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Can payments for ecosystem services protect Southeast Asian birds?

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Southeast Asia is a hotspot of threatened biodiversity: 17% of bird species are endemic to the region, but the region suffers the highest intensities of logging and rates of forest conversion to agriculture on Earth. Against this background of severe habitat degradation, conservationists must seek novel solutions to protect remaining biodiversity. One of the most important potential sources for funding of forest protection is 'Payments for Ecosystem Services (PES)' schemes. Grouped under the PES umbrella are an array of services, including carbon storage under REDD+ (Reducing Emissions from Deforestation and Forest Degradation 'plus'), water provision and ecotourism. The key question is whether such PES can compete with destructive activities and protect the remaining forest of Southeast Asia?

We focus on Sabah, Borneo, where we have used logging records from 300 000 ha of forest to calculate the Net Present Value (NPV) of timber within a primary rainforest. Unlogged (primary) rainforests have undisputed value for bird biodiversity, making them a critical component of conservation strategies in the region. Much land might also be suitable for oil palm and so we also calculate the NPV of land under a primary forest timber + oil palm conversion scenario. We find that the NPV of primary forest timber is $12 750 per hectare and that under the timber + oil palm scenario is $24 000 (Figure 1). Against this backdrop of very high NPVs, we ask whether PES schemes are likely to protect biodiversity. We find that such schemes would need a carbon price of $28 per tonne of CO_2 for timber and a price of $47 per tonne of CO_2 for timber + oil palm. The addition of payments for other ecosystem services (water, biodiversity, ecotourism) could raise $2700 per hectare across a 30-year period, which would reduce the price per tonne of CO_2 by $6. Consequently, the high costs of offsetting lucrative logging and oil palm activities means that PES schemes, including REDD+, are unlikely to protect the last remaining tracts of threatened primary forests and the vital biodiversity that they contain.

We thus turn our attention to the potential of logged forests to conserve significant areas of rainforest in Southeast Asia. The provision of timber represents an ecosystem service: whilst timber extraction is destructive, the selective-logging techniques used yield significant timber whilst the degraded forest that remains afterwards can regenerate to provide further timber yields. But how do the financial gains to logging compare with the impact of logging on biodiversity? We use our logging records to understand the NPV of timber across two rotations of logging and then to compare this value with the biological value of logged forests. The NPV of timber in logged forests drops by 80% across two rotations to $2000 per hectare of wood remaining on a twice-logged forest. However, biodiversity value remains very high. Bird species richness is maintained, while most IUCN red-listed species and primary forest species survive, albeit sometimes in reduced abundances. In the case

of primary forest species, there is a 20% reduction across the two logging rotations. The non-linear relationship between the timber value of a twice-logged forest (just 20% of a primary forest) versus the biological value of a twice-logged forest (fully 80% of the primary forest value) represents a big opportunity for conservation (Figure 2). Crude estimates would put the opportunity cost of protecting 1 ha of primary forest as being the same as conserving 5 ha of twice-logged forest. These results suggest that it is vital for conservation non-governmental organizations to incorporate costs into their decision-making frameworks, and that if they do so, then there will be a clear benefit to protecting large areas of twice-logged forest, including expanding protected networks, improved connectivity in the landscape and buffering of existing reserve edges.

