PROVOCATION

Ecologies, One and All

Singularity and Plurality in Dialogue

ANNE RADEMACHER
Department of Environmental Studies, New York University, USA

MARY L. CADENASSO
Department of Plant Sciences, University of California Davis, USA

STEWARD T. A. PICKETT
Cary Institute of Ecosystem Studies, USA

Abstract This essay considers *ecology* in its singular and plural forms. It asks whether and how the knowledge forms generated by practitioners of the singular science of ecology might weave more fully into a robust plural analytic that is grounded in the acknowledgment of multiple ways of knowing, experiencing, and attributing meaning to consequential connections between the human and the more-than-human world. Although Western science, with singular ecology as one of its many descendants, leaves an undeniable imprint, the essay aims to ask whether the contemporary, lived life of ecological science as postpositivist practice might be working in ways that, while imperfect, may be more legible and shared with scholars in the environmental humanities than is usually noted. It describes the knowledge base of the singular science of ecology, which in contemporary theory and practice consists of collections of disparate, complementary, or contradictory models—ecologies—in the plural, thus holding generality and infinite particularity in constant dialogue. The authors, two natural scientists and one social scientist, aim to provoke fresh discussions about the ways ecological analytics circulate in contemporary research and scholarly practice. The authors' goal is to further the essential work of more direct and clear conversation, translation, and mutual learning between scholars in the environmental humanities and biophysical ecology. They hold this to be essential as transdisciplinary initiatives endeavor to study, and better understand, how social and environmental change coproduce one another.

Keywords ecology, ecosystem, nature, ecologies, science

The Plural as an Analytical Position

Scholars in the environmental humanities tend to use the term *ecologies*. Doing so indexes the multiple layers of political, cultural, and historical experience through

Environmental Humanities 15:1 (March 2023)
DOI 10.1215/22011919-10216195

which social groups perceive, experience, and narrate environmental change. If and when *ecology* appears in singular form, it is often to mark the distinct Western scientific discipline by that name. Singular ecology tends to imply scientific knowledge or the history of the science of environmental systems. In this sense, *ecology* is not *ecologies*, and at times the singular Western science is wholly excluded from the analytical rubrics that employ the plural counterpart.

While scholars in the environmental humanities study, analyze, and write about ecologies, however, the plural term sometimes confuses biophysical ecologists.[1] Some wonder if and when there is a place for a contemporary, grammatically singular scientific discipline of ecology among the ways of knowing environmental change deemed meaningful for social analysts. The myriad uses of "ecology" that circulate in commercial and colloquial spheres exacerbate this quandary and further underscore the need for care and precision not only in language but in the concepts that language signals.[2] As researchers concerned with the coproductive dynamics through which human social worlds and biophysical environments transform, the authors (henceforth, "we") ask in this essay how thinking through ecologies—singular and plural—may help us better integrate social analytics and biophysical approaches toward more fully understanding interconnected social and environmental change.

We are collaborators from the natural and social sciences who have engaged in nearly a decade of learning together, exploring our shared analytical vocabularies and aspirations while noting the ways that our epistemological approaches diverge. Our work together includes a practice of regular weekly meetings, collaborative research projects, coauthored research papers, and shared workshops and teaching strategies. Our recent projects include a systematic exploration of keywords from our shared analytical lexicon, work on system dynamism in relationship to the changing nature of catastrophic fires worldwide, thinking and writing together about social and biophysical coproduction,[3] and an interdisciplinary collaboration titled "The Ecology of Segregation."[4] We have long noted the obstacles to our thinking and analyses that can inhabit the analytical space between the singular science of ecology and the plural rubrics of ecologies. We have also noticed significant gaps in our own understanding of the ways contemporary ecology theory and practice diverge—and converge—with the theories and practices that are fundamental to ecologies analytics.

This exploration is nested in, and must be fully accountable to, the historical situatedness of Western scientific positivism and the development of a science called ecology. The imprint of the Enlightenment; its positivist assertions of fully knowable, essential social and natural laws; and subsequent projects of colonial domination formed a scaffold of enduring and multiple structures of oppression to which the history of the

1. For uses of ecologies, see, for example, Peet and Watts, *Liberation Ecologies*; Guattari, *Three Ecologies*; Grose, *Constructed Ecologies*. For a counterpoint, see Pickett, "Ecology of the City."

