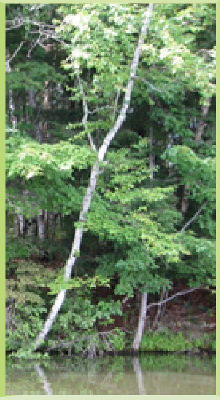
How To Shrink the Human Footprint: And How Going Back to Nature Would Be a Disaster for Nature

Matt Ridley



Bizarrely, most of the policies urged by the environmental movement would increase the acreage each person needs to support her lifestyle.

To sustain our current lifestyle, we human beings require 1.4 planets. That's the number calculated by a mysterious organisation called the Global Footprint Network, which defines the ecological footprint as "A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices." In short, we are consuming the earth's food, fuel and fibre 1.4 times as fast as it can be replenished.

Actually, this number is misleading almost to the point of dishonesty. More than half of it consists of the land that would needed by each person to plant trees with which to absorb his or her own carbon emissions. If you take the view that we can cut emissions, or find better ways to sequestrate them, or even cope with at least some increase in them, then the footprint shrinks and we are living well within our ecological means.

Even if the footprint number is right, the interesting question is whether it is getting bigger or smaller. I am going to argue that the ecological footprint of human activity is probably shrinking at an accelerating rate and that we are getting more sustainable, not less, in the way we use the planet. In a nutshell, the most sustainable thing we can do, and the best for the planet, is to accelerate technological change and economic growth.

I hope that got your attention. You don't believe me? Then let me start with my own lifestyle. I am sitting in a centrally heated home, wearing a synthetic fleece, wool socks, leather shoes and a cotton shirt and trousers, having just eaten a bowl of muesli with milk and drunk a glass of imported mango and passion fruit juice.

You'll agree that this life is about as disgraceful in ecological terms as you can imagine. Gas and oil wells, cotton and oat fields, cattle and sheep pastures, passion fruit and mango orchards all over the world are diverting their output to little old me. Acres and acres just to support my lifestyle.

Yes, but suppose I gave all this up and decided to be a hunter-gatherer, clad in animal skins, possessing little more than some firewood, home made stone tools, wicker baskets and shell beads. I chase deer while my wife digs for roots. How much land do I need? The surprising answer is that I would need roughly 1000 hectares, less if I live on a well-watered tropical plain by a fecund river but more if I live—as I do—in what was once a chilly boreal oak forest. That is how much acreage the hunter-gatherer lifestyle requires. If 6.8 billion of us tried to live like hunter-gatherers we would need 18 planets (54 if we couldn't exploit the ocean). Going back to nature would be a disaster for nature.

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Of course, hunter-gatherers tread more lightly on the land than I do. But even the thinly spread hunter-gatherers of 50,000 years ago did a lot of ecological damage. The archaeological record in Israel, Turkey and Italy reveals that the first modern human beings around the Mediterranean switched from eating horses, rhinos, mammoths, bison and tortoises to rabbits, hares, partridges and smaller gazelles. Reason: they had largely wiped out the slow-breeding species. Hunter-gatherers caused spasms of extinction when they got to Australia, North America, Madagascar and New Zealand.

The remarkable thing about farming, when it was invented 10,000 years ago, was how much smaller its footprint was. The first farmers needed about ten hectares each to support their lifestyles—one-hundredth of what the hunter-gatherers needed. Likewise, the introduction of fossil fuels 200 years ago further shrank the footprint and so halted deforestation: in the 1700s, Britain's iron industry was dying for lack of wood fuel on a largely deforested island. A century later, Britain was burning coal equivalent to the output of a forest the size of Scotland and trees were spreading again.

In fact, coming back to my lifestyle, every item that I use today takes less land to produce it than it did in times past. My fleece came out of an oil well, whereas the wool sweater I used to wear on a cold day like this came from a sheep farm. The footprint of the fleece system—well, refinery, factory and shop—is minuscule compared with the land needed for sheep farming. My socks, shoes, shirt and breakfast each take roughly half as many acres to produce as they did before synthetic fertilisers. My gas-fired central heating takes far less than a wood fire.

