Supplementary Information

Biodiversity effectiveness of conservation

Data

In addition to details given in the main paper, of the 16 transects established across the plantation, six were situated in areas dominated by oil palm with the remainder in locations of primarily secondary forest or recently cleared land with some seasonally flooded areas and palm nurseries also being represented across the sampling scheme (see Fig. S1). Distances to different surrounding land uses were also varied. Transects where walked diurnally (starting at 7am), and nocturnally (starting at 7pm) in rotation across all months of the year and in a range of weather conditions. Transects were walked a minimum of 20 times each over the course of the study, with a mean of 28 walks per transect. A trained team of 12 assistants was employed and observers walked in groups of 2-3. As noted, additional data were gathered from GIS analysis of local map and satellite images. These latter data gathering exercises included measures which extend into the area surrounding the concession (e.g. the distance to secondary forest may be much shorter to areas outside rather than inside the concession). These surrounding land use types are illustrated in Fig. S1. All explanatory variables were generated at the same 200m resolution as the transect segment data yielding the set of explanatory variables detailed in Table S1.

Figure S1: The concession and surrounding area.

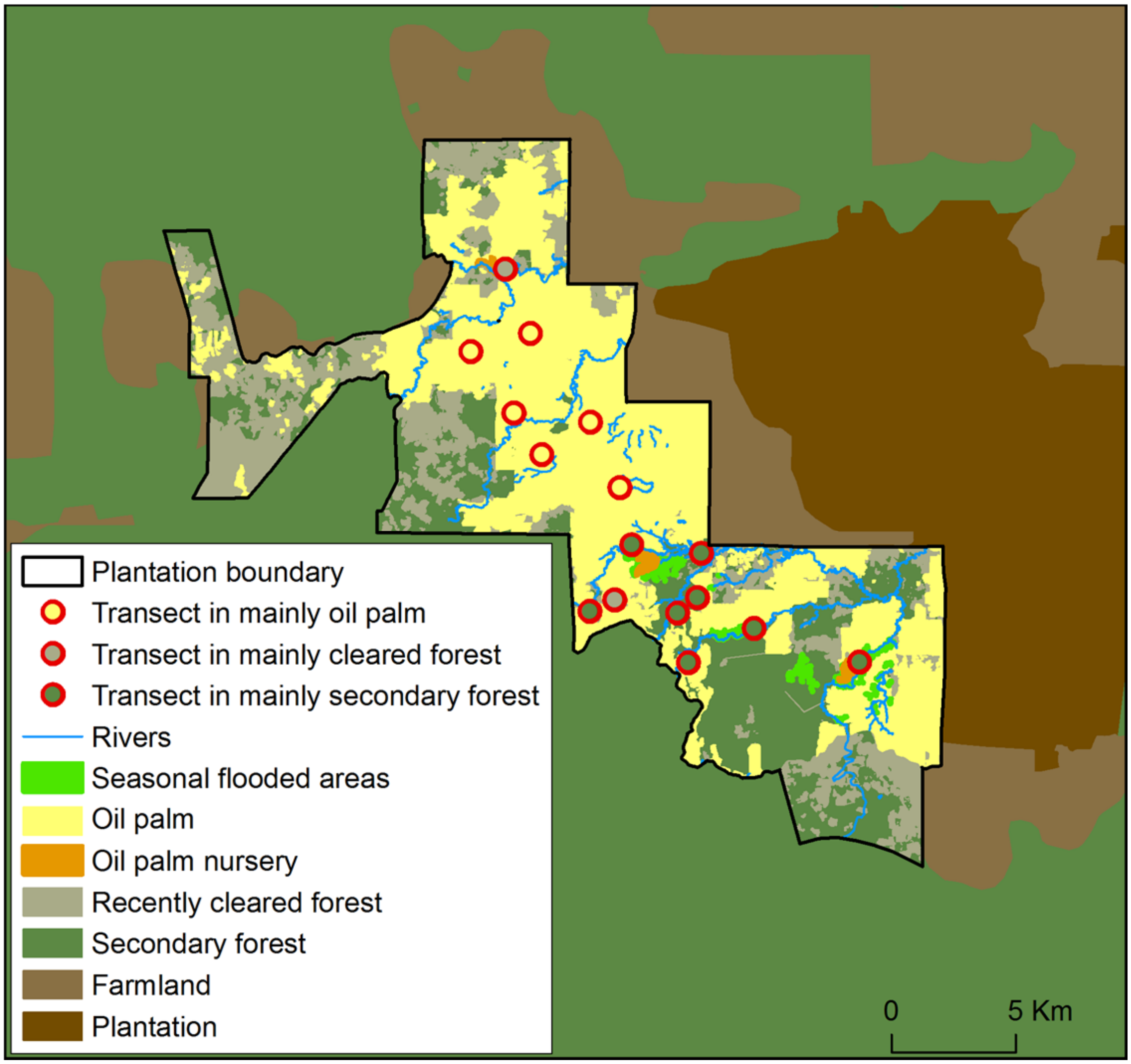


Table S1: Description of independent and explanatory variables used to examine variation in mammal numbers across the plantation, including the data sources from which they were derived within the GIS.