2. See, for example, Kukertz, "Let's Take the Entrepreneurial Ecosystem Metaphor Seriously!"

3. Rademacher, Cadenasso, and Pickett, "From Feedbacks to Coproduction."

4. Pickett and Grove, "An Ecology of Segregation."

sciences and social sciences are inextricably linked.[5] Scientific racism, ecological determinism, and the very demarcation of universal eras such as the Anthropocene all originate in the assumptions of the Enlightenment, the colonial encounter, and the domination of Western European economic, cultural, and political ideology. Yet we note that, while the contemporary science of ecology originated in this legacy, it, like many of the social sciences whose histories are similarly anchored, has undergone significant and reflexive transformation—a process never complete or separate from its history, but, we contend, worthy of consideration and engagement.

Although each of the authors of this essay is disciplinarily grounded in the singular or the plural of ecology, our working collaboration has long found its most fruitful and genuine work to be predicated on humility and translation. Concepts like model, system, and boundary, to name a small subset, have proven to be rich sites for interdisciplinary historiography but also opportunities to notice shared contemporary theoretical assumptions and norms in analytical practice. In this essay, we briefly describe some of these, noting that plural ecologies and the singularized science of ecology share some essential epistemological aspirations, if not actual methodological ground, in contemporary practice. Our goal is thus to further the essential work of more direct and clear conversation, translation, and mutual learning between scholars in the environmental humanities and biophysical ecologists.

Ecologies as Many

As readers of this journal will know, pluralizing ecology emerged largely in response to social critiques of singular ecology as both science and as practice. The plural acknowledges both that basic Western scientific "facts" are the products of historically specific and often violent ideas, procedures, and institutions, and that political, cultural, and historical contexts beyond and outside of Western scientific ones also generate meaningful and consequential explanations, narrations, and experiences of environmental change. Pluralizing ecology is also an important way to underline and explore the myriad ways of knowing more-than-human worlds and to trace the asymmetrical power relations within which they circulate and vie for legitimacy. As Anne Rademacher has cowritten as part of a decade of work on the ecologies of urbanism, for example,

> [An] analytic . . . of urban ecologies assumes the presence of multiple, simultaneous, and overlapping representations of the urban nature-urban culture interface. Each represents competing visions, ideas, and stakes of urban environmental change. Their corresponding efforts to ensure, create, or imagine ecological stability are often infused with, and shaped by, aspirations for political, social, or cultural stability; to promote particular urban ecologies may also involve the reproduction or contestation of cultural ideas of

5. See, for example, Crosby, *Ecological Imperialism*; Chailou, Roblin, and Ferdinand, "Why We Need a Decolonial Ecology"; R. Grove, *Green Imperialism*.

> belonging to certain social groups, including the city, the nation-state, the region, and the realm called the "global."[6]

The primacy of a singular scientific—that is, singular ecological—understanding of environmental change is often deliberately backgrounded in this rubric, quieted as an otherwise more powerful and dominant arbiter of "facts." Yet as this body of work on the ecologies of urbanism evolved in collaboration with scholars from across social disciplines, it became an imperative to assert more clearly the ways that ecologies of urbanism did or did not encompass ecology in the singular. In a more recent volume with K. Sivaramakrishnan, for example, Rademacher cowrites,

> [Scientific urban ecology] approaches may sometimes conceive of ecology as a set of closed loops, and configure singular connections and flows. A singular ecology, in this kind of analysis, provides a neat system, but it also requires erasures and omissions. By extending our understanding of urban ecology to humanistic perspectives that encompass questions of affect, meaning made in lived experience, and the politics of representation, we employ a framework that pluralizes ecology and permits an examination of ecologies—understood as multiple webs of dynamic connection across human and non-human worlds. These webs may be emergent, contested, and often expressive of divergent patterns and processes of change, adaptation, transformation, and re-stabilization.[7]

As we reflected on some of the statements above more carefully, we began to note that in fact a wide range of assumptions about the present and future of the (singular) science of ecology—from its penchant for something often shorthanded as "systems thinking" to its enduring quest for complete, coherent, and causal models—proved worthy of careful discussion, and sometimes revealed more epistemological ground held in common than the passage above implies.

