



SYMPOSIUM

Knowing Your Field Community: Elevating the Human Dimension in Ecological Research and Teaching

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Synopsis Public health researchers have long been aware of the importance of defining the human community associated with research on environmental health initiatives. However, the field community’s human components where applied ecology research is conducted, e.g. diverse participants and perspectives, are often overlooked in environmental problem solving. We outline a framework for elevating the human dimension in defining the field community in applied ecology research and for teaching diverse undergraduate students the skills needed to address Anthropocene environmental concerns. We promote broadening participation and incorporating cultural and racial perspectives in ecology research planning, implementation, and teaching. We use the environmental research problem of concern to identify the diverse human community groups potentially connected to the problem and guide the strategies for incorporating their perspectives in the proposed research project. Which human community, whether local, ethnic, or visiting public community, affects the resource management strategy, i.e. people protect what they love, can change the outcomes of applied ecological research, as well as promote development of a diverse environmental workforce. Broadening participation and perspectives means that the people asking the research questions are also part of the social ecological community processes who choose which questions to pursue to manage the natural resources of the community. Here, we promote research and teaching practices that consider the long-standing multicultural connections to nature to allow all students to pursue their love of nature and its beauty in a safe, comfortable, and mentoring setting. We integrate current human diversity, equity, and inclusion-focused pedagogical knowledge into the Ecological Society of America-endorsed 4DEE multidimensional curricular framework. We provide a faculty action guide to engage and train diverse students in ecological practices that meet the needs of today’s environmental problem-solving workforce.

Ecological researchers need to address the major environmental concerns of the current Anthropocene, such as the impact of climate change on human-environment interactions, lack of access to essential natural resources and ability to recover from environmental disasters. The field communities where today’s applied ecologists do research are socialecological systems, in which the human community components are impacting environmental and social change. Because environmental problems are more likely to affect marginalized cultural and racial populations (Cobble et al. 2020; EPA 2021; Kuntsman et al. 2021), know-

ing the field community’s social and ecological context, i.e. being aware of its human components relative to any environmental research problem or investigative question, is essential to develop an effective research action plan.

Ecologists have incorporated humans as major agents of environmental change in the Anthropocene (Vitousek et al. 1997), but have not engaged with the social components they study in order to produce knowledge i.e. relevant to the socialecological systems’ problem solving. Today’s environmental professionals and the effective training of stu-

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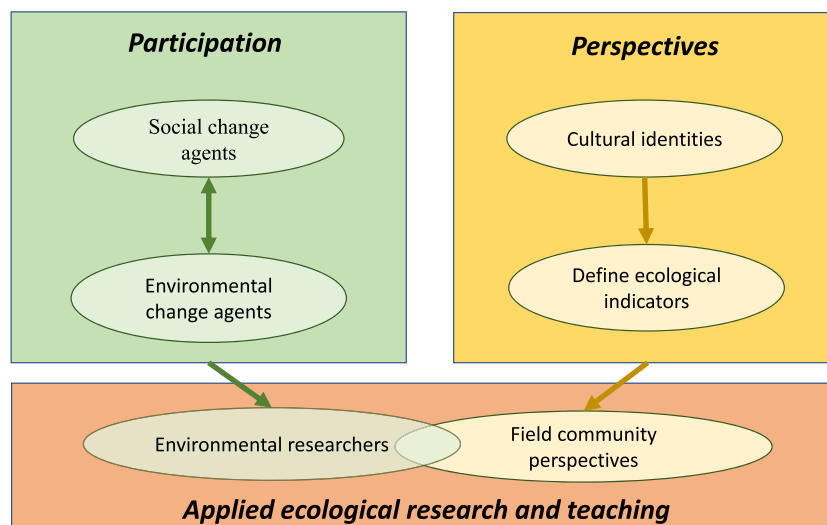


Fig. 1. A framework for defining the community in applied ecological research and teaching

dents for the environmental workforce need to develop research skills that facilitate appropriate solutions to the community-wide environmental problems (Gale et al. 2022).

