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Introduction

The seed for this book was planted in 2005 when we organized an *ad hoc* graduate seminar on ecology's philosophy of science. Earlier experiences had demonstrated how such seminars, rich in readings and discussions, were effective ways to explore unfamiliar and complex topics. After we announced the seminar, some 15 students joined us, and as soon became clear, they were as uneasy and puzzled about philosophical problems and solutions in ecology as we were.

What were some of these questions that drove our explorations at the interface between ecology and philosophy? First, what was the nature of a scientific philosophy associated with ecology – if there was one? Ecology itself seemed to be disintegrating into ever more sub-fields with fragments reintegrating into meta-sciences like earth system science, conservation biology, and so forth. Did anything "hold the center" of ecology? Could there be a single philosophy for all of our science, and if there were many philosophies, were they coherent with one another?

Second, what place did laws or theories hold in ecology? In fact, semantic usage of these terms was confusing. "Theory," "law," "paradigm," and "model" clearly meant different things to different people. Maybe after we clarified the language we would discover what these terms meant to ecologists.

Third, in the apparent absence of widely accepted generalizations about the nature of the world, how could we determine whether ecology was actually progressing in its quest to understand that part of nature it addresses? And what constituted progress? Were ecologists seeking objective truth, simplicity, unification, coherence, human well-being, or some other objective against which improvement could be assessed? To be sure, ecology had accumulated an enormous understanding of the details of particular situations and phenomena: how isolated functions

worked, the imprint of history, the importance of spatial relations, and the criticality of scale definition. Aside from this mass of information, though, was ecology actually assembling a set of general theories or rules that could be universally applied – and to what ends? For some of us, most of the more current conceptualizations of nature seemed to be merely flashy jargon supported by *avant garde* mathematical, statistical and analytical methods that, with some historical perspective, simply echoed older views. Had we achieved a more profound (as opposed to detailed) understanding of nature than Forbes described in 1887?[1] If so, what was the basis for this claim?

Fourth, we realized that standard notions and terminology of philosophy were largely missing from ecological debates. This suggested that there really was little explicit connection between science – at least this science – and philosophy. But was such an association important or useful?

As the seminar progressed, we came to realize and grudgingly admit that our scientific activities were driven by our human needs and wants, as well as personal interests. This too was a part of ecological philosophy. In spite of our high-minded rationalizations of what we do, we had to admit we explored nature along paths we preferred for sometimes unknown (or at least unexamined), and often non-rational reasons. Some of these motivations derived from our individual cognitive development, cultural fixations, sense of natural aesthetics, or ethical impulses. Very often, funding availability set our ecological agendas.

We asked ourselves – and invite readers to do the same – these questions:

(1) Why did we choose to become ecologists? Was it the intellectual qualities of the material, the lifestyle, the social approbation of the field, the possible relevance to stewardship of Earth, the beauty and value of organisms and their interactions, the potential to ameliorate human suffering, or something else? What affect did these motivations have on what we chose to study and claimed to believe?
(2) Are the things we study real, or did we just make up some of them? Is nature truly composed of populations, organized into communities, and related to the physical universe as ecosystems? Are these entities really demonstrable? Does it matter if ecology is a useful fiction? Are there limits to what we can create?
(3) If we are serious about the reality of entities and processes we study, then what standards of evidence do we require to test the truth of what we think? On what grounds can we say yes, here is the evidence for a population, community or ecosystem and its properties? Is there

more than one legitimate way to perceive reality? Is just any way allowable or are there constraints?

(4) Are the things that we believe to be true, just true under certain circumstances, or are any of them universally true? If they are only contingently true, what rules do we follow to relate the necessary auxiliary information to apply a "law" to a particular case? And exactly what do we mean by something being true?

(5) Is there just one truth about how nature *really* is – an ecological "holy grail" – or can there be more than one? Are truths relative to the domains in which they exist or can we access absolute Truth? Can some truths be only partial, but still have great value? Is it possible to know the truth or are we so burdened by our own cultural and individual conditioning that we may only get glimpses through distorted personal lenses? Is the discovery of objective truth the best or only purpose of ecology?

