

Two Conceptions of Sustainability

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Mathis Wackernagel and William Rees describe the 'ecological footprint' (i.e. the ecological capacity, measured in hectares of biologically productive land, needed to supply a given person's consumption of natural resources and absorb their waste) as a conception of environmental sustainability, and have accumulated significant data to measure the footprints of nations, cities and even individual persons. Although the authors refrain from explicitly drawing normative inferences from their measurements, such implications lie not far beneath the surface of their work. Besides providing an empirical tool for assessing efforts to improve environmental performance, the footprint implies a normative ideal of global resource egalitarianism, once the conception is examined through the lens of contemporary political theory. In this article, I trace out the normative implications of ecological footprinting in comparison and contrast with those of carrying capacity, an alternative conception of sustainability which the footprint ought (or so I shall argue) to replace.

The concept of environmental sustainability identifies a state of affairs and invests it with normative import: in reference to the essential life-supporting capacities of the environment (providing clean air, water, food and a stable climate), sustainability results from acts or policies which allow for the human use of ecological services in perpetuity without their diminution (the ideal with which the concept is associated), avoiding those unsustainable ones which are incompatible with that aim. As a contested concept, however, sustainability offers competing normative premises and evaluative standards with its various formulations, identifying different root causes of environmental problems and prescribing different remedies to those problems with rival accounts of the concept's meaning and measurement. Given the importance of promoting sustainability in practice, a sound conceptual framework must provide the means by which progress toward the ideal can be tracked (distinguishing sustainable actions and policies from unsustainable ones) while grounding the ideal itself in a defensible normative foundation. Together, these criteria offer the critical standards by which alternative conceptions of sustainability may be compared; the latter is necessary for identifying the desirable state of affairs to be promoted, and the former for the operational means to realizing that ideal. Both of these criteria are essential, for the failure of either prevents the concept from being used in the service of promoting a genuinely sustainable world, either because we cannot know what such a world looks like or because we will not know how to get there from here.

The normative implications of competing conceptions of sustainability typically go unnoticed by those relying upon the evaluative standards that they entail, yet

are based in controversial claims about equality and global justice that warrant further examination before they can be accepted as valid. Although such normative concerns are ostensibly distinct from issues of environmental sustainability, they are inexorably linked to the way in which the ideal of sustainability is conceptually understood as well as to the means by which its aims might be promoted. In this article, the two leading conceptual models of sustainability¹ will be examined in the terms noted above, with their normative bases in claims about justice and equality featured as a crucial point of contrast between them, and their contrasting causal accounts of the origin and nature of environmental degradation highlighted. The first such conception is *carrying capacity*, which can be defined as ‘the maximum number of a species that can be supported indefinitely by a particular habitat, allowing for seasonal and random changes, without degradation of the environment and without diminishing carrying capacity in the future’ (Hardin, 1977, p. 113). The second, which was developed as a corrective to several claimed shortcomings within carrying capacity (to be examined below), is the *ecological footprint* (Wackernagel and Rees, 1996), which measures the average per capita ecological impacts of persons or groups (independent of their *de facto* territory of residence), and compares those against both the impacts of other persons or groups and some aggregate measure of ecological capacity.

While these may initially appear to represent merely semantic differences, they have far-reaching implications for each conception, and their respective diagnoses of root causes of environmental problems and bundles of prescriptions for action and policy diverge significantly. This article examines the normative implications of both carrying capacity and the ecological footprint as conceptions of sustainability, ultimately arguing that the latter more accurately diagnoses the causes and consequences of macro-level environmental problems than does the former, yielding a more effective conceptual tool for theorizing sustainability as an ideal and for identifying those acts which frustrate the realization of this ideal in the world, and placing sustainability upon a more defensible normative foundation. In so doing, it aims to demonstrate the critical role that normative analyses of key concepts like sustainability can play in fully understanding such concepts in theory and applying them in practice.

Carrying Capacity as a Conception of Sustainability

Both conceptions of sustainability take as a central premise that the ecological capacity of the earth is finite (defining sustainability in reference to those limits), and are centrally concerned with identifying the causes of environmental degradation. Although there are many such acts that tax the planet’s ecological capacities, observers remain far from agreement over which among these constitute the most pressing environmental problems, or indeed which constitute problems at all. Defining sustainability need not presuppose a rank ordering of humanity’s most urgent environmental threats, but a sound definition must yield such a list and allow comparisons between its various items in terms of their

respective contributions to environmental ills, setting standards and implicitly recommending priorities for action, and permitting *post hoc* evaluation of policies in terms of their effects upon sustainability indices. It is largely for this reason that various definitions of sustainability have rightly been the subject of scrutiny and contestation.

Debates over humanity's most urgent environmental problems (or over their root causes) carry over into the way that environmental ideals like sustainability are defined. One such debate concerns the centrality of population growth rates in developing nations as a root cause of environmental degradation. Noting that the aggregate human demand for food and other natural resources was growing while the earth's capacity to yield such resources remained finite (even if food production had become increasingly efficient since Malthus's famous essay),² and confronted with more frequent and severe outbreaks of famine in the developing world, some observers began in the 1960s to see the latter as evidence for Malthusian predictions about exponential population growth outpacing arithmetic growth in food supply, at least in certain parts of the world (Ehrlich, 1968; Hardin, 1968). From this observation about the consequences of exceeding ecological limits in a given area (and based also in growing awareness about the increasing scarcity of other resources that were once treated as abundant), the first-generation sustainability conception of carrying capacity was born.

Carrying capacity offered a powerful heuristic device for understanding the root causes of famine and the consequences of exceeding ecological limits, for the two were portrayed as one and the same. The biological capacity of land to grow food is limited, but within those limits it can (if managed appropriately) yield a constant supply of agricultural produce and ecological services without any diminution in that capacity. Should one attempt to extract more produce or services from the land than is sustainably possible, carrying capacity instructs, future yields will inevitably suffer. Within a closed system for the production of food (i.e. with no import or export), a given parcel of land can therefore support only a finite resident population, and famine predictably results when populations exceed that threshold. While some technological innovations in agriculture may increase the productive capacity of land (and have done so, delaying the onset of neo-Malthusian predictions of scarcity), other technologies merely increase current yields by depleting other resources (e.g. petroleum-based fertilizers or aquifer-based irrigation) or depleting resources from other regions (e.g. reclamation-based irrigation), allowing some temporarily to exceed their region's carrying capacity by drawing upon the 'phantom carrying capacity' made possible by depletion of stored resources (Catton, 1980). Ecological limits are finite, carrying capacity accurately maintains, and while (contrary to the claims of resource cornucopians like Julian Simon,³ who reject limits on gains in efficiency) technological advances can increase productive capacity at the margins (and have done so in the past), technology's main effect over the past century has been 'to increase per capita resource requirements, and thus aggravate the overload'

(Catton, 1980, p. 36). As a conception of sustainability, carrying capacity presents itself as a kind of immutable natural law, applicable to humans and non-humans alike, and manifesting most clearly in cases of famine.

