For the last three decades, the Ecological Society of America (ESA) has been urging ecologists to include human community outreach and human welfare concerns in its sustainable biosphere and Earth stewardship initiatives (Lubchenco et al. 1991, Chapin et al. 2011). For the science of ecology to solve societal environmental problems, it requires the intentional collaboration of ecologists and community leaders in the co-development of innovative approaches in order to enhance Earth stewardship and limit environmental injustices (Bowser and Cid 2020). Ecologists have provided considerable guidance on how to integrate Earth stewardship in the training of graduate students (Colón-Rivera et al. 2013), in developing the multidisciplinary research teams needed for these comprehensive investigations (Cheruvelil et al. 2014), and in providing alternative measures for professional success that value interdisciplinary collaborations in ecology (Goring et al. 2014).

ESA’s efforts on developing a diverse and community-engaged environmental workforce were started nearly 25 years ago (Mourad et al. 2018) with its Strategies for Ecology Education, Diversity, and Sustainability (SEEDS) initiative. ESA education staff and ESA ecology leaders have co-developed the SEEDS STEM undergraduate student leadership and ecology mentoring programs, which promote students as agents of change in ecology. In 2009, two SEEDS students, Ana Elisa Pérez and Leonardo Calle, coined the term “action ecology” to define the intentional approach to designing and conducting ecological research and education that addresses the environmental issues of concern in socioecological systems (Bonilla et al. 2012). Such targeted research can provide a fast analysis of existing regional data.
sets, creating new data that leads environmental management and decision making over temporal and spatial scales (White et al. 2015). SEEDS has retained 71% of its alumni in ecology careers, and many of them are involved in community outreach projects that promote equal access to ecosystem benefits (Mourad et al. 2018). Given such exceptional ESA efforts, why has not action ecology research, and the community outreach plans provided by ESA student leaders, not become central to applied ecological scholarship?

“... ecologists must consider the responsibility of taking their findings beyond the academic realm into disciplines and mediums for communication they may never have considered before. Translating this knowledge into direct action through conservation initiatives, environmental justice, sustainability, and community efforts, or into doing research on how best to accomplish these goals, is what we have termed action-oriented ecology.” Rivera et al. (2010)

What does it mean for students to be agents of change? Ecology students have motivated their mentors to pursue action ecology and fuel needed social change. Ecology educators can now teach students how to connect basic ecology concepts to environmental justice through the human-centered, place-based...
approach (Fig. 1; Cid and Pouyat 2013, White et al. 2015, Klemow et al. 2019). Action ecology connects to the four components of the Environmental Justice Collection of articles recently released by Wiley (Bowser and Cid 2020, full collection available online). In this collection of ESA journal publications, four areas of environmental justice research in ecology are highlighted and two (access to knowledge and access to natural resources) echo the core concepts identified in action ecology: for example, biocultural conservation and science, and political action. These topical areas highlight the overlap between the concepts of action ecology, environmental justice research, and ecological education (Rivera et al. 2010).

“...honor diversity when thinking about your research questions, methodologies, and the communication of your findings. Science that leads to social change is at the crux of action ecology and a noble way of addressing the broader impacts of our research.” Marshall et al. (2011)

Who is affected by the lack of environmental justice research? The demographics of the U.S. population are changing while the diversity of students in ecology has not. Given this imbalance, how do we empower agents of change who are representative of the population at large? Moving forward ten years after action ecology ideas were proposed, the question of human dimensions and culture within ecological inquiry remains on the edges of ecology education practices (Reiners et al. 2017). To fully address environmental justice issues using co-creating paradigms, ecological research and education strategies need to fully embrace human dimensions as part of the ecosystem. In 2018, ESA endorsed a four-dimensional ecology education curricular framework (4DEE) that elevates the human dimension in the teaching of ecology (Klemow et al. 2019). The Environmental Justice Collection highlights ecological research, bridging the first discussion of action ecology to the current landscape that includes the Black Lives Matter movement, greater health risks of people of color in the COVID19 pandemic, and a continuing lack of diversity within the environmental sciences. More than ever, human dimensions need greater incorporation into ecological education and research to reap the benefits of action ecology.

“Action ecology is conducting research that has broader socio-ecological implications for the welfare of society as well as the ecosystems, and it requires collaboration with other disciplines, stakeholders, and any sectors that compose the socio-ecological system.” Bonilla et al. (2012)

Moving the discipline toward action ecology means changing how research questions are generated. Co-creating research questions that include cultural contexts important to today’s diverse youth plays an essential role in solving environmental challenges. Access to knowledge about environmental threats, from extreme climate events to harmful pollutants or pandemics, is important to biocultural conservation and eliminating environmental injustices (Chapin et al. 2011, Krasny and Tidball 2012, Bowser and Cid 2020). Translating ecological knowledge into direct community action needs the human-centered environmental focus of ESA’s 4DEE (Klemow et al. 2019). Action ecology needs to be policy-ready (White et al. 2015), and training students to identify the intersectionality of science and culture within ecological space is critical (Fig. 2). Ecological practices that integrate the human dimension of 4DEE teach students to communicate research to policy makers and community members. This is a critical skill within the action ecology framework.

“A world in which the human rights of every young person are realized; that ensures every young person is empowered to achieve their full potential; and that recognizes young people’s
Fig. 2. Providing diverse students with the opportunities to participate in research inquiry and address environmental concerns is a critical first step to broadening participation in the sciences. Photo credit G. Bowser.
The future of ecology and Earth stewardship requires bringing agents of change into action, prioritizing the integration of environmental justice concerns, and promoting the achievement of a global sustainable future. The leadership of students within ecology has given us a blueprint for improving ecological inquiry, leading the discipline to be more inclusive of both people and justice issues that affect ecological and societal wellbeing. Access to knowledge and access to natural resources become elements of environmental injustices, and action ecology is a vehicle to address defying future research that includes the community (Fig. 3). The recently published Environmental Justice Research Collection provides insights into gaps in ecological research that can be addressed by recruiting and retaining more students as agents of change. ESA’s Diversity Equity Inclusion and Justice Task Force 2020 has started the conversation on the integration of action ecology principles (recommendations from the task force available online). One of the recommendations is to elevate the focus on environmental justice to diversify ESA membership and the associated scientific publications represented within the family of journals that ESA manages. The era of climate justice and sustainability needs to define how we teach undergraduates so they are prepared to solve worldwide environmental problems and be the agents of change.
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Notes

1 https://esajournals.onlinelibrary.wiley.com/doi/toc/10.1002/(ISSN)9999-0005.environ mental-justice-in-ecological-research
2 https://www.esa.org/about/diversity-in-ecology/deij-recommendations/

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