Public health researchers have long been aware of the importance of defining the human community associated with a research question on environmental health initiatives (MacQueen et al. 2001; Brown 2004). However, the human components of a field research community that may have knowledge or perspectives on ecological issues explored by applied ecology researchers are often overlooked. Extensive literature review has shown that scientific research is significantly affected by the cultural identity of the researcher (Kozlowski et al. 2022). In environmental research, engaging diverse perspectives on how to address the problem is essential for project success (Cooke et al. 2020). The structural diversity of a community affects the ecological patterns and processes typically investigated by applied ecologists (LaRue et al. 2023). Today's applied ecologists, both in their research and in training of the future environmental workforce, need to assess how the human components of a community are connected to a proposed environmental research question and how those socioecological components change over time (Harris et al. 2023). Here we examine the role of elevating the human dimension in applied ecological inquiry and ecology teaching to best inform environmental problem solving and enhance the training of the diverse environmental workforce needed to address the challenges of the Anthropocene (Cooke et al. 2020; Gale et al. 2022).

What do today's applied ecology professionals need to know about their field community to effectively address local environmental concerns?

Who is part of the social ecological field community and why does it matter?

The research field community can be more than a geographical location, comprising human, and ecological components, seasonal and permanent, that impact the environmental research question being investigated. In ecological research or field teaching, the "community" is often defined as the ecological components of the physical field site studied; whereas, who interacts at the study site and interprets the data are not always considered in the combination of social and ecological factors that affect ecosystem function and ultimately natural resource management. We define the field community to include the social, geographical, or cultural connections of a group of people, either as residents or users in an ecosystem, associated with a particular applied research question and biophysical components of a field site (MacQueen et al. 2001; Brown 2004).

We propose a framework that considers how the proposed research question for applied ecology investigations is impacted by the researchers' cultural identity and connected to the multiple perspectives of identified human community stakeholders (Fig. 1). As environmental researchers and educators in the Anthropocene we advocate for broadening participation and perspectives in applied ecological research and teaching. Participation refers to the human elements of the research field community and the researchers involved. Perspectives include the cultural identities and local ecological

knowledge of those associated with the environmental problem in question, who also impact research project design and implementation.

A field community where research is conducted or where students are trained in ecological practices, is composed of human and other biological species interacting with each other and the physical components of the site. The human components associated with a particular research investigation have knowledge perspectives that affect the field community's response to natural or human-caused environmental change—and are environmental change agents. Human elements also affect the social change processes of the field community, such as community governance or coproduction of knowledge, and as such are social change agents. Who participates in defining the research community's stakeholders, who is affected by social change processes associated with community governance or determines a field community's response to environmental change agents, and who asks the ecological research questions to implement an environmental research plan, can impact the outcome of applied ecology fieldwork (Fig. 1). Concurrently, how the field community is defined for applied ecology can be affected by cultural factors associated with that community, such as unique knowledge systems, which can impact the ecological indicators chosen for immediate study and can determine the perspective put forth in the field study outcomes. Our framework's goal is to address the community's environmental issue of concern with strategies for broadening participation and perspectives impacting the proposed research.

Why is it important who participates in the research process?

For the last 30 years there has been little increase in the representation of ecologists from diverse cultural backgrounds and racial identities in applied ecology, in contrast to the increasing representation of those groups in the US population (O'Brien et al. 2020; Tseng et al. 2020; Bowser and Cid 2021).

Broadening participation means that the people asking the research questions are part of the social ecological community processes who choose which questions to pursue to manage the natural resources of the community. Who asks and chooses the question determines the ecological legacy of the field site in terms of its uses and in knowledge gathered to modify the environmental solution approach. A literature review of several million articles from 2008–2019 listed in the Web of Science, shows how race, class, and gender affect, which science research questions are asked and investigated (Kozlowski et al. 2022).

