Thoughts on aligning ethics with a new concept of ecosystems and ecosystem management.

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The Journey of the Universe and its antecedent "The Universe Story" by Swimme and Berry[1] provide a narrative for the geological-time-scale unfolding of the Earth's biota. It offers a way to reconcile, and perhaps even harmonize, the interpretation of creation offered by religious traditions with a scientific one rooted in evolutionary biology and ecology. In this context, adaptive evolution can be viewed as the perpetual creative process that embodies what we effectively believe to be the creative power of God. In the tradition of the great Victorian naturalists[2,3], I believe that God is revealed in Nature. But, I also believe that the deepest revelation comes from studying and understanding the creative process as opposed to merely marveling at the magnificence of its products (e.g. the diversity of extant species). Such a view has implications for the moral and ethical standing that we extend to non-human entities, especially as regards human management and conservation of the Earth's biota[4].

Much of current biodiversity and ecosystem conservation still focuses on protecting the magnificence of creation—the collections of species that comprise the Earth's biota. Such a perspective overlooks the myriad ways that species have assembled into ecosystems and the nature of associated ecosystem functioning and provisioning of resources and services[5]. But, even when there is appreciation for the biota's role in the provisioning of services, rising human demands for space and resources continues to create a sentiment that we cannot protect everything, and so we must be strategic about what we keep and what we choose to let go. This reveals a deeply held human-centered ethic that species are largely expendable showpieces and that it is reasonable to engage in ecological triage if conservation conflicts with human economic well-being. But, herein lies a potential fallacy in reasoning.

Human economic well-being is inextricably tied to the well-being of another economy—nature's economy, aka ecology. This intertwining of economic systems is what inextricably couples humans and Nature. In order to prevent these linkages from being severed, humans must abandon their human-centered, utilitarian ethical perspective about nature. We can no longer simply view Nature as a magnificent collection of species for our passing enjoyment or see it merely as a means to fulfillment of immediate material need[5]. Species play integral roles in maintaining essential functions and services that drive Nature's economy[6]. Moreover, species physiological, morphological and behavioral traits are continually being shaped and reshaped through adaptive responses to ecological interactions with other species and the abiotic environment[7,8]. This revelation is showing us that evolution and ecological processes operate contemporaneously[8]. Accordingly, human agency does not simply eliminate the product of creation, but jeopardizes the creative process itself. As scientists we are learning more and more that the creative

adaptive process is integral to maintaining the inherent resiliency of ecosystems to disturbances or the ability of ecosystems to recover from severe natural and human-cased damages[9]. The variety of life that this ongoing process creates is what gives complex ecosystems as a whole the ability to buffer and adjust to the changing fortunes of time[9].

Ecosystem management thus requires a new ethical position that aligns the aims and goals of conservation with processes and outcomes that ensure long-term sustainability of the Earth. Given that the process of evolutionary adaptation is integral to long-term sustainability, a holistic concept of ecosystem management will require a framing of holistic environmental ethics that recognizes the standing and value not only of extant biotic and abiotic components of ecosystems and their linkages, but also embraces the need to sustain the creative processes that give rise to that diversity and associated ecosystem resilience.

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