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A set of principles and practical suggestions for equitable fieldwork in biology.

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Abstract

Field biology is an area of research that involves working directly with living organisms *in situ* through a practice known as “fieldwork.” Conducting fieldwork often requires complex logistical planning within multiregional or multinational teams, followed by collaborative research led by one or a few of the core team members. However, existing power imbalances stemming from geopolitical history, discrimination, and professional position perpetuate inequities in the context of these research endeavors. After reflecting on our own research programs, we propose four general principles to guide equitable, inclusive, ethical, and safe practices in field biology: Be Collaborative, Be Legal, Be Safe, and Be Respectful. Although many field biologists already structure their field programs around these principles or similar values, executing equitable research practices can prove challenging and requires careful consideration, especially by those in positions with relatively greater privilege. Based on experiences and input from a diverse group of global collaborators, we provide suggestions for action-oriented approaches to making field biology more equitable under these guidelines, with particular attention to how those with greater privilege can contribute. While we acknowledge that not all suggestions will be applicable to every institution or program, we hope that they will generate discussions and provide a baseline for training in proactive, equitable fieldwork practices.

Significance Statement

Parachute science, harassment, and discrimination in biological fieldwork perpetuates global inequalities in resource investment and career advancement. Many biologists are actively engaged in dismantling these inequities, yet there is no general set of best practices for biological fieldwork. Here we present four organizing principles that are grounded in relevant literature, evidence-based practices, and input from field biologists representing countries and cultures from around the world. The suggested actions, considerations, and tools included herein can be useful to anyone, whether they are building a new field program from the ground up or implementing small changes in long-standing collaborations. We believe that following these principles will help promote positive, reciprocal experiences that encourage diverse participation in field biology and facilitate collaborations between communities and researchers.

Main Text

Introduction

Field biology, the practice by which investigators seek out organisms in their natural habitats to collect samples and associated materials, perform experiments, and record natural history observations, is essential for the description, analysis, and conservation of biodiversity (1). Fieldwork not only provides foundational materials in the form of vouchered and unvouchered biological samples, but it also produces vast amounts of scientifically valuable data on species’ distributions and abundances, habitat characteristics, environmental measurements, ecological interactions, and behaviors (2, 3). Moreover, voucher specimens obtained through fieldwork are invaluable for scientists aiming to quantify the effects of historical changes in climate, pollutants, diseases, and other features of the environment on biodiversity (4–6). The value of natural history collections to the broader research community is only increasing over time, as recent collection digitization initiatives have made remote inspection of the world’s biodiversity possible for anyone with internet access (7–11). Given the ongoing declines of global biodiversity (12, 13), research that incorporates natural history collections and *in situ* field data have garnered sustained interest (14). Thus, field studies continue to be essential for the advancement of

organismal, ecological, evolutionary, and conservation biology, while also being fundamental to the education of students at all levels.

Although we find tremendous value in field-collected data and conduct fieldwork extensively in our own research programs, we recognize that this activity and other practices fundamental to the scientific enterprise have been shaped by power asymmetries tied to the foundations of the modern world (15, 16). For example, the early history of biodiversity sampling was intimately associated with colonialist activities. Colonial nations and later powerful countries sent scientists around the world with the aim of furthering scientific progress, but also often with capitalist goals and resource extraction in mind (17–20). Although many field biologists today are aware of this inequitable history and are working to make field biology more ethical, parachute science – a non-reciprocal practice wherein scientists conduct research with local help and then publish those data without further involvement of those communities – remains common (17, 21–23). Moreover, research programs are often highly asymmetrical in terms of how the scientific benefits (e.g., position of authorship, access to funding, etc.) are distributed among team members (23–27).

The conscious need to confront power asymmetries gained traction in the US after the murder of George Floyd in 2020, with a focus on addressing inequities for people of color, people with disabilities, women, Indigenous people, members of the LGBTQ (Lesbian, Gay, Bi, Trans, Queer) community, and others (e.g., 28, 29). These conversations opened spaces to re-evaluate aspects of current scientific practice that perpetuate inequalities. Fieldwork – the focus of this piece – is one such area that we believe would benefit from additional introspection. We are optimistic that self-reflective and action-oriented discussions, combined with proactive approaches to planning research, will help address existing inequalities. We share this document with the hope that it will be useful to a broader audience conducting research domestically or internationally, especially when working in locations where local communities and scientists are less privileged than the organizing institution. Nevertheless, we acknowledge that there may be equally valid alternative guidelines (i.e., this guide is not intended to be prescriptive, and may not be appropriate for all scenarios). To facilitate the use of these principles, we also provide a set of potential actions and considerations, a permit flow chart and checklist based on our experiences with US regulations, and a field safety plan template (see *SI Appendix*). We conclude with a set of open questions that arose during the creation of this document. Intentional planning that emphasizes inclusivity and equity in field biology is fundamental to the set of principles proposed herein.