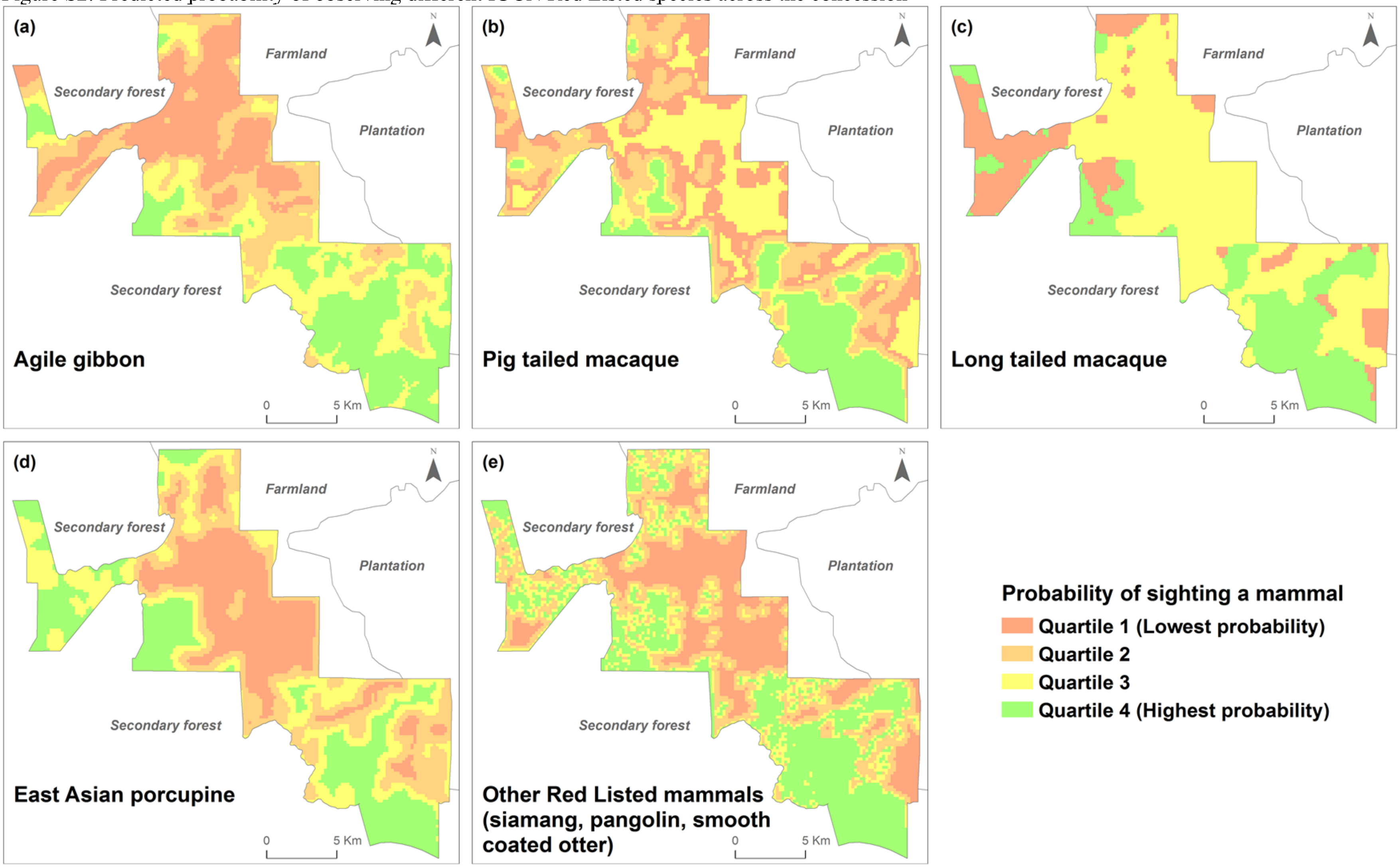
Variable Categories	Variable Names	Units	Sources of Data
Mammal	Agile gibbon sighted Pig tailed macaques sighted Long tailed macaques sighted East Asian porcupine sighted Siamang, pangolin or smooth coated otter sighted Leopard cat sighted Wild pig sighted Tree shrew sighted Palm civet sighted Mouse deer sighted	0=no 1=yes	Recorded in the field by visual observation.
Predominant habitat within each transect segment	Oil palm Recently cleared forest Secondary forest	0=no 1=yes	The distribution of habitats was identified from satellite images (obtained from the plantation management) and Jambi Government GIS data (obtained under license from the Jambi Government). The predominant habitat of each transect segment was calculated using a GIS. Secondary forest is typified by areas where large trees had been logged but were otherwise relatively undisturbed. Recently cleared areas include land under preparation for potential planting with oil palm or cleared as a result of illegal settlement (burnt and in preparation for crop planting). These areas typically had little vegetation cover, although some grasses and herbaceous plants occur amongst the tree stumps.
Distance based habitat measures	Distance to edge of the plantation Distance to oil palm Distance to recently cleared forest Distance to secondary forest Distance to primary forest Distance to the nearest tree nursery Distance to farmland Distance to secondary forest if predominant habitat is oil palm	Kilometers	The distribution of habitats was identified from satellite images and Jambi Government GIS data. All distances were calculated using a GIS.
Area and presence based habitat measures (area or presence of each habitat type within a $1km^2$ zone around each transect segment)	Area of oil palm Area of recently cleared forest Area of secondary forest Area of primary forest Area of tree nurseries Area of farmland	$kilometres^2$	The distribution of habitats was identified from satellite images and Jambi Government GIS data. The area of each habitat within a $1km^2$ zone around each transect segment was calculated using a GIS.
	Presence of oil palm Presence of recently cleared forest Presence of secondary forest Presence of primary forest Presence of tree nursery Presence of farmland	0=no 1=yes	The distribution of habitats was identified from satellite images and Jambi Government GIS data. Habitats present within a $1km^2$ zone around each transect segment were identified using a GIS.
Water features	Distance to rivers Distance to seasonally flooded areas	Kilometers	Rivers were identified from satellite images and Jambi Government GIS data. All distances were calculated using a GIS.
Season	Rainy season	0=no 1=yes	Weather data was obtained from plantation records. The rainy season was defined as the wettest months of the year from October to April.
Weather conditions	Rain Heavy rain	0=no 1=yes	Recorded in the field by visual observation.
Time of day	Night	0=no 1=yes	Recorded in the field by visual observation.
Measures of human disturbance	Distance to major roads Distance to minor roads Distance to harvest roads Distance to any road (major, minor or harvest) Distance to settlements	Kilometers	Roads and settlements were identified from satellite images and Jambi Government GIS data. All distances were calculated using a GIS.

