

# Ecological forecasts

Gretchen C. Daily

Until the next big asteroid hits us, the future of life on Earth will depend much more on humanity than on anything else. Collectively, we have the power to wipe out most macroscopic species and to change radically the ecological and evolutionary playing fields of any that remain. Humanity exercises this power largely inadvertently, with consequences that increasingly threaten our well-being. What will happen from here on? Clues are being sought in the countryside, where in subtle but profound ways the possible futures of life are already unfolding.

'Countryside' refers to the growing fraction of the Earth's unbuild land surface whose ecosystem qualities are strongly influenced by humanity. It includes agricultural plots; gardens and pasture; plantation or managed forest; and remnants of native vegetation in areas devoted primarily to human activities. The countryside offers a broad arena where the functioning and fates of species can be studied under alternative predicted futures.

Yet surprisingly little is known about countryside biogeography, especially in rapidly changing tropical ecosystems. Initial studies and conservation efforts understandably focused on natural ecosystems and, more recently, on their remaining fragments. 'Island biogeography', a conceptual framework assuming islands of natural habitat surrounded by an inhospitable sea of agriculture and other development, informed much of the early work. Now, the 'sea' itself has become a focus of study as the fraction of the biosphere free from human influence is tiny

and rapidly shrinking; and many countryside habitats are actually not so inhospitable.

Three broad questions face us as wilderness fades away. First, assuming that human impacts intensify as currently projected, what sorts of species and ecosystems will exist over the coming decades and centuries? Second, what sorts do we want – and how do we decide? And third, how, and to what extent, can we achieve our desires? (See Box.)

Inspiring progress on all three questions has been made over the past two decades. New approaches and perspectives centre around building a science that will let us forecast changes both in biodiversity and in the way that ecosystems function. Many efforts aim to integrate ecology further with fields such as anthropology, climatology,

## Seeking clues to the future

Scientific questions within the broad framework of biodiversity change include:

- Which species traits are advantageous in the face of major habitat alterations, and why?
- How will human-induced extinctions shape future diversity and evolution?
- What roles will countryside biotas play in supplying ecosystem services, such as water purification, flood control, pollination and preservation of options for the future?
- Are existing tools (ecological theory, remote sensing, interdisciplinary models for forecasting changes in land use) up to the task of predicting the persistence and functioning of countryside biotas?
- What practical measures can be taken to increase the capacity of countryside habitats to sustain biodiversity and ecosystem services?
- What are the trade-offs for society of alternative land-use regimes?

## Countryside

*"Humanity has always been, and always will be, a part of nature."*

economics, history and law to characterize the consequences to society of 'ecosystem change' and possible responses to it.

There is great potential for biodiversity conservation, at least in the short term, in tropical countryside of 'low' to 'intermediate' intensity of use — small plots and paddocks (say, 0.1 to 10 hectares), and scattered remnants of native vegetation (0.1 to 100 or 1,000 hectares). For instance, more than half of Costa Rica's native bird species occur in largely deforested countryside habitats, together with similar fractions of mammals and butterflies. Little is known about long-term survival of biotas, however; work in Kenya and elsewhere shows that the path to extinction can be many decades or centuries long. Europe, much of which has been 'countryside' for a long time, shows clearly that some farming landscapes retain more biodiversity and valuable ecosystem services than others.

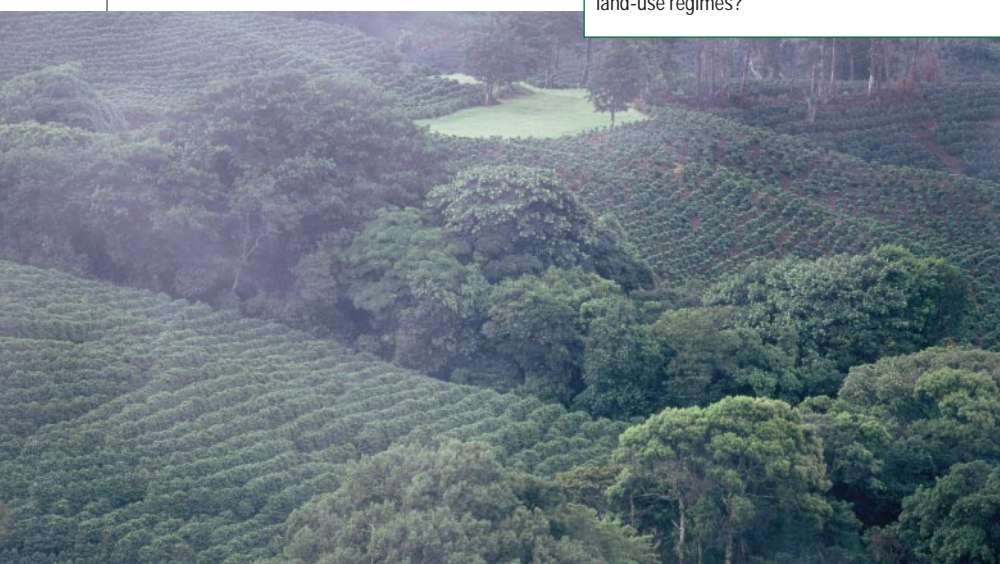
Much work is needed, and little time remains, to help steer a course that will at least protect the most vital of the Earth's life-support services. A three-pronged scientific effort is under way to serve this end. It has the daunting task of building models of ecosystem change, with emphasis on understanding the functional roles of species and ecosystems, especially in countryside. To preserve options, it must also develop more comprehensive strategies to conserve native biotas and their services on human-dominated lands, as well as in remaining 'natural' areas. Finally, there are interdisciplinary efforts to characterize the biophysical and socio-economic trade-offs associated with alternative regimes of land management — and to inform farmers, foresters and society generally about policy options. Nothing less than life is at stake. ■

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### FURTHER READING

- Daily, G. C. *Nature's Services* (Island Press, Washington DC, 1997).
- Daily, G. C., Ehrlich, P. R. & Sánchez-Azofeifa, G. A. *Ecol. Appl.* 11, 1–13 (2001).
- Myers, N. & Knoll, A. (eds) *The Future Course of Evolution*. Special issue of *Proceedings of National Academy of Sciences* (in the press).
- Salzman, J. (ed.) *Protecting ecosystem services: science, economics, and policy*. *Stanford Environmental Law Journal* (in the press).
- The Millennium Ecosystem Assessment* <http://www.millenniumassessment.org>

In search of the future: countryside offers an opportunity to assess changes to ecosystems.



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