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# BIODIVERSITY ELIMINATIVISM

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In this chapter<sup>1</sup> I defend *biodiversity eliminativism*, the thesis that biodiversity should not be the principal object of conservation. My argument is simple. The principal role played by the concept *biodiversity* in conservation biology is as a comparative measure of value. Biodiversity does not fulfill that role well, in part because it is not a straightforwardly measurable quantity. Moreover, it does not fulfill that role well because it does not closely track *ecological value*, the aggregate of values we place in the environment. Given these failures to fulfill its conceptual role, we should eliminate the biodiversity concept from its central place in conservation biology, in favor of using more direct assessments of ecological value as our primary comparative measures in conservation.

### The role of biodiversity

The concept *biodiversity* plays a number of roles in scientific discourse. It is, for instance, a political rallying cry, and the use of the term “biodiversity” in a publication generally signals a commitment to environmental values as well as participation in a public conversation about how best to achieve them. It has also been convincingly argued that the biodiversity concept plays an important role within the sciences by creating an interdisciplinary common ground; it serves as a bridge concept allowing a researcher working in one field to easily locate work from other disciplines relevant to their interests (Meinard *et al.* 2014). These uses for the term “biodiversity” are valuable, and I don’t mean to suggest that we should give up on them or eliminate biodiversity talk altogether.<sup>2</sup> I aim only to eliminate biodiversity from its role as the principal target of conservation.

A standard picture of conservation biology is that its goal is to provide systematic methods for prioritizing which areas to protect. These methods prioritize areas on the basis of their biodiversity value, as measured using surrogates (Sarkar and Margules 2002, Margules and Sarkar 2007). In other words, biodiversity plays a central role in conservation biology as the primary measure of value. It is, of course, a comparative measure, used not only to determine the relative worth of the members of a set of areas, but also to measure the extent to which the ecological value found in different sets of areas is complementary. Additionally, it can serve as diachronic measure, comparing a single area across time in order to assess the success or failure of conservation practices. It is this use – as the primary comparative measure in conservation science – for which biodiversity is not well-suited.

### Biodiversity is a poor measure

A primary reason why biodiversity is not well-suited to its role is that it has resisted a consistent operationalization, rendering it a poor candidate to be used as a comparative measure. The problem has its root in the standard definitions of biodiversity. Consider, for instance, the definition determined by the 1992 United Nations Convention on Biodiversity: “‘*Biological diversity*’ means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part” (Convention on Biological Diversity 1992). A contemporary textbook on conservation biology offers a succinct alternative: biodiversity “is *the variety of life*, in all its many manifestations” (Gaston 2011: 27). Both these definitions are typical, but as Sarkar (2002: 137) observes, such definitions end up saying merely that biodiversity is equivalent to “all of biology.”

For many purposes, using the term “biodiversity” as shorthand for all of biology can be useful. A broad, imprecise characterization of biodiversity might be best for the role the concept plays in political activism and interdisciplinary communication. But vagueness and imprecision are poor qualities in a measuring stick. If we are trying to determine whether to prioritize conserving area *A* or area *B*, asking which has a greater portion of “all of biology” won’t get us very far. In all but the starkest cases of contrast, there is no obvious sense in which one area has more biology than another. Moreover, conservation biology is tasked with giving us the tools to make triage decisions, and a broad, imprecise measure won’t do. We *can’t* preserve all of biology, so we need a measure with units of a finer grain.

The conventional response to this problem is to use more precise, quantifiable entities as the actual operational measures in conservation. The most common of these is some variant of *species richness*, the cardinal number of distinct species inhabiting a place. Measures of other levels of organization such as genes or higher phylogenetic taxa are sometimes employed as well. The thought behind using a quantity like species richness as an operational measure is that species richness (or genetic diversity, or phylogenetic diversity, etc.) is both precisely quantifiable and representative of biodiversity in general. To use the standard language, species richness is a *surrogate* for general biodiversity. But as Sarkar and Margules (2002) point out, even a more specific quantity like species richness cannot in practice be directly measured, so we must use methods of estimation. For example, we might count the number of bird species, on the assumption that avian richness is a good proxy for species richness. Sarkar and Margules call this actually measured quantity the *estimator surrogate*, and the quantity for which the estimator serves as proxy for the *true surrogate*. Putting the chain of inference visually, measurement of biodiversity appears as: estimator surrogate → true surrogate → biodiversity. So in practice, biodiversity is at least two steps removed from the empirically observed measure used to make conservation decisions.

