Letters

A REDD Light for Wildlife-Friendly Farming

Carbon-payment schemes such as reducing emissions from deforestation and degradation (REDD), through which credit is extended to landowners who protect forests for carbon storage, may affect the land-sparing versus wildlife-friendly farming (WFF) debate (Fischer et al. 2008). Land-sparing posits that conservation is best achieved by maximizing agricultural production per unit area, thereby alleviating pressure on forests elsewhere. Wildlife-friendly farming promotes agricultural practices that minimize local environmental impacts, the trade-off with which are lower yields and more land under cultivation (Fischer et al. 2008). Recent evidence suggests that compared with conventional intensive farming, low-intensity farming has far less impact on biological diversity, including the ecological processes that maintain species and populations across the agricultural matrix (e.g., Perfecto & Vandermeer 2002; Naidoo 2004). This has led some to argue for the adoption of WFF in the tropics (e.g., McNeely & Scherr 2002; Vandermeer & Perfecto 2007).

Implementation of REDD will bar large areas of land from development, possibly keeping WFF from meeting increasing agricultural demands. Failure to meet rising demands could drive agricultural intensification (undermining WFF) and raise opportunity costs for REDD. For example, intensification of oil-palm agriculture in Southeast Asia could drive net present values of land upward from US$3835 (low-yield scenario) to US$9630/ha (high-yield scenario) (Butler et al. 2009). Land sparing, that is intensive farming on a smaller area of land, may offer more hope for meeting agricultural demands at lower costs to biological diversity than WFF, as long as yield increases through intensification keep up with increasing demand for commodities. Otherwise, forests may have to be cleared. Because land productivity under intensive agriculture is high, the opportunity costs of REDD will rise, particularly as demand for commodities rises.

We assume that demand for agricultural commodities will continue to rise. Is this likely? Globally, 2260 million new cars are projected to be in operation by 2050, which will necessitate production of 164 million t of natural rubber for the tires alone (Chamon et al. 2008; see Supporting Information). This implies an additional 54 million ha of land will be under intensive rubber production or 161 million ha will be under lower-yield agroforestry production, equivalent to 5–15% of the current extent of tropical forests (approximately 1.1 billion ha). Biofuels is another group of commodities expected to be in great demand. Biodiesel consumption is projected to reach 277 million t/year in 2050, which will require an additional 114 million ha of land for production of oil crops (Koh 2007). Long-term projections are uncertain, but these examples illustrate the magnitude of possible increases in demand for just two agricultural products.

Another uncertainty is whether degraded land (i.e., land, including forests, with a productive potential that has declined temporarily or permanently) will absorb the seemingly necessary expansion of agriculture. Estimates of the amount of degraded land in the tropics are difficult to obtain, in part because there is no clear definition of *degraded land*. The best global estimates suggest there are 480 million ha (Field et al. 2008), which implies there is sufficient degraded land to meet the forecasted needs for expanded rubber and biofuel production. Yet approximately 120 million additional ha for agriculture and 110 million ha for timber plantations (Bruinsma 2003; see Supporting Information) need to be added to the equation to meet future projected demands. Taken together, production of rubber, biofuels, food, and timber would require 83–105% of all degraded land. This assumes intensive development of remote and degraded lands is feasible and that there will be generous increases in annual yield, which is unlikely given the marginal productivity of most degraded lands.

We believe WFF is not a feasible long-term strategy because it will come at the expense of agricultural expansion into forests with little to no history of human use, a scenario that is self-defeating. We argue WFF is not credible under current projections of demand for food, cars, and other goods (Bruinsma 2003; Koh 2007; Chamon et al. 2008; Supporting Information), but it is especially not credible if REDD successfully sets aside forests for long-term carbon storage. If REDD were successfully and widely implemented, intensification of agriculture would be exacerbated with consequent undesirable environmental impacts in intensively managed areas. Agricultural expansion into degraded land may offset some of the undesirable effects on forests and reduce opportunity costs for REDD. Nevertheless, this is only likely to occur if degraded land is turned over to intensive production, which would necessitate the near abandonment of proposals for REDD+, a variant of REDD that also offers carbon credits through reforestation and forest restoration (Campbell 2009). From a broad conservation

Conservation Biology, Volume 24, No. 3, 644–648

DOI: 10.1111/j.1523-1739.2010.01502.x

perspective, advocates of WFF as a means to achieve conservation may need to reconsider their perspective under a REDD light.

