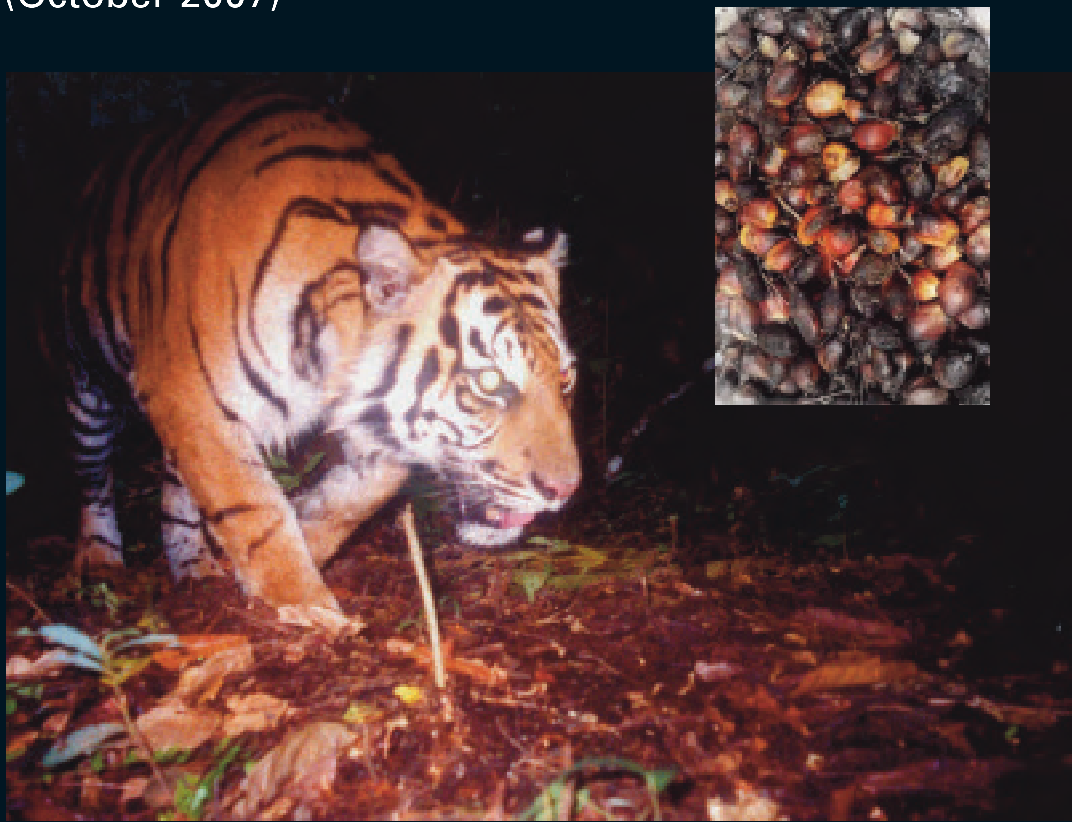
LIVING CONSERVATION

ZSL Conservation Report No.7

# THE CONSERVATION OF TIGERS AND OTHER WILDLIFE IN OIL PALM PLANTATIONS

Jambi Province, Sumatra, Indonesia
(October 2007)



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LIPI

21st CENTURY TIGER

WILDLIFE VETS INTERNATIONAL

SAVE THE TIGER FUND

Published by: The Zoological Society of London, Regents Park, London, NW1 4RY

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ISSN: 1744-3997

Citation: T. Maddox, D. Priatna, E. Gemita & A. Salampessy.
The conservation of tigers and other wildlife in oil palm plantations. Jambi Province, Sumatra, Indonesia (October 2007). ZSL Conservation Report No. 7. The Zoological Society of London, London.

Key Words: Tiger, Oil palm, Sumatra, Indonesia, Sustainable development

Front cover: Wendy, one of the resident female Sumatran tigers photographed by camera trap within the PT Asiatic Persada oil palm concession.
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Page layout: candice@chitolie.com

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The aim of this Conservation Report series is to inform people of the work that ZSL and its partners do in field conservation. Results of work carried out in field projects are often only reported in unpublished technical reports. This series seeks to bring this grey literature into a more accessible form to help guide conservation management and inform policy. The main intention is to report on particular achievements, especially where lessons learnt form the field can benefit other conservation professionals. The results of field surveys will also be disseminated through this series.

The primary audience for these reports is ZSL's conservation partners. These include government departments, private sector actors and conservation organisations. In some cases this type of report will also be useful for local communities. This series will be published in English and other languages as appropriate. Because only a limited number of hard copies will be produced, electronic versions of all these reports will be available through the ZSL library. (https://library.zsl.org)

# The conservation of tigers and other wildlife in oil palm plantations

Jambi Province, Sumatra, Indonesia
(October 2007)

By T. Maddox
D. Priatna
E. Gemita
A. Salampessy

# Summary

Traditional wildlife conservation often focuses on protected areas, management of which forms the core of most countries' conservation efforts. While such areas are absolutely essential for conservation success, limitations of size, location, isolation and management mean that for many species the protected area system is at best restrictive and at worst insufficient. In many cases, land outside protected areas also has conservation value. Whilst this is rarely of the quality found in protected areas, using the conservation potential of unprotected lands can help overcome many of the shortfalls of the protected area system. For certain species, especially those which naturally occur at very low population densities, this support could tip the balance from extinction to survival.

Indonesia is one of the most biodiverse countries in the world and despite its extensive system of protected areas, many of its species are in decline. Commercial landscapes dominate the unprotected areas in Indonesia, with the oil palm industry – particularly following recent demands for biofuel - the fastest growing sector and a major cause for concern amongst environmentalists. Whilst many argue against its expansion, palm oil's increasingly important role in both the Indonesian and world economies ensures that it will be a significant part of the landscape for the foreseeable future. If the environmental impact of this crop is to be mitigated at any meaningful level, the extent to which oil palm and biodiversity can coexist and the mechanisms by which this may occur must be assessed. In this report we investigate how oil palm plantations may play a role in wildlife conservation in Sumatra, Indonesia. The study focuses on tigers and other large, terrestrial mammals living on and around an oil palm plantation concession in central Sumatra, an area that included patches of degraded forest and scrubby unplanted areas as well as the oil palm crop itself. The analysis looks at species survival at the landscape level (including forested habitats adjacent to the plantation), at the plantation *concession* level (including unplanted areas within it), and finally species survival within the oil palm crop itself.

The results show that oil palm monoculture is very poor habitat for most terrestrial mammal species. Only four species (10% of the number detected within the landscape) were regularly detected in the oil palm itself and none of these species had a high conservation value. The degree of aversion to oil palm shown by the other mammals varied. Most endangered species, including tigers, tapirs, clouded leopards and dhole, were never detected in oil palm. Some species, including deer, macaques and pangolins showed limited tolerance but, with the exception of pigs, all species showed a general preference for non-oil palm habitats. However, many species continue to survive in the vicinity of the oil palm, utilising other habitat types also present in the matrix. Surveys of the overall landscape around the crop revealed 38 medium to large mammal species, 25 of which are protected under Indonesian law and 18 of which are on the IUCN red lists, including the Sumatran tiger (*Panthera tigris sumatrae,* IUCN: Critically Endangered). Ninety percent of these also occurred in the heavily degraded, unplanted areas within the plantation concession itself. Many of these species were previously thought to be highly intolerant of disturbed habitats, yet most showed evidence that they were existing in functioning, persistent populations. Finally the study highlighted the fragility of wildlife survival in such marginal habitats. Over the course of the study, substantial loss of conservation value was witnessed as land clearance and settlement of the wildlife habitats was illegally carried out by settlers. The plantation managers, though sympathetic to wildlife conservation, were unable to prevent this. The tiger population was particularly strongly affected, completely disappearing from the plantation concession in the third year of the study.

The study concludes that compatibility of oil palm crop with most mammal species is very low and that therefore conversion of land to oil palm plantations will have major detrimental effects on most terrestrial mammal species, both through the initial impact of habitat loss and through restrictions on remaining local populations by habitat fragmentation. However, the study also highlights the conservation

importance of marginal or degraded habitats often found within palm oil concessions, which can retain high conservation values. This has important implications for the palm oil industry, both in guiding new planting and as a mechanism for reducing impacts on local wildlife populations.  It also has serious implications for large-scale land-use planning, both by governments and conservationists, showing that conservation value occurs widely outside primary forest and existing definitions and criteria must be broadened to reflect this. Finally, the study concludes that the fragility of wildlife survival in unprotected areas is such that active management and protection is essential if conservation value is to be anything more than transient.

The report ends with recommendations for action to mitigate the impacts of oil palm on wildlife survival at three levels. First, it is recommended that current policies on avoiding forest clearance for new planting are supplemented with field surveys in degraded areas to identify which are low priority and which are in fact integral to wildlife conservation on a landscape scale. Second, recommendations are made on how to best manage existing plantations, primarily through placement and management of unplanted areas to reduce impacts on local wildlife populations. Third, biodiversity offsets are suggested for oil palm plantations, as only with additional action offsite can the entire impact of a plantation be mitigated. It is also recognised that such actions need to be taken as part of a wider, collaborative landscape approach if significant and sustainable impacts are to be achieved. The final section therefore proposes a collaborative framework for conservation between protected areas on a landscape scale, into which action by the oil palm industry must be fitted.

Conservation outside protected areas is essential if many wildlife populations and endangered species are to survive into the future. The palm oil industry represents one of the key land users in these areas with one of the largest environmental 'footprints'. If palm oil production is carried out without regard for environmental impacts it is also likely to be a key factor in the extinction of a range of tropical species. But if production is developed responsibly, with environmental impacts mitigated as far as possible, oil palm should be able to provide important economic growth and development in the region without turning some of the earth's most important tropical ecosystems into ecological deserts.  This is a big "if", and achieving responsible development is a major challenge; but it is one that must be met if biodiversity and ecosystem functionality are to be conserved in Indonesia and elsewhere.

# Ringkasan

Konservasi satwa liar tradisional umumnya hanya terpusat pada kawasan-kawasan lindung, yaitu satu bentuk pengelolaan utama dari upaya konservasi di kebanyakan negara. Ketika kawasan-kawasan tersebut begitu sangat penting bagi keberhasilan konservasi, dengan terbatasnya ukuran, penempatan, keterisolasian dan pengelolaan, maka bagi banyak spesies sistem kawasan lindung seperti ini amat menjadi pembatas dan sangat tidak cukup. Pada banyak kasus, lahan di luar kawasan-kawasan konservasi juga memiliki nilai konservasi. Meski kualitasnya jarang menyerupai dengan apa yang dijumpai di kawasan konservasi, namun dengan memanfaatkan potensi konservasinya dapat membantu mengatasi permasalahan pada sistem kawasan lindung. Bagi spesies tertentu, khususnya spesies-spesies yang secara alamiah hidup pada populasi yang sangat rendah, dukungan seperti ini dapat menghindarkan kepunahan serta memberi peluang pada mereka untuk mempertahankan hidup.

Indonesia merupakan salah satu negara di dunia yang paling beragam kehidupan hayatinya. Namun, meskipun memiliki sistem kawasan perlindungan yang luas, banyak spesies-spesiesnya yang sedang dalam penurunan. Bentang alam komersial mendominasi kawasan-kawasan non-lindung di Indonesia, dengan industri kelapa sawit – terutama mengikuti permintaan akan *biofuel* akhir-akhir ini – sebagai sektor yang paling cepat tumbuh dan merupakan penyebab paling utama yang menjadi perhatian para aktivis lingkungan. Meski banyak perdebatan yang menentang perluasannya, peran yang semakin penting dari kelapa sawit, baik dalam ekonomi Indonesia maupun dunia, telah memastikan bahwa kelapa sawit akan menjadi bagian yang signifikan dari bentang alam di masa depan. Apabila dampak lingkungan dari tanaman ini akan dikurangi hingga taraf yang berarti, pada tingkat dimana kelapa sawit dan keanekaragaman hayati dapat hidup bersama, maka mekanisme-mekanisme yang memungkinkan hal tersebut terjadi harus dikaji. Dalam laporan ini kami mengkaji bagaimana perkebunan sawit mungkin memainkan suatu peran dalam konservasi satwa liar di Sumatera, Indonesia. Studi difokuskan pada harimau serta mammalia besar terestrial lainnya, yang hidup di dalam dan sekitar satu konsesi perkebunan sawit di Sumatera bagian tengah, yaitu suatu kawasan yang terdiri atas lahan-lahan hutan kecil yang terdegradasi, lahan-lahan semak yang tidak ditanami, dan tanaman sawit itu sendiri. Analisis meninjau pada kebertahanan hidup spesies pada tingkat bentang alam (termasuk habitat-habitat berhutan yang terhubung dengan perkebunan), kemudian pada tingkat konsesi perkebunan (termasuk lahan-lahan yang tidak ditanami yang ada di dalamnya), dan akhirnya pada kebertahanan hidup spesies di dalam tanaman kelapa sawit itu sendiri.