Core Principles for Equitable Fieldwork

In the last decade, many research institutions and scientific conferences have adopted codes of conduct to clarify community norms and provide guidelines for reporting harassment or misconduct (e.g., 30–32). Most scientific disciplines that work directly with human participants, such as public health and anthropology, have established guidelines for ethical fieldwork (33–37). In this spirit, and through assessment and reflection of our own field programs and those of global collaborators, we created a set of four general principles for biological fieldwork to help researchers engage proactively in equitable and inclusive practices (Box 1, Figure 1).

For institutions and research groups, we envision that these principles can foster discussions of field practices and act as a basis for generating or revising codes of conduct and designing pre-fieldwork training programs. For students or researchers beginning a field program, we hope that these principles provide a helpful starting point for creating individualized fieldwork plans that are intentionally ethical. By discussing how to apply these principles to their own field research, members of field teams can increase

awareness about how research activities affect other people(s) and communities, especially in contexts where pre-existing power imbalances and implicit biases strongly affect collaborations, research products, and funding outcomes. While much of our experience comes from fieldwork in academic and natural history museum settings, and mostly in the context of fieldwork led by or in collaboration with researchers from the USA (see *SI Appendix,* Positionality Statement), we focus on principles that can apply to a broad array of disciplines that rely on field biology. We also understand that fieldwork is diverse and involves many different types of communities and cultures, and that not all suggestions are appropriate or feasible in every circumstance.

Box 1. A set of principles* to promote equitable fieldwork.

Be collaborative: We embrace collaborative science and fieldwork practices with our partners, field teams, and the communities with whom we work. Inequitable involvement of local collaborators can perpetuate historical power imbalances, erode trust in the scientific enterprise, and limit the sense of co-ownership of the science being produced. In planning fieldwork, we encourage colleagues to consider historical power imbalances and strive for equity in collaborations and inclusivity in field teams by communicating clearly, compensating appropriately, and sharing samples, data, and research products equitably.

Be legal: We commit to obtaining all necessary permits, authorizations, and land permissions, and to following all legal guidelines and requirements. Legislation helps circumvent some aspects of biopiracy and exploitation, and functions to systematically track and regulate biological material. We aim to be vigilant against expropriating knowledge and materials, both by following local regulations and by respecting local authorities and cultural customs.

Be safe: We work proactively to promote a safe physical and emotional working environment for all members of research teams and local communities with clear guidance and communication. Field safety takes many forms and risk is not evenly distributed across team members. We support creating field safety plans that include general guidelines for safety (e.g., working in pairs), emergency protocols, and protocols addressing Sexual Violence and Sexual Harassment. We ask our team leaders to solicit feedback and communicate clearly with all team and community members. We further urge team members to be cognizant of unintentionally spreading potentially detrimental pathogens or invasive organisms.

Be respectful: We invest time and effort in learning about and respecting local history and communities, and in prioritizing local sovereignty. Long-lasting and reciprocal relationships founded on mutual respect are often crucial for fieldwork. By learning about local history and culture, we seek to understand norms and acknowledge diverse experiences and understandings of the world. We also strive to prioritize local community decisions, to promote modification of our research plans accordingly, and to plan research in a way that has lasting positive impacts, as judged by local communities.

*These principles are not meant to be ordered in any specific way.

Be collaborative: We embrace collaborative science and fieldwork practices with our partners, field teams, and the communities with whom we work

Equitable collaboration bolsters the scientific enterprise, and awareness of the sociopolitical history of a region in relation to scientific practices can be invaluable to fostering successful collaborations (38). The involvement of local collaborators in logistical but not intellectual aspects of research can perpetuate historical power imbalances and exclude researchers with more marginalized identities from a sense of co-ownership of the science being produced (23, 39). Such asymmetries may erode trust in the scientific

enterprise and deter local interest in international collaboration (21). Disrupting these structural imbalances requires a constant effort by everyone – but especially by those who have historically held positions of influence globally and/or locally – towards decentralizing one's own perspective and creating spaces for new perspectives in science. Reciprocal collaborations that equitably include people and scientists from host regions can help foster inclusivity and a diversity of ideas in field biology (40). Below are some suggestions to foster intentionally reciprocal and collaborative research among scientists from different regions.

Figure 1. Four principles to promote equitable fieldwork. Art by Camila Pacheco Bejarano.