Supporting Information

Information and calculations used to estimate future agricultural land needs are available as part of the online article (Appendix S1). The authors are responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Jaboury Ghazoul,*‡ Lian Pin Koh,* and Rhett A. Butler†

*Institute of Terrestrial Ecosystems, ETH Zürich, Universitätsstrasse 16, 8092 Zürich, Switzerland
†Mongabay.com, P.O. Box 0291, Menlo Park, CA 94026, U.S.A.
‡email jaboury.ghazoul@env.ethz.ch

Literature Cited

Bruinsma, J. 2003. World agriculture: towards 2015/2030: an FAO perspective. Earthscan Publications, London.

Butler, R. A., L. P. Koh, and J. Ghazoul. 2009. REDD in the red: palm oil could undermine carbon payment schemes. Conservation Letters **2:**67–73.

Campbell, B. M. 2009. Beyond Copenhagen: REDD+, agriculture, adaptation strategies and poverty. Global Environmental Change **19:**397–399.

Chamon, M., P. Mauro, and Y. Okawa. 2008. Mass car ownership in the emerging market giants. Economic Policy **23:**243–296.

Field, C. B., J. E. Campbell, and D. B. Lobell. 2008. Biomass energy: the scale of the potential resource. Trends in Ecology & Evolution **23:**65–72.

Fischer, J., et al. 2008. Should agricultural policies encourage land sparing or wildlife-friendly farming? Frontiers in Ecology and the Environment **6:**380–385.

Koh, L. P. 2007. Potential habitat and biodiversity losses from intensified biodiesel feedstock production. Conservation Biology **21:**1373–1375.

McNeely, J. A., and S. J. Scherr 2002. Ecoagriculture: strategies to feed the world and save wild biodiversity. Island Press, Chicago.

Naidoo, R. 2004. Species richness and community composition of songbirds in a tropical forest-agricultural landscape. Animal Conservation **7:**93–105.

Perfecto, I., and J. Vandermeer. 2002. Quality of agroecological matrix in a tropical montane landscape: ants in coffee plantations in Southern Mexico. Conservation Biology **16:**174–182.

Vandermeer, J., and I. Perfecto. 2007. The agricultural matrix and a future paradigm for conservation. Conservation Biology **21:**274–277.

Prevention of Secondary Extinctions through Taxon Substitution

Intuitively, many conservationists would agree with Oliveira-Santos and Fernandez's (2010) argument that conservation efforts should focus on refaunation of degraded habitats with native taxa. Nevertheless, many habitats are degraded because topological keystone species, often large vertebrates (Woodward et al. 2005), have been driven to extinction globally. So, should conservationists abandon hopes of restoring the integrity of such ecosystems?

Conceptually, "taxon substitutes"—exotic species with functions similar to extinct native species—could reinstate the ecosystem functions of extinct native species and thus prevent further species losses and ecosystem degradation. Nevertheless, the lack of empirical evidence from taxon-substitute projects hinders understanding how they can be used in restoration ecology (Marris 2009). In the absence of such data, their use has been condemned. Caro and Sherman (2009), for instance, call for "a moratorium on importing non-indigenous megafauna," even though this would prevent collection of the very data needed to evaluate the potential contribution of taxon substitutes to improving ecosystem resilience and preventing biotic homogenization.

Grandiose prehistoric restoration schemes (Pleistocene rewilding; Donlan et al. 2006) have many inherent problems and are not conservation priorities because the trophic cascades that followed Pleistocene megafaunal extinctions are long past. Nevertheless, many large vertebrates have become extinct recently, especially on islands, where local extinction often translates into global extinction. Concerns about the perils of introducing exotic species as taxon substitutes or biological control agents have overshadowed the risks of ignoring the ensuing effects of extinctions of large vertebrates on ecosystem dynamics and resilience. Many of the candidate species for replacement by taxon substitutes were driven to extinction by humans and possess life histories predisposed to extinction. Thus, we see no reason why opponents should automatically consider their proxies, which generally have very similar life-history traits, to be potential pests (Caro & Sherman 2009; Oliveira-Santos & Fernandez 2010). Conservationists have a negative perception of exotic species, and these perceptions "sometimes rest more on prejudice than science" (Davis 2009). Much of the concern about taxon substitutes becoming invasive species is based on inferences from introduced animals with r-selected life-history traits and seems to overlook the fact that the majority of introduced species do not become invasive (Williamson & Fitter 1996).

Addressing the problem of endangered species is a conservation priority; however, their long-term sustainability may depend on interactions with extinct species. In habitats that lack suitable native functional equivalents to maintain ecosystem functions, taxon substitutes may be able to restore recently lost key ecological functions and contribute to significant conservation gains by reducing secondary extinctions (Griffiths et al. 2010). Such situations are common on islands, which have lower functional redundancy and are consequently more prone to ecosystem dysfunction.

For instance, the extirpation of Mascarene giant tortoises (*Cylindraspis* species), megafaunal herbivores