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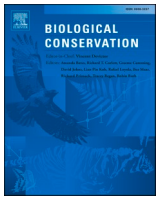

Conservation ethics in the time of the pandemic: Does increasing remote access advance social justice?

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ABSTRACT

The COVID-19 pandemic is stimulating improvements in remote access and use of technology in conservation-related programs and research. In many cases, organizations have intended for remote engagement to benefit groups that have been marginalized in the sciences. But are they? It is important to consider how remote access affects social justice in conservation biology—i.e., the principle that *all people should be equally respected and valued in conservation organizations, programs, projects, and practices*. To support such consideration, we describe a typology of justice-oriented principles that can be used to examine social justice in a range of conservation activities. We apply this typology to three conservation areas: (1) remote access to US national park educational programs and data; (2) digitization of natural history specimens and their use in conservation research; and (3) remote engagement in conservation-oriented citizen science. We then address the questions: Which justice-oriented principles are salient in which conservation contexts or activities? How can those principles be best realized in those contexts or activities? In each of the three areas we examined, remote access increased participation, but access and benefits were not equally distributed and unanticipated consequences have not been adequately addressed. We identify steps that can and are being taken to advance social justice in conservation, such as assessing programs to determine if they are achieving their stated social justice-oriented aims and revising initiatives as needed. The framework that we present could be used to assess the social justice dimensions of many conservation programs, institutions, practices, and policies.

1. Introduction

The COVID-19 pandemic has altered conservation and human interactions with the environment. Concerns about the spread of COVID-19 caused people to restrict their physical movement, especially for indoor activities in public areas to limit in-person interactions (Bates et al., 2021). People dramatically increased visitation to local parks and natural areas to relax outdoors and improve their physical and mental health (Kleinschroth and Kowarik, 2020; Miller-Rushing et al., 2021; Primack and Terry, 2021). However, in-person interactions at those sites—e.g., educational programs and team-based fieldwork—declined and many programs were instead offered online (Miller-Rushing et al., 2021).

Prior to the pandemic, many organizations were working to increase remote access to resources like educational programs, scientific data, and natural history collections. The pandemic has accelerated this trend (Miller-Rushing et al., 2021; Paul and Soltis, 2020). For example, museums have been digitizing natural history specimens and associated data for more than a decade, with the intent of making their specimens more accessible to researchers, educators, and the public (Nelson and Ellis, 2019; Willis et al., 2017). The increased accessibility of specimens has facilitated an uptick in conservation and ecological research using data from museum specimens (Nelson and Ellis, 2019; Soltis, 2017), providing remote research opportunities under pandemic-driven

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restrictions on laboratory and fieldwork. For many years, US national parks have been expanding their use of web articles, videos, social media, and other digital media to provide access to park experiences for people who cannot visit in-person and to extend interactions with people before and after in-person visits. The pandemic amplified the demand for these remote interactions and National Park Service (NPS) staff increased efforts to provide new content (Miller-Rushing et al., 2021). Citizen science programs—also known as public participation in scientific research, participatory action research, or community science (Eitzel et al., 2017)—increased their use of smartphone apps and web-based training resources to increase the ability of people anywhere in the world to participate, to standardize data collection, and to improve data management (Bonney et al., 2014). We acknowledge that the term "citizen science" fails to include and welcome all participants, but use the term in this paper because of its widespread use, including in US legislation encouraging the use of citizen science by federal agencies (Crowdsourcing and Citizen Science Act, 2016), and because of the current lack of consensus around appropriate alternatives (Cooper et al., 2021). Remote access to citizen science apps has contributed to the astounding increase in participation in and scientific output from citizen science over the past 40 years (Chandler et al., 2017; Miller-Rushing et al., 2020; Theobald et al., 2015).

In many cases, organizations have increased investments in remote access to programs, data, and collections with the declared intention of increasing access to and benefits for groups who have been marginalized in the sciences (e.g., women, people with disabilities, and people of color) and who are underrepresented in associated activities, like national park experiences, work with museum collections, and participation in citizen science programs (Lendemer et al., 2020; NASEM, 2018, 2020; NPS, 2014b). Increasing access to data can disproportionately benefit scientists with fewer resources and can promote diversity of scientific research (Nagaraj et al., 2020). And remote education programs can allow more students to engage with national parks than could possibly visit in person. These goals and impacts of increasing remote access and providing more opportunities for engagement have clear significance for social justice—i.e., the commitment that all people should be equally respected and valued. However, realizing their social justice potential requires developing and structuring them with a contextual understanding of what social justice involves.