Carrying capacity's immense appeal is owed to its intuitive plausibility, capturing something essential about the proper understanding of sustainability. It highlights the role of aggregate indicators rather than individual actions: many acts might be sustainable when performed by limited numbers of people within some territory, but can become unsustainable when performed in sufficient numbers (implicitly detaching sustainability from particular acts and attaching it instead to population size within a given territory). It emphasizes the extent to which the environment performs a vital and ongoing productive function (later spawning the term *natural capital* in reference to this function),⁴ where overuse has consequences for future productivity as natural capital accounts are drawn down. The distinction between natural resources (which may be produced at sustainable levels in perpetuity) and natural capital (which is necessary for this process of producing natural resources, and so must be conserved) further refines the conception in order to highlight the difference between resource extraction practices (a 'sustained yield') that are infinitely renewable and those which are not.

But in so doing, carrying capacity draws attention away from several other issues and phenomena that likewise deserve some place in a sustainability conception. Most significantly, its emphasis upon aggregate effects of entire human populations obscures relevant differences among human individuals and groups, and so is led to invoke several norms that are neither necessary for meeting sustainability aims nor defensible under its terms. Because the carrying capacity conception necessarily starts with the ecological capacity of some delimited territory and (with the help of an additional premise, to be examined below) proceeds to distinguish sustainable from unsustainable activities and policies in reference to that capacity (allowing for some act to be sustainable in one region but unsustainable in another), its purview is often parochial and its ability to make interpersonal or international comparisons (in so far as these transcend the delimited territory in question) constrained. The result is a conception that adequately defines sustainability in the aggregate, but which is plagued either by indeterminacy in inferring norms of action (distinguishing sustainable from unsustainable acts and policies) or else based upon a premise that is empirically and normatively flawed. To these conceptual shortcomings – made evident through the examination of the normative implications of carrying capacity as described by perhaps its most outspoken advocate – we now turn.

Carrying Capacity and Its Discontents

While carrying capacity usefully diagnoses one causal aspect of environmental problems like famine, also instructive are the conception's shortcomings in this regard. Famine does not always or only occur in regions where carrying capacity

is exceeded, for food and other essential goods commonly flow freely over borders, whether natural or political.⁵ It is possible both for a territory that produces little or no food to avoid food shortages permanently as well as for famine to occur in a territory that produces sufficient food to feed its resident human population, making famine neither a necessary result of unsustainable activities nor a reliable indicator of them. Moreover, sufficient global food supplies exist to feed the entire world human population, and no 'natural law' forbids the delivery of food aid to starving peoples. On a global scale, carrying capacity instructs us to view the planet's finite ecological capacities in terms of a closed system (or 'spaceship earth'), but extrapolating this conception to particular regions belies the very real sense in which those are individually open systems, and while each is ecologically limited, those limits cannot be prescribed to local residents in the same way that a global sustainability imperative entails aggregate limits. When they are, the carrying capacity conception of sustainability implies norms that become misleading and ultimately indefensible.

Garrett Hardin, who is best known for diagnosing overpopulation as a collective action problem of an unregulated commons, has traced out what he calls the 'ethical implications' of carrying capacity, and these provide an instructive comparison with the norms implied by the ecological footprint. Morality itself, Hardin argues, is contingent upon environmental conditions, as the niceties binding human action under conditions of limited scarcity cannot continue to apply as scarcity increases. Even the quintessential moral prohibition against killing the innocent cannot apply absolutely, but depends upon carrying capacity. He asks: is killing wrong? In reference to deer populations (though equally applicable to human populations under the same conditions), Hardin's answer is that '*it depends*. If the herd size is less than the carrying capacity we might insist on this rule; but if the herd has grown beyond carrying capacity we should deliberately kill animals, until the size of the herd is brought to a safe level' (Hardin, 1977, p. 133, emphasis in original). Hardin's well-known prescription for the deliberate withholding of food aid from famine victims (Hardin, 1974) follows from this analysis, which relies upon a version of holism⁶ that logically implies a moral duty to cull human 'herds' when carrying capacity is exceeded.

Hardin's version of holism is unique in that it operates as an environmental constraint upon conventional human ethics, rather than (as elsewhere in environmental ethics)⁷ as a value theory that weighs the respective claims of whole non-human species or ecosystems against those of their constituent members. Remaining within one's carrying capacity is taken by Hardin to be a precondition for any other limits on action prescribed by ethical or political theory, making carrying capacity a kind of master principle with the power to override competing moral principles or social norms. Hardin applies this carrying capacity trump to all other morally protected human liberties as well, claiming (in response to the objection that the demands of holism limit individual freedom) that 'individualism is cherished because it produces freedom, but the gift is condi-

tional: the more the population exceeds the carrying capacity of the environment, the more freedoms must be given up' (Hardin, 1998, p. 683). In effect, he transforms sustainability into a form of ethical monism capable of subordinating all other moral imperatives (calling it the 'prime commandment') – leaving room for other ethical judgements to be made, but only after this lexically prior condition is met – with highly disturbing implications that cannot be justified by the ecological facts alone.

For carrying capacity to yield such normative prescriptions, however, it requires a further premise, which Hardin never explicitly acknowledges but reveals in his argument against feeding the world's poor based upon the consequences for the world's affluent:

But does everyone on earth have an equal right to an equal share of its resources? The spaceship metaphor can be dangerous when used by misguided idealists to justify suicidal policies for sharing *our* resources through uncontrolled immigration and foreign aid. In their enthusiastic but unrealistic generosity, they confuse the ethics of a spaceship with those of a lifeboat (Hardin, 1974, emphasis added).