Hasil menunjukan bahwa tanaman monokultur kelapa sawit merupakan habitat yang sangat miskin bagi kebanyakan spesies mamalian terestrial. Hanya 4 spesies (10% dari jumlah yang ditemukan pada bentang alam) yang umum ditemukan dalam lahan tanaman sawit, dan tidak satupun dari spesies-spesies tersebut memiliki nilai konservasi tinggi. Derajat ketidak-sukaan terhadap lahan tanaman sawit yang ditunjukan oleh mammalia-mammalia lainnya bervariasi. Spesies-spesies yang paling terancam, termasuk harimau, tapir, macan dahan, dan anjing hutan, tidak pernah ditemukan di lahan kelapa sawit. Beberapa spesies, termasuk rusa, monyet dan trenggiling menunjukan toleransi yang terbatas, tetapi (dengan pengecualian babi hutan), semua spesies menunjukan suatu kesukaan yang umum terhadap habitat-habitat non-sawit. Bagaimanapun, banyak spesies yang tetap bertahan hidup di sekitar lahan kelapa sawit, memanfaatkan tipe-tipe habitat yang terdapat di dalam matrix bentang alam. Survey pada keseluruhan bentang alam di sekitar tanaman sawit menyatakan bahwa terdapat 38 spesies mammalia berukuran sedang dan besar, yang 25 spesies di antaranya dilindungi undang-undang, dan 18 di antaranya termasuk dalam daftar merah (*red list*) IUCN, termasuk harimau Sumatera (*Panthera tigris sumatrae,* IUCN: Kritis atau *Critically Endangered*). 90% dari jumlah spesies tersebut juga ditemukan pada daerah yang sangat terdegradasi, yaitu areal di dalam konsesesi perkebunan yang tidak ditanami. Banyak di antara spesies-spesies itu sebelumnya diduga sangat tidak toleran terhadap habitat yang terganggu, namun kebanyakan menunjukan bukti bahwa spesies-spesies

tersebut masih ada dalam populasi yang tetap dan berfungsi. Dalam pembelajaran selama studi, kehilangan besar nilai konservasi tercerminkan oleh pembukaan lahan dan pemukiman pada habitat satwa liar yang secara tidak sah dilakukan oleh para perambah. Meskipun para pengelola perkebunan memberi perhatian pada konservasi satwa liar, namun mereka tidak dapat mencegahnya. Yang terutama sangat terpengaruh adalah populasi harimau, yang seutuhnya hilang dari konsesi perkebunan pada tahun ketiga masa studi.

Studi berkesimpulan bahwa kecocokan tanaman sawit dengan kebanyakan spesies mammalia sangat rendah, dan oleh karena itu konversi lahan menjadi perkebunan sawit akan memberikan dampak yang sangat mengganggu terhadap kebanyakan spesies mammalia terestrial, baik melalui dampak awal yaitu kehilangan habitat, maupun melalui pembatasan pada populasi lokal yaitu dengan adanya fragmentasi habitat. Namun demikian, studi juga menggaris-bawahi bahwa kepentingan konservasi dari habitat-habitat tipis (*marginal*) atau yang terdegradasi, yang banyak dijumpai di dalam konsesi-konsesi perkebunan, dapat mempertahankan tingginya nilai konservasi. Hal ini memiliki implikasi yang amat penting bagi industri kelapa sawit, baik dalam memandu penanaman atau pembukaan lahan baru maupun sebagai mekanisme untuk mengurangi dampak negatif terhadap populasi lokal satwa liar. Hal tersebut juga memiliki implikasi yang serius terhadap rencana tata guna lahan berskala besar, baik oleh pemerintah maupun para praktisi konservasi, yang memperlihatkan bahwa nilai konservasi terdapat secara luas di luar hutan primer, yang kemudian ketentuan dan kriteria yang ada harus diperluas guna merefleksikan hal tersebut. Akhirnya, studi berkesimpulan bahwa kelemahan kelangsungan hidup satwa liar di kawasan-kawasan non-lindung, yaitu lemahnya pengelolaan dan perlindungan aktif, menjadi sangat penting apabila nilai konservasi tersebut ingin menjadi sesuatu yang lebih daripada sekedarnya.

Laporan diakhiri dengan tiga tatanan rekomendasi bagi kegiatan pengurangan dampak dari perkebunan sawit terhadap kelangsungan hidup satwa liar. Pertama, direkomendasikan bahwa kebijakan yang ada sekarang, yang menghindarkan pembukaan hutan bagi penanaman baru, perlu ditambah dengan suatu survey lapangan di kawasan-kawasan yang terdegradasi, yang gunanya untuk mengidentifikasi dimana yang prioritasnya rendan, dan dimana yang ternyata integral terhadap konservasi satwa liar pada skala bentang alam. Kedua, rekomendasi dibuat pada bagaimana pengelolaan terbaik bagi perkebunan yang sudah ada, khususnya pada bagaimana menempatkandan mengelola areal yang tidak ditanami agar dampaknya terhadap populasi lokal satwa liar dapat dikurangi. Ketiga, penggantian kerugian keanekaragaman hayati (*biodiversity offset*) diusulkan bagi perkebunan kelapa sawit, yaitu hanya sebagai suatu aksi tambahan di luar konsesi yang dapat membuat dampak keseluruhan perkebunan dapat dikurangi. Perlu diperhatikan bahwa aksi seperti ini perlu lakukan sebagai bagian dari sesuatu yang lebih luas, yaitu pendekatan bentang alam kolaboratif, apabila dampak berkelanjutan yang signifikan ingin dicapai. Oleh karenanya, pada bagian terakhir diusulkan suatu kerangka kerja konservasi yang terkolaborasi antara kawasan-kawasan perlindungan dalam satu skala bentang alam, yang mana aksi yang dilakukan oleh industri sawit harus di masukan ke dalamnya.

Konservasi di luar kawasan non-lindung menjadi amat penting apabila populasi-populasi satwa liar dan spesies terancam ingin dipertahankan hingga masa yang akan datang. Industri sawit mewakili salah satu pengguna utama akan lahan pada kawasan ini, yang juga merupakan salah satu satu dari "*footprints*" lingkungan terbesar. Jika produksi kelapa sawit dilakukan tanpa adanya penghormatan terhadap dampak-dampak lingkungan, maka hal ini sepertinya akan menjadi faktor pada kepunahan banyak spesies tropis. Tetapi, jika dalam produksi tersebut dikembangkan suatu tanggung-jawab, dengan seluas-luasnya dampak-dampak lingkungan dikurangi, maka seharusnya kelapa sawit dapat mempersembahkan pertumbuhan ekonomi yang penting, serta pembangunan regional tanpa harus merubah ekosistem-ekosistem tropis yang sangat penting menjadi gurun-gurun ekologis. Ini merupakan suatu "JIKA" besar, dan adalah suatu tantangan yang besar dalam menerima tanggung-jawab pembangunan; tetapi, hal ini merupakan sesuatu yang harus dicapai, jika keanekaragaman hayati dan fungsi ekosistemnya akan dilestarikan di Indonesia dan dimanapun.

# Contents

# Sponsors and Contributors

This work was initiated in 2001 at the invitation of Sean Marron, then President Director of PT Asiatic Persada (Asiatic) oil palm plantation. The initial year's work that established the presence of tigers within the oil palm concession and laid the foundations for the project was co-funded by Asiatic and the Zoological Society of London (ZSL) and led by Robert Gordon with supervision by Dr. Chris Carbone. From 2002 to 2006 Dr. Thomas Maddox has been running the project in the field with joint supervision from Sarah Christie and Dr. Carbone at ZSL. Satrio Wajimukti worked as a counterpart from 2002-3 with Dolly Priatna joining as project co-manager in 2004. Field work has primarily been carried out by Elva Gemita and Adnun Salampessy who both joined in 2003, as well as volunteer assistants from the University of Lampung, the University of Jambi and Gita Buana. All trapping work was taught by Bart Schleyer and veterinary training was provided by Dr. John Lewis. Joseph Smith worked as a volunteer to help run the survey of Asialog. Permissions, support and funding were provided by the following organisations:

The Indonesian Institute of Science (LIPI) through the Department of Biology has been the sponsor for the project since it began research activities in 2002 through Dr. Jito Sugarjito. Dr. Suyanto took over as the primary counterpart in 2006.

The Indonesian Department of Forestry has been closely involved with the project since 2002, granting permission to work with animal radio collaring and providing representatives from the local forestry office (BKSDA) on an informal secondment since 2003.

PT Asiatic Persada and their original parent company, the Commonwealth Development Cooperation (CDC) provided in kind and logistical support from 2001-2006, including the provision of a purpose-built office on site and twelve conservation scouts.

PT Asialog controlled the logging concession included in this study and kindly gave permission for research to be carried out on their land.

21st Century Tiger, jointly administered by the Zoological Society of London and Global Tiger Patrol, provided financial support for 2002-3, 2003-4, 2004-5 and 2005-6.

The Save the Tiger Fund, administered by the National Fish and Wildlife Foundation (NFWF), provided financial support between 2002-3 and 2004-5.

The Rhino and Tiger Conservation Fund, administered by the US Fish and Wildlife Service, provided financial support from 2004-2005.

Wildlife Vets International (WVI) donated veterinary equipment and provided the services of veterinarian Dr. John Lewis.

The Tufton Charitable Trust supported tiger wildlife radio collaring work between 2003-5.

BSI Travel provided flights between 2003 and 2005.

The Charles 10th Duke of Rutland Memorial Trust provided funding for staff development and training in the UK and US in 2005 and 2006.

Chessington World of Adventures provided veterinary equipment through WVI.

Thanks to Sarah Christie, Chris Carbone and Glyn Davies for editorial comments.

# Introduction

## Protected areas and conservation

Most conservation strategies are based around the system of protected areas and the general principle that separating people and wildlife is beneficial for wildlife survival. The success of this approach has been demonstrated repeatedly, showing inverse relationships between human density and wildlife success (*e.g.* Woodroffe, 2000), higher densities of wildlife inside national parks compared to outside (*e.g.* Caro et al., 1998) or positive relationships between human density and conservation conflict problems (*e.g.* Newmark et al., 1994). The persistence of many species is entirely attributable to protected areas. They also play a vital role as ecological baselines, demonstrating how ecological systems exist with little or no human influence and thus allowing measurement of the extent to which human activities alter these processes in other areas (Arcese and Sinclair, 1997).

However, whilst the importance of protected areas as a core component of conservation strategy is unquestionable, the protected area system does suffer from several key limitations (see Table 1 for a summary). Firstly, protected areas are almost always limited by size. Setting land aside for protection is an expensive process in terms of lost revenue from other land uses, especially in poorer countries. The result is that protected areas are frequently not big enough to perform their stated conservation role. This particularly affects wide ranging species, such as large carnivores, which need vast areas to sustain viable populations. Secondly, similar issues occur with the placement of protected areas, which is often done without reference to the requirements of the species and is instead driven by human demands for scenic areas, rival economic requirements for land, political decisions and national boundaries. Again such issues can be particularly important in poorer countries, where protected area gazetting is less frequently motivated by an internal desire to conserve and more frequently by symbolic gestures towards, or in response to demands from, the international community (O' Neill, 1996). Consequently, it is frequently land unwanted or unusable for other purposes that is gazetted as protected areas, rather than the highest priority conservation locations. Thirdly, limitations in size and location also lead to isolation. Connectivity between protected areas is vital, with the island biogeography theory showing the difference between the potential of a single area and that of the same area divided into smaller islands (MacArthur and Wilson, 1967). This has important implications for effective population size, gene flow and dispersing individuals. Fourthly, protected areas can also suffer in biological terms from the effect of a "hard" edge between protected and unprotected land. Again this is a particular problem for wider ranging, larger species which come into conflict with people at the park edges causing higher mortality and population 'sinks' (Woodroffe and Ginsberg, 1998) with effects then spreading to individuals throughout the park (Parks et al., 2002).

