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Reducing Human Numbers and the Size of our Economies is Necessary to Avoid a Mass Extinction and Share Earth Justly with Other Species

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Abstract
Conservation biologists agree that humanity is on the verge of causing a mass extinction and that its primary driver is our immense and rapidly expanding global economy. We are replacing Earth's ten million wild species with more of ourselves, our domesticated species, our economic support systems, and our trash. In the process, we are creating a duller, tamer, and more dangerous world. The moral case for reducing excessive human impacts on the biosphere is strong on both anthropocentric and biocentric ethical grounds. The sine qua non for doing so is reducing human numbers and the size of our economies, while increasing the global acreage set aside in protected areas. We should take these steps as part of comprehensive efforts to create just and sustainable societies in which both humans and other species can flourish.

Keywords Extinction · Overconsumption · Overpopulation · Limits to growth

This paper begins by summarizing evidence that humanity is on the brink of causing a mass extinction event, through rapidly and intentionally displacing other species with more of ourselves and our rapidly expanding economies. I argue that this is wrong and that we should instead decrease our numbers and the size of our economies and set aside much more of Earth's lands and seas for other species. I justify these policy proposals on the basis of humanity's moral obligations to other species and current people's moral obligations to future people. Finally, I consider objections to my proposals and argue they are both possible and necessary, that they can be implemented fairly, and that failure to implement them would itself be unjust.

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1 What we are doing

Humanity is rapidly displacing much of Earth's existing biodiversity. We are extinguishing many of its life forms, reducing the numbers of most others, and extending our impacts ever more intensively over previously wild ecosystems. In the process, we are also degrading the ecosystem services future human societies will depend on for their survival and flourishing.

1.1 Enacting a mass species extinction …

A scientific consensus exists that biodiversity is rapidly dwindling. In just the past fifty years, wild vertebrate populations declined by approximately 60% globally (World Wildlife Fund, 2020). Rosenberg et al. (2019) report that approximately 2.9 billion fewer wild birds bred in Canada and the United States in 2018 compared to 1970. Anthropogenic extinction levels are an estimated 1000 times higher than the historical background rate and predicted to continue climbing (Pimm et al., 2014). The UN's Secretariat of the Convention on Biological Diversity (2010) estimates that humanity could extinguish one out of every three species on Earth within the next one to two hundred years, while according to Raven et al. (2011), "biodiversity is diminishing at a rate even faster than the last mass extinction at the end of the Cretaceous Period, 65 million years ago, with possibly two-thirds of existing terrestrial species likely to become extinct by the end of this century." Even using conservative estimates for current extinction rates and holding these rates steady, projecting them forward a few hundred years predicts immense losses (Ceballos et al., 2015).

The United Nations has created a scientific panel modelled on the Intergovernmental Panel on Climate Change (IPCC) to summarize what is known about the causes, extent, and possible solutions to biodiversity loss: the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES). Their first comprehensive *Global Assessment Report on Biodiversity and Ecosystem Services* summarizes human impacts on wild nature thus:

> Humanity is a dominant global influence on life on earth, and has caused natural terrestrial, freshwater and marine ecosystems to decline. Global indicators of ecosystem extent and condition have shown a decrease by an average of 47 per cent of their estimated natural baselines, with many continuing to decline by at least 4 per cent per decade.
>
> High-biodiversity tropical forests continue to dwindle, and global forest area is now approximately 68 per cent of the estimated pre-industrial level. … Only 13 per cent of the wetland present in 1700 remained by 2000; recent losses have been even more rapid.
>
> Marine ecosystems, from coastal to deep sea, now show the influence of human actions, with coastal marine ecosystems showing both large historical losses of extent and condition as well as rapid ongoing declines. … Live coral cover on reefs has nearly halved in the past 150 years, the decline dramatically accelerating over the past two or three decades due to increased water temperature and ocean acidification.

> Human actions have already driven at least 680 vertebrate species to extinction since 1500 . . . The proportion of species currently threatened with extinction according to the IUCN's Red List criteria averages around 25 per cent . . . More than 40 per cent of amphibian species, almost a third of reef-forming corals, sharks and shark relatives and over a third of marine mammals are currently threatened. (IPBES, 2019, 24)

In short, humanity is on the verge of causing a mass extinction event. If these trends continue for another hundred years, there will be little wild nature left to worry about. A hundred years after that, our descendants could live on a completely humanized planet, crowded but strangely lonely (Wilson, 2016).

1.2 … caused by growing human numbers and economies …

The cause of global biodiversity loss is clear: other species are being displaced by a rapidly growing human economy (Diaz et al., 2019). *We* are replacing *them* with *us*, our economic support systems, our domestic animals, and our trash. From 1970 through 2020, the same period wild vertebrate populations declined 60%, human numbers doubled, the size of the global economy quadrupled, and international trade increased tenfold. The wildlife decline was caused by the human expansion. People took habitat and resources away from other species, displacing them, because there were a lot more of us and because our economy became more successful at transforming the wild world into resources for human use and profit—its primary goal. As IPBES (2019) notes: "Today, humans extract more from the Earth and produce more waste than ever before."