Among many questions that have emerged as the authors' broader interdisciplinary collaboration has progressed,[8] a few seem notable to raise here: When/do scholars assume that the science of ecology is an abstract and universalized science that necessarily brackets the human social, lived experience and cultural meanings that inform layered environmental understandings of different social groups? When/do scholars assume that the view of "systems" in ecology automatically suggests a quest to develop closed causal circuits, static structures, and firm boundaries between system components? When/do scholars assume that scientific ecological knowledge and its application to conservation and restoration policies are always and automatically generated in ways that uphold existing power relations and reinforce the values of elites? Finally, when/do practitioners of the singular science of ecology regard their own analytics as

6. Rademacher and Sivaramakrishnan, *Ecologies of Urbanism in India*, 11.
7. Rademacher and Sivaramakrishnan, *Places of Nature in Ecologies of Urbanism*, 12.
8. See, for example, Locke et al., "Residential Housing Segregation"; J. Grove et al., "Legacy Effect."

valid outside of social life and social context, and therefore generative of what Anna Tsing has described as "universals" while social analytics describe "particulars"?[9]

To follow, we explore the theory and practice of contemporary ecosystem ecology from the standpoint of ecologists, noting that no single discipline is ever free of debates and contests over "correct" epistemological posture. We do not pretend to speak for all ecology, or all ecologies, but we do aim to explore whether contemporary, singular ecology may seem more familiar to scholars in the environmental humanities than is sometimes assumed.

Ecology as One: A Scientific Way of Describing and Knowing Environmental Change

Let us then consider the historical perspective and contemporary approach of the two scientists contributing to this essay: Steward T. A. Pickett and Mary L. Cadenasso. We, Pickett and Cadenasso, ground our work in a discipline whose central idea, ecology, has changed over time. The earliest formal disciplinary definition emerged from biogeography, a branch of natural history that described the largest patterns of similarity and difference in the structure of vegetation cover of the earth, and associated those with climate, geology, and soils.[10] That definition, which remained influential through the middle of the twentieth century, held that ecology was the study of the relationships of organisms and environment,[11] or the distribution and abundance of organisms.[12] This perspective took the environment as a relatively fixed context to which organisms had to adapt and which governed their physiology, behavior, and reproduction.[13] In 1935, Arthur Tansley then argued that the relationships of organisms to each other, and to the physical environment, actually represented a kind of ecological system—an ecosystem—tied together by transfers and feedbacks. Early animal ecologists used ideas such as food webs to capture some of the interactions in which they took interest.[14] Raymond Lindeman, a graduate student of G. Evelyn Hutchinson, was one of the first to measure how energy and nutrients move in ecosystems.[15] In the middle of the twentieth century, following a period during which most "systems thinking" was closely tied to military industrial and technological objectives associated with World War II, the ecosystem view of ecology became widely operational, using technologies of radioactive and stable isotope tracers, for instance, and quantitative systems modeling. Brothers Eugene and Howard Odum[16] were major figures in that new ecosystem ecology, cementing a biogeochemical approach to the discipline. For the Odum brothers and their

9. Tsing, *Friction*.
10. See, for example, the work of Alexander von Humboldt as summarized in Wulf, *Invention of Nature*.
11. McIntosh, *Background of Ecology*.
12. Andrewartha and Birch, *Distribution and Abundance of Animals*.
13. Shelford, *Animal Communities in Temperate America*.
14. Elton, *Ecology of Invasions*.
15. Lindeman, *Trophic-Dynamic Aspect of Ecology*.
16. See E. Odum, *Fundamentals of Ecology*; H. Odum, *Environment, Power, and Society*.

many students, ecology was the study of ecosystems as biogeochemical and energetic structures and networks. As multiple definitions and approaches persisted and competed over time, scientists at the Cary Institute, with which Pickett is affiliated, proposed a broader definition of ecology. From our current perspective,[17] the singular science of ecology is usefully conveyed through some important and effective unifying features, illustrated here by the Cary Institute definition: "Ecology is the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation and flux of energy and matter."[18]

Centered as it is on the transformative role of organisms—plants, (human and nonhuman) animals, and microbes—in the world, almost all of ecology's most significant ideas have something to do with those focal beings. It is worth repeating a core idea: the practice of scientific (singular) ecology embodied in the newer, integrative definition above, investigates how organisms are engaged in transformations of energy, matter, information, and each other. Transformation is the key process here; it signals the disciplinary expectation of constant dynamism and change. Neither stasis nor fixity have a place in the practice of contemporary ecology.

