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Theoretical ecology as etiological from the start

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ABSTRACT

The world's leading environmental advisory institutions look to ecological theory and research as an objective guide for policy and resource management decision-making. In addition to the theoretical and broadly philosophical merits of doing so, it is therefore practically significant to clear up confusions about ecology's conceptual foundations and to clarify the basic workings of inferential methods used in the science. Through discussion of key moments in the genesis of the theoretical branch of ecology, this essay elucidates a general heuristic role of teleological metaphors in ecological research and defuses certain enduring confusions about work in ecology.

As ecology is the science of complex biophysical dynamics directly relevant to environmental policy and resource management decision-making, advisory institutions around the world have increasingly emphasized the guiding role the science should play in such decision-making. Indeed, ecology is now seen as an objective guide for "urgent political, ethical, and management decisions about how best to live in an apparently increasingly-fragile environment" (Colyvan, Linquist, GreyGriffiths, Odenbaugh, & Possingham, 2009, p. 1).

This is reflected in countless regional, national, and international directives and pieces of legislation that call to protect ecological entities (e.g. ecosystems), their functionality (e.g. stability), and properties (e.g. biodiversity) (Donhauser, 2016). For example, the U.S. Environmental Protection Agency (EPA), European Union, and National Resources Canada each emphasize 'long-term sustainability of ecosystems' structure and functioning' as an overarching guide for all policy and management strategy decision-making (cf. Apitz, Elliott, Fountain, & Galloway, 2006; McAfee & Malouin, 2008; McFadden & Barnes, 2009; McGinty, Pipkin, & Gelburd, 1995). And one finds many explicit normative claims about ecological entities in the expanding literature on mitigating losses of human goods (e.g., agricultural species and human health benefits) due to climate change (see Donhauser, 2016). For instance, the United Nations Framework Convention on Climate Change 2013 analysis of non-economic losses lists loss of "ecosystems," "ecosystem services" (goods dependent on ecosystem functionality), and "biodiversity" (an ecosystem property), as the "main types of non-economic losses" that will be experienced due to climate change (UNFCC, 2013, p. 4).

Explicit claims that environmental policy-makers and resource managers should consult ecological theory as an objective guide for decision-making are also easy to find. For example, the EPA's general resource management guidelines emphatically state that efforts to protect any particular natural ecosystem should be guided by "the latest scientific understanding of the inherent properties (i.e., patterns and processes) of that ecosystem type" (2002, p. 78). Leading ecologists even straightforwardly promise that ecological theory can serve as "a strong guide for environmental management and resource conservation" (Jørgensen, 2006, p. 21).

At the same time, critics of ecology-guided policy continue to contend that such promises ring empty and warn that advisory organizations have been foolhardy to embrace ecological theory as a guide for decision-making—on the grounds that the science has shaky philosophical foundations (see Sagoff, 2013 for recent arguments). Many have questioned whether the entities described in ecological theory exist in any meaningful sense at all (see Jordan, 1981; Sagoff, 1997; Schizas & Stamou, 2010; Sterelny, 2001; Wittbecker, 1990).[1] And numerous authors have argued that theoretical ecological research is empirically unfounded (even empirically unfoundable), and contend that directives that advise looking to it for guidance in policy and management decision-making are therefore deeply problematic (cf. Hall, 1988; Haskell, 1940; Peters, 1991; Sagoff, 2003, 2013).

Of course, ecology's critics are right that it is advisable to recognize the limitations of theories and research methods

[1] I am sympathetic to the view that many concepts employed in ecology (e.g. 'ecosystem' and 'community') can, and arguably do, serve as useful and practically valuable theoretical constructs even if they haven't any naturally delineated referents; cf. Fitzsimmons, 1999 and O'Neill, 2001.

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employed in the science. To best understand those limitations and how ecological research may be useful for practical decision-making despite them, it is also crucial to dissipate confusions about ecology's conceptual foundations and to clear away misguided critiques that engage such confusions. Numerous philosophers and ecologists have attempted to flesh out a reasonable metaphysics and epistemology of ecology with the aims of:

contributing to ecology itself by working toward a unifying theoretical foundation;
exploring the implications of inferential methods used in ecology for philosophy of science in general;
better understanding potential applications of research processes used by ecologists;
defending the science against misguided criticisms (see, for example, Cooper, 2007; Eliot, 2011; McIntosh, 1985; Odenbaugh, 2011b; Reiners & Lockwood, 2010).

Many confusions about ecology's philosophical foundations stem from the absence of a straightforward narrative of the genesis and evolution of thinking in the science. So, an approach that has been fruitful in philosophical work on ecology has been to illuminate conceptual innovations that brought the science to its current form through analyses of key moments in its historical development (see Donhauser, 2014; Golley, 1993; Odenbaugh, 2007, 2011a; Ulanowicz, 1999; de Laplante & Picasso, 2011). This essay employs this jointly historical and analytic approach to clarify certain inferential methods used in modern ecology and clear away a class of persisting confusions about the science's conceptual foundations.