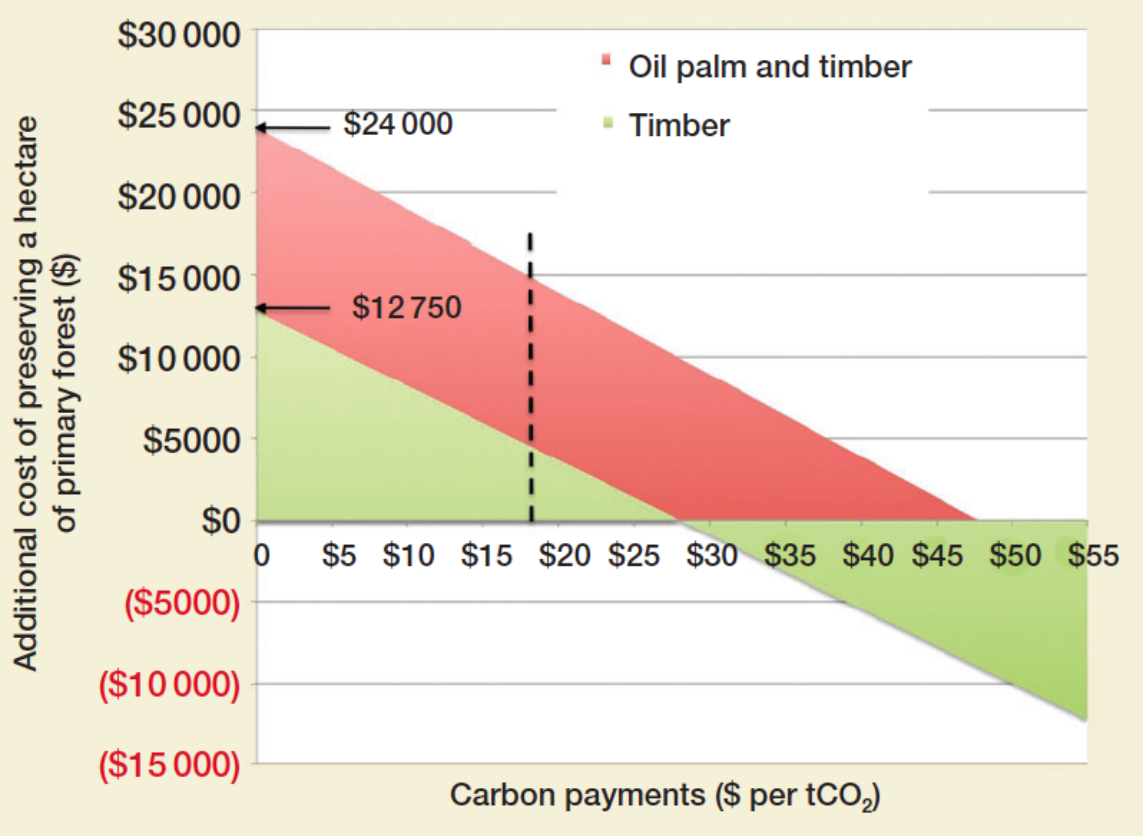

Figure 1. The additional cost of preserving 1 ha of primary dipterocarp rainforest at a given carbon price. Forests that have high timber stocks but are unsuitable for conversion to oil-palm plantations after logging (green) carry an opportunity cost of conservation around $12 750 per hectare in the absence of carbon payments. When carbon payments reach $28 per tonne of CO_2, conservation becomes cost effective relative to logging. At carbon prices greater than $28 per tonne CO_2, conservation becomes a revenue generator in areas not fit for oil palm. Areas where primary forests can be converted to oil-palm plantations carry an opportunity cost of $24 000 per hectare in the absence of a carbon market, and conservation does not become cost effective until payments reach $48 per tonne CO_2. The dashed vertical line shows the 2009 European Union Emissions Trading Scheme (EU ETS) price for carbon ($17.40 per tonne CO_2).

There are changes to the bird community after logging, and therefore it is vital to ascertain how functional traits differ between logged lands, primary forests and the oil palm that threatens to replace them. We used the Functional Diversity (FD) metric, which incorporates an array of functional traits. In this instance, we use traits that impact upon resource use: feeding guilds, behavioural foraging strategies and morphological adaptations. FD yields a single continuous measure that directly relates to the provision of ecosystem functions by the bird community. We found that FD remains at primary forest levels within logged forests, but that conversion to oil palm results in a dramatic loss of FD. Behavioural and morphological traits appear to be driving this relationship. Not only is FD similar between logged and primary forest, but it appears that the traits provided are very similar between the bird communities. In contrast, many traits are lost and others gained after the conversion of logged forest to oil palm.

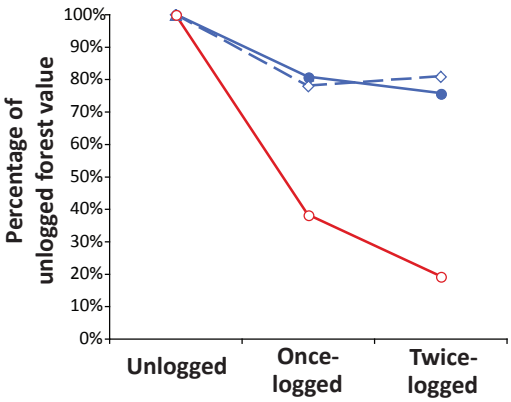

Figure 2. Percentage changes in number of species from unlogged (primary) forests and standing timber values across unlogged, once- and twice-logged forests. Values from unlogged (primary) forests are taken as the baseline, i.e. 100%. Solid red line = timber value, solid blue line = birds point counts, dashed blue line = birds mist-nets.

Whilst logging is harmful, logged forests nevertheless retain very high biological value and a fully functioning community. The protection of logged rainforests in Southeast Asia is thus vital for bird conservation. Pivotally, these lands have lost the majority of their standing timber value, making them potentially 'cheaper' to protect than a primary forest. How can this be achieved? First, logged forests retain substantial carbon stores and could thus receive REDD+ funds for avoided deforestation. Second, because they have lost carbon via the removal of trees and residual damage, carbon enhancements via forest restoration techniques (such as liana cutting, planting of native timber tree saplings) can be used to enhance the rate of carbon sequestration onto the logged landscape. This can also receive funding under REDD+. Third, by using Reduced-impact Logging (RIL) techniques, such as directional felling, comprehensive harvest plans, and restrictions on the number of roads and logging dumps, the future commercial value (and sustainability) of logging concessions can be enhanced. This can help to reduce the comparative value of converting logged forest to oil palm, rather than the retention of logged forests for future timber harvests. The aggressive silvicultural techniques used in forest restoration do not further harm bird communities compared with naturally regenerating logged forests, whilst there are no additional benefits to RIL for birds. The high value of a naturally regenerating logged forest is thus retained under both of these techniques.

In conclusion, retaining logged forests, via payments received from logging activities and from subsequent REDD+-related projects will protects the vast majority of bird species in Southeast Asia. Logged forests thus represent a key way of financing the protection of large landscape areas of forest to supplement the protection of birds within unlogged forest preserves.