As is standard in the conservation biology literature, the IPBES report explains the causes of biodiversity loss in terms of five main direct drivers, the most important of which are habitat loss and overexploitation of wildlife. As they write: "Globally, land-use change is the direct driver with the largest relative impact on terrestrial and freshwater ecosystems, while direct exploitation of fish and seafood has the largest relative impact in the oceans. Climate change, pollution and invasive alien species have had a lower relative impact to date but are accelerating" (IPBES, 2019, 28). The leading cause of *terrestrial* habitat loss is agricultural expansion: "over one third of the world's land surface and nearly three-quarters of available freshwater resources are devoted to crop or livestock production" (ibid.). The leading cause of declining *marine* biodiversity is overfishing, much abetted by destructive industrial fishing technologies. In other words, as we feed more people more richly, less food (fewer resources) is left for other species (Crist et al., 2017; D'Odorico et al., 2018).

All five direct drivers do enormous harm to other species. According to the IPBES (2019, 30), this "unsustainable use of the Earth's resources is underpinned by a set of demographic and economic indirect drivers that have increased, and that furthermore interact in complex ways, including through trade. The global human population has increased from 3.7 to 7.6 billion since 1970 unevenly across countries and regions, which has strong implications for the degradation of nature. Per capita consumption also has grown … Total gross domestic product is four times higher" since 1970. The term "indirect driver" is misleading—fundamental causes

would be more accurate—yet the message is clear enough. "Anthropogenic drivers of biodiversity loss, including habitat loss as a result of land-use and sea use change, unsustainable agriculture, aquaculture and forestry, unsustainable fishing, pollution, and invasive alien species are [all] increasing globally" (ibid., 33). They are increasing due to increasing human numbers, wealth, and overall economic activity. These fundamental causes of global biodiversity loss were also the fundamental causes of increased global greenhouse gas emissions during this period (IPCC, 2014) and of humanity pushing toward or beyond other "planetary boundaries" for safe use of the biosphere (Higgs, 2017).

1.3 … intentionally

It is important to acknowledge that people are *intentionally* displacing wild species, through our refusal to limit our numbers and our societies' relentless pursuit of economic growth (Foreman and Carroll, 2014). While biodiversity loss is mostly a byproduct rather than a primary goal of this growth, it is not accidental or surprising (Cafaro, 2015). It has been clear for a long time that economic growth and development come at the expense of the natural world. Just as people today can no longer claim ignorance that we are disrupting the global climate, we now know we are displacing wild nature on a scale that will cause a mass extinction unless we reverse course.

2 What we are doing is wrong

Human beings, like all species, use resources and displace other species. In themselves such use and displacement are not wrong. But their excessive scale in the 20th and 21st centuries is wrong. For a single species to engross so much of the biosphere's limited habitat and resources that it threatens to extinguish millions of other species is a great injustice against those species and against future human generations that will never be able to know them. Beyond biodiversity loss and species extinctions, excessive economic activity is undermining the ecosystem services human societies depend on, threatening to cause great human suffering—reason enough to ratchet it back.

2.1 It is unjust to other species

Most importantly, mass ecological displacement is a gross injustice against other species, whether we focus on harms to individual non-human beings (Palmer, 2009; Donaldson and Kymlicka, 2011) or the more fundamental and irreversible loss of entire species (Rolston, 1994; Noss, 2020). Natural species are the primary expressions and repositories of organic nature's order, creativity, and diversity. They represent thousands of millions of years of evolution and achievement. They show incredible functional, organizational, and behavioral complexity. Every species, like every person, is unique, with its own history and destiny. For these reasons natural species

possess great intrinsic value (Rolston, 2020) and arguably a right against untimely anthropogenic extinction (Staples and Cafaro, 2012; Cafaro, 2015). When people take or degrade so much habitat that another species is driven extinct, we have taken or damaged too much and brought a valuable and meaningful story to an untimely end (Cafaro and Primack, 2014).

Species may be majestic keystone predators or humble detritivores; flashy birds of paradise or exquisitely camouflaged sparrows; towering redwoods, home to myriads of other species, or diminutive mites, inhabiting the interstices of the bristles of a particular bird species' feathers.

These particularities, too, may support species' right against anthropogenic extinction (just as human uniqueness, however humble or easy to overlook, helps justify rights for individual people). Arguably, we should respect the cheetah's right to exist because it can run up to seventy miles per hour while bringing down gazelles. We should preserve chimpanzees in the wild because they engage in complex social interactions, tool making, and the rudiments of language, in addition to being our closest nonhuman kin. We should preserve horseshoe crabs because of their extreme longevity as a species, hundreds of millions of years in essentially the same form; and the Arctic Tern because its peregrinations tie together Earth's Arctic and Antarctic regions as they travel up to 40,000 miles per year.