What makes famine relief 'suicidal' is that the relevant agents in this case are limited to those residents of wealthy nations that are in a position to opt either for or against such aid (denied agency, the world's poor are reduced to the status of moral patients, which can only be acted upon), and the decision to send food aid (or to open borders in order to allow immigration by environmental refugees) would ultimately (or so Hardin asserts) speed population growth, exceeding carrying capacity and thus causing further famine. Hardin rejects those calls for famine relief based in charity, utility (Singer, 1972) or egalitarian justice (O'Neill, 1993) in favor of an entitlement theory in which the world's poor and hungry have no claim upon 'our' resources, and we have no duty to share them.

Hardin's invocation of a right to the exclusive use of 'our' resources (even as this results in *their* predictable suffering and death) begs not only the empirical question of whether the resources now claimed by the residents of industrialized nations lie entirely within their territories (giving rise to the ownership claim asserted above), but also the more basic normative question of whether populations residing in some territory have an exclusive moral right to the resources located within their borders such that they may legitimately exclude others from access to them. Without such a right, those resources cannot be exclusively 'ours' to allocate, nor would food production deficits in famine-prone regions constitute adequate grounds for refusing to move food aid across borders, as regional origin would not necessarily generate entitlement. Absent a countervailing entitlement claim, obligations to assist the needy (or to prevent large-scale humanitarian crises) would weigh in favor of deploying the resources necessary to prevent suffering.

But, one may ask at this point, what does carrying capacity have to do with these two questions? Surely one can observe the explanatory power of carrying capac-

ity, and even recognize some of its implied norms, without assuming that geographical residence grants exclusive moral rights to the use of local resources. To see why Hardin makes this inference, and more generally why carrying capacity offers an inadequate conception of sustainability, we might distinguish between two versions of a key normative premise. When applied to the entire planet, carrying capacity usefully illuminates the long-term consequences of exceeding the capacity of a closed system. Capacity can be exceeded in the short run, since the unused products of past capacity can be stored in the form of fossil fuels or underground aquifers, but tapping these depletes natural resources more quickly than they can be replenished (or, in the case of fossil fuels, depletes finite stocks of non-renewable resources), and is therefore unsustainable. No closed system can long maintain negative resource flows (where currently produced and stored resources are consumed more quickly than they are replenished), as carrying capacity usefully posits. Globally, carrying capacity implies Hardin's 'prime commandment' (in that exceeding capacity necessarily shifts the costs of unsustainable activities on to others), but when the same conception is applied to specific regions of the globe demarcated either by natural ('bioregional') or political boundaries, it falsely implies that those regions are also closed systems, and are therefore subject to the same set of ecological limits. The normative implications that follow are based upon one or another form of what might be termed the *bioregionalist premise*.

The term 'bioregionalism' names a social movement advocating the formation of environmental policy within the natural boundaries of a bioregion rather than the artificial boundaries of existing states or other political jurisdictions (McGinnis, 1999), and the following objection is not to this sensible claim. Hardin's argument for denying famine aid to the world's poor rests upon (although never explicitly acknowledges) the *strong bioregionalist premise* (or SBP), which maintains not only that the planetary ecosystem must remain within its carrying capacity (implied by any conception of sustainability), but also that individual bioregions must likewise remain within their carrying capacities, and it is upon this premise that Hardin's conclusions about the justified withholding of famine aid are based. The full set of normative implications identified by Hardin need not necessarily follow from this premise (one could, for example, move persons from one bioregion to another rather than withholding food aid from them), but the strong version of the premise maintains that the net flow of environmental goods (e.g. food) and bads (e.g. pollution) across either natural or artificial boundaries cannot be negative, since the SBP defines negative resource flows in any territory as unsustainable. This premise, as Hardin describes it, overrides moral claims for relieving famine-related human suffering with what appears to be an absolute prohibition against exceeding the carrying capacity of a given bioregion, no matter the consequences.

A weaker version of the bioregionalist premise might occasionally allow for negative net resource flows, instead preferring local to more distant sources of

natural resources and repositories for locally produced wastes. Advocates of bioregionalism argue against relying upon far-flung sources of natural resources by pointing out, for example, the environmental costs of transporting food or water over vast distances, or noting the psychological effects (the 'out of sight, out of mind' syndrome) and incentives for action produced by laws requiring that waste produced within some region also be disposed of within that region. Place-based environmental ethics (like those informing bioregionalism) rightly assume that persons are more likely to be concerned with those ecological problems that they cause within their own backyards, and the consequent effects upon behavior may therefore recommend a presumption against inter-regional resource and waste flows. Even though bioregions are open systems in fact, perhaps the demands of global sustainability may be more easily met if inhabitants are discouraged from producing ecological 'spillover' into surrounding regions. However, such reasons are merely instrumental to realizing the ideal of bioregional sustainability, and cannot serve as non-circular justification for the ideal itself. There are, to be sure, often good reasons to justify a preference for locally produced goods over ones transported from afar (i.e. for the *weak bioregionalist premise*), but these are rarely (if ever) decisive reasons, and they certainly cannot justify an absolute prohibition upon the flow of environmental goods and bads over bioregional borders.

Understood in terms of carrying capacity, sustainability offers a normative ideal that applies only to aggregate effects within entire systems, frustrating efforts to identify discrete acts within those systems in the same terms (failing one test of the adequacy of a conception of sustainability). Absent the SBP, carrying capacity cannot distinguish sustainable from unsustainable acts and policies, since it cannot disaggregate micro-level actions from macro-level phenomena. Applied to whole systems, it merely describes a state of affairs – a system is sustainable in so far as its carrying capacity is not exceeded, and unsustainable otherwise – and not the means by which that state of affairs is to be promoted. In response, carrying capacity often relies upon the SBP in order to narrow sustainability's purview (falsely promising to identify root causes of environmental problems, as ever-smaller 'sustainable' regions are compared against 'unsustainable' ones), but in doing so commits the fallacy of assuming that a rule which applies to the whole applies equally to each part. Hardin's rejection of appeals for food aid to the starving (based upon the SBP) is mistaken in that it misapplies a rule implied by the unavoidable limits of a closed system ('do not exceed carrying capacity') to one that is open, and which is therefore not subject to the same kind of physical limits. In so far as ecological limits are global rather than local, constraints upon resource consumption that are implied by those limits can likewise only be global rather than local.

