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The Orangutan–Oil Palm Conflict:

Economic Constraints and Opportunities for Conservation

ABSTRACT

The future of the orangutan (*Pongo* spp.) is far from secure despite the species' high profile and media attention. The traditional threat to the orangutan has been widespread logging, but the continuing conversion of remaining habitat for oil palm (*Elaeis guineensis*) cultivation is hastening its extinction in the wild. This situation is driven by a robust global market for palm oil as a vegetable oil and biofuel. In tackling this conservation problem, therefore, economic factors cannot be overlooked. This article analyses these factors and how they curtail effective orangutan conservation. Of significance are the high opportunity costs of orangutan conservation and market failures associated with the public-goods nature of the orangutan's forest habitat. Conservationists should consider these constraints when formulating remedial action. This article assesses strategies that reduce the opportunity cost of conserving habitat (via supply-side approaches that divert oil palm cultivation away from forests) and enhance the realisable value of orangutan habitat (by capitalising on the demand for non-market values such as carbon storage). It is concluded that the former group of strategies are likely to have limited effect on curtailing deforestation, but with the right institutional policies in place they can act as stopgaps while strategies involving carbon financing and payments for biodiversity develop sufficiently to render habitat retention financially competitive.

Keywords Conservation; oil palm; opportunity cost; orangutan; public goods

The Orangutan–Oil Palm Conflict:

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1. Introduction

Most wildlife is vulnerable to agricultural development because expanding croplands replace natural habitat. A prominent case involves the highly threatened orangutan (*Pongo* spp.) of Indonesia and Malaysia (Wich et al. 2008). Industrial logging has usually received most attention as endangering the species, but deforestation as a consequence of expanding oil palm (*Elaeis guineensis*) cultivation is now seen as the larger threat to the species' persistence (Nelleman et al. 2007; Wich et al. 2008). The orangutan directly competes for limited lowland terrain with the production of palm oil, one of the most lucrative cash crops of recent times.

The extract of the oil palm fruit is the world's most-consumed vegetable oil and constitutes almost 60% of all trade in oils and fats by volume (Carter et al. 2007). Palm oil is used in making an array of food, personal care and other consumer products. A large share of global demand derives from China and India, where it is mostly used as cooking oil. It is finding increasing application in Europe as a feedstock for producing biodiesel in response to the need to mitigate climate change.

Heightened demand and prices for palm oil and its lagging supply point to continued growth in production and cropland area in the near future (Clay 2004; Basiron 2007). Indonesia and Malaysia produced 18.3 million and 17.4 million tonnes of palm oil respectively in 2007/2008 and account for 87% of global output (FAS 2008). Production is centred in these countries because they are the most cost-efficient for setting up and running oil palm plantations: wages and production costs are low and ideal agro-climatic factors deliver high per-hectare yields (Clay 2004; Basiron 2007).

Between 1990 and 2007, the area planted with oil palm in Indonesia and Malaysia more than trebled from 24,200 km^2 to 83,700 km^2 (FAO 2008) — an annual average increase of around 3,500 km^2. A forecast for the period 2008-2012 suggests a doubling in the expansion rate to about 7,210 km^2 per year (1,620 km^2 for Malaysia, 5,590 km^2 for Indonesia) (see Carter et al. 2007, p. 314). As land in established production zones in Peninsular Malaysia and North Sumatra has become scarce, oil palm cropland is expanding across Sumatra but especially Borneo where land is still plentiful in Indonesia's Kalimantan provinces and, to a lesser degree, in the Malaysian states of Sabah and Sarawak (Clay 2004; Carter et al. 2007, p. 312; FAS 2007).

During 1990-2006, it is estimated that at least 55% of the oil palm expansion in these countries came at the expense of natural forests (Koh and Wilcove 2008). The remainder was obtained from the conversion of pre-existing croplands such as rubber and cocoa plantations. However, as convertible pre-existing croplands become limited or expensive, or as fresh land frontiers are reached, larger proportions of oil palm expansion will involve the levelling of forests.

The orangutan is a charismatic, arboreal primate that virtually depends on the lowland rainforests and peat forests of Borneo and Sumatra — lands often claimed for establishing oil palm plantations. The loss of orangutan habitat as a result of the spread of oil palm territory can be dramatic. Ancrenaz et al. (2007a) report that the area planted with oil palm on Borneo increased by 25,000 km^2 between 1984 and 2003 (1315 km^2/year on average), and that many of the converted areas used to be prime orangutan habitat, e.g., the eastern lowlands of Sabah and the plains of central Kalimantan. In comparison, the overall rate for orangutan habitat loss in Borneo is estimated to have been 3,122 km^2/year between 1990 and 2004 (Meijaard and Wich 2007). If half of the anticipated oil palm expansion expected for Malaysia and Indonesia between 2008 and 2012 occurs in Borneo (3,605 km^2/year), a minimum of between 496 and 901 km^2 of orangutan habitat could be lost to oil palm annually[1].

Where commodity markets dictate land use, such as in the case of palm oil, it is in the interest of conservation to counteract economic factors that may bias against habitat retention. This paper examines two key economic factors that disadvantage the conservation of the Bornean orangutan vis-à-vis oil-palm agriculture, and the strategies for mitigating these. Borneo is the focus of this paper in view of the fact that it is simultaneously a major oil palm expansion frontier and home to a sizeable number of orangutan populations and a significant remainder of Southeast Asia's biodiversity.

We consider first the opportunity cost of conserving the orangutan when oil palm agriculture is the next best land use. We demonstrate that the opportunity cost is high given the large home range requirement of the orangutan and the value of palm oil. The second conservation problem examined is the public-good nature of the value of the orangutan and its forest habitat. Given that the use value of the orangutan is relatively low and its main economic value appears to be its non-use value, local communities and nations having orangutan populations appropriate little economic gain from conserving these. Strategies assessed that can support orangutan conservation are those that reduce opportunity costs (by intensifying agriculture and making use of non-forested lands for oil palm plantation) and policies that increase the realisable value of orangutan habitat (e.g., by making biodiversity and carbon values pay). We conclude by discussing the prospects that these strategies will achieve effective orangutan conservation.