This method of using biodiversity surrogates might seem to skirt any issues that might be caused by the vagueness of standard definitions of biodiversity. At the very least, it provides quantities that can be used to make precise comparisons between areas, which is what we expect out of the biodiversity concept. The practice of using surrogates is laden with its own problems, however. One of these is that any standard surrogate will fail to represent some aspects of biodiversity. “No single parameter,” Sarkar argues, “whether or not it can be realistically estimated, is likely to capture all biological features that we may find of interest” (2002: 140). The correlation between the true surrogate and biodiversity itself will be imperfect at best, just as there will be some degree of error in estimating the true surrogate from observations of the estimator surrogate. Of course, some uncertainty about the relationship between observed parameters and the

entities of interest is just part of the cost of doing science. We can minimize, but not eliminate sources of error, and so as long as the sources of potential misrepresentation are ineliminable, we have no reason to question the practice.

My worry, however, is that one major source of potential misrepresentation *is* eliminable. Biodiversity itself is also only a surrogate, because ultimately the goal of conservation is to promote ecological value. By *ecological value* I mean the totality of values we place in the environment. Assume for the sake of argument that biodiversity is a reasonably good proxy for ecological value. Then the chain of representation looks as follows: estimator surrogate → true surrogate → biodiversity → ecological value. Each arrow in that chain is an imperfect relationship, and thus a source of potential error. It's troubling that the parameters we actually use to make conservation decisions are so far removed from the entities of actual interest. More importantly, it's unnecessary. The use of surrogates is ineliminable, but we don't need two layers of vaguely defined objects of value. We could find surrogates for ecological value directly: estimator surrogate → true surrogate → ecological value. By cutting out the middleman – biodiversity – we eliminate one major link in the chain and thus decrease the distance between the operational quantities and the objects we actually want to conserve. Thus, by eliminating biodiversity, we actually improve our ability to conserve ecological value.

My argument is that biodiversity is an extraneous addition to measures of ecological value. The best way to respond to this argument would be to argue that the connection between biodiversity and ecological value is so close that eliminating biodiversity would not eliminate a significant source of error. This response can take at least three forms, each of which I will discuss in detail below. Perhaps the most intuitive argument along these lines appeals to the claim that “all of biology” is intrinsically valuable, so our comparative measure of value must include biodiversity. Another response gives up on intrinsic value, but argues that biodiversity is nevertheless an excellent surrogate for ecological value, because it captures almost all features of interest. Finally, it is commonly argued that biodiversity should be our conservation target not because it necessarily tracks value directly, but because the close link between biodiversity and the stability of ecosystems means that conserving biodiversity is the best way to sustain ecological value. In the following sections, I will explain why each of these responses – intrinsic value, faithful representation, and diversity-stability – falls short.

### Biodiversity, ecological value, and intrinsic value

I have defined ecological value as the aggregate of values we place in the environment. This means that ecological value will include a diverse range of values. Many of these will involve practical utility. Healthy fish stocks feed us, extensive forests remove carbon dioxide from the atmosphere, and flourishing vegetation feeds livestock, prevents erosion, and directs the flow of water. Economic values of these sorts are all part of ecological value, but do not exhaust it. Much of ecological value is aesthetic. We value the beauty of healthy ecosystems, of rare animals, and of migratory birds and butterflies not for practical or economic gain, but because we find the experience of them pleasing. This too is part of ecological value. Other ecological values are cultural values. The history of a cultural group is often connected to places, and the natural state of those places can thus be valuable to that group. Similarly, certain organisms, such as the giant panda in China, can take on symbolic meaning for a cultural group, and thus become imbued with ecological value. Some ecological values are none of these, but are merely *existence value*, which is the satisfaction derived merely from knowing that an object persists in a desired form. For example, most of us will never aesthetically experience the environment in the Alaska

National Wildlife Refuge (ANWR), don't benefit economically from the remote ecosystem services it provides, and don't attach cultural significance to it, yet many of us derive satisfaction from the knowledge that ANWR is protected from destructive exploitation. That satisfaction is existence value. Ecological value comprises at least these economic, aesthetic, cultural, and existence values.<sup>3</sup>

All these kinds of value, however, are non-intrinsic<sup>4</sup> values in the sense that they attribute value to a place or an organism only in relation to a valuing agent. This leaves open the possibility that not "all of biology" is valuable, since some parts of biology will not possess that relation to an agent, or will possess it to a comparatively insignificant degree. Because of this, the opponent of biodiversity eliminativism might argue that the focus on non-intrinsic values is misplaced. Using biodiversity as our primary measure of value, they could argue, acknowledges that "all of biology" is intrinsically valuable: that a major portion of the value of places and organisms is not derived from their value to cognitively sophisticated organisms. If this intrinsic value is important, and it is evenly apportioned across all of biology, then biodiversity would turn out to be an ineliminable part of our measurement of ecological value.