Let's look at food in a bit more detail. When fields were cultivated with oxen or horses, which needed pasture, 25% more needed to be set aside to feed them, says the Canadian energy expert Vaclav Smil. The introduction of the tractor reduced the human footprint. In the past 50 years, thanks to innovations in genetics, pesticides, and fertilisers the tonnage of cereals grown in the world has almost trebled even though the acreage of cereals grown has stayed roughly the same—at a little under 700m hectares.

If we were to try to feed the present population of 6.8 billion people using the methods of 1960, we would have to cultivate 82% of the land area of the planet instead of 34%, calculates the economist Indur Goklany. That would mean ploughing an extra area the size of South America minus Chile.

The biggest land-shrinking innovation of all is the capacity to extract nitrogen from the air through the Haber process. Organic agriculture gets its nitrogen from air, too, but by using plants such as clover and passing it through cattle—and that requires land. To feed the world with organic agriculture would require an extra seven billion cattle grazing an extra 30 billion acres just to supply the manure.

So much for food. The same is true of fibre. Cotton, wool, silk and linen all still require land, but their yields have roughly doubled since the introduction of synthetic fertilisers. In many cases, they have given way to "man-made" fibres that come out of what are effectively point sources. The acreage needed to clothe a man or a woman is therefore shrinking all the time.

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Likewise fuel. A log fire requires up to ten acres of intensively harvested woodland just to heat a house: more if you cook on it all year. A typical shale gas well in Pennsylvania occupies half an acre and produces 50,000 cubic feet a day, enough to heat about 150 houses. That's to say, your fuel acreage today if you use gas can be one three-thousandth of what it would be if you relied on wood. Hence one of the best ways to take the pressure off forests in Asia and Africa is to get fossil fuels to people—for example, in the form of electricity.

Transport, too, requires less land than it did. Whereas a typical horse needs more than an acre of pasture and can take one person just 30 miles in a day, a typical oil well in California produces enough gasoline every day from a well head of less than half an acre to drive 200 people 30 miles. Even if you throw in roads, runways, refineries and car plants, the difference in passenger-miles per acre is overwhelming. Every improvement in fuel efficiency is a reduction in fuel acreage.

Shelter, too, is less land hungry than it once was: concrete and steel come from quarries and factories with tiny footprints compared with logging concessions. Add in the effect of urbanisation, where people are moving into cities at an accelerating rate all across the world, and the acreage required to house each person is shrinking.

Even semi-luxuries like artificial lighting are experiencing the acreage decline. To keep your home lit with candles of tallow, beeswax or spermaceti oil from whales, or with ancient Babylonian lamps burning sesame oil, would have required many acres of pasture, flowers or seabed. Now it requires a hole in the ground: a surface coal mine produces roughly as much electricity per acre as a field of corn would produce in 2,000 years.

So my point is simply this: human land needs—as measured in acres to produce food, acres to produce fibre, fuel, shelter or lighting—are all getting smaller and smaller and have been doing so for a very long time. How then is it possible to argue that we are increasingly and unsustainably overdrawn at the planetary ecological bank?

To this question you will hear three common answers. **First: population.** The eight-fold explosion in the numbers of people in 200 years has overwhelmed the reduction in the land hunger per person. **Second: finite resources.** It is only possible to produce so much per acre by burning lots of oil, coal and gas, which are stored sunlight from past ages, and will soon run out. **Third: pollution.** The increase in the yield per acre has come at the expense of air pollution, water pollution and climate change.

As for population, it is quite true that any reduction in the land used per person in the twentieth century was overwhelmed by the quadrupling of the number of people. Suppose that the Haber process, by which nitrogen is extracted from the air, had never been invented. The twentieth century would have surely seen terrible famines (and much less population growth). Suppose that fossil fuels had not been tapped in the nineteenth century. Britain's industrial revolution would have ground to a halt as soon as all the streams of the Pennines had been exploited for water mills. It was because of the reduction in acreage needed per person achieved by both these innovations, and many others, that population was able to grow so much.

