, potentially motivating well-intentioned efforts that are ultimately ineffective. Oversimplified narratives can also draw attention away from more impactful strategies, either inadvertently or when they are coopted for the purposes of greenwashing. In all cases, the issues outlined above could undermine conservation efforts

TABLE 2 A synthesis of critiques relevant to global prioritization analyses in conservation and ecosystem restoration organized by the elements of the framework for thinking through the justice dimensions of conservation data

Justice framework element	Critique	Example
Data composition	Data underpinning the analysis have significant biases or omissions. Data do not represent important forms of variation.	McRae et al. (2017) discuss biases in global biodiversity data. Although not a conservation analysis, a good example is a recent fine-grained poverty map developed by Chi et al. (2022) using social media and asset data. The latter may capture variations between urban and rural areas but may not be based on assets that differentiate rural poverty and prosperity.
	Some forms of knowledge cannot be easily represented through the large-scale quantitative data required for these analyses, particularly Indigenous and local knowledges.	Briggs et al. (2020) discuss bridging the gap between geospatial technologies and Indigenous knowledge of place.
Data control	Increased use of remotely derived data makes new areas visible to governments and corporations and reduces accountability to those living on the land.	McCarthy and Thatcher (2019) make this argument for renewable energy mapping products, but the same argument can be made for global conservation analyses.
Data access and data processing and use	Author teams are dominated by Global North scholars with a shared natural science perspective, and the ability to benefit from the data underlying global prioritizations is not evenly distributed.	Agrawal et al. (2021) discuss this issue in relation to the global analysis by Waldron et al. (2020). Kontinen and Nguyahambi (2020) and Kothari (2021) also discuss the problem of inequity in research authorship.
Data processing and use	Social parameters are excluded from analyses, obscuring potential trade-offs between ecological and social impacts.	Dutta et al. (2020) critique the noninclusion of population data in the global analysis by Dinerstein et al. (2020) (see also the response to this critique from Burkart et al. [2021]). Schleicher et al. (2019) show the number of people who would be affected by a Half Earth conservation strategy, despite population data often being omitted from prioritization analyses. Zeng et al. (2020) demonstrate that inclusion of socioeconomic variables dramatically reduces restoration area potential in Southeast Asia.
	Ecological parameters are excluded that could result in damaging impacts on particular ecosystems.	Bond (2016) and Veldman et al. (2017) discuss the misrepresentation of tropical grasslands in the WRI (2014) Atlas of Forest Restoration opportunities.
	Unrealistic assumptions in the ways that data are analyzed lead to misleading or overstated conclusions.	Veldman et al. (2019) and Lewis et al. (2019) argue there are analytical errors in Bastin et al.'s (2019) estimate of global tree restoration potential. Ploton et al. (2020) detail limitations in large-scale ecological mapping models.

(Continues)

TABLE 2 (Continued)

Justice framework element	Critique	Example
	Results are reported as large-scale aggregates, meaning important distributive impacts are obscured.	Agrawal et al. (2021) discuss Waldron et al. (2020), who reported economic costs and benefits in net terms without adequately recognizing the potential disproportionate impact on poorer people (see also Brockington & Wilkie [2015]).
Data consequences	The increasing number of global-scale analyses is crowding out other forms of knowledge and ways of knowing about conservation.	Wyborn and Evans (2021) discuss the increasing number of global prioritization analyses and how this could crowd out other kinds of conservation analysis.
	Implementation of proposals based on the data is complicated by factors not considered in the analysis and causes harms not anticipated by the original authors.	Fleischman et al. (2020) discuss the risks of oversimplified arguments for large-scale tree planting.
	Overly broad recommendations are vulnerable to application to purposes other than those originally envisaged by the authors, which can result in an unjust distribution of costs and benefits.	Seddon et al. (2021) argue against claims for "natural climate solutions" (such as those put forward by Griscom et al. [2017]) being used to facilitate greenwashing by large corporations and governments.

and lead to social harms (i.e., produce conservation data injustices).

TOWARD DATA JUSTICE IN CONSERVATION

The philosopher Nancy Fraser describes "abnormal justice" as when the procedures, authorities, and goals of arguments about justice depart from their normal confines (Fraser, 2008). Fraser had in mind such things as the culture wars in the United States and the changing international regime governing trade, when who decides what it means to be just about what and to whom are all far from certain. Conservation data present a similar moment of abnormality. The authorities governing use of data, the justice questions they pose, and the means by which they are resolved are all unclear.

