Why do we fly? Ecologists' sins of emission

Peer-reviewed letter

We write to address an increasingly unsustainable paradox: a hallmark of modern science is frequent air travel, but the realities of global climate change will force us to find creative and constructive ways to reduce our carbon emissions (IPCC 1999; Pacala and Socolow 2004; Gremillet 2008). The unease about frequent flying should be particularly acute for the community of ecologists and conservation scientists – a group of professionals who commonly speak out against emissions, yet by virtue of their own behavior have individual carbon footprints that probably exceed the per capita footprints of most Americans.

We know of no large survey of carbon footprints for scientists or conservationists, so we each completed a carbon calculator (www.climatecrisis.net/takeaction/carboncalculator/) for 2007 (WebPanel 1) and documented our "sins of emission" (Figure 1). We thirteen conservation scientists span a wide range of jobs (academic institutions and non-governmental organizations) and career stages (junior to senior scientists), and – although not a random sample – we are fairly representative of those in the conservation field. The results give pause: the emissions from our flights account for an astonishing two-thirds of our average carbon footprint. Thus, in spite of considerably lower-carbon lifestyle choices (eg diet, purchasing/driving a hybrid car, home energy conservation) that made our non-flying carbon footprint 16% smaller than the average American's, our total emissions are double that of the American average and more than ten times the global average (Figure 1; WebPanel 1). The mismatch between individual behavior and conservation platitudes has already been noted (eg Bearzi 2009) and is a source of considerable embarrassment for the conservation community (Dowie 2008).

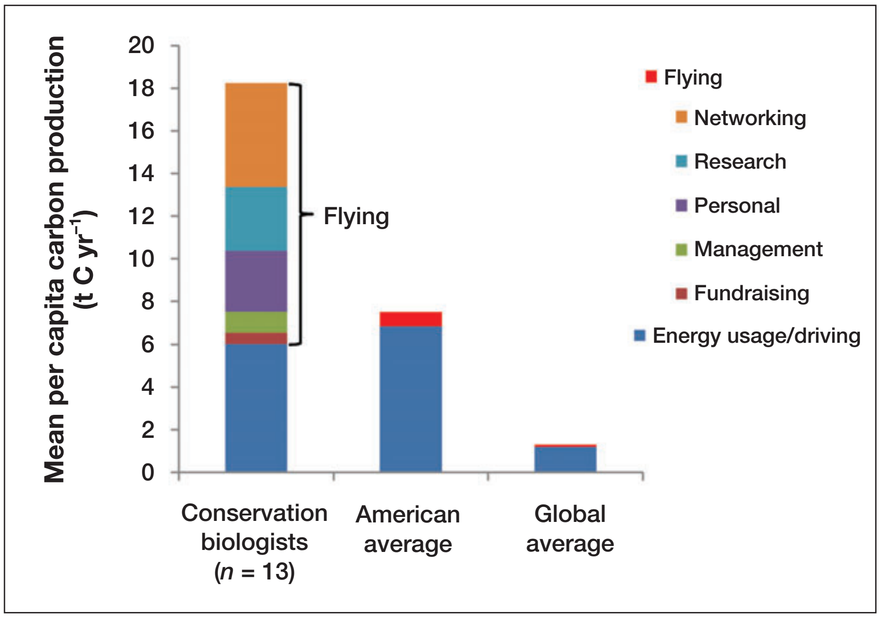

Figure 1. Estimated average annual per capita carbon footprint from transportation and home energy use for a sample of conservationists and Americans (WebPanel 1), as well as global citizens (WebPanel 2). The conservationists' flights have been further subdivided by category. Variance is large (standard deviation = 6.6 t C yr^{-1}) resulting from differences in proximity of family, specific job demands, and personal choices.

The question for scientists who believe emissions must be reduced is whether we can achieve those reductions while remaining globally engaged in our professions. To address this question, we first asked: "Why do we fly?" Collectively, the reasons for our flights fell into five broad categories. Networking (eg attending conferences and external meetings) and research were by far our largest reasons for flying, followed by personal, management (eg internal organizational meetings, grant review panels, etc), and fundraising (Figure 1). These categories are likely to apply to all scientists globally, albeit in varying proportions, depending on the field. Not surprisingly, no two scientists are the same, and there will not be a one-size-fits-all solution to reducing individual carbon footprints. However, flying in our professional lives occurs for both well justified and poorly justified reasons (Table 1). While organizations and individuals can find their own ways to reduce the amount of travel without needing these definitions, we propose general solutions that can reduce air travel through better discipline and more efficient prioritization (Table 1). Any categorization such as ours has shades of gray, will likely differ among sectors, and may change depending on factors such as career stage. But because air travel is the single greatest source of carbon emissions for many scientists, individual and institutional reductions in air travel will have immediate and important impacts.

The largest reduction could be achieved if individuals attend – and institutions hold – fewer meetings. As is already happening with many businesses (James and Pamlin 2009), the scientific sector should further invest in and demand increased video conferencing to reduce in-person meetings. Moreover, tools to facilitate coordinating conferences temporally and geographically to minimize travel already exist in simplified form (eg www.meetomatic.com; www.doodle.com), and could be enhanced (eg Primerano *et al.* 2008). Research trips can be reduced by establishing collaborations and empowering others to assist in investigations, lead on sub-projects, and send data digitally. For flights that cannot be eliminated, carbon offsets are an option.