All species are what they are and what they are is good. It is a fatal mistake to take human beings as the sole template for natural goodness and decide what has importance or intrinsic value, what deserves rights, what shall live or die, based on other things' similarity to us (Rolston, 1994). This is simply another form of unjustified self-partiality (Shoreman-Ouimet and Kopnina, 2015).

As Aldo Leopold notes, respecting other species cannot keep people from displacing them sometimes: "a land ethic cannot prevent the alteration, management and use of these 'resources,' but it does affirm their *right to continued existence*, and, at least in spots, their continued existence in a natural state" (Leopold, 1966, emphasis added). It may sound strange to affirm rights of a non-human whole, such as a species, given that individual human beings are our paradigm rights holders (Palmer, 2009; Sandler 2012). But biocentric individualists can reformulate such claims in terms of the rights of individual wild animals to thrive and reproduce, supporting robust claims for preserving their habitats as a matter of justice (Donaldson and Kymlicka, 2011). Arguably, laws such as the U.S. Endangered Species Act affirm a de facto legal right against extinction (Callicott and Grove-Fanning, 2009); this suggests there are no conceptual problems with such rights claims. The bottom line is that these natural kinds are good kinds. The flourishing of the diversity of life is a great good, while anthropogenic species extinction, ripping great holes in the tapestry of life, is a great and preventable evil.

2.2 It is unjust to future human generations

Extinguishing other species is also unjust to future human beings, who have a right to experience the richness of the natural world (Louv, 2019; Mangrum,

2021). Their lives will be significantly worse without opportunities for appreciation and connection to other species. As Rachel Carson asked in *Silent Spring*:

> Who has decided, who has the *right* to decide, for the countless legions of people who were not consulted, that the supreme value is a world without insects, even though it be also a sterile world ungraced by the curving wing of a bird in flight. The decision is that of the authoritarian temporarily entrusted with power; he has made it during a moment of inattention by millions to whom beauty and the ordered world of nature still have a meaning that is deep and imperative. (Carson, 1962, emphasis in the original)

Human flourishing depends, in many ways, on appreciation and connection to the natural world (Rolston, 1989; Kahn and Hasbach, 2013), in addition to the reliable provision of ecosystem goods and services. But appreciation, connection and provision require access. We owe such access to our descendants as a matter of justice (Nolt, 2021; Kallhoff, 2021). In an address to journalists, Carson (1998) affirmed: "I am not afraid of being thought a sentimentalist, when I stand here tonight and tell you that I believe natural beauty has a necessary place in the spiritual development of any individual or any society. I believe that whenever we destroy beauty, or whenever we substitute something man-made and artificial for a natural feature of the earth, we have retarded some part of man's spiritual growth." This spiritual growth—which following Carson we may interpret broadly as humanity's emotional, artistic, scientific, and moral development—depends on common citizens' continued access to a full, diverse, wild nature. Not a world of mere scraps and tatters, or one relegated to a human feedlot. Different people will respond to different aspects of nature, giving us reason to extend protection broadly to the full diversity of Earth's life forms.

One hundred years before Carson spoke, Henry Thoreau wrote in his journal, reflecting on the diminished ecological landscape around him in Concord, Massachusetts:

> When I consider that the nobler animals have been exterminated here, I cannot but feel as if I lived in a tamed, and, as it were, emasculated country ... I take infinite pains to know the phenomena of the spring, thinking that I have here the entire poem, and then, to my chagrin, I hear that it is but an imperfect copy that I possess and have read, that my ancestors have torn out many of the first leaves and grandest passages, and mutilated it in many places. (Thoreau, 1962, 985)

Like Thoreau, many of our descendants will "wish to know an entire heaven and an entire Earth." They will have a right to explore the beauty and grace manifested in wild nature, and their lives will be worse if such opportunities are foreclosed (Cafaro, 2001; Smith, 2022). Current societies still have an opportunity to strike a decent balance between developed and natural landscapes (Rolston, 2008), but it is slipping away fast as we continue to ratchet up the size of our economies at the expense of other species. We are creating a world where our descendants' lives will be poorer even if they are materially richer—and where

the latter is by no means assured. For there is a further danger to human over-expropriation of the biosphere, beyond the moral and spiritual losses entailed by biodiversity loss. The processes causing these losses also threaten future generations' access to the environmental services necessary for basic health and security (IPBES, 2019).

2.3 It threatens great human suffering

Rapid biodiversity loss is the flip side of rapid human economic expansion. But leaving aside any ethical concerns focused on biodiversity loss, this expansion itself is poisoning the biosphere and endangering the ecosystem services human economies depend on, threatening great human suffering. So even those who acknowledge no direct or indirect moral duties to preserve other species still have good reasons to rein in the processes extinguishing them, which directly threaten people as well. Basic principles of intergenerational justice demand, at a minimum, that the current generation leave global ecosystem services sufficiently unimpaired so that future generations can lead materially adequate lives (Meyer, 2009; Holland, 2022). If we affirm (as I think we should) the more demanding moral claim that future generations are owed "as much and as good" as past generations have enjoyed in the way of resources to secure basic physical safety and wellbeing, the failure to preserve an unimpaired biosphere seems even more egregious (Caney, 2014).