2. How opportunity costs and market failure disadvantage orangutan conservation

Orangutan conservation and oil palm cultivation are conflicting land uses: the orangutan requires forest cover, oil palm cleared land; one excludes the other. Foregoing land that is suitable for oil palm cultivation to conserve a viable orangutan population involves giving up a certain income opportunity. The magnitude of this financial “opportunity cost” of conservation is a function of the size of the cultivatable area renounced, the palm oil yield, and the profitability of palm oil sales (which essentially depends on the market price of palm oil and production costs).

To sustaining a minimum viable population of 250 orangutans (Singleton et al. 2004) would require at least 250 km^2 of suitable forest if a carrying capacity of 1 orangutans/km^2 is assumed[2]. The 17 key orangutan populations in Borneo each consist of 1,000 to 7,000 individuals, and these populations are found in a mix of lowland dipterocarp and peat swamp forests that range between 1,000 and 6,500 km^2 in size (Wich et al. 2008). In Kalimantan, oil palm concessions of 1,000 km^2 to 2,000 km^2 are normally granted (AFP 2008a). Setting up plantations across this area can displace entire orangutan populations if habitat and concessions overlap.

The value of the forgone income opportunity increases with the rising profitability of producing palm oil. The current palm-oil boom has seen average crude palm oil prices jump in real terms by 2½ times from US$417/tonne in 2006 to US$1041/tonne in 2008 (up till August) (IMF 2008). While market prices have spiralled, production costs have remained relatively low and slow-rising. This increased profit margin generally quickens the pace of cropland expansion.

For the typical Malaysian palm oil plantation, the net (pre-tax) profit per hectare could average between US$528 and US$790 annually[3]. An oil palm company in giving up the opportunity to establish an average 1000-hectare plantation on suitable land thus forgoes an annual profit of at least half a million dollars. If the land concerned is prime orangutan habitat, then this value is reflective of the private opportunity cost of conserving an orangutan habitat when oil palm agriculture is a viable alternative use of that land. To outbid this expansion, orangutan conservation must be able to generate commensurate benefits.

The associated high rates of return to oil palm production are a draw for private sector investment. Governments too are supportive of the oil palm subsector since it contributes to public coffers and rural employment. In 2007 alone, Malaysia and Indonesia raked in US$14 billion and US$5.5 billion respectively in palm oil export revenue (AFP 2008b; Wright 2008). Governments, whether local, state or national, benefit by appropriating a part of palm oil profits by taxing producers (land, windfall and export taxes, palm oil cesses etc.). The industry also directly and indirectly employs around a million workers in each of these countries (Damodaran 2007; Barlow et al., 2003 p. 9)[4]. Governments have facilitated the growth of the industry by setting up research institutes and fostering smallholder schemes such as FELDA in Malaysia (Basiron 2007) and by implementing positive regulations such as permitting the conversion of production forests into oil palm plantations in Indonesia (Casson 1999).

Orangutan conservation has not received this scale of investment or support from the private and public sectors, least of all on economic grounds, because it is a comparatively poor paymaster and employer. The orangutan in itself has little direct use value, apart from tourism. Tourists visiting Borneo see the orangutan mainly as a consequence of *ex-situ* conservation measures, in orangutan rehabilitation centres such as Sepilok in Sabah and Camp Leakey in Kalimantan. Some have argued that this form of tourism is not the outcome of orangutan conservation but a by-product of its failure, noting detrimental economic activity as cause for these orangutans' displacement (Rijksen and Meijaard 1999, pp. 163-171). Tourism in the wild based on orangutans, on the other hand, is limited since the orangutan is cryptic and difficult to see in its dense forest setting. Neither are all of the important habitats accessible or attractive to tourists. However a community-based tourism venture in the village of Sukau, Sabah takes small numbers of tourists into nearby habitat for orangutan viewing (Ancrenaz et al. 2007b), though the success of spotting the animal is not always guaranteed. This venture generated a revenue of RM157,424 (≈ US$45,500) for the year 2003-2004, and 44% of this amount covered operating costs while the rest was ploughed into projects that benefited the villagers, such as boat and bus services and payments to village guides and shops that serviced the tourism venture (Red Ape Encounters 2008). There are of course, other direct use values of the orangutan, such as its hunting by indigenous people for food and its poaching for the illegal wildlife trade, but these have been shown to be inimical to the species' long term persistence (e.g. Rijksen and Meijaard 1999; Marshall et al. 2006).

The bulk of the benefit of orangutan conservation resides in its non-use and ecological values (Table 1). Non-use values are the satisfaction people derive from knowing that the species or its ecosystem exists (existence value) and from being able to bequeath these to future generations (bequest value). Ecological values are indirect use values that stem from the ecological functions these entities perform: the orangutan is a fruit eater that disperses seeds, contributing to forest health and vitality. Healthy forests in turn generate localised ecosystem services such as the provision of clean water and materials and global ones such as climate regulation through carbon sequestration and storage. Though these are valued by global stakeholders, local stakeholders in developing countries tend to place greater weight on the use benefits of land because tradable commodities such as palm oil earn them income. Most local stakeholders do not receive comparable returns from preserving orangutan habitat, notwithstanding investments by conservation donors in various localised conservation projects.