The fields of environmental health and justice have long considered the impact of race, class, and culture on community study (Brulle and Pellow 2006; Taylor 2014). To solve any community's environmental problems, a clear understanding is needed of who is interacting with whom, when, and where in relation to any plan for environmental management of such a community. Recent and thorough literature review shows that environmental justice issues on a global scale are concentrated on poor women and people of color in a variety of communities, due to long standing systemic racism (Alvarez and Evans 2021). Understanding the demographic and cultural history of a research site and how those factors impact the research question and definition of the field community is essential for aligning research with social justice (Craig and Dillon 2023).

Why be concerned with broadening perspectives in applied ecology research?

In ecology, "broadening perspectives" is an expression often connected with considering multiple ways of knowing, such as incorporating the long term local or traditional ecological knowledge in community resource management. However, the groups of organisms reflected in local knowledge may differ from the ones targeted in the natural resource parameters being measured. How an organism or habitat is viewed through one set of cultural lenses affects the perspective on the desired outcome for a restoration project (Schulz et al. 2022). For protected areas, such as national parks, balancing the management of a cultural landscape like a battlefield, while addressing conservation of local species of concern, and the tourist visitor experiences, means integrating natural and cultural resource perspectives that may differ from each other. An example is a national park like Devil's Tower in WY, where the concerns of rock climbers, access to the sacred site by Native Americans, and conservation of the endangered peregrine falcon set up a management conflict. Which human community group defines the resource, whether a local ethnic community or a visiting public one, changes the perspective of which organisms are significant (Pimbert and Pretty 1995). Paying attention to these unique human components of the field community and recognizing that community action, i.e. people protect what they love, may drive natural resource management success (Halliwell and Bowser 2019). Thus, the environmental workforce needs to reflect the demographics and perspectives of the people most affected by the Anthropocene's environmental challenges.

How may ecologists best engage and train diverse students in pursuing environmental careers?

Ecology researchers who are also educators are tasked with incorporating pedagogical strategies in the training of today's environmental workforce to help broaden participation and perspectives of future environmental professionals. Undergraduate ecology training is an Ecological Society of America's (ESA) priority. ESA has been promoting faculty engagement in implementing its society-endorsed four-dimensional curricular ecology education curricular framework (4DEE) of ecological topics, field work practices, the study of human-environment interactions, and how our students connect basic ecological principles to the foundational cross-cutting themes in biology (Klemow et al. 2019). Integrating diversity, equity, and inclusion-focused (DEI)-focused pedagogical knowledge into the ESA's 4DEE multidimensional teaching approach to promote faculty actions that can support broadening participation and perspectives in ecological research and teaching for meeting the needs of today's environmental problem solving.

Recent literature has outlined the systemic and pedagogical barriers to recruiting and retaining diverse ecologists (Bailey et al. 2020; Morales et al. 2020; Cronin et al. 2021; Jensen et al. 2021; Whipple et al. 2021; Graham et al. 2022; Woods et al. 2023). Barriers affecting diverse students in pursuing necessary ecological field experiences may be financial, physical, cultural, affected by the lack of similar role models in environmental careers, or by their experience in field coursework (Morales et al. 2020; Emery et al. 2020; Jensen et al. 2021). Some researchers have focused on increasing awareness of potentially discriminatory practices that affect the development of ecology as a discipline inclusive of all participants and to promote systemic change in ecological research and teaching approaches (Chaudhury and Colla 2020; Schell et al. 2020; Miriti et al. 2023). Others have focused on potential strategies for enhancing comfort, empowerment, and development of a sense of belonging in students of color engaged in field ecology experiences (Halliwell et al. 2020; Morales et al. 2020; O'Brien et al. 2020; Bowser and Cid 2021; Vereen 2022; Miriti et al. 2023). Some researchers have addressed the potential lack of safety for students of color doing environmental field work in different settings or in a field course environment (Demery and Pipkin 2021; Lundin and Bombaci 2022).

