Weighing Species

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Richness theory offers an alternative to the paradigms that have dominated the short history of environmental ethics as a self-conscious field. This alternative theoretical paradigm defines *intrinsic value* as "richness"—a synonym for "organic unity" or "unity in diversity." Richness theory can handily reconcile two kinds of ideas that seem to be in tension with each other: that (1) an individual human being has a greater worth than an individual organism of just about any other species; and (2) yet the world would be a better place with substantially fewer humans and/or less consumption per capita, thus leaving more resources for other species. The mutual compatibility of such ideas within the framework of richness theory can be demonstrated both verbally and through a simplified mathematical model.

I. INTRODUCTION

[E]nvironmental ethicists should continue to articulate and refine different accounts of objective intrinsic value.[1]

How heavily should we weight the interests of nonhuman organisms, species, and ecosystems? Much debate has centered on whether nonhumans should count at all, except insofar as they further human interests. The anthropocentric side of this debate—that nonhumans have no independent moral standing whatsoever—is irredeemably partial. Yet, while the biocentric/ecocentric side affirms that both humans and nonhumans have standing in their own right, proponents have not said enough about how much value or standing different entities have. Nor have they generally provided rigorous foundations for such judgments.

In this essay, I attempt to advance the difficult but necessary project of weighing the value of nonhuman entities against that of humans. As a foundation for this project, I appeal to a neglected strand of environmental philosophy, according to which

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[1] Christopher J. Preston, "Epistemology and Intrinsic Values: Norton and Callicott's Critiques of Rolston," *Environmental Ethics* 20 (1998): 428 (emphasis added).

intrinsic value is identical to "richness," also known as "organic unity." Richness, in turn, supervenes on other properties—perhaps ultimately just two: variety and harmony. More-or-less synonymous terms for *variety* include "diversity"; and for *harmony,* "unity," and "integration" or "integrity." Richness theorists thus ground their framework in the widely held ideal of "unity in diversity." Antecedents of richness theory go back at least as far as Gottfried W. Leibniz.[2] Richard Sylvan and David Bennett's "deep green" philosophy resonates with it in key respects.[3] Peter Miller and Ben Bradley articulated it further, and Chris Kelly and Graham Oddie have recently extended and defended it.[4]

Many environmental philosophers who do not explicitly subscribe to richness theory nonetheless acknowledge variety as a constituent of intrinsic value. For example, the first two of eight planks in the deep ecology platform read:

> 1) The well-being and flourishing of human and nonhuman life on Earth have value in themselves (synonyms: inherent worth; intrinsic value; inherent value). These values are independent of the usefulness of the nonhuman world for human purposes.
>
> 2) Richness and diversity of life forms contribute to the realization of these values and are also values in themselves.[5]

These planks also imply that variety ("diversity") is not the only determinant of value, since "flourishing," "well-being," and "richness" are invoked independently of it. Because neither deep ecology nor richness theory have variety as the sole constituent of intrinsic value, they do not fall prey to easy counterexamples that merely point out that in some cases one can increase variety while reducing overall value.[6] Richness theorists disagree about whether harmony is the only other determinant of value. Below, I assume that it is (as Kelly argued), but I believe similar conclusions would also follow from Miller's more complex vision.

In this essay, I do not repeat the work of the richness theorists cited above, and thus do not offer a full-blown defense of richness theory. Instead, I limit myself to one additional argument in its favor: that it provides a relatively straightforward

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[2] Gottfried W. Leibniz, *Discourse on Metaphysics* (1686); translated in *Philosophical Texts* (Oxford: Oxford University Press, 1998), pp. 54–89.

[3] Richard Sylvan and David Bennett, *The Greening of Ethics* (Tucson: University of Arizona Press, 1994).

[4] Peter Miller, "Value as Richness: Toward a Value Theory for an Expanded Naturalism in Environmental Ethics," *Environmental Ethics* 4 (1982): 101–14; Ben Bradley, "The Value of Endangered Species," *Journal of Value Inquiry* 35 (2001): 43–58; Chris Kelly, *A Theory of the Good* (Boulder: University of Colorado, 2003); Graham Oddie, *Value, Reality, and Desire* (Oxford: Oxford University Press, 2006).

