DISCUSSION

The pervasive poleward population swells documented herein among North American bird species have several important implications for conservation. First, as can be appreciated in Fig. 1, population shifts will likely be *followed by* distributional shifts. This situation will have myriad implications for conservation efforts: presently well-situated reserves may no longer contain populations of the species that they were designed to protect, and discords among appropriate climate conditions and appropriate land cover types may arise (Peters and Darling 1985; Lovejoy and Hannah 2005). As such, we suggest serious reconsideration of the configuration of both current and planned protected natural areas to take into account ongoing climate change and the likely future configuration of distributional areas (Papeş 2006; Hannah *et al.* 2007)—clearly, this recommendation has serious implications, but the frequency with which we have observed species' numbers shifting northward strongly suggests dramatic range shifts in years to come.

More subtly, these results indicate the need for caution in interpreting estimates of overall trends in species' numbers, which has become a popular means of summarizing results of long-term monitoring data sets (Robbins *et al.* 1989; Butcher and Niven 2007; Butcher *et al.* 2007). Certainly, given our results, an overall 'species trend' would oversimplify the population processes that may differ in different sectors of species' distributions. Of particular note are species that are shifting in the northernmost tier of Breeding Bird Survey routes may *appear to be* in decline, when they are simply shifting out of the survey region populationwise—recent high-profile press releases and proposals for priority conservation status (Hamel 2000; Hunter *et al.* 2001) should be reconsidered in this light. In general, though, this study serves to indicate that the poleward, upward, and earlier shifts that have been documented in recent years (Parmesan 1996; Visser *et al.* 1998; Parmesan *et al.* 1999; Inouye *et al.* 2000; Crozier 2003; Parmesan and Yohe 2003; Nakazawa *et al.* 2007) are but the tip of the (melting?) iceberg. That is to say, we readily publish on the observed distributional or phenological shifts, and perhaps do not publish so readily on negative evidence (Peterson 2003; Archaux 2004). Nonetheless, among the large majority of species not as yet showing distributional responses to warming climates, based on the results of this study, many more are undergoing population shifts probably based on differential fitness across latitudinal gradients that will eventually manifest as real distributional shifts.

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Protecting the future: Carbon, forests, protected areas and local livelihoods

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Abstract. The current proposals on reducing emissions from deforestation and forest degradation in developing countries being discussed under the UN Framework Convention on Climate Change (UNFCCC) could have significant implications for biodiversity conservation and for forest-dependent livelihoods. In the post-2012 period, developing countries could receive financial benefits in return for decreasing their greenhouse gas emissions from deforestation and forest degradation (REDD).

Protected areas can act as a case study for REDD: lessons can be learnt from their success or otherwise in reducing deforestation and supporting local livelihoods. Depending upon the exact mechanisms decided between and within countries, protected areas could have a role to play in reducing national-scale deforestation, through strengthening existing forest protected areas and/or declaring new areas. Overall, protected areas are effective at limiting deforestation, but there are exceptions. Their track record in supporting livelihoods is more variable. The early indications are that community-managed and indigenous reserves are often effective in achieving both goals, but that biodiversity conservation is not necessarily such a high priority within these areas. Further research into the most effective management and governance frameworks for achieving goals on carbon emissions, biodiversity and communities, and the extent to which protected areas reduce (or merely displace) deforestation within national boundaries would be useful in informing REDD implementation.

BACKGROUND

Reducing emissions from deforestation and forest degradation (REDD) in developing countries was first raised at a UN Framework Convention on Climate Change (UNFCCC) meeting in 2005. The UNFCCC aims to *stabilize greenhouse gas concentrations* in the atmosphere at a level that prevents dangerous interference with the climate system. Decisions made under UNFCCC can therefore be expected to focus on stabilizing emissions of carbon dioxide and other greenhouse gases, and not to make explicit provision for maximizing any other benefits of reduced deforestation and forest degradation. The prospect that forest issues could be tackled through the Convention has been welcomed by many conservationists, but also sparked an increasing amount of controversy, especially amongst forest user groups. Whilst there are some risks both for conservation, and for the livelihoods of people dependent on forests or forest conversion, participatory planning and monitoring of the effects of REDD activities on these co-benefits could help to minimise the risks.

A UNFCCC decision on compensation to developing countries for REDD is only likely to arise as part of an overall post-2012 agreement on greenhouse gas emissions. Major issues yet to be decided include whether the international agreement involves a forest carbon market or fund, and to what extent broader forest conservation efforts and carbon stocks in non-forest ecosystems would be accounted for. At the December 2007 Conference of Parties in Bali, Parties to the Convention agreed a 'demonstration' phase to test REDD methodologies and share experiences. Various donors, tropical forest countries, non-governmental organisations and private sector players are now investing in this pilot phase.