Table 1 The properties of the benefits obtained from palm oil production and orangutan conservation

	Land use option	
	Palm oil production	**Orangutan conservation**
1. Type of value	Direct, productive use (as a commodity)	Some direct use (tourism), but mostly indirect use (ecological) and non-use (psychic)
2. Characteristics of the benefits	Largely material/monetary (the palm oil and products made of it are tradable for cash) The utility gained from (or disutility experienced from the loss of) these benefits are clearly/immediately perceptible (e.g., the wealth effect as a result of cash gains from the sale of palm oil or the loss of that income opportunity) Short-term	Largely experiential/non-monetary (e.g., the 'existence' of the orangutan is experienced but not tradable — no market exists for this) The utility gained from (or disutility experienced from the loss of) these benefits is less clearly/less immediately perceptible (e.g., the climatic benefits of carbon sequestration) Long-term
3. The form of the benefits, its distribution and beneficiaries	Concentrated Accruing to specific groups of beneficiaries (such as consumers of palm oil products, oil palm plantation owners and workers), usually at the local or national scales	Diffuse Accruing to a broad group of beneficiaries without exclusion (e.g., the satisfaction from knowing the orangutan exists cannot be restricted), at regional or global scales

The non-use and ecological values embodied by the orangutan and its habitat have public-good characteristics that are not easily captured and translated into cash returns (Table 1). Essentially, these values have no markets in which they are traded for money because their supply cannot be withheld on the condition that payments are first made. No "investment" was made for the provision of orangutans and tropical forests (these are naturally-endowed capital), and so the benefits that flow from these are considered as given or free. As such, there is a tendency for those who demand these non-use and environmental benefits to free-ride, i.e, to enjoy the benefits without paying for them, and donor mechanisms are therefore unable to adequately secure in money terms the full value of conserving all necessary orangutan habitats. In short, then, the costs of retaining orangutan habitat are borne immoderately by a few, the locals, who could directly capture greater short-term benefits by eliminating habitat, while the benefits of habitat retention are enjoyed by many, including the well-off, at the regional or global scale, without them adequately compensating the cost-bearers (e.g., Balmford and Whitten 2003). This market failure results in the conservation of orangutans being undersupplied.

3. Measures that address the economic impediments to orangutan conservation and their effectiveness

The importance of palm oil as a commodity in both the developing and developed world and as a source of economic welfare in producer countries, such as Indonesia and Malaysia, cannot be denied, and demand for it is likely to strengthen as the global population and their per capita incomes increase. For orangutan conservation to remain a competitive land-use alternative, it must lower opportunity costs by accommodating oil palm expansion in a way that minimally impacts habitat, or deflect expansion by offsetting the opportunity costs with revenue orangutan conservation can raise on its own. Several strategies with the potential to fulfil these goals have been proposed in the literature (Fig. 1). Amongst these are supply-side measures encouraging palm oil planting on non-forested lands (e.g., idle, degraded lands or grasslands) and intensifying agriculture by increasing crop yield. Demand-side measures include sustainable forestry, developing markets for carbon storage and payments for biodiversity. Each is discussed in turn.

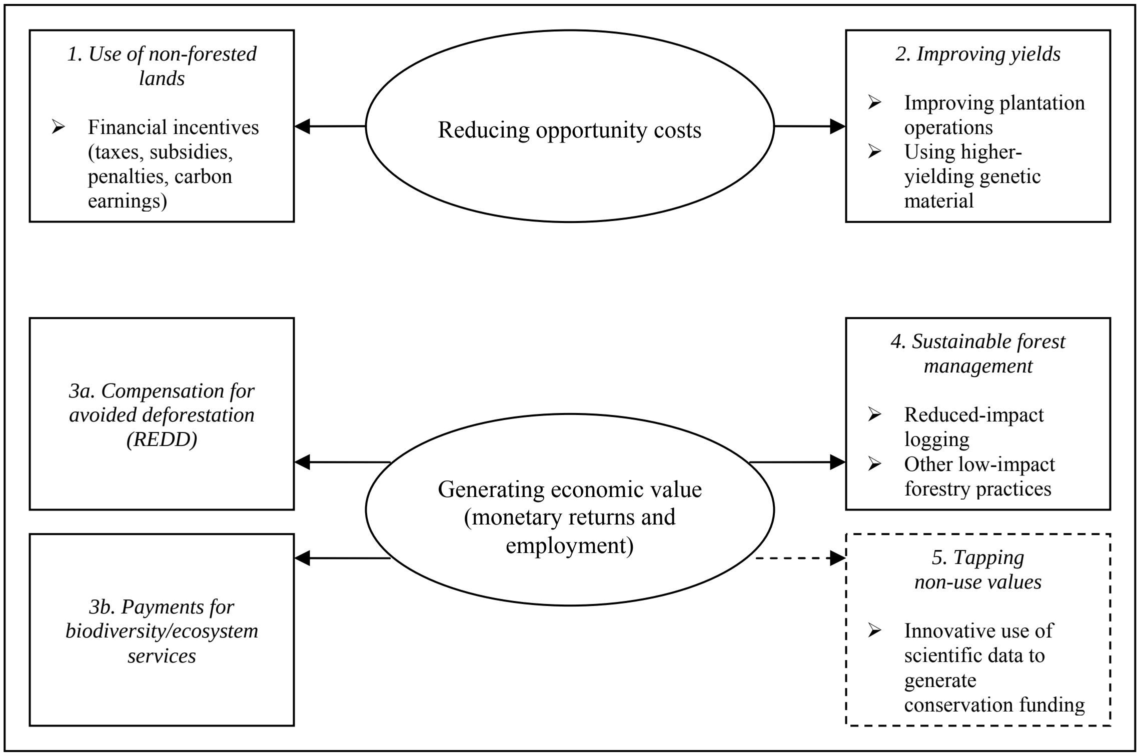

Fig. 1 Strategies for orangutan conservation and mechanisms for achieving them

3.1 Using non-forested lands for oil palm cultivation

To reduce pressure on forests, it has been suggested that non-forested lands such as *Imperata cylindrica* grasslands be used for cultivating oil palm. However a number of questions must first be answered, namely, how much of these are available, how suitable are they for oil palm cultivation, how effective are they in staving off habitat clearing, what hinders their use, and how can their use be motivated.