I am skeptical that intrinsic value exists, but for the sake of argument let's assume it does, and that it is significant. Even so, it would not provide a good reason not to eliminate biodiversity from the conservation decision-making process. Why? Because the features of intrinsic value generally aren't amenable to making comparative decisions, so they don't belong in the conservation decision-making process. Some of the problem is technical. If intrinsic value is ubiquitously distributed, or incommensurable with other values, or of infinite worth – all features often attributed to intrinsic environmental value – it will not allow us to use quantitative decision-making tools to prioritize conservation efforts (Colyvan and Steele 2011). In other words, it would not allow us to do conservation biology.

It could be argued that we rational conservation decision-making doesn't require the use of these quantitative decision-making tools, and thus intrinsic value could play an important role in environmental planning.<sup>5</sup> The problem with appealing to intrinsic value is not only technical, however, but also political. Even if we can skirt the issues raised by Colyvan and Steele, as Maguire and Justus observe, intrinsic value is "not amenable to the sort of comparative expression needed for conservation decision-making," whether this comparative expression is precisely quantified or not (2008: 910). Moreover, they argue that it lacks the motivational force to "take precedence over competing claims and guarantee conservation" (2008: 910). The problem is twofold. On the one hand, conservation doesn't occur in isolation from social value conflicts, and appeals to intrinsic value may not provide political capital on the same order of magnitude as appeals to non-intrinsic values. On the other, even non-quantitative deliberation requires the ability to assess tradeoffs and make compromises, and intrinsic values tend to resist that sort of assessment.

I find Maguire and Justus's reasons why intrinsic value is a poor foundation for conservation planning compelling, but they are controversial.<sup>6</sup> I'll thus buttress them with one of my own. Continue to suppose for the sake of argument that biological units do have intrinsic value, and that this value matters. On top of that intrinsic value those biological units will also have non-intrinsic value. Additionally, if a response to biodiversity eliminativism is going to be grounded in an appeal to intrinsic value, units will not differ in any meaningful way in the intrinsic value they possess. They will, however, differ significantly in the non-intrinsic value attributed to them. Consequently, in situations of conservation triage, decisions between different units must be made on the basis of non-intrinsic value. Because there is no difference in intrinsic value to attend to, intrinsic value would not allow us to make the tough decisions in situations where we can't save everything. Since this is precisely the situation conservation biology finds itself

in, intrinsic value cannot be the value conservation biology uses to make comparative decisions. Therefore, appeals to the intrinsic value of biodiversity, or to how well the broad nature of biodiversity captures the broad distribution of intrinsic value, don't ground an objection to biodiversity eliminativism.

### Biodiversity and non-intrinsic value

The opponent of biodiversity eliminativism can agree that conservation planning shouldn't focus on intrinsic value but maintain that biodiversity is the best measure for conservation on the grounds that biodiversity is a particularly reliable index for ecological value. According to this argument, the broad generality of biodiversity is its strength, as it allows us to capture the varied facets of ecological value. If biodiversity truly is a reliable index for ecological value, then we would have little reason to eliminate it from conservation practice.

But biodiversity is not a reliable index for ecological value. As I'll demonstrate in this section, in many significant cases it fails to capture or even misrepresents important ecological values. Before diving into specific cases, however, we should attend to an in-principle reason why biodiversity is in fact distant from ecological value: although both are properties of ecosystems, they are, methodologically speaking, properties of very different sorts. Biodiversity is an *endogenous* property of ecosystems. This means that, given a convention about how to operationalize *biodiversity*, we can measure the biodiversity of a system merely by studying the system itself, much in the same way as we measure other endogenous properties of ecosystems such as biomass, production, and resilience. Ecological value, however, is an *exogenous* property of ecosystems, meaning that it depends on an abundance of facts about entities external to the system as well as some system-internal facts. To determine the ecological value of, for example, ANWR, we have to study both the actual system in Alaska and the states of agents who have an interest of some sort in ANWR. Since ecological value is an exogenous property of ecosystems, it will be determined by a number of facts imperceptible to any endogenous property. Therefore, we should expect in principle that biodiversity, an endogenous property, will frequently fail to track ecological value.