As noted in the main paper, models of the probability of observing different IUCN Red Listed species were estimated using a generalized linear model with a logistic link function and a binomial distribution. Observation data were structured as a panel data set to account for repeated sampling of transect segments and fit with robust standard errors to account for spatial and temporal autocorrelation. Table S2 presents the various models as estimated. These models were then employed to generate predictions of the probability of observing different species for each 200 x 200 m grid cell across the concession. Maps of these predictions are given in Fig. S2.

Table S2: Odds ratios for sighting different IUCN Red Listed mammals in relation to habitat availability.

Independent variables	Coef. (β)	s.e.	Odds ratio (OR)	p-value
Agile gibbon				
Constant	-3.43	0.62	0.032	<0.001
Night	-20.55	5.78	1.19E-09	<0.001
Distance to seasonally flooded areas (km)	-0.39	0.21	0.677	0.068
Oil palm area within $1km^2$	-1.31	1.48	0.270	0.376
Pig tailed macaque				
Constant	-6.86	0.62	0.001	<0.001
Secondary forest area within $1km^2$	7.45	3.88	1720.920	0.055
Distance to oil palm (km)	4.44	3.66	84.463	0.225
Predominant habitat is secondary forest	-6.21	2.27	0.002	0.006
Long tailed macaque				
Constant	-7.98	0.80	0.000	<0.001
Night	-2.14	1.05	0.117	0.042
Predominant habitat is secondary forest	3.01	0.56	20.297	<0.001
Predominant habitat is oil palm	2.10	0.56	8.180	<0.001
East Asian porcupine				
Constant	-4.67	1.05	0.009	<0.001
Night	1.27	0.62	3.548	0.040
Oil palm area within $1km^2$	-2.85	1.21	0.058	0.019
Siamang, pangolin and smooth coated otter				
Constant	-5.73	0.61	0.003	<0.001
Distance to secondary forest (km)	-3.30	0.54	0.037	<0.001

Figure S2: Predicted probability of observing different IUCN Red Listed species across the concession



Examining the models and maps of the probability of observing IUCN Red Listed species, it is clear that continuous forest is preferred to oil palm, recently cleared land or fragmented mixtures of land use types, a finding which concurs with the extant literature (1-3). Preferences between non-forest land uses vary across species with most finding oil palm the most adverse habitat but macaques preferring oil palm to recently cleared land, a result which accords with the findings of Chung (4) who notes that these mammals feed on oil palm fruits. However all land use types remain clearly inferior to forest. The latter finding is echoed through the synthesis analysis of Fig 1b in the main paper which is obtained by using the models of Table S2 to predict the probability of sighting a given species and assigning a value of 1 for probabilities equal to or greater than fifty per cent and zero otherwise. These values are then summed for all Red List species to yield the probability measure given in Fig. 1b.

Alongside the various IUCN Red List species observed on site a number of other mammals were observed in our transect studies. Table S3 and Fig. S3 present models and maps of these species, derived as described previously.

Table S3: Odds ratios for sighting non-IUCN Red Listed mammals in relation to habitat availability.