In the Asian tropics, *Imperata* grass occupies lands that have been deforested or affected by fires. Garrity et al. (1997) had put the extent of these grasslands in Indonesia at about 86,000 km^2, with 21,252 and 21,940 km^2 of this in Sumatra and Kalimantan respectively. The area of *Imperata* grasslands in Malaysia was reported as small, at no more than 2,000 km^2, and the largest contiguous block of this grassland was reported to be in northwest Sabah but much of this may now have been reforested with *Acacia mangium* for timber and pulp production.

Imperata lands may have soil fertility constraints (low phosphorus and nitrogen content), but by and large are suitable in terms of topography and climate for tree crops such as the oil palm (Santoso et al. 1997). Because the presence of the flammable *Imperata* grass can pose a fire risk as well as impede the growth of oil palms (Chikoye 2003), these lands must first be rehabilitated by weeding out the grass using herbicide or manual labour and fertilising the soil if necessary (Santoso et al. 1997, p. 198). The *Imperata* grass is shade-intolerant, and the establishment of fast-growing trees with high shade value such as *Acacia mangium* can suppress *Imperata* reinfestation. There is a risk of *Imperata* reestablishing itself during the early stages of an oil palm plantation (year 1 to 5) when canopy cover is still low (Purnomosidhi et al. 2005) but this is not too difficult to control by planting catch crops. Rehabilitating these grasslands and maintaining it grass-free thus has costs, and small-scale farmers may avoid it if the are able. Apart from issues related to soil fertility and preparatory costs, a stronger reason why oil palm planters clear forests is because it provides an injection of timber revenue that can help recoup the cost of establishing palm plantations (Clay 2004). It is observed in Indonesia that forests are felled for timber and subsequently left idle only on the pretext of establishing plantations (Holmes 2002).

Whether or not a significant amount of forests can be saved by using grasslands for oil palm expansion depends on how large the usable area of these grasslands are relative to projected oil palm expansion. If the annual oil palm expansion rate of 3,605 km^2 on Borneo mentioned earlier is assumed, then these grasslands could theoretically accommodate six years' worth of this expansion. This is assuming that these lands offer the same fruit yield per hectare as do plantations established on cleared forest land, that the sheets of grasslands are continuous, found in accessible locations, and are all available for cultivation. However it is likely that much of the grasslands in Kalimantan are patchy and scattered and that little of the large *Imperata* tracts remain (Lesley Potter, pers. comm.).

Another possible obstacle to making full use of grasslands by oil palm cultivators is that there may be a number of other claims over them. Locals living near these grasslands lay claim over and retain these lands for cultural and commercial values, e.g., for use in making thatched roofs or growing others subsistence crops (Potter and Lee 2007). There may be other competing uses for these lands too, such as industrial timber plantation and for smallholder rubber planting. Some of these uses may be more preferred on this type of land than growing and maintaining oil palms, or may be more valued for the greater economic independence they confer local landholders. These reasons may also explain the preference of palm plantation companies for forests or peat swamps over which there are fewer claims or competition to ownership, despite the fact that peat swamps are the least favourable environment for growing oil palm and require much fertiliser use (Lesley Potter, pers. comm.). In Central Kalimantan, orangutans are in direct competition with plantations established in peat areas in Tanjung Puting National Park and other areas surrounding it (Lesley Potter, pers. comm.).

An economic analysis of the use of non-forested lands reveals that if the increase in the supply of palm oil resulting from their use does not adequately reduce palm oil prices and if abundant forest lands are available, then the conversion of forests for oil palm will still continue, albeit at a slightly abated rate of conversion (Tisdell and Swarna Nantha forthcoming). This applies especially when markets are large such as in the case of palm oil, and demand is elastic — increases in supply at the margin do not reduce prices enough to significantly curb deforestation. If the demand for palm oil also strongly rises, then the use of non-forested lands may not be enough to dampen the rate of forest conversion.

For the use of non-forested lands to have any noticeable impact in reducing oil palm expansion, the technical constraints to using these lands must be overcome and inducements to minimise the use of forests must be applied. For instance, the use of non-forested lands, whether grasslands or other types of idle or shrub lands, could be subsidised to make it more attractive to oil palm growers. Governments can grant tax breaks to companies that use grasslands and desist from using primary forests or previously disturbed (e.g., logged) secondary forests that have high conservation value, or taxes or even penalties could be applied on forest conversion activity when there are suitable non-forested lands nearby that can be used. The additional cost of cultivating oil palm on grasslands could possibly even be offset by the sale of carbon credits earned from "reforesting" these lands with oil palm under the Kyoto Protocol's Clean Development Mechanism (CDM) (the oil palm meets the criteria for inclusion into the category of 'Forest Land' — see Murdiyarso et al. (2006, p. 1)), and by selling the palm oil at a premium under a 'sustainably-produced' label. All the same, if this is to work, protective measures for forests must be concurrently enforced by the authorities.

At present, conflicting signals have been given by the palm oil industry with regard to the use of non-forested lands. Palm oil companies operating in Indonesia pledged to use 7 million hectare of non-forested idle land in response to global criticism of the use of forested lands, but of late this group expressed opposition to any moratorium on rainforest and peat forest conversions (Simamora 2008a, b).

3.2 Intensifying oil palm yield

The average annual yield of palm oil for Malaysia and Indonesia remains under 4 tonnes/ha, although some plantations in Malaysia produce 5.5 tonnes/ha (Jalani et al 2002), and the theoretical yield is claimed to be 18.6 tonnes/ha (Corley 1996). There is thus scope to reduce the yield gap between the potential and the actual yield, a fact recognised by the industry.

