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COMMENTARY

Tropical Biodiversity in Human-Modified Landscapes: What is our Trump Card?

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ABSTRACT

Many conservationists are now convinced that the expansion of the world system of protected areas combined with appropriate levels of biodiversity persistence within human-modified landscapes would drastically mitigate the announced impoverishment of tropical biotas. In this context, an inherent/intrinsic biodiversity ability to persist and recover within human-modified landscapes has emerged as a 'trump card' in the conservation battle, renewing our hope in a more sustainable development of the tropical region. However, this optimistic perspective on the conservation value of human-modified landscapes sounds, a priori, a little unrealistic in face of the current knowledge on the nature of human environments and the spectrum of native species that is likely to persist there. Rather than relying on illusory levels of biodiversity resilience and consequent flexible land-use regulations, our real trump card reposes on a radical and ambitious shift from freely exploited landscapes to strictly managed ones, despite the misleading noise produced by those voices advocating for immediate and almost unlimited access to natural resources. Otherwise, we are condemning future human populations to live in biologically impoverished and fragile environments with limited opportunities for life support.

Key words: land-use regulations; old growth species; species extinction; tropical forests.

IN THE YEAR IN WHICH GLOBAL BIODIVERSITY is publicly and internationally celebrated, scientists and conservationist worldwide are forced to admit that this invaluable heritage has succumbed to human livelihood priorities and increasing demands for natural resources, particularly in the tropical region (Wright 2005). The title of the ATBC 2010 meeting is illustrative: 'Tropical biodiversity: surviving the food, energy and climate crisis'. Indeed, disturbing news continues to arrive from the tropical forest front as forests are converted into human-modified and hyper-fragmented landscapes, within which remaining forest patches provide goods and services for local human populations (Norris *et al*. 2010). This is not a trivial shift in the land-use regime, as human-modified landscapes catalyze both historic sources of human-driven disturbances (*e.g.*, hunting and plant gathering) and also modern ones such as ecosystem fertilization and contamination by biocides. We are in fact witnessing the emergence of novel landscapes and ecosystems, which appear in response to a package of synergistic and additive anthropogenic disturbances. Although this ongoing trajectory has already led thousands of species to the brink of global extinction, tropical biodiversity is not necessarily condemned to perish (DeClerck *et al*. 2010).

Many conservationists are convinced that the expansion of the world system of protected areas, together with the sometimes remarkable persistence of biodiversity within human-modified landscapes, would substantially mitigate the impoverishment of tropical biotas (Harvey *et al*. 2008). In this context, the potential of biodiversity to persist and recover within human-modified landscapes has emerged as a 'trump card' in the conservation battle, renewing our hope in a more sustainable development of the tropical region. However, this optimistic perspective about the conservation value of human-modified landscapes appears somewhat unrealistic in face of the unabated erosion of species and our current understanding of the nature and development of human environments, including the spectrum of native species that is likely to persist there.

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HUMAN-MODIFIED LANDSCAPES, ITS COMPONENTS AND DWELLERS

Tropical human-modified forested landscapes often refer to agromosaics that support a variable combination of privately owned elements such as old growth forest relicts, edge-affected forest remnants, early-to-late secondary forest patches recovering from cropland or pasture abandonment, small patches of assisted regenerating forests, agroforestry areas, and managed exotic tree plantations. Rarely, they also support protected areas but all these elements remain embedded within predominantly open-habitat matrices (Tabarelli *et al*. 2010). Moreover, human landscapes are progressively deforested, frequently reaching < 30 percent of native forest cover, the theoretical fragmentation threshold below which structural connectivity drops dramatically and rates of species extinctions increase (Fahrig 2003), and remaining patches of native forests become confined to economically marginal lands. These patches should be described as continuously disturbed rather than post-disturbed forests as they are exposed to recurrent fire, logging, hunting, and exploitation of forest products by local populations (Tabarelli *et al*. 2004). Depending on the socioeconomic context, human-modified landscapes can be hyper-dynamic in response to, for example, cycles of deforestation, concomitant with land abandonment resulting from agricultural fallow periods, suppression of secondary forest patches for crop/pasture lands, and shifting economic activities (*e.g.*, growing demands for biofuel and other commodities). Yet for many Atlantic Forest landscapes in

Brazil, there is convincing evidence that secondary forests following clearcutting are becoming increasingly younger.

In synthesis, human-modified landscapes are highly dynamic in terms of spatial configuration, composition, and between-landscape structural connectivity. They tend to be periodically disturbed and biologically isolated at regional scales in the absence of restrictive land-use regulations. Translating these land use trends to the context of the conservation value of such landscapes, it is reasonable to argue that human landscapes are unlikely to accumulate native species over time as local species loss is expected to exceed species gain. Instead, the original pool of disturbance-sensitive or forest-obligate species (many of which might be restricted range endemics) will progressively erode, while disturbance-adapted species (*e.g.*, edge species, generalists, matrix-tolerant, and gap-crossing species) persist or proliferate. The service provided by modified landscapes is thus primarily restricted to forest habitats for disturbance-adapted species, such as those inhabiting small fragments, edge-affected habitats, regenerating forests, and agroforestry patches (Tabarelli *et al.* 2008). But how about the old growth species, the pearl of tropical forest biodiversity?

OUR REAL TRUMP CARD

Along its evolutionary history, tropical biodiversity has managed to survive and diversify in response to past, global-scale landscape changes. It is now, for the first time, challenged to persist totally immersed within a 'human aquarium'. With few exceptions, human encroachment of natural landscapes across the tropics is violating all basic requirements for long-term biodiversity persistence (at least for the old growth species), such as the safeguarding of large blocks of core primary forests, maintenance of landscape structural and biological connectivity, and sustainable harvesting of forest products (see Gardner *et al.* 2009, Sodhi *et al.* 2010). Instead of relying on perhaps illusory biodiversity resilience and weak land-use regulations, we should increment the conservation value of human-modified landscapes via: (1) strict pre-deforestation land-use regulations to guarantee landscape configurations that are more biodiversity-friendly; (2) controlled access to forest products regardless of whether they are explored commercially or for subsistence; and (3) permanent supervision of economic activities to avoid excessive turnover of land-use regime and the resulting episodes of species extinction every time landscapes are spatially reconfigured.

I am consciously arguing for intensive and permanent management of human-modified landscapes before and after any wave of human disturbance, focused on the requirements for biodiversity persistence. Landscape-level management includes substantial and urgent investments in habitat restoration via assisted forest regeneration to rapidly reduce the immense extinction debts already credited to hyper-fragmented and degraded tropical biotas, *i.e.*, the predominant 'human aquarium' in many tropical regions.

I shall admit, however, that such pre-requisites may be difficult to implement across most of the tropics, as they represent a radical and ambitious shift from freely exploited landscapes to strictly managed ones. In the short term, unfortunately, the urgency for poverty alleviation and economic development eclipses the appeal for a more sustainable use of biodiversity and management of ecological services. Clearly, the imposition of multi-target regulations and weak or inappropriate conservation guidelines to attend to livelihood needs conflict with the requirements for the long-term persistence of native species. Assuming that a significant fraction of tropical forest biodiversity is sensitive to human disturbances, it is realistic to expect that the predicted massive extinctions will sooner or later become reality as human populations expand, agricultural frontiers become consolidated, and disturbance-driven effects accumulate over time. Our real trump card thus depends on the implementation of strictly managed landscapes along with a substantial increment in the coverage of protected areas. Otherwise, we are condemning future human populations to live in biologically impoverished and fragile environments with limited opportunities for life support.

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