Let's consider this point a little longer, because it is one of the most important reasons to favor biodiversity eliminativism. Conservation biology occupies a particularly value-driven scientific niche. Like any science, it aims in part at creating accurate descriptions of parts of the world, but to a much greater degree than most sciences, conservation biology is driven by non-epistemic normative goals. These normative goals are reflected most clearly in the measures conservation biologists use to make conservation assessments. At issue, then, is where those measures are derived from. My argument is that we should derive those measures in large part from the values of society at large – from states of agents exogenous to the systems in question – and this will require conservation biology to involve much more (admittedly messy) social scientific work in assessing these values.<sup>7</sup> The status quo tends to leave out an assessment of these values in favor of using biodiversity as a catch-all. This approach is understandable, even if not justifiable, because biodiversity, as a property endogenous to ecosystems, is assessable using the tools of biology alone. Conservation biology is, after all, a field of biology, so we should expect it to exhibit a preference for biological methodology. Nevertheless, by elevating biodiversity to its position as primary comparative measure in conservation, conservation biology establishes by scientific fiat what we will take to be valuable in ecosystems. It assumes that the conservation scientists know best what is valuable in nature, and largely excludes the public from the determination of the normative goals of conservation biology. By eliminating biodiversity in favor of ecological value, my aim is to increase the role the public's values play in setting the

conservation agenda. The purpose of conservation science is to facilitate the rational management of the environment, according to the values of all stakeholders. All stakeholders thus need a say in determining our measures of ecological value.

To see why this matters, let's review a number of examples of how biodiversity in its various forms misrepresents commonly held ecological values. We'll begin with species richness, the most common biodiversity surrogate. The trouble with species richness is two-fold: extinction-based measures of value fail to capture a whole range of ecological values, and richness measures implausibly treat species as equally valuable.

If we're using richness as a principle surrogate for biodiversity, and thus ecological value, we will be missing out on a wide variety of gains and losses of value. As Angermeier and Karr have observed, richness-based surrogates can only measure biodiversity loss through species extinction, so they will fail to capture situations such as the "elimination of extensive areas of old growth forest, dramatic declines in hundreds of genetically distinct salmonoid stocks in the Pacific Northwest, and the loss of chemically distinct populations from different portions of a species' range" (1994: 692). Some of these sorts of losses might be captured by expanding our richness measures to additional levels of biological organization, but others cannot, such as the loss of forested land, deviation from a valued historical state, or replacement of one species by an invader. These are significant changes in ecological value, which a richness-based measure can't reliably capture.

Worse, species richness often misrepresents value. Standard prioritization and complementarity algorithms assume that each species "counts for one" (Magurran 2004). This is patently problematic. The extinction of a useful pollinator like the honeybee would be a terrible loss of ecological value, the extinction of a beetle species from a densely packed genus would be a trivial loss of value, and the extinction of a mosquito species which spreads malaria might be a net gain. The right conservation priorities would thus treat the honeybee as a top priority, the beetle as an afterthought, and the mosquito as a priority target for elimination. If, however, our conservation priorities are framed in terms of diversity, we'll frustrate our values by over-prioritizing the less valuable species.

Another example of how richness can misrepresent value comes from the fact that cultural and existence values often attach to the natural, historical state of a place. But if we equate value with biodiversity, and biodiversity with richness, then we can increase the value of an area by introducing new species. It might be objected that the introduction of foreign species is actually prone to decrease richness by driving native species extinct, but such a situation could be avoided through careful experimentation and planning. For example, in a broad-ranging study, Ruesink (2003) found that introduced fish species significantly altered their adopted environments less than a third of the time, which suggests that with careful planning we could easily increase the richness of many aquatic habitats. Presumably, however, if conservation biologists expended their efforts in discovering which foreign species could be safely introduced, they would be failing in their task to promote ecological value (particularly in cases where the historical composition of an ecosystem is valued), despite successfully promoting biodiversity.