Although these changes are relatively simple, they have enormous potential to reduce carbon emissions in the scientific community. If the 10 000–12 000 members of the Ecological Society of America (www.esa.org/member_services/) or the Society for Conservation Biology (www.conbio.org/join/) – assuming the members of both organizations have footprints comparable to ours – collectively reduced their travel by 30%, it could result in reductions of ~42 000 tons of carbon per year (t C yr^{-1}). That is the equivalent of taking ~7300 cars off the road for a year (www.epa.gov/RDEE/energy-resources/calculator.html) or eliminating 172 Boeing 747 US–Europe transatlantic flights.

Institutional changes to reduce flying are beginning. For example, The Nature Conservancy (TNC) reduced trustee meetings from annual to biennial events and reduced science leadership meetings from three to one per year. These changes have not compromised either activity. Similarly, the World Wildlife Fund (WWF) has pledged a 10% reduction in business-related flights. We urge others to do the same and more. Because the environmental impact of flying is very large, small changes in how we conduct our private and professional lives, leading to fewer flights, will substantially reduce carbon emissions.

Table 1. Our assessment of well justified (1) and poorly justified (2) reasons for flying, along with suggestions (3) for how institutions can institute policies to reduce travel for these reasons

(1) Well justified reasons to fly

To network with a large group of professional colleagues in a specific area and limited time period, thus eliminating the need for multiple trips to see individual colleagues.
To develop a relationship for fundraising or professional partnership.
To build a sense of team, with new collaborators or colleagues.
To work closely together over an extended time period.
To conduct field research that cannot be done any other way.

(2) Poorly justified reasons to fly	*(3) Institutional solutions*
To ensure you actually do the work involved in the project or give it your full attention.	Enforce deadlines, encourage reasonable work commitments and better self-discipline.
To ensure you are "in the loop" and do not miss any key discussions or sub-texts, or to ensure that your ideas will be given as much weight as competing ideas brought in person by others.	Require participation in video conferencing to "level the playing field". Establish clear and disciplined decision-making processes (consensus, vote, senior manager/leader under advice of group) so that the role of personal interactions is minimized.
To meet with a group you know well (including flying as part of a large group of your in-house colleagues).	Meet less frequently and work as "virtual teams". Provide online forums for important discussions and improve other forms of communication, such as electronic newsletters.
To symbolize that the topic is important.	Do not require symbolism to establish importance, but rather have a clear priority system that highlights importance.

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Using nature's clock to measure phenology

An important detail related to the timing of ecological events was omitted from Morisette *et al.*'s otherwise excellent review of the critical role of phenology in tracking 21st-century climate change (*Front Ecol Environ* 2009; **7[5]**: 253–60). Trends in the arrival of the vernal equinox (the "true" start of spring) create a bias in phenological records when these records are reported relative to calendar date, because the calendar date of the spring equinox occurs earlier each year throughout a given century (Sagarin 2001). The bias is created by the slight mismatch between the length of the true Earth year and the slightly longer average year on the Gregorian calendar, which we currently use to mark time. This bias will tend to cause researchers to overestimate trends toward earlier spring signals (budding, emergence from hibernation, migration, etc), but the exact magnitude of the bias cannot be predetermined. Moreover, the bias usually resets at the turn of each century (ie years divisible by 100) when a leap year is skipped, but the Gregorian calendar requires the year 2000 (and other centuries' opening years that are divisible by 400) to be a leap year, thereby allowing the bias to increase through the 21st century.

Fortunately, this bias can be easily corrected long after data collection, by recording phenological trends in relation to each year's true start of spring (vernal equinox) rather than by calendar day. Doing so preserves two key components of phenological data that were highlighted by Morisette *et al.* – the availability of long-term records and the accessibility of phenology to non-scientists. Phenology holds great promise to encourage people of all ages and abilities to venture into nature, wherever they live, and record what they see. Indeed, I discovered this bias while conducting my own analysis of an unusual phenologically related dataset – a now 92-year-old gambling contest to guess the exact minute of spring ice breakup in an Alaskan river (Sagarin and Micheli 2001).

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Phenological trend estimation: a reply to Sagarin

Sagarin notes correctly the disparity between anthropocentric calendars and timekeeping that relies on orbital dynamics. We agree that the bias (up to 0.8 days per century; Sagarin 2001) induced by the difference between the solar calendar and the Gregorian calendar should be accounted for in any analyses of long-term trends where field observations are recorded by calendar day (rather than by solar position). An additional bias, not raised by Sagarin, is the change in the relative length of the seasons due to the precession of the equinoxes. This effect, while considerably less than a day per millennium (Meeus 1998), argues in favor of referencing phenological events in winter-dormant ecosystems to the winter solstice (rather than to the spring equinox, as suggested by Sagarin).

Although not accounting for these effects can bias estimates of phenological responses to climate change, we note that, in both cases, the effects are small relative to (1) the high interannual variability (a week or more from year to year) of the spring "greenwave" in temperate and boreal regions, which is driven principally by atmospheric circulation patterns and their anomalies and, secondarily, by local environmental constraints (Schwartz *et al.* 2006); and (2) the magnitude of the observed trends toward earlier spring (2.3–5.2 days per decade according to the IPCC AR4; Parry *et al.* 2007) over the past 30 years.

Independent of this point, our review (*Front Ecol Environ* 2009; **7[5]**: 253–60) highlights key advances and the growing importance of phenological research for addressing several pressing environmental challenges.

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