Communication among colleagues. We encourage team leaders to discuss the research project, individual responsibilities, and expected products before, during, and after fieldwork, allowing collaborators to shape the fieldwork and research. It is also important to establish regular communication among collaborators throughout the research process, not only for specific trips to research sites. Flexibility, fairness, and honesty about research goals and limitations is key during these conversations, yet perceptions of fairness can be biased by one's historical viewpoint and institutional norms. Moreover, desired outcomes and evaluation systems may differ among collaborators. For example, countries and institutions (e.g., academic vs. governmental) differ in whether they reward researchers for being first rather than last author, for having many rather than a few high-impact publications, or for bringing in infrastructure and funding. Understanding each parties' desired outcomes at the outset, and discussing any changes as the project progresses, can help promote equity in scientific advancement for all team members.

Forming inclusive research teams. We encourage Principal Investigators to reflect on the diversity of their field teams and to provide access to training and leadership opportunities for individuals of identities historically excluded from fieldwork (e.g., women, LGBTQ+, Black, Indigenous, People of Color [BIPOC], disabled individuals, low-income communities). Examples include extending invitations to go on expeditions, adopting inclusive hiring practices, and providing students with funds to conduct their own field-based projects. Students from regions where fieldwork is being conducted can benefit greatly from financially supported field research opportunities, especially if they are undertaking thesis work that might otherwise need to be financed with personal funds. Likewise, supporting graduate program applications from students of regional collaborators and inviting regional collaborators to serve on student committees can foster bilateral exchange of trainees, skills, and knowledge. In addition, involving social scientists (e.g., anthropologists and sociologists) in research teams, from planning to generating research outputs, can be a useful strategy for spotting power imbalances at work and considering inclusion and equity at all stages of field research. Equitably structured collaborations can diversify and enhance the research programs of both host and visiting research groups by providing new ideas that draw on different scientific and cultural expertise.

Compensation. Planning ahead for fair compensation of field assistants and other team members is necessary to conduct truly equitable fieldwork. Indeed, equitable compensation can help avoid sentiments of bias or resentment among team members (41). We suggest working with collaborators in advance to set salary rates that reflect local norms and are fair for the work being undertaken. When recruiting assistants to find specific organisms, we recommend paying by the hour or day rather than by the number found. It is important to pay for work even if people do not succeed in their search. Other less direct methods of compensation could also be considered in tight budgetary situations. For example, providing training, equipment, or resources that are in line with local needs (e.g., mosquito netting, boots, repellents, etc.) can be extremely valuable for researchers and their communities. Overall, communication with local collaborators about how their research programs can be supported shows reciprocity and helps reinforce the value of host-region research (see also Box 2).

Sample and data management. An agreement among parties on how to equitably share and store research products such as specimens, samples, tissues, and data is recommended *prior to* conducting fieldwork. We strongly recommend that all products of fieldwork and their associated metadata – vouchered specimens, tissue or blood samples, audio or video recordings, and other materials – be deposited in a collection where they will be taken care of and made accessible to others. Research materials that are held in private or non-curated collections (e.g., personal lab freezers) risk getting lost or discarded. When permits require information about where materials will be deposited, researchers should communicate with personnel at the intended repository during the permit application process to confirm that they are able to receive and house the materials. Given ongoing financial challenges faced by museums (42, 43), funding could be provided to help with curation and support training students in museum practices (44).

Material sharing or repository agreements often require that specimens and samples be deposited or subdivided among participating institutions involved in the collaboration. These agreements should be equitable and reciprocal and have the added benefit of insuring against the risk of catastrophic loss. Pertinent examples include the destruction of the California Academy of Sciences in the 1906 San Francisco Earthquake, the loss of museums in Dresden, Hamburg, and Manila during World War II, the destruction of the collection at Museo La Salle in Bogotá during the 1948 riots, and the more recent losses by fire of priceless specimens, fossils, and cultural artifacts in Portugal, Brazil, South Africa, and India. Special consideration should be given to the disposition of type specimens. Holotypes are best deposited in the country of origin if a well-supported national collection exists, while depositing paratypes or topotypes across multiple collections facilitates access to comparative material and protects against

complete loss of reference material for a species. To increase access to materials stored outside of their countries of origin, museums could adopt a policy of prioritizing loans of collection materials (or returns in cases of unethical possession) to institutions from those respective countries. In countries or regions without a collection, collaborators affiliated with a museum can proactively hold specimens in trust until a collection is established. Further, collaborators can help set up local teaching collections as a way of educating students and the community about local biodiversity and potentially generating institutional interest in starting a research collection.

Researchers also can take steps to ensure that field data are documented in an accessible and reproducible manner (45, 46) and shared with collaborators. Digitization and/or duplication of field notes and data provides a timely, relevant resource to all parties about the nature and scope of the recent work. In addition, collaborators can help implement collection management systems that follow Darwin Core data standards (47), establish portals that provide access to regional biodiversity resources (e.g., 48), and register museums with the national CITES authority to facilitate scientific exchange of CITES-listed species (see *SI Appendix,* Scientific Permit Checklist). Collection management systems can track the current location of specimens (which is important if materials from a field project are divided among multiple institutions), manage sample loans or exchanges, link to publications resulting from the research, and protect sensitive data (e.g., precise locality data for endangered species), among other features.