Finally, forested protected areas also have an important effect on human socio-economics and welfare, most commonly on the residents on or next to the land where they are created. Many of these derive from the fact that protected areas worldwide are generally managed using a "fences and fines model" (Wells, 1992) whereby protected areas are set up and imposed by central government, often for reasons unrelated to conservation and/or at odds with the needs of people living in the area (Mackinnon et al., 1986), (Hales, 1989). Recent focus on climate change and 'low carbon' economics offers important new opportunities for deriving economic benefits from the ecosystem services provided by forested protected areas. However, these benefits will need to reach stakeholders on the ground if the forest habitats are to be maintained.

**Table 1 -** Limitations of national parks

| Limitation | Explanation |
|---|---|
| Size | Because they compete with human requirements for land, national parks are always limited in size which restricts their capacity to support wide-ranging species *e.g.* tigers and elephants |
| Distribution | Because of human land requirements, national parks are generally in areas less favoured by people, such as mountains or swamps. Some habitats, such as lowland forest in Indonesia, are poorly represented. |
| Edge effects | With limited size comes an increased edge effect, the impact of 'conservation unfriendly' land surrounding national parks, which can suck wildlife out of the park in a source-sink relationship |
| Connectivity | Due to the limitations on their physical placement and the impacts of surrounding land, national parks are frequently a chain of isolated 'islands' of conservation. This can have important effects on their capacity for wildlife survival. There may be several hundred tigers within Indonesia's national parks, but many of them are likely to be living in populations of only a few tens of individuals. |
| Cost | National Parks rely heavily on effective management and protection since there is rarely sufficient incentive for local people to assist in their protection. The costs of running national parks are therefore a further limitation on their extent. |
| Conflict | Conservation areas are usually gazetted and imposed by a central government, with benefits often not reaching local people that suffer the disadvantages of protected areas, leading to resentment and conflict. |

## Unprotected areas and conservation

As a result of these limitations, isolated protected areas may not be sufficient for long-term conservation of several species. However, conservation in unprotected areas has the potential to alleviate or even resolve many of the limitations described for core-protected areas. Firstly, in terms of size, if additional habitat – even if sub-optimal – can be provided outside protected areas, it can have major impacts on expanding the effective 'niche' available to a species (Pulliam, 1988). This 'overflow' area may not be sufficient on its own to support a species, but may significantly expand the capacity for a population beyond what might be predicted from the resources in the protected area alone, as well as reducing edge effects. Even more importantly, conservation success in unprotected areas could resolve the issue of connectivity between core protected areas.

Despite the potential value in alleviating the restrictions of protected areas, biodiversity on unprotected lands is under-researched and poorly understood scientifically (Shafer, 1999) with almost nothing known of the role of unprotected areas in conservation of mammals (Caro, 1999). In general, human-dominated lands outside protected areas are highly unsuitable habitats for wildlife with various studies demonstrating intolerance to disturbance and habitat change for various species. The limitations of unprotected areas are particularly clear for species with a high economic value, for example rhinoceros (Leader-Williams, Albon and Berry, 1990) and elephants (Douglas-Hamilton, 1987), both of which rely heavily upon protected areas for their survival (Western, 1989). Consequently, various priority setting exercises and conservation predictions are based upon the assumption that most species only survive in 'good' habitat – areas with low or no human presence or high forest cover for example. However, in reality, the distribution of species between wilderness areas and human-dominated landscapes is not clearly defined. Primary rainforest, for example, often does not hold the highest densities of terrestrial species since most of the biomass is found in the canopy. Many species may prefer protected and therefore non-degraded habitat, but if necessary prove to be highly adaptable at surviving in sub-optimal habitats outside protected areas. Evidence of survival is scarce, possibly because species coexisting with humans or under increased threat are far more secretive and therefore more difficult to detect (Maddox 2002), or simply because most research is focussed in areas where species survival is more obvious. However, persistent coexistence has been demonstrated between man and even the most unlikely of species outside protected areas (Maddox, 2002) and for some species, survival rates can even be better in unprotected areas. This can be true for smaller and medium carnivores, for example wild dogs (Woodroffe, Ginsberg and Macdonald, 1997) and cheetahs (Marker-Kraus and Kraus, 1994) which survive better outside core-protected areas by avoiding high densities of their predators (Creel, 1996). Other species, such as large, wide ranging carnivores, may survive better in protected areas but due to the limitations on protected area size, existing protected areas are simply too small to encompass viable populations. For example, a conservation plan for grizzly bears in the state of Idaho in the United States showed that 34% of the state was required for a viable population (Shaffer, 1992, quoted in (Noss et al., 1996). Such a large proportion of land could never be dedicated solely to conservation, thereby necessitating work outside protected areas to allow species survival.

## The importance of industrial landscapes

Whilst the importance of local communities and their land in conservation is well established in conservation theory, the importance of industrial landscapes is often overlooked, beyond their role in environmental damage. However, these landscapes must be considered for several important reasons. Firstly, the very fact that industrial concessions can be a source of environmental damage is reason in itself for engagement, in an effort to reduce it. This damage can either be direct, a consequence of activities carried out on site *e.g.* pollution or hunting; or indirect *e.g.* due to habitat loss or disturbance. The indirect effects in particular are thought to be key factors in the decline of various species. Second, industrial land is usually located in the most productive areas, for example most industrial land in Sumatra is in areas that are or were lowland tropical forest, which increases the negative impacts and hence also increases the importance of addressing these impacts. Thirdly, areas under industrial management are often under the control of a small number of people. This has the crucial advantage that if a decision is made, change can be implemented relatively quickly, easily and in an enforceable manner, in contrast to communal lands that require a consensus to reach a decision and often lack the resources to enforce it once made. Fourthly, pressure is increasing on companies to implement change as consumers around the world become more and more aware of the importance of environmental problems and their own ability to change things. Environmental issues, such as global warming, have rapidly moved from a marginal position to central determinants of company policy, and biodiversity conservation issues are moving the same way (F&C Asset Management Ltd, 2004). Movements within the forestry sector towards sustainable production are well established, with various wood certification schemes, a relatively aware consumer market and recent moves to incorporate wildlife conservation standards within this. Extraction industries are also under increasing pressure with several high profile campaigns conducted through the media and various progressive solutions being trialled, such as biodiversity offset schemes (ten Kate, Bishop and Bayon, 2004) and the creation of industry working groups specifically to address such issues, such as the EITI (Extractive Industries Transparency Initiative). The primary producers like agricultural plantations are also under fire from continued campaigns against agricultural industries such as soya bean and oil palm (*e.g.* (World Rainforest Movement, 2001b; World Rainforest Movement, 2001a), (Wakke, 2005), (Buckland, 2006), and a recent report for investors and shareholders by F&C Asset Management Ltd (2004) places food producers as one of the key areas for investment risks associated with biodiversity losses.

The options for resolving conflict between industry and conservation are wide-ranging. At one end of the scale, pressure can be placed on industries or governments to stop their activities altogether, or to site or re-site themselves away from the most sensitive areas for environmental damage. At the other end of the scale, established industries can be pressured to minimise their impacts. Campaigns to stop commercial activity in an area get headlines and, when successful, achieve important environmental results for key areas of conservation importance. In contrast, working on existing commercial landscapes to minimise impacts rarely provides clear cut environmental successes, particularly for wildlife conservation, and consequently is a poorly understood area receiving little attention. However, there is a need and a demand for the products industrial landscapes produce, the jobs they provide and the taxes they pay. Commercial landscapes are already extensive, covering huge areas, and there is a limit to how often they can be blocked or re-sited before we have to accept the challenge of incorporating them into conservation plans. Be they for agriculture, horticulture or resource extraction, industrial landscapes are a key part of any country's economy and environmentalists must face this head on if their environmental impact is to be tackled.

## Conservation in industrial landscapes in Indonesia

### Protected and unprotected areas in Indonesia

Indonesia is one of the most important centres of biodiversity in the world, with 10% of the world's flowering plants, 12% of the mammals and 17% of the birds. This diversity is not only disproportionately high – much of it is not found anywhere else. Of the approximately 500 mammal species, about one third are endemic. As with most countries, Indonesia relies on a system of protected areas to conserve its biodiversity. Compared to world averages, this accounts for a relatively large proportion of its land (12% compared to the world average of 10%, with approximately 3% as core protected areas). However, the existing protected areas are not thought to be sufficient to protect species (Jepson, Momberg and van Noord, 2002) with various evidence that even established national parks are not sufficient to fulfil their conservation functions e.g. (Gaveau, Wandonoc and Setiabudi, 2007).

However, in Indonesia the potential for wildlife benefits outside protected areas are greater than in many other countries, thanks to the relatively low level of historical land clearance and exploitation which has left large areas of unprotected land with high conservation potential still available Figure 1). Nevertheless, this situation is changing rapidly, particularly in Sumatra, with massive losses of potential habitat occurring annually. Forest cover, for example, fell from 162 million hectares to 98 million hectares between 1950 and 2000 (Glastra, Wakker and Richert, 2002) with losses from 2000-2005 estimated at 1.8 million hectares / year or 2% of the remaining forest, making it the fastest rate of deforestation in the world (FAO, 2007). The future of many of these areas currently hangs in the balance. As forest concessions reach the end of their cycle, with for example many areas no longer able to support selective logging due to excessive exploitation, decisions are being made on what to do with the land. In September 2006, the Indonesian Forestry Minister announced that 17 million hectares of lapsed or unused forestry concessions across Sumatra, Kalimantan and Sulawesi were to be offered for development by the Indonesian government with $1 billion allocated from their reforestation fund to support the work. Eight million hectares were specifically allocated to agriculture, primarily oil palm and sugar, with the aim of meeting biofuel targets. Replacing these swathes of natural forest is a patchwork of production forests, plantations and human habitations, fast becoming the prevailing landscape. Determining how to access the remaining conservation potential in this increasingly degraded and human-dominated landscape is an urgent priority.

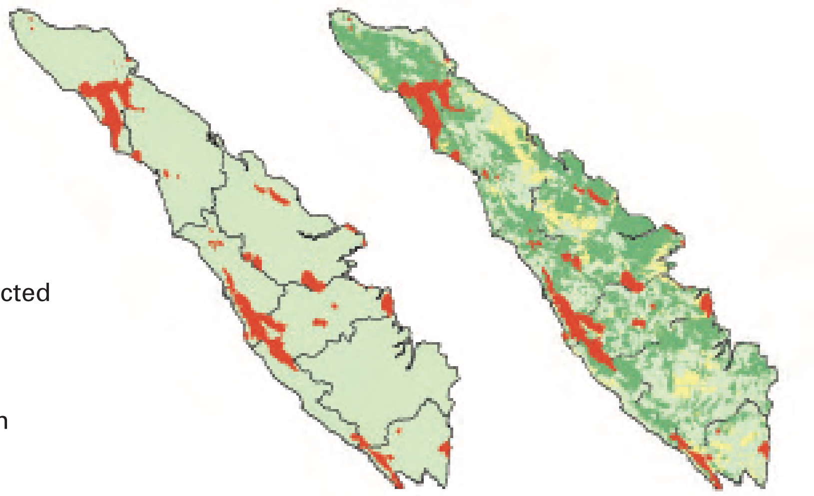


**Figure 1** -
Left: Isolated protected areas in Sumatra;
Right: the potential of unprotected forests (green) and industrial plantations (yellow) to connect protected areas.
Data from Global Forest Watch (www.globalforestwatch.org)

Indonesia's biodiversity wealth is phenomenal, but it is also home to the highest number of IUCN red listed species of any country in the world. Sumatran tigers (*Panthera tigris sumatrae*) provide a good example of the potential value of unprotected areas. Listed as "Critical" by the IUCN, and on CITES Appendix I, the Sumatran tiger is the last remaining subspecies in Indonesia following the extinctions of the Balinese tiger in the 1930s and the Javan tiger fifty years later (Seidensticker and Suyono, 1980). As a wide ranging, large and persecuted carnivore, Sumatran tigers are also particularly vulnerable to the restrictions of protected areas (Woodroffe and Ginsberg, 1998). The number thought to remain in the wild is only several hundred in protected areas (Franklin *et al.*, 1999) however these are thought to be distributed between a number of increasingly isolated protected areas with only two national parks (TN Kerinci Sablat and TN Leuser) considered large enough to hold self-sustaining populations and up to 75% of likely tiger forest habitat located outside protected areas (Philip Wells, *pers. com*). The future for tigers, if relying entirely on protected areas, looks grim; however, tigers are a surprisingly adaptable species (Sunquist, Karanth and Sunquist, 1999) and even apparently inhospitable cleared or agricultural land does not necessarily represent a barrier to them (Seidensticker, 1987). Unprotected areas could therefore play a vital role in tiger conservation, and in that of many other species, but almost no research has been carried out into this subject.

