



## Population and climate change – a response to Meyerson

Meyerson's editorial about population, biodiversity, and human well-being (*Front Ecol Environ* 2009; **7**[10]: 511) makes many good points. I wish to comment on two. The first was the absence of population policy from the agenda of the 2009 Copenhagen climate conference, due in part to the lack of trust between rich and poor nations that characterizes the wider issue. Population has been a vexed subject since at least the 1974 Bucharest meeting, when the Indian delegation famously declared development as the best contraceptive. This Indian truism still applies, but is made more complex because development generates an increased per-capita carbon footprint in poor nations, as is now occurring in China. Thus, some high-income populations are nervous that wider development will raise rather than lower carbon emissions, at least until the benefit of lower fertility bears fruit.

More fundamentally, however, high-income populations want to maintain their advantage; they fear any reduction in inequality will either lessen their affluence or reduce their security. This "Old World thinking" (Ornstein and Ehrlich 1989) is embedded in the human institutions that evolved when pre-modern peoples were isolated from one another by walls, rivers, and oceans, but is counterproductive in a common future with a single atmosphere and shared climate. Nonetheless, this view impedes affluent world leadership on the issue of population. Suspicion about the motivation of high-income people also slows understanding of demographic issues by low-income people and governments, despite the manifest economic and developmental benefits that accrue when low-income populations reduce their fertility rate – including a lessened vulnerability to climate change (Campbell *et al.* 2007; Bryant *et al.* 2009).

Many other issues link population and climate change, most of them also poorly understood and largely taboo. Unfortunately, the absence of population issues from the Copenhagen agenda and the paucity of discussion in the broader environmental literature help to sustain the resulting confusion.

The second point regards the uncertainty of future UN population projections, which have long been simplistic. This is not only because of the crude assumptions concerning the future "total fertility rate". More importantly, there is little consideration of the feedbacks and interactions that relate to human population size, with a single exception: the assumption that the total global fertility rate will continue to fall and eventually stabilize. This decline, long predicted, is based on the valid assumption that such a decline is a rational response, at the population level, to factors that have stimulated the "demographic transition".

However, there is another, "hidden" assumption in the UN population scenarios, namely that the Earth has the capacity to support – and that humans have the capacity to organize – a population of 9.2 billion (or even 8.9 billion, the recently supplanted estimate of the level at which global population would level out). Meyerson mentions the fossil-fuel-related limits to growth that constrain the "green revolution". Many other constraints also apply (Butler 2004).

The assumption that human population will stabilize at ~ 9 billion people has not been tested. Its validity is far from certain, and much about it warrants more thought, exploration, and preparation. Indeed, population should not only be part of the global climate agenda, but should also be central to all high-level discussions regarding ecology, food, peace, and sustainability.

Population is generally excluded from these wider agendas for the same reason it was largely absent at Copenhagen. Frank discussion of population opens the door to many uncomfortable feelings and possibili-

ties, including guilt and fear. Yet, more discussion may prevent far worse consequences.

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Bryant L, Carver L, Butler CD, *et al.* 2009. Climate change and family planning: least developed countries define the agenda. *Bull World Health Organ* **87**: 852–57.

Butler CD. 2004. Human carrying capacity and human health. *PLoS Medicine* **1**: 192–94.

Campbell M, Cleland J, Ezeh A, *et al.* 2007. Return of the population growth factor. *Science* **315**: 1501–02.

Ornstein R and Ehrlich P. 1989. *New world, new mind*. London, UK: Methuen.

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## Population and consumption – a response to Meyerson

Meyerson's guest editorial (*Front Ecol Environ* 2009; **7**[10]: 511) could not have come at a more propitious time. And its subject matter – the persistent centrality of population as a principal driver in biodiversity loss – could hardly be more poignant. To the growing list of threats to nature's capital and services, we can add biodiversity loss, greenhouse-gas emissions, and ecological footprints. The systematically cumulative research from our STIRPAT research program (Stochastic Impacts by Regression on Population, Affluence, and Technology; [www.stirpat.org](http://www.stirpat.org)) has unequivocally re-affirmed population's causal role in untoward environmental change.

But ignoring the role of population is a scratch on the surface of a more fundamental problem in the scientific and policy communities: a neglect of the ultimate drivers of global climate and other environmental changes, and a policy focus on proximate causes exclusively. We debate and research carbon taxes and cap-and-trade but pay little attention to the contributions of overall patterns of change in population and consumption.