The first problem with carrying capacity as a conception of sustainability, then, lies in its inability to disaggregate the normative implications of recognizing global limits into defensible norms applicable to circumscribed regions or indi-

vidual actions. So long as resource flows across bioregional borders are possible, the only justified limits upon natural resource consumption or pollution are global ones from which little about the sustainability of individual actions or policies can be inferred. Bioregional limits of some kind may be necessary as a means for realizing global sustainability, but nothing in the conception of carrying capacity allows for the valid inference of non-global limits. Given the trans-boundary nature of many environmental problems (in which the consequences of pollution or resource depletion in one region transcend that region's borders), the division of the global environment into self-contained bioregions is both practically misleading and morally indefensible, as the systems posited as closed are in fact open ones. One cannot derive operational sustainability norms from carrying capacity without the SBP, but can only derive invalid ones with the addition of that premise, which eschews the sort of interpersonal and inter-regional comparisons highlighted by the ecological footprint.

Another problem concerns the normative question of how the planet's existing ecological capacity ought to be allocated among various persons or peoples, given not only the geographic origin of resources within national borders but also the other claims of entitlement that might be made on their behalf. Having a justified claim to natural resources (or their products, as in the case of food) also includes a claim to the exclusion of others from their benefits, so such entitlement claims are often considered to be issues of justice and not merely of positive law. Working from the main premises of egalitarian justice, and in so far as access to natural resources is a primary determinant of welfare, a valid claim to unequal shares of resources (with the unequal life chances that result) must be based in some set of voluntary acts or choices rather than upon the morally arbitrary characteristics ascribed at birth. As Brian Barry articulates this principle, 'A legitimate origin of different outcomes for different people is that they have made different voluntary choices ... The obverse of this principle is that bad outcomes for which somebody is not responsible provide a prima facie case for compensation' (Barry, 1999, p. 97). Given that goods produced through the use of natural resources (e.g. food) *can* be moved across political and bioregional borders, the question of whether or not such goods *should* be so moved becomes paramount. Although justice issues are distinct from problems of sustainability, the practical means of promoting sustainability often involve distributive justice problems (e.g. prescribing global limits upon consumption and waste production), so a defensible sustainability conception must be able to accommodate this dual concern.

Some deny that a justice principle such as Barry's applies across national borders, claiming that the sort of community for which distributive justice principles are binding does not exist among and between nations (Miller, 1999; Rawls, 1999); such objections to this sort of cosmopolitanism will be considered below. Suffice it for now to notice why the wide variation in per capita ecological capacities across natural and political borders might be viewed as an unjustified basis for entitlement claims to natural resources, as Charles Beitz (1979) claims. Persons can

no more choose the geographic region of their birth than they choose their parents' incomes or education – characteristics that are elsewhere described as 'accidents of birth' from which no entitlement follows (Rawls, 1971, pp. 11–22) – and most other variables that determine a person's bioregion of residence are likewise beyond their voluntary control (given immigration laws and other impediments to inter-regional residential mobility), yet a person's bioregional ecological capacities matter a great deal in defining their opportunity structure (perhaps more than all other variables combined), as Jared Diamond (1999) has observed. Since the SBP maintains that peoples are entitled to all and only the products of the ecological capacity that lies within their borders, this claim warrants further examination.

How might one go about unpacking this geographically based claim about natural resource entitlement? Since the SBP holds that the aggregate environmental impact within a given bioregion cannot exceed that area's carrying capacity, average individual shares of that region's overall capacity for n residents cannot exceed $1/n$ of total capacity. In order to meet the normative demands of sustainability, then, allowing one person to exceed their share by one unit necessarily entails that one unit must be deducted from the allowances of others within the bioregion, as distribution of a finite good like ecological capacity is necessarily zero-sum. Setting aside questions of unequal distribution within a bioregion, it is clear that per capita shares will be highly unequal between bioregions, as they vary significantly in both population and ecological capacity. Residents of densely populated and highly urbanized bioregions would be allocated relatively small per capita shares under this scheme, while those residing in sparsely populated areas (particularly those containing productive agricultural land or forest) would receive relatively large shares. Since each person's share sets the limit for their consumption of resources and production of waste (processes involved in most welfare-generating activities), these disparate shares translate roughly into proportionally variable opportunities for welfare. Depending upon one's bioregion of residence, then, opportunities would vary widely, with some enjoying practically unlimited consumption options and others barely able to consume enough to stay alive.

Upon what basis, though, might such an allocation be justified? Are some entitled to much more, and others much less, based solely upon their bioregion of residence (rather than upon their voluntary acts and choices)? As Barry's principle holds, one's bioregional location of birth (with its advantages and disadvantages in per capita resource stocks) can no more be a justified determinant of unequal life chances than can other un-chosen and morally arbitrary attributes. The enormous inequality of resources (with their associated suffering for those least advantaged) that such an allocation entails can in no way be traced to the sort of voluntary choices which egalitarians recognize as legitimate origins of inequality, despite the contrary implications of the SBP. Unless persons can be held responsible for their bioregion of birth, therefore, the entitlement theory upon which

the SBP rests is indefensible, and carrying capacity itself rests upon a normative foundation that contradicts principles of egalitarian justice.

Of course, persons could migrate from bioregions with low per capita shares to bioregions with higher ones (in which case birth need not dictate opportunity, and the variation in per capita resource allowances could be linked to voluntary choices), but this is neither a practical solution nor a tenable theoretical reply to the problem noted above. Cross-border migration is likely to be complicated by highly restrictive immigration laws in privileged regions aiming to maintain their high per capita ecological capacities, since allowing immigrants necessarily entails that per capita shares decline for each new resident (in so far as shares are set at $1/n$ of regional capacity). Such a choice is likely to be practically impossible for most, and available only to those relatively affluent citizens who are able to uproot themselves and relocate, and who therefore are least likely to have such a motive for moving in the first place. Moreover, opting to move from ecologically poor to rich bioregions differs from the sort of voluntary choice that is typically held to be a valid source of inequality, as such backward-looking rewards or forward-looking incentives connote approval for some socially desirable action. The mere fact that migration from low to high per capita capacity bioregions is voluntary does not by itself make the action worthy of reward, and it is doubtful that waves of immigration across bioregions (resulting in the lowering of per capita resource shares within those regions) would be regarded as socially desirable by those in the position to dispense such rewards.

