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Key Points:
- Words are critically important to thinking and communicating.
- Words carry baggage in the form of historical meanings.
- In the Anthropocene, we need to be especially sensitive to the words we use.

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Watch your language: Power words at the human–nature interface

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Abstract Words are integral to thinking and communicating. Words also carry old baggage. The Anthropocene necessitates new thinking and communication at the human–nature interface. Words like progress, natural, and thresholds are pervasive in both scientific and policy discourse, but carry baggage that will likely slow understanding of the Anthropocene and appropriate adaptation. The dynamic systems thinking with emergent properties of ecology needs to replace the efficiency and growth framework of economics. Diversity and resilience are productive and less historically burdened words.

> "Everything is vague to a degree you do not realize till you have tried to make it precise." [*Russell*, 1918, The Philosophy of Logical Atomism]

> "Many great theories are held together by dubious chains of dubious metaphor and analogy." [Gould, 1976, Darwin's Untimely Burial]

1. Introduction

Words implicitly share in the act of framing problems, designing experiments, sorting evidence, seeing and interpreting findings, communicating, and retaining knowledge. Words are more noticeably important when scientists try to explain their findings to policy makers and the public. Recognizing that words can be problematic, scientists seek to make their definitions clear and reduce reasoning to consistent symbols and mathematics when possible. For almost a century, beginning with Gödel's proof and Wittgenstein's descent from the purity of mathematical philosophy to an unrequited obsession with the problems of thinking and language, it has been clear that we are always caught in a tangle of historically laden words, analogies, metaphors, and similes [*Hofstadter*, 1979; *Lakoff and Johnson*, 1980].

To dwell on our entrapment in words while practicing "normal science" is a grand waste of time [*Kuhn*, 1962]. While the vast majority of scientists remain engaged in normal science, the growing acceptance of the idea that the earth's history is now in the Anthropocene, an underlying premise spurring the founding of this journal, demands a significant paradigm shift. This means that the historical baggage of words associated with how science has been done comes to the fore. To understand the human-nature interface now, or even to understand what we have thought to be "nature," we need to include how the social system drives people to influence nature and vice versa. Scientists concerned with Earth's future need to pay more attention to the words they use to facilitate an effective paradigmatic transition.

To get through and beyond the Anthropocene, existing words will evolve new meanings and new words and phrases will arise, but they will need to do so in particular ways to aid the survival of people and nature. Some words might best be altogether abandoned. This commentary explores some of the most powerful words, past and arising, both affecting and effecting the human–nature interface. How well have they served humanity and nature for framing Earth's future?

2. Progress

Certainly the grand daddy of powerful words is "progress." Francis Bacon envisioned that the advance of science would eventually give us a "God's-Eye" view of the world that would make it possible to control our material destiny. This idea pervades modern thinking. It has been critical to how we justify science and

explain where we are and will eventually be with respect to our relations with nature. A century and a half ago, in a major global treatise on how people had long been transforming the natural world they depended on, *Marsh* [1864 (1965)] wrote:

> … within a comparatively short space, there will be an accumulation of well established constant and historical facts, from which we can safely reason upon all the relations of action and reaction between man and external nature …
>
> … *But we are, even now, breaking up the floor and wainscoting and doors and window frames of our dwelling, for fuel to warm our bodies and seethe our pottage, and the world cannot afford to wait til the slow and sure progress of exact science has taught it a better economy.* (p. 52)

Such grand thoughts on scientific progress and how we will interface with nature are alive and well. Two decades ago, *Wilson* [1998] wrote:

> *When we have unified enough certain knowledge, we will understand who we are and why we are here*. (pp. 6–7)
>
> *The legacy of the Enlightenment is the belief that entirely on our own we can know, and in knowing, understand, and in understanding, choose wisely*. (p. 297)

The idea of progress is deceptively powerful. With the help of sociologist Herbert Spencer, the idea captured and distorted the public's understanding of Darwinian evolution. Scientists, however, also found it easier to teach that species became better and better fit relative to a fixed environment until some scientists and much of the public equated evolution with progress. Realizing that species form each other's environment and evolve with respect to each other as much as their abiotic surroundings brings the realization that there is no set initial conditions by which to measure evolutionary progress. In spite of the efforts of some very talented writers [e.g., *Gould*, 1990], this confusion is still prevalent. In the Anthropocene, we need to be extra careful with "progress."