Ecology as defined above is typically operationalized by general principles. Samuel M. Scheiner and Michael R. Willig,[19] for example, identify eight core principles of ecology:

1. Organisms are heterogeneously distributed.
2. Organisms engage in abiotic and biotic interactions.
3. Organism variation generates heterogeneity in ecological processes.
4. Distribution of organisms and their interactions depends on contingencies.
5. Environment is perceived by organisms as heterogeneous in space and time.
6. Resources are perceived by organisms as finite and heterogeneous in space and time.
7. Abiotic and biotic environments constrain organism birth and death rates.
8. Ecologically relevant organismal properties result from evolution.

These principles emphasize spatial heterogeneity and the open-endedness of change over time. As ecologists, we (Cadenasso and Pickett) tend to employ these principles, in turn, guided by background assumptions that regard ecological entities: as open to energy,

17. Here, "our" refers to all three authors of this essay.
18. Cary Institute of Ecosystem Studies, "Definition of Ecology."
19. Scheiner and Willig, *Theory of Ecology*.

material, and information exchange; to be regulated by processes that arise outside their boundaries; to operate via dynamics that can follow multiple pathways; to often lack a single equilibrium point; to be subject to disruption or disturbance; and to encompass humans as residents or agents. Ecological entity functions as a placeholder for any of the many dynamic foci of ecological research, including but not limited to such phenomena as genes, organisms, populations, communities, biogeochemistry, networks, systems, or landscapes.[20] These constitute our practice within the contemporary paradigm of ecology, and we, Cadenasso and Pickett, find them crucially relevant to building bridges with those who study and analyze ecologies in the plural.

We also note that in scientific ecological concept and practice, our shared objective is to hold generality and specificity in dialogue. On the general side of the conversation is ecology as a body of patterns of knowledge, and from this generalizing perspective, we, as ecologists, refer comfortably to one science of ecology. At the same time, as practitioners we operate by locating specific questions within broad processes of diversity, difference, spatial heterogeneity, and change. Some of these questions may include: What influences the changes in collections of organisms over various time scales—from seasonal, to yearly, to decades, to millennia? or, What things and conditions shape and allow the kinds of transformations (such as chemical, energy, or information) in which organisms engage? These questions may seem quite simplistic, but they beget multiple and different answers in analytical practice. Each answer relies on one or several models, in the scientific ecology sense of the term—in which a model is a hypothesized and observed representation of organisms, processes, and their interactions, along with controls on the interactions. Models can be expressed in verbal, mathematical, graphical, or experimental terms and can be specified for particular locations, time spans, or situations.

Each model might take a different approach to the given question: for example, models of change in the identity and mixture of plant species in a specific place over time—succession—can be represented as tables of formulas, flow charts of observed transitions, or diagrams of the changing structure of the vegetation in three-dimensional space. In the present, new data sets that encompass spatially broad landscapes or transitions in forest communities over long time periods provide grounds for new models of the process of succession. In turn, our understanding of succession itself continues to change. There is no singular and fixed "succession," then, but rather context after context through which to revisit it as a process.

Transitioning from general concept to specific context reminds (singular) ecologists, then, that process rather than some universal or essential "thing" helps us address the question of why plant assemblages change over time. There is, then, no fixed and singular answer for any of the core ecological questions posed above. Each can only

20. See Pickett, Parker, and Fiedler, "New Paradigm in Ecology"; Pickett, Kolasa, and Jones, *Ecological Understanding*.

be examined as a variety of specific, contextualized models, bringing together different representations of the interactions that might be occurring at the specific time and place within which we work in the biophysical world. Perhaps each of these models might be called an ecology, but in the (singular) science of ecology we simply call them models. Models, in this sense, are intended to bring together the observations, quantifications, computer programs, or experiments that describe the contextualized changes in their specific terms. The knowledge base of the singular science of ecology thus consists of collections of disparate, complementary, or contradictory models—ecologies—in the plural. Generality thus stands on one side of the dialogue, with marvelous and endless particularity on the other.