Whilst REDD is likely to involve national-scale policy changes and planning, forest management changes will have to be implemented at a site scale. Although protected areas are by definition (IUCN 1994) established for biodiversity conservation rather than climate mitigation purposes, they can offer existing experience in the effectiveness of different approaches to reducing deforestation and supporting co-benefits. Protected area experience could thus help to inform REDD decision-making at local to national scales.

HOW SUCCESSFUL ARE PROTECTED AREAS AT REDUCING DEFORESTATION?

Successful implementation of REDD is likely to require the reduction of deforestation rates on a national scale. It is therefore useful to know the effects of forest designation and management on deforestation rates, and to consider the design and management-related factors that influence protected area effectiveness in reducing deforestation and forest degradation. Here, we focus on deforestation, as there is little research on the impacts of protected areas on the degradation of forest carbon stocks.

The evidence suggests that protected areas are an effective tool for reducing deforestation within their boundaries. That is, there is usually less deforestation within formally protected areas than in their immediate surroundings (Sánchez-Azofeifa *et al.* 1999, 2003; Pelkey *et al.* 2000; Bruner *et al.* 2001; Deininger & Minten 2002; Helmer 2004; Curran *et al.* 2004; DeFries *et al.* 2005; Mas 2005; Naughton-Treves *et al.* 2005, 2006; Sommerville 2005; Bleher *et al.* 2006; Nepstad *et al.* 2006; Chowdhury 2006; Gaveau *et al.* 2007; Oliveira *et al.* 2007; Phua *et al.* 2008). A minority of studies have reported that protection status had no significant impact on deforestation, indicating that legal designation alone is insufficient when land-use change pressures are high and governance limited (Marizán 1994; Cropper *et al.* 2001; Rautner *et al.* 2005; Roman-Cuesta & Martinez-Vilalta 2006). In addition, the extent to which deforestation is merely displaced to surrounding areas is unclear. This issue is particularly relevant in the context of REDD, where the aim is to reduce total greenhouse gas emissions.

Whilst protected areas tend to reduce the rate of deforestation *relative to their surroundings*, forest may still be cleared at high rates. In an extreme example, Gunung Raya Wildlife Sanctuary in Sumatra lost nearly 81% of its forest cover between 1972 and 2002, with a deforestation rate only

0.1% less than that of the surrounding area (Gaveau *et al.* 2007). Annual deforestation rates in excess of 3-6 percent have been reported within protected area borders (Achard *et al.* 2002; Linkie *et al.* 2004). Such vulnerable protected areas could offer useful test sites for reducing deforestation within the REDD demonstration phase, as the necessary land designations and legislative frameworks are already in place, and the biodiversity co-benefits are already identified.

This raises the question of what factors influence protected area effectiveness in reducing deforestation, assuming an equal degree of pressure. Effectiveness in reducing deforestation is commonly linked to the level of funding (Jepson *et al*. 2002; Wilkie *et al*. 2001; Aung 2007). Without adequate funding, protected areas lack the necessary infrastructure and management resulting in "paper parks". Dudley *et al*. (2004) suggest that legal gazettement does immediately confer some protective effect, but that active management (including planning, monitoring and evaluation) improves this. Strong involvement of NGOs can be a significant factor in protected area success, probably as a result of their contribution to management practices and employee accountability (Sommerville 2005). Staff education, training, and salaries are all often listed as weaknesses in protected area management that limit effectiveness (Aung 2007).

The World Conservation Union (IUCN) describes six management categories for protected areas, based on the reasons for establishment. In general, protected areas with a higher IUCN category (I-II) are more (and sometimes completely) restrictive of resource exploitation and land use change than the lower categories (V-VI). Protected areas designated under categories (I-II) seem to be more effective at reducing deforestation than those which include a focus on sustainable use (V-VI) (Jones 1990; Sánchez-Azofeifa 1999; Pelkey *et al.* 2000; Dudley *et al*. 2004; Naughton-Treves *et al*. 2005; Bleher *et al*. 2006; Nepstad *et al*. 2006). However, there are comparatively few studies on deforestation rates within category V-VI protected areas, so further investigation would be useful.