Independent variables	Coef. (β)	s.e.	Odds ratio (OR)	p-value
	Leopard cat			
Constant	-8.55	0.98	0.000	0.000
Secondary forest present within 1km2	0.54	0.23	1.709	0.020
Oil palm area within 1km2	5.72	1.02	304.735	0.000
Distance to village (km)	-0.57	0.19	0.565	0.003
Night	1.29	0.10	3.613	0.000
	Greater mouse deer			
Constant	-30.20	7.43	7.685E-14	0.000
Secondary forest area within 1km2	14.55	5.32	2.088E6	0.006
Oil palm area within 1km2	11.93	4.77	1.517E5	0.012
Number of land uses within 1km2	2.69	0.86	14.796	0.002
Night	2.04	1.03	7.725	0.048
Distance to any road (km)	8.56	2.48	5224.997	0.001
	Common palm civet			
Constant	-13.88	3.14	9.395E-7	0.000
Secondary forest present within 1km2	-0.90	0.55	0.405	0.102
Secondary forest area within 1km2	7.17	3.12	1304.248	0.021
Oil palm area within 1km2	8.48	2.93	4816.534	0.004
Distance to village (km)	0.69	0.37	1.989	0.060
Number of land uses within 1km2	0.85	0.29	2.340	0.004
	Common tree shrew			
Constant	-7.45	1.15	0.001	0.000
Distance to village (km)	1.18	0.44	3.242	0.007
Number of land uses within 1km2	0.56	0.24	1.742	0.022
Night	-2.29	0.66	0.102	0.001
Distance to any road (km)	4.09	2.11	59.633	0.053
	Wild pig			
Constant	-739.59	329.71	63.20E-32	0.025
Distance to oil palm (km)	-3.36	1.78	0.035	0.059
Oil palm area within 1km2	-1.70	0.727	0.183	0.019
Year	0.37	0.16	1.444	0.025
Distance to village (km)	0.42	0.21	1.517	0.052
Number of land uses within 1km2	0.22	0.10	1.250	0.023

Figure S3: Predicted probability of observing different non-IUCN Red Listed species across the concession

Comparison of Figs S3 and S2 reveal some clear contrasts between Red Listed and other species. As expected, in all habitats numbers of all the latter species significantly exceed those of Red Listed mammals. Nevertheless the patterns of variation show some differences. While tree shrews and wild pigs clearly prefer secondary forest and can cope with fragmented landscapes, generalists such as the leopard cat, mouse deer and (not surprisingly) palm civet all fare well and indeed flourish amongst oil palm, feeding off either the fruits or other species (such as rodents) attracted to the area. Note that, while they are not themselves considered of conservation interest, wild pigs form a significant element of the diet of the endangered Sumatran tiger (*Panthera tigris sumatrae*) which we observed on the concession via camera traps, although not in sufficient numbers for modeling purposes. As can clearly be seen in Fig. S3, the conversion of secondary forest into oil palm plantation is associated with substantial reductions in the population of wild pigs; which would in turn reduce food supplies for the Sumatran tiger. Conversely, again as shown in Fig. S3 avoiding the loss of secondary forest not only helps secure the food supply of the tiger, but also conserves the IUCN Red List Species which were the focus of our modelling exercise. Insufficient data precludes us from examining whether or not this would be sufficient to conserve the tiger, but clearly securing its food supply is a prerequisite for such conservation.

Conducting transect surveys raises a question as to whether data concerning different species of mammal collected across different habitats are comparable. Oil palm plantation provides relatively little in the way of visual obstruction and it might be expected that a relatively high proportion of those species which are present in such areas will be observed during transect surveys. Conversely, in more obstructed, closed environments, such as secondary forest, it might be that a lower proportion of those species that are present will be observed. Furthermore, one might expect any bias to be relatively greater for smaller as opposed to larger mammals.

To assess the presence and significance of any bias surveyors estimated detection distances for various species. Table S4 reports mean detection distance for three species; the relatively large wild pig, the smaller leopard cat and the yet smaller common palm civet. These mean distances are shown for surveys conducted within and beyond oil palm areas.

Table S4: Mean survey detection distance (m) for different mammals across two environments. Figure in parentheses are standard deviations.

Survey areas	Wild Pig	Leopard cat	Common Palm Civet
Oil Palm	15.88 (9.34)	15.01 (10.32)	14.36 (9.52)
Non Oil Palm	8.58 (3.63)	7.40 (2.88)	8.15 (5.27)

Results show that, within either environment, there is no significant difference in average detection distances across the three species. Similarly, for any given mammal, there is no significant difference in detection differences across the two environments. Furthermore, even if the detection distances had proved to be significantly higher in oil palm habitats (suggesting that our estimate of mammal numbers in secondary forest was lower than might actually be the case), then any resulting bias would mean that, if anything, we would have actually understated the likely conservation benefits of preventing the conversion of land from secondary forest into palm oil plantation. This in turn would suggest that our conclusions are, if anything, conservative in terms of the wildlife benefits that would be generated by the schemes considered in our main analysis. However, as noted, these differences proved insignificant and therefore such an argument remains unsupported.

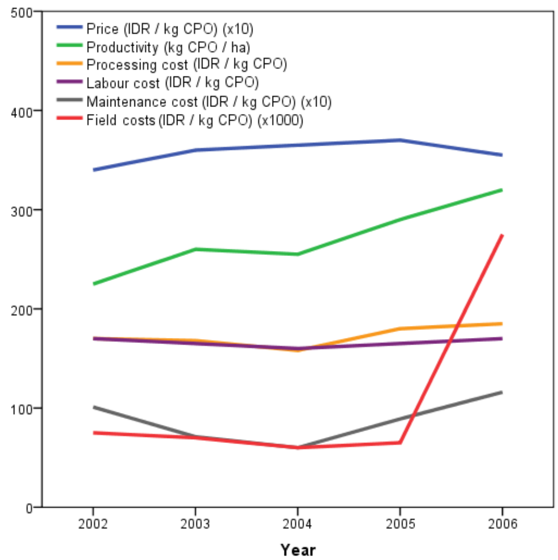
Opportunity cost of conservation

The principal element of the opportunity cost of conservation on productive private lands is foregone profit. Therefore is it useful to initially consider the nature of palm oil production.