[5] Arne Naess and George Sessions, "Deep Ecology Platform" (http://www.deepecology.org/platform.htm).

[6] For example, while adding an invasive species to a natural ecosystem would boost its species diversity at least temporarily, it might very well disrupt relationships between other species, and thus reduce the harmony/unity/integrity of the ecosystem, enough to detract from its overall richness.

way to reconcile four broad intuitions, each of which seems *prima facie* to be in tension with at least one other:

(1) Individual human beings have greater intrinsic value than most if not all individual nonhuman organisms.
(2) Yet a biodiverse Earth with a moderate number and per-capita impact of humans would have greater intrinsic value than the current, human-dominated, biotically impoverished Earth does—even if biodiversity loss and other downsides of economic growth had no negative effect on human well-being.
(3) Taken as a whole, the nonhuman part of the living world—even in its currently impoverished state—has greater intrinsic value than does humanity.
(4) Yet a biodiverse Earth with a moderately sized human economy would also have greater intrinsic value than an Earth still more biodiverse, yet devoid of whom Blaise Pascal called "the glory and shame of the universe," i.e., *Homo sapiens*.[7]

The fact that richness theory can handily harmonize these intuitions proves its ability to support a "deep" environmental ethic, even while ascribing special status to humans.

II. INDIVIDUAL ORGANISMS

The eye may be the best part of the animal, but that doesn't mean that the best animal would be one completely covered with eyes.[8]

A living organism is a paradigmatic example of a rich entity.[9] For example, under normal conditions 210 different types of cells cooperate within the human body.[10] When cells become sufficiently un-cooperative—e.g., when some become cancerous—it detracts from the richness of a human life (not to mention possibly ending it altogether).

Of course, the number of cell types and quality of their interactions are far from being the only criteria of organismal richness. For example, we might also cite the variety and coherence of an organism's behavior. Yet these aspects of richness depend importantly on cell-type number and organization, as well as on other facets

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[7] Blaise Pascal, *Pensées* (New York: E. P. Dutton, 1932).

[8] Jill LeBlanc, "Eco-Thomism," *Environmental Ethics* 21 (1999): 301 (emphasis added).

[9] Kelly, *A Theory of the Good*, p. iii.

[10] James W. Valentine, Allen G. Collins, and C. Porter Meyer, "Morphological Complexity Increase in Metazoans," *Paleobiology* 20 (1994): 131–42. This figure counts only the cells that are genetically human, thus ignoring the myriad of "nonhuman" cells—e.g., gut flora—that nevertheless reside within the human body and contribute indispensably to the survival and functioning of the human organism.

of anatomical richness.[11] Therefore, if we assume that the harmony manifested by individual organisms has any of the following general relationships with their anatomical and behavioral variety, then we can accept cell diversity as a rough proxy for overall richness at this level: (a) greater harmony goes with greater variety, (b) harmony is independent of variety, or (c) harmony decreases with variety, but not sharply enough to outweigh the the value of increasing variety.

This richness proxy affirms that humans are indeed special. Most if not all nonhuman organisms have fewer cell types than humans do.[12] I thus conclude that richness theory, conjoined with information from biology, confirms the intuition that an individual human being has greater intrinsic value than individual organisms of most if not all other species.

III. AGAINST TOTALITARIAN HUMANISM

> *An angel is more valuable than a stone. It does not follow, however, that two angels are more valuable than one angel and one stone.*[13]

Does it follow that we should maximize human population size and/or per-capita resource consumption at the expense of other species? No. First of all, if we stuck with cell-type number as an indicator of richness, a biodiverse Earth would rank higher than the current one with human domination driving a wave of extinctions.[14] As an illustration, consider that a world with one human and one cyanobacterium (i.e., one single-celled "blue-green alga") would have more cell types in it (211) than a world with two humans (210).

Yet, at the species and ecosystem levels, other richness indicators become more relevant than cell-type number. For example, genetic and cultural diversity are reasonable indices of richness at the species or population level, and species diversity and functional diversity serve that same purpose at the ecosystem or community level. I submit that a biodiverse Earth ranks higher than a biotically impoverished one by all of these criteria—including cultural diversity, since many nonhuman beings also have cultures that vary within and between species.[15] But rather than letting the argument rest there, let us explicate the concept of richness a bit more deeply, so as to more rigorously test the second intuition listed in the Introduction above.