We didn't have to look far to find expressions of confusion, criticism, cynicism, angst, and counter-angst in the ecological literature (Box 1.1).[2] We weren't alone in our suspicions. Many of the voices we read were harshly critical and often contradicted one another.

At the conclusion of the seminar, the students returned to their courses, teaching, and degree research; doing what they were paid – and paying – to do. Time will tell whether the seminar experience has lasting meaning for them. We, the putative instructors of the course, remained so intrigued by this experience, however, that we continued to read, discuss with others, and shape our tentative conclusions into essays. Those essays finally led to this book.

Our book is organized into six sections, each representing a specific purpose. These objectives are:

(1) to illustrate the ambiguity, conflict, confusion, and vagueness[3] within the ecological community about the intellectual basis of our pursuit of useful knowledge and "truth";
(2) to explore reasons why ecology is especially vulnerable to such uncertainties;
(3) to introduce the basic framework of philosophy, in general, and the pursuit of truth and knowledge, in particular;
(4) to introduce a conceptual framework that both accounts for current practices and advocates creating a sound basis for what ecologists ought to believe is valuable, known and real, and how they can justify their claims to know what is true about nature;

Box 1.1
Critical statements about ecology

"*ecology is awash with all manner of untested (and often untestable) models . . . many simply elaborations of earlier untested models.*" (Simberloff 1980: 52).

Speaking of fields including ecology: "*goals and criteria are poorly enunciated, less accepted, and more sporadically applied. These sciences are less coherent, they contain many constructs of dubious merit, and their growth is lethargic.*" (Peters 1991: 1).

Paraphrasing a listing of short-comings: "*1) lack of rigour, 2) weak predictive capability, 3) failure to harness modern technology.*" (DiCastri and Hadley 1986: 300).

"*ecology is dominated by complex and inadequately undefined* [sic] *terms which confound the development of predictive theory. As a result, ecological classifications, ecological characteristics and ecological relationships may refer to phenomena that vary with each change in focus, scale, or author, and ecologists are often not sure they are talking about the same thing.*" (Peters 1991: 104).

"[*The*] *attempt to establish ecology as a mechanistic science like physics . . . is self-defeating.*" (Keller and Golley 2000: 320).

"*much of ecology is confused in its goals, uncertain of its strengths, and inconsistent in its terminology.*" (Rigler and Peters 1995: 77).

"*We shall argue that, insofar as ecology is required for solving practical environmental problems, it is more a science of case studies and statistical regularities, than a science of exceptionless, general laws.*" (Schrader-Frechette and McCoy 1993: 1).

"*We are practicing ecologists. We are not statisticians, numerical analysts, or philosophers.*" (Hilborn and Mangel 1997: 11).

"*Enough of . . . poking ecological material to see what happens in some general way. Ecology needs to identify the critical points of tension, and then the empiricists need to test predictions coming from explicit theory.*" (Allen and Hoekstra 1992: 332).

"*Ecology is replete with dichotomous debates, divergent scales, causal alternatives, and conceptual difficulties that can be solved by integration.*" (Pickett *et al.* 2007: 24).

(5) to suggest ways that ecologists can come to terms with explanatory and, to the extent possible, predictive theory in a contingency-laden, heterogeneous, changing world; and
(6) to consider the nature of what we teach, the state of cognition and attitude of our students, and how our teaching serves as a kind of intellectual template that shapes ways of knowing into a common form across the generations.