Biodiversity in the guise of richness clearly fails to represent ecological value well. But conservation scientists have long been aware that richness is imperfect. It does not, many have pointed out, even fully capture the intuitive notion of diversity. For this reason among others, Maclaurin and Sterelny have argued that species richness should be "supplemented in various ways for various purposes" (2008: 173). One common supplement for richness is measures of *abundance*, the evenness of relative population sizes. The idea behind abundance is intuitive. The folk concept of diversity includes not only the presence of a number of distinct varieties (richness), but also concerns whether each variety is well-represented. A grove consisting of

fifty beech and fifty aspen is as species-rich as one consisting of ninety-nine beech and one aspen, but is intuitively much more diverse. Measures of abundance typically use information-theoretic mathematical techniques to quantify how evenly represented each unit is (in conjunction with richness), thus capturing this aspect of diversity.

Supplementing measures of species richness with measures of abundance notably increases our ability to capture intuitive notions of diversity, but does not necessarily improve how well biodiversity measures represent ecological value. Ecological value often has little to do with abundance. Abundance-based measures assume that even population sizes are preferable, but this misses the mark. For some species, a disproportionately small or disproportionately large population size might be the status quo, and a shift in population size to make it more even with other species might impact the system adversely. In fact, in terms of value to humans, rarity itself is sometimes preferable. Booth *et al.* (2011) demonstrate, for instance, that the comparative rarity of a bird species determines how highly prized that species is among birdwatchers. So long as the species has a large enough population size to be out of danger from extinction, then, increasing the abundance of a rare bird species would actually decrease ecological value. In short, abundance faces the same problem as richness – it fails to consider the variety of ways in which species are valued or disvalued, and therefore a poor surrogate for ecological value.

Richness and abundance, of course, don't exhaust the toolkit of surrogates for biodiversity, but they are the most commonly used. Additionally, other measures of biodiversity, focusing on genes, morphology, higher taxa, environment types, etc. tend to either be poor measures of value, or just poorly suited for comparative measurement (Santana 2014). Extant measures of biodiversity thus all exhibit significant departures from non-intrinsic ecological values, which should not be surprising, since most of what is valuable about a particular biological unit isn't due to its contributions to diversity. Consequently, we can't justify using biodiversity as the primary target of conservation by appealing to how well it represents the values we place in the environment.

### Biodiversity and ecosystem stability

I have argued that biodiversity is an extraneous addition to our chain of inference in conservation planning, and we have considered two arguments to the contrary. The first emphasized that biodiversity and intrinsic ecological value have similar coverage, thus making biodiversity an important conservation target. In response, I appealed to reasons why intrinsic values should not be part of conservation decisions. The second objection focused on the utility of biodiversity as a faithful surrogate for non-intrinsic ecological values. We saw, however, that it misses out on some values, and misrepresents others, which undermines the force of the objection. One path still remains open to the opponent of biodiversity eliminativism, however. They can contend that although biodiversity frequently falls short as a direct index for ecological value, it succeeds as an index for ecosystem stability. Since all other ecological values rely on some measure of stability, biodiversity remains a useful conservation target despite its failings.

I have two responses to this objection. First, even if there is a close relationship between diversity and stability, general measures of biodiversity are probably not our best way to promote stability. Second, the relationship between stability and ecological value isn't particularly tight.

The *diversity-stability hypothesis* is the claim that there is close causal relationship between the diversity of an ecosystem and its stability. The hypothesis is controversial, for reasons having to do both with mixed empirical support and with a lack of clarity regarding the concepts *diversity* and *stability* (Justus 2008). Regarding the empirical support, the literature is too large to review here (for entry points to the literature, see Tilman and Downing 1994, Sankaran and

McNaughton 1999, and Gross *et al.* 2014), but the typical finding supports only a carefully caveated version of the hypothesis. For example, a review of the empirical research regarding the diversity–stability hypothesis concludes that biodiversity is at best a rough guide to stability, and that for any particular area there are better methods for maintaining stability than by targeting biodiversity (Johnson *et al.* 1996). If this is the case, the need to maintain stability does not necessarily commit us to employing biodiversity as a conservation target.

On the other hand, it isn't clear that general stability is a guide to ecological value of the relevant sort at all. "Stability" is taken to mean many different things (Justus 2008), but if, to take on standard definition, "stability" is the persistence of species, populations, or other biological units, then conservation biology by definition aims at stability of some sort. But we cannot preserve all biological units, so aiming for stability of this sort will be a poor guide to conservation for many of the same reasons that aiming for intrinsic values is. More importantly, stability of this sort isn't always valuable to the same degree. As we've seen, biological units vary dramatically in their value, and sometimes we will value the stability of some more than others. In many cases, we will even want to promote change. Ecological value is thus not always closely tethered to stability. In conjunction with the empirical weakness of the diversity–stability hypothesis, this gives us reason to reject the claim that considerations of stability motivate the central role of biodiversity in conservation biology.