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[11] Daniel W. McShea, "Functional Complexity in Organisms: Parts as Proxies," *Biology and Philosophy* 15 (2000): 641–68.

[12] Sean B. Carroll, "Chance and Necessity: The Evolution of Morphological Complexity and Diversity," *Nature* 409 (2001): 1102–09.

[13] Thomas Aquinas, quoted in Klaus Nehring and Clemens Puppe, "A Theory of Diversity," *Econometrica* 70 (2002): 1155–98 (emphasis added).

[14] Cf. Richard Leakey and Roger Lewin, *The Sixth Extinction: Biodiversity and Its Survival* (London: Weidenfeld and Nicolson, 1996).

[15] Franz B. M. de Waal and Peter L Tyack, eds., *Animal Social Complexity: Intelligence, Culture, and Individualized Societies* (Cambridge: Harvard University, 2003).

Diminishing Returns and Higher-Level Interaction

Life is an artist; indeed, it is always a tribute to a work of art to say that it has organic unity.[16]

As artistic examples illustrate, the concept of diminishing returns can shed light on the intrinsic value of variety. A painting has a certain degree of aesthetic value. But if two paintings are quite similar to each other, then the total value of the twain, while greater than that of either one alone, is yet less than the sum of their separate values. In other words, as we add similar paintings, we add to the total value at a diminishing rate. Kelly used an extreme case to demonstrate this point:

> Considered alone, a reproduction of a Rembrandt has some value; it is a unified variety. Call this V. But now consider a booklet made of three hundred of the same Rembrandt. What is the value of this whole? It is certainly not 300V. The repetition of the same painting (in the absence of some other rich reason for this repetition) clearly reduces the value [of the whole below the sum of the intrinsic values of the parts]. . . .[17]

Other things being equal, a booklet with greater variety would be richer and therefore have more value.

A different concept—what I call "higher-level interaction"—helps to illuminate the intrinsic value of harmony:

> [I]magine putting together the two halves of Shakespeare's sonnet. It is clear that the value of the whole sonnet is greater than the value of the two halves by themselves.[18]

Not only do two halves of Shakespeare's poem (e.g., lines 1–8 vs. 9–14) differ enough from each other to avoid monotonous repetition. They also "interact" or relate harmoniously so as to raise the value of the whole above the sum of the separate values of the halves.

Further Economic Growth Unconscionable

Let us now apply these insights to the case at hand. No matter how harmoniously a moderately sized human economy might function, at some point there will be diminishing returns. This truism applies to both components of economic size:

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[16] Holmes Rolston, III, "Values in Nature," *Environmental Ethics* 3 (1981): 122 (emphasis added).

[17] Kelly, *A Theory of the Good*, p. 25.

[18] Ibid., p. 26. The sonnet in question (Number 116) reads: "Let me not to the marriage of true minds / Admit impediments. Love is not love / Which alters when it alteration finds, / Or bends with the remover to remove: / O, no! it is an ever-fixed mark, / That looks on tempests and is never shaken; / It is the star to every wandering bark, / Whose worth's unknown, although his height be taken. / Love's not Time's fool, though rosy lips and cheeks / Within his bending sickle's compass come; / Love alters not with his brief hours and weeks, / But bears it out even to the edge of doom. / If this be error and upon me proved, / I never writ, nor no man ever loved."

per-capita consumption and population size. With regard to per-capita consumption, economists have long recognized the diminishing marginal utility of money, and therefore the goods and services procurable with it.[19] Objective quality of life indicators, such as health-adjusted life expectancy, also show diminishing returns to income. A person making $100,000 a year does not live twice as long or healthily as someone making $50,000. As more resources are devoted to any single individual, any plausible indicator of richness, and hence intrinsic value, must eventually also show diminishing returns. The same goes for human population size. Beyond a certain point, adding any given number of humans would increase the intrinsic value of humanity less than adding that same number to a smaller population did. Beyond another point, adding more humans would result in a less intrinsically valuable Earth than would leaving those resources to nonhuman organisms instead. Figure 1 presents a simplified illustration of these claims.