These comparative studies typically make use of remote sensing to assess deforestation levels, and rarely consider the forms of governance within the protected areas, or the level of community involvement. Protected area management and governance regimes can differ both within and between IUCN categories (Naughton-Treves *et al.* 2006). The land and resources in any of the six management categories can be owned and/or directly managed, alone or in combination, by government agencies, NGOs, communities and private parties (Borrini-Feyerabend 2007). At one end of the governance spectrum, the state has ownership of the area and may involve the surrounding communities in some decision-making through representation in stakeholder groups; at the other end, protected areas are owned and run by the communities themselves. Some insight can be gained through studies of indigenous lands and community forestry areas, which indicate success in reducing deforestation (Bray *et al*. 2003, 2004; Ruiz Perez *et al*. 2005; Hayes 2006; Murdiyarso & Skutsch 2006; Nepstad *et al*. 2006; Stocks *et al*. 2007). These factors need further investigation if the potential for REDD to provide carbon, biodiversity and livelihood benefits is to be assessed.

Land tenure and land use rights differ across protected areas, as do the number of people living in and around the area. Thousands of people, indigenous or otherwise, may live within individual protected areas. These protected areas vary in their governance and in the level of community involvement. From a conservation perspective, the rationale for community involvement is that denying locals access to protected area resources or decision-making leads to tension between protected area officials (where present) and residents (Hayes 2006). When government agencies allocate land for certain purposes without consulting local residents, they may simply ignore the restrictions (Werner 2001), or violent conflict may erupt (Naughton-Treves *et al*. 2006). There are various effective approaches to involving local people, ranging from compensation for costs incurred (Bruner *et al*. 2001) to full co-management (Brown 1999). Environmental education can help communities to understand the benefits of protected areas and increase local support for their protection. This type of outreach has been found to correlate strongly with management effectiveness (Dudley *et al.* 2004), though not in all cases (Struhsaker *et al*. 2005). The strength of public support has also been correlated with overall conservation success (Mugisha & Jacobson 2004; Struhsaker *et al*. 2005), although again, not in all cases (Bruner *et al*. 2001).

A protected area network that incorporates all levels of protection, as appropriate for the situation at site level, could be a valuable component of a national REDD strategy. Unless a country's protected area network includes a high proportion of remaining forest, it can form only part of a successful REDD strategy, as the local reduction in carbon emissions resulting from the success of a protected area may be offset by an increase in deforestation outside of the area (Ewers & Rodrigues 2008).

WHAT ARE THE LIVELIHOOD IMPACTS OF FOREST PROTECTED AREAS ?

The majority of the rural poor make use of forest resources: in Africa alone, 600 million people have been estimated to rely on forests and woodlands for their livelihoods (Anderson *et al*. 2006). The benefits of protected areas for local communities can include direct revenue from environmental protection, livelihood diversification, security of access to given resources, and the maintenance of ecosystem services such as watershed protection. Costs can range from significant crop damage by wildlife (e.g. Bajracharya *et al*. 2006) to displacement of local communities from their customary lands (West *et al*. 2006), and may include restricted access to resources and disadvantageous changes in land tenure. The nature of these costs and benefits depends largely upon the protected area's status and governance, as well as its history of use. Some protected areas restrict access to resources, whereas others allow sustainable use; and land tenure arrangements and benefit sharing vary across the six IUCN management categories.

The *net* livelihood impacts of protected areas are not easy to summarise, as standardised assessment methodologies are lacking, and because it is difficult to place a monetary value on some aspects. However, general patterns can be identified from the literature. Livelihood impacts vary with protected area status, management strategies and community involvement in governance. Management structures can provide direct benefits, for example through employment, but can restrict access to resources, alter local power structures, and change social/traditional values and behaviours. Strictly protected areas with top-down management structures (often associated with IUCN management categories I-II) can result in major livelihood costs, generating conflict with local communities. Community management schemes, and protected area management allowing sustainable use of forest resources (often associated with IUCN management categories V-VI), have been shown to provide tangible livelihoods benefits. However, significant costs can still be incurred by communities if management and institutional capacity is lacking or if issues of governance, particularly benefit sharing and tenure, are not resolved.

Attitudinal surveys are sometimes used to measure local perception of protected areas. Even with high costs, communities can support protected areas, citing the forest use benefits that they receive (Sekhar 1998). Positive or negative attitudes are sometimes correlated with measurable costs and benefits (Allendorf *et al*. 2006), but communities may undervalue protected areas, as many of the benefits of protected areas (such as forest products and ecosystem services) are future use values, and may not be perceived to be under threat by the community. Wealth, ethnicity, age, gender and occupation have all been shown to be important in predicting attitudes, often as a result of differential impacts on livelihoods (Infield 1988; Infield and Namara 2001; McClanahan *et al*. 2005; Allendorf *et al*. 2006; Kideghesho *et al.* 2007). The impact of protected area designation on an individual is likely to depend on his or her use of the forest, tenure rights and political power within the community. Those with high dependency on the forest, few land-tenure rights and little political influence will be most at risk from protected area designation, which in turn is likely to influence their attitude towards conservation.