# Oil palm in Indonesia

## The oil palm crop

Of all the industrial landscapes in Indonesia, the increasing number of oil palm plantations covering the country, primarily in Kalimantan and Sumatra, presents the largest challenge to conservation. Oil palm (*Elaeis guineensis*) is a palm native to West Africa, producing fruit rich in oil from which foods and non-food products such as biofuel can be manufactured. It is a particularly efficient crop, producing an average of 3-4 tonnes of crude palm oil or about 4000 litres per hectare, compared to other leading vegetable oils such as soya (approx. 450 litres pre hectare) or corn (170 litres per hectare), though it must also be noted that it generally displaces high-biodiversity habitat due to its climatic requirements. About 80% of palm oil produced is used in human foods and the remainder in cosmetics, pharmaceuticals, animal feed and domestic products, although use as a biofuel is rapidly increasing. It has been estimated that 10% of all supermarket products contain palm oil derivatives (Rosenthal, 2007). Soy bean and oil palm are the most important sources of vegetable oil in the world; each comprises about 30% of the global market, with Malaysia and Indonesia producing nearly 90% of the oil palm (Patzek and Patzek, 2007).

## Economic importance of oil palm

Oil palm is a vital part of the Indonesian economy. Since the first plantation in 1911 oil palm has spread, primarily in the last ten years, to over 3 million hectares currently planted in Indonesia (Potter and Lee, 1999), (Wakker, 1999). In 1997 it earned 1.4 billion US$ of foreign exchange, accounting for 31% of agricultural exports (Casson, 1999). It is also one of the fastest growing sections of the Indonesian economy. Between 1975 and 1995 output of crude palm oil increased ten times, whilst consumption increases between 1990 and 1996 were higher than for any other edible oil (Potter and Lee, 1999). Global demand for palm oil is predicted to rise to 40 million tonnes by 2020 (Glastra et al., 2002) and in late 2006 palm oil futures rose by nearly 30% as demand outstripped supply. In an effort to meet this demand, "Oilworld" confirmed in 2007 that Indonesia had just overtaken Malaysia as the worlds leading producer of CPO (Crude Palm Oil), with an annual production of 17.1 million tonnes predicted for 2007 (Leow, 2007). This was 5 years earlier than the 2012 prediction Oilworld initially made in the late nineties (Casson, 1999).

Recent interest in oil palm as a source of biofuel has exacerbated this increase. First seen as a solution to the problems of carbon emissions from fossil fuels, biofuels were initially promoted for their environmental value. However, recent discussions have highlighted the negative sides to biofuel caused by the impacts of growing it (Monbiot, 2005), (Rosenthal, 2007), with particular concern over the clearance of peatlands and the net increase in carbon dioxide (Hooijer et al., 2006). Nevertheless, encouraged by the 2003 European Union Directive on Biofuels – which demands member states have 5.75% of all vehicle fuel coming from renewable sources by 2010; by America, which has deemed palm oil eligible for biodiesel tax credits (Patzek and Patzek, 2007); and by its own desire to replace 10% of its oil demands, the Indonesian government has launched a massive biofuel programme with a production target of 200,000 barrels per day by 2010. About 5 million hectares of land have been allocated specifically for biofuel development (Moghe, 2007) of which about 1.5 million hectares will be for oil palm (Krismantari, 2007). $1.4 billion has already been allocated for biofuel development in its 2007 budget, with around sixty agreements worth over $12 billion already signed.

## Environmental impact of oil palm

Oil palm represents a major direct threat to many conservation interests. Initially this is through forest clearance. Oil palm plantations require high rainfall, relatively flat land and an altitude of below 200m - the exact same conditions as tropical lowland diptocarp forest. Consequently, oil palm production has an important role in forest clearance and the associated environmental problems, in particular when fire is used illegally for land clearance. Land clearance fires are an annual occurrence in Indonesia, accounting for Indonesia's rise to third largest producer of global warming gases in the world, the highest of Kyoto signatories. In 1997 the Indonesian government accused133 oil palm companies of starting massive forest fires, which were estimated to have burnt nearly 12 million hectares or 6% of the land (Patzek and Patzek 2007).

Further problems are caused by the layout of the plantations. Between harvesting and processing oil palm fruit degenerates rapidly, meaning it cannot be transported easily. Palm oil production is therefore most efficient when the crop grown in a large monoculture around a central processing mill rather than in small-holdings interspersed with other vegetation. Such large patches of monoculture, largely devoid of biodiversity, are far less compatible with conservation interests than more heterogeneous agricultural production methods. Finally, even after establishment oil palm plantations retain the potential to impact on local wildlife populations, through various management practices resulting in pollution or in increased access to wildlife areas with consequent disturbance and hunting.

One of the biggest concerns for environmentalists is the siting of the proposed expansions of the palm oil industry. Whilst a presidential decree in 2006 stated that only idle land could be used for plantations (Krismantari, 2007), definitions of what constitutes idle land are unclear. According to the Energy and Mineral Resources Ministry, environmental damage will be minimal since expansion is not planned in protected areas (Krismantari, 2007); however, impacts which may further weaken the protected area system have not been investigated, and the Ministry's statement makes the large and unsupported assumption that no potential for either conservation or environmental damage exists outside protected areas. Besides, as a recent editorial in an Indonesian newspaper puts it, many believe "palm oil-based biofuel development is too important to cancel simply because of criticism from environmental groups" (Jakarta Post Editorial, 2007).

# Project Framework

## Study objective

The aim of this study was to investigate the impacts of palm oil on mammals and the potential for reducing these impacts. The study focused on large, terrestrial mammals, specifically the Sumatran tiger.

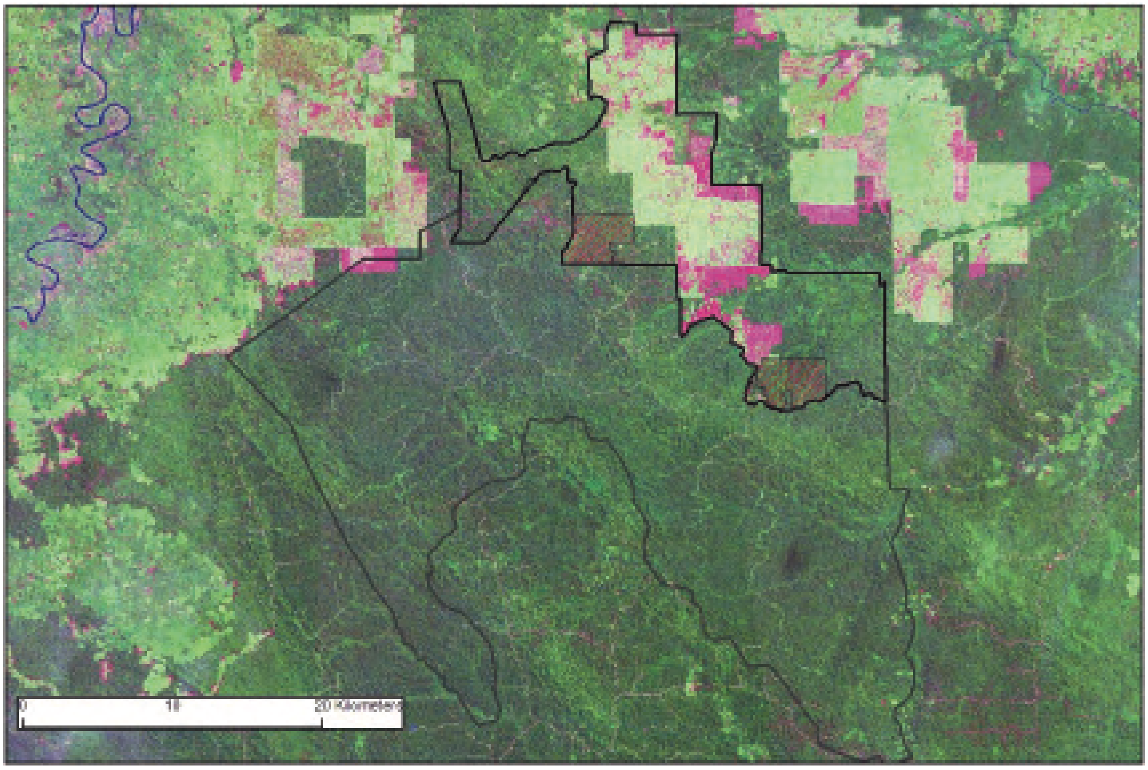
## Study location

The study was located within and around the PT Asiatic Persada oil palm concession and the adjoining PT Asialog HPH (selective logging) concession in Jambi Province on the island of Sumatra, Indonesia, approximately 90 km from the city of Jambi. The nearest major protected areas are Suaka Marga Satwa Dangku (35km) and Taman Nasional Bukit 12 (50km). The majority of work was focussed on the oil palm plantation and the fringes of the logging concession.

PT Asiatic Persada was formed in 1979 and by 1996 represented a total concession size of 27,000 hectares. A central processing mill was built in 1994 and a major phase of planting and clearing took place until 1996, with palm oil production starting in 1997. Pacific Rim Palm Oil Limited, (PRPOL), part of the Commonwealth Development Cooperation (CDC) acquired a majority holding of 51% in AP in early 2000 and took over management in February 2000. By this time major forest fires in 1997 and poor maintenance of plantings had reduced the original area of cultivated land to approximately 9000ha, with the remaining 18,000 ha consisting predominantly of clear felled areas that had re-grown as bamboo-dominated scrub and ex-logging areas that had been heavily logged but not clear-felled. From 2004 clearing and planting was restarted, with the aim of increasing production from 45,000 tonnes of crude palm oil (CPO) to 63,000 tonnes, however 15% of the concession was earmarked to remain fallow for conservation purposes (PRPOL, 2003). In 2005 PRPOL was acquired by American commodities company Cargill and in late 2006 it changed hands again to oil palm company Wilmar International.

**Figure 2** - Location of the oil palm plantation (PT Asiatic Persada) and logging concession (PT Asialog).

**Figure 3** - Land use within the study area. Dark green denotes forest, light green oil palm. Purple areas are bare land and the areas allocated to conservation are orange.

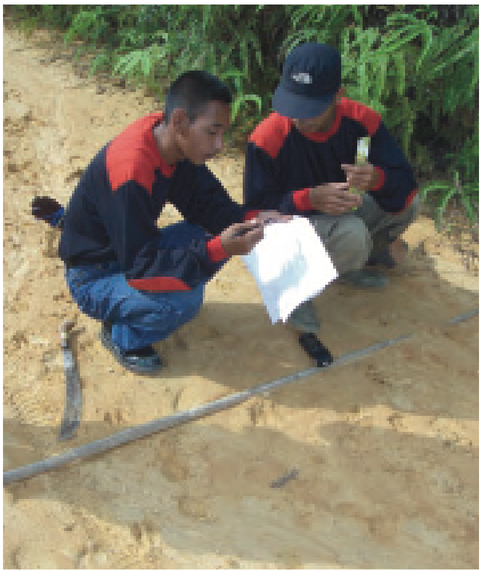



## Materials and methods

### Foot surveys

**Secondary sign transects**
Secondary signs (footprints, faeces *etc.*) of wildlife were recorded whilst walking known distances along man-made tracks as part of wildlife protection patrols. Footprints were identified using a collection of mammal footprint ID guides and all tracks are measured to allow later checking for false identifications. Records were classed according to confidence, with 1 being a positive identification and 3 being a guess. All '3's were excluded for the purpose of this report.

