Nature needs half: Implications for population, consumption and inequality in the 'other half'

Conservation biologists have called on human society to give half the Earth back as natural habitat for our fellow species. This idea has prompted debates about population size, economic production and *per capita* consumption, and the distribution of conservation's benefits and burdens, in the 'other half'. This paper reviews some key aspects of these debates, and presents an empirical analysis of the relative importance of population versus *per capita* consumption as drivers of environmental impact. It concludes by asserting an overall synergy, rather than any fundamental trade-off, between the half-Earth and de-growth movements.

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To turn the tide against the worldwide collapse of biological diversity, Wilson (2016) urged great expansion of the area protected as natural habitat, to include at least 50% of the Earth's surface. This idea goes under the name of 'half-Earth' or 'nature needs half' (NNH). Dinerstein *et al.* (2017) refined Wilson's proposal, to aim at 50% protection within each of the 846 terrestrial ecoregions that collectively span the entire land surface of the planet. This refinement could also apply to the 232 marine ecoregions identified by Spalding *et al.* (2007).

Surely our 10 million fellow species collectively deserve at least half an Earth on which to exist, flourish and continue to evolve (Nash, 2011; Mikkelson, 2019). However, some critics have sounded the alarm that such a dramatic increase in the area kept off limits to industrial activity "would have widespread negative consequences for human populations" (Büscher *et al.*, 2017b). These same critics argued that tackling economic growth and inequality would preserve species more effectively than NNH's focus on protected areas. NNH supporters have, in turn, defended the idea against these charges. Below, I review these defences and a reply to them by Büscher *et al.* (2017a). To adjudicate on one aspect of the debate – about the relative environmental impacts of human population size versus *per capita* production and consumption – I employ a data set compiled from public sources.

Nature getting half: Social and economic correlates

To allay the fear of harm to human populations, Dinerstein *et al.* (2017) stressed that expanding protected areas can empower and otherwise benefit indigenous and other local communities. They cited "[m]any indigenous reserves in Latin America, Asia, Africa, and Australasia" as precedents. And they highlighted Namibia and Nepal as two countries "advancing to or already surpassing Half Protected" thanks largely to engagement in conservation by local peoples.

Cafaro *et al.* (2017) responded to another argument, that "instead" of NNH, society should take "alternative radical action [...] shifting the global economy from its current foundation in growth" (Büscher *et al.*, 2017b). Cafaro *et al.* agreed on the necessity of challenging the "neoliberal growth economy." But they pointed out that rather than posing an alternative to NNH, a challenge to growth would actually result from NNH's protection of much larger areas from the economy's "ravenous demands for natural resources". They thus echo an insight expressed in a recent book on ecological economics, that protected areas play an important role in limiting economic throughput (Dietz and O'Neill, 2013).

Büscher *et al.* may have posed a second false dichotomy in declaring that "cutting inequality in half would do more for conservation than attempting to protect half of the Earth from humanity". Studies by colleagues and myself have indeed shown that countries and US states with lower Gini indices of income inequality have lower rates of biodiversity loss (Mikkelson *et al.*, 2007; Mikkelson, 2013). In fact, we found that for each one per cent drop in inequality, metrics of biodiversity loss fall by even more than one percent. However, I speculate that one reason for this connection is precisely that more equal societies tend to protect natural areas more effectively against harmful human activities like commercial extraction of natural resources, industrial agriculture, and urban, suburban and exurban sprawl. If this is true, then it is misleading to propose less inequality as an alternative to more protected areas, since the two go hand in hand.

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The relative importance of population size versus *per capita* production and consumption

Another bone of contention between supporters and opponents of the NNH idea concerns the relative importance of human population size versus economic production and consumption *per capita* (henceforth 'consumption' for short), as drivers of biodiversity loss. While Cafaro *et al.* accused Büscher *et al.* (2017b) of ignoring the contribution of population increase to overall economic growth, Büscher *et al.* (2017a) implied that Cafaro *et al.* were "focusing attention on the reproductive habits of the poor rather than the more environmentally damaging consumption habits of the rich." Is consumption indeed more "damaging" than population? Historical data on population size, gross domestic product (GDP) *per capita* and ecological footprints permit us to compare the strength of these two primary drivers of environmental impact.