We propose that a meaningful way to think about an ecology is as a Western scientific version of empirical, testable knowledge about the material world in which organisms exist, interact, evolve, and transform nutrients, energy, and each other. We propose further that, in the experience of Cadenasso and Pickett, it can, at its best, aim to derive a more integrative understanding of how organisms generate or catalyze myriad transformations. Each ecology, which an ecologist would generally refer to as a model, marks a scientist's observation and record of a time period, a place, or a network of interactions. This, in turn, represents a particular collection of organisms and the connections among and between them, with physical processes and conditions, and the human actions and artifacts of the place. As a broad body of knowledge, ecology in general (without a definite article) is thus in practice a collection of diverse, context-dependent models that aim to better understand and describe transformations in particular circumstances or places.[21] In other words, each specific model constitutes an ecology (with an article). Each detailed model is, for ecological scientists, an ecology of some situation, or the ecology of some forest, field, city, or historical period—ecologies of the multifaceted, contingent, probabilistic, heterogeneous material world, in which humans play a ubiquitous part. We note here a further and essential point: in the authors' practice of contemporary ecological science, we aspire to fully and meaningfully include human beings, their cultures, and their activities as components of ecosystems.[22] We restate further that there is no presumption of scientific neutrality or unpositioned objectivity in the contemporary science of ecology we practice. The knowledge form our practice generates is one among many, and its utilities may be vast or limited. In short, context matters in the contemporary making of (singular) ecology.

From Ecology to Ecologies

In our discussion thus far, many contemporary scholars in the environmental humanities might immediately index fields like the sociology of science, science and technology studies, and the history and philosophy of science. These have all fruitfully explored

21. Pickett, Kolasa, and Jones, *Ecological Understanding*.

22. McDonnell and Pickett, *Humans as Components of Ecosystems*.

how, as a social undertaking, science embodies social processes, power relations, knowledge formation, and context. All science, in other words, is indisputably a historically situated social practice and social product.

As collaborators we (all three authors) embrace this position and note further that in our experience, ecologists are generally becoming more conscious of it. Science, insofar as we have experienced it, is ideally conducted by communities of practitioners who depend on its social nature in order to have confidence in its function. All scholars are, of course, socially positioned agents, working in the context of their experiences, cultures, social status, and biases. However, in our experience ecologists generally aspire to be mindful of the specific and often privileged social contexts within which they work.[23] Like all forms of knowledge-making, science is bound up in power relations, individual egos, and competitions to make persuasive cases. Yet equally true in the authors' experience of ecology is that, as a community of practitioners, reflexivity and positional awareness should and do remain central to our work. The ecology community's efforts here are never perfect, and they may well be uneven, but they exist in ways that may bridge to arenas of social analytics that are also concerned with positionality, representation, and reflexive recognition of multiple forms of knowledge.

It follows then that as authors and collaborators we further embrace the long-held critique of scientific knowledge as never neutral or objective and never fully independent of its community of researchers. We sometimes find, however, a failure of social analyses to fully engage relevant scientific data and knowledge, and vice versa, and as authors and collaborators we wonder how much fuller our analyses across ecological questions might be if born of fuller ecology-ecologies engagement. While older versions of ecology may have derived from a formulaic scientific method assumed to ensure rationality and objectivity, in contemporary practice this is more caricature than reality. Embracing ecology, then, might beget important insights into the extent to which environmental conditions are socially produced, for example, or new ways of seeing the structuring dynamics and conditions within which human agents engage with the more-than-human world.[24]

We are further mindful of critiques that focus on the quest for causal explanations in scientific ecology. It is true that in Pickett and Cadenasso's practice as scientists the knowledge-building process is considered to be answerable to our observed biophysical world. So, we assume, "if this happens or holds, then we should observe that." We then hold that this "if-then" formulation can be applied to observations of the biophysical world across space, to sequences of events through time, to the outcomes of experiments, and to the results of quantitative mathematical models and computer simulations. The "this and that," however, are decided through the lived experience and social position of ecology practitioners—based on discussions, arguments, revelations, and critiques of different social biases. Helen E. Longino's description of this process