Oil palm (*Elaeis guineensis Jacq.*) is a perennial crop that is primarily produced in intensive plantations. Seedlings are initially grown in nurseries for the first two years of their life after which they are planted out into management blocks of around 30 ha at a density of between 130-143 palms per hectare. The young palms are classed as immature until they start to produce fruit, usually 3 years after planting out. The fruit is dark orange with a thick, fibrous, oily outer flesh with a large seed from which palm kernel oil is produced. Fruits range from <2cm to 5 cm long, are ovoid in shape and grow in large compact fruit bunches weighing between 40-60 kg. Fruit takes approximately 6 months to ripen from pollination and is produced continually throughout the year, each palm producing between 6-12 fruit bunches per year. Harvesting occurs at regular intervals of between 5 and 12 days to ensure fruit is cut at the optimum time, not all palms would be harvested in a rotation. Oil palms are generally replanted every 15 to 20 years due to the difficulty of effectively harvesting older, taller plants. Continuous upkeep and maintenance of the crop is required, most of which is conducted by manual laborers. This involves fertilizer regimes, weeding, pruning and pesticide application. Once harvested the fruit needs to be processed quickly in order to minimize the rapid esterification of its oil content. For this reason large plantations will often have a primary processing mill on site or nearby, as is the case of our study site. In the mill the fruit is pressed to extract the crude palm oil (CPO), which is the primary sale product.

In order to establish the opportunity costs of conservation we first need to follow basic principles of agricultural economics to establish the distribution of gross margins across the concession for our low and high productivity periods. Gross margins differ from profits in that they omit fixed costs such as those associated with road construction. For several decades now, gross margin analysis has been the standard approach for assessing agricultural operations (6,7) as fixed cost levels can vary very substantially across operations often for historical reasons and prevent the generation of generalizable results. The basic data required for calculation of gross margins is summarized in Figure S4 which clearly demonstrates the noticeable increase in productivity (with an accompanying increase in field costs) over the period.

Figure S4: Plantation level trends in price, output and costs of palm oil production; 2002-2006.



Notes: Productivity is measured in kg CPO per hectare per month. All other variables are measured in Indonesian Rupiah (IDR) per month.
In Table S2 we convert overall conservation costs to US$ values using an exchange rate of 1 IDR = 0.000117 US$, which was typical for the period which these costs relate to).

The gross margin calculations were undertaken using monthly figures for enhanced accuracy. Prior to the calculation of revenues, an analysis of yield data showed no significant spatial variation across the plantation. Despite the size of the concession and the diversity of current land cover, this finding was not surprising as the study site occupies a relatively flat area with homogenous soils and environmental conditions. We therefore do not spatially differentiate revenues, although this may be necessary if transferring results to other or larger areas (an approach to such an analysis for timber production is set out in (8)). By taking data on the proportion of fruit mass converted to oil we calculate output of CPO in kilograms produced per month. Bringing in data on monthly prices then yields our revenue estimates. All values were initially calculated in nominal Indonesian Rupiah (IDR) and subsequently deflated to 2006 values (overall inflation was 12 % between January 2002 and December 2006 (9)).

Costs include inputs, maintenance, field administration, wages, plant nursery, development and planting costs as well as processing charges, all of which do not vary spatially. However, this is clearly not the case for harvesting costs which have a substantial transportation element. As harvesting costs were not disaggregated to individual sub-compartments a digital representation of the road network within the concession was constructed using road data obtained from the Jambi Government. Network routing algorithms were used in the GIS to identify the most direct (least cost) route along the road network to the processing mill located in the center of the plantation and to calculate the total distance for that route. This provided us with a distance measure for each 200m x 200m grid cell within the concession and was used to provide a measure of cell specific transport costs scaled by information on overall transport costs (additional costs of road construction for currently unplanted cells are discussed below).

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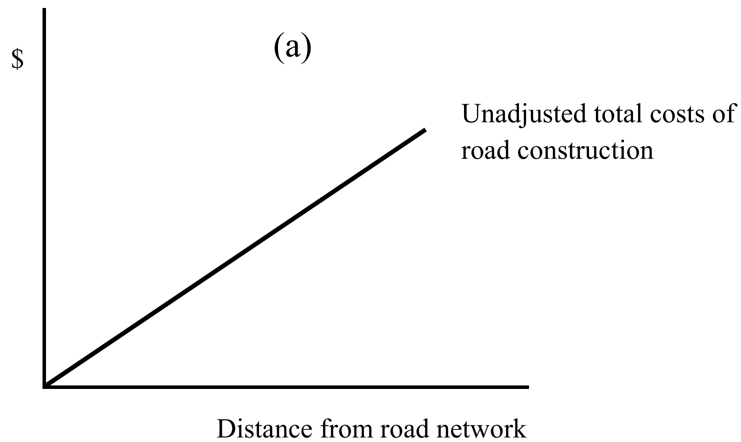
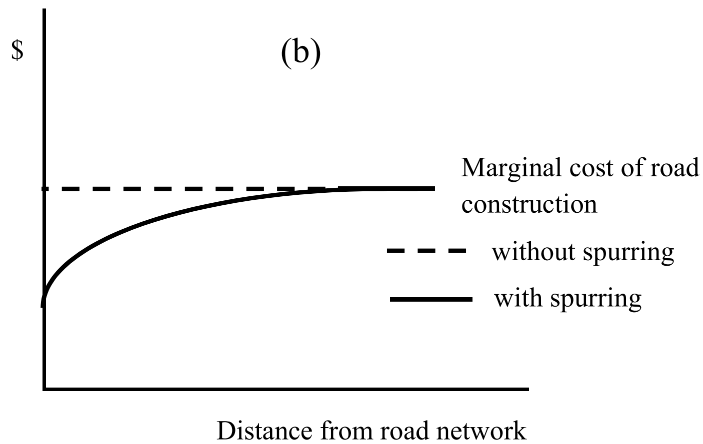
Comparison of revenue and cost streams provides our assessment of gross margin within currently planted areas. This declines with increasing distance from the processing plant due to higher transport costs. However, this does not give us our full estimate of the opportunity cost of conservation (OCC) within such areas as existing palms would have to be felled, the land ploughed and restored and a variety of costs incurred to encourage the re-establishment of high quality forest cover. Estimates of restoration costs were taken from (10) who also supplied indications of the relevant time profile for such projects allowing us to annuitize costs using formulae provided by (10) and discount rates (of 10%) for Sumatra given in (12) and (13). Adding this restoration cost to the foregone gross margin gives us our estimates of OCC within presently planted areas.