Inattention to population reflects the issue–attention–saturation cycle of public policy issues. Once a topic of considerable national attention and debate, population – like many policy issues – reaches a saturation point and is then dropped from public agendas. This recurrent cycle is particularly disturbing in the case of the population issue, because typical discussions tend to lead many to think that the problems have been solved. Adding 79 million people a year worldwide is simply unsustainable over the long run, unless there are massive shifts in our patterns of consumption, another issue not on the policy agenda.

Although clear reminders, such as Meyerson's, of population's important role in threatening environmental sustainability are essential, they also carry a danger. A singular focus on population can detract attention from the larger contexts that amplify or dampen the effects of population. There is also the mathematical reality that population drives environmental impacts not in isolation, but as a multiplier of other drivers – consumption, in particular. We have developed empirical estimates of the respective weight of each of the driving factors (Dietz *et al.* 2007). These results indicate that, even in those countries that are approaching or are already below replacement level fertility, this respite in population pressure is more than offset by the ideology of unfettered economic growth and high levels of consumption.

The consumption problem, however, is not confined to the industrialized West. The problem looms large among a growing list of developing and transitional countries that are experiencing unprecedented economic growth. There are now approximately 20 countries with over a billion new consumers: that is, citizens whose income exceeds US\$2500 per year (Myers and Kent 2003). While such annual incomes may seem puny to Americans – whose median income per family of four is over \$70 000 per year (\$17 500 per capita) – and citizens of other affluent nations, the \$2500 figure is crucial. It represents a rough tipping point where individual income is not absorbed

entirely by necessities, so there is more discretionary purchasing power to buy products typically consumed in economically advanced societies. In 2000, China alone had an estimated 300 million of these new consumers, equivalent to more than the US population size at that time. Ultimately, a large population with a growing appetite for consumption is a lethal combination for the environment.

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Dietz T, Rosa EA, and York R. 2007. Driving the human ecological footprint. *Front Ecol Environ* **5**: 13–18.

Myers N and Kent J. 2003. New consumers: the influence of affluence on the environment. *P Natl Acad Sci USA* **100**: 4963–68.

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## Population and invasives – a response to Meyerson

In his excellent editorial (*Front Ecol Environ* 2009; **7**[10]: 511) Fred Meyerson explains how the increasing human population is reducing species biodiversity – a vital global resource that helps support the basic functioning of the environment.

Presently, there are 6.8 billion people on Earth; based on its current growth rate, this population will double within 13 years. Human numbers already cause the extinction of more native species each year than any other factor. Along with the escalating human population, the growing number and accelerated spread of invasive species are also contributing to the extinction and extirpation of native species. In the US, we currently have more than 50 000 invasive plant, animal, and microbe species (Pimentel *et al.* 2007). Collectively, they are second only to humans as causes of extinction of native species in the US (Pimentel *et al.* 2007).

In the US, environmental damage

associated with invasive species is estimated to cost more than US\$120 billion per year (Pimentel *et al.* 2007). Their direct impact on our domesticated crops and livestock reduces our food supply. Several invasive species are also responsible for major diseases of humans, including influenza, tuberculosis, and West Nile virus.

A prediction has been made of what would constitute a sustainable population for the US when fossil-fuel-based energy sources are exhausted, presumably within the next century. With a human population consuming half the resources per capita that it does today, it has been estimated that the land, water, and solar-energy resources could support a sustainable US population of only about 200 million (Pimentel *et al.* submitted). One major question is, how do we begin to reduce US population numbers to such a sustainable level? Meyerson aptly noted that “Population policy is virtually absent from the agenda of the 2009 [Copenhagen] climate conference”. Now, in retrospect, we note that it was indeed absent from the conference itself. But who are we Americans to complain? Aside from the unimplemented reports of a few commissions, a US population policy has long remained completely absent from the agenda of our own government.

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Pimentel D, Pimentel M, and Wilson A. 2007. Plant, animal and microbe invasive species in the United States and world. In: Nentwig W (Ed). Berlin, Germany: Springer-Verlag.

Pimentel D, Whitecraft M, Satkiewicz P, *et al.* Will limited land, water, and energy control human population numbers in the future? *Hum Ecol*. Submitted.