23. Childers et al., "Advancing Urban Sustainability Theory."

24. See Phillips, *Truth of Ecology*.

as "transformative interrogation" resonates strongly with our experience.[25] Her framing of a dialogue within an ideally open community that generates creativity and innovation in identifying the "this and that" captures a far more complex process than is conveyed by simple assumptions of causal "if-then" mechanisms. Here, communities of scientists determine how to represent each "this-that," reminding us that these communities must be ever more broad, inclusive, and varied. Naomi Oreskes has advanced a similar, albeit aspirational, point in her recent book, *Why Trust Science?*[26] In a cogent review, Saleem Denholme underscores Oreskes' point that "science is not the realm of any one individual but an open society built on consensus and self-awareness whose strength is mirrored by its diversity."[27] Rather than framing ecology as a quest to discern universal causal mechanisms or totalizing models in environmental change, then, we stress that all scientific understanding is, and ideally expects, an open-ended process. It is never final, always partial, and perhaps nowhere more dynamic than in contemporary ecosystem ecology.

And yet. The entrenched power networks in which we as scientists operate, and the long-standing and tenacious social biases we all hold, scientists and nonscientists alike, can and do influence the places we study, the questions we ask, and the data we privilege. This, too, is a characteristic of science that marks it as an inevitably social process and its knowledge as a social product. As in all forms of knowledge production, this ultimate social embeddedness of science can only be held in reflexive tension with the quest to understand how the environment and society transform—and how we might find a place for the singular science of ecology among the ecologies of social analysis.

History and the present are replete with examples of scientists serving despicable social agendas. Infamous examples abound, including the use of evolution to justify racism, with data on eugenics to act as its support, paternalism to silence the perspectives of women, and all manner of moments in which scientific knowledge was and is deployed in the service of symbolic or overt violence, reproducing inequities, deepening marginalities, and skewing already asymmetrical relations of power. We neither deny this history nor regard it as inconsequential; in fact, it forms the basis of some of our work as collaborators.[28] Yet, as with all social forms of knowledge creation, the only way to address these effects is to build the field's capacity for reflexivity and to refine it through reinvention. Part of this process involves including and amplifying as many possible backgrounds, experiences, social positions, racial and gender identities, and more, in the community of scientists. Inclusion and difference are not simple decoration; we hold that they are and must be the core of the knowledge generation process, from innovation to criticism.

25. See, for example, Longino, *Science as Social Knowledge*; Kellert, Longino, and Waters, *Scientific Pluralism*.

26. Oreskes, *Why Trust Science?*

27. Denholme, "Some Studies Are More Equal."

28. For example, see Locke et al., "Residential Housing Segregation"; Pickett and Grove, "Ecology of Segregation."

Dueling ecologies—or different and perhaps conflicting models of places and processes in dynamic conversation—can only exist when there is a diverse assemblage of knowledge makers fully present at the proverbial knowledge-making table. Transformative interrogation, in other words, requires many and varied voices and experiences. It requires social reflexivity and the expectation that process—not universal explanation—is the epistemological guide.

Yet we also note a consistent confusion among scientific ecologists—those whose first analytical impulse is in service of ecology in the singular. That confusion derives from the fact that the social sciences and humanities have an extraordinary richness of different ways in which they view ecology, some of which resonate with the scientific discipline of ecology as we have described it above, and many of which do not.[29]

Translations, Resonance, and Learning Together

Whether as a singular science or pluralized analytical strategy, *ecology* and *ecologies* suggest the need to continue to strive for meaningful links between the (singular Western) science of ecology and rich, varied, and plural ecologies of social scientific and humanities analysis. We contend that part of the challenge is understanding the linkages that may already be there, albeit sometimes obscured by shared terms but divergent meanings, the dynamism of disciplinary practices over time, and the often perspective-narrowing norms of academic knowledge creation.