### Deflationary accounts of biodiversity

Even someone who accepts most of the arguments I've made above might still be hesitant to accept biodiversity eliminativism. Sarkar, for instance, recognizes many of the same problems with the traditional role of biodiversity in conservation science, but opposes eliminativism. "The trouble with eliminativism," he writes, "is its excessive ambition: it would require a complete restructuring of conservation practice with no recourse to 'biodiversity'" (2014: 3). The cost of giving up the term, he thinks, might not be worth the benefit. So instead of eliminativism, he proposes remedying the problems with biodiversity by adopting a deflationary version of the concept. On a deflationary account (Sarkar 2002, 2014), the meaning and operationalization of the term "biodiversity" would be conventionally fixed and adjusted, as needed, to account for the conservation desiderata in particular circumstances. This would allow conservationists to incorporate the interests of all stakeholders into conservation targets.

Weakly deflationary accounts merely allow for flexibility in what aspects of biodiversity to take into account in making conservation decisions. These accounts will be vulnerable to my earlier arguments. But entirely deflationary positions – that is, ones which allow local conventions complete freedom in determining the conservation goals in any particular circumstance – are nearly identical to eliminativism. The only difference is that the deflationary account prefers to retain the word "biodiversity" as a shorthand for ecological value. Given its similarity to eliminativism, I have no major objection to the strong deflationary account, but there is good reason not to retain the word "biodiversity" in its role as representation of value. "Biodiversity" is a historically and theoretically laden term. If we use the term as our primary name for ecological value, we will import that history and theory, and thus skew our perspective of ecological value towards those things with reasonably fall under the concept *biological diversity*. Since much of ecological value does not, it makes sense to push the deflationary account to its logical conclusion, eliminativism.

To reiterate, eliminativism does not propose doing away with biodiversity talk altogether. I acknowledge that the term might continue to play an important role in conservation discussions, both for its political appeal and its utility as a bridge concept. Insofar as Sarkar's



objection to eliminativism reflects worries about the loss of these important uses of the term “biodiversity”, this acknowledgement should rob the objection of some of its sting. But I do think, given the likelihood that use of the term as shorthand for all of ecological value is likely to elide some important values, that eliminativism is preferable to a deflationary account.

## Conclusion

Biodiversity eliminativism is in some ways a drastic proposal. It would require some deep restructuring of conservation practice. I don't think, however, that the cost of adopting eliminativism is disproportionate to the benefit. Wise environmental stewardship is one of the most important items on the human agenda, so it's worth considering drastic options like biodiversity eliminativism if it will help us get conservation done right. Under the biodiversity-focused status quo, we get it right sometimes, but biodiversity isn't optimally sensitive to the varieties of ecological value. Not everything valuable can be adequately labeled “diversity.” Nor can we accurately assess ecological values by measuring only endogenous properties of ecosystems. Our best bet for prudentially managing our environment is thus to eliminate biodiversity from its exalted position in conservation planning.

## Notes

- 1 This chapter is a development of ideas found in Santana (2014).
- 2 I am, however, open to the possibility that we *should* eliminate biodiversity talk from all contexts. It's quite possible that other concepts would fulfill each conceptual role currently played by *biodiversity* better than *biodiversity* currently does.
- 3 For an illuminating point of comparison, see Sarkar (2012, esp. chapter 2), who outlines a similar taxonomy of what he calls *natural values*: biodiversity, welfare, fidelity, service, and wild nature. His taxonomy of natural values differs from my taxonomy of ecological value in part my taxonomy is meant to be less fine-grained, and in part because Sarkar sees more of a divide between descriptively held and normatively justified values than I do.
- 4 The literature often contrasts intrinsic values with *instrumental* values. I avoid the ambiguous term “instrumental” here because instrumental values are sometimes understood to comprise merely economic values, but “non-intrinsic” leaves room for aesthetic, cultural, and existence values as well.
- 5 This objection was brought to my attention by Sahotra Sarkar.
- 6 Callicott (2006), for instance, argues that we can roughly quantify intrinsic value.
- 7 See Kareiva and Marvier (2012) for a distinct but compelling argument for the same conclusion.

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