Consider climate change. According to the IPCC's (2014) *5th Assessment Report*, "Globally, economic and population growth continue to be the most important drivers of increases in CO2 emissions from fossil fuel combustion." To date the governments of the world have attempted to deal with climate change through technological and managerial fixes, without addressing these fundamental drivers (Dodson et al., 2020). Indeed, in the case of economic growth, governments typically try to increase it as quickly as possible. These attempts stand as obvious failures, with efficiency improvements overwhelmed by growth. Total greenhouse gas emissions, which need to trend sharply down to limit climate disruption, continue to grow, and the prognosis is for more of the same, with business-as-usual scenarios leading to temperature increases of 4 °C to 5 °C by the end of this century (IPCC, 2014). In plain English, continued growth in human wealth and numbers is set to cause a worldwide climate disaster within the lifetimes of many people alive today. A recent "Warning of a Climate Emergency," signed by over 11,000 scientists, forthrightly describes continued increases in human population and the world gross domestic product as "profoundly troubling signs" of ecological decline (Ripple et al., 2020).

Similar worries attend other human stressors on the biosphere. According to scientists affiliated with the Stockholm Resilience Center, the scale of human economic activities threatens to exceed safe "planetary boundaries" in seven additional areas besides atmospheric carbon loads and biodiversity loss: ocean acidification, excessive nitrogen and phosphorus loading, atmospheric aerosol loading, stratospheric ozone depletion, land system change, freshwater use, and introduction of harmful novel entities (Steffen et al., 2015, 2018). Exceeding any of these nine identified planetary boundaries could threaten essential global ecosystem services, with

potentially catastrophic results for people. All of them are driven by increases in human numbers and economic activity (Higgs, 2017; Bourban, 2019). As with biodiversity loss and climate change, setting aside natural areas as protected habitats for other species—areas that are off limits to intensive human economic development—could help humanity remain within the seven other safe planetary boundaries. Both directly, for example by providing buffers to sequester carbon and process human wastes (Griscom et al., 2017), and indirectly, by placing resources and economic opportunities off limits, thus slowing or reversing economic growth.

It is time to admit the obvious moral of climate change, biodiversity loss, and our other planet-wide ecological assaults: the human economy has grown too big for the earth. Pursuing continued growth represents a foolish gamble in which humanity wagers the irreplaceable for the unnecessary. In the past, proponents of continued growth have argued that its environmental losses were outweighed by its economic gains (Beckerman and Pasek, 2001; Friedman, 2006). But the possibility of environmental collapse fundamentally changes the cost-benefit balance. We can no longer plausibly justify the continued pursuit of growth as likely to benefit future generations. Instead, it stands revealed as the immoral sacrifice of the interests of future generations for our own short-term benefit (Daly and Farley, 2010; Cafaro, 2010).

Status quo demographic trends and economic policies threaten to disrupt basic ecosystem services in ways that could kill many millions of people and cause immense human suffering (Bradshaw et al., 2021). But by limiting economic expansion, more extensive natural buffers could preserve functioning economies for our descendants, helping them avoid drastic economic dislocations or abrupt population crashes. So even from the anthropocentric and philistine ethical perspective common in mainstream economic thinking, in which neither other species' existence nor our own higher pursuits make any ethical claims on us, we have good reasons to preserve wild lands and their associated biodiversity from humanity's economic onslaught.

3 What we should do instead

Existing growth-focused economies are leading human societies deeper into ecological overshoot and creating a depauperate world. We need to transition to a new economic paradigm: one with economies designed to provide sufficient material goods for limited numbers of people, not ever more (stuff) for ever more (people) forevermore. At the same time, we must leave more of nature's economy free to support other species. This is a radical proposal, yet it makes more sense than piling new ecological insults on the biosphere while expecting it to continue supporting us. Such a shift is demanded by both justice and prudence.

3.1 Significantly decrease the size of our economies

To preserve global biodiversity and essential ecosystem services in the future, we must shrink the size of our economies. We need to grow less food, drive fewer cars,

fly fewer airplanes, pour less concrete (Crist, 2019). It is true that increased efficiency and new technologies may help decrease the environmental impacts of our economic activities (provided they are actually put to that use) and a few sectors of the economy might benefit the environment if they grew (solar panel sales, for example). But given our current ecological overshoot, humanity must: (1) increase material and energy efficiencies; (2) reduce harmful pollution through technical improvements; *and* (3) decrease the overall size of our economies. Not (1) and (2) *instead of* (3); not (1) and (2) to facilitate more growth. Our new task is to deploy clever technologies and managerial efficiencies to create genuinely sustainable economies, by shrinking overall economic demands on the biosphere.