Species descriptions. When describing new species, it is worth acknowledging that local people are often familiar with the behavior and biology of these organisms long before they are described for science (49–52). Including local names, terms, and knowledge (53), and/or working directly with local communities to select new species names (54), are simple ways to honor and integrate communities with scientific pursuits and to generate local pride and awareness that can dovetail with conservation efforts (55). Reviewers and editors of manuscripts that describe new species can suggest incorporating local knowledge into new species descriptions if such data are not already included.

Rethink authorship criteria. Recent proposals have been made to expand the CRediT authorship criteria system to recognize that collaborators who secure permits, foster important relationships and act as the responsible authority in the field are often integral to project success and thus deserve to be involved in the writing process and offered co-authorship (23, 56). Additionally, community scientists who help collect data can be included as authors (56, 57). It is important to have a conversation with local collaborators and community members to ask what attribution or credit they would value most, and to recognize that authorship may not always be meaningful. Likewise, it is important to understand that local guides, assistants, and collaborating team members may not request authorship due to social or cultural norms surrounding workplace hierarchy (23). In general, we recommend discussing and working collaboratively with local team members to decide on authorship and contributions to any research products based on field studies.

Publishing and sharing research results. Language can present a substantial barrier to sharing and obtaining scientific knowledge (58–60). One solution is for investigators to translate research results into local language(s), free of charge. Translated copies of manuscripts could be included as supplementary published material, and resources such as DeepL or Google Translate can help facilitate these efforts for some languages. Collaborators who are fluent in English or other languages also can proofread manuscripts written in English if needed (61). Further, it is helpful to directly share PDF copies of papers (following publisher agreements) on sites such as ResearchGate, or to consider other legal ways of distributing papers so that they reach in-country members (e.g., as part of research permit reports). In addition to sharing PDFs, researchers can consider publishing open-access or posting preprints on public archives. Normalization of these practices could provide an invaluable resource to local scientists and

policy makers and demonstrate academic goodwill that is locally impactful and strengthens international collaboration (59).

Be legal: We commit to obtaining all necessary permits, authorizations, and land permissions, and to following all legal guidelines and requirements.

A key to successful fieldwork entails following the laws, local customs, and decisions of the country or region where you are working, in addition to institutional requirements such as Animal Care and Use protocols. While legality does not always translate to justice, many legal frameworks are geared towards creating symmetrical and ethical relationships between the parties involved. For centuries, researchers and collectors from high-income countries traveled around the world to collect and export specimens to their home institutions for study or profit, without local authorizations or credit to local contributions (18, 19, 62). The establishment of international laws and regulations partially leveled the playing field by requiring that all scientists obtain the necessary permits and honor expectations for collaborative science. Unfortunately, the practices of conducting research without appropriate permits, working with specimens of questionable origins, and bribing officials to circumvent regulations continue today (21, 40, 63, 64). These approaches are not only illegal and unethical, but they also threaten biodiversity, deepen existing power imbalances, and create wariness among researchers and between science and society. Researchers who follow local laws and regulations tend to honor ethical research practices and are likely to make ethical decisions where legality is unclear, thus avoiding accidental collection or acceptance of unpermitted specimens. To facilitate tracking of legally sourced material, we encourage all researchers to associate permit numbers with samples in published works and online data repositories. Moreover, some data aggregators require evidence of legality (e.g., 65). We encourage journals to adopt and enforce policies requiring authors to provide information on permits as they do for animal care protocols.

Permit requirements. Identifying the rules and regulations for each region or country can be a daunting challenge, involving substantial time and effort when working in a country or region for the first time. Furthermore, the permit landscape is constantly changing, and thus it is important to keep up with new or revised regulations. In addition to research, collecting, and/or export permits, many countries require research visas, Material Transfer Agreements (MTAs), and Memoranda of Understanding (MOUs) or Agreements (MOAs) to conduct legal research (see *SI Appendix,* Scientific Permit Checklist). Obtaining all of the necessary documents may require visits to multiple government offices and working closely with local institutions. In China, for example, permits for aquatic animals are managed by the Ministry of Agriculture while those for terrestrial animals are managed by the National Forestry and Grassland Administration. In Indonesia, researchers are required to obtain a research permit, research visa, traveling papers issued by the national police, documents issued by the Kementerian Dalam Negeri Republik Indonesia (the Ministry of Home Affairs of the Republic of Indonesia), and Material Transfer Agreements for moving specimens between provinces, in addition to an export permit. In the United States, permit requirements depend on national and state regulations, land ownership, and species. Successfully navigating requirements often necessitates assistance from regional collaborators.