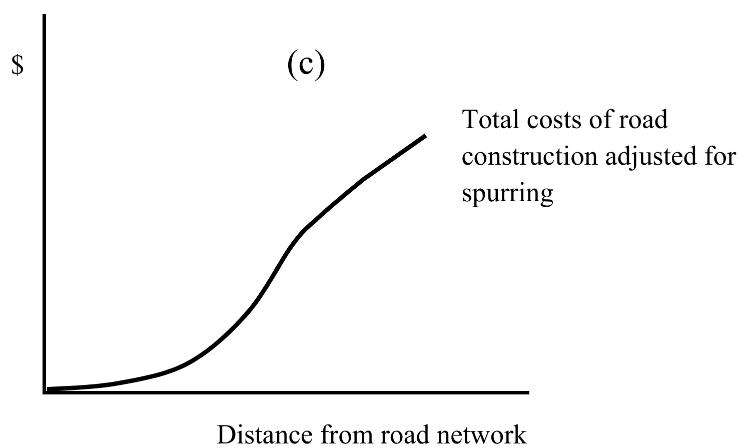
Of course it is likely that any profit maximizing plantation manager will be loath to rip up mature palms if there are unplanted areas within their concession. However, the OCC for unplanted areas is far from zero as they have a potential gross margin. This will also vary spatially because of the transport costs described previously. However, part of the reason why these areas are often currently unplanted is because at present they do not have roads running to them (indeed road density is closely linked to land development, habitat fragmentation, deforestation and the disappearance of wild-lands and wildlife (14, 15)). The potential gross margin of presently unplanted lands has, therefore, to be adjusted for the need to extend the road network to reach those areas. To estimate per kilometer road construction costs we again consulted the wider literature, taking values from the Indonesian studies of (16) and annuitizing as before. A problem in this calculation is to allow for the fact that as an unplanted area is developed so new roads will spur off each other. Calculating the cost of constructing a unique, new road to any given unplanted area, therefore, risks overestimation of those costs. A simple, theoretically driven, model is therefore adopted which assumes that the closer a potential palm planting areas is to an existing road, the higher is the probability of reducing road construction costs by spurring off that existing road, i.e. the marginal per-kilometer costs of roads will be reduced in such locations. However, as we progressively consider areas further from the road network, so the chances of being able to spur off the existing network decline and hence the expected marginal costs of road construction are not reduced.

Expected relationships are sketched in Fig. S5. Here in panel (a) we show total construction costs for a unique new road to a given area assuming constant marginal costs per kilometer and no spurring from existing roads. Panel (b) shows both the constant marginal costs (dashed line) implicit in the preceding panel and the lower marginal costs for locations near to, and hence spurring off, the existing road network (solid line). Panel (c) shows the adjusted total cost curve assuming diminishing marginal costs for locations near to the existing road network.

Figure S5: Sketch of relationships adjusting for spurring effects in road construction costs.







Parameterization of the functions sketched in Fig. S5 requires the calculation of a road construction cost adjustment factor (SPUR_ADJ). To define this we modelled the proportion of oil palm contained within a 1 km^2 buffer around each grid cell mid-point (PROP_OP) using the single explanatory variable LnDIST (the natural logarithm distance in kilometers from each grid cell to the road network). Because PROP_OP is measured as a proportion we used a Tobit regression model to estimate this relationship (17); the results are reported in the upper part of Table S5 with adjusted linear predictor values (18) given in the lower part of that table.

Table S5. Tobit regression model of the proportion of oil palm in areas as distance from the processing mill varies.

	Coef.	s.e.	t	Sig. (p)	Lower 95% CI	Upper 95% CI
Unadjusted parameters						
LnDIST	-0.26	0.01	-35.02	<0.001	-0.28	-0.25
Constant	0.98	0.02	59.27	<0.001	0.95	1.01
Sigma	0.44	0.01			0.43	0.10
N = 8180						
LL = -5546.76						
Adjusted values						
	dF/dx	s.e.	Z	Sig. (p)	Lower 95% CI	Upper 95% CI
LnDIST	-0.22	0.01	-35.02	<0.001	-0.23	-0.21
Constant	0.81	0.01	59.27	<0.001	0.79	0.84

The results given in Table S5 confirm that the proportion of oil palm to unplanted land falls significantly and logarithmically as distance from the processing mill increases. This provides the shape for our SPUR_ADJ function which can then be used to calculate road construction costs as sketched in Figure S5. These were annuitized as previously.