1.1. The relevance of social justice to conservation

Conservation is a value-laden environmental and social practice. Conservation ethics concerns identifying the full range of values that are at stake in conservation and how they should inform conservation practice and decision-making with respect to both goals and methods. Conservation ethics therefore requires considering the social significance of conservation initiatives, institutional structures, methods, and innovations. These social considerations are important on their own and they are also important to protecting biodiversity. People will more likely support conservation activities that promote social justice, environmental values, and the conservation of biocultural diversity, that is, the dynamic, place-based links between human cultural diversity and biological diversity (Bridgewater and Rotherham, 2019; Martin et al., 2016; Vucetich et al., 2018). Conversely, people will be more likely to resist conservation activities that appear to promote or maintain unjust social arrangements, regardless of the environmental benefits (Fanari, 2022; Redpath et al., 2015). Conservation ethics also concerns protecting and promoting environmental values, such as the protection of biodiversity and ecosystem functions. The most effective forms of conservation generally protect environmental values and advance social justice. In this paper, we focus on social justice elements.

Many people in the conservation community have prioritized treating people fairly and equitably. However, not everyone has access to the same environmental goods, not everyone shoulders the same burdens (or costs) associated with conservation practices, and not everyone is equally empowered and represented in decision-making. For example, there is concern that the main users of national parks and citizen science programs are well-educated, affluent white participants, and that underrepresented minorities do not benefit as much from the health, recreation, and learning opportunities, or from the outcomes of the science being done (NASEM, 2018; Pateman et al., 2021; Weber and Sultana, 2013; Xiao et al., 2021). Inequities such as these have contributed to tensions between the aims and methods of conservation organizations and those of social and environmental justice groups and Indigenous communities (Hernandez, 2022; Sandler and Pezzullo, 2007; Selemani, 2020).

During the COVID-19 pandemic, the conservation community has been challenged to more seriously consider issues of differential power, privilege, access, and vulnerability associated with race, gender, sexual orientation, ability, health, class, and their intersections. The conservation community recognizes that social justice requires dedicated efforts to increase inclusion and belonging within conservation practice and at all levels of conservation organizations (Envision, 2019; Foster et al., 2014; Smith et al., 2017; Tallis and Lubchenco, 2014). It also requires acknowledging and addressing past and present social injustices related to racism, sexism, and colonialism.

In some cases, organizations have deployed technologies to broaden overall access and increase remote access that may reflect incomplete consideration for social justice. For example, as natural history collections become available online and citizen science apps are developed, they may remain unknown or inaccessible to underserved groups, which may include groups who live where specimens were collected, where citizen science data are most sparse, or where well-designed citizen science projects could contribute to improving policies and living conditions. Further, educational programming, online datasets and resources, and some citizen science projects are only accessible to those with reliable Internet access or smart phones.

1.2. Are increases in remote access increasing social justice?

Our goal is to provide an approach to assess whether pandemic-driven expansion of remote access to conservation-related education programs, data, and collections is also advancing social justice. We describe a typology of justice-oriented principles to consider (Basl et al., 2021) and apply the typology to three distinct areas related to conservation: (1) remote access to US national park educational programs and data on park resources; (2) digitization of natural history specimens and their use in conservation and ecology research; and (3) remote engagement in citizen science (Fig. 1). We address two questions: Which justice-oriented principles are salient in which contexts or activities? How can those principles be best realized in those contexts and activities? We then identify steps that can be taken to advance social justice related to remote access to US national parks, citizen science, and museum specimens and suggest ways the conservation community can use this approach more generally.

2. Framework for assessing promotion of social justice in conservation

The commitment to social justice is underwritten by a value commitment, the equal worth and political standing of people (Rawls, 1971). Social justice is fundamentally about how to organize and conduct social practices, institutions, and structures consistent with that value, and conservation involves all of these. Thus, when it comes to social justice in conservation there is a general or overarching social justice principle: *all people should be equally respected and valued in conservation organizations, programs, projects, and practices*.

There are multiple ways in which this value and general principle intersect with conservation organizations and activities (Basl et al., 2021) (Table 1). Some of these ways concern the processes involved in conservation practice (procedural justice). Others concern the outcomes

Fig. 1. Images representing the conservation areas examined in this paper. Clockwise from top-left: national park rangers providing an online educational program from Everglades National Park (photo courtesy NPS, Denise Diaz), visualization of National Park Service air quality data (image courtesy NPS), digitizing herbarium specimens at the Central Michigan University Herbarium (image courtesy Anna Monfils), and a volunteer using the Nature's Notebook smart phone app to monitor plant phenology (image courtesy Brian F. Powell).

of conservation practice (distributive justice). Still others concern who is involved in conservation activities as participants and subjects (recognition justice).