As a matter of justice, persons with the misfortune to be born into a bioregion with one of the lowest per capita shares of natural resources should not face worse prospects for living a good life than those with the good fortune to be born into more (ecologically) affluent regions, yet the entitlement theory implicit within the SBP holds otherwise. Hence, the SBP countenances the withholding of food aid to famine victims even though it may be (globally) sustainable to provide such aid, while it fails to identify wasteful practices within ecologically affluent regions as such. At the aggregate level, carrying capacity is able only to determine the total sustainable quantity of resource consumption and waste production, and without a further premise like the SBP is unable to distinguish sustainable from unsustainable activities or policies. As such, it offers no useful criteria for action or policy-making, and so fails one test for a sound conception of sustainability. Adding the SBP remedies this practical indeterminacy, but does so by presuming normative claims that cannot be justified, even if they are rarely called into question. The result is a conception that is not only factually mistaken (it is possible to move resources and waste across bioregional borders while remaining within the bounds of sustainability) and based in a contestable empirical claim about the root causes of global environmental problems (i.e. that rapid population growth in developing countries, rather than high consumption rates within industrialized countries, is to blame and ought therefore to be the focus of

sustainability policy efforts), but also one that posits a resource entitlement principle that cannot withstand critical scrutiny.

Hence, the second (and more serious) problem with the conception of carrying capacity is that it bases its normative framework upon existing inequalities of resources, and so implicitly commends those whose 'sustainable' practices are mostly outside their control (as their bioregion of birth largely determines the sustainability of a given level of resource consumption and waste production) and encourages actions which are ecologically ill-advised. Some bioregions enjoy relative advantages in resource stocks (often due to their low population density), and so would offer their residents virtually unlimited consumption opportunities, while others would face considerable deficits and consequent hardships if forced to live within their ecological means. Although the suggestion that human communities ought to live within their ecological means is surely a good one, the *de facto* allocation of natural resources into existing bioregions would hardly constitute a fair starting point for developing a more sustainable society. Those with the good fortune to be born into regions high in resources and low in population density would be big winners in this version of the natural lottery, while those with the misfortune of being born in resource-poor regions or densely populated ones would suffer for something that has nothing to do with either their voluntary choices (for which they may be held responsible) or their individual impacts upon the environment. So long as the conception of carrying capacity retains some normative force, we are tempted to this conclusion from Hardin's argument against famine relief: that those born resource rich and those born resource poor both deserve their fates. Unless we can defend this conclusion against the critique noted above, we must abandon this normative implication (validly derived from the conception's premises) and the conception of sustainability from which it is derived.

Aside from the unfairness of assigning each person a share of their bioregion's overall carrying capacity, this conception of sustainability implicitly condemns some of the living patterns which are most sustainable and recommends some that would be not only unsustainable but also impossible for all but an elite few. Ironically, many of the densely populated regions that would fare most poorly as self-contained bioregions offer the greatest opportunities for minimizing individual impacts upon the environment (Light, 2003), and the sparsely populated ones (in which persons can more easily remain within carrying capacity) are among those where per capita environmental impacts are highest. The implicit prescription that city dwellers pack up and move to the relatively unpopulated and ecologically sensitive rural countryside or undeveloped wilderness would so speed the process of resource depletion and environmental degradation that its resulting equilibrium of bioregional equity (in which, after a global redistribution of population from lower to higher capacity regions, all have roughly equal consumption opportunities) would soon result in a planet subject to frequent ecological calamity and on the verge of ecological collapse. Whether accompa-

nied by a policy allowing global migration (tending toward the outcomes noted above) or one of closed borders (generating Hardin's conclusions about famine aid), carrying capacity is inadequate as a diagnostic tool for identifying the planet's most pressing environmental problems and recommending appropriate solutions to them.

The Ecological Footprint

The shortcomings of carrying capacity as a conception of sustainability point the way toward the second-generation conception of the ecological footprint, which (suitably modified) better diagnoses the root causes of environmental problems while avoiding the objectionable normative implications noted above. Most of the planet's environmental problems are indeed exacerbated by increasing populations of humans, but focusing upon sheer numbers of people (as carrying capacity does) belies the significant variation in resource consumption and waste production patterns across societies, and obscures some of the real sources of increasing anthropogenic environmental stress. In order to identify and correct these causal patterns and processes, we must begin with a conception of sustainability that can more adequately define the proper normative ideals and measure the efficacy of various policy solutions in terms of their ability to promote those ideals.

Wackernagel and Rees propose the ecological footprint as just such a conception of sustainability, and this conception takes us a considerable distance (although not all the way) to rethinking sustainability in a manner that avoids the above objections and assists in more usefully framing the challenges of sustainability. The crucial step involves shifting the focus away from ecological capacity and toward ecological demand, as the authors explain:

The Ecological Footprint starts from the assumption that every category of energy and material consumption and waste discharge requires the productive or absorptive capacity of a finite area of land or water. If we sum the land requirements for all categories of consumption and waste discharge by a defined population, the total area represents the Ecological Footprint of that population on the Earth *whether or not this area coincides with the population's home region*. In short, the Ecological Footprint measures land area required per person (or population), rather than population per unit area (Wackernagel and Rees, 1996, p. 51, emphasis in original).

Since the planet's ecological capacity is finite, the entire biosphere must have a carrying capacity, but localized human activity varies widely in its demand for ecological goods. In order to conceptualize this variety in a manner that allows for interpersonal and inter-regional comparisons of consumption and waste patterns, a defensible sustainability conception must control for variation in territory size or biological productivity of local land and aquatic resources. The ecological footprint does this by measuring individual and collective demands for ecological resources in terms of the average area of land and water needed to meet those demands. One person's footprint, then, amounts to the total territory (at average

terrestrial rates of biological productivity) needed to support that person's consumption patterns, and makes no assumptions about resource entitlement following from geographical residence.

The ecological footprint was not developed in response to objections to carrying capacity such as those sketched above, but rather as a correction to one of the earlier conception's factual premises (that resource consumption and waste production tend primarily to affect the region in which resources are consumed or waste produced). Rees, who claims that he 'sides solidly with Hardin' and sees ecological footprints as a way to 'revive' the carrying capacity conception, describes his work as the inversion of carrying capacity based on the recognition that 'the ecological locations of human settlements no longer coincide with their geographic locations' (Rees, 1996, p. 204). The advantages of the ecological footprint identified by Rees, then, lie in the comparative soundness of its core premises, not in its normative implications. In tracing out some of those implications, however, several differences from Hardin's conception become apparent. Rees notes, for example, that 'the wealthy already consume on average three times their fair share of sustainable global output' (Rees, 1996, p. 210) (invoking a notion of equity in resource allocation that Hardin straightforwardly rejects), and that 'trade is one of the mechanisms by which the rich appropriate carrying capacity and increase their own ecological footprints' (Rees, 1996, p. 210) (where Hardin largely ignores the extent to which trade conceals unsustainable practices of the affluent).

