Figure 2. *Examples of over-represented and under-represented taxa in postage stamps illustrating animals. (a) One favorite in philately, the scarlet macaw (*Ara macao*), depicted on a four-stamp set issued by Belize in 2003. (b) A set of stamps showing several insects issued by the UK in 2008.*

Therefore, we compared the observed number of WWF stamps with the expected number of stamps based on the respective diversity of each animal taxon on the IUCN Red List.

We identified the same general pattern previously observed for all stamps and all animals, but with a weaker bias – most notably for Chordata (within Kingdom Animalia); mammalian Orders Perissodactyla and Proboscidea; and avian Orders Phoenicopteriformes, Sphenisciformes, and Struthioniformes (WebFigure 1). However, although WWF stamps seem to reduce the bias and favor the issuing of stamps illustrating less-popular taxa, the dataset with which WWF stamps were compared is biased itself; for instance, on the IUCN Red List, there are more vertebrates than invertebrates.

Educational programs are known to be effective in increasing the number and variety of species that people, regardless of age or gender, can recognize (Weilbacher 1993; Lindemann-Matthies 2002). Stamps cannot be regarded as a conventional "educational program" but, given their wide audience, their impact on public opinion can be large. For example, when the World Health Organization launched an international campaign for the eradication of malaria in the early 1960s, 110 countries issued stamps dedicated to that campaign (Borgsteede 2001). Our results show what kind of message concerning animal diversity people are receiving directly or indirectly through stamps. We found that images of birds and mammals, and especially some groups within those taxa, appear much more frequently on stamps than members of other groups with greater diversity (Figure 2), reinforcing the public perception that the former are perhaps "more important" in nature. As Wilson (1987) pointed out, "if human beings were not so impressed by size alone, they would consider an ant more wonderful than a rhinoceros".

The 21st century is considered to be the century of extinctions (Dubois 2003; Rudd 2011). However, as some have argued, people will only miss a species if they know it and have developed a relationship with it (Weilbacher 1993). In this sense, postage stamps may represent an important but so far underestimated tool to disseminate information about the enormous diversity of plant and animal species living on Earth. To increase the effectiveness of this tool, we suggest that conservation societies should be encouraged to work with governments and postal agencies to promote the issuance of plant and animal stamps that will help to broaden the public's exposure to groups of organisms that are not normally featured.

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New tracking philosophy for birds

Peer-reviewed letter

In 1835 the English poet William Wordsworth wrote *"Resplendent Wanderer! followed with glad eyes, Where'er her course; mysterious Bird! To whom, by wondering Fancy stirred"*, capturing both our intrigue of bird movement and our helplessness to determine it. But things have since changed. Minute leg rings allow for banded individuals to be resighted by

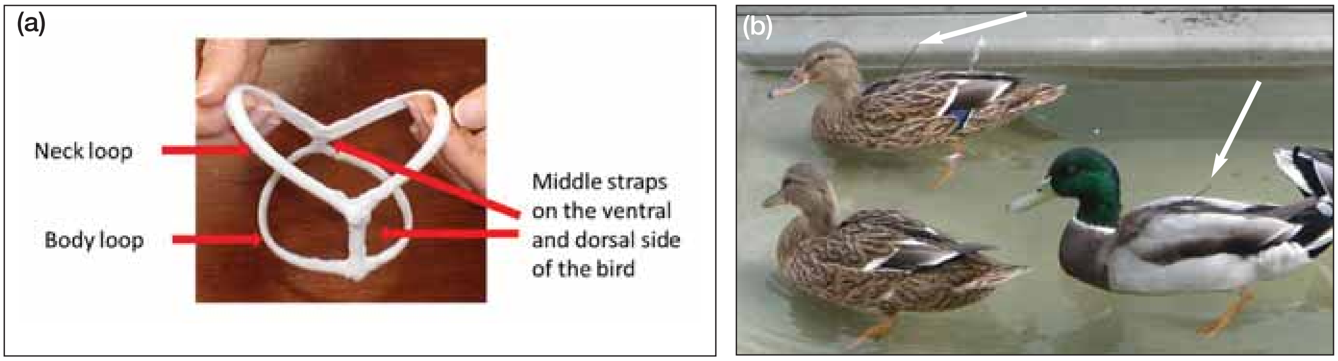

Figure 1. *(a) As with other backpack harnesses, the Silastic harness is formed of two loops: one neck loop and one body loop joined together by middle straps. The V-shaped neck loop sits on the shoulders, passing under the sternum to avoid disrupting swallowing. The body loop sits around the main body, not too close to the moving limbs (ie wings and legs) with the wings going through the open spaces between the two loops. (b) Two mallards (*Anas platyrhynchos*) wearing the harness and carrying mock VHF transmitters. Note that no aspect of the harness is visible.*