International agreements governing the movement of genetic resources or endangered organisms add another layer of complexity to the permitting process (66–68). For instance, the Nagoya Protocol on Access and Benefit Sharing is an international agreement ratified by 132 countries that outlines the equitable use of genetic resources for biodiversity conservation (69). Compliance with the Nagoya Protocol has important implications for how research is conducted, collections are managed, and information is shared among collaborators. Likewise, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (70) regulates import and export of endangered organisms as well as common species that are subject to international trade. Sharing of material from

CITES-listed species requires specific permits that are often administered separately from permits for non-CITES species.

While conducting fieldwork, each team of researchers should always have a copy of their permits and a form of identification. Researchers should also carry letters of invitation from local collaborators (ideally in the local language), documentation of permission to access private land (e.g., an email from the landowner), a letter certifying the individual is conducting research, or other documents endorsing the legality of the work. These proactive measures can help foster positive potential interactions with local community members and law enforcement officials.

Drafting permits. Permits may take months to obtain; thus, researchers should plan ahead. In addition, researchers should be aware of governmental or community concerns over bioprospecting – the search for bioresources from flora and fauna that can be commercialized – in the regions they propose to work. The wording of permit documents should be sufficiently clear and transparent about whether or not the research has bioprospecting objectives. We encourage students and early career professionals who are starting field programs to work closely with their mentors and local collaborators to ensure that research goals and projected outcomes are well-justified in permit applications. Multiple field seasons may be necessary to achieve desired sample sizes, but timely reporting and equitable collaboration can increase the likelihood of desired permits being renewed or adjusted.

Local sovereignty. Many state and federal laws do not necessarily consider local community norms and regulations. Indigenous nations (e.g., Guna Yala in Panama, Nasa in Colombia, highland communities in Perú) and African-descendant communities (e.g., San Basilio de Palenque in Colombia) may have explicit rules, laws, or constitutions that pertain to scientific sampling in their territories. This can be especially complex in countries such as Indonesia, where 1,300 ethnic groups are recognized (71). Careful consideration can be made to respect spiritual or ceremonial areas by discussing any potential work in these regions with local authorities. In general, it is important for researchers to plan field expeditions according to national *and* local regulations, and to work with regional collaborators to ensure proper communication with communities living in or near research sites (see *Be Respectful*). Scouting trips with regional collaborators in advance of field trips can help researchers plan accordingly and are sometimes required to obtain permits.

Be safe: We work proactively to promote a safe physical and emotional working environment for all members of research teams and local communities with clear guidance and communication

Working in the field comes with inherent risks, but field teams can reduce risks to themselves, to the communities in which they work, and to wildlife with proper preparation. For teams in the initial stages of planning a field program or looking to update their policies, we provide some examples of proactive safety practices that can be modified as needed.

Field safety plans. Fieldwork is often fast-paced and presents novel situations but having a comprehensive field safety plan for dealing with dangerous, medical, or interpersonal scenarios can help mitigate risk or avoid it in the first place (72, 73). At their core, safety plans include information about the closest medical facilities, nearest law enforcement authorities, and trusted local contacts, as well as plans for specific emergencies such as medical evacuations and political instability. Field plans should consider mental and emotional safety in addition to physical safety, especially for coping with incidents of Sexual Violence and Sexual Harassment (SVSH) or discrimination. We also recommend developing a specific communication and check-in plan with at least one emergency contact, identifying multiple safety officers, and investing in the resources needed to facilitate check-ins (e.g., a satellite phone or spot tracker). We

recommend checking whether guidelines for field safety and for handling SVSH incidents already exist at your host institution(s). See the *SI Appendix* for an example Field Safety Plan template.

We believe that field safety plans should include proactive guidelines for protecting at-risk individuals on field teams (e.g., 74). For example, SVSH is not uncommon in field teams, and it disproportionately affects women and other underrepresented peoples (75, 76). In general, people with different racial, cultural, gender, sexual orientation, ability status, and religious identities, as well as job title (e.g., team members with different levels of power), may be more or less at risk of SVSH or health issues within the context of a research environment (28, 77–79). Ideally, field safety plans address SVSH by including procedures for dealing with inappropriate interactions within field teams and between field teams and local communities. Having more than one designated SVSH contact can facilitate reporting issues in case the designated contact or team leader also happens to be the accused offender. A relatively simple way to reduce the risk of an unsafe or targeted event is by having team members work and move in pairs or groups while in the field. Safety plans can also include a set of responses that team members or leaders can employ in the face of racist or discriminatory acts inside the team or towards/from other groups (for more ideas, see *SI Appendix,* Field Safety Plan).