It is presumed that if increasing demand could be met by increasing the per-hectare yield of the oil palm then this might lessen pressures to open up newer lands (e.g., Corley and Tinker 2003, p. 18). Yields can be increased by planting higher-yielding and resource-efficient seedlings and by improving plantation operations, i.e., by improving the timing, method and dosage of fertiliser application, avoiding the harvest of unripe fruits and actively replanting to replace old palms with lowered productivity (Jalani et al. 2002). It must be noted too that yields may be difficult to raise on soils that are poor or marginal, even with large amounts of fertiliser, and so not all planted areas are amenable to significant yield improvement.

But intensification need not necessarily lead to reduced land conversion; in fact, extensification can co-occur with intensification (Angelsen and Kaimowitz 2001; Tisdell and Swarna Nantha forthcoming). As demonstrated in the case of using non-forested lands, if increased yields from intensification do not generate output that sufficiently reduces palm oil prices, extensification will continue so long as there are no constraints to procuring arable land for farming. When intensification improves returns per-hectare but saves labour, the surplus labour may then participate in additional forest clearing to grow oil palm (Angelsen and Kaimowitz 2001). Greater returns from intensification (higher revenue and lower costs) could also result in farmers investing surplus money in expanding their agricultural areas. The viability of cultivating palm oil that comes with greater productivity may also draw additional people to the forest frontier. Replacing older, less productive oil palms in order to plant higher-yielding seedlings may involve a temporary reduction in the palm oil output for some farmers. It is possible that before taking a section of a holding "offline" for replanting, the farmer may wish to expand his planted area first to maintain output levels before choosing to replant existing plots.

There are, however, inducements for oil palm planters to increase intensification and reduce extensification. Because extensification means higher management and labour costs, especially in Malaysia where labour is more expensive than in Indonesia, intensification cuts cost. Furthermore, when palm oil prices decline, portions of an extensively cultivated area (e.g., at the periphery) may have to be abandoned when cutting down production, and this is a costly waste of investment. Even so, regulations to mitigate cropland expansion or encroachment into forest habitat are a necessary safeguard.

Yield improvements may not be uniformly achieved across the entire expanse of oil palm croplands. It is likely that major improvements in yield may occur only in lands with the best soils for oil palm. On marginal soils, yield improvements may be modest. Therefore it is difficult to state with certainty whether the overall output of palm oil would be augmented through intensification in the short to medium term to a degree that can significantly diminish the rate of oil palm expansion.

3.3 Piggybacking orangutan conservation on schemes for reducing carbon emissions and using direct payments for biodiversity conservation

Tropical forest clearing is responsible for roughly 20% of all anthropogenic carbon emissions (Gullison et al. 2007) yet preventing tropical deforestation is one of the most direct and cost-effective ways to achieve significant emission reductions (Laurance 2008). Negotiations are underway to enable developing countries to earn carbon credits by retaining tropical forests under the REDD scheme ("Reducing Emissions from Deforestation and Degradation"). This mechanism to complement the CDM may be implemented in 2012 when the Kyoto Protocol commitments are reviewed.

The value of carbon investments in preventing the deforestation or degradation of tropical forests as part of REDD would be enhanced if the goal of conserving biodiversity is simultaneously achieved. Accordingly, the United Nations Environmental Programme (UNEP) and the Great Apes Survival Project (GRASP) have begun to explore how funding under the REDD mechanism for forest conservation can benefit priority great ape populations (GRASP 2008).

If such an initiative is carried out, then the habitat of major orangutan populations could serve as node points for REDD investment, from which protection is extended to surrounding forest terrain. The exact perimeter of these areas could be designed to capture biodiversity and other ecosystem services benefits (e.g., by including species-rich forest tracts, watersheds and riparian zones) in addition to using the carbon-value criterion. State or provincial governments in Borneo could identify forest lands with high conservation value, such as those containing populations of orangutans and other co-habiting wildlife species, and use these as compelling selling points to obtain carbon credits. Oil palm plantations could also set aside suitable areas within their concessions that may contain orangutans for this purpose. But to be of value for the conservation of orangutans, these would need to be contiguous or linked to other larger habitat area to ensure viability. Agreements may need to be struck with oil palm concessionaires to achieve this and the returns from such a scheme may have to be attractive enough to induce cooperation.

There are also ready opportunities for orangutan conservation through REDD. Protecting the peat swamps of Central Kalimantan would achieve huge carbon savings while simultaneously conferring protection to the orangutan populations found there. Butler and Conway (2007) show that preserving peat land in Central Kalimantan for carbon earnings can be at least as profitable as producing palm oil. For a 1000-hectare area, carbon value is worth US$6.32-8.02 million compared to a net income of US$6.58 million from a 25-year oil palm plantation project. Tax revenue for governments would also be higher.

REDD may however become less attractive if the price of palm oil increases relative to the price of carbon credits. Tying carbon credits to biodiversity values such as orangutan conservation could hedge against this by drawing extra funding and support. Payments can be made for the conservation of specific wildlife species under direct payment schemes designed for biodiversity conservation (e.g., Niesten and Rice 2007). This approach to secure orangutan populations can be taken where the value of the habitat is inadequate in carbon terms to be considered for REDD. Payments can be linked to conservation performance; for example, the stream of payments can be made on the condition that the payee preserve the health of a protected ecosystem as measured by indices of species richness or by indicators of the health or population size of an umbrella species such as the orangutan.

