



Ecology, the humbling science

I was both puzzled and troubled by the viewpoint expressed in *Frontiers* September guest editorial entitled “Ecology, the optimistic science” (Feagin 2017). I’m an optimistic ecologist, for reasons I will explain; but if many practitioners of our science view the world as Feagin seems to, I may become a pessimist instead.

Ecology is a systems science, and one of its first principles is captured in the old phrase “the whole is greater than the sum of its parts”. The complex interactions between the components of systems create emergent properties that don’t exist in the parts alone, and can’t be predicted from knowing all about the parts. The biosphere is the most complex system we know of.

No matter how much we understand, predicting the behavior of complex systems is very difficult and (probably) ultimately impossible. There are too many thresholds and tipping points. Compared to predicting the behavior of ecosystems, predicting the weather is easy.

And because we are completely dependent on the biosphere for our lives and livelihoods, we should be careful when messing with it. Pioneering ecologist and conservation philosopher Aldo Leopold said: “To keep every cog and wheel is the first precaution of intelligent tinkering” (Leopold 1949). He was talking about conserving species (the “cogs” and “wheels” of ecosystems), which we have been busy throwing away for millennia. Likewise, in human biology class during my freshman year in college, Paul Ehrlich used the analogy of an airliner slowly losing the rivets on its wings, the “airliner” being Spaceship Earth (Ehrlich and Ehrlich 1981). Both were advising a precautionary approach toward modifying ecosystems.

Human activities are causing the sixth major mass extinction in the history of life on Earth and changing the planet’s atmosphere and oceans. As we rapidly deconstruct natural ecosystems that have evolved over

eons, what is left in our wake are ecosystems with reduced functioning, reduced production of ecosystem services, and reduced resilience. Our species is very young – an eyeblink in evolutionary time. It is true, of course, that no matter what our species does, nature will endure. But humans very well may not.

For at least a century, some ecologists have been trying to translate the core principles of our science into societal applications to address the ecological mess we’ve gotten into (Leopold 1991; Wilson 2015). Some ethical values are embedded in ecological science, as Leopold argued so articulately. We need those ecocentric values to balance the anthropocentric predispositions of our species and guide our decisions.

Feagin asks us to “Imagine building, replicating, and manufacturing functional ecosystems across multiple scales”. He implies that because we have been able to change ecosystems so drastically, we should also be able to build and design them for the better, and his optimism seems to arise from that viewpoint. Although he doesn’t use the term “eco-engineering”, that is what he’s promoting.

But that view, in my opinion, misrepresents certain fundamental ecological principles regarding emergent properties and unpredictability. Ecologists must always resist the destruction of the natural world. Our science has taught us that we can never “reconstruct” or “manufacture” anything as complex and resilient as evolution has. In that regard, the proper attitude is humility – but Feagin’s editorial had a tone of anthropocentric hubris, the opposite. The contrast between humility and hubris is a different dimension than that between pessimism and optimism, however. Anthropocentrism is not a requirement for optimism; one can be an ecologically humble optimist.

Ecologists should be prophets, not Pollyannas or Panglossians. We should promote a precautionary view of the human–nature relationship. We should be mining the roots of our ecological worldview, from Alexander von

Humboldt to John Muir, from Aldo Leopold to EO Wilson, and stepping out to warn our politicians and fellow citizens that ecosystems aren’t necessarily resilient and forgiving of our ecological sins. The best of all possible worlds, as far as ecologists know, is the one we inherited, and one that we are still busy unintelligently tinkering with, at our own extreme peril.

I hope that our species will survive beyond the Anthropocene, but it won’t be through eco-engineering. Let’s use the science of ecology to continue to promote the ethics of conservation, precaution, and ecocentrism, which are embedded in it. Ecology can help us by humbling us. Therein lies our hope.

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What is the path forward for ecology?

I agree with Byers that we should be humble and respectful of Nature. Ecology the science provides justification for these feelings in quantitative terms. We have identified the damage that we have done in the past and also know that it can get worse. The main idea in my editorial (Feagin 2017) was that we should be optimistic, because now we have a diagnostic tool: the science of ecology. The excellent analysis by Byers suggests that placing too much faith in