This is a version of the Jevons Paradox, named after the nineteenth century economist Stanley Jevons. He pointed out that when things get cheaper, people use more of them, so that the reduction in the price of energy led to more profligate use of energy, while the increase in the availability of food led to the survival of more babies. Today we use the spared acres to help us flick on light switches, drive hummers, eat mangoes and buy mansions in ways that would amaze our frugal ancestors.

Yet, bizarrely, thanks to a worldwide phenomenon called the demographic transition, the richer and healthier and more urbanised we become now, the fewer babies we have. Population growth rates worldwide have been plummeting so fast that the rate at which the world is adding people—in actual numbers, not just percentages—has now been falling for 22 years. Even in Africa the birth rate is falling fast. The United Nations now estimates that world population will probably have ceased growing altogether when it hits around 9.3 billion some time after 2060.

This means that far from doubling as it did in the nineteenth century, or quadrupling as it did in the twentieth, the population of the world will have multiplied by less than 1½ times during this century. The falling land-intensity of life will then begin to have more and more impact. As the population growth rate slows, the footprint of humanity itself will start to shrink. By 2070, every reduction in land use per person will be a gain to the whole species.

In fact, it is happening now. The east coast of the United States was once intensively farmed. It now consists of islands of farming in a sea of forest. In much of highland Scotland the cattle and sheep have left the hills to the deer. If it were not for subsidies and tariff barriers, a great deal more land would go out of production in the rich west.

Yes, but since resources are finite, surely we will run out of oil, gas, phosphorus, copper, nickel or some other such non-renewable resource? Well, first observe the surprising fact that it is the renewable resources that keep running out: mammoths, blue whales, herrings, passenger pigeons, white pine forests, Lebanon cedars, guano. By striking contrast, there is not a single non-renewable resource that has run out yet: not coal, oil, gas, copper, iron, uranium, silicon, or stone. "It is one of the safest predictions," wrote the economist Joseph Schumpeter in 1943, "that in the calculable future we shall live in an embarras de richesse of both foodstuffs and raw materials, giving all the rein to expansion of total output that we shall know what to do with. This applies to mineral resources as well."

So my point is simply this: human land needs—as measured in acres to produce food, acres to produce fibre, fuel, shelter or lighting—are all getting smaller and smaller and have been doing so for a very long time.

Consider the humiliating failure of the predictions made by a computer model called World3 in the early 1970s. World3 attempted to predict the carrying capacity of the planet's resources and concluded, in a report called *Limits to Growth*, authored by the Club of Rome, that exponential use could exhaust known world supplies of zinc, gold, tin, copper, oil and natural gas by 1992 and cause a collapse of civilisation and population in the subsequent century. *Limits to Growth* was enormously influential, with school textbooks soon parroting its predictions minus the caveats. "Some scientists estimate that the world's known supplies of oil, tin, copper, and aluminium will be used up within your lifetime," said one. "Governments must help save our fossil fuel supply by passing laws limiting their use," opined another.

The truth is that as the best sources of copper, phosphorus or oil run out, and as new extraction technologies are invented, the less good reserves become economically viable. In the past few years, horizontal drilling and hydraulic fracturing to extract shale gas have doubled America's reserves of accessible and cheap natural gas; the same technology is now being tried in Europe, Asia and Australia and promises a global gas glut that will last decades. Even if conventional oil runs low, tar sands, oil shale and coal-bed methane will ensure plentiful fossil fuels for at least a century, perhaps much longer. They will be priced out of the market by cheap nuclear or solar power long before they physically run out.