Whether in ecology or ecologies, it is always fashionable to invoke interdisciplinary or transdisciplinary imperatives. Yet as authors and collaborators, our actual scholarly practices often lead us back to scientific perspectives on one hand, and social perspectives on the other. To conclude, then, we caution against disciplinary, defensive postures. In reviewing the singular and plural as threads that might weave together, we suggest that all ecologists—both social and scientific—have responsibilities to one another and to their interlocutors. Those interlocutors are human and more-than-human, and in our era of climate change they are the planet itself.

The act of defining one's terms—the gesture of translation—is foundational to fuller and more effective learning, and indeed to social and environmental justice.[30] Articulating the *what*, *why*, and *how* of the analytics scholars employ amplifies the embedded assumptions for which those analytics stand. As authors and collaborators, we are committed to understanding the ways in which all environmental researchers use the terms *ecology* and *ecologies*, and we humbly invite more inclusive conversations that begin with, "And by ecology/ecologies I mean . . . " Our experience in so doing has shown us ways that both approaches recognize the dynamic relationship between the general and the specific, which has generated a clearer rationale for collaborative work and learning, and, we hope, a more robust understanding of the myriad ways that social and biophysical processes coproduce one another.

29. For comparison, see Guattari, *Three Ecologies*.

30. Harvey, *Justice, Nature, and the Geography of Difference*.

ANNE RADEMACHER is professor of environmental studies at New York University. Her research explores ecological, social, and political transformation in cities.

MARY L. CADENASSO is professor of landscape and urban ecology in the Department of Plant Sciences at the University of California, Davis. Her research investigates ecological processes in coproduced, social-ecological systems. Currently this includes impacts of drought and fire on vegetation and nutrient dynamics.

STEWARD T. A. PICKETT is a distinguished senior scientist at the Cary Institute of Ecosystem Studies in Millbrook, New York. His current interests include urban ecology, regional landscape processes, and the ecology of racialized segregation.

References

Andrewartha, H. G., and Charles Birch. *The Distribution and Abundance of Animals*. Chicago: University of Chicago Press, 1954.

Cary Institute of Ecosystem Studies. "Definition of Ecology." https://www.caryinstitute.org/news-insights/definition-ecology (accessed January 15, 2022).

Chaillou, Aurore, Louise Roblin, and Malcom Ferdinand. "Why We Need a Decolonial Ecology." *Green European Journal*, June 4, 2020. https://www.greeneuropeanjournal.eu/why-we-need-a-decolonial-ecology/.

Childers, Daniel L., Steward T. A. Pickett, J. Morgan Grove, Laura Ogden, and Alison Whitmer. "Advancing Urban Sustainability Theory and Action: Challenges and Opportunities." *Landscape and Urban Planning*, no. 125 (2014): 320–28.

Crosby, Alfred W. *Ecological Imperialism: The Biological Expansion of Europe, 900–1900*. 2nd ed. Cambridge: Cambridge University Press, 2004.

Denholme, Saleem. "Some Studies Are More Equal than Others." *Nature Physics* 16, no. 2 (2020): 121.

Elton, Charles S. *The Ecology of Invasions by Animals and Plants*. London: Chapman and Hall, 1933.

Grose, Margaret. *Constructed Ecologies: Critical Reflections on Ecology with Design*. New York: Routledge, 2017.

Grove, J. Morgan, Laura A. Ogden, Steward T. A. Pickett, Chris Boone, Geoff Buckley, Dexter H. Locke, Charlie Lord, and Billy Hall. "The Legacy Effect: Understanding How Segregation and Environmental Injustice Unfold over Time in Baltimore." *Annals of the American Association of Geographers* 108, no. 2 (2017): 524–37. https://doi.org/10.1080/24694452.2017.1365585.

Grove, Richard H. *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1860*. Cambridge: Cambridge University Press, 1995.

Guattari, Félix. *The Three Ecologies*. London: Athlone, 2000.

Harvey, David. *Justice, Nature, and the Geography of Difference*. Cambridge, MA: Blackwell, 1996.

Kellert, Stephen H., Helen E. Longino, and C. K. Waters. *Scientific Pluralism*. Minneapolis: University of Minnesota Press, 2006.