Whether REDD or payments for conservation works would depend on whether the accruing payments match opportunity costs. Spatial factors, for one, play a role. Habitats that are located in areas far from agricultural frontiers may be more cheaply secured than habitat near actively expanding frontiers or established cultivated areas with high productivity and thus higher opportunity costs. Another matter is whether this payments-based approach would generate enough employment opportunities for locals. It is possible that conservation-related jobs could be created but research on the comparative employment value of conservation-friendly land uses and oil palm production would shed light.

3.4 Sustainable forest management

In Borneo, most orangutans occur in forests that are legally exploited for timber (>60% in Sabah and >75% in Kalimantan) (Wich et al. 2008). Provided that sustainable logging methods are used, logged areas may still be of adequate quality to support orangutans, although possibly at lowered orangutan densities (Marshall et al. 2006). If the appropriate forest conditions are maintained, orangutan density can recover with forest regeneration and the retention of fruit-bearing trees (Wich et al. 2008). Studies done in the Deramakot production forest in Sabah where sustainable forest management is practiced reveal that orangutan densities may be higher than where uncontrolled conventional logging is carried out (Ancrenaz et al. 2005).

Sustainable logging methods may however have finance-related drawbacks. First, reduced-impact logging is perceived as less profitable than more destructive, conventional logging practices (Pearce et al. 2003) although some claim that it has lower operation costs and can bring in higher profits (see Gascon et al. 1998). Second, earnings from long-term forestry practices are intermittent, as it takes decades for tropical forests to regenerate after a rotation of timber felling. An oil palm plantation on the other hand begins to produces cash flows within eight years (Clay 2004, p. 208) and does so continuously until the 25th or 30th year when production declines and new palms are re-planted. Conservation-compatible forestry could on its own be deemed economically less attractive than oil palm agriculture.

This financial disadvantage could be lessened if supplementary returns are obtained from carbon crediting and trading. Putz et al. (2008) show that improved forest management can potentially save at least 10% of the carbon reduction achievable from avoided deforestation. This is equivalent to 0.16 gigatons of carbon saved per year if improved forest management was practiced in all tropical forests worldwide designated for logging (Putz et al. 2008). The value of this amount of carbon on global carbon markets would be US$4.83 billion if the average carbon price for the first half of 2008 is assumed (€20.61, or US$30.20 per tonne) (Point Carbon, 2008).

The absence of such incentives, especially when forest habitats lack merchantable timber, would make forestry difficult to adopt for the long term. As it stands, timber concessionaires in Sabah have mooted the idea of converting part of their forest concessions into monoculture timber or oil palm plantations to increase revenue (see Toh and Grace 2006, p. 267). In Indonesia, the conversion of production forests into oil palm plantation has been occurring for years (Curran et al. 2004).

4. Discussion and conclusion

Although a number of the discussed conservation strategies are feasible in theory, technical, political and institutional complications exist that must be surmounted for their effective application. The technical ones are such as those identified in the use of non-forested lands, where the physical conditions and incentives for their use in lieu of forests may be lacking, or the risk of forestry exacerbating habitat degradation when road access into concessions inadvertently facilitates encroachment. Political constraints include changing government attitudes on what it considers as valuable or productive land uses and enabling alternative land uses such as conservation-oriented ones to compete more fairly with conventional land uses such as oil-palm agriculture (e.g., by eliminating perverse subsidies for agriculture). In relation to this, subduing the lure of official corruption in the management of natural resources usually marked by patron-client relationships is vital. It is stressed that established protected areas and areas designated for orangutan conservation must be recognised, adequately managed and enforced in tandem with implementing the strategies outlined here. The failure of enforcement has been noted as a key reason for the continued loss of orangutan habitat, particularly in protected areas (Rijksen and Meijaard 1999). To minimise unsustainable use of forests and to enable local communities to benefit from habitat conservation, institutional issues pertaining to land tenure security and rights to forest use must also be resolved.

The lack of competitiveness of orangutan conservation on the economic front is the argument put forth here as to why conservation does not prevail as the preferred land use on unprotected lands. Some of the market-based strategies described in this paper can enhance the realisable worth of retaining habitat. However, carbon schemes that remunerate forest conservation are still under development and the effectiveness of direct payments for biodiversity conservation is unclear in Malaysia and Indonesia given that the majority of forests are owned by the state and the mechanism for transmitting the financial benefits from these schemes to locals are yet to be ironed out. In Sabah, Malaysia, a biodiversity credit venture has already been proposed to help protect the Malua Forest Reserve, which is an orangutan habitat (SMH 2007). While this is encouraging, it remains to be seen whether this scheme turns out to be beneficial to both locals and the orangutan populations in the long-run. Additionally, there is the question of whether this can be replicated in other habitats where the opportunity costs may be higher.

In comparing the two sets of strategies outlined in this paper, it emerges that the use of non-forested lands as a method to divert oil palm expansion away from forests that are orangutan habitat, even if successfully done, may be a short-term or temporary measure if demand for oil palm stays ahead of supply and the availability of such land is low. The overall raising of yields on existing oil palm cultivated areas, though a promising way of catering for higher demand, may not be realisable immediately and certainly not on all types of soils, and is likely to be a gradual process. While private plantations have the financial and organisational means to ratchet up oil palm yields, many of the smallholders who own 43% of Indonesia's total palm area (FAS 2007) may not have the know-how or technology to intensify production. Technical extension services offered by the relevant government institutions may help address this. But there is also evidence that intensive agriculture may not be fully adopted as long as extensification is still a more attractive option (e.g., Angelsen and Kaimowitz 2001). Thus it is important that while intensification of existing croplands and the use of non-forested lands are encouraged, bearing in mind the dynamics of intensification–extensification, the value of retaining habitat should be promoted. Conservation-compatible uses include sustainable forestry, but preferable from a conservation standpoint would be uses that minimise physical impact on habitat, such as realising carbon and biodiversity values.