All right, but surely the one resource that will run out, and perhaps soon, is the earth's capacity to absorb our waste. If you seek the human ecological footprint, look not just on land, but in the sea, rivers and air. This is why the Global Footprint Network places such emphasis on carbon sequestration. The land needed to suck man-made carbon dioxide from the air is vast. Yet even here there are all sorts of improving trends. The Hudson and the Thames have less sewage and more fish. Pasadena has less smog. Swedish birds' eggs have 75 per cent fewer pollutants in them than in the 1960s. American carbon monoxide emissions from transport are down 75 per cent in 25 years. Radioactive fall-out from weapons tests and nuclear accidents is 90 per cent down since the early 1960s.

As for carbon dioxide, decarbonisation is already happening. The Italian engineer Cesare Marchetti once drew a graph of human energy use over the past 150 years as it migrated from wood to coal to oil to gas. In each case, the ratio of carbon atoms to hydrogen atoms fell, from 10 in wood to 1 in coal to ½ in oil to ¼ in methane. Thanks to cheap shale gas, methane may soon begin to price coal—the most carbon-rich fuel—out of the market for electricity. In 1800, carbon atoms did 90 per cent of combustion, but by 1935 it was 50:50 carbon and hydrogen, and by 2100, 90 per cent of combustion may come from hydrogen— most probably made with nuclear or solar electricity. The energy expert Jesse Ausubel predicts that "if the energy system is left to its own devices, most of the carbon will be out of it by 2060 or 2070."

Of course, these shifts may not prove fast enough to avert climate change. (However, I would argue that the evidence points towards climate change being mild and slow for many decades yet—an argument for another time.) But the key is that things are going in the right direction. The footprint is shrinking.

So it is with incredulity that I watch the governments of the world, urged on by greens, assiduously trying to increase the human ecological footprint in the name of saving the planet. They praise organic farming, which means a massive increase in land taken for agriculture. (Don't get me wrong: I don't object to people buying organic; I just object to them telling me it is ethical to do so.) And almost every measure espoused for fighting climate change—wind, waves, solar, tide, hydro and above all biofuels—would increase the acreage required to support a human lifestyle.

If America were to grow all its own transport fuel as biofuel, for example, it would need 30 percent more farmland than it currently uses to grow food. Where would it then grow food? The biofuel boondoggle is a truly awful mistake, a "crime against humanity" in the words of Jean Ziegler, the United Nations special rapporteur on the right to food. Between 2004 and 2007, the world maize harvest increased by 51 million tonnes, but 50 million tonnes went into ethanol, leaving nothing to meet the increase of demand: hence the spike in food prices in 2008, which caused riots and hunger. In effect, American car drivers were taking carbohydrates out of the mouths of the poor to fill their tanks.

Which might just be acceptable if biofuel had a big environmental benefit. But the environmental benefits of biofuels are not just illusory; they are negative. Every acre of maize or sugar cane requires tractor fuel, fertilisers, pesticides, truck fuel and distillation fuel—all of which are made with fossil fuel. So the question is: how much fuel does it take to grow fuel? Answer: about the same amount. Depending on which study you cite, each unit of energy put into growing maize ethanol produces 71-134% as much in energy output. Drilling for and refining oil, by contrast, gets you a 600 per cent energy return or more on your energy used.

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Every increment in the price of grain that the biofuel industry causes means more pressure on rain-forests, the destruction of which is—by the way—the single most cost-effective way of adding carbon dioxide to the atmosphere. Moreover, it takes about 130 gallons of water to grow, and five gallons of water to distil, a single gallon of maize ethanol – assuming that only 15 per cent of the crop is irrigated. By contrast, it takes less than three gallons of water to extract, and two gallons to refine, a gallon of gasoline. To meet America's stated aim of growing 35 billion gallons of ethanol a year would require using as much water as is consumed each year by the entire population of California. Be in no doubt: the biofuel industry vastly increases the human footprint.