Using the ecological footprint, comparisons in consumption and pollution patterns among persons and peoples can be made, since the footprint does not imply any privilege for those living in resource-rich bioregions. In a closed system like the earth, the relevant facts for sustainability are not where one's resources originate or where one's waste ends up, but how much one consumes and how much waste one produces. Given the ease by which resources and waste may now be transported across borders, it makes more sense to base evaluative judgements of sustainability upon the sources (in resource consumption and pollution) of environmental impacts rather than the region in which they eventually manifest. Timber unsustainably harvested in Indonesia and then exported to Europe or America presents a problem in Indonesia (and elsewhere, given the role of forests in absorbing greenhouse gases), but the primary *cause* of the problem lies in Europe and America (a fact obscured by carrying capacity's supply-centered analysis), and policies aiming to promote sustainability must recognize this fact. Likewise with other resources that are typically extracted in one part of the globe but consumed in another – an adequate conception of sustainability must be able to account for the sources of *de facto* claims upon natural resources and waste sinks, and the ecological footprint is designed to do this much more effectively than can carrying capacity, which is indifferent to the source of ecological demand.

Computing the ecological footprints for average national resource consumption, Wackernagel and Rees (working out of the University of British Columbia)

found that (using 1995 data) the average Canadian consumes and pollutes at a rate that requires 4.3 hectares of biologically productive land per person while the average US citizen needs 5.1 hectares per person (Wackernagel and Rees, 1996, p. 97). By contrast, the average Indian requires only 0.38 hectares, and the worldwide average footprint is 1.8 hectares per person. Given the 8.9 billion hectares of biologically productive land worldwide, and reserving the existing 1.5 billion hectares of wilderness (i.e. land not currently being put to direct use for human consumption) for sustaining the needs of all other terrestrial and aquatic species, they assume that 7.4 billion hectares of land might be available for human use. That comes to less than 1.3 hectares of available biologically productive land per person – one-quarter the footprint of the average American and 72 per cent of average global rates (amounting to a global ‘ecological deficit’ of 0.5 hectares per person). Based upon global footprints, the earth could not sustainably support its current human population if the planet’s entire ecological capacity were devoted to humanity (a 0.18 hectare/cap deficit would remain), much less if adequate ecological capacity (i.e. more than the 20 per cent allotted to it by the authors for illustrative purposes) was reserved for supporting non-human life. Given present overuse of the planet’s ecological capacity (depleting stored resources and adding waste to the biosphere faster than it can be safely absorbed), such figures portend future problems that are sure to be exacerbated as per capita footprints and populations increase while stocks of ecologically productive resources continue to decline.

Regional ecological deficits – whether the result of relatively high consumption rates, relatively unproductive land and waterways or relatively high population densities – can be ‘financed’ in one of three ways: regions with aggregate ecological demand that exceeds aggregate supply can ‘borrow’ from the past (by depleting stored resources like coal or oil, draining underground aquifers, etc.), they can ‘borrow’ from the future (by depleting natural capital, which diminishes the land’s future capacity to yield natural resources or absorb waste) or they can ‘borrow’ from other regions (importing mineral or other natural resources or relocating ecologically ‘dirty’ processes such as heavy industry or energy production abroad). All three of these forms of ecological deficit financing have their costs, and the latter two transfer these costs directly on to other populations (creating a negative externality) which are not causally responsible for the deficit, while the first (borrowing from the past) has an indirect effect similar to that of the second (borrowing from the future) in that increased future scarcity is the consequence. All, that is, involve cost shifting to others, and together illustrate the macro-level causal processes driving ecological degradation. Environmental problems, that is, can usefully be seen as resulting from unsustainable consumption patterns where demand for ecological services (in the form of the footprint) exceeds supply.

In focusing upon carrying capacity (with its supply emphasis) rather than upon the disparate sources of demand for ecological goods, all equal ecological deficits

appear as relevantly similar, regardless of their causes. Canada, with its high demand for and even higher supply of ecological goods and services, misleadingly appears virtuous from the perspective of sustainability, while the Netherlands, with its relatively low demand but even lower supply, is falsely portrayed as doing a worse job in promoting sustainability. Measuring local ecological demand only against local supply (as in carrying capacity) fails to offer the conceptual means by which the proactive Dutch sustainability efforts might be commended, or the (until quite recently) Canadian lack of such efforts might be criticized. Absent the ability to compare consumption and waste production rates across nations or other groups, carrying capacity identifies the Netherlands as an environmental problem (a false positive, relatively speaking) while failing to identify Canada as one (a false negative). So long as one assumes entitlement to the ecological goods and services that lie within national (or bioregional) boundaries, a misleading picture of the relative rates of ecological stress upon the planet's biosphere results (replete with false positives and negatives). Take away that entitlement claim, and meaningful comparisons can be made among world consumption and waste production rates, and the primary drivers of unsustainable ecological deficit financing more accurately identified.

Hardin's identification of consumption patterns in famine-prone regions (where per capita footprints are typically well under world per capita supply) as the root cause of global environmental problems, with its failure to see those in industrialized nations like the US as significantly greater per capita sources of environmental stress, illustrates the myopic focus upon population rather than consumption endemic to carrying capacity's supply-centered analysis. While the international delivery of food aid to famine victims likewise presents an example of ecological deficit financing, unaccounted for by such an analysis are the means of financing ecological deficits that rely upon political, economic or military power in order to 'borrow' needed resources from other regions rather than appealing to altruism, as in calls for famine relief. The primary difference between those famine-prone poor nations that are identified by carrying capacity advocates as root causes of environmental problems and the industrialized nations from which calls to deny famine aid originate lies not in their relative sustainability (as both require the finance of ecological deficits) but rather in the power differential that requires the former to depend upon charity while the latter relies upon coercion. This power differential is also reflected in debates over the primary causes of environmental problems, where avoiding attribution of blame for causing environmental problems becomes another advantage of power. The ecological footprint, with its focus upon ecological demand rather than exclusive concern with supply, uniquely identifies these differences without being led astray in its diagnosis of the nature and causes of current problems.