**Figure 4** - Left: A patrol unit records wildlife tracks. Right: A tiger pugmark.



### Occupancy surveys

A variation of the patrol transects, which continually monitored specific areas of the landscape, was a one-off occupancy survey designed to rapidly assess wildlife status and threats across the entire landscape over a short period of time. The occupancy survey operated at two levels. Firstly, presence or absence of target species (medium and large mammals) and threats across the landscape were measured. This was done using repeated sampling to estimating detection probabilities for different species or threats, thus allowing confidence levels to be calculated, as described by MacKenzie *et al.* (2002). Secondly, occupancy surveys also recorded rates at which species were detected across the landscape, giving a crude measure of distribution.

The occupancy survey was carried out in April-May 2005 using teams of two people to search 36 randomly placed 3x3 km cells for wildlife. Each cell was independently surveyed three times by three different teams, with six hours spent by each team in each cell and repeats carried out on consecutive days to reduce the possibility that animal movements and rainfall during the survey affected results. The objective within each cell was not to achieve total coverage of the $9km^2$ but to establish whether the target species were present or not, and if so how many times they were independently recorded in each cell. Therefore, within cells teams were free to search selectively and ignore areas they deemed unlikely to contain wildlife. Data were then analysed by building detection history matrices for each cell and analysis using PRESENCE software version 2.0 (Pledger 2000). For species with sufficient data the naïve estimate of occupancy, detection probability and proportion of area occupied was calculated using the "single group, constant *p*" model which had the best fit in every case.

## Camera-trapping

Camera-trapping is an increasingly widely used technique used for measuring relative abundance (Carbone et al., 2001), minimum population sizes based on individual recognition or sophisticated estimates of density based on capture mark recapture if data are sufficient (Karanth, 1995). They are suitable for a range of medium to large mammals, with previous studies focussing on tigers (Karanth and Nichols, 1998), bears (Mace et al., 1994), small carnivores (Moruzzi et al., 2002) and ungulates (O'Brien, Wibisono and Kinnaird, 2003). In this study a mixture of "Camtrakker" and "Photoscout" cameras were used with passive sensors. In almost all cases, cameras were attached to trees about 1-2m from the expected path of the animal and generally about 30-70cm above the ground (depending on vegetation length). Cameras were aimed at an animal the size of a crawling or crouching human.

### Non-random camera placement

Cameras were placed using two methods. Some cameras, referred to here as "non-random cameras" were used to target tigers and were set up on tracks with known tiger activity, particularly at junctions, to maximise the chances of a tiger passing. Ideally such cameras should be set up in pairs to allow both sides of recognisable animals to be photographed (Karanth and Nichols, 2002); however, the tiger cameras were primarily set up to keep track of already known tigers rather than to survey new areas, therefore cameras were set up singly but over a larger area. These cameras were left in place indefinitely once a successful location for tiger photos was identified.

### Random camera placement

Other cameras, referred to as "random cameras" were set up randomly so as to minimise bias in the species targeted or the chances of photographing individuals. These cameras were set up in grids of sixteen cameras in a 4x4 configuration, with 500m spacing between cameras. The grids were then placed in target areas along UTM gridlines. The actual camera position was flexible within 100m of the randomly chosen point to avoid placing cameras in positions with almost no chance of any photographs (for example in the middle of a thick bush) and cameras were placed on animal trails, tracks, watering holes or crossing points within the 100m radius. The cameras were left in position for one month, giving a maximum of 496 trap nights (16x31), if every camera worked for every night.  Analysis was carried out using the number of independent photographs for each species per trap night on which the camera was definitely working (rather than the total time in the field).

**Figure 5** – A Photoscout camera-trap (left). Following persistent theft and vandalism some cameras were set up in metal cages, sunk into concrete bases (right).

Plotting total species recorded by camera-traps over time show a curve levelling off at about 6000 trap nights, indicating that most of the camera-trappable species had been detected during the study.

**Figure 6** - Species detection rate by camera-trapping

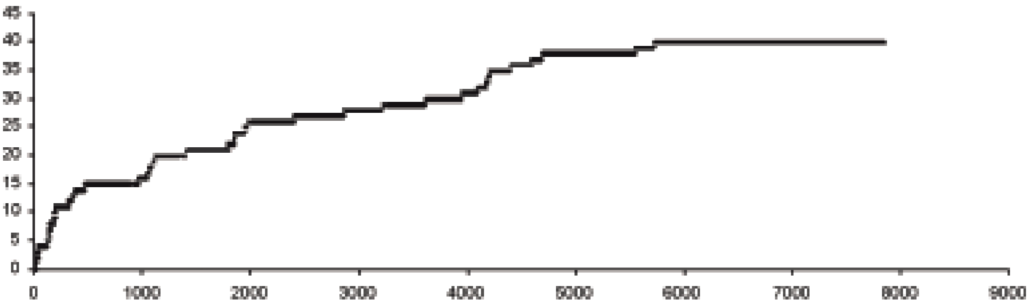
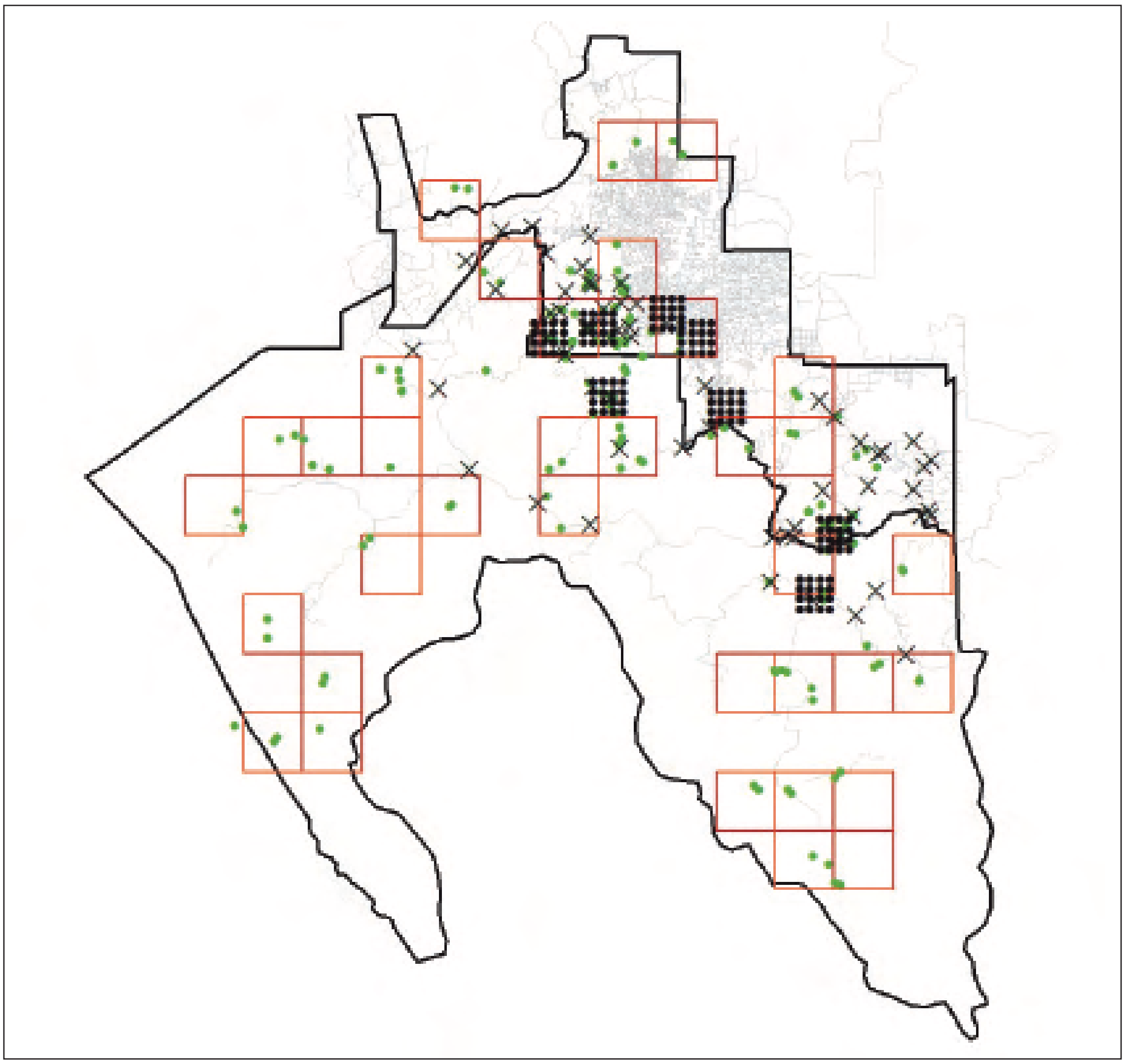


**Figure 7** - Distribution of study techniques. Crosses mark patrol transect start and end points. Black dots denote randomly placed cameras, green non-random. Red squares mark occupancy cells.



## Wildlife tracking

### Capturing wildlife

In most cases humane Aldrich snares, also known as leg-hold traps, were used. These consist of a loop of cushioned heavy-duty wire laid over a hole in the ground and attached to a tree, with tension provided by a spring. They are triggered when weight is placed on a trigger in the middle of the loop. Triggering the trap is painless. To minimise stress and injury subsequent to capture, traps were modified by padding the foot-loop with plastic tubing and by attaching a weight between the loop and the tree to act as a shock absorber. Most importantly, all leg-holds were also fitted with Telonics trap transmitters. These give a signal when traps are triggered and were monitored twenty four hours a day when traps were live, ensuring the capture team could respond as quickly as possible and minimise the time animals spent in the trap. One sun bear capture was carried out by the Department of Forestry using their own box trap.

All wildlife captures were carried out under the supervision of either the Jambi KSDA, Bart Schleyer (a professional wildlife trapper) or Dr. John Lewis (a veterinarian from Wildlife Vets International specialising in large mammal anaesthesia). For some captures all three were in attendance.

Captured animals were anaesthetised by a low pressure gas dart gun using Zoletil (tiletamine/zolazepam) for pigs, Zoletil and Medetomedine for pigs, sun bear and tapir and ketamine and Medetomedine for tigers. In addition, an innovative air-based isoflurane field anaesthesia kit (Lewis, 2004) was used to prolong anaesthesia if necessary, with the benefit of increased safety (inhaled anaesthetic is instantly adjustable and easier to administer than injectables) and smoother recovery. All captures were monitored for temperature, breathing and heart rates, long acting antibiotics were administered if there were any wounds and a range of emergency drugs were available in case of complications.

### Tracking wildlife

Radio tracking was carried out using a Telonics receiver and a Televilt extended Yagi antenna. Animal locations were determined by recording three or more bearings on the signal from different locations and triangulating a location using LOCATE software. Analysis was carried out after excluding locations with 95% confidence limits of over 200m and Minimum Convex Polygons, excluding the 5% furthest outliers, were used to estimate areas used.

**Figure 8** – From left: Bart Schleyer and BKSDA forest police setting a snare trap for tigers; Dr. John Lewis supervising a pig anaesthetic using isoflurane; radio tracking with the extendable antenna.

# Results

## Habitat definitions used in the analysis

<u>Species survival in and around oil palm was investigated at three levels:</u>

1. *Human dominated landscape* – defined as the whole area covering the working oil palm plantation and logging concession (areas 1,2 and 3 on map).
2. O*il palm concession* – defined as all habitat within the plantation concession boundary *i.e.* all land directly under control of the plantation company. This included the oil palm crop but also unplanted areas that primarily comprised heavily degraded forest and clear-felled regenerating habitat (areas 2 and 3 on map).
3. *Oil palm crop* – areas actually planted with oil palm monoculture (area 3 on map).