Figure 1 expresses the ideas of both diminishing returns and human superiority. First, the curves indicate that increasing the population size of and/or per-capita consumption by a given species (the horizontal axis) would yield an increase in its collective intrinsic value (the vertical axis). But increasing the population or consumption of a species by any given amount would boost its intrinsic value more if the species were rare, and/or "frugal" on a per-capita basis, than if it were common and/or "gluttonous." Second, figure 1 extends the point made in a previous section—that the organic unity, and therefore intrinsic value, of an individual human exceeds that of an individual organism in most if not all other species. The fact that the curve for humans is higher than the one for nonhumans means that for any given amount of resources (any point along the *x* axis), intrinsic value would be greater if those resources were devoted completely to humanity than if they went completely to the other species.

But neither of these "totalitarian" scenarios would yield as much value as devoting some resources to each species. To illustrate, let us imagine starting with a substantially but not completely human-dominated world such as our own. Let the *x*-coordinate of the point on the upper curve, at the left end of the top-right horizontal arrow, represent the total consumption of resources by humans (number of people times per-capita consumption); and the *x*-coordinate of the point on the lower curve, at the right end of the bottom-left horizontal arrow, represent consumption by the nonhuman species. If we then added still more humans, and/or ramped up per-capita consumption still further, so that total human consumption increased all the way out to the right end of the diagram, it would increase the total intrinsic value of humanity by the amount indicated by the top-right vertical arrow pointing up to the upper curve.

But in this simplified two-species system, devoting those resources to humanity would deny them to the other species. In fact, it would deny any resources to the

[19] Hilary Putnam, *The Collapse of the Fact/Value Dichotomy, and Other Essays* (Cambridge: Harvard University Press, 2002).

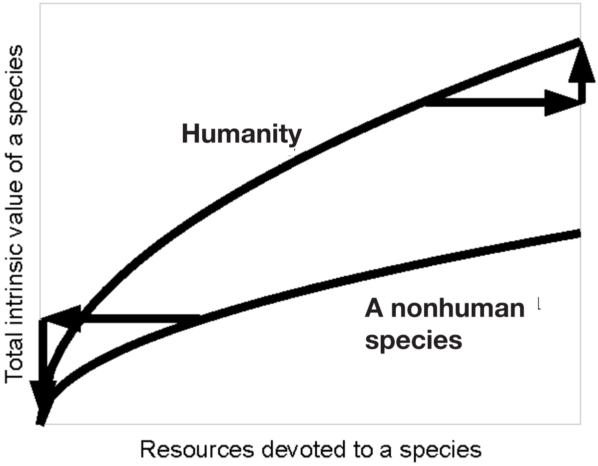

Fig. 1. Diminishing Returns and Human Superiority

other species, and therefore drive it extinct. Doing so, in turn, would annihilate the intrinsic value indicated by the bottom-left vertical line pointing to the origin. This loss of value would exceed that gained by humanity, as comparing the lengths of the two vertical arrows shows. Thus, other things being equal, growing the already-large human economy at the expense of the already scarce nonhuman species would result in a net loss of intrinsic value.

I qualified this last assertion with the caveat "other things being equal," because we have not yet considered harmony and higher-level interaction. Many lines of reasoning indicate that anthropogenic species extinctions are decreasing the overall harmony of life on Earth. For one thing, the positive relationship between species diversity and total ecosystem productivity means that such extinctions are knocking down the sheer amount of life happening on the planet.[20] Helmut Haberl et al. estimate that we have reduced Earth's terrestrial net primary productivity (the amount of new living material created through photosynthesis each year) by at least ten percent.[21] Many

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[20] Darwin noted the positive relationship between diversity and productivity, and Loreau reviews the mass of recent experimental evidence confirming it: Charles Darwin, *On the Origin of Species by Means of Natural Selection* (London: John Murray, 1859); Michel Loreau, *The Challenges of Biodiversity Science* (Oldendorf/Luhe: International Ecology Institute, 2010).

