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Short communication

Reprint of "Systems ecology and environmentalism: Getting the science right"☆

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ABSTRACT

Problems of environmentalism—environmental protection, conservation, and preservation—are now widely appreciated as important to human enterprise and destiny. Called to attention by advances in descriptive empirical ecology, the new problems are too complex for this same ecology to solve without further expansion of basic knowledge. Environmentalism needs an ecological science of complex systems, but its development is hindered by over-commitment of attention and resources to the applied problems. Certain aspects of environmentalism may run against the grain of how nature works; it is important to get the science right.

A selection of ecological and environmental topics is reviewed from a systems ecology perspective. The ecological topics include system dynamics (linearity vs. nonlinearity, steady vs. non-steady state behavior) and indirect effects. The environmental topics are global change, overpopulation, biodiversity, and sustainability.

A comprehensive hypothesis is formulated to emphasize that two kinds of science are needed, one empirical focusing on what is immediate and tangible, and the other theoretical dealing with what is indirect and intangible. Empirically based environmentalism is attentive to only the first. The hypothesis has the following elements: (1) Living processes degrade their immediate and nearby environments. (2) A maximum power principle holds that this degradation should be as quick and complete as possible. (3) By direct harnessing of maximum power, biota perform work to maximize their fitness (Type I, biological), at the cost of degraded environments. The life-environment relationship therefore becomes win-lose. (4) Maximum power also contributes to a network property, dominant indirect effects, giving rise to (5) network synergism that converts proximate interactions, mainly (+, −), and negative ones (−,−) to predominantly positive (+, +) relations, which become quantitatively dominant. (6) In following the indirect line from maximum power to network synergism, biota do work that maximizes both their own and their environment's fitness (Type II, biological and ecological). By this, the life-environment relationship becomes win-win. (7) This hypothesis has a built-in paradox: the invisible positive benefits deriving from the network synergism → Fitness-II line are (i) proportional to, and (ii) greater in magnitude than, the negative costs generated by the tangible, immediate, maximum power → Fitness-I line. (8) Therefore, environmental programs designed to power down to reduce environmental degradation will reduce not only Fitness-I, but also Fitness-II by foregoing the network synergism benefits that exceed the maximum power costs. (9) Misguided environmentalism could then produce the worst case of a lose-lose life-environment relationship. (10) Environmentalism must resolve and manage this apparent conflict, and ecology as its foundational science must expand to provide the knowledge to do so.

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. . .life is a gift bestowed without anyone asking for it; . . . the thinking person has a philosophical duty to examine both the nature of life and the conditions it comes with . . .

Julian Barnes, *The Sense of an Ending*, Knopf, New York, 2012, p. 52.

1. Introduction

I attended several sessions of the EcoSummit 2012 symposium that gave rise to this Special Issue of *Ecological Engineering*, and contributed to some of the email exchanges that followed. I was asked during the final panel and audience discussion to give some of my views. After hesitating, I commented out of concern that scientific ecology has been transformed in a few decades into a bandwagon applied environmental discipline when there are still basic-science fundamentals to be learned about its subject matter. While applied problems can and do motivate pure science, the social press of hegemonic environmentalism inhibits this by directing attention and resources away, to pragmatic ends. I was not sure we had enough science, or that what we do have is right, considering the enormity of the biosphere and the environmental problems we see ourselves facing in it. Descriptive empirical ecology may have been good for identifying the problems, but not for solving them. They are too complex to yield to old-paradigm knowledge and ways of acquiring it. Also, certain aspects of ecology-based environmentalism may actually run against the grain of how nature works; it is important to get the science right. New science—complex systems science that goes beyond empirical description—is needed. Several authors in this Special Issue, and the editors also, hold this advocacy.