Ecological footprints quantify the renewable resources depleted, and carbon emitted, to produce the goods consumed within any given region, and support the built infrastructure there. Footprints allow different categories of depletion and pollution to be compared in terms of standardized 'global hectares' (gha): the area of forests, fields, farms and fisheries needed to renew the resources depleted, and absorb the carbon emitted, to sustain the region's current level of consumption. The Global Footprint Network (2018) compares this measure of demand for ecological sources and sinks to the corresponding measure of supply, termed 'biocapacity' – the gha of the region's biologically productive land and water. Ecological footprints are perhaps the most comprehensive measure of environmental damage that is currently available (Wackernagel and Beyers, 2019). Since they reflect human expropriation of habitat area and greenhouse gas emissions – two leading proximate drivers of other species' depopulation and extinction (WWF, 2018) – footprints have significant relevance for conservation.

Perhaps the simplest way to compare the environmental damage done by population versus consumption is to apply the well-known IPAT equation to the global economy over time. The IPAT framework (Ehrlich and Holdren, 1971) considers total negative environmental impact (I) as a function of population size (P) times production and consumption *per capita* (A for 'affluence') times environmental impact per unit of production or consumption (T for 'technology'). In this case, we can measure I as humanity's total ecological footprint, P as global population size, A as world GDP *per capita* (corrected for inflation) and T as gha of ecological footprints per dollar of GDP. The good news is that ecological footprints per US dollar have declined steadily over the period tracked by the Global Footprint Network. Whereas it took 6.1 gha to produce US$10,000 of world GDP in 1961, it took only 2.6 gha in 2016 – a decrease of nearly 60%. This reflects dramatic improvements in resource efficiency and pollution control.

However, the bad news is that population and consumption both exploded over the same period, to the point that either one, by itself, would have more than offset the gains in efficiency. Human population size ballooned from 3.1 billion people in 1961 to 7.5 billion in 2016. Meanwhile, GDP *per capita* surged proportionally even faster: from US$3700 to US$10,400 (Global Footprint Network, 2018). As a result, humanity's total ecological footprint mushroomed from 7.1 billion gha in 1961 – well within world biocapacity at the time – to 20.5 billion gha in 2016. This nearly three-fold expansion has taken us to a state of overshooting Earth's biocapacity of 12.2 billion gha by almost 70%. If we apportion this rise in ecological footprints to population and consumption according to how much the latter two variables increased over that same period, we can conclude that consumption slightly outweighs population as a driver of environmental impact. To wit, while population growth contributed 44% of the increase in footprints, consumption growth contributed 56%.[1]

Data on individual countries afford a more detailed comparison of population versus consumption as drivers of ecological footprints. Public sources make available the populations, GDPs *per capita* and ecological footprints of 120 countries over 56 years (1961–2016), for a total of 5705 data points – (*i.e.* combinations of one country and one year; see Appendix 1 for more detail about sources and methods). Across these countries and years, ecological footprints increased by 1.2% for each one per cent of population growth, but only 0.5% for each one per cent of growth in GDP *per capita*. By themselves, these two figures suggest that population has more to do with environmental degradation than does consumption.

However, we must also take into account the fact that GDP *per capita* has generally grown much faster than has population size. Within this sample, populations grew at an average rate of 1.1% per year, whereas GDP *per capita* grew by an average of 2.9% per year. Multiplying these average rates of increase by the corresponding footprint expansion attributable to each one per cent of increase yields the following estimate: while population growth drove 47% of the expansion in ecological footprints across this extensive set of countries and years, consumption growth drove 53%. This confirms the inference made above on the basis of humanity's total footprint: consumption slightly outweighs population as a driver of environmental degradation.

This suggests these two root causes deserve nearly equal attention when it comes to relieving and reversing biodiversity loss and other ecological disasters unfolding in the 21st century. Crist *et al.* (2018) rehearsed ways of easing population pressure. Reduction of working hours may be the most promising way of easing down *per capita* production and consumption. Working hours have stronger ties to both ecological footprints and income inequality than does any other of the following basic determinants of GDP – population size, the employment rate or labour productivity (Mikkelson, in review). Given all of the above, we can predict that de-growth in population size and working hours would interact synergistically with NNH. The project of slowing, stopping or reversing growth in GDP, while distributing it more equally within and among societies, therefore fits in well with NNH.