[21] Helmut Haberl, K. Heinz Erb, Fridolin Krausmann, Veronika Gaube, Alberte Bondeau, Christoph Plutzar, Simone Gingrich, Wolfgang Lucht, and Marina Fischer-Kowalski, "Quantifying and Mapping the Human Appropriation of Net Primary Production in Earth's Terrestrial Ecosystems," *Proceedings of the National Academy of Sciences* 104 (2007): 12942–47. In other words, it is *not* the case that "in our global world, nature is as alive as ever," whatever phenomenology might purport to tell us: see Irene J. Klaver, "Stone Worlds: Phenomenology on (the) Rocks," in *Environmental Philosophy: From Animal Rights to Radical Ecology*, edited by Michael E. Zimmerman, J. Baird Callicott, Karen J. Warren, Irene J. Klaver, and John Clark (Upper Saddle River: Pearson/Prentice Hall, 2005), p. 348.

other "ecosystem functions" besides productivity also suffer when species diversity declines. These include carbon fixation, retention of soil nutrients, and overall ecosystem stability.[22] Such functions are the best indicators we have of integration or integrity—near synonyms of harmony as noted above—at the ecosystem level.

Even at the level of the individual organism, numerous studies have documented increased parasite burden caused by species loss.[23] Finally, the fewer species there are, the smaller is the chance that any given species has a strongly positive relationship with at least one other (e.g., a mutualism such as those between some plants and mycorrhizal fungi). I thus conclude that anthropogenic destruction of life's variety is also wrecking its harmony. Thus, once the human economy has reached a certain size, not only variety but also harmony would be best achieved by ceding nonhuman species their fair place in the sun, than by insisting on further economic growth.

Has the economy already reached or passed that size? I submit that it has. Ecologists estimate that humans expropriate at least a quarter of global terrestrial net primary productivity.[24] Yet *Homo sapiens* is only one out of ten million or so species. This means that humans collectively consume millions of times more than the average species' share. No plausible measure of human superiority can justify such colossally disproportionate consumption.[25]

IV. A MODEL OF INTRINSIC VALUE

> *[T]o multiply one and the same thing only would be superfluity, and poverty too. . . . [T]he value of a* bonum variationis *is greater than the sum of the values of its constituent parts.*[26]

To flesh out the above claims—and to test their consistency with each other, with other claims made below, and with known biological facts—I designed a simple mathematical model. Before presenting it, I ask the reader to keep in mind that while such models are intended to capture essential aspects of a given subject, they can almost never include all of even the most important factors involved. Because of this model's particular simplifications, I expect the model to work better, the

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[22] Again, for a review, see Loreau, *The Challenges of Biodiversity Science*.

[23] See, for example, Janet Pelley, "Biodiversity is Good for Your Health," *Frontiers in Ecology and the Environment* 7 (2009): 349. In thus citing a rise in parasitism as a fall in harmony and thus intrinsic value, I do not deny that *some* level of parasitism can have various *instrumental* values, e.g., in driving the evolution, through natural selection, of individually richer host organisms.

[24] Haberl et al., "Human Appropriation."

[25] Nor does humanity "need" to consume as much as we do in order to survive as a species. Indeed, for most of our 100,000-year tenure on this planet we survived on orders of magnitude less. Furthermore, the accelerating environmental damage caused by further expansion today may be rendering our survival less, rather than more, secure.

[26] Gottfried W. Leibniz, and Roderick Chisholm; quoted in Bradley, "Value of Species," p. 51 (emphasis added).

broader the comparison being made. For example, for the calculations reported below, I chose the golden northern bumblebee (*Bombus fervidus*) as a representative nonhuman species. I believe doing so to be a reasonable choice because most species on Earth are insects (of which bumblebees happen to be my favorite). I would not expect the model to work very well for comparisons that are much finer-grained than humans vs. bumblebees—e.g., for comparisons between different mammal species, let alone comparisons between organisms of the same species.