To convince local stakeholders to adopt conservation, various combinations of strategies such as sustainable timber harvesting and carbon and biodiversity crediting may need to be examined to determine which generates returns equal to those obtainable from oil palm cultivation. This merits future study. Others have proposed that environmental organisations set up oil palm plantations and invest profits from these into acquiring forests with high conservation value (Koh and Wilcove 2007). But environmental organisations may not have adequate know-how of running oil palm plantations and could make negative returns on their investments, thereby undermining their conservation efforts (cf. Tisdell 1999).

If broadening the financial base for conservation is an imperative, then there are opportunities for doing so that are yet untapped. Scientific data obtained from research and monitoring of orangutan populations, such as that collated under GRASP, could be put to creative uses that enhance conservation. Among the recommendations of an orangutan population and habitat viability workgroup is the setting up and maintenance of a website with links to changes in the status (population and habitat size, threats) of orangutan populations (Singleton et al. 2004, p. 11). If such an Internet database materialises, then it could be used as to generate funding from individual donors. An "adopt-a-population" venture through the Internet could allow individuals to select one or several orangutan populations and "adopt" these by providing a sum of money that is payable through the Internet for live information updates about the status of these populations, how much funds have been generated for these populations and how these are being used, or even allowing individuals to direct their donations to a set of conservation actions such as enhancing enforcement by directing funding for enforcement officers/park rangers or creating wildlife corridors. This strategy capitalises on the non-use values of the orangutan.

In addition to sourcing new funding, improvements can be sought in the efficiency and efficacy with which existing resources are expended to achieve conservation outcomes. Conservation NGOs working on their own may duplicate each others' activities and may act in an uncoordinated manner and this can result in them forgoing economies of scale in operation and result in expenditure overlaps (Tisdell 2007). Enhancing the cooperation and coordination between conservation NGOs on the field can minimise these consequences. There are opportunities for jointly developing common, coherent and synergetic conservation action plans by environmental NGOs working in the field to conserve the orangutan. In Sabah, for example, WWF (World Wide Fund for Nature) and KOCP (The Kinabatangan Orangutan Conservation Project) working in different parts of the Kinabatangan floodplain to conserve the orangutan could consolidate conservation efforts, on technical aspects or for fund-raising. Fund-raising for orangutan conservation for example could be done under a common umbrella project. Transparency in how donated money is used to achieve conservation objectives can minimise inefficiency in the use of funds and improve donor confidence and commitment. Wastage can also be reduced by collaborating on the technical front (e.g., joint training for capacity-building, integrating wildlife corridors etc.).

To recap, the fundamental message is that conservationists must seek diverse solutions to countervail the source of economic pressure for orangutan habitat conversion. Already, conservation groups have engaged with the oil palm industry under the Roundtable of Sustainable Palm Oil (RSPO) and have come up with a set of criteria for sustainable production. It would be fruitful to press the industry, in association with governments, to commit to efficient supply-side (production) measures such as using idle lands and improving yields. However, as pointed out in the text, these orangutan conservation measures are neither long-lasting nor of direct value. Therefore focus should be on expediting the implementation of demand-side strategies that involve the forestry sector and carbon and biodiversity markets. These potentially offer returns that can match those of oil palm production, and designing a conservation plan that integrates these various approaches with the appropriate enforcement measures should be the highest priority.

5. Endnotes

1. This estimate is obtained assuming palm oil expansion will result in 55% to 100% deforestation and that the proportion of this forest loss involving orangutan habitat is approximately 25%. The '25%' value is the average fractional share of orangutan habitat area out of the total extent of lowland forests in Borneo. This is calculated using (i) Langner et al.'s (2007, p. 2335) estimate of 92,286 km^2 of peat swamp forests and 235,536 km^2 of lowland forests (>40% crown cover) in Borneo (2005 figures), and (ii) Wich et al.'s (2008, p. 333-334) areal estimate of remaining Bornean orangutan habitat ($\approx$ 81,950 km^2). This proportion is an average ballpark figure. It assumes that orangutan habitat is evenly distributed across Borneo's lowland forests. In general, though, the orangutan is unevenly distributed in "clumps" of varying density depending on the degree of habitat suitability.

2. Depending on the habitat type (floodplains or uplands), the carrying capacity of orangutans for Borneo may vary, on average, between 0.2 and 3.4 individuals/km^2 (Soehartono et al. 2007, p. 8).

3. These estimates were derived from a simple cost-revenue model built for a hypothetical, 25-year palm oil production project using production cost, oil palm yield and market price data. The lower-bound value for net profit applies when the 10-year (1998-2008) average crude palm oil price is used for all future time periods of the model whereas the latter profit value applies if the 5-year (2003-2008) price is used. Internal rates of return for the project are 33% and 36% when 1998-2008 and 2003-2008 average prices are used, respectively. The crude palm oil prices used are in current dollars normalised to 2005 average prices. Production costs and oil palm yield profiles are internal publications of the Malaysian Palm Oil Board obtained via e-mail correspondence. For more information, see Appendix. Tomich et al. (2002) calculated the opportunity cost for an Indonesian case to be US$617/hectare, or US$1493/hectare if timber sales are included (1997 figures). Koh and Wilcove (2007) calculated an annual net profit of US$2,078/hectare based on data from an oil palm plantation in Sabah, but this is a static (single point-in-time) calculation.

4. In Malaysia, where labour costs are higher than in Indonesia, field workers are in private plantations are largely migrant workers.

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APPENDIX

Spreadsheet Model

The spreadsheet model follows that is used to analyse the per-hectare revenue, production cost, profit and NPV for crude palm oil (CPO) production in a typical Malaysian oil palm estate over a project duration of 25 years (from the establishment of a plantation until the end of the economic life-span of a producing oil palm).