We can now estimate the OCC for any given area *i* at any time period *t* as per Equation (1):

$$OCC_{it} = GM_{it} - Trans_{it} - Construct_{it} + Restore_{it} \quad (1)$$

where:

OCC_{it} = opportunity cost of conservation for area *i* at time *t*

GM_{it} = the (potential) gross margin for area *i* at time *t*

$Transport_{it}$ = Transport cost from area *i* to the processing mill at time *t*

$Construct_{it}$ = Annuitized cost of road construction from existing road network to area *i* at time *t* adjusted for spurring probability (=0 for existing oil palm plantation)

$Restore_{it}$ = Restoration cost for grid cell *i* at time *t* (= 0 for currently unplanted areas)

Calculating an OCC_{it} value for each grid cell then describes the spatial distribution of costs of setting aside each cell across the plantation for conservation. The OCC will clearly vary according to the location of any conservation area. Most particularly, the OCC will be substantially higher for conservation occurring on existing oil palm plantation than when targeted towards unplanted areas using spatial cost-effectiveness analysis. Cost estimates for such alternative strategies are presented in Table S6. The difference between conversion strategies is greatest for smaller conservation scheme as larger schemes necessarily include some oil palm even when targeted using cost-effectiveness analyses. OCC is also always greater for higher productivity regimes as any loss of plantation area incurs a greater reduction of output than for low efficiency producers.

Table S6. Mean opportunity cost of conservation (OCC) per hectare for various sizes of conservation scheme implemented under two productivity levels and via two alternative spatial targeting methods.

		Spatial targeting →	Mature oil palm		Cost-effective	
		Productivity level →	Low	High	Low	High
Area converted to conservation	'small' scheme 5,000 ha	IDR ('000) per month	502	639	87	212
		US $ per month	59	75	10	25
		US $ per year	704	897	122	298
	'medium' scheme 10,000 ha	IDR ('000) per month	494	620	131	247
		US $ per month	58	72	15	29
		US $ per year	693	870	183	347
	'large' scheme 20,000 ha	IDR ('000) per month	483	594	267	379
		US $ per month	57	70	31	44
		US $ per year	679	835	375	532

Note: For each of the three scheme sizes (small, medium, and large) and the two approaches to spatial targeting (on mature oil palm or targeted to maximize cost-effectiveness), Table S6 shows the mean opportunity cost of conservation per hectare presented in three different monetary units: (i) IDR ('000) per month, (ii) US$ per month, and (iii) US$ per year. The original data that our opportunity costs were calculated from was available in IDR per month for each of the 400 or so sub-compartments of the concession. After we had calculated the opportunity cost of conservation in IDR ('000) per month, we then converted these values to US$ per month and per annum using the exchange rate 1 IDR = 0.000117 US$, which was the typical exchange rate during the study period, being reasonably stable (with one peak) over that period. The exchange rate has since fluctuated somewhat and stood at 1 IDR = 0.000085 US$ as of 9th September 2014. Researchers wishing to use these figures in the future should apply time series purchasing power parity adjustments (19) to adjust from the study period and location.

The analysis given in Table S6 is sufficient to show that private incentives will mean that landowners will be highly resistant to the conversion of productive palm-oil plantation to conservation purposes. Indeed it would be a highly inefficient use of any price premium to pay for such conversion. However, the cost-effective solution incurs much lower costs which, as demonstrated in the main paper, have for appropriately side conversion areas, the potential to be more than adequately compensated for by the induced price premium. Comparison of the location of cost-effective conversion areas (Fig 1d) with the opportunity cost of conservation (Fig 1c) show that these are highly correlated. This suggests that, at least for the present concession, this addresses the problem of asymmetric information between the land-owner and the conservationist. It is in the land owner's private interest to adopt the cost-effective solution in this case.

Cost-effectiveness analysis: Calculation of potential populations

Estimates of the numbers of mammals corresponding to the different conservation area are derived by using results reported by (19). This derives the minimum area required by some number (N) of a given mammal with respect to their diet and mass (M) according to the power equation $N = \alpha M^{\beta}$ where the values of α and β are as given below:

Diet category	α	β
Herbivore	1.01	0.76
Omnivore	3.62	0.73
Carnivore	34.43	0.86

Source: (19)

Table S7 applies the findings of (19) to derive estimates of the number of mammals corresponding to the different conservation extents considered in our analysis. Note that the equations reported by (20) may not apply to isolated and unconnected pockets of conservation land. However, as Figure S1 shows, the conservation areas are linked either directly or through the surrounding secondary forest area. The work of (20) is based on a global scale data set of mammal population densities (21). As many threatened species are poorly studied (22), it is possible that population size estimates derived from (20) may differ from those of the threatened Sumatran species cited here and should therefore be treated as first order approximation. We cannot say whether these populations would persist in the long term as the concept of a universal minimum viable population size is questioned (23). Nevertheless, these numbers are substantial and indicate that the conservation benefits of applying the procedures advocated in this paper would be considerable in terms of promoting population viability. As noted in the main paper, the areas conserved are considered significant and a sophisticated approach to certification design would incentivize the creation of larger conservation areas across adjoining concessions.

