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Sustaining Earth's biodiversity

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The decline in the biodiversity of the Earth is a critical global issue with potential impacts on essential ecosystem services. The rate of biodiversity loss has already far exceeded safe planetary boundaries (Rockström et al. 2009) and measures to arrest species extinction have been found wanting, with conservation reserves too small, too few and too subject to change. So, society has called for a significant increase in investment in biodiversity conservation, particularly given the additive impacts of accelerated climate change (Pecl et al. 2017). In concert, understanding of ecological function and process is needed if ecosystem services are to be managed sustainably.

Conservation biology has long been identified as the "crisis science" (Soulé 1985). However, preventing species extinction is not enough to maintain ecological function, socio-ecological resilience and evolutionary potential (Sgrò et al. 2011). The links with society and the sustainable use of landscapes are increasingly part of the broader conservation remit (Wu 2011). The magnitude of the issues encountered greatly exceeds the foundational ecological knowledge available, and counting species and population declines is not enough. Historically, conservation biologists have grappled with the design of protected area networks, and preventing deforestation and desertification. Today, the portfolio of challenges has expanded to include ecological isolation, fragmentation and degradation of terrestrial and aquatic systems, and accommodating species whose habitats are at risk from changing climate patterns, as well as the sustainable use of natural resources. Furthermore, maintaining and restoring appropriate disturbance regimes has become increasingly important as land use has pushed disturbance regimes beyond their historical limits (North and Keeton 2008).

In fact, the rate of biodiversity loss tempts conservation biologists to focus predominantly on the recent, and even just the now. Here, however, they run the risk of misunderstanding the landscape elements that influenced system function, the factors that drove the declines and the historical role of people as ecological architects (Fig. 1). Further, they may overlook the existence of cultural ecosystems and the past, and future, role of people in them (Wu 2011). Yet even the value of these lessons may be challenged, as "novel ecosystems" emerge due to anthropogenic climate change, land use and alien species (Williams and Jackson 2007).

We maintain that the study of long-term ecosystem change can provide critical insights into the resilience of ecosystems, the restoration of disturbance regimes and the prediction of future responses to changing climate and disturbance – even when conditions are novel. This collection of papers is an illustration of this view.

Figure 1: The Gamo Highlands of Ethiopia – a landscape shaped by multiple interacting drivers (Photo: Rob Marchant).

The role of disturbance in ecosystems is widely recognized but rarely is the legacy of historical disturbance, particularly by humans, acknowledged in conservation planning. The neo-tropical Gran Sabana is a mosaic of vegetation that reflects the influence of climate change but also human burning as an agency of vegetation dynamics (Rull et al., p.82). The management of the vegetation mosaics here, as well as in the North American pine communities, requires an appreciation of the influence of cultural practices, and the impact of their removal (Colombaroli et al., p.78). The east African landscapes too, that have supported diverse megafaunas in close association with long human habitation (Marchant et al., p.80), attest to long interactions between people and biodiversity, but with this balance challenged in recent decades by the intensification of development.

The legacy of human occupation is often an increase in regional biodiversity, and cultural landscapes are themselves now considered valid conservation targets. The contemporary richness of some European communities evolved in association with human disturbance (Ekblom and Gillson, p.88). Similarly, the legacy of horticulture is the augmentation of botanical diversity in long-reforested Central and South American regions (Whitney and Cárdenas, p.84).

These vignettes of human-ecosystem interactions attest to the importance of long-term evidence to inform appropriate landscape management. Rarely has this occurred, however UN programs such as the Ramsar Convention are recognizing long-term variability to better ascribe natural ecological character and limits of acceptable change (Gell, p.86). Understanding ecological responses to external, including human, stressors is critical if management efforts are to be well targeted (Seddon, p.94). The scaling up of paleoecological records represents a means by which long-term data (Harrison, p.96) could be brought to biodiversity management decision making.

This issue of *Past Global Changes Magazine* focuses on the perspectives that can be brought to the crisis science from paleoecological evidence. It draws on lessons from the Americas, Africa and Europe, while also providing new insights into the long-term geological (Fritz and Baker, p.90) and climatic (Ledru et al., p.92) forces of biodiversity evolution, critical transitions in ecosystem change (Seddon, p.94) and utility of ecosystem change evidence for global conservation programs to enable them to better address the challenges imposed by intensive development. Lastly, it advocates for big data as a means of scaling up our knowledge to contribute best to informing programs that address biodiversity management (Harrison, p.96).

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