Broadening the participation and valuing diverse perspectives in ecology education includes addressing factors that influence ecological learning in a broad range of students, keeping in mind the bigger picture of systemic racism in ecology. The field community is a mosaic of permanent and seasonal elements, human

and non-human, which can affect the level of comfort and safety of diverse students, in field coursework and research collaborations with faculty mentors. To further develop the students' love of nature, the faculty should provide students with the tools to facilitate their ability to collect and analyze environmental data; but also encourage them to bring their individual perspectives or cultural connections to the study of different types of field communities.

Strategies for enhancing teaching of all ecology students and reconnecting with the joy of nature-based research

We take our lead from the recent literature's recommendations for more effective DEI training tools, e.g. to focus our strategies on modifying "*actions and behaviors rather than hearts and minds*" (Livingston, 2020; Singal 2023). As Livingston (2020) indicates: "*racism has less to do with what's in your heart or mind and more to do with how your actions or inactions amplify or enable the systemic dynamics already in place.*" Using a precautionary approach to resolve conflicts in field experiences, especially for students of color working on off campus sites, avoids reinforcing a culture of fear, and promotes the joy in connecting nature to field ecological practices. Students of color differ, within each cultural group, in how they connect to environmental field work. We encourage an educator approach that combines a focus on broadening participation of field community change agents while concurrently broadening the perspectives to celebrate different cultural identities and include their collective knowledge in forming any research agenda. Such a switch in focus for applied ecologists is critical and a pivotal step toward knowing the identity and definitions of any field community at the start of research inquiry.

Teaching strategies for developing multicultural pedagogical practices that embrace both broadening the perspectives of different researchers and communities while also broadening the participation of the same can nurture a sense of place in students (Kudryavtsev et al. 2012). We encourage educators to provide diverse students with the variety of tools most helpful to facilitate hands-on learning in addressing field research questions (Emery et al. 2020; Cronin et al. 2021). Which approaches to focus on or tools to give to students (see Table 1) requires some assessment of the diversity of perspectives and previous nature connections of their students prior to taking them to the field community to learn environmental data collection, analysis, and research implementation methods (Super et al. 2021). We encourage ecology educators to celebrate human diversity and promote actions and behaviors that help diverse

Table 1 Faculty actions to enhance inclusive teaching and help increase students' overall comfort, connection, confidence, and capacity in field course experiences, when utilizing the ESA-endorsed four-dimensional ecology education curricular framework (4DEE).

Components of 4DEE curricular framework				
Desired outcome of faculty actions	Ecological topics	Ecological practices	Human-environment interactions	Cross-cutting themes in biology
Comfort	Doing field site's physical safety assessment and action plan relative to ecological topic investigated with students (Rudzki et al. 2022)	Providing individual student advice and access to diverse tools for field sampling and data analyses (Morales et al. 2020)	Doing human community perception assessment relative to students of color (Demery and Pipkin 2021)	Discussing factors that affect community stability and change
Connection	Engaging students in research about field sites' cultural history (Zavaleta 2020)	Engaging students in connecting their cultural ecological practices to field investigation themes (Kimmerer 2002; Albuquerque et al. 2021)	Discussing human activities that are currently affecting community study site functions	Discussing cultural impacts on systems thinking and community function (Daniel et al. 2012)
Confidence	Introducing students virtually to diverse researchers doing similar field work for chosen ecological topic	Having students decide components of field study and developing field teams that showcase value of individual talents (Bowser and Cid 2021)	Encouraging student presentations on human-environment interactions that can affect the ecology of the study field site	Discussing how biological and structural diversity affect community structure and function and human well being
Capacity	Mentoring student engagement in planning discussion of their chosen ecology topics—(Bowser and Cid 2021)	Promoting active learning in field study planning, data collection, presentation, and discussion of study results (Super et al. 2021)	Engaging students in observation and participation in local community environmental monitoring projects and governance (Vance-Chalcraft and Jelks 2023)	Having students choose point of view and discuss how regional environmental change can affect study site

students grow their sense of wonder and joy in natural study to be effective field ecologists today.

