Ethics, Policy & Environment
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/cepe21

Species are the Building Blocks of Ecosystem Services and Environmental Sustainability

Ashish Sharma [a] , Frank Bouchard [a] , Sean Ryan [a] , Derrick Parker [a] & Jessica J. Hellmann [a]

[a] Environmental Change Initiative & Department of Biological Sciences , University of Notre Dame , Notre Dame , IN , USA

To cite this article: Ashish Sharma , Frank Bouchard , Sean Ryan , Derrick Parker & Jessica J. Hellmann (2013): Species are the Building Blocks of Ecosystem Services and Environmental Sustainability, Ethics, Policy & Environment, 16:1, 29-32

To link to this article: http://dx.doi.org/10.1080/21550085.2013.768388

Ethics, Policy and Environment, 2013
Vol. 16, No. 1, 29–32, http://dx.doi.org/10.1080/21550085.2013.768388

Open Peer Commentary

Species are the Building Blocks of Ecosystem Services and Environmental Sustainability

ASHISH SHARMA, FRANK BOUCHARD, SEAN RYAN, DERRICK PARKER & JESSICA J. HELLMANN
Environmental Change Initiative & Department of Biological Sciences, University of Notre Dame, Notre Dame, IN, USA

Rather than advance novel *strategies* for achieving the objectives of conservation, Sandler (2013) suggests that we change the *goals* of conservation itself, emphasizing ecological processes through place-based protection instead of species preservation. We agree strongly that land management goals and strategies need to be revisited under climate change, but we disagree with several of Sandler's central arguments. In particular, we disagree strongly that land managers and conservation biologists should abandon species-level conservation, or replace or demote it with Sandler's alternative, process-based conservation. In fact, we argue that this is a false dichotomy as no function exists without the species that provide it. Also, we point out that in deemphasizing species-level conservation, we risk a critical conservation objective: preserving global biodiversity. Further, we question if the change that Sandler proposes would preclude assisted colonization (managed relocation), a strategy he seeks to avoid.

First, Sandler fails to acknowledge that species perform ecosystem functions. All ecosystem services depend on species to some extent. This is particularly clear when considering keystone species, a species that has an affect on an ecosystem disproportional to its abundance or biomass (Paine, 1995). The extinction of a keystone species can lead to a loss of critical ecosystem functions, often within a reserve or place-based conservation strategy.

One classic example showing how species conservation is critical to reserve oriented conservation is the reintroduction of gray wolves (*Canis lupus*) to Yellowstone National Park (Fritts et al., 1997). Fifteen years following the reintroduction, a number of positive effects have been observed (Ripple & Beschta, 2012). Most notably, aspen, cottonwood, and willow tree recruitment and growth seem to have returned to levels seen prior to wolf extermination. This is probably due to the top-down population control that wolves exert on browsing ungulates such as elk. The presence of wolves may also explain increases in populations of rodents, predatory and scavenger birds, bears, beavers, and bison through a trophic cascade (Pace et al., 1999). Other examples of keystone species affecting

Correspondence Address: Ashish Sharma, Environmental Change Initiative, University of Notre Dame, 1400 East Angela Blvd, Unit 117 South Bend, IN 46617, USA. Email: ashish.sharma.15@nd.edu

important ecosystem services include sea otters and their role in kelp bed maintenance (Estes et al., 1998) and prairie dogs, whose burrowing activity increases soil biodiversity and promotes nutrient cycling (Miller et al., 2000). Unfortunately, it is difficult to know *a priori* which species are or will be keystones. Important associations between species may not be known until species-level research and conservation efforts are conducted, making targeting of keystone species difficult. Promising new techniques such as network analysis (Jordán, 2009) and functional metagenomics (Dinsdale et al., 2008) may eventually give us a better understanding of important relationships between species, but until these new techniques become better developed, species-level research and conservation will continue to be the most effective way to preserve communities and their ecosystem services.

Second, we see biodiversity conservation—including species preservation—as a key part of maintaining the adaptive capacity advocated by Sandler. Some of the adjustments made by species and ecosystems to climate change will arise from adaptive evolution, a product of genetic diversity (Hellmann & Pfrender, 2011). Evolutionary potential is maximized by maximizing species richness and maintaining large population sizes over environmental gradients (Crandall et al., 2000). Thus, it will be difficult to maintain this adaptive potential without some emphasis on species-level preservation. Furthermore, biodiversity in the form of species richness and genetic diversity increases the stability of biotic communities, their resilience in the face of disturbance and fluctuating conditions, and their resistance to invasion by harmful species (species that reduce local diversity) (Doak et al., 1998; Naeem, 1998; Tilman, 1999; McCann, 2000; Chesson, Pacala, & Neuhauser., 2002; Cardinale et al., 2006; Gamfeldt, Hillebrand, & Jonsson, 2008). As a major threat of climate change is erosion of global biodiversity, as described by Sandler and widely reported elsewhere, it is also important that we can fight against population and species extinctions where key evolutionary novelties and ecosystem functions are at stake (Purvis, Gittleman, & Brooks, 2005). Genetic diversity in standing populations and species that are lost to climate change cannot be replaced by artificial means.

Further, Sandler claims that by deemphasizing species we can potentially avoid assisted colonization or reduce its application. This over-simplification fails to acknowledge considerable practical constraints that will likely limit the application of managed relocation, even if species remain a central focus of conservation activities. Most of these include considerable cost, difficulty of implementation, and insufficiency (Hellmann et al., 2011; Schwartz et al., 2012). Second, and more importantly, assisted colonization could be used to maintain ecosystem services, the very goal that Sandler advocates as an alternative conservation goal. Lunt et al. (2013) recently described a scenario where species might be 'pulled' into an ecosystem from another location to fill a service that has declined due to climate change. This service-oriented objective stands in contrast to Sandler's view that assisted colonization primarily involves species being 'pushed' into new regions for conservation purposes. Examples of service-delivering managed relocation include translocation of timber species (McKenney, Pedlar, & O'Neill, 2009), species that provide ecological services in locations where there is low redundancy, or species that could prevent or reduce the invasion of pests that diminish biodiversity or ecosystem function (Lunt et al., 2013).