This typology and these principles indicate the range of considerations that can be relevant to evaluating whether a conservation activity advances or undermines social justice. It is not meant to be exhaustive of all social justice considerations. For example, it does not capture all dimensions of intergenerational justice (Gardiner, 2021), but rather it is intended to provide robust resources for assessing conservation activities. These principles will not be equally applicable in all situations. In some contexts—such as conservation activities involving Indigenous lands or knowledge—reparative justice, equality of participation, and benefit-sharing might be highly salient. In institutional contexts—such as nongovernmental organizations (NGOs), governmental organizations, and universities—equality of opportunity and inclusion might be highly salient. In environmental remediation contexts, such as those involving contaminant removal, reparative justice and prioritizing the worst-off might be most imperative. In publicly funded conservation activities, such as government-funded research and national parks, equality of participation and equality of access might be the most important priorities for promoting social justice. Moreover, the principles can sometimes require compromises. For example, to promote reparative justice it is sometimes necessary to target policies or resources for communities that are or have been disadvantaged and disempowered. To accomplish substantive equality of opportunity and inclusion, it might be necessary to conduct outreach and co-create programs with members of groups historically excluded or underrepresented in conservation.

Thus, the question to ask about these principles is not which of them is correct or which is the most important social justice consideration. The questions are: Which principles are salient in which conservation contexts, situations, or activities? How can those principles be best realized in those contexts, situations, or activities? In the following sections we address these questions in the context of recent efforts to increase remote access to national parks, museum collections, and citizen science. We indicate the salient social justice principles in bold.

Table 1
Typology and examples of social justice-oriented principles applicable in conservation. Adapted from Basl et al. (2021).

Procedural	Distributive	Recognition
Non-discrimination Conservation practices and policies should not be biased against certain groups or treat people differently based on the groups to which they belong	*Equality of access* Everyone should be provided same/similar access to conservation benefits	*Inclusion* Conservation activities should not marginalize or exclude people or groups of people and should foster a sense of belonging
Equality of opportunity Everyone should have equal/similar chance of realizing success in conservation activities (e.g. in careers, funding, programs, etc.)	*Benefit-sharing* Everyone who contributes to a conservation activity should share in its benefits as should those who shoulder any associated burdens	*Reparative justice* Past wrongful harms should be addressed and not compounded through further harms or disadvantages from conservation activities
Equality of participation People should be appropriately empowered in decisions on conservation activities that impact them (or for which they otherwise have standing)	*Prioritizing worst-off* Outcomes should preferentially benefit those who are most vulnerable or in need	*Representational accuracy* People or groups of people should be consulted about their presentation in conservation-oriented activities, materials, or data

3. US national parks

3.1. Remote engagement of the public

3.1.1. Goals

The COVID-19 pandemic led to dramatic increases in remote public engagement with US national parks, as measured by visits to NPS web sites and online program offerings by NPS staff (Miller-Rushing et al., 2021). This engagement included individuals, families, and school groups who were not able to visit the parks in person. Online park programs can dramatically expand the ability of people to engage with national parks, including many audiences that have historically been excluded from national parks. Prior to the pandemic, NPS was increasing remote public engagement as a part of an effort to ensure that people's experiences with national parks are relevant, inclusive, active, and fun (NPS, 2014b). The agency aimed to achieve that goal, in part, by telling all Americans' stories, inviting the public to share their stories, improving accessibility of programs, and using social media, distance learning, and other technologies (NPS, 2014b; Washburn, 2020).

3.1.2. Salient social justice principles

Providing opportunities for remote engagement can increase **equality of access** to national park programs. However, there are obvious and significant trade-offs between remote and in-person engagement with national parks. It may be challenging for remote experiences to match the inspirational value of in-person experiences at national parks. But many people cannot engage with national parks in person, including some people with disabilities or health problems. Other people, disproportionately people of color, may not be aware of or may not feel welcome or included in many national parks, so may not visit parks on their own (Krymkowski et al., 2014; Weber and Sultana, 2013; Xiao et al., 2018, 2021). Remote engagement can provide an important way to engage these audiences and to provide opportunities to experience national parks and access educational programs. Remote engagement can also begin a longitudinal process to facilitate a sense of belonging and foster future in-person visits and experiences.

Strategies for providing remote access can benefit from more **inclusive participation** in the design of programs, if resources allow. In some cases, national park managers have convened culturally aware focus groups to evaluate interpretive material, programs, and other offerings to ensure that they reflect perspectives of local communities (Ryan et al., 2020). This focus-group approach is not the norm (Henry et al., 2020), but NPS is expanding its use (T. Watkins, pers. comm.). NPS also partners with NGOs and community organizations to engage target audiences. Evaluations suggest that this method can be successful and should be expanded (Santucci et al., 2014; Schultz et al., 2019). NPS has also increased use of social science to inform development of educational programs and content and to reach priority audiences and achieve intended educational outcomes. The agency hopes to further increase investment in social science to design, evaluate, and refine inclusive experiences.

Additionally, programs should **recognize diverse groups**. NPS is taking steps to promote **inclusion** within its programs, telling the stories of historically marginalized groups (NPS, 2014b). The agency also works to ensure that people are **accurately represented** in programs—often working with Indigenous groups and descendent communities to provide first-person narratives, for example, when describing Indigenous sites or traditions, thereby also promoting **equality of participation** (Newsom et al., 2021). In other cases, NPS has explicitly adopted a social justice goal for its educational programs (NPS, 2014a), engaging people with the country's natural and cultural heritage, including past wrongs such as displacement of Indigenous peoples, damage from pollution and climate change, and mistreatment of marginalized groups (Coslett and Chalana, 2016), which is a step toward **reparative justice**. As this example illustrates, the various dimensions of justice are often intertwined in ways that enable, indeed require, addressing many of them simultaneously.