Kuckertz, Andreas. "Let's Take the Entrepreneurial Ecosystem Metaphor Seriously!" *Journal of Business Venturing Insights*, no. 11 (2019): e00124. https://doi.org/10.1016/j.jbvi.2019.e00124.

Lindeman, Raymond L. "The Trophic-Dynamic Aspect of Ecology." *Ecology* 23, no. 4 (1942): 399–417. https://doi.org/10.2307/1930126.

Locke, Dexter H., Billy Hall, J. Morgan Grove, Steward T. A. Pickett, Laura A. Ogden, Carissa Aoki, Christopher G. Boone, and P. M. O'Neil-Dunne. "Residential Housing Segregation and Urban Tree Canopy in Thirty-Seven US Cities." *npj Urban Sustainability* 1, no. 15 (2021): 1–9. https://doi.org/10.1038/s42949-021-00022-0.

Longino, Helen E. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton, NJ: Princeton University Press, 2020.

McDonnell, Mark J., and Steward T. A. Pickett, eds. *Humans as Components of Ecosystems: The Ecology of Subtle Human Effects and Populated Areas*. New York: Springer, 1993.

McIntosh, Robert P. *The Background of Ecology: Concept and Theory*. Cambridge: Cambridge University Press, 1985.

Odum, Eugene P. *Fundamentals of Ecology*. Philadelphia: W. B. Saunders, 1953.

Odum, Howard T. *Environment, Power, and Society*. New York: Wiley-Interscience, 1970.

Oreskes, Naomi. *Why Trust Science?* Princeton, NJ: Princeton University Press, 2019.

Peet, Richard, and Michael Watts. *Liberation Ecologies: Environment, Development, and Social Movements*. New York: Routledge, 2004.

Phillips, Dana. *The Truth of Ecology: Nature, Culture, and Literature in America*. Oxford: Oxford University Press, 2003.

Pickett, Steward T. A. "Ecology of the City: A Perspective from Science." In *Urban Design Ecologies*, edited by Brian McGrath, 162–71. Chichester, UK: John Wiley and Sons, 2013.

Pickett, Steward T. A., and J. Morgan Grove. "An Ecology of Segregation." *Frontiers in Ecology and the Environment*, 18, no. 10 (2020): 535. https://doi.org/10.1002/fee.2279.

Pickett, Steward T. A., Jurek Kolasa, and Clive G. Jones. *Ecological Understanding: The Nature of Theory and the Theory of Nature*. 2nd ed. San Diego: Academic, 2007.

Pickett, Steward T. A., V. Thomas Parker, and Peggy L. Fiedler. "The New Paradigm in Ecology: Implications for Conservation Biology above the Species Level." In *Conservation Biology: The Theory and Practice of Nature Conservation, Preservation, and Management*, edited by Peggy L. Fiedler and Subodh K. Jain, 65–88. New York: Chapman and Hall, 1992.

Rademacher, Anne, Mary L. Cadenasso, and Steward T. A. Pickett. "From Feedbacks to Coproduction: Toward an Integrated Conceptual Framework for Urban Ecosystems." *Urban Ecosystems* 22, no. 1 (2019): 65–76. https://doi.org/10.1007/s11252-018-0751-0.

Rademacher, Anne, and K. Sivaramakrishnan, eds. *Ecologies of Urbanism in India: Metropolitan Civility and Sustainability*. Hong Kong: Hong Kong University Press, 2013.

Rademacher, Anne, and K. Sivaramakrishnan, eds. *Places of Nature in Ecologies of Urbanism*. Hong Kong: Hong Kong University Press, 2017.

Scheiner, Samuel M., and Michael R. Willig. *The Theory of Ecology*. Chicago: University of Chicago Press, 2011.

Shelford, Victor Ernest. *Animal Communities in Temperate America, as Illustrated in the Chicago Region: A Study of Animal Ecology*. Chicago: University of Chicago Press, 1937.

Tsing, Anna Lowenhaupt. *Friction: An Ethnography of Global Connection*. Princeton, NJ: Princeton University Press, 2011.

Wulf, Andrea. *The Invention of Nature: Alexander von Humboldt's New World*. New York: Knopf Doubleday, 2015.