Field safety training. We recommend that team leaders (and other trip participants) take a wilderness first aid or first responder course prior to conducting fieldwork, and that they develop a first aid kit with material relevant to possible hazards. Training in implicit bias, bystander intervention, and conflict resolution also can be organized and provided to team members (see *SI Appendix,* Field Safety Plan for more information on training).

Safety meetings. Field safety plans can be improved if teams meet prior to field trips to provide input on procedures and relevant scenarios, discuss codes of conduct, and distribute copies prior to departure. Although medical history is personal by nature and team leaders may be limited in what they can ask, knowledge about basic health considerations including prescription medications (e.g., blood pressure), pre-existing conditions (e.g., asthma, extreme allergies), and blood group can make a critical difference in an emergency. If blood group is unknown, we encourage researchers to find out prior to conducting fieldwork. Consider volunteering health information to team leaders when developing the safety plan, and/or sealing medical documents where they can remain confidential unless an emergency occurs.

Team leaders should be upfront with the team about specific challenges and dangers they may face because of health issues (e.g., dietary restrictions) or personal identity (e.g., LGBTQ+, women) in a way that does not reveal sensitive identities of specific team members. Further, team leaders can make a good faith attempt to defer to the group's comfort levels while also creating space for private conversations or subgroup meetings regarding safety (see 28). If a given area or field site is too dangerous for some members of the group, team leaders can consider whether it is appropriate for any member to conduct field research there. In the field and afterward, we suggest that team leaders proactively check-in with team members if conditions or plans change and to ensure that everyone feels positive about the experience, as well as debrief afterward to collect feedback about how to improve future trips (see *SI Appendix,* Field Safety Plan for suggested debriefing questions).

Biosafety. As biologists, we strive to protect the ecosystems and human communities where we work. Teams should be careful to avoid contaminating local ecosystems (e.g., with soap, chemicals, or foreign biological material) and to protect themselves from potential biological dangers, including dangerous animals and pathogens. Any potentially dangerous chemicals or animals being used for research should be labeled clearly in languages of the team and local communities to prevent human and wildlife accidents. To mitigate the risk of spreading potentially detrimental pathogens and invasive species, teams can disinfect field equipment when moving between sites, before returning home, and between sampling individual organisms, when relevant (80). The spread of white-nose syndrome, chytridiomycosis, and the

possible transmission of viruses between wildlife and humans underscore the importance of this step (81–84). In addition to sanitizing gear to protect wildlife, scientists can consider undergoing wellness checks themselves or including time to quarantine before moving between sites where infecting local populations with zoonotic diseases is possible (for example, in times of global pandemics like COVID-19). We encourage team leaders to provide personal protective equipment to all field members and to lead by example, always handling potentially dangerous wildlife, equipment, and materials in a safe manner.

Health care. Team leaders are responsible for any health emergencies that occur during fieldwork. Thus, being informed and prepared about local health care options, such as obtaining short-term or travel insurance for all team members – including local collaborators – can facilitate response to emergencies. In some cases, registering collaborators with institutional travel plans may allow them to be covered by university travel and/or medical evacuation insurance. Additionally, team members may need to receive vaccinations and medications prior to fieldwork depending on the country and possible diseases present, the species that may be handled, and the available health care infrastructure (e.g., getting a flu shot in advance of the trip could help prevent an outbreak in a region that does not have regular access to flu vaccines). Team leaders should alert members to local requirements regarding vaccines with ample time for individuals to schedule appointments at clinics or university health centers prior to the proposed work.

Be respectful: We invest time and effort in learning about and respecting local history and communities, and in prioritizing local sovereignty.

Many field researchers are drawn to different countries or regions to collect data and answer questions about the flora and fauna. Especially during initial visits, researchers may not be familiar with local cultural norms and history. Acknowledging our own biases and respecting local customs, including spoken language, body language, gestures, greetings, signs of respect, clothing, etc., can help create reciprocal and trusting relationships between local communities and visiting researchers. The behavior of visiting researchers impacts the reputation of local collaborators, and thus it is of utmost importance to learn and abide by local norms and align research goals with in-country rules and expectations, as well as with the sovereignty of local and indigenous communities. To increase the positive impact of fieldwork, researchers can take time to plan activities in a way that maximizes immediate and long-term benefits for the community (Box 2). Long-term investment in sharing the impacts of research with communities can strengthen relationships and create positive sentiments towards science in general.