3.2. Remote access to data

3.2.1. Goals

As a part of its responsibilities, NPS preserves specimens, documents, data, photographs, and many other records associated with each national park unit, particularly records related to understanding and managing natural and cultural resources. Since the 1990s, when NPS began its website NPS.gov, NPS has increased remote access to this information. This work sped up in 2009 when the US federal government launched an effort to make data held by federal agencies freely available online, an effort that began with executive actions (Executive Order 13642, 2013; Obama, 2009) and was later put into legislation (OPEN Government Data Act, 2019). The goals of providing online access to US federal government data include strengthening democracy, promoting government efficiency, contributing to economic growth, facilitating science and innovation, and improving people's lives (Executive Order 13642, 2013). These goals are similar to the goals of open data initiatives in other countries and the goals of the open data field more broadly (Nosek, 2017; Zuiderwijk et al., 2019).

NPS generally frames remote access to data as a part of enhancing stewardship of natural and cultural resources—i.e., using the latest scientific information to inform resource management (NPS, 2013b, 2016). The target audiences for these data include the general public, NPS staff, local and state governments, other federal agencies, scientists and scholars, Indigenous communities, NGO partners, and Congress (NPS, 2013b, 2016). Access to data increases the ability of researchers to study important conservation questions and can allow a broader participation in the research process (Nagaraj et al., 2020). The hope is that increased quantity and quality of research, conducted by more diverse researchers, can improve conservation outcomes (NPS, 2013b, 2016).

3.2.2. Salient social justice principles

Equality of access is the social justice principle most explicit in efforts to provide remote access to data, as reflected by federal law and policy (Executive Order 13642, 2013; Obama, 2009; OPEN Government Data Act, 2019). However, access for most people does not occur simply

by an agency making data available on a website. For remote access to satisfy its intended benefits, people must be able to find, access, interpret, and use data (Janssen et al., 2012; Pritchard et al., 2022; Purwanto et al., 2020; Wilkinson et al., 2016; Zuiderwijk et al., 2015). Data can be difficult to find because they are scattered in different repositories (e.g., irma.nps.gov/datastore, museum.nps.gov, npgallery.nps.gov) or because centralized repositories have overwhelming amounts of data or are difficult to navigate (e.g., data.gov, irma.nps.gov/datastore). People must also have the technology to access data, including the proper hardware, adequate internet bandwidth, and enough storage to download and hold data. People must be able to read the data in the format they are presented—people with vision impairments or who speak other languages may not be able to access much data posted online. Finally, to truly access data, people must also have the skills to interpret and use the data (Zuiderwijk et al., 2015). These skills can be difficult to gain.

NPS and other organizations are working to overcome these barriers by making it easier to find data, providing easier-to-understand metadata, following accessibility standards for online content, providing tools to work with and visualize data online, and summarizing key findings in web articles, videos, and other stories that are understandable for broad audiences. For example, the US federal government is required by law to make online resources accessible to people with disabilities, including employees and members of the public (Rehabilitation Act, 1973; section508.gov). NPS is also investing in easy-to-use and interpret online visualizations of key data (Fig. 1). However, considerable work remains to improve equality of access to data—much NPS data remain difficult to find and access.

Other salient social justice principles related to remote access to data include **equality of participation** in plans to make data accessible, **sharing in the benefits** (and avoiding harm) that result from remote access to data, and **representational accuracy** in data. Some open government and open data efforts explicitly include civic groups in co-creating plans for making data accessible (Dawes et al., 2016; Sieber and Johnson, 2015). This co-creation process brings more voices to the planning process. If done well, equality of participation in planning can improve the ability of data access efforts to meet their goals, benefit more of the intended audiences, and overcome obstacles that might prevent some audiences from accessing data. NPS has primarily engaged resource managers and researchers in planning for data access. There is room to expand this to other likely users of NPS data, including educators and community organizations. This is happening for some NPS programs, such as the Dragonfly Mercury Project (e.g., https://www.nps.gov/articles/dragonfly-mercury-project.htm).

Policies governing what data are shared and how people can use data can prevent exposure of sensitive data (e.g., culturally sensitive sites, Indigenous knowledge, endangered species, human subject data) and can help ensure the public benefit of resulting uses of the data (e.g., public access to resulting analyses, benefit-sharing for commercial success resulting from data, and avoiding use of data to harm people and conservation goals). It is also critical that the data accurately represent the people, natural, and cultural resources that they describe. NPS has policies protecting sensitive data and ensuring benefit-sharing in many circumstances. For example, NPS does not share information about specific locations of endangered species, archeological sites, or commercially valuable resources (NPS, 2006). NPS is also required to enter into benefit-sharing agreements with research organizations when research results may become commercialized; benefit-sharing contributes to the preservation and management of park resources that are available for study and public enjoyment (NPS, 2013a). It is less clear how representationally accurate (Table 1) the data are—that question deserves further research and consultation with represented or otherwise impacted communities and groups.