Recent studies affirm, commonsensically, that the more people we want to sustain, the more modest their average standard of living needs to be (Dasgupta, 2019; Tamburino and Bravo, 2021). For example, a recent study by Lianos and Pseiridis (2016) calculates that the world could safely accommodate 3.1 billion people living on an average annual income of $9000, an amount they deem sufficient to sustain a materially satisfactory life. Ecological sustainability was determined based on remaining within the global constraints assumed by the Living Planet Index; the authors then calculated sustainable populations for the world's 52 most populous nations, on the premise that each country was entitled to a share of the sustainable global population equal to its share of global agricultural land. Table 1 shows the difference between recent and sustainable populations for the world's five most populous countries based on these stipulations. It also provides recent UN population projections to 2100, showing how far all these countries are from achieving sustainability under status quo demographic and economic trends.

Again, these sustainable national population numbers assume a willingness to limit or reduce average annual incomes; in the case of the U.S. to reduce incomes by a factor of six or more. At higher average incomes, the sustainable population decreases proportionally. It's a trade-off. Similarly, ecological studies show that the more people we try to sustain, the less habitat and resources remain available to sustain other species (Weber and Sciubba, 2018; Marques et al., 2019). Thus to be just to other species, we need to limit ourselves (Wienhues, 2018). Such trade-offs are unavoidable.

Sustainable economies can differ in numerous ways: in population density, per capita wealth, equality of wealth distribution, technological sophistication, the percentage of available habitat and resources left for other species to use. But to really be sustainable *and therefore just to future generations*, they must remain within ecologically sustainable limits of resource use and waste generation. And to be *just toward other species*, they must devote substantial percentages of potential habitat and resources to them, not hog them all for people. This foregrounds two key policy goals I believe all societies should pursue.

3.2 Preserve much more acreage in protected areas

Protecting or restoring sufficient habitat is the key to preserving other species. Conservation biologists calculate that setting half the globe's terrestrial and aquatic

Table 1 Population and overpopulation in the world's five most populous countries. Data in first four columns from Lianos and Pseiridis (2016), last column from United Nations (2019)

	Population (2010), in millions	% share of the world's permanent cropland and arable land	Share of a sustainable world population, in millions	Required population change, in millions	Projected population (2100), in millions
China	1337.7	8.17	253.2	−1084.5	1065
India	1205.6	11.0	341.0	−864.7	1450
U.S.	309.3	10.53	326.5	17.2	434
Indonesia	240.7	2.83	87.6	−153.0	321
Brazil	195.2	5.02	155.6	−39.6	229

habitat off limits to intensive human economic uses could preserve 85 to 90% of the world's species long-term; a higher percentage could be protected through extra efforts to safeguard particularly rich ecosystems (Locke, 2015; Wilson, 2016). In response, an international movement has sprung up: Half Earth, or Nature Needs Half (Dinerstein et al., 2017). Half Earth calls for preserving half the planet's terrestrial and marine areas in protected areas that exclude or greatly limit intensive economic uses, with inclusive representation of all ecosystems (Rewilding Charter Working Group, 2020). Today only about 15% of the Earth's land surface and 5.5% of the oceans are protected with designations ranging from strict protection to sustainable use and management.

Half Earth proposes radically limiting people's economic demands on nature, thus providing a blueprint for human co-existence with rather than displacement of wild nature (Noss, 2020). To achieve this, we would also have to greatly reduce the pollution, climate disruption, transport of exotic species and other damages caused by our more intensive use of Earth's other half, limiting habitat degradation as well as habitat loss (Büscher et al., 2016; Crist et al., 2021). While this proposal is radical, it appears no less drastic limitation on human economic activity can keep us from exterminating a large percentage of the world's species (O'Leary et al., 2016; Locke et al., 2019). Half Earth has begun to enter the political mainstream: the Biden administration has outlined plans to protect 30% of U.S. lands and ocean territories by 2030 (Lieberman, 2021), while the European Parliament (2020) recently passed a resolution to protect 50% of the European Union's ecosystems by 2050.

Whatever the likelihood of achieving 50% protection globally, or in particular regions, we know this level of protection will be necessary to avoid mass species loss going forward. Nations committed to sharing resources justly with other species cannot sustain them on landscapes devoted primarily to human profit and use, or in zoos. Densely crowded countries thus face a choice: they may ratchet back their numbers and economic demands or accept a depauperate and unjust human-dominated status quo. Even very crowded countries with little wild nature left may make efforts to redress such interspecies injustice. A nation with 2% of its landscape dedicated to preserving other species that achieves 20% protection over several

generations of rewilding efforts could be proud of that achievement. Even small increases in protecting particularly rich habitats, such as wetlands or coral reefs, can provide important benefits to other species.