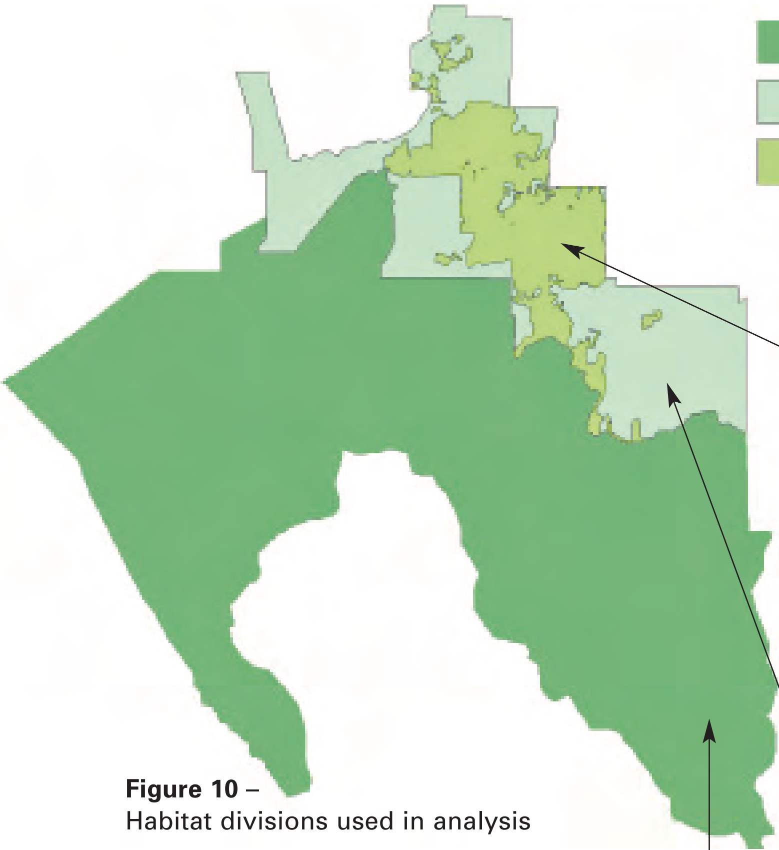



**Figure 10** –
Habitat divisions used in analysis

**Figure 9** – Oil palm crop (3)

**Figure 12** – Logging road through HPH forestry concession (1)

**Figure11** – Unplanted land within the plantation concession (2)

## Species survival within a human-dominated landscape

### Species diversity within a human-dominated landscape

A list of mammal species identified on or close to the plantation by the range of methods used on the project is presented in taxonomic order in Table 2. The list focuses on medium to large terrestrial species, since camera-trapping and track transects are not effective for arboreal species or for smaller bodied species, but small and arboreal mammals that were recorded are also listed. Bird species recorded opportunistically during the study are listed in the appendix on page 63. Species identification is confident, with 98% of species confirmed by photograph or direct sighting. Only one species (short-clawed otter) was identified by tracks alone. In Table 3 the same species are presented in terms of conservation importance using the IUCN red data list status, the Indonesian legal status (*based on Lampiran Perarturan Pemerintah Nomer 7, 1999*) and the CITES status for each species recorded at the study site. Conservation importance is ranked according to IUCN status > Indonesian protection status > CITES status. Those in red are priority species of key conservation concern and considered 'threatened' by the IUCN. Species in orange are species that are judged by the IUCN as being close to being threatened, or expected to be in the near future, or species with insufficient data to judge. Species in yellow are not considered high priority globally by the IUCN but are still protected species within Indonesia therefore plantations still have a legal responsibility for them.

The results show a wide range of species inhabiting the area of the oil palm plantation, with 40 mammals listed in total (38 not including domestic species). Of these, 63% have an important conservation value or are protected under national law, and 25% are listed as 'Vulnerable' or higher on IUCN red lists. The tiger is the most endangered species recorded on site, rated as 'Critical'. Asian elephants (*Elephas maximus*) and dhole or wild dog (*Cuon alpinus*) are the next most endangered. Elephants were only ever recorded once on the fringes of the site, but dhole were a fairly frequent sighting.

**Figure 13** - Mammals of high conservation importance recorded in the plantation landscape: clockwise from top left – tiger, clouded leopard, tapir, sun bear, dhole.

**Table 2** - Mammal species recorded in the oil palm-dominated landscape

| Order | Latin name | Common name | Photos | Tracks | Faeces | Sightings |
|---|---|---|---|---|---|---|
| Artiodactyla | *Cervus unicolor* | Sambar | 41 | 748 | 32 | 10 |
| | *Muntiacus muntjak* | Muntjac | 101 | 297 | 28 | 8 |
| | *Sus barbatus* | Bearded pig | 442 | 0 | 0 | 8 |
| | *Sus scrofa* | Pig (wild) | 1861 | 48 | 583 | 58 |
| | *Tragulus napu* | Greater mouse deer | 12 | 15 | 0 | 1 |
| | | | | | | |
| Carnivora | *Canis familiaris* | Domestic dog | 59 | 7 | 0 | 3 |
| | *Cuon alpinus* | Dhole | 29 | 7 | 3 | 1 |
| | *Catopuma temminckii* | Golden cat | 0 | 1 | 0 | 2 |
| | *Felis cattus* | Domestic cat | 5 | 0 | 0 | 39 |
| | *Neofelis nebulosa* | Clouded leopard | 3 | 11 | 1 | 0 |
| | *Panthera tigris sumatrae* | Tiger | 115 | 184 | 25 | 4 |
| | *Prionailurus bengalensis* | Leopard cat | 201 | 324 | 1069 | 110 |
| | *Prionailurus viverrinus* | Fishing cat | 0 | 0 | 8 | 1 |
| | *Herpestes brachyurus* | Short-tailed mongoose | 25 | 11 | 0 | 2 |
| | *Mydaus javanensis* | Malay badger | 1 | 0 | 0 | 0 |
| | *Aonyx cinereus* | Small-clawed otter | 0 | 1 | 0 | 0 |
| | *Lutra sumatrana* | Hairy-nosed otter | 0 | 3 | 1 | 0 |
| | *Lutrogale perspicillata* | Smooth-coated otter | 0 | 7 | 3 | 2 |
| | *Martes flavigula* | Yellow-throated marten | 2 | 0 | 0 | 2 |
| | *Helarctos malayanus* | Sun bear | 45 | 116 | 3 | 5 |
| | *Arctictis binturong* | Binturong | 0 | 10 | 0 | 1 |
| | *Hemigalus derbyanus* | Banded palm civet | 2 | 0 | 30 | 0 |
| | *Paradoxurus hermaphroditus* | Common palm civet | 58 | 235 | 2156 | 51 |
| | *Viverra tangalunga* | Malay civet | 18 | 4 | 0 | 2 |
| | | | | | | |
| Erinaceomorpha | *Echinosorex gymnura* | Moon rat | 0 | 2 | 1 | 2 |
| | | | | | | |
| Perissodactyla | *Tapirus indicus* | Malayan tapir | 63 | 506 | 4 | 1 |
| | | | | | | |
| Pholidota | *Manis javanica* | Pangolin | 3 | 8 | 0 | 1 |
| | | | | | | |
| Primates | *Macaca fascicularis* | Long-tailed macaque | 67 | 6 | 0 | 9 |
| | *Macaca nemestrina* | Pig-tailed macaque | 855 | 13 | 2 | 14 |
| | *Presbytis cristata* | Silvered langur | 0 | 0 | 0 | 1 |
| | *Presbytis melalophos* | Banded langur | 1 | 0 | 0 | 11 |
| | *Hylobates agilis* | Agile gibbon | 0 | 0 | 0 | 5 |
| | *Symphalangus syndactylus* | Siamang | 0 | 0 | 0 | 5 |
| | *Nycticebus coucang* | Slow loris | 0 | 0 | 0 | 4 |
| | | | | | | |
| Proboscidea | *Elephas maximus* | Asian elephant | 0 | 1 | 1 | 0 |
| | | | | | | |
| Rodentia | *Hystrix brachyura* | East Asian porcupine | 150 | 239 | 4 | 6 |
| | *Trichys fasciculata* | Long-tailed porcupine | 1 | 1 | 0 | 0 |
| | *Callosciurus prevostii* | Prevost's squirrel | 0 | 0 | 0 | 4 |
| | *Petaurista petaurista* | Red giant flying squirrel | 0 | 0 | 0 | 2 |
| | | | | | | |
| Scandentia | *Tupaia glis* | Common tree shrew | 1 | 0 | 0 | 4 |

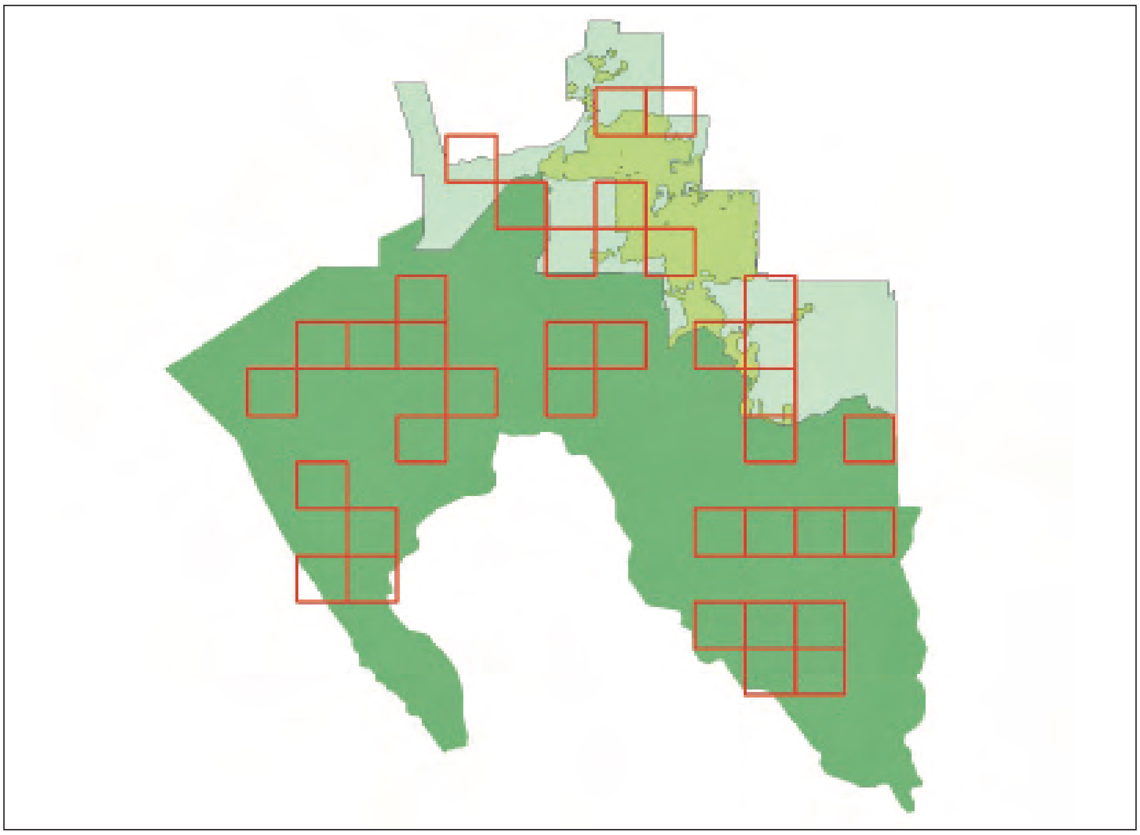
**Table 3** – Conservation and protection status of mammals occurring in and around oil palm plantations. Colours highlight species of key conservation importance.