We know that ecologists don't care about philosophy very much. Even in the most academic variants of self-defined basic research we are uncomfortable and impatient with philosophy. Ecologists may well ask (and do): does this philosophizing matter – or is it just pedantic distraction lying between us and doing "good science"? As practical as ecologists tend to be, it is easy for established scientists to continue to work comfortably in their studiously guarded domains, continuing to do what assures professional advancement (i.e. generates contracts, external funding and refereed publications). As such, near-consensus concerning philosophical skepticism is to be expected given the sociology of science. We are all in this together – participating in a culture that reinforces the same, familiar, and comfortable ways of asking questions, securing funds, performing research, and valuing ideas. This may be especially true with government-sponsored, basic research. The norms of science become self-reinforcing as successful researchers become agency panelists, program directors, National Research Council committee members, book editors, and societal officers. It is natural, then, for us to become entrenched via positive feedback loops in this successful mode of doing business. In that context, we can understand the irony that new or unusual phenomena external to the human institution of ecology (e.g. acid rain, exotic species invasions, disease and pest epidemics, epic wildfires, climate change, and requirements for ecological restoration) dramatize the weaknesses of ecology as a science on one hand, and stimulate it to be a better science on the other. Applied ecology is good medicine for basic science. There's nothing like a dose of empiricism to treat a theoretical malaise – and nothing like a jolt of economics and politics to stimulate inquiry.[4]

But we return to the question, "Does philosophizing matter?" Whereas ecologists can, and do, respond negatively, pointing to success as internally defined by the culture of which we are a part (many "productive" scientists are utterly disassociated, intellectually if not operationally, from philosophical matters), we insist that philosophy always matters and we should do better. If we are to be scholars, rather than technicians (which is not to disparage technicians, who are essential to the practice of

ecology), then it is incumbent upon us to think deeply and critically about the nature of our work. Surely a university education, let alone a Ph.D., means more than mere methodological competence.[5] And we will insist that a grasp of philosophy is no less (and perhaps more) important if we teach.

Where students – those outside our culture peering in – encounter our worldview(s), we experience a revealing disjunction between our way of seeing nature and seeking evidence to inform ourselves, and theirs. Of course, we see a central task of our teaching as simply informing students of our way of perceiving nature. But, as those who teach general ecology to undergraduates know well, our multiple approaches to understanding nature and our fuzzy systems of theories and laws seem incoherent, or at least disconcerting, to our "naïve" students. These innocents see that the emperor has an elaborately woven fabric of rhetoric, but suspect that such obfuscation is surely evidence of nakedness. Teachers may interpret this as the students' failure to learn a complex and nuanced science, but it could be our failure to appreciate the students' philosophical realization. Just as a child recognized the emperor had no clothes, our students' more nascent, uncommitted states allow them to see through the cloak of our authority (we write the texts and exams) into the seemingly incoherent ideas of what ecologists contend is real and how they claim to know.

We propose in this book a philosophical position that is "descriptive" of our perception of the contemporary, American ecological endeavor. This description is explicitly tolerant and intentionally pluralistic, albeit not without limits. On the other hand, this position is also "prescriptive," in maintaining that we ought to recognize and tolerate different ways – but not just any ways – of understanding nature. This position requires that we allow the possibility of multiple truths and that we seek value in different ways of knowing nature, but it also demands that we judge with rigor and discrimination the evidence used to support claims about truth and knowledge. We term this position "constrained perspectivism."

Contrary to the sense we may have conveyed to this point that ecologists are philosophically ambivalent or even averse, we have come to believe that the position of constrained perspectivism is the most widespread philosophy that American ecologists hold, even if they aren't entirely conscious of it. And, as we shall see, this lack of conceptual clarity has led us into unproductive conflicts which might well have been avoided – or more effectively resolved – if the disputants had been able to see the philosophical roots of their positions. In a sense, we seek to make

the implicit explicit, so that ecologists can more effectively and confidently pursue their research and teaching. This task is analogous to moving from a vague idea, to a graphical representation, and then to a mathematical expression. When we become more precise in our understanding of nature – or science – we can appreciate the limits and opportunities of a system. Our philosophical prescription should be non-threatening to the vast majority of ecologists and, indeed, helpful to their understanding of their own beliefs and behaviors – as subconscious as those might be. It seems to us that while ecologists do not share an acknowledged "conventional wisdom" (philosophy) about their discipline, they do share a "conventional intuition." Many will read this and say, "Why of course – this is how we do it. This is not news!" In this regard, William James, the great American pragmatist philosopher, wrote:[6]

> I fully expect to see the pragmatist view of truth run through the classic stages of a theory's career. First, you know, a new theory is attacked as absurd; then it is admitted to be true, but obvious and insignificant; finally it is seen to be so important that its adversaries claim that they themselves discovered it.