The same is true of other renewables. To get an idea of just how landscape-eating they are, consider that to supply just the current 300 million inhabitants of the United States with their current power demand of roughly 10,000 watts each (2,400 calories per second) would require: solar panels the size of Spain; or wind farms the size of Kazakhstan; or woodland the size of India and Pakistan; or hayfields for horses the size of Russia and Canada combined; or hydroelectric dams with catchments one-third larger than all the continents put together.

An engineer called Saul Griffith has a name for this vast land grab: Renewistan. He calculates that to keep the carbon dioxide level at 450 parts per million the land area dedicated to renewable energy would occupy a space about the size of Australia. And don't go away with the idea that this is a benign, cuddly and green use of the land. One wind farm in California kills 24 golden eagles a year and at least 2,000 other raptors; each turbine in the Appalachians needs four acres of forest cleared. Solar panels require huge amounts of steel and concrete. Tidal barrages change the ecology of estuaries. All renewables need to be linked with long lines of marching pylons. To generate the power that keeps civilization going with renewable energy would mean going back to the medieval habit of industrialising the entire landscape, only with ten times the population.

Here's a different way of thinking about the human footprint. Helmut Haberl of the University of Vienna has calculated that of the 650 billion tonnes of carbon potentially absorbed from the air by land plants each year, human beings pinch about 23% for their own use: 80 billion tonnes are harvested, 10 are burnt and 60 are prevented from growing by ploughs, streets and goats, leaving 500 to support all the other species. This is what Haberl calls HANPP: the human appropriation of net primary production.

It varies a lot by region. In Siberia and the Amazon, perhaps 99 per cent of plant growth supports wildlife rather than people. In much of Africa and central Asia, people reduce the productivity of land even as they appropriate a fifth of the production—an overgrazed scrubland supports fewer goats than it would support antelopes if it were wilderness.

But in western Europe and eastern Asia—and here's the crucial point—people increase the productivity of the land so much that they actually increase the flow of energy into nature, even while they purloin half of the productivity for themselves. Thanks to the Haber process, in Europe both people and wildlife have more to eat.

This actually gives great cause for optimism, because it implies that intensifying agriculture throughout Africa and central Asia could feed more people and still support more other species, too. Haberl says: "These findings suggest that, on a global scale, there may be a considerable potential to raise agricultural output without necessarily increasing HANPP."

By far the best way to cut the human footprint down to size in the 21st century is to use more technology to raise productivity.

The ecological footprint of humankind is too large. It is our duty to shrink it. But going back to organic farming, self-sufficiency, renewable energy or even hunter-gathering will only increase it at the expense of other species. By far the best way to cut the human footprint down to size in the 21st century is to use more technology to raise productivity, more fertiliser to raise yields, more natural gas—the least carbon-rich, least land-hungry and possibly most abundant of the fossil fuels—to amplify human work and more prosperity to lower birth rates.

Then our great grandchildren can live lives of great wealth, health and wisdom while surrounded by vast wildernesses. **More cities *and* more tigers. That's my dream.**

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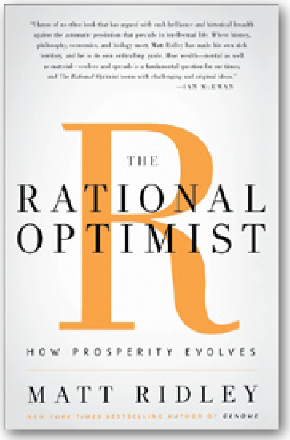

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Matt Ridley is the author of provocative books on evolution, genetics, and society. He has worked as a zoologist, conservationist, and journalist, and has written such prize-winning books as *The Red Queen*, *The Origins of Virtue*, *Genome*, *Nature Via Nurture*, and *Francis Crick*. His books have sold over 800,000 copies, been translated into 27 languages and been short-listed for six literary prizes. In 2004, he won the National Academies Book Award from the US National Academies of Science, Engineering and Medicine for *Nature via Nurture*. In 2007 he won the Davis Prize from the US History of Science Society for *Francis Crick*. To learn more about his latest book, *The Rational Optimist*, visit rationaloptimist.com.

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