| Latin name | Common name | Red list category | Indonesian status | CITES Appendix |
|---|---|---|---|---|
| *Panthera tigris sumatrae* | Tiger | Critically Endangered | Protected | I |
| *Elephas maximus* | Asian elephant | Endangered | Protected | I |
| *Cuon alpinus* | Dhole | Endangered | Protected | II |
| *Catopuma temminckii* | Golden cat | Vulnerable | Protected | I |
| *Neofelis nebulosa* | Clouded leopard | Vulnerable | Protected | I |
| *Tapirus indicus* | Malayan tapir | Vulnerable | Protected | I |
| *Helarctos malayanus* | Sun bear | Vulnerable* | Protected | I / II |
| *Macaca nemestrina* | Pig-tailed macaque | Vulnerable | Protected | II |
| *Prionailurus viverrinus* | Fishing cat | Vulnerable | Protected | II |
| *Hystrix brachyura* | East Asian porcupine | Vulnerable | Protected | Not listed |
| *Lutrogale perspicillata* | Smooth-coated otter | Vulnerable | Not protected | II |
| | | | | |
| *Hylobates agilis* | Agile gibbon | Near threatened | Protected | I |
| *Symphalangus syndactylus* | Siamang | Near threatened | Protected | I |
| *Manis javanica* | Pangolin | Near threatened | Protected | II |
| *Presbytis melalophos* | Banded langur | Near threatened | Protected | II |
| *Macaca fascicularis* | Long-tailed macaque | Near threatened | Not protected | II |
| *Aonyx cinereus* | Small-clawed otter | Near threatened | Not protected | Not listed |
| *Lutra sumatrana* | Hairy-nosed otter | Data deficient | Protected | II |
| | | | | |
| *Nycticebus coucang* | Slow loris | Least concern | Protected | II |
| *Prionailurus bengalensis* | Leopard cat | Least concern | Protected | II |
| *Arctictis binturong* | Binturong | Least concern | Protected | III |
| *Cervus unicolor* | Sambar | Least concern | Protected | Not listed |
| *Muntiacus muntjak* | Muntjac | Least concern | Protected | Not listed |
| *Mydaus javanensis* | Malay badger | Least concern | Protected | Not listed |
| *Tragulus napu* | Greater mouse deer | Least concern | Protected | Not listed |
| | | | | |
| *Hemigalus derbyanus* | Banded palm civet | Least concern | Not protected | II |
| *Tupaia glis* | Common tree shrew | Least concern | Not protected | II |
| *Herpestes brachyurus* | Short-tailed mongoose | Least concern | Not protected | III |
| *Martes flavigula* | Yellow-throated marten | Least concern | Not protected | III |
| *Paradoxurus hermaphroditus* | Common palm civet | Least concern | Not protected | III |
| *Callosciurus prevostii* | Prevost's squirrel | Least concern | Not protected | Not listed |
| *Echinosorex gymnura* | Moon rat | Least concern | Not protected | Not listed |
| *Petaurista petaurista* | Red giant flying squirrel | Least concern | Not protected | Not listed |
| *Sus barbatus* | Bearded pig | Least concern | Not protected | Not listed |
| *Sus scrofa* | Pig (wild) | Least concern | Not protected | Not listed |
| *Trichys fasciculate* | Long-tailed porcupine | Least concern | Not protected | Not listed |
| *Viverra tangalunga* | Malay civet | Least concern | Not protected | Not listed |
| *Presbytis cristata* | Silvered langur | Not listed | Not protected | Not listed |

*Listed as 'data deficient' in 2006 but an upgrading to 'vulnerable' is currently in process

## Species distribution across a human-dominated landscape

**Figure 14** – Distribution of randomly placed survey cells used to measure species occupancy across the landscape



Repeated walked transects were conducted in 2005 within 36 randomly placed 4km$^2$ survey cells to measure how much of the landscape different species occupied and where distribution was concentrated. Occupancy analysis of species presence /absence in each of the cells (Table 4) was used to estimate true occupancy based on measures of detectability. The results show that pigs, leopard cats and porcupines were the most widespread across the landscape, occurring in almost every transect and habitat. Muntjac, sambar, sun bear and pig-tailed macaque also showed good distribution, estimated to occupy over 80% of the landscape. Tapir, however, were absent from 25% of the landscape, clouded leopards from nearly half the landscape and tigers occurred in less than 10% of the landscape.

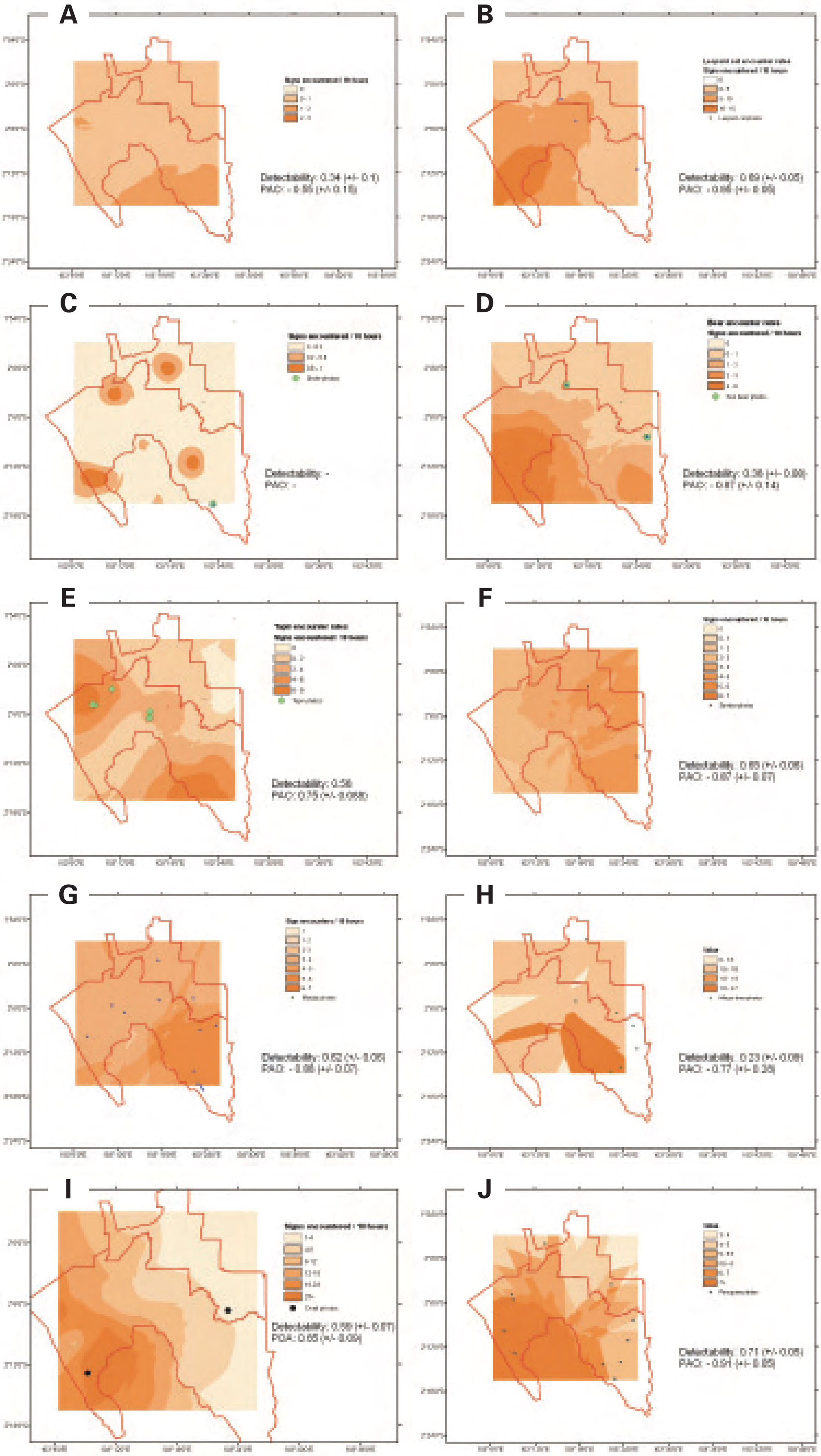
Mapping the frequency of detection within cells and interpolating results using GIS gives a measure of species distribution across the landscape. The results (Figure 15) show that all species, including those able to survive in oil palm, were more evident outside the oil palm. These results were particularly strong for tiger, clouded leopard, tapir and sun bear.

**Table 4** - Occupancy analysis for twelve main species

| **Species** | **Naïve occupancy Estimate** | **Detection probability (*p*)** | **p(SE)** | **PAO** | **SE** |
|---|---|---|---|---|---|
| Pig sp.* | 1 | 1 | 0 | 1 | 0 |
| Leopard cat | 0.92 | 0.69 | 0.052 | 0.95 | 0.05 |
| Porcupine sp. | 0.89 | 0.71 | 0.050 | 0.91 | 0.05 |
| Muntjac | 0.83 | 0.62 | 0.059 | 0.88 | 0.07 |
| Sambar | 0.83 | 0.65 | 0.057 | 0.87 | 0.07 |
| Sun bear | 0.67 | 0.38 | 0.077 | 0.87 | 0.14 |
| Pig-tailed macaque | 0.47 | 0.25 | 0.089 | 0.82 | 0.26 |
| Mouse deer sp. | 0.42 | 0.23 | 0.093 | 0.77 | 0.28 |
| Tapir | 0.69 | 0.58 | 0.067 | 0.75 | 0.09 |
| Civet sp. | 0.61 | 0.59 | 0.071 | 0.65 | 0.09 |
| Clouded leopard | 0.39 | 0.34 | 0.100 | 0.55 | 0.15 |
| Long-tailed macaque | 0.22 | 0.22 | 0.125 | 0.43 | 0.23 |
| Tiger | 0.08 | 0.63 | 0.049 | 0.09 | 0.05 |

*Pig evidence occurred in every repeat of every transect, although species could not be determined by tracks

**Figure 15** - Distribution maps based on GIS interpolation of track encounter rates. Clouded leopard (A), leopard cat (B), dhole (C), sun bear (D), tapir (E), sambar (F), muntjac (G), mouse deer (H), civet sp. (I), East Asian porcupine (J). (Tiger on p42)



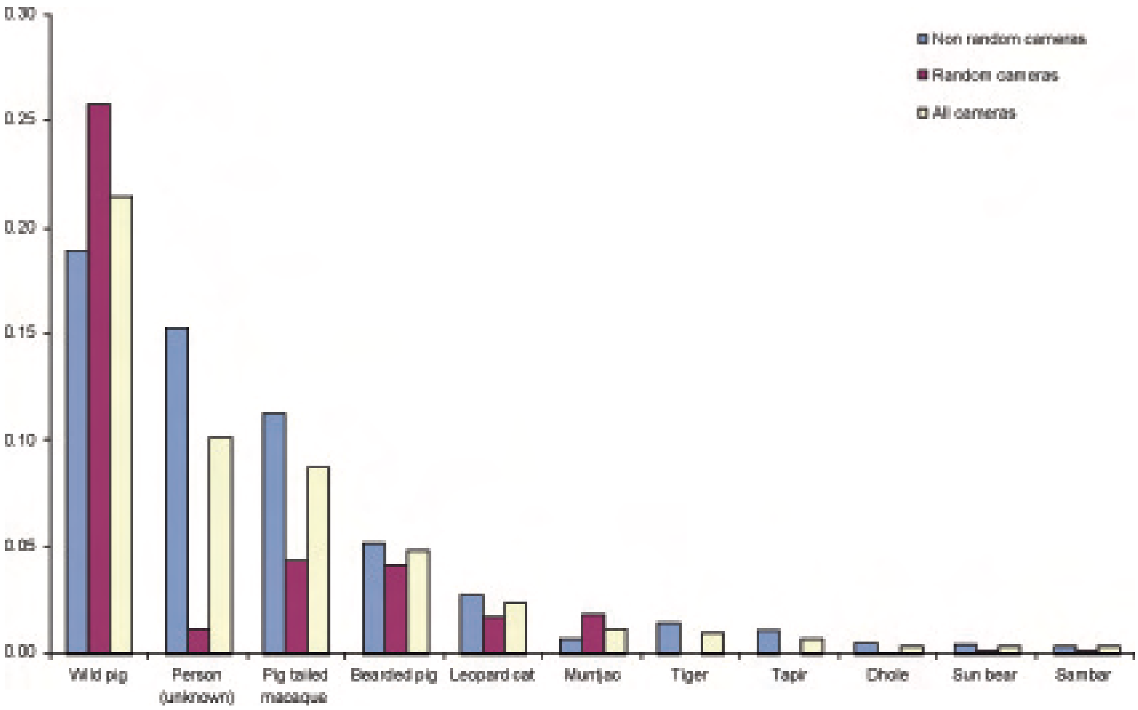
## Relative abundance of species across a human-dominated landscape

Relative abundance for the top ten most common large mammal species was measured using camera-trapping rates from over 7000 trap nights, with results presented separately for randomly placed cameras (2587 trap nights) and non-random (tiger-targeted) cameras (4515 trap nights). The number of 'unknown' people photographs (*i.e.* not plantation or conservation staff) is also included for comparison. The results (Table 5 and Figure 16) show that wild pig are by far the most common species on site, closely followed by pig-tailed macaques and bearded pig. Based on randomly placed cameras only, which should give less bias estimates of abundance, leopard cats, muntjac, sambar and sun bear were the next most common species, but placing cameras specifically for tigers showed that tiger, tapir and dhole were also photographed regularly.