Conclusion

The idea of giving half the Earth back to nature promises to help incite the bold action required to reverse the current, incipient mass extinction. Already, NNH has inspired scholarship bridging gaps between natural science, social science and the humanities (and, in particular, ecocentric environmental ethics, on which see, for example, Washington *et al.* [2018]). Like any bold proposal, it has also attracted criticism, and responses to that criticism. Above, I essayed to adjudicate on three aspects of the debate, concerning economic de-growth, economic equality and the venerable question of whether it is more important to reduce population size or *per capita* production and consumption in order to reverse environmental degradation. I sided with defenders of NNH in framing de-growth as a natural correlate of NNH, rather than a competing alternative as imagined by NNH critics. I added that enhancing economic equality would probably also go along with NNH, thus dispelling another false dichotomy posed by NNH critics.

I delved deepest into the question of population versus consumption as drivers

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of ecological damage. Based on analyses of ecological footprints over nearly six decades at the global level, as well as among 120 countries over that same period, I sided with NNH critics in holding consumption more responsible than population as a cause of environmental impact. However, since the two differ only slightly in the magnitude of their effects, it would be horrifically irresponsible to ignore either one. Reducing each requires strong measures that, happily, would enhance human well-being along with the survival prospects of our fellow species (Götmark *et al.*, 2018; Mikkelson, in review). Thus, while local trade-offs certainly exist between conservation and true human development, in general they go hand-in-hand.

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Notes

1 Some sources have misleadingly implied that, to the contrary, population far outweighs other root causes of environmental impact. For example, Gerlach *et al.* (2018) began their working paper by stating "The historical increase in [greenhouse gas] emissions is for [*sic*] one-fourth attributable to the growth of emissions per person, whereas three-fourths are due to population growth." The problem with this statement, and others like it, is that they hide increases in GDP *per capita*, by collapsing together the last two factors in the IPAT equation.

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Appendix 1. Further information on the methods used in the author's empirical analysis.

This appendix is presented as supplementary information, in the form supplied by the author, and has not undergone the same level of peer review as the main article.

The empirical analysis reported above draws on data from the Conference Board and Global Footprint Network. The Conference Board (2019) supplies information about countries' population size and gross domestic product (GDP) *per capita*, corrected for inflation over time and differences in purchasing power between countries (2018 US$, purchasing power parity). Data on ecological footprints come from the Global Footprint Network (2018). Estimates are available for population size, GDP *per capita* and ecological footprints; in anywhere from 5 to 56 years between 1961 and 2016; for 120 countries.* This makes for a total of 5705 observations.

To estimate the relationships among these variables, I performed a two-way panel regression of the natural logarithms of ecological footprints on the logs of population and GDP *per capita*. This method estimates the logged footprint in a particular country and year as a linear function of the logged population size and GDP *per capita* in that same country and year, while controlling for both the time-invariant characteristics of individual countries, and the characteristics of individual years that are common to all countries. Using logged variables entails that the slope estimates are elasticities (Bailey, 2015). In this case, this means the per cent increases in ecological footprints that are associated with one per cent increases in either population or GDP *per capita*, while holding the other constant. To estimate the average yearly percent increases of population size and GDP *per capita*, I took the means of those increases across the whole sample, weighted by the ecological footprint in any given country and year.

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*Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Burkina Faso, Côte d'Ivoire, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Democratic Republic of Congo, Ecuador, Egypt, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, Guatemala, Hungary, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyz Republic, Latvia, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Mali, Malta, Mexico, Moldova, Morocco, Mozambique, Myanmar, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia and Montenegro, Singapore, Slovak Republic, Slovenia, South Africa, South Korea, Spain, Sri Lanka, St Lucia, Sudan, Sweden, Switzerland, Syria, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, UK, USA, Uruguay, Uzbekistan, Venezuela, Vietnam, Yemen, Zambia and Zimbabwe.