Cross-cultural relationships. Diverse customs and communication styles, including within our own teams, are often encountered during both domestic and international field research (85, 86). Learning from cross-cultural interactions allows us to be more empathetic with our teams and local communities, and to have a more open view of the context in which we do research. In addition, understanding and respecting local customs can help field teams avoid misunderstandings or conflict. For instance, special considerations can be given to the following: maintaining appropriate interpersonal distance in different situations; respectively addressing certain political, religious, and gender-related topics; dressing appropriately for different occasions; knowing appropriate behavior when invited into someone's home; understanding expectations regarding monetary compensation (e.g., “tips”); learning about and honoring preferred styles of communication; and appropriately addressing community elders. An action that may be commonplace or inoffensive in one culture can have an unexpected meaning in another, so it is helpful to familiarize oneself with local norms while also reflecting on one’s own customs.

Honoring community sovereignty. Conducting fieldwork often means that local communities open their territory (and sometimes their homes) to researchers. It is important to be respectful in these situations, and to prioritize suggestions and modifications of the research plan from the local community before,

during, and after travel (37). We suggest that field teams formally introduce themselves to the community and explain the research before work begins, as well as communicate with communities when a project is concluded to discuss results, any future collaborations, preferred method of acknowledgement, and potential outreach activities (see Box 2). In addition, a meeting with local authorities could help connect research teams with local guides who can help inform researchers of any ongoing safety risks. For work involving commonly poached species (e.g., for the pet trade or bushmeat), researchers can take particular care to explain the work, how it differs from illicit activities, and answer any questions or concerns that arise from this discussion.

Researchers can implement community peer review methodologies (87) that incorporate community feedback into research plans. By collaboratively assessing whether the project goals are relevant and realistic, researchers can help generate positive and long-lasting impacts for local communities. Questions about the impact of the research, the source of funding, the planned research methods, accessibility of the generated data, and the beneficiaries of the research should be put on the table. We recommend approaching these discussions from an equity perspective, as one's expectations, knowledge, and experiences are not universal or more important than those of another. We suggest that researchers allow for discussion of ideas that do not align with their own, and that territorial and local regulations hold precedence even if they are more restrictive than permits allow (87). For example, ideas surrounding the concept and use of "nature" vary (88), and the practice of specimen collection can be a controversial subject for some communities and scientists. Some indigenous nations have spiritual relations, oral histories, or belief systems based on particular organisms, and caution should be exercised when working within the ancestral domain of various groups to avoid collecting, sampling, or disturbing these species. It is also worth noting that fluency in the local language is critical for these discussions to take place on a level playing field. Thus, team leaders in particular should make a concerted effort to gain a working fluency in the local language (if different from their own), and groups can invest in paid translators or guides when that is not possible.

Conflict resolution. Despite our best intentions, conflicts may arise both within research teams and among stakeholders. Because fieldwork often involves groups of researchers spending long periods of time together in stressful situations, training in conflict resolution can make a large difference in smoothing team dynamics. In addition, conflicts with the local community may arise. It is important to be aware of one's position in existing power structures and to try to reach an agreement that respects local sovereignty.

Box 2. How can we give back to the communities where we work?

Reciprocity does not solely translate to broadening authorship criteria but also to how we return valuable information, resources, and infrastructure to local communities. Field biologists can choose to plan their research in a way that maximizes the immediate and longer-term benefits for the community. Here we list several ideas that can be implemented by teams of biologists and communities.

Educational projects
Local schools and communal assemblies are important meeting and gathering spaces. Thus, they can be perfect locations to offer talks, organize conferences or workshops, display posters, collaboratively create or display visual products (e.g., high-quality images of local species, field guides, or educational booklets), or have forums to share ideas and get to know the community. Learning how knowledge is shared in each community will enhance time and resource investment. For example, contacting the local radio station may be a good idea in communities that rely on oral transmission of knowledge.

Grassroots science

Community-led and participatory action research, which include community members in the research team, make scientific methods and ideas available to others in a permanent manner and ensure that the research is in line with local goals (89, 90). For example, collaboratively creating a list of local species can make scientific knowledge more accessible and help preserve local names and information about the species (91). Long-term monitoring or reporting systems also can be valuable (92); for example, local communities in Argentina, Peru, and Colombia have used traditional knowledge to document water contamination from mining (93). Grassroots approaches decentralize science and bring new tools to the community to understand their territory. Researchers can join organizations led by local scientists (including groups on social media) and present findings at regional conferences, which are often well attended by government entities, tourist guides, and non-profit representatives as well as academics.

Broadcasting local issues and achievements
Unfortunately, many of the places where fieldwork is conducted are territories that still suffer from the imposition of extractivism, poverty, and biopiracy (94). Visiting researchers can remain informed and use social media and interviews to broadcast the issues of concern in the region to raise international awareness. Likewise, promoting local efforts in conservation, research, or other achievements aimed at maintaining biodiversity or building scientific capacity could bring new allies and ideas to regional communities. One easy step towards remaining informed of local issues and achievements is for researchers to maintain contact through social media with local collaborators, guides, and community hosts (e.g., through social media, WhatsApp, Facebook).