3.3 Greatly reduce human populations

In order to set aside enough habitat to preserve robust populations of their native species, most nations around the world will have to significantly shrink their human populations. Simply stabilizing already bloated populations will not be sufficient (Crist et al., 2021). As already noted, conservation biologists standardly talk about five main causes of biodiversity loss: habitat loss, overexploitation, pollution, invasive species, and climate change. All five direct drivers of biodiversity loss are made worse by increased human numbers and population density (Butchart et al., 2010; Cafaro and Götmark, 2019). Conversely, *declining* human populations are often key to successful rewilding projects that restore biodiversity to unproductive farmlands, abandoned industrial sites, or other areas that shrinking populations no longer need (Queiroz et al., 2014; Navarro and Pereira, 2015).

Beyond their role in opening up ecological space for other species, smaller human numbers are necessary to shrink economic demands and keep humanity within safe planetary boundaries for resource use and waste generation. We have already discussed the role shrinking human numbers can play in limiting global climate disruption; similar arguments hold regarding other major human harms to the biosphere (Higgs, 2017; Ripple et al., 2020). And if we want all people around the world to live comfortable and secure lives, the need to reduce our numbers takes on even greater importance (Cripps, 2015). There is an unavoidable trade-off between raising consumption levels for the global poor and the sustainable number of their descendants.

For these reasons, governments in both rich and poor nations should embrace policies to shrink their populations. Most important, all national governments should guarantee their citizens universal, affordable access to family planning services, modern contraception, and abortion on demand (Cottingham et al., 2012). When women are free to choose whether to bear children and couples can limit the size of their families, fertility rates typically decline, often rapidly (Hardee et al., 2013; O'Sullivan, 2018). Globally, over 200 million women do not have access to the family planning services they desire.

To facilitate significant population decrease, not just population stabilization at current unsustainable levels, governments should work to make one-child families the norm (Conly, 2016; Rieder, 2016). They should encourage their citizens to stop at one child and discourage them from having more, through tax and safety net policies: for example, by providing tax credits for a first child, but not for subsequent ones (Cafaro, 2021). They should support the decisions of people who choose to remain child-free, recognizing this as an important contribution to sustainability. I am not proposing that governments harshly punish people who have more than one child. But they should make population reduction an explicit policy goal, with targeted policies to humanely reduce their populations.

Reproductive rights should be balanced by reproductive responsibilities (Coole, 2018).

I see no moral way around the need to substantially reduce current human populations. Recent estimates of a sustainable global population run between two to three billion people, depending on how optimistic researchers are about international cooperation to solve wicked global collective action problems (Lianos and Pseiridis, 2016; Tucker, 2019; Dasgupta, 2019). If we take two billion as a conservative estimate, the world has four times as many people as it can support in safety and comfort over the long term. Overpopulation threatens suffering for billions of people and extinction for millions of species. These facts don't merely justify stringent efforts to reduce human numbers as quickly as humanely possible, they morally require them. Such efforts must start not someday, somewhere else, but here and now in our own overpopulated societies. Thus—and only thus—will we have a chance to create sustainable societies and share the world fairly with other species.

4 Objections

The foregoing policy proposals are likely to spur strong objections, in part because they are so demanding compared to the easy, false solutions to environmental problems often promoted by politicians. Let me briefly sketch responses to some likely objections, recognizing they deserve fuller consideration than I can provide here. These objections range across three categories depending on whether my proposals seem unnecessary, unfair, or impossible. My responses rely heavily on the injustice of continuing the economic status quo, given potential environmental catastrophe.

4.1 Shrinking the human project is unnecessary

Some may see shrinking the human population and our global economy as unnecessary, because they reject claims that mass species extinction is immoral. Above I express this claim in the language of justice and rights; other environmental philosophers prefer to speak in terms of duties to other species (Rolston, 1994) or the awe or reverence they should command (Sandler, 2012, 2021). But some reject all such moral claims and state that when other species come between human beings and our economic goals, we can sacrifice them with a clean conscience. For example, Kareiva and Marvier (2012) describe concern for the extirpation of wolves and other predators as misplaced "nostalgia" for "the world as it once was." "Some realism is in order," they write, regarding whether people should be required to preserve inconvenient or economically worthless species. They contemplate mass extinction with equanimity, in part because they believe such extinctions will not necessarily harm human beings (see also Kareiva et al., 2011).

I have criticized such anthropocentric defenses of intentional species extinctions elsewhere (Cafaro and Primack, 2014; Cafaro 2015), as have others (Noss et al., 2013). But Kareiva and Marvier have the virtue of honestly admitting what many

silently assume: that when push comes to shove, other species should take a back seat to human beings. And not just a back seat: they can legitimately be shoved off the bus altogether to make room for more of us. It's important to acknowledge this is what human societies are doing right now. We thus face a moral choice: should we continue doing it, or should we change course? Some further realism may be in order regarding the likelihood that people can extinguish other species wholesale without this coming back to harm ourselves.