4. Digitization of museum specimens

4.1. Goals

For more than two decades, the biodiversity community has digitized natural history specimens and the information associated with them (Nelson and Ellis, 2019). As a result of these efforts, online repositories of specimens and associated metadata like the Global Biodiversity Information Facility (GBIF) and US-based Integrated Digitized Biocollections (iDigBio) provide access to tens of millions of specimens to anyone with access to the internet (Nelson and Ellis, 2019). These records have facilitated an explosion in publications using them to address research questions related to conservation, ecology and evolution, including grand challenge questions (Heberling et al., 2021; Losos et al., 2013; Soltis and Soltis, 2016). The COVID-19 pandemic limited in-person access to museum collections and the ability to do some types of fieldwork, further speeding the digitization of specimens and metadata and increasing the use of digital collections (Paul and Soltis, 2020).

Facilitating research is the primary aim of most of these digitization efforts (Hanken, 2013; Nelson and Ellis, 2019). Social justice-related goals are mainly aimed at digitizing records from large and small collections around the world, providing online access to records, and improving educational opportunities. For example, an updated strategy for digitization of US biodiversity collections describes the importance of strengthening international collaborations and filling in gaps in specimens that have been digitized to date; and the value of online specimen information for supporting formal and informal education and helping to recruit a more diverse workforce in biodiversity science (Lendemer et al., 2020; NASEM, 2020).

4.2. Salient social justice principles

Equality of access is the social justice principle most explicit in efforts to provide remote access to natural history collections data. However, even if digital natural history collections data are freely available and follow FAIR principles (Findable, Accessible, Interoperable, and Reproducible) (Wilkinson et al., 2016), many barriers prevent equality of access. These barriers include those described for remote access to national park data—e.g., lack of awareness of data portals, complex data search portals that are difficult to navigate, and skills needed to successfully acquire, clean, analyze, and interpret collections data correctly in conservation applications—as well as the fundamental challenge of reliable internet access. Because collections data are explicitly aimed at international audiences, language-related barriers are particularly important. Digital information about specimens might only be accessible from an English-language database or aggregator, for example, even if the physical specimens were collected in non-English speaking parts of world. This can make it difficult for researchers to access "their" data and data relevant to their local organisms. GBIF has provided access to data in a number of languages via gbif.org and this model could be implemented more widely.

Equality of participation and **benefit-sharing** are also relevant social justice principles. Digitization efforts have largely relied on government grants and institutional funding. Thus, collections at smaller institutions and in countries with smaller science budgets (e.g., those outside of Europe, Australia, and North America) have largely been excluded from the digitization revolution. Small collections and those housed at minority-serving institutions provide deep local knowledge and information that is often missing from larger collections with more funding (Glon et al., 2017; Marsico et al., 2020), though large digital collections are also being leveraged to repatriate specimens (Canteiro et al., 2019). The data in these smaller collections are critical to conservation at local scales and are an important aspect of social justice in digitizing collections (Monfils et al., 2020). Future digitization efforts could consider the **prioritizing worst-off** principle and prioritize funding for specimens stored by small collections and from underserved

communities. This prioritization could help ensure that digitization efforts benefit organizations and communities that are most vulnerable and where specimen data might have the greatest benefit. Digitization of small collections can have the added benefit of bringing recognition and added value to institutions, potentially allowing them to leverage research gains into funding and research opportunities.

The collections community is working to improve **representational accuracy** in collection records (Lendemer et al., 2019; NASEM, 2020). Historically, many contributors have gone unrecognized in the data life cycle of natural history specimens (Thiers, 2020). These people include technicians, volunteers, spouses, local guides, and Indigenous communities. These hidden figures often hold identities marginalized in science and the erasure of their contributions is a part of the colonial legacy that persists in natural history museums today. Examples of these efforts include the Biocultural (BC) and Traditional Knowledge (TK) Labels projects (Anderson and Hudson, 2020). Developed through sustained partnership with Indigenous communities across multiple countries, "the [BC and TK] Labels allow communities to express local and specific conditions for sharing and engaging in future research and relationships in ways that are consistent with already existing community rules, governance and protocols for using, sharing and circulating knowledge and data" (https://localcontexts.org/labels/traditional-knowledge-labels/). This initiative offers the possibility for "substantive change in how biological and cultural data from Indigenous contexts can maintain cultural relationships and responsibilities, connecting Indigenous people and places over time with data and in the metadata and with future researchers for the cultural, ecological and commercial benefit of Indigenous peoples" (https://www.enrich-hub.org/bc-labels). BC and TK labels provide researchers a point of entry for integrating Western science and Indigenous Knowledge in ecology and conservation. Appropriately done, direct and continued engagement with people and communities can provide particularly rich and valuable impacts (Jessen et al., 2022).