observers, thereby demonstrating avian dispersal capacities (Salomonsen 1956). But leg-ring sightings are subject to chance and only provide point locations in space with unknown trajectories between them. This problem was partially solved by "geolocation" (Wilson *et al.* 1992), in which miniature data loggers on leg rings record light intensity against Greenwich Mean Time, thereby allowing daily determination of latitude and longitude (Shaffer *et al.* 2006). As with leg rings, however, the miniature loggers must be recovered to retrieve the data. With the inception of radio (very high frequency [VHF]) telemetry, researchers were able to pinpoint the location of transmitter-equipped individuals without recapture; furthermore, when such transmitters (eg platform transmitter terminals [PTTs]) communicated with satellites, global coverage of bird movements was available (Jouventin and Weimerskirch 1990). Such devices are unlikely to ever work on leg rings, however, being too large and with ventral positioning hindering tag–satellite communication. Ideally, these devices should be positioned dorsally, although physical attachment in this position is challenging. Methods to tape (Wilson and Wilson 1989) and glue (Raim 1978; Sykes *et al.* 1990) tags to dorsal feathers work well until the feathers are molted, limiting deployment duration to weeks (Warnock and Warnock 1993), and harnesses have an inconsistent performance history (Rappole and Tipton 1991), with some reports pointing to behavioral anomalies (Perry 1981), feather wear or skin abrasion (Buehler *et al.* 1995), and even mortality (Peniche *et al.* 2011).

The problem with harnesses may lie in their conception as being able to withstand all possible environmental conditions as well as unwelcome attention from the bird itself, which explains why Teflon is popular despite its mixed success (Steenhof *et al.* 2006). We tried a fundamentally different approach, fashioning a harness from a soft, elastic, hypoallergenic, silicone-based compound called Silastic (Dow Corning Corporation, Midland, MI) that is designed to sit directly on the skin under the plumage (Figure 1). The idea behind this was that if the attachment system was imperceptible (both visually and by touch) and protected by the birds' feathers, it would be subject neither to external conditions nor to the attention of the wearer. In addition, Silastic's variable elasticity should be able to accommodate seasonal mass changes in outfitted birds. Our work has proceeded carefully; with trials ranging from days to months, we examined potential behavioral anomalies and possible plumage and skin changes on example species of passerines, gulls, ducks, and corvids, with no deleterious effects observed (WebTable 1). Nineteen adult jackdaws (*Coloeus monedula*) wore VHF and PTT tags for a maximum of 5 months in captivity before being successfully released in the wild.

Other researchers are also experimenting with a similar approach. Two teams have recently reported recovering tags attached with elastic harnesses from northern wheatears (*Oenanthe oenanthe*; Bairlein *et al.* 2012) and hoopoes (*Upupa epops epops*; Bächler *et al.* 2010) after yearlong deployments on wild birds migrating across hemispheres and trans-equatorially, respectively. Such long periods and arduous migrations are a severe test for the attachment protocol, and the results appear promising.

Ultimately, the ability to resolve normal bird movements over long time periods depends on both an appropriate attachment mechanism and minimal tag size, while still maintaining tag contact with a satellite. Future success in this approach has been facilitated by the confirmation that a VHF receiver, dedicated to detection of animal-borne VHF transmitters, will be carried in 2014 by the low-orbiting International Space Station, which is supported by the European Space Agency and the German Air and Space Agency (Pennisi 2011). This system relies on modern CDMA (code division multiple access) communication technology in miniaturized electronic circuits and thus will not only help to shrink animal tag size but also allow for an expansion in onboard nano-sensing technology. Currently, the ICARUS (International Cooperation for Animal Research Using Space) initiative plans to have 5-g Global Positioning System logging tags and 1-g communication-only tags ready for experiments in 2015.

With technological advances in harnesses and solar-powered transmitters, as well as remote access to satellites, wildlife biologists should be able to track individual birds for years, revealing information on, for instance, where birds perish (eg Burnham and Newton 2011), addressing both conservation and pure research issues. Empowered with such science, we may see a day when Wordsworth followers will appreciate that there is no more mystery in bird paths, leaving them to lyricize about remarkable avian traveling feats instead.

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In memoriam

The plant physiologist shown on the cover of the December 2012 issue of *Frontiers* was Dr Fitzgerald Booker, a valued colleague in the ozone (O_3) effects community. Fitz passed away in late October. His work with the US Department of Agriculture's Agricultural Research Service (USDA–ARS) Plant Science Research Unit in Raleigh, North Carolina, led to many peer-reviewed papers and reviews on the ecophysiological responses of crops to O_3 pollution and climate change, spanning scales from molecular to organismal to ecosystem ecology. In particular, his recent *Science* paper (Cheng *et al.* 2012) challenged the assumption that elevated carbon dioxide improves carbon (C) sequestration in soils, suggesting instead that arbuscular mycorrhizae may be stimulated to release additional C. This finding has important implications for models of terrestrial C budgets. Fitz's work, including that with the soybeans depicted in the cover's central photo, continues to stimulate researchers concerned with environmental impacts on crop production.

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Erratum

In Wilmers *et al.* (2012; 10[8]: 409–15), values for kelp biomass in Table 1 were incorrectly reported. A corrected version of the relevant section of the Table appears below.

Table 1. Comparison of kelp carbon dynamics between scenarios with and without sea otters at ecologically effective densities

	Sea otters absent	*Sea otters present*
Kelp biomass (wet weight)	750–1330 g m^{-2}	9110–16 180 g m^{-2}
Kelp carbon	8–14 g C m^{-2}	101–180 g C m^{-2}
Net primary productivity	25–70 g C m^{-2} yr^{-1}	313–900 g C m^{-2} yr^{-1}