A second group of objectors shares the view that other species should be preserved, either for their own sakes or to benefit people. But they believe this can be done without shrinking human economies or numbers. This position is explicitly defended by the authors of the *Ecomodernist Manifesto* (Asafu-Adjaye et al., 2015) and is the de facto position of many environmental groups around the world. At a minimum, these objectors must support my proposal to preserve much more natural habitat in protected areas, given the scientific consensus that this is necessary to avoid a mass extinction. But they believe sufficient habitat preservation for other species and the protection of global ecosystem services for people are compatible with current human numbers and continued economic growth, as long as we get a lot more serious about mandating greater energy and materials efficiency, ending fossil fuel use, phasing out toxic materials, deploying clever new technologies, coordinating these efforts internationally, etc.

I take the steady drumbeat of bad environmental news from around the globe as an ongoing refutation of this position (Bradshaw et al., 2021). The melting glaciers, the acidifying oceans, the dying coral reefs, the degraded forests, the growing dead zones at the mouths of the world's rivers: all suggest humanity is running up against ecological limits to growth. We seem to be doing so on about the timetable that Donella Meadows and her colleagues studying limits to growth predicted we would back in the early 1970s (Meadows et al., 2004). Even if in theory eight or ten billion people could live sustainably on Earth in modern industrial economies, it seems foolish to wager our children's or grandchildren's lives on imperfect, selfish humans actually accomplishing it (Wessels, 2013). As for other species, we are very unlikely to achieve the increased habitat protection necessary to preserve most of them over the long term without much lower human numbers making much smaller demands on the biosphere (Crist et al., 2021). The same attitudes that disincline us to accept lower human numbers, less consumption, or smaller profits seem likely to prevent us from deploying efficiency improvements or new technologies to benefit other species rather than ourselves (Johns, 2019). In the end, preserving other species depends on addressing the root causes of biodiversity loss, not saving a few remnants in the gaps between an ever-expanding humanity (Diaz. et al., 2019).

4.2 Shrinking the human project is unfair

Many of the policy proposals in section 3 may seem unfair on first hearing. But readers need to ask whether riding the economic status quo into possible ecological collapse is really fairer to other species or future human beings. We need to ask whether these concerns should be used to dismiss the dangers of excessive populations and

overlarge economies, as usual, or to develop the fairest possible policies to reduce them.

For example, policies that incentivize one-child families and disincentivize larger ones can be criticized as intrusive at best, unjust at worst. Don't couples have a right to as many children as they want (Hendrixson et al., 2019)? Don't women have a right to have children or not have them, free from intrusive laws made primarily by men (Hartmann, 2016)? Won't such policies limit poor or middle-class families' choices while rich people continue to have as many children as they want (Conly, 2016)? Might they not stigmatize children from large families (Robeyns, 2021)?

I share these concerns. It's good to raise them—to help craft the one-child incentives that societies need and make them as fair as possible. My own view is that every competent adult couple that is willing to take on the burdens of raising a child should be able to do so, as a basic human right. However, that right should be limited to one child (see Conly, 2016 and Meijers, 2016 for cogent defenses of this position). That's because a right to multiple children cannot be universalized in a world with 8 billion people, not at anything near modern levels of per capita resource use. If we continue charging deeper into ecological overshoot, many future couples will not have a secure right to raise any children safely (Burket, 2021). Children living in societies enduring ecological collapse will not have secure rights to food, shelter, or basic physical well-being. And of course, many other species will do even worse than us, disappearing altogether, deprived of their right against untimely anthropogenic extinction.

Human beings have created a world where overpopulation threatens all these rights. For that reason, for several generations, the right to have children should be interpreted narrowly as a right to have one child (Gheaus, 2016). Societies should do all they legitimately can to uphold this right—including convincing couples to stop at one child, so that future couples can also have one and other species can raise families, too (Cafaro, 2021). In one or two hundred years, when societies are no longer overpopulated, they can shift to two-child family norms. But the case for a one-child family norm now is strong.

Again, readers who sympathize with calls for wealthy societies to curb economic growth to protect the environment may object to the idea that poorer nations should do so. Many of their citizens need more wealth to secure basic comforts, not to pile up luxuries (Shue, 1993). It seems unfair to ask them to sacrifice: for example, to forego access to electricity and the comforts that come with it (Caney, 2018); or to burn less coal and pay higher energy prices to help deal with climate disruption, a problem they haven't caused (Hedberg, 2020). How can we ask poor societies to forego economic growth?

The short answer is I don't think *we*—comfortable members of wealthy societies—can. But neither can we pretend that continued economic growth isn't destroying the world. Citizens everywhere, in poor nations as well as rich ones, need to consider the costs and trade-offs of growth. Leaders of poor nations as well as rich ones need to keep their countries' ecological footprints within sustainable bounds. They need to coordinate with other political leaders around the world to keep humanity, now a geological force, from charging past planetary boundaries for safe use of the biosphere. Otherwise, their successors may find themselves unable to feed their

enormous populations (Hall et al., 2017). Their descendants may drown in their own wastes, lose access to clean water, or never have an opportunity to see an eagle fly or a free-flowing river (Smirnov et al., 2016).