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## Population and species extinction – a response to Meyerson

As an environmental writer, I was heartened to see Meyerson's editorial (*Front Ecol Environ* 2009; **7**[10]:

511). In my experience, few in the general public are aware of the accelerated species extinction rates in evidence today. Fewer still recognize the clear link between these losses and the size and growth of the human population. Yet, while climate change grabs the popular headlines, what ecological problem could be of more profound importance to future generations than the preservation of some semblance of healthy biodiversity? It is a goal that cannot be achieved without much more attention to human population numbers.

Bravo to Meyerson and *Frontiers* for stepping forward on a difficult but critical topic.

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## Linking ecology to human limits – Meyerson replies

The responses to my editorial were thoughtful and constructive. In reply, I want to focus particularly on ways in which ecologists and others can more directly engage in research and communicate with policy makers on the critical relationship between population and environmental issues.

As Colin Butler points out, beyond the simple assumptions about fertility (and mortality) rates in the UN population projections, there is a fundamental, unsupported core assumption about carrying capacity. Recent human demographic projections have essentially involved an extrapolation of current trends, in combination with the arbitrary selection of a future date at which fertility rates will stabilize at or below replacement level, as Cohen (1995) and others have described (Meyerson 2009).

The only limiting factor in the current UN model is a belief that people will self-regulate their fertility en masse to a below-replacement level (1.85 children per woman) within the next few decades (United Nations

Population Division 2009). Yet it is clear that factors that limit the populations of other species – resources (eg food, energy, water), interference competition, and disease – also affect human mortality and longevity.

Here is an opportunity for ecologists and other scientists who work closely with population and systems models to develop more sophisticated and credible methods for projecting human population growth and trends. As Eugene Rosa *et al.* mention, the dynamics of human demographic change are also linked to consumption patterns. One modeling quandary is that slowing growth leads to a population dominated by more affluent, older consumers, as is rapidly occurring in China.

Limits to human food supply and energy are difficult (but not impossible) to project – our ingenuity and adaptability as a species both help and hurt us in that regard. Easier for ecologists to tackle are projections regarding limits to the use of ecological resources, if we plan on maintaining some substantial percentage of remaining species and ecosystems. As David Pimentel points out, the virtually unstoppable spread of once geographically isolated species, including invasives, to the four corners of the Earth complicates conservation problems, as does human migration (Meyerson *et al.* 2007). Rapidly shifting climate zones and habitat, and the nature of evolution itself, make the task even more interesting. However, ecologists thrive on complexity and are well-suited to these modeling challenges.

It is unfortunately true that ecologists' silence has been (and will be) interpreted as an implicit endorsement of the current flawed projection models, which are used as a core input and driver for global climate, conservation, and economic models. These models – which show a “smooth and painless”, near-term resolution to current rapid population growth (79 million per year) – have led to complacency among political leaders, the family-planning community, the public, and even sci-

entists, who should know better.

One key task will be to improve the population models while maintaining the transparency and simplicity that make projections accessible to the public, the media, and policy makers. Few people even connect population growth with the loss of biodiversity, as John Feeney says in his letter. This is partly due to the complexity of factors and processes that lead to species' extinctions. But it is also the result of the continued use of human population projections in which the capacity and limits of the planet to support human and other life are neither considered nor communicated.

All of the responders point out that the personal and political sensitivity of population issues leads to their omission from climate negotiations and ecological research discussions. Yet we live on a planet where species go extinct and people starve as a result of the growing imbalance between human population and natural resources, which in turn threatens our long-term biological security (Meyerson *et al.* 2009). The responsible path for an ecologist is to take an active role in the process, instead of just being a passive observer.

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Cohen JE. 1995. How many people can the Earth support? New York, NY: WW Norton and Company.

Meyerson FAB. 2009. Population. In: Schneider SH, Rosencranz A, Mastrandrea MD, and Kuntz-Duriseti K (Eds). Climate change science and policy. Washington, DC: Island Press.

Meyerson FAB, Merino L, and Durand J. 2007. Migration and environment in the context of globalization. *Front Ecol Environ* **5**: 182–90.

Meyerson FAB, Meyerson LA, and Reaser JK. 2009. Biosecurity from the ecologist's perspective: developing a broader view. *Int J Risk Assess Manag* **12**: 147–59.