Museums are also grappling with **reparative justice**. Museums have a long history of colonial practices that have involved expeditions funded by wealthy European and North American countries, institutions, or individuals. These expeditions have filled predominantly European and North American collections spaces (https://ibol.org/resources/natural-history-collections/) with hundreds of years of specimens from around the world. The contrast between the location of the world's largest natural history collections and the locations where the specimens were collected is dramatic, with a great number of specimens from South America, Asia, and Africa housed outside of those regions (Das and Lowe, 2018). This practice has created a record of biodiversity but has prevented scientists, educators, and policy makers from localities across much of South America, Africa, and Asia from having ready access to many physical specimens from their local ecosystems. It is only relatively recently that specimens and collections are being repatriated back to the countries in which they were collected. In the absence of repatriation, or while repatriation is given due consideration, digitization of specimens can help provide access to locally relevant specimens, even if the physical specimens are held far away, but barriers to remote access must be minimized. The Reflora Virtual Herbarium program in Brazil, for example, is working with herbaria around the world to improve digital access to specimens collected in Brazil (https://floradobrasil.jbrj.gov.br/reflora/PrincipalUC/PrincipalUC.do). The program has contributed to more than 800 publications, roughly half conservation-related, and has informed conservation actions in Brazil (Canteiro et al., 2019). Remote access to information should supplement, not replace, the repatriation of physical specimens along with the development of physical infrastructure to house the specimens.

4.3. Overcoming barriers

Many collections-based organizations are working to overcome these barriers by promoting the digitization and open-access of collections data, providing tools (some freely available and others that require payment) to work with and visualize data online, and creating trainings and tutorials via web articles, videos, webinars, and teaching materials that are understandable for broad audiences. The biodiversity data community has also developed and expanded ways that educators can engage their students in collections-based learning. For example, groups such as Biodiversity Literacy in Undergraduate Education (BLUE; biodiversityliteracy.com) are creating and sharing teaching modules for using digital natural history collections data in undergraduate courses. The Biological Collections Ecology and Evolution Network (BCEENet; https://bceenetwork.org/) is sharing course-based undergraduate research experiences that use digital natural history collections data as a gateway for research experiences for undergraduates. iDigBio (idigbio.org) offers standalone training workshops as well as symposia, workshops and "Data Help Desks" in association with other events like the annual Botanical Society of America and Ecological Society of America conferences that are aimed at providing field-specific or even personalized assistance with data access.

During the pandemic many of these educational and professional events were held online, increasing the number and diversity of participants. For example, the Digital Data Conference (https://www.idigbio.org/tags/digital-data-conference) attracted 595 participants representing 31 countries in 2020 and 439 participants representing 40 countries in 2021. This represented more than twice as many participants and more than three times as many countries than had participated in previous in-person conferences. The online conference still presented challenges for participation, such as time zones, reliable internet access, and the difficulties for networking, which is particularly important for people new to the community. In the future, continued improvements to online conference design and streaming services, as well as the ability to provide options such as hybrid virtual and in-person events, may help alleviate some of these challenges. Many organizations and societies support participants directly to attend meetings, and these efforts could be expanded.

5. Citizen science

5.1. Goals

Citizen science—also known as public participation in scientific research, participatory action research, or community science—is the involvement of the public in scientific research, whether driven by communities or by professional scientists (Eitzel et al., 2017). Citizen science engages millions of volunteers and adds billions of dollars of value to scientific research every year (Theobald et al., 2015). Participants, researchers, and communities benefit from citizen science by exchanging ideas and perspectives, learning new skills, and translating results to actions that benefit science, communities, and individuals (Charles et al., 2020b; NASEM, 2018; Shirk et al., 2012). Citizen science also allows researchers to expand the range and sampling intensity of research projects and address questions that cannot be answered using other methods (McKinley et al., 2017; Resnik et al., 2015).

The goals of citizen science projects vary dramatically depending on the goals of the organizers. Goals generally fall into three main categories: outcomes for research (e.g., scientific results), outcomes for individual participants (e.g., learning new skills or knowledge), and outcomes for social-ecological systems (e.g., influencing policy, taking conservation action) (Shirk et al., 2012). Projects can focus heavily on one of these categories or can simultaneously aim to achieve goals in all three areas. For example, one citizen science project might encourage people to submit biodiversity observations from around the world to improve understanding of species distributions. In another project, scientists might work closely with communities to identify sources of pollution and take actions to eliminate them. Because of this variability, it is difficult to generalize across citizen science projects. Each of the social justice principles described in Table 1 is salient to some citizen

science projects, but their salience varies depending on project goals and target audiences.