I spent the months after EcoSummit trying to organize my thinking into a paper. A long manuscript emerged that I have now split into two papers (Patten, 2014a,b); this one is a synopsis of their contents. The thought processes led me to review some aspects of how many ecologists see the world working that do not correspond with my sense of system dynamics. Eventually a synthesis emerged, with three sections—first, topics in ecology from amalgamated views of field natural history and systems science; second, systems oriented perspectives on modern-day environmentalism; and third, a hypothesis about the life-environment relationship that presents a serious challenge to both ecology and environmentalism. This hypothesis holds that what the latter seeks to achieve is already built into nature's hidden networks as a "greater goods from lesser bads" prescription driven by *throughflow*—the sum of biospheric energy and matter mobilization and use in life support. Powering down living activity, the essential program of environmentalism, though well intentioned, may actually have as an unintended consequence the diffuse (therefore unseen) and widespread (therefore insidious) sub-optimization of the biosphere, its biota, and maybe also ourselves.

An optimal biosphere does not, of course, have to include any particular species, such as *Homo sapiens*; we just want it to. That is perhaps the dilemma we, and all species, face—we are chained to a wheel of maximizing throughflow (power) by natural law, but by performing processes required to compete, grow, and survive we degrade specific environmental properties critical to our own welfare, even as the larger scene improves by our activities. For example, if we contribute to global warming and injure ourselves in the process, the unlocking of high latitudes to life are compensatory, biologically favorable outcomes to follow and keep unfolding into the long planetary future.

Throughflow, manifested by an incessant, insistent, growth imperative, of biota (fitness) and economies (GDP), is then the sworn enemy of environmentalism. Yet, maximizing throughflow may be the law of the planet. The hypothesis I developed frames this as a necessary basis for all living processes. Sustainability and good things at broader scales depend on un-sustainability and not-so-good things at lesser ones—and the "goods" outweigh and are proportional to the "not-so-goods." This is an enigma for budding sustainability science because an evolutionary Catch-22 lies in the contrapositive—life that does not churn at maximum activity will be replaced by that which does. This is basic competition biology, and anthropology too as reflected in classical and neoclassical economics' tacit imperatives driving human greed and conflict.

As a committed environmentalist myself, it is a troubling proposition, but it has behind it the weight of an environmental system theory I helped create, so I have to take notice. The good news so far is it is only a theory. My hope is ecological science will take notice too, turn to its investigation, and in the end vigorously deny and replace it with something that more salubriously defines the life-environment relationship. Because the new hypothesis is strictly based in theory, unproven theory grounded in holism, ecology will have to expand its reach to evaluate it. That is what I hope my "getting the science right" theme might provoke.

2. Getting the science right: ecology

Scientific ecology is confused about many fundamentals of how systems work. In this section I will give cameo snapshots of topics in system dynamics covered in Patten (2013a) that I think many ecologists might better understand.

2.1. Steady vs. non-steady states

It is widely held in ecology there are no steady states in nature. Certainly, change is of the essence, everywhere and ongoing, but natural systems tend to be steady state *seeking*. System dynamics universally entail initial → transient → steady state sequences, including recovery following new initial states induced by disturbance deflections. Ontogeny, succession, and global change, as examples, all fit this scheme. As most systems spend most of their time in the concluding region of this three-part dynamic (in ontogeny, adulthood; in succession, climax; in global change, stasis), steady state seeking gets most expressed. Disturbances deflect states away from steady values, and resilient systems recover to states at or near where they began. It is therefore steady state seeking, and tracking, not necessarily realization, that is important—climbing the mountain is more imperative than reaching the summit in a world whose "mountains" are continually shifting under all the earthly forces for change.

2.2. Linearity vs. nonlinearity

Ecologists are typically untrained in the distinctions between linear and nonlinear systems. Most of us equate linear systems to linear regressions. Few could give the correct definition of a linear system—one whose outputs are the same linear combination as a linear combination of its driving inputs. Linear systems have the property of "superposition"—their behavior is separable into a dissipative portion due to state, and a forced portion due to inputs. In nonlinear systems inside and outside drivers of dynamics cannot be teased apart. The experimental method therefore carries an implicit assumption of linearity because it assumes that intrinsic (zero input) behavior persists across a wide set of extrinsic (zero state) conditions. My own sense is that if I change my environment I still retain my "me-ness" (a linear assumption) and my behavior changes only because the changed environment drives my states differently.

Simple realizations like this are overlooked in common blanket assertions like "the world is nonlinear." Most ecologists believe this