We strongly agree with Sandler that thoughtful conversation about the ways that we pursue conservation and natural resource management is necessary, thanks to climate

change. We agree with Sandler that we should change our emphasis away from site-specific conservation and intensive single-species activities. However, we disagree that process-based conservation is a suitable alternative to emphasizing the important role that species play in ecosystems and sustaining human life more generally. Surely there are conservation strategies that embrace the importance of individual organisms with particular identities and the global total of their diversity. In addition, it will not be so easy to eliminate assisted colonization by changing focus. Instead, we must confront assisted colonization head on and question the costs and benefits of management strategies, like assisted colonization, that are difficult to reverse (Schwartz et al., 2012).

References

Cardinale, B. J., Srivastava, D. S., Duffy, J. E., Wright, J. P., Downing, A. L., Sankaran, M., & Jouseau, C. (2006). Effects of biodiversity on the functioning of trophic groups and ecosystems. *Nature*, 443, 989–992.

Chesson, P., Pacala, S., & Neuhauser, C. (2002). Environmental niches and ecosystem functioning. In A. Kinzig, D. Tilman & S. Pacala (Eds.), *Functional consequences of biodiversity: Experimental progress and theoretical extensions* (pp. 213–245). New Jersey: Princeton University Press.

Crandall, K. A., Binida-Emonds, O. R. P., Mace, G. M., & Wayne, R. K. (2000). Considering evolutionary processes in conservation biology. *Trends in Ecology and Evolution*, 15, 290–295.

Lunt, I., Byrne, M., Hellmann, J., Mitchell, N., Garnett, S., Hayward, M., Martin, T., McDonald-Madden, E., Williams, S., & Zander, K. (2013). Using assisted colonisation to conserve biodiversity and restore ecosystem function under climate change. *Biological Conservation*, 157, 172–177.

Dinsdale, E. A., Edwards, R. A., Hall, D., Angly, F., Breitbart, M., Brulc, J. M., … Rohwer, F., (2008). Functional metagenomic profiling of nine biomes. *Nature*, 452, 629–632.

Doak, D. F., Bigger, D., Harding, E. K., Marvier, M. A., O'Malley, R. E., & Thomson, D. (1998). The statistical inevitability of stability–diversity relationships in community ecology. *American Naturalist*, 151, 264–276.

Estes, J. A., Tinker, M. T., Williams, T. M., & Doak, D. F. (1998). Killer whale predation on sea otters linking oceanic and nearshore ecosystems. *Science*, 282, 473–476.

Fritts, S. H., Bangs, E. E., Fontaine, J. A., Johnson, M. R., Phillips, M. K., Koch, E. D., & Gunson, J. R. (1997). Planning and implementing a reintroduction of wolves to Yellowstone National Park and Central Idaho. *Restoration Ecology*, 5, 7–27.

Gamfeldt, L., Hillebrand, H., & Jonsson, P. R. (2008). Multiple functions increase the importance of biodiversity for overall ecosystem functioning. *Ecology*, 89, 1223–1231.

Hellmann, J. J., & Pfrender, M. E. (2011). Future human intervention in ecosystems and the critical role of evolutionary biology. *Conservation Biology*, 25, 1143–1147.

Hellmann, J. J., Meretsky, V. J., and McLachlan, J. S. (2011). *Strategies for conserving biodiversity under a changing climate*. Pages 363–288 In: Hannah, L., ed. Saving a Million Species: Extinction Risk from Climate Change. Island Press, Washington, DC.

Jordán, F. (2009). Keystone species and food webs. *Philosophical Transactions of the Royal Society B*, 364, 1733–1741.

McCann, K. S. (2000). The diversity–stability debate. *Nature*, 405, 228–233.

McKenney, D., Pedlar, J., & O'Neill, G. (2009). Climate change and forest seed zones: Past trends, future prospects and challenges to ponder. *Forestry Chronicle*, 85, 258–266.

Miller, B., Reading, R., Hoogland, J., Clark, T., Ceballos, G., List, R., … Uresk, D. (2000). The role of prairie dogs as a keystone species: Response to Stapp. *Conservation Biology*, 14, 318–321.

Naeem, S. (1998). Species redundancy and ecosystem reliability. *Conservation Biology*, 12, 39–45.

Pace, M. L., Cole, J. J., Carpenter, S. R., & Kitchell, J. F. (1999). Trophic cascades revealed in diverse ecosystems. *Trends in Ecology and Evolution*, 14, 483–488.

Paine, R. T. (1995). A conversation on refining the concept of keystone species. *Conservation Biology*, 9, 962–964.

Purvis, A., Gittleman, J. L., & Brooks, T. (2005). *Phylogeny and conservation*. Cambridge University Press.

Ripple, W. J., & Beschta, R. L. (2012). Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation*, 145, 205–213.

Sandler, R. (2013). Climate change and ecosystem management. *Ethics, Policy & Environment*, 16, 1–15.

Schwartz, M., Hellmann, J., McLachlan, J., Sax, D., Borevitz, J., Brennan, J., … Safford, H. (2012). Managed relocation: Integrating the scientific, regulatory and ethical challenges. *BioScience*, 62, 732–743.

Tilman, D. (1999). The ecological consequences of changes in biodiversity: A search for general principles. *Ecology*, 80, 1455–1474.