United Nations Population Division. 2009. World population prospects: 2008 revision. <http://esa.un.org/unpd/wpp2008/index.htm>. Viewed 11 Feb 2010.

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## Immigration numbers – a response to Hiding

It is refreshing to see the interconnections of immigration and environmental issues addressed in an ESA publication (*Front Ecol Environ* 2009; **7**[7]: 350–51). Foreign immigration has been the major driver of US population growth for a few decades, as Hiding notes in her letter. And it is also the major driver of US environmental degradation that is most amenable to quick reduction – or quick increase. Post-2000 immigrants and their descendants are estimated to account for 62% of the 12.2 million people added to the US population between 2000 and 2004 (Lee *et al.* 2005). If current trends continue, the US population is projected to increase to 438 million by 2050, and 82% of that increase will be due to post-2005 immigrants and their descendants (Passel and Cohn 2008). But the US Congress, the White House, and the growth *über alles* political, religious, and commercial establishments are not satisfied with “current trends”. They want to increase immigration rates. According to Martin and Fogel (2006), if Congress enacts “comprehensive immigration reform” of the sort the US Senate passed in 2006 (Senate Bill 2611), then the US population is projected to reach over 500 million by 2050, with nearly 100% of the projected increase attributable to post-2006 immigrants and their descendants.

Three statements in Hiding’s essay merit comment. First, citing Meyerson (2004), Hiding states that US “fertil-

ity rates hover consistently around replacement”. What Meyerson showed is that US fertility rates dropped from about 3.7 children per woman in the mid-1950s to a below-replacement level of 1.7 by 1975 and then rose to 2.0 by 2002. By 2007 it was 2.1. That 24% increase in US fertility rate since the 1970s coincided with a large influx of immigrants from cultures favoring large families. That total fertility rate is operating synergistically with high immigration rates to postpone US population stabilization indefinitely.

Second, Hiding says that, “Ecology can help distinguish impacts of immigration on biodiversity, but it cannot provide the answers regarding what to do”. I believe that ecologists not only can “provide the answers” but also have a moral obligation to do so. Whether decision makers will accept our advice is a different matter; they certainly have no obligation to accept it blindly. But if we do not present sound advice, strongly and clearly, who else will give better advice on such matters? Is it not irresponsible to abandon the field to the anti-environmental, pro-growth establishments? They will not mimic our timidity. As professional ecologists, we should be no more shy about presenting advice on all aspects of US population policy than we have been about offering guidance on forest management, pesticide use, industrial pollution, the draining of wetlands, and the hunting of whales.

Third, quoting blogger Stephen Holder, Hiding says, “...illegal immigration degrades the environment; enforcing the border against illegal immigration degrades the envi-

ronment. Glad that’s clear”. This statement conveys the impression that it’s “six of one, half a dozen of the other”. Yet the US population is already larger by many tens of millions of people as a result of just post-1970 *illegal* immigrants and their descendants – certainly more people, for example, than the combined populations of Los Angeles, Chicago, Dallas, New York, and Miami. And illegal immigration into the US continues on a massive scale. To imply that there is even an approximate equivalence between the environmental damage done by such large increments in the US population and the localized environmental damage done by border fences and patrols along them is very misleading.

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- Lee J, Martin J, and Fogel S. 2005. Immigrant stock’s share of US population growth 1970–2004. Washington, DC: Federation of American Immigration Reform. [www.fairus.org/site/News2?page=NewsArticle&id=17213&security=1601&news\\_iv\\_ctrl=1902](http://www.fairus.org/site/News2?page=NewsArticle&id=17213&security=1601&news_iv_ctrl=1902). Viewed 21 Jan 2010.
- Martin J and Fogel S. 2006. Projecting the US population to 2050: four immigration scenarios. Washington, DC: Federation of American Immigration Reform. [www.fairus.org/site/DocServer/pop\\_projections.pdf?docID=901](http://www.fairus.org/site/DocServer/pop_projections.pdf?docID=901). Viewed 21 Jan 2010.
- Meyerson FAB. 2004. Policy view: immigration, population policy, and the Sierra Club. *Popul Environ* **26**: 61–69.
- Passel JS and Cohn DV. 2008. US population projections: 2005–2050. Washington, DC: Pew Research Center.

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