In Table 1, we build our recommendations on ecology education research for making ecology learning meaningful and accessible to diverse groups of students (Beltran et al. 2020; Super et al. 2021). We provide literature references on inclusive ecology teaching practices to engage diverse students from various cultural backgrounds. We define “inclusive teaching” here as an approach that builds a mindful and accessible bridge between the students' cultural appreciation for nature, physical ability, and experience in field work and the proposed field teaching experience. We focus our recommendations on four factors that have been shown to affect diverse student learning in field experiences, e.g. students' comfort, connection, confidence, and capacity in the field (Bowser and Cid 2021). We connect our pedagogical recommendations to the existing Ecological Society of America-endorsed four-dimensional ecology education curricular framework (4DEE) (Klemow et al. 2019).

It is important to be mindful that students' field safety is a parallel issue that impacts both the students' perceptions of field experiences as well as the participation

by some in such experiences; therefore, faculty need to assess tools and safety access issues needed to facilitate ecology education of their diverse students while in the field. Such assessment requires greater awareness of what is needed to help a diverse group of students continue to pursue their joy and balance their interest in the study of nature with the challenges faced by diverse populations. How students get to the field site, either with faculty supervision or on their own, can also bring on additional predictable and unpredictable exposure to unsafe conditions for students of color in environmental work.

Using the ESA 4DEE curricular framework coupled with embedded DEI-focused pedagogy that broadens perspectives and participation, brings new research ideas and innovation to ecology training, and new voices to enact such ideas. Inclusive teaching approaches allow students to implement the multidimensional thinking required for addressing today's complex environmental problems (Gale et al. 2022). Just as essential is that we engage students in discussion and reflection of the importance of integrating the information on ecological topics with their cultural history, and environmental problem-solving approaches

required to address human-environment interactions (Bowser et al. 2021; Super et al. 2021). For today's environmental workforce, teaching practices that consider the long-standing multicultural connections to nature and field ecological practices will allow all students to pursue their love of nature and its beauty in a safe, comfortable, and mentoring setting.

The literature on the mosaic of unsafe environments that can be encountered across the landscape of field biology courses is significant, contributing to a culture of fear among diverse students over the love of nature and the joy of field experiences. Fieldwork safety plans need to highlight the risks as well as the rewards of field-based research that also aims to prevent problems for students and practitioners of color who must drive through unsafe areas to get to chosen research sites. Promoting positive change and reengaging the conversation of the participation of all in the joy of discovery in field-based research requires focusing on the immediate need of a “sense of belonging” intervention to promote positive change in institutional and discipline culture that nurture career development of ecologists of color in full recognition of both the safety concerns and the joy of nature.

Conclusions

To broaden participation and perspectives in applied ecology will require that we include multicultural experiences, complex knowledge systems, and provide safe field experiences for all, along with appropriate tools for diverse students that integrate their love of nature and approach to research in their fieldwork. Where we do applied ecology research and how different knowledge systems are applied or acknowledged influences the resultant research questions, field methods, and sets the parameters of safety and inclusion for diverse researchers, as well as for the students being trained and the impact that our research investigations can have on the overall research community.

We envision a world where it's commonplace and doable for all students to aspire to be an ecologist from a young age, not by chance but by choice—not as a lesser of two evils in some undergraduate college program or chosen because we know little about it and hope it is better than the other known curricular choice we perceive as bad—a world where ecological study is a goal that brings joy and not one where only the very stubborn and resilient diverse students tackle pursuing an ecology career.

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Conflict of interest

The authors have no conflict of interest to declare regarding this paper.

Data availability statement

No new data were generated or analyzed in support of this research.

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