The COVID-19 pandemic caused many citizen science projects to minimize in-person interactions and emphasize remote participation through smartphone apps and web interfaces (Crimmins et al., 2021; Kishimoto and Kobori, 2021). Remote participation in citizen science has a long history, and growth in remote participation is generally recognized as one of the primary contributors to the huge increase in citizen science participation and scientific outputs over recent decades (Bonney et al., 2014; Miller-Rushing et al., 2012). The pandemic sped the trend toward remote engagement. Some citizen science programs that have robust apps and online platforms, such as eBird and iNaturalist, experienced increases in participation during the pandemic, especially in heavily populated areas (Basile et al., 2021; Crimmins et al., 2021). These increases in remote participation can enhance the ability of citizen science projects to achieve some social justice goals, but can also present challenges. Here we describe a subset of remote engagement situations where particular social justice principles are most salient, and we describe work being done to realize them in practice.

5.2. Salient social justice principles

Equality of participation is among the most discussed social justice principles for citizen science (NASEM, 2018; Pateman et al., 2021). Many citizen science programs have an explicit goal of increasing participation in science, particularly the participation of groups underrepresented in science (NASEM, 2018). However, citizen science participants in the United States are often overwhelmingly white, affluent, and well-educated, and therefore do not represent the general population (Pateman et al., 2021; Rutter et al., 2021; Scott, 2021). For example, a study of eBird participants in urban areas (who used the eBird app to contribute observations of birds) found that participants were primarily from middle income areas; participants from lower income areas were underrepresented (Perkins, 2020). Such imbalance in participation can result in uneven data collection: in the eBird study, biased participation led to spatial bias in the bird observations reported. To address these imbalances, citizen science designers, researchers, participants, and other stakeholders should consider the interests and priorities of underserved communities during all phases of design and implementation (NASEM, 2018). For example, organizers could target underserved communities in the design of projects to ensure that community priorities are met and barriers to participation are overcome (Cooper et al., 2021). Working with communities on project design is a common feature of community science or co-created and collaboratory projects (Charles et al., 2020b; Shirk et al., 2012). Actions might include supplying necessary technology or training to participants, adding community-driven goals to the project, incorporating community expertise, or adapting the project to meet local cultural norms (Chesser et al., 2020).

Equality of access, **benefit-sharing**, and **inclusion** are also the subject of much discussion within the field of citizen science. For example, it is important that participants and other stakeholders in citizen science projects can access data from projects to which they contribute, that participants are credited and share in ownership of the data, and that data are handled responsibly to prevent harm to participants and conservation goals (Christine and Thinyane, 2021; Resnik et al., 2015). Sharing the results of citizen science projects can be a challenge if processing data and publishing results are delayed (Riesch and Potter, 2014; Theobald et al., 2015). Communicating findings to project participants in ways that are useful for participants—whether to achieve scientific, educational, or social-ecological goals—can require specialized communication skills (Alender, 2016). Project updates and results might be conveyed through newsletters, distributed in print or via email, posting on blogs and websites, or community meetings. Two-way dialogues with participants and community members might improve interpretations of results and how they might best be applied to address conservation issues in line with community and participant priorities and goals. Or community members might co-lead projects, which can further improve communication (Charles et al., 2020b). The USA National Phenology Network (usanpn.org), for example, facilitates this type of communication by sending regular newsletters, developing interactive visualizations, publicly recognizing participants, and encouraging regional campaigns in which local organizations apply the network's standard phenology monitoring methods to address issues of local and regional interest (Crimmins et al., 2020).

Benefits from citizen science projects often accrue primarily to the professional scientists involved. These benefits can include grant funding, scientific publications, and prestige. Many projects also provide benefits to participants and communities, such as empowering more people to learn about the relevant scientific processes and engage in conservation decision-making, and provide deeper meaning for participants (Aristeidou and Herodotou, 2020; Bonney et al., 2016; Dhillon, 2017). But these benefits can be more difficult to share when programs rely on remote participation. Organizers must intentionally design projects to share benefits broadly and inclusively, whether by improving learning outcomes for participants or addressing conservation issues important to communities (NASEM, 2018). Thriving Earth Exchange (thrivingearthexchange.org), for example, trains scientists to work with communities to address environmental problems at local scales. Problems can include flood mitigation, greenhouse gas emission inventories, air quality assessments, and ecosystem restoration. In some cases, the interactions between scientists and communities are entirely remote. The training and guidance that Thriving Earth Exchange provides helps scientists and communities to establish relationships, clear goals and communication strategies, and ensure that projects benefit all participants (Fig. 2). These projects exemplify how deliberate design, training, and use of online tools and communication can facilitate deep engagement, dialogue, and benefit-sharing between scientists and communities.