Societies need to be sustainable, as well as fair. These two moral desiderata are equally important, if only because rights are claims on limited resources, and thus can be undermined by unsustainability as well as by injustice. Few philosophical ethicists have fully taken this truth on board (Bell, 2015). I assume advocates for poor people's rights to basic economic sustenance would want to affirm similar economic rights for future generations. But continued economic development threatens those rights, as does lack of development. Fair or not, that's the world we have created. It's irresponsible to pretend otherwise. Those who warn against solving global environmental problems on the backs of the poor are right to do so—but only as part of efforts to solve those problems fairly, rather than arguing them away. In fact, the world would be better able to address hunger and poverty with smaller populations (Dasgupta, 2019).

The two kinds of objections discussed in this section should be considered together as we weigh environmental policy options. If you reject efforts to reduce human numbers, you must support more stringent efforts to limit per capita consumption and the pursuit of economic growth. Conversely, the less willing you are to reduce consumption or corporate profit-seeking, the more supportive you should be of efforts to limit human populations to accommodate such laissez-faire behavior. In practice, both sorts of objections are commonly used to dismiss the problem of limits to growth altogether (Hendrixson and Hartmann, 2019) and to ignore the impacts of continued economic and demographic growth on other species (Angus and Butler, 2011). That is irresponsible and unfair.

4.3 Shrinking the human project is impossible

Finally, some object that consciously choosing to shrink human numbers or the size of human economies is impossible. This is the viewpoint of conventional politics and conventional environmental advocacy (Asafu-Adjaye et al., 2015). People will never accept limits on how many children they can have, or how much wealth they can pile up, or how they choose to spend it. Politicians who advocate for such limits will never get elected, or re-elected. So it is pointless to argue for such limits. Better to strive for what is possible and get what little environmental protection we can.

This is also the viewpoint of mainstream economic theory. Businesses must maximize profits or find themselves displaced by their competitors. Capitalist economies must grow; they cannot shrink without all the harms commonly associated with economic recession (Friedman, 2006). Fortunately, our environmental problems aren't caused by growth, but by *the wrong kind* of growth. We can identify harmful "externalities," put a price on them and let markets efficiently solve our environmental problems. We can "decouple" growth from increased material and energy use; or, increase energy use while limiting climate disruption by "decarbonizing" our energy sources. We can have our cake and eat it too, all while slimming down. Which is a good thing, since if we ever stopped baking more and bigger cakes the whole bakery would explode.

The main argument against such objections is that curbing or reversing growth is not impossible. There are more examples every year of countries whose populations are declining without the sky falling down, several dozen at last count. There is the example of Japan, a wealthy country with the third largest economy in the world, maintaining a high standard of living with little to no economic growth in recent decades (Matanle, 2017). Politicians at various levels have ridden opposition to controversial development projects into office and re-election. Citizens have voluntarily limited their consumption to further the common good, as in times of war. These things are possible, even if they are rare or hard. The patterns of rapid economic and demographic growth that came to seem normal over the past century or two are quite anomalous in the larger sweep of human history (McNeill and Engelke, 2014). They should not be taken as timeless norms about what is possible. In fact, the evidence seems compelling that continued economic growth on a finite planet is the real impossibility (Ripple et al., 2020).

Current economic and environmental policies are leading us closer to a mass extinction event and the collapse of essential global ecosystem services. If we want to avoid this, we must "move upstream" and address the fundamental causes of our environmental problems: excessive human populations and ever-growing human economies (Shragg, 2015). I have no detailed blueprint for how to accomplish this while minimizing harms and injustices to vulnerable groups. Good theoretical work on such questions is being done by a few far-sighted ecological economists (Daly and Farley, 2010; Stuart et al., 2020) and environmental philosophers (Crist, 2019). It is time for practicing politicians and environmental activists to join them, rather than continuing to chase the impossibility of "sustainable growth." Success in this endeavor can only come as part of an iterative process of political experimentation and aspiration (Johns, 2019).

Of course, it might prove impossible for contemporary societies to apply the brakes and ratchet back the human footprint on Earth. Craig Dilworth (2010) has argued persuasively that human societies follow a growth imperative and that political elites rarely have the insight or ability to limit growth in ways that avoid ecological collapse. Dilworth may be right that efforts to take other paths are doomed to failure. Let's hope he is wrong. Since the question remains open, we are free to act as if sustainability and justice toward other species and future generations are possible.

5 Conclusion

I have argued that humanity should decrease our numbers and the size of our economies and set aside much more of Earth's lands and seas in protected areas. Whether we do so for our own sakes or for other species, the time has come to accept limits to growth. The scientific and moral case for this is clear. But that is no cause for lamentation. Acknowledging limits, we can create a better world than the one we are now blundering towards. It will be a world where people are less likely to suffer hunger, resource wars, and other ills stemming from the overuse and collapse of ecosystems.

A world with significant room for human economic activity, but also one where we can enjoy more places where such activity is largely absent. Nothing less will secure life's flourishing and preserve Earth's unique and priceless species in the long run, and in the long run that will be best for us, too.

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