Some may find "constrained perspectivism" (which is derived from pragmatism) to be absurd, but we think these will be few. Rather, we expect that many will find it to be obvious once it is explicated, as might be expected of an account that accords with one's intuitions and experiences – even if the precise terms and form of the account weren't quite self-evident.[7] As for adversaries, and we are not so naïve as to believe that our philosophy of ecology will be without its critics, it may be a bit too optimistic to expect that they will embrace our views as being their own – at least within our professional lifetimes. In the end, we hope that this book will clarify for ecologists how we mostly think and behave, and allow us to better pursue our understanding of nature.

Endnotes

1. Forbes, S. A. 1925. The lake as a microcosm. *Illinois Natural History Survey Bulletin* **15**: 537–550. Reprint of original publication in 1887 from the *Bulletin of the Scientific Association (Peoria, IL)* (77–87).
2. Simberloff, D. 1980. The sick science of ecology: symptoms, diagnosis, and prescription. *Eidema* **1**: 49–54; Peters, R. G. 1991. *A Critique for Ecology*. Cambridge, UK: Cambridge University Press, 1; De Castri, F. and M. Hadley. 1986. Enhancing the credibility of ecology: is interdisciplinary research for land use planning useful? *GeoJournal* **13**: 299–325; Peters, *A Critique for Ecology*, 104; Keller, D. R. and F. B. Golley. 2000. *The Philosophy of Ecology: From Science to Synthesis*. Athens, GA: University of Georgia Press, 320; Rigler, F. H.

and R. Peters. 1995. *Science and Limnology*. Oldendorf/Luhe: Ecology Institute, 77; Schrader-Frechette, K. S. and E. D. McCoy. 1993. *Method in Ecology: Strategies for Conservation*. Cambridge, UK: Cambridge University Press, 1; Hilborn, R. and M. Mangel. 1997. *The Ecological Detective: Confronting Models with Data*. Princeton, NJ: Princeton University Press, 11; Allen, T. F. H. and T. W. Hoekstra. 1992. *Toward a Unified Ecology*. New York: Columbia University Press, 332; Pickett, S. T. A., J. Kolasa and C. G. Jones. 2007. *Ecological Understanding: The Nature of Theory, the Theory of Nature*, 2nd ed. San Diego, CA: Academic Press, 24.

3. McNeill, D. and P. Freiberger. 1993. *Fuzzy Logic*. New York: Simon and Schuster.
4. Wimsatt, W. C. 2007. *Re-engineering Philosophy for Limited Beings*. Cambridge, MA: Harvard University Press, 6. "this view of science and nature [re-engineering] is constructed largely (as with all creative acts) by taking, modifying, and reassessing what is at hand, and employing it in new contexts, thus *re*-engineering. . . . And any engineering project must be responsive to real world constraints, thus realism. Our social, cognitive, and cultural ways of being are no less real than the rest of the natural world, and all together leave their marks. But putting our feet firmly in the natural world is not enough. Natural scientists have long privileged the "more fundamental" ends of their scientific hierarchy, and pure science over applied – supposing that (in principle) all knowledge flowed from their end of the investigative enterprise. Not so."
5. Ibid, 26. "An adequate philosophy of science should have normative force. It should help us to do science or, more likely, to find and help us avoid sources of error, since scientific methodologies are by nature open-ended."
6. James, W. 2006 (1906). What pragmatism means. In *Pragmatism Old & New: Selected Writings*, ed. S. Haack. Amherst: Prometheus, 289–308.
7. Wimsatt, *Re-engineering Philosophy*, 8. Constrained perspectivism may be a more formal description of Wimsatt's "heuristic techniques" involving scarcely conscious mental judgments we all make to understand how things work.