Remuneration and infrastructure
Knowledge and practices that are not usually considered scientific are often key to the development of scientific enterprises, and thus should be acknowledged and appropriately compensated if used in research studies. Hiring workers from the local communities (e.g., to be drivers, cooks, guides, field assistants, illustrators, translators) and paying them fairly is crucial to give back to the community and recognize their participation in the research process. These actions do not need to be limited to “non-scientific” labor: biologists and other scientists are also part of the communities where research is done. Involving them in the project, providing training when necessary, and sharing infrastructure or field materials could help in their scientific development and increase diversity in science.

Concluding Remarks

Here, we present a set of principles based on our self-assessment of how to ingrain equity, reciprocity, access, benefit-sharing, and safety into field biology practices. While many of our suggestions are not new (95, 96) and could be applied more generally or in other circumstances, we hope that compiling these ideas into a single document can help researchers plan intentionally inclusive fieldwork. We recognize that no two field programs are identical, and that our suggested actions may not be applicable to all institutions, teams, or regions. Therefore, each group of collaborators will need to make decisions about how to carry out their own fieldwork as equitably and inclusively as possible. Conducting fieldwork can have a positive, transformative effect on an individual’s relationship with science and nature; conversely, bad field experiences can discourage researchers (especially students) from pursuing careers in field biology and dissuade communities from collaborating with scientific researchers (21, 41). We believe that following the proposed principles can help ensure positive outcomes.

In reflecting on our own research programs, we recognize that power imbalances are prevalent within field teams and that they can substantially impact collaborative dynamics despite our best intentions. Power imbalances can be a product of economic asymmetries (e.g., high- and low-income regions or countries), geopolitical history (e.g., former colonies and colonialist countries, indigenous communities, Black communities in the Americas), job title (e.g., field assistant), and discrimination on specific groups

of people (e.g., women, LGBTQ+, people of color, people with disabilities). In field biology, power imbalances can result in the formation of collaborative agreements and structural norms that consistently favor those with greater power (e.g., parachute science; 21). Recognizing and taking power dynamics into consideration can promote equity and safety in field biology, ultimately leading to a more inclusive scientific community.

As power imbalances favor those in privileged positions by default, deliberate planning and proactive efforts, especially by privileged individuals and institutions, can allow for more equitable benefits in science. This could mean discussing each collaborator's goals at the start of a project and asking rather than assuming what collaborators and communities expect and need out of the research program. In being legal, we hope that researchers will follow precedents that allow local governments and communities to have the final decision on whether research is conducted and to provide input on how research is carried out. In thinking about field safety, we encourage team leaders to emphasize concerns and feedback from team members with less power (e.g., field assistants and student researchers). Finally, in being respectful, we ask field researchers to prioritize the safety, comfort, and input of local communities in all stages of their field research.

We would like to highlight that this document is the result of months of discussion among the authors and that it represents a general agreement that arose through collaboration and compromise. As such, it does not entirely reflect each individual's point of view but does capture our collective goal of making field biology a more ethical, inclusive, and fair domain of knowledge production. During the process of writing this paper, numerous questions arose that we could not fully address nor answer here, but that we hope will initiate further discussion (Box 3). We encourage other programs, institutions, and individuals to engage in such discussion and to join us in this effort for more inclusive and equitable fieldwork.

Box 3. Questions for further discussion.

1) While we are calling for fair compensation for field assistants and investment in local infrastructure, we recognize that it can be difficult to obtain funding from national agencies to support salaries for researchers and/or purchasing equipment located in other countries. How can funding agencies better promote equitable international research?

2) Rules and regulations regarding proper collection of wildlife continue to increase. Though the intentions may be positive, in practice they often make field biology much more difficult (67–69). How can we ensure fair international collaborations and fair use of biological data without greatly increasing time and resources spent on bureaucratic tasks?

3) Some researchers and collectors choose not to share their specimens or samples with natural history museums or repositories, sometimes because local museums do not exist. How can we ensure the safety and accessibility of natural history specimens and field-derived samples, while also prioritizing the equitable sharing of such specimens and associated data?

4) We underscored the importance of having a safety plan and medical resources for field teams. How can we address or in some way remedy the disparities that may exist in access to healthcare by researchers and the local community in the field?

5) Considering that 15% of the world's population have at least one form of disability (97), how can we better support and accommodate disabled people in field biology (e.g., see 79, 98)?

6) What opportunities can be developed to equip and engage scientists or students who obtain advanced degrees outside of their home country to maintain independent research programs upon returning home?

7) One important way to address the power imbalances between researchers from high and low-income countries or communities would be to substantially increase the financial resources available to less privileged researchers. How can the global community help encourage local investment in biodiversity science?

8) Add your own ideas here: _____
_____

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