The model: The spreadsheet used to estimate per-hectare revenue, production cost, profit and NPV for crude palm oil (CPO) production in a typical Malaysian oil palm plantation over a project duration of 25 years

Period	Year	Stage	Establishment/production cost (RM/ha)[a]	CPO price (US$/T)[b]	FFB yield (T/ha)[c]	Average annual OER (%)[d]	CPO Yield (T/ha) (FFB x OER) (T/ha)[e]	Revenue (US$/ha)	Profit (US$/ha)	Cumulative profit (US$/ha)	NPV calculations (US$/ha)
1	2002	Project begins	695.01	356.74	0	0	0	0.00	-695.01	-695.01	
2	2003		803.73	410.37	0	0	0	0.00	-803.73	-1,498.73	Discount rate/Internal rate of return:
3	2004	Production starts	760.75	434.72	5.25	19.30	1.01	440.48	-320.27	-1,819.01	0.05
4	2005		744.14	367.69	9.70	19.30	1.87	688.35	-55.80	-1,874.80	
5	2006		796.46	416.81	14.18	19.30	2.74	1,140.71	344.26	-1,530.55	NPV (cost):
6	2007		843.15	719.12	17.21	19.30	3.32	2,388.59	1,545.44	14.89	15,266.39
7	2008		891.73	1041.01	19.45	19.30	3.75	3,907.80	3,016.07	3,030.96	
8	2009		940.32	474.92	21.58	19.30	4.16	1,978.02	1,037.71	4,068.67	NPV (revenue):
9	2010		988.90	474.92	22.16	19.30	4.28	2,031.18	1,042.28	5,110.95	22,575.60
10	2011	Peak harvest (peak palm productivity)	1,037.48	474.92	22.4	19.30	4.32	2,053.18	1,015.70	6,126.65	
11	2012		1,086.07	474.92	22.51	19.30	4.34	2,063.26	977.20	7,103.85	Net NPV (NPV revenue - NPV cost):
12	2013		1,134.65	474.92	22.85	19.30	4.41	2,094.43	959.78	8,063.62	*7,309.21*
13	2014		1,183.24	474.92	23.28	19.30	4.49	2,133.84	950.61	9,014.23	
14	2015		1,231.82	474.92	22.02	19.30	4.25	2,018.35	786.53	9,800.76	
15	2016		1,280.41	474.92	21.53	19.30	4.16	1,973.44	693.03	10,493.79	
16	2017		1,328.99	474.92	21.17	19.30	4.09	1,940.44	611.45	11,105.24	
17	2018		1,377.57	474.92	20.97	19.30	4.05	1,922.11	544.53	11,649.77	
18	2019		1,426.16	474.92	19.76	19.30	3.81	1,811.20	385.04	12,034.82	
19	2020		1,474.74	474.92	20.17	19.30	3.89	1,848.78	374.04	12,408.85	
20	2021		1,523.33	474.92	20.67	19.30	3.99	1,894.61	371.28	12,780.13	
21	2022		1,571.91	474.92	20.31	19.30	3.92	1,861.61	289.70	13,069.84	
22	2023		1,620.50	474.92	19.67	19.30	3.80	1,802.95	182.45	13,252.29	
23	2024		1,669.08	474.92	19.36	19.30	3.74	1,774.54	105.45	13,357.74	
24	2025		1,717.67	474.92	18.19	19.30	3.51	1,667.29	-50.37	13,307.37	
25	2026	Project ends	1,766.25	474.92	18.06	19.30	3.49	1,655.38	-110.87	13,196.50	
	Total		*29,894.05*					*43,090.55*		*13,196.50*	

Notes for spreadsheet:

[a] Establishment/production cost data used here are an internal publication of the Malaysian Palm Oil Board (MPOB) which were obtained via e-mail correspondence. Two sets of data were provided by the MPOB covering the period 1995-2006, namely immature stage cost data and mature stage cost data. The former were used for the first three periods/years of the project (when an oil palm is usually still considered immature) and the latter for the rest of the periods. For periods beyond the year 2006, it was assumed that mature stage costs increases for each subsequent period at the same rate as it did between the years 1995 and 2006. Costs were quoted in Malaysian Ringgit (RM) but have been converted here into US dollars based on the current exchange rate of US$1 = RM3.46 (September 2008).

[b] The market CPO prices used are in current US dollars, based (indexed) on 2005 prices (2005 = 100). Source: IMF, 2008. The average CPO price used for all future periods (year 2009 onwards) in this base case is the average price for the 10-year period of 1998-2008.

[c] The normal, fresh fruit bunch (FFB) yield profile for an average palm oil plantation in Malaysia for a 25-year duration is used. This data was procured via email contact with the statistical division of the MPOB.

[d] An average of the oil extraction ratio (OER) for the years 1995 to 2006 is used. Data was obtained from MPOB's online database (http://161.142.157.5/v1/input.asp?pid=prd)

[e] The CPO yield is the product of the fresh fruit bunch yield and the oil extraction ratio.

Other assumptions:

1. The various taxes (cess, sales tax, corporate tax etc.), savings from economies of scale, and possible earnings from the sale of timber obtained from land clearing were not considered in this model.
2. A discount rate of 5% was used in this model to calculate the net present value.
3. The costs of establishing palm oil mills and other processing facilities are not included.

Additional notes:

Koh and Wilcove (2007) directly calculated an annual per-hectare net profit of US$2,078 (at the then prevailing exchange rate), but as mentioned, this is a static estimate using the palm oil yield and production cost data for the Malaysian state of Sabah (4.88 T/ha and US$812/ha/yr, respectively) and a crude palm oil price of RM2,041 (US$591) (for January-May 2007).

Summary information:

	In US$/hectare/year	In RM/hectare/year
Average annual revenue	1723.62	5963.73
Average annual cost	1195.76	4137.34
Average annual profit	527.86	1826.40
Average annual NPV	292.37	1011.59

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