Progress is an extremely potent word in the modern mind. We promise it in our research proposals and use it throughout our professional and political discourse. No doubt the vast majority of the scientific community will go on as before, assuming that the progress of science will solve the challenges of the Anthropocene. The gap between what we know and what we need to know is closing; we simply need to work harder to close it faster.

And yet, in what sense has the gap been closing given species loss, environmental transformations, and new uncertainties that accompany rapid global environmental change? Have we progressed given the material and psychological conditions of many people after two centuries of rapid economic growth? Is science keeping up with the environmental and social problems that several centuries of progress or, more appropriately just rapid change, has wrought? The positive feedback system between science, technology, and our economy feeds the drivers of global change. Can there by any sense to the idea that science has progressed given that we now live in a significantly different biosphere? Will science continue to progress in a more rapidly changing future where species die-off even faster, the remaining species reconfigure, and some new species emerge?

Even physical nature shifts. It is certainly good that science helps us envision how the ocean's thermal-haline driven currents could dramatically shift, for now we might be able to avoid such a change, but is such knowledge progress in light of the fact that it is only good now that humanity, through what we thought were years of progress, has driven Earth into the Anthropocene?

Might the very idea of progress be part of modern humanity's deepest problem [*Norgaard*, 1994]? Either the idea of progress needs an evolutionary leap, in the minds of scientists and the public, or we should be speaking of "trying to keep up" hereafter.

3. Thresholds, Limits, and Tipping Points

Explorer-scientists like Alexander Humboldt, Lewis and Clark, John Wesley Powell, those who first reached the poles of the Earth, and those who are now exploring the depths of the seas and outer space have long been important to our understanding of the human–nature interface. Our understanding of Earth affects how we relate to it *per* se. But scientists really became critical to this interface when they started advising on how people should adjust the human–nature interface. For example, late in the 19th century scientists were asked to determine how much pollution is acceptable? The idea of thresholds certainly existed before scientists tackled this question, but this early role of scientists in policy making confirmed the idea, in the minds of scientists and the public, that it was OK to pollute the environment and thereby our bodies and those of other species up to a limit. After reaching this limit, bad things would happen.

By portraying nature as having thresholds that can be determined scientifically, health and environmental policy makers and regulators can avoid making value judgments. Invoking the scientific existence of thresholds brought scientists into power and got regulators and policymakers off the hook for making tough choices. Soon a significant part of the scientific community was doing "regulatory science" to fill the public, indeed political, need for determining regulatory thresholds, limits, and tipping points comfortably in denial of the scientific problems of these very words [*Jasanoff*, 1990].

The problems with threshold, limit, and tipping point are many. Consider the use of dose–response curves in public health and environmental contaminant policy. First, dose–response curves may not have thresholds. Second, even if dose–response curves had the property of a threshold, they rarely have insignificant effects until the threshold is reached. Third thresholds are different for young and old, male and female, healthy and not. Fourth, dose–response relationships and thresholds also differ for pulses and continuous doses. Fifth, there are problems of how multiple pollutants together, whether in single doses, sequential doses, or continuous doses, can be brought into environmental regulations. Sixth, the environmental effects of multiple stressors at the same time and sequentially are difficult to analyze and incorporate in enforceable rules as to how people should relate to nature. These collective challenges have never been adequately tackled. One of the difficulties is that the simple powerful idea that there are scientifically measurable thresholds link science to public practice so strongly that science itself cannot get beyond the public's need for simple determinations.

The word "limit" has a long and solid history of conveying to the public that minerals and other stock resources are limited and important to how society relates to nature [*Meadows et al*., 1972]. In the Anthropocene, scientists are drawing on the power of these words to warn the public again of environmental and ecological thresholds [*Rockström et al*., 2009] and tipping points [*Barnosky et al*., 2012]. As problematic as the words may be scientifically, scientists now desperately need them to communicate the human and earthly predicaments to the public.

The word "threshold," along with the words limit and tipping point, have been and continue to be very powerful in our efforts to understand, to convey information, and to construct policy at the human–nature interface. While the terms are meaningful in some cases, in other instances the idea of "phase-shift" would be scientifically more appropriate. We are going to be observing more phase shifts in the Anthropocene, those opposed to changing human behavior have already made fun of the overuse of the term "limits" [e.g., *Lomborg*, 2001], so it may be helpful to work with the public toward deeper understanding rather than building on limit setting.