In §1, I discuss major innovations in early ecologists' thinking about the nature of ecological entities that mark the historical beginning of *modern* ecology. I then examine the role of teleological characterizations in modern ecology—i.e. characterizations of ecological populations, communities, or systems, as 'goal-directed' or as 'functioning toward some goal state.' In §2, I elucidate a general epistemic role of such characterizations through discussion of G. Evelyn Hutchinson's landmark paper "Circular Causal Systems in Ecology" (1948), which I place as the first, and in certain ways archetypal, *theoretical* research project in modern ecology. I argue that Hutchinson (1948) does not use teleological characterizations of ecological phenomena literally but as *metaphors* that aid in developing "mechanistic," component-to-component, accounts of the underlying causes of observable ecological network-level dynamics. I support this reading by offering an operational account of the heuristic role teleological metaphors play in the reasoning process he employs in his landmark paper. I contend, moreover, that ecologists have apparently followed Hutchinson, and typically use teleological characterizations as metaphors that play heuristic roles in advancing understanding of the underlying mechanics of ecological network-level phenomena.

In §3, I then further defend my position and critically respond to opposing literalist construals of teleological characterizations in ecology—including arguments according to which theoretical ecological research is unscientific, and allegedly of no value for practical decision-making, because it is supposed to rely on teleological, "magical," thinking (Sagoff, 2013, p. 248). I support my contention that robust teleological views are not and have not been embraced as a mainstream convention within ecology since Hutchinson (1948) at least, by pointing to textual evidence showing that ecologists have stayed on board with the idea that teleological characterizations are not literal but instrumentally useful metaphors. I then show that ecologists can block claims that their functional accounts of ecological phenomena rely on commitments to a robust teleology by outlining a deflationary, etiological and instrumentalist, view available to them. In essence, in stark contrast to a teleological metaphysics that accepts "top-down" causality, the endorsed 'etiological' view sees teleological characterizations as shorthand *ways of describing* the complex component-to-component, "bottom-up" or "efficient," causes of ecological network-level properties.

1. Time-stamping the birth of modern ecology

While I cannot deny that some modern ecologists embrace robust teleological metaphysics, I will establish that this commitment *is not relied on within modern theoretical ecology*—as some authors would have us believe. Since I will begin to establish this by discussing key moments in the historical genesis of modern ecology and the subfield theoretical ecology, it is sensible to begin by pinning down when *modern* ecology began. As I understand the history of ecology, modern ecology began when, in certain well-known works, ecologists traded ontologically robust ideas of populations, communities, and ecosystems, for a more ontology-neutral view according to which ecological entities are contingent causal networks resulting from species-typical interactions between organisms and components of their shared environment(s) (Donhauser, 2016).

Despite the fact that ecologists still use language that can easily elicit misinterpretations of their ontological commitments, the ecological literature shows that this more neutral view has been the received view for a long time. Some authors argue that Karl August Möbius (1877) articulated this understanding of ecological entities as contingent causal networks in the 1800s, and others argue that the view took root even earlier (see, for example, Shrader-Frechette & McCoy, 1993, p. 19; Egerton, 2012; Ch. 1). I won't make heavy work of pinpointing the view's exact origin or tracking its genesis, since I wish to simply demarcate when *modern* ecology began by establishing when it became a widely received view.

In my view, three specific articles published in the 1940s ushered in the wide-spread acceptance of the salient network-based view, and stimulated the growth of the theoretical branch of ecology by demystifying the holistic ("top-down") study of populations, communities, and ecosystems. These are Raymond Lindeman's "The Trophic Dynamic Aspect of Ecology" (1942), A. B. Novikoff's "The Concept of Integrative Levels and Biology" (1945) and Hutchinson's "Circular Causal Systems in Ecology" (1948). I will now "time-stamp" the birth of modern theoretical ecology by outlining what Lindeman and Novikoff did in each of their papers to help usher in the modern era of ecology and then explaining why I place Hutchinson's paper as the first work in modern theoretical ecology.

In essence, Lindeman (1942) first explicitly described community and ecosystem-level dynamics as the product of complex series of ecological interactions—what he calls "physical-chemical-biological processes"—in a paper published in *Science* (cf. Golley, 1993; Chaps. 3 and 4).[2] So, Lindeman helped popularize the networked—based view simply by explicitly describing ecological

[2] Some may complain that I have unfairly overlooked earlier works in which ecologists seem to discuss ecological phenomena in network-based terms. For example, Elton (1927) and Tansley (1935) both discuss ecological communities and "systems" in terms of trophic interactions and "webs"; see Donhauser, 2016. As an anticipatory response, I submit that substantive claims made in earlier works I know of are roughly the same as Lindeman's, in that they are too vague to warrant concluding that their authors' understood ecological entities as natural causal networks in the way modern ecologists do. I also think there is a reasonable case to be made that noteworthy ecologists working in the mid-1920s and 1930s (namely Elton and Tansley), embraced more thoroughgoing antirealist views. More to the point of my overall argument, remember also that I am here concerned with outlining what was done in those works that effectively "ushered in the wide-spread acceptance of the salient network-based view"; and earlier works just didn't do this since the view was not generally accepted until later, in the 1940s and 50s.