According to the model,

$$(1)\ V_i = (\Sigma_{j = 1 \text{ to } T}\, C_j^{2/3}) \text{ x } T^{1/3} \text{ x } R^{2/3}$$

V_i is the intrinsic value, i.e., the richness, of an organism in Species *i*. *T* is the number of cell types in the organism, C_j is the number of cells within Cell Type *j*, and Σ_j means to take the sum over all of those cell types. *R* (for "resources") is the ratio of the "net primary productivity" (NPP) appropriated by the organism, relative to the minimum NPP necessary to stay alive and reproducing. Raising C_j and *R* to the two-thirds (2/3) power entails diminishing returns of value to increasing numbers of cells within any given cell type, and to increasing organismal consumption. $T^{1/3}$, the second factor in the equation, expresses the assumption that within organisms, cells interact in such a way that harmony (cooperation within and/or between cell types) increases with variety (number of cell types). But this increase shows even faster-diminishing returns. Equation (1) scales the richness metric by setting it equal to one for all single-celled organisms consuming just enough to survive and reproduce; with larger, more complex, and/or higher-consuming organisms all having greater value.

Filling in the quantities on the right side of equation (1) for a human and a bumblebee, I estimate that a human with today's global average consumption has an intrinsic value nearly 300,000 times greater than that of our representative individual nonhuman organism. (Contact the author for more details about this estimation, and the input quantities employed therefor.) This estimation satisfies intuition number one listed in the introduction above.

The model treats species on Earth as somewhat analogous to cell types within an organism:

$$(2)\ V_E = [\Sigma_{i = 1 \text{ to } S}\, (V_i \text{ x } O_i^{2/3})] \text{ x } S^{1/3}.$$

V_E is the total intrinsic value/richness of life on Earth, *S* the number of species, and O_i the number of organisms in Species *i*. V_i (from equation [1]) accounts for the differential richness of organisms in different species. Just as equation (1) entails diminishing returns of value to the number of cells within any given cell type, as well as to the number of cell types; so also does equation (2) entail diminishing returns to the number of organisms within any given species, as well as to the number of species. However, since the overall biological productivity of the

Earth is not increasing,[27] equation (2) includes no variable for increasing overall consumption.[28]

Again, filling in the relevant quantities on the right side of this equation, I calculate that a global ecosystem containing 100 million humans, each "appropriating" today's global per-capita human share of NPP, and the rest left to other species, would have an intrinsic value fourteen percent greater than today's overly human-dominated one (cf. intuition [2] in the introduction above). I chose 100 million, because Naess suggested that we aim to slowly reduce the world human population to around that level.[29] Ehrlich entertained a larger figure—around two billion—as being sustainable.[30] According to my richness model, an Earth with that many humans, again assuming unchanged per-capita consumption, would be twelve percent richer than today's. Again, contact the author for details. Below, I will register further results of the model as they pertain to intuitions (3) and (4) from the introduction above.[31]

V. HUMANITY'S PLACE IN THE WORLD

I want to tell what the forests
were like
I will have to speak
in a forgotten language.[32]

So far, I have compared the intrinsic value of a single human being to that of a nonhuman organism; and the intrinsic value of our current, biotically-impoverished, human-dominated planet to that of a biodiverse Earth with a more moderate human

[27] Haberl et al., "Human Appropriation."

[28] One reviewer pointed out that equation (2) also ignores geological diversity as a contributor to the overall richness of the ecosphere. I would argue that "geo-diversity" is not important *for the comparisons made here,* between an Earth with greater vs. lesser human domination and thus biodiversity loss. While human domination has surely affected geo-diversity (e.g., through heinous mining practices that level entire mountains), it has not done so to nearly the same degree as it has impacted biodiversity. For example, I know of no types of geological formation that we have driven entirely "extinct."

[29] Arne Naess, *Ecology, Community, and Lifestyle: Outline of an Ecosophy* (Cambridge: Cambridge University Press, 1989).

[30] Paul R. Ehrlich, "Key Issues for Attention from Ecological Economists," *Environment and Development Economics* 13 (2008): 1–20.