4. Natural

The natural world has had value in itself in all cultures. Many natural scientists treasure nature as well and have joined, sometimes led, efforts to set aside wilderness areas and establish national parks, conserve species and ecological systems, and more recently restore ecological systems. In these contexts, the word natural has had a whole systems connotation that has been helpful for people across cultures to situate themselves in their larger environment.

The natural sciences are about the natural system, a world apart from people. Thus natural scientists, especially field biologists and ecologists, have ventured good distances to study nature seemingly untouched, though people had usually impacted these places at some time in the past. With climate change being

a global on-going phenomenon, there are no longer places that can even be imagined to have been untouched.

Nature, in its natural form, has also served as a referent as to how things should be in environmental management. While biologists have long known that nature keeps changing, some time period in the past before people had major effects on earth is used as a reference point for how nature "should" be. In an effort to understand different conceptions of nature, social scientists have struggled with the contradictions in the accepted usages by natural scientists, deconstructing their idea of nature, and biologists have defended their understanding in a counter attack [*Soulé and Lease*, 1995].

Now, in the Anthropocene, some of these historic differences in the perspectives of natural and social scientists have been breaking out among biological scientists themselves. In the Anthropocene, conservation biologists skirmish internally with their historic stance that invasive species are bad, for some may now be climate change refugees struggling for their survival or simply moving comfortably with environmental conditions. Perhaps to support species survival, conservation biologists should assist in the migration process, but this too is a mind shift for which conservation biologists are not well prepared, scientifically or psychologically [*Sansilvestre et al*., 2015]. Ecological restoration continues to largely be about restoring past conditions, except that much of the restoration is occurring along the coasts and restoration ecologists are keenly aware of sea level rise, temperature shifts, and changes in fresh water inputs. Would shifting the mindsets of restoration ecologists toward ecological "futuration" increase the effectiveness of their efforts given the reality of a more rapidly changing nature?

In the Anthropocene, the very identity of natural science is at stake for there is no longer an unchanging nature out there to stake an identity on. For decades I have joked that the problem is that we have unsocial sciences and unnatural sciences, but now we just have whole systems thinking and un-whole thinking.

5. New Words for Earth's Future

Without the presupposition of a long-standing nature as a referent, wholly new criteria for environmental management are needed. Indeed, perhaps the term "environmental management" itself is tattered baggage. Management seems a little too much like maintenance of something already there. So, are there signs our language is changing?

Scientists, futurists, and environmentalists have long advocated taking a more holistic systems view. Now it is becoming clear that we also need to combine human and natural systems in our thinking. The vocabulary of systems thinking, however, is not well understood by policy makers and the public. Ecological thinking, to be sure, has been on a slow but steady rise since the "ecology now" days of the 1970s. Counterbalancing connected thinking of ecology, however, there has also been a "takeover" by market economic thinking in the public sphere that denies the connectivity of an ecological worldview [*Nelson*, 2010].

The field of ecological economics, unfolding since the 1990s in an effort to understand and improve the human and planetary predicament, strives to be transdisciplinary across economic and ecological mindsets. But ecological economists struggle with language in the process. Consider the concept of ecosystem services. Ecological economists advanced the concept so successfully that it is now used widely in other disciplines as well as popularly and by the World Bank. The vocabulary of economics proved very effective in conveying the importance of nature, but the implementation of the term violates the systemic nature of ecological thinking. What started as an eye-opening metaphor became a blinder to ecological and social complexity [*Norgaard*, 2010; *Muradian et al*., 2013].

I have found two words describing systems, "diversity" and "resilience", to be fairly successful across the human–nature interface without significant old baggage arising. These terms describe systems properties and are generally "good" things to have for a system. Diversity has positive connotations in biological, evolutionary, and social thinking. These terms come with less historical baggage because they have been little used historically. Indeed, resilience is almost a virgin term in the social sciences, yet it has immediate application for economic and other social systems. Resilience and diversity do not complement and can be used to counter our modern economistic stress on efficiency and growth.

6. Watch Your Language

To use a much-popularized accounting term, the "bottom line" of this commentary is clear if not easy. We need to think about how the words we use are embedded in tangles of old meanings that might be getting in the way of what we now want to characterize, frame, and convey. This is especially true now that we are trying to understand and communicate in what appears to be a new era for the natural and social sciences.

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