6. Is remote access advancing social justice?

Each of the sections above describes enormous potential for remote access and engagement to advance social justice in and through conservation. The pandemic highlighted this potential—limited in-person interactions required rapid expansion of remote access and engagement in many aspects of conservation work. Many people benefited from remote access, and much new science was done (Crimmins et al., 2021; Miller-Rushing et al., 2021; Paul and Soltis, 2020).

However, our discussions of remote access to national park education programs and data, museum specimens, and citizen science also show that simply increasing use of information technology and remote interactions in conservation does not itself advance justice. Technology often restructures the activities into which it is introduced and is a form of social power (Leopold, 1949; Sandler, 2020; Winner, 1980, 1983). Technological intensification in a field frequently advantages those who are already well resourced and creates new forms of appropriation and exploitation of those who are not as empowered or technologically enabled. For example, the largest museums in wealthy countries fund many digitization programs, which benefits researchers from around the world without access to physical collections, but the large museums and researchers from wealthy countries tend to benefit most from specimen digitization. And citizen science participants tend to skew toward white, affluent, and well-educated (Pateman et al., 2021; Rutter et al., 2021; Scott, 2021).

As a result, advancing social justice is not merely a matter of increasing the use of information technology and remote access in conservation. It is also a matter of defining the role that information technology and remote access should play in conservation to advance social justice. It requires attentiveness and thoughtfulness regarding what justice requires in particular contexts; and it requires socially,

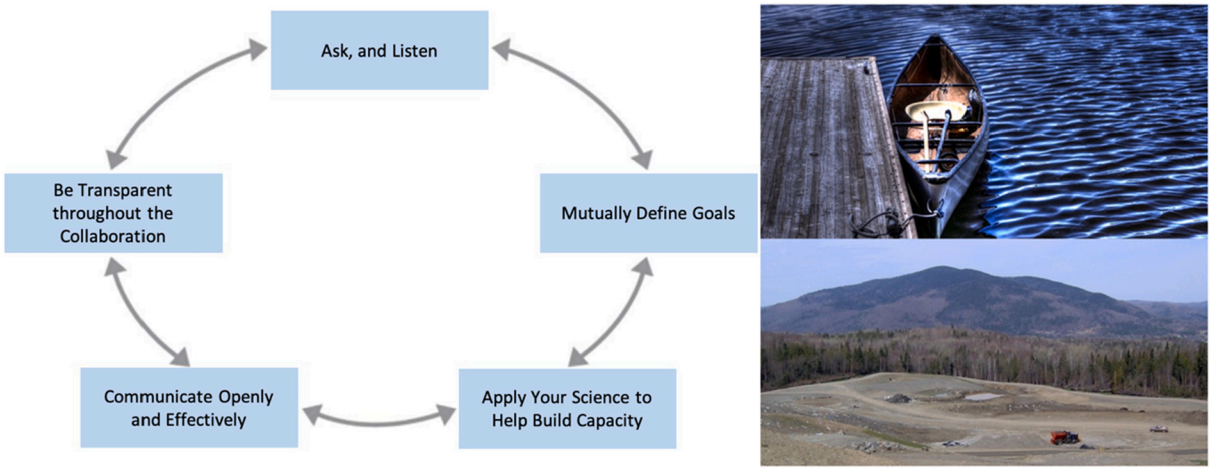

Fig. 2. Illustration of the Thriving Earth Exchange approach to community-driven science, and images of two Thriving Earth Exchange community projects: (top) monitoring water quality in the Salton Sea, a landlocked saltwater lake in southern California, and (bottom) remediating groundwater pollution to prevent contamination of an ecologically important marl pond in New Hampshire. Images adapted from the American Geophysical Union Thriving Earth Exchange.

culturally, historically, and economically sensitive design of technologies, programs, and policies (Mathiesen, 2015; Pacey, 1985). Achieving social justice aims also requires assessing programs and initiatives to determine if they are achieving inclusion, access, participation, benefit-sharing, representational and other aspects of social justice (Table 1). Managers must then revise programs and initiatives when they could do better or when evaluations identify barriers to success. All of this, of course, requires commitment, resources, expertise, and partnership. Promoting social justice in conservation—just like promoting social justice in any context—is not easy.

We hope that this article will stimulate discussion among conservationists and ecologists about addressing issues of social justice, particularly in the context of technological expansion. As evidenced by policy and strategic planning documents, organizations intend for remote access to data, education programs, specimens, and citizen science programs to increase social justice, including principles described in Table 1 (Charles et al., 2020a; NASEM, 2018, 2020; NPS, 2014b; OPEN Government Data Act, 2019; Shirk et al., 2012). We suspect that many people implementing these programs may lack training and awareness for how to assess the effectiveness of such projects to meet social justice goals and how to best adjust projects to overcome shortcomings. Social justice may be a "hidden value" in many projects that is not explicitly addressed. We hope that our framework for thinking about social justice will provide a resource to help analyze and assess the social justice dimensions of conservation programs, institutions, practices, and policies, including and beyond those related to remote access.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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