The first step in resolving these uncertainties is to recognize that they exist. The altered conservation data landscape offers many opportunities for conservation researchers and practitioners. It also invites—perhaps requires—more careful consideration of how one can engage with conservation data in ways that are both just and effective (conditions that may well be mutually reinforcing). This means making more conscious and informed choices about assumptions, data sets, inclusion, research design, framing, and more that can all increase or reduce the risk of unjust outcomes.

We see three priority areas for work on data justice and conservation that focus on new research frontiers, legal frameworks, and methodologies. There is a wealth of questions to be asked about the nature of the data used in conservation and the consequences of data use. In the case of the prioritization analyses, for example, one needs to understand how the construction and analysis of data layers can conceal or obscure particular people and ecosystems, as well as the roles these kinds of analyses play in environmental policy discourse. But more generally, and most importantly, one needs to understand better the ways in which new data can reinforce or challenge existing inequities (the "matrix of domination" [Vera et al., 2019]). Research on conservation monitoring technologies (Millner, 2020; Simlai & Sandbrook, 2021), the social science of remote sensing (Bennett et al., 2022), digital environmental politics (Machen & Nost, 2021), and the political ecologies of data (Nost & Goldstein, 2021) has begun to engage with these important questions.

From a methodological perspective, advocates of environmental data justice argue for adopting approaches to environmental data collection that are more participatory and can empower those living in observed areas (Vera et al., 2019). Similar arguments for coproductive approaches have been made before in relation to conservation and sustainability (Chambers et al., 2021). A challenge is reconciling such smaller-scale, coproductive approaches with addressing the kinds of biases and gaps identified in large-scale conservation data sets, such as global biodiversity data. Citizen science and participatory monitoring have been suggested as one possible strategy (Chandler et al., 2017), but participation in such schemes is not equal and raises new questions about whose values and interests are represented in the resulting data (Mah, 2017). Methodological innovation will be needed to address data injustices in ways that do not compound others. But as a first pragmatic step, conservation researchers and practitioners can give more thought to issues of data access and control: who can influence the kind of data collected, who has the ability to benefit from the data, and to what extent do the answers to these questions reflect long-standing inequalities in ecological research (Maas et al., 2021). A more inclusive conservation is more likely to avoid some of the potentially damaging consequences of data use.

Unfortunately, reflexive, coproductive approaches can also slow down conservation researchers under pressure to meet publication imperatives. Challenging these perverse incentives requires open conversation about how to be a good academic citizen in one's use of conservation data while navigating a system that sometimes penalizes those who seek to be so. Senior scholars, funding agencies, and university systems all have a role to play in providing space for and acting on this conversation.

The research system that produces conservation knowledge is also embedded in a broader sociolegal context that influences how research and conservation can take place. In the context of rapid ecological change caused by human socioeconomic systems, conservation researchers and practitioners already increasingly engage with broader policy debates. In recognizing the potential of conservation data to produce harms, conservationists have an opportunity to productively engage in evolving debates over data privacy, access, and sovereignty to ensure legal and policy frameworks that work for researchers and those peoples and species living in conservation areas. This means questioning the extent to which existing legal frameworks, such as the General Data Protection Regulation in the European Union, can mitigate the potential harms arising from conservation data and whether new legal means are needed to reflect the altered data landscape (as argued by some advocates of Indigenous data sovereignty). But this also entails thinking about which data injustices are amenable to legal remedies and which could be better addressed through channels such as academic ethical review processes or best practice standards such as the FAIR data principles.

By proposing a framework to think through the justice dimensions of conservation data, we hope to motivate further work toward developing new understandings of the nature and impacts of conservation data. We also hope to encourage conservation researchers and practitioners to think more explicitly about what data they use, how, with whom, and with what potential harms or benefits to people and environments. Doing so opens the door to more ethical conservation practices that take seriously concerns about privacy, rights, risks, and harms, from the individual to the global scale. As a starting point, we suggest engaging with data with humility and transparent acknowledgment that conservation data come with risks as well as rewards.

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