[31] The sources of input for the richness model are Janet W. Goldblatt and Richard D. Fell, "Adult Longevity of Workers of the Bumble Bees *Bombus fervidus* (F.) and *Bombus pennsylvanicus* (De Geer) (Hymenoptera: Apidae)," *Canadian Journal of Zoology* 65 (1987): 2349–53; David H. Wright, "Human Impacts on Energy Flow through Natural Ecosystems, and Implications for Species Endangerment," *Ambio* 19 (1990): 189–94; Valentine et al., "Morphological Complexity"; Michael L. Rosenzweig, *Species Diversity in Space and Time* (Cambridge: Cambridge University Press, 1995); Robert E. Ricklefs and Gary L. Miller, *Ecology* (New York: W. H. Freeman, 2000); Haberl et al., "Human Appropriation"; United Nations, *World Population Prospects: The 2006 Revision* (New York: United Nations, 2007); Barbara Zorn-Arnold and Henry F. Howe, "Density and Seed Set in a Self-Compatible Forb, *Penstemon digitalis* (Plantaginaceae), with Multiple Pollinators," *American Journal of Botany* 94 (2007):1594–1602; and Wikipedia, en.wikipedia.org/wiki/Human_body, en.wikipedia.org/wiki/Human_cell_types (2010).

[32] W. S. Merwin, *The Rain in the Trees* (New York: Alfred A. Knopf, 1988), p. 65 (emphasis added).

footprint. In this section I briefly compare the value of humanity to that of all other species combined, as well as that of an Earth with humans vs. an Earth without humans.

Current scientific knowledge barely scratches the surface, when it comes to the variety and harmony of life on Earth. So far scientists have identified only one or two million out of the estimated ten million species. Of the fraction identified, they have studied only a much smaller fraction in any depth. What is known indicates that humans' fellow species have an astounding array of physical, chemical, biological, psychological, social, ecological, and evolutionary capabilities; and achieve complexity and coordination at many levels—genetic, cellular, organismal, population, and ecosystem. Of course, the human species also has some spectacular achievements to its credit. For example, not only have many individuals led very rich lives, but collectively humanity has manifested an amazing variety of cultures. However, global capitalism is now rapidly effacing this cultural diversity.[33] Nor do the wars, gross inequalities, and environmental devastation of recent millennia give much evidence that economic growth has led humans to interact more harmoniously with each other, much less with the rest of the biosphere.[34]

Given such considerations, I conclude that the intrinsic value of nonhuman nature still much exceeds that of humanity. The model described in the preceding section supports intuition (3) from the introduction. As noted above, the model ascribes much greater intrinsic value to an individual human than to a representative individual nonhuman organism (≈ 300,000 times greater). Nevertheless, it estimates the collective intrinsic value of the nonhuman living world—despite its present state of impoverishment—to be over 700 times that of humanity. Even without the assumption that harmony increases with increasing species diversity (i.e., even if $S^{1/3}$ is simply dropped from the end of equation [2]), humanity would still have around four times less intrinsic value than the rest of life according to the model. I intend these conclusions and results as a dramatic corrective to anthropocentrism.

Would an ideal world then have no humans at all? No. Up to a certain point in the history of economic growth, humanity added more richness to the world than it subtracted by driving a relatively small number of other species extinct. Humans are individually and collectively richer, for any given amount of resources consumed, than other species are. Such a situation suggests that humans may deserve not just an equal share of those resources, but a much larger share than the average species. Indeed, according to my richness model an Earth with 100 million humans (though not one with two billion) would be richer than one without any at all (intuition [4] from the introduction). At current levels of per-capita consumption, this would entail a share of Earth's terrestrial net primary productivity nearly 40,000 times greater for *Homo sapiens* than for the average species.

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[33] For example, consider the extinction crisis of human languages documented by Kieran Suckling in "A House on Fire: Linking the Biological and Linguistic Diversity Crises," *Animal Law* 6 (2000): 193–202.

[34] Clive Ponting, *A New Green History of the World: The Environment and the Collapse of Great Civilizations* (New York: Penguin, 2007).

VI. CONCLUSION

In this essay, I have applied richness theory to the question of just how special humans are. The answer, I have argued, is that humans are special enough to warrant using quite a bit more than an equal share of the Earth's resources, but not anywhere near the twenty-five percent of terrestrial net primary productivity currently "appropriated." Thus, in addition to the compelling human-centered reasons for limiting the overall size of the human economy,[35] we also have weighty moral reasons to do so for the sake of our fellow species and the global ecosystem.

[35] Cf. Herman E. Daly and Joshua Farley, *Ecological Economics: Principles and Applications* (Washington, D.C.: Island Press, 2010).