2

Conceptual confusion in ecology

Ecologists understand the nature of science, of ecology, and of nature itself in various ways. Why is there such variety? And does it matter? Should this heterogeneity be seen as a regrettable but necessary source of confusion, symptomatic of an underdeveloped discipline? Should it cause a sense of intellectual inadequacy or even anguish and stimulate efforts to unify or homogenize our understandings? Or should it be recognized as a necessary and natural source of strength in the science? In this chapter, we explore the sources of variety at a philosophical level and how variety in both perception and practice creates confusion and controversy on one hand, but also represents the raw material of ecology and the efficacious products of our science on the other. We also explore whether these questions might better be considered as having value to ecologists when understood in terms of the purposes that motivate them, rather than being rejected because of the ways that they differ from our normal, entrenched, or monolithic perspectives.

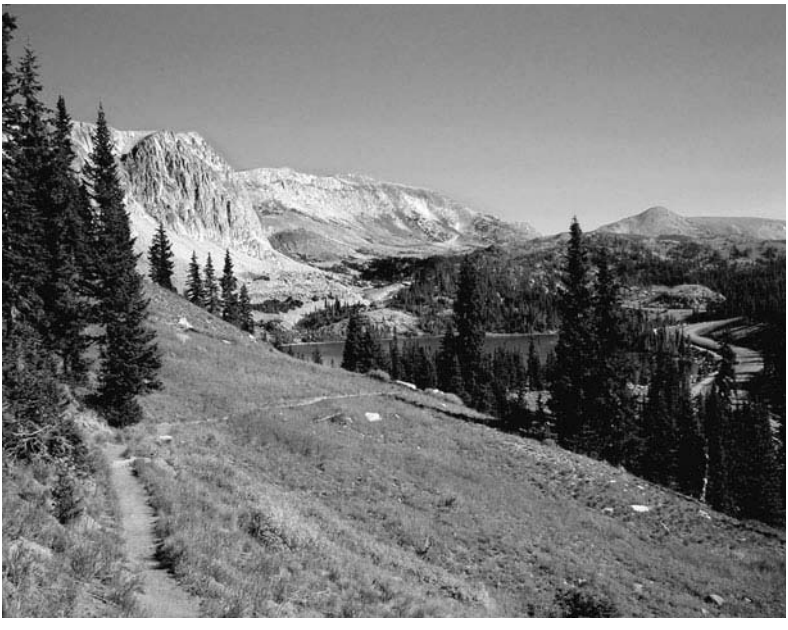
The roots of confusion

Even if we are individually certain about the philosophical underpinnings of what we do, it should be evident from a walk down the hall of a biology or ecology department in the average American university that there is little consensus in how the natural world is seen or how the science of ecology is practiced. If one were to show an image of a landscape to an array of ecologists and if each individual were asked privately what relevant ecological phenomenon was portrayed in that image, every response would be different in some respect (Box 2.1).

Differences among colleagues' perceptions are more profound than this exercise demonstrates. They are only a glimpse of how we differ in

Box 2.1
Diversity of perceptions expressed by ecologists

This image of the Snowy Range in the Medicine Bow Mountains of Wyoming (below) was distributed to 15 ecologists at the University of Wyoming with this question: "... what is the first ecological message/concept/paradigm/story/example that comes to your mind in this image?"



The following illustrates the range of responses to this image.

1. Examples of community development following disturbance: rockslides, glaciation.
2. Limits to seedling establishment in this arid, treeline environment.
3. The Snowy Range may be one of the most exemplary (as well as accessible) examples of the subalpine/alpine ecotone in the Intermountain West.
4. The impact of humans on fragile systems.