A further advantage of ecological footprint analysis lies in its critical insight into the source and nature of cosmopolitan obligation, providing the concep-

tual means to reject the entitlement theory upon which the SBP is based. Given Beitz's observations about the arbitrariness of natural resource distribution and the implications for global justice that follow from applying Rawlsian principles to those as well as to the social primary goods that egalitarians more commonly see as subject to distributive justice concerns (Beitz, 1979), some now treat this global inequality of natural resources as a key part of the justification for cosmopolitan justice itself. Thomas Pogge, for example, urges a 'global resources dividend' (GRD) based partly upon the premise that 'those at the top enjoy significant advantages in the use of a single natural resource base from whose benefits those at the bottom are largely, and without compensation, excluded' (Pogge, 1998, p. 507). Pogge's 'modest proposal' is for compensation of the world's poor by its rich (in which this dividend is levied on the basis of resource extraction), rejecting the entitlement theory characteristic of the SBP and grounding moral cosmopolitanism in the negative responsibility on the part of the affluent for the poverty of the world's poor. Unlike Beitz, who locates the source of injustice (and the basis for compensation claims) in the initial global distribution of natural resources, Pogge sees the natural distribution as exacerbated by those responsible for higher resource consumption and waste production rates, no matter where they reside, and prescribes the GRD as compensatory justice for those disadvantaged by the current 'radical inequality' in resource use.

The sort of negative responsibility upon which Pogge's cosmopolitanism is based can more clearly be seen through ecological footprint analysis, however, as it establishes causal connections between consumption in one place and increased scarcity elsewhere. As Tim Hayward argues, the collected footprint data confirm Pogge's premise that 'a country's wealth indeed depends on its command of natural resources' only when 'a *full* account of the resources at its disposal' (including those originating outside its region) is included in its total footprint, and thereby avoids the 'mistake' of assuming that global inequality follows directly from extant resource inequality within national borders (Hayward, 2005, pp. 324–5, emphasis in original). Conceiving of sustainability in terms of ecological space, as Hayward suggests, not only forces us to ask how much total space humanity can claim as part of a total human footprint, but also why some persons or nations might have justified claims to more of that space than others. In order to rectify such unequal claims, Hayward proposes a tax upon excess ecological space rather than the GRD, invoking the ecological footprint conception to incorporate the fact that unequal claims upon natural resources have a compounding effect upon international inequality over time. Similarly, Andrew Dobson argues that ecological footprints demonstrate the sort of global interdependence that is necessary for grounding duties of cosmopolitan justice – which, as Dobson notes, must not only undergird principles but must also motivate political action – illustrating chains of causal responsibility from unsustainable acts in one place to bad consequences or diminished opportunity elsewhere. Such causality, Dobson argues, yields 'a thicker connec-

tion between people than appeals to membership of common humanity' made by most universalist views while avoiding the relativism characteristic of communitarianism (Dobson, 2006, p. 172), using ecological footprint analysis to 'take us well beyond our immediate geographic location' (Dobson, 2006, p. 177). Responding to the criticism that theories of cosmopolitan justice mistakenly apply egalitarian principles where no genuine justice community exists (Miller, 1999; Rawls, 1971), the ecological footprint conception calls attention to the causal role that high rates of resource consumption or waste production anywhere play in decreasing the ecological space available to others (with the hardships that result), demonstrating global ecological interdependence and thereby providing a more robust foundation for obligations of global justice.

In addition to establishing negative responsibility for large-scale environmental problems by conceiving of sustainability in terms of *de facto* claims made upon available ecological space through resource consumption and waste production (undermining the entitlement theory of the SBP), the footprint conception provides the conceptual means by which principles of cosmopolitan justice might inform sustainability efforts. Although the footprint conception merely measures per capita ecological demand, the core problem of sustainability concerns the proper allocation of ecological space among nations and persons (invoking distributive principles from egalitarian justice theory as well as offering ecological space as an alternative 'metric of justice' to Rawlsian primary goods, Dworkin's resources and Sen's capabilities), and a modified version of that conception allows cosmopolitan justice principles to be applied to such allocation. Dispensing with the SBP's entitlement claim, upon what basis may an unequal allocation of ecological space be justified? Given that different energy budgets are necessary for achieving a given level of welfare in different regions of the world, footprint data might be modified in order to account for this regional variation in the welfare-producing ability of an individual's footprint, allowing for more meaningful comparisons between jurisdictions (McManus and Haughton, 2006). Beyond this modification in the way that footprints are compared among persons and peoples, though, claims to what Pogge terms 'radical inequality' in current distributions of ecological goods and services appear unfounded, given the causal interdependence of unsustainable consumption by the affluent and diminished ecological space for the disadvantaged. While ecological space lacks some features of a comprehensive justice metric (failing, for example, to address meaningfully the role of social resources or variation in individual desert), it offers a genuinely global and basic good (Shue, 1980) upon which cosmopolitan claims may rest and toward which cosmopolitan principles may be applied. The conception of sustainability embodied within the ecological footprint – with the causal responsibility it captures – calls attention to both the degree and consequences of such inequality, while maintaining its focus upon the practical means by which sustainability's aims can be promoted.

Conclusion

By either conception examined above, sustainability instructs that humans must observe global limits upon resource consumption and waste production. In deriving the means by which sustainability might be promoted in practice, however, carrying capacity is unable validly to infer operation norms of action, and so often invokes the SBP in order to disaggregate this global sustainability imperative into more specific policy directives, but fails in so doing, for reasons noted above. Indeed, the shortcoming of that conception and strength of the ecological footprint can be found in the way that each conceptualizes the relationship between sustainability's global imperative and the proper human means for promoting it. Taking the world as it is (with humanity's unsustainable consumption and waste production patterns), the ecological footprint encourages us to think about the fair allocation of the planet's available ecological space (allocating that space among humans and non-humans, between nations and people and between present and future), regardless of the current *de facto* claims that persons now make upon that space through their ecological footprints. Carrying capacity, on the other hand, merely notes that there is now too much consumption (exceeding the planet's overall capacity), from which it is most often inferred that there are too many humans. Absent the conceptual means for making meaningful comparisons between human groups, its prescriptions are typically to reduce population, and (with the addition of the SBP) its prescribed population policies often (for reasons surveyed above) mistakenly target the world's poor as uniquely and causally responsible for global environmental degradation. Once we dispense with the mistaken notion that persons or peoples deserve the ecological capacities of their nations of residence, the injustice of assigning unequal shares to persons or peoples based on geographic or national identity likewise becomes apparent, and once we conceptualize the challenge of environmental sustainability as one of fairly allocating limited ecological space among the planet's living things (present and future), attainment of the normative ideal itself becomes less elusive.