Table S7: The predicted population of each Red List mammal under three conservation area scenarios (based upon allometric relationships described in (19)).

Species		IUCN Red List Category	Mass (kg)	Diet	Individual Area (ha)	Population numbers within different conservation areas		
Common name	Latin name					5,000 ha	10,000 ha	20,000 ha
Agile gibbon	*Hylobatres agilis*	3	5.6	herbivore	4	1337	2673	5347
Pig tailed macaque	*Macaca nemestrina*	2	12	herbivore	7	749	1498	2996
Long tailed macaque	*Macaca gascicularis*	3	5	herbivore	3	1457	2914	5828
East Asian porcupine	*Hystrix brachyuran*	2	8	herbivore	5	1019	2039	4077
Siamang	*Symphalangus syndactylus*	3	23	herbivore	11	457	914	1828
Pangolin	*Manis javanica*	3	6	carnivore	161	31	62	124
Smooth coated otter	*Lutrogale perspicillata*	2	9	carnivore	228	22	44	88

Price premium for conservation grade products

It important to clarify that we do not suggest that the price premium for conservation grade goods reflects the true underlying value of biodiversity to individuals. Rather this is merely the uplift in prices that consumers are prepared to pay for a preferred mode of production which in turn has the potential to promote conservation. Importantly this does not encapsulate what economists refer to as the non-use value of conserving a species (24).

With this in mind, a choice experiment was designed to test for the size and potential determinants of any price premium for developed world consumers (palm oil being traded internationally, with the EU and USA being in the top five largest consumers in the world (25)). Supermarket shoppers were presented with a choice between two tubs of margarine in which palm oil was a major ingredient. Both were described as physically and chemically identical except that one used conventionally produced palm oil while the other used conservation grade palm oil.

Information on the biodiversity effects of conservation focused upon the iconic and highly endangered Sumatran tiger (*Panthera tigris sumatrae*) which, as previously noted, was observed on the concession via camera traps, although not in sufficient numbers for modeling purposes. This focus on the charismatic species which benefits from conservation reflects the findings of prior choice experiments which reveal these to be the main objects of value by developed country respondents and a prime motivator of conservation support (26). However, as shown in our modelling results (Fig. S3), avoiding the conversion of secondary forest to oil palm not only helps secure food supplies for the tiger (e.g. wild pigs), it also conserves IUCN Red List species.

The choice presented to shoppers was varied across individuals, in some cases presenting pairs of high quality products while in others a pair of regular quality margarines was presented. Furthermore, again across shoppers, three different levels of marketing information were used. One third of the sample (the *LowInfo* treatment) was simply informed that purchasing the conservation-grade good would protect the land where tigers hunt. Another third of the sample was additionally informed (*MedInfo*) that over the previous 30 years tiger numbers had halved to only about 500 individuals. The remainder of the sample (*HiInfo*) was given the prior information and also shown color images of tiger adults and cubs. All of this information is deliberately brief and intended to represent the highly accessible mix of general, quantitative and visual image marketing information likely to be used in a mass-market commercial setting.

Table S8 reports a model of the propensity of individuals to choose the conservation grade (CG) product over the conventionally produced alternative. This shows expected relationships with the preference for the CG good declining as its price (*PriceCG*) increased and being significantly higher when the choice was between two high quality (*HiQuality*) alternatives. Compared to the *LowInfo* base case, the addition of marketing information in the *MedInfo* treatment significantly increased the propensity to choose the CG good, an effect that was further enhanced by the *HiInfo* treatment.

Table S8: Logit model of propensity to choose the conservation grade (CG) good.

	$\hat{\beta}$	s.e.	*P*
PriceCG	-2.021	.230	.000
HiQuality	2.408	.235	.000
MedInfo	0.546	.248	.028
HiInfo	1.388	.267	.000
Constant	-0.074	.214	.728

Dep. Var = 1 if respondent chose the conservation grade good and 0 otherwise. χ^2 = 230.1 ($p<.001$); LL = 565.78; Nagelkerke R^2 = .434). Base case level of marketing (low) = *LowInfo*

Table S9 reports mean willingness to pay for the conservation grade good which, in all treatments, reveals a significant price premium over the conventionally produced alternative. This increases with the level of marketing as expected. While the willingness to pay is highest in absolute terms at the upper end of the market, in relative terms the conservation grade premium is greatest for the lower quality product. Further details of this aspect of the study are given in (27)

Table S9: Mean willingness to pay for the conservation grade good: Quality and marketing effects (parentheses show 95% confidence interval and percentage price premium compared to the conventionally produced good; $p<0.05$ throughout).

Level of marketing	Lower quality product (conventional good price = £0.75)	Higher quality product (conventional good price = £1.12)
LowInfo	£1.03 (0.98 – 1.07; 37%)	£1.29 (1.24 – 1.33; 15%)
MedInfo	£1.10 (1.05 – 1.15; 47%)	£1.35 (1.30 – 1.40; 21%)
HiInfo	£1.17 (1.11 – 1.23; 56%)	£1.52 (1.47 – 1.57; 36%)

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