The inequitable distribution of livelihood costs and benefits between and within communities and households is thus an obvious barrier to sustainable reduction of deforestation as well as a direct issue for human development. Although richer members of forest communities are often the biggest harvesters of forest products, the poor can be more dependent on these resources, relying on the collection of forest products as a safety net during times of low-employment and food production (Ferraro 2002). Forest restrictions can therefore have large impacts on the poorest sections of forest communities. Resource restrictions may also differentially affect the livelihoods of men and women: such as allowing collection of non-timber forest products and firewood, but banning hunting (e.g. Sekhar 1998; Allendorf *et al.* 2006). Overall, however, the more prominent members of society tend to capture most of the benefits from protected areas whilst suffering less of the costs. This is often true regardless of the protected area status or the level of community involvement in governance.

In contrast with the norm of government planning, some protected areas are designated in response to the desire of local communities to safeguard local resources (De Lacy 1994; Catton 1997; Naughton-Treves 1998; Chapin 2000; Colchester 2000; Lawrence 2000; Schwartzmann & Zimmerman 2005; Sohn 2007). Whilst the direct benefits depend upon protected area management strategy, designation is likely to be more favourable to local livelihoods than the transfer of land ownership to external companies. For example, when the Peruvian government declared that the Madre de Dios region of the Amazon was to be opened up to oil and gas exploration, locals and conservation groups objected to the plans (Chicchón 2000). The outcome included the designation of the Bahuaja Sonene National Park in 1996, and an agreement that the exploration activities in adjacent regions would return any land not desired for extraction programmes for inclusion in the protected area.

Increased efforts are required into the standardization of methodologies for social impact assessment, to facilitate further assessment of the costs and benefits of protected areas to local livelihoods. Further study into the combined effects of protection status and governance on the costs and benefits of forest protection would also be a valuable input into the development of REDD strategies.

LESSONS FOR REDD

There is still much uncertainty regarding the factors influencing effectiveness of protected areas in reducing deforestation and impacts on local livelihoods, and a clear need for a detailed assessment of these factors in order to inform climate change policy. Although strictly protected areas are often effective in reducing deforestation, it is clear that protected areas allowing some resource extraction can still reduce deforestation whilst imposing fewer livelihood costs. The type and quantity of resources extracted will determine the effect on forest carbon stocks. Further research is required into the impact of the relationship between protected area status, community involvement and governance within protected areas on forest carbon stores and livelihoods.

An agreement on REDD could create an international market or fund for avoided emissions of greenhouse gases from forest

loss or damage. The impact on protected areas and livelihoods will depend upon the national as well as global approaches selected. The potential exists for REDD to remove the large scale drivers of deforestation, secure land tenure rights in forest areas, and increase the potential benefits to local people from conservation through community management regimes. The carbon market offers increasing opportunities for payments for restoration and retention of forest carbon. However, existing forest carbon schemes share many of the issues seen in protected area management, including lack of established tenure and the inequitable distribution of resources (May *et al.* 2004; Nelson and de Jong 2003; Griffiths 2007). The transaction costs of projects tend to favour large operators at the expense of small landholders (Pfaff *et al*. 2007). Clear governance, including well-defined property rights, is critical for emerging international markets (Landell-Mills and Porris 2002), and these issues need careful consideration as REDD policy develops. Currently, carbon forestry projects are particularly weighted against those whose livelihoods are dependent upon less formal rights to forest resources, such as poor or landless households and women (Brown *et al*. 2004; Grieg-Gran *et al*. 2005); leading to the capture of most of the benefits by elite groups (Brown & Corbera 2003; Brown *et al*. 2004). Increased finance could exacerbate these issues, and protection of carbon areas could intensify livelihood impacts if a strict 'fences and fines' approach was employed. Where strict protection is implemented, local people need to be involved in management and compensated for losses if they are expected to cooperate with the goal of reducing emissions.

If livelihoods issues are treated with care, avoided deforestation and other carbon storage schemes could provide much needed funds for conservation and development. Addressing the root causes of deforestation is likely to require improved governance of forest areas rather than heavy restrictions on the activities of local communities (Chomitz 2006). Consideration of the potential impacts of REDD approaches based on past experience is therefore required, including an assessment of the management and governance strategies that facilitate provision of livelihood benefits. REDD implementation could provide the incentive for governments to strengthen policies for forest protection and settle tenure issues. An increase in the economic value of standing forests could also have positive impacts on the livelihood benefits of protected areas. Involvement of local communities in planning and implementation of REDD, and ensuring sharing of the benefits from REDD finance is likely to result in a more sustainable solution to deforestation and forest degradation.

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