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Notes

- 1 The controversy examined here concerns the way in which aggregate measures of sustainability can be translated into evaluations of the sustainability of discrete acts or policies, and does not consider which goods are thought to be among those properly counted within sustainability indices. For a thorough consideration of this latter question, see Andrew Dobson's *Justice and the Environment* (1998), in which he considers three alternative conceptions of sustainability based on three different kinds of good to be sustained.

- 2 In his 1798 'An Essay on the Principle of Population', Malthus famously predicted that arithmetical increases in agricultural productivity could not keep pace with unchecked geometric growth in human populations. Less well known, though implied within the essay's subtitle ('As it Affects the Future Improvement of Society with Remarks on the Speculations of Mr Godwin, M. Condorcet and Other Writers'), is that Malthus wielded this observation in opposition to the egalitarian social policies trumpeted by Godwin and Condorcet, going so far as to claim, for example, that 'the actual distresses of some of the lower classes, by which they are disabled from giving the proper food and attention to their children, act as a positive check to the natural increase of population' (Malthus, 1798, p. 21). The association between population theories and inequalitarian politics has a long history.
- 3 See, for example, Julian Simon and Herbert Kahn (1984), in which Simon dismisses the predictions of harm resulting from future environmental scarcity caused by economic and population growth. He claims to be 'confident' that 'the nature of the physical world permits continued improvement in humankind's lot in the long run, indefinitely' (Simon and Kahn, 1984, p. 3).
- 4 David Pearce defines sustainability itself with reference to stocks of natural capital rather than yields of natural resources, suggesting that a sustainable society is one in which total natural capital does not decline. See Pearce *et al.*, (1989, esp. p. 34).
- 5 Relying upon ecological footprint data, the United States, Europe and Japan all well exceed the carrying capacities of land within their borders, yet all three have managed to avoid famine by importing needed resources as well as exporting waste. The Irish Potato Famine of 1848–50 presents a case of a territory experiencing famine while producing sufficient calories to feed its population, due to food exports.
- 6 A value theory which holds that conflicts of interest between individuals and groups ought to be resolved in favor of the latter.
- 7 Most holists seek to distinguish between environmental ethics, in which human actions are to take account of the interests of whole systems (whether entire species or ecosystems) rather than their individual constituent members, and human ethics, in which the interests of individuals are primary, retaining prohibitions from human ethics upon the intentionally killing of the innocent.

References

- Barry, B. (1999) 'Sustainability and Intergenerational Justice', in A. Dobson (ed.), *Fairness and Futurity*. Oxford: Oxford University Press, pp. 93–117.
- Beitz, C. (1979) *Political Theory and International Relations*. Princeton NJ: Princeton University Press.
- Catton, W. (1980) *Overshoot: The Ecological Basis of Revolutionary Change*. Urbana IL: University of Illinois Press.
- Diamond, J. (1999) *Guns, Germs, and Steel*. New York: W.W. Norton & Company.
- Dobson, A. (1998) *Justice and the Environment*. Oxford: Oxford University Press.
- Dobson, A. (2006) 'Thick Cosmopolitanism', *Political Studies*, 54 (1), 165–84.
- Ehrlich, P. (1968) *The Population Bomb*. New York: Ballantine Books.
- Hardin, G. (1968) 'The Tragedy of the Commons', *Science*, 162, 1243–48.
- Hardin, G. (1974) 'Lifeboat Ethics: The Case Against Helping the Poor', *Psychology Today*, September, 38–43, 124–26.
- Hardin, G. (1977) 'The Ethical Implications of Carrying Capacity', in G. Hardin and J. Baden (eds), *Managing the Commons*. San Francisco CA: W.H. Freeman, pp. 112–25.
- Hardin, G. (1998) 'Extension of the Tragedy of the Commons', *Science*, 280, 682–3.
- Hayward, T. (2005) 'Thomas Pogge's Global Resource Dividend: A Critique and an Alternative', *Journal of Moral Philosophy*, 2 (3), 317–32.
- Light, A. (2003) 'Urban Ecological Citizenship', *The Journal of Social Philosophy*, 34 (1), 44–63.
- Malthus, T. (1798) *An Essay on the Principle of Population, as it Affects the Future Improvement of Society, with Remarks on the Speculations of Mr Godwin, M. Condorcet, and Other Writers*. London: J. Johnson
- McGinnis, M. (ed.) (1999) *Bioregionalism*. New York: Routledge.
- McManus, P. and Haughton, G. (2006) 'Planning with Ecological Footprints: A Sympathetic Critique of Theory and Practice', *Environment and Urbanization*, 18 (1), 113–27.
- Miller, D. (1999) 'Justice and Global Inequality', in A. Hurrell and N. Woods (eds), *Inequality, Globalization, and World Politics*. Oxford: Oxford University Press, pp. 187–210.

- O'Neill, O. (1993) 'Lifeboat Earth', in C. Beitz, G. Cohen and T. Scanlon (eds), *International Ethics*. Princeton NJ: Princeton University Press, pp. 262–81.
- Pearce, D., Barbier, E. and Markandya, A. (eds) (1989) *Blueprint for a Green Economy*. London: Earthscan.
- Pogge, T. (1998) 'A Global Resources Dividend', in D. Crocker and T. Lindon (eds), *Ethics of Consumption*. New York: Rowman & Littlefield, pp. 501–36.
- Rawls, J. (1971) *A Theory of Justice*. Cambridge MA: Belknap Press.
- Rawls, J. (1999) *The Law of Peoples*. Cambridge MA: Harvard University Press.
- Rees, W. (1996) 'Revisiting Carrying Capacity: Area-Based Indicators of Sustainability', *Population and Environment*, 17 (3), 195–215.
- Shue, H. (1980) *Basic Rights*. Princeton NJ: Princeton University Press.
- Simon, J. and Kahn, H. (1984) *The Resourceful Earth*. New York: Basil Blackwell.
- Singer, P. (1972) 'Famine, Affluence, and Morality', *Philosophy & Public Affairs*, 1 (1), 229–43.
- Wackernagel, M. and Rees, W. (1996) *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island BC: New Society Publishers.