**Table 5** - Trapping rates from random and non random placed cameras

| | **Non random cameras** | | **Random cameras** | | **All cameras** | |
|---|---|---|---|---|---|---|
| Species | Photos | Photos/trap night | Photos | Photos/trap night | Photos | Photos/trap night |
| Wild pig | 856 | 0.19 | 669 | 0.26 | 1525 | 0.22 |
| Person (unknown) | 691 | 0.15 | 31 | 0.01 | 722 | 0.10 |
| Pig-tailed macaque | 512 | 0.11 | 114 | 0.04 | 626 | 0.09 |
| Bearded pig | 235 | 0.05 | 108 | 0.04 | 343 | 0.05 |
| Leopard cat | 124 | 0.03 | 45 | 0.02 | 169 | 0.02 |
| Muntjac | 34 | 0.01 | 48 | 0.02 | 82 | 0.01 |
| Tiger | 68 | 0.02 | 0 | 0.00 | 68 | 0.01 |
| Tapir | 49 | 0.01 | 0 | 0.00 | 49 | 0.00 |
| Dhole | 25 | 0.01 | 1 | 0.00 | 26 | 0.00 |
| Sun bear | 21 | 0.00 | 3 | 0.00 | 24 | 0.00 |
| Sambar | 16 | 0.00 | 5 | 0.00 | 21 | 0.00 |

**Figure 16** – Camera-trapping rates for top ten mammals and people



## Species survival within the plantation concession

### Species diversity within the plantation concession

Species photographed within the plantation concession (*ie* all land under control of the company, including unplanted forest and scrub areas), together with species sighted opportunistically,, are listed and their conservation status given in Table 6. The results show that 34 species, or 90% of the 38 species recorded in the landscape as a whole, were also recorded within the plantation concession. Key species absent from the plantation concession included the clouded leopard, banded palm civet, fishing cat, Malay badger, siamang and elephant, although of these only clouded leopards were recorded with any frequency in the landscape as a whole. Furthermore, all of these species were found within five kilometres of the plantation border with the exception of the elephant, which was found on the opposite border about 25 km away.

**Table 6** - Species diversity within the plantation concession

| Latin name | Common name | Red list category | Indonesian status | Sightings | Photos |
|---|---|---|---|---|---|
| *Panthera tigris sumatrae* | Tiger | Critically Endangered | Protected | | 83 |
| *Cuon alpinus* | Dhole | Endangered | Protected | | 28 |
| *Catopuma temminckii* | Golden cat | Vulnerable | Protected | Yes | 0 |
| *Tapirus indicus* | Malayan tapir | Vulnerable | Protected | | 28 |
| *Helarctos malayanus* | Sun bear | Vulnerable* | Protected | | 21 |
| *Macaca nemestrina* | Pig-tailed macaque | Vulnerable | Protected | | 644 |
| *Hystrix brachyura* | East Asian porcupine | Vulnerable | Protected | | 119 |
| *Lutrogale perspicillata* | Smooth-coated otter | Vulnerable | Not protected | Yes | 0 |
| | | | | | |
| *Hylobates agilis* | Agile gibbon | Near threatened | Protected | Yes | 0 |
| *Manis javanica* | Pangolin | Near threatened | Protected | | 3 |
| *Presbytis melalophos* | Banded langur | Near threatened | Protected | | 1 |
| *Macaca fascicularis* | Long-tailed macaque | Near threatened | Not protected | | 35 |
| *Aonyx cinereus* | Small-clawed otter | Near threatened | Not protected | Yes | 0 |
| *Lutra sumatrana* | Hairy-nosed otter | Data deficient | Protected | Yes | 0 |
| | | | | | |
| *Nycticebus coucang* | Slow loris | Least concern | Protected | Yes | 0 |
| *Prionailurus bengalensis* | Leopard cat | Least concern | Protected | | 129 |
| *Arctictis binturong* | Binturong | Least concern | Protected | Yes | 0 |
| *Cervus unicolor* | Sambar | Least concern | Protected | | 20 |
| *Muntiacus muntjak* | Muntjac | Least concern | Protected | | 68 |
| *Tragulus napu* | Greater mouse deer | Least concern | Protected | | 5 |
| | | | | | |
| *Tupaia glis* | Common tree shrew | Least concern | Not protected | | 1 |
| *Herpestes brachyurus* | Short-tailed mongoose | Least concern | Not protected | | 24 |
| *Martes flavigula* | Yellow-throated marten | Least concern | Not protected | | 1 |
| *Paradoxurus hermaphroditus* | Common palm civet | Least concern | Not protected | | 46 |
| *Callosciurus prevostii* | Prevost's squirrel | Least concern | Not protected | Yes | 0 |
| *Echinosorex gymnura* | Moon rat | Least concern | Not protected | Yes | 0 |
| *Petaurista petaurista* | Red giant flying squirrel | Least concern | Not protected | Yes | 0 |
| *Sus barbatus* | Bearded pig | Least concern | Not protected | | 236 |
| *Sus scrofa* | Pig (wild) | Least concern | Not protected | | 1523 |
| *Trichys fasciculate* | Long-tailed porcupine | Least concern | Not protected | Yes | 0 |
| *Viverra tangalunga* | Malay civet | Least concern | Not protected | | 15 |
| *Presbytis cristata* | Silvered langur | Not listed | Not protected | Yes | 0 |

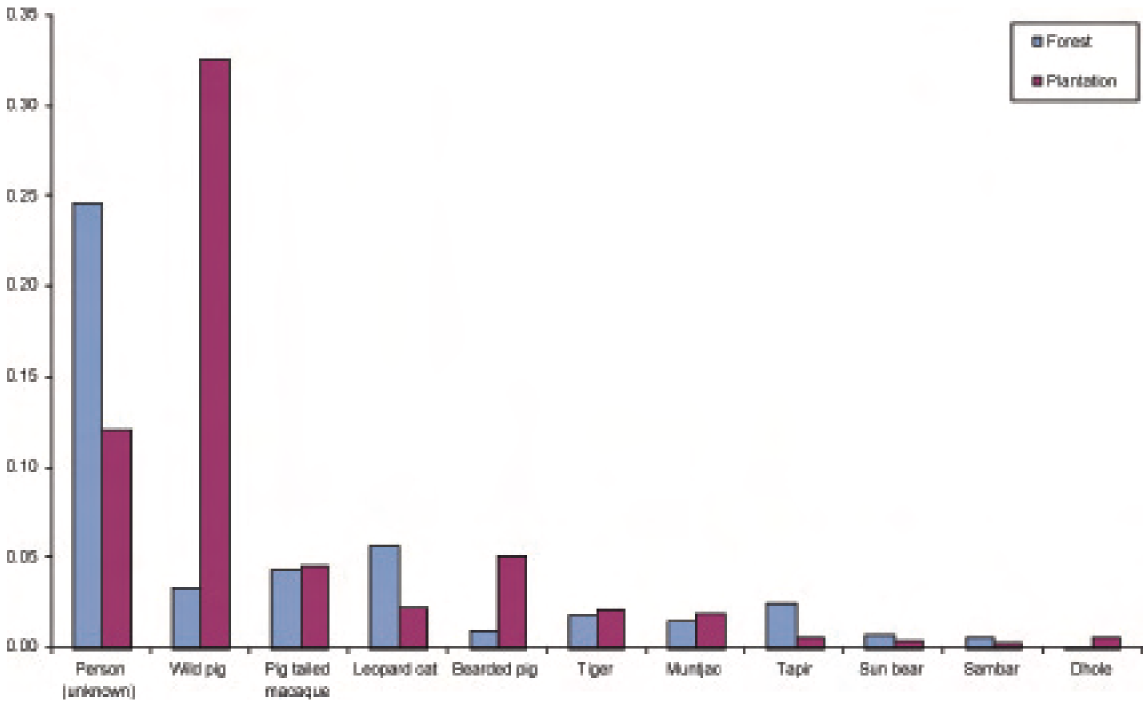
## Relative abundance within the plantation concession

To compare the plantation concession with the forest concession in more detail, camera-traps were set up in random and non-random positions either side of the border. Trapping rates were then calculated according to the species; if possible, random cameras were used. However, some species, such as tigers, were never recorded on randomly located cameras and therefore results were taken from cameras set up at good camera-trapping points (such as on logging roads and junctions). The results (Table 7, Figure 17) show that whilst tapir, leopard cat and sambar were all evident within the plantation concession, they were actually photographed more frequently outside the concession in the logging forest, although differences were only really clear for tapir and leopard cats. On the other hand, both species of pigs and also people were photographed far more frequently within the plantation concession. However, several species of note showed little difference in preferences – tigers and dhole were actually photographed more frequently within the plantation concession than outside in the forest concession. Muntjac, pig-tailed macaque and even sun bear also showed little difference between trapping rates inside and outside the plantation concession, demonstrating that the plantation concession still contained valuable habitat for a range of species.

**Table 7** - Comparison of trapping rates (photos per trap nights) inside and outside the plantation concession

| Species | Forest | Plantation | Survey method |
|---|---|---|---|
| Person (unknown) | 0.25 | 0.12 | Non random |
| Wild pig | 0.03 | 0.33 | Random |
| Pig-tailed macaque | 0.04 | 0.05 | Random |
| Leopard cat | 0.06 | 0.02 | Random |
| Bearded pig | 0.01 | 0.05 | Random |
| Tiger | 0.02 | 0.02 | Non random |
| Muntjac | 0.02 | 0.02 | Random |
| Tapir | 0.03 | 0.01 | Non random |
| Sun bear | 0.01 | 0.00 | Non random |
| Sambar | 0.01 | 0.00 | Non random |
| Dhole | 0.00 | 0.01 | Non random |

**Figure 17** – Photo-trapping rates (photos/trap night) for key species inside and outside the plantation concession



## Evidence of persistence in oil palm landscapes

Apart from abundance showing that species present on the plantation were more than transient passers-by, various other signs were recorded showing populations were part of functioning ecosystems. Firstly, evidence of breeding. Whilst not a good method for photographing young, camera-traps nonetheless still picked up evidence of breeding amongst several species, including wild and bearded pig, bear, tiger, pangolin and leopard cat.

**Table 8** – Total photographs of dependents during the study

| Subject | Total photographs |
|---|---|
| Bearded pig | 25 |
| Leopard cat | 1 |
| Muntjac | 2 |
| Pangolin | 1 |
| Pig (wild) | 184 |
| Pig-tailed macaque | 110 |
| Sun bear | 4 |
| Tiger | 16 |

**Figure 18** - Evidence of breeding amongst species detected within the plantation

## Species survival within the oil palm crop

### Species diversity within oil palm

Species presence within the oil palm crop was measured from a grid of 16 cameras placed randomly with 500m spacing. The grid was left in three different areas of the oil palm for one month in each, providing a total of 1111 camera-trap nights. These data were then supplemented with opportunistic sightings recorded whilst moving around the plantation.

Table 9 shows the species recorded and their conservation value. The results show that a sizeable number of species were recorded present at some point within the oil palm – 17 species or 45% of species known to exist in the area were recorded within the oil palm crop at some point during the study. Several of these have a conservation value, most notably sun bear, otters, pig-tailed macaques and porcupines. However, of the species recorded, just four, or 10% of species in the area, were regularly detected. Of these, none are of particular conservation importance, although leopard cats are a protected species.

**Table 9** - Species recorded in oil palm and their conservation status. Only the two pig species, leopard cats and common palm civets (in red) were detected on a regular basis

| Latin name | Common name | Red list category | Indonesian status | Sightings | Photos |
|---|---|---|---|---|---|
| *Helarctos malayanus* | Sun bear | Vulnerable* | Protected | 1 | 1 |
| *Macaca nemestrina* | Pig-tailed macaque | Vulnerable | Protected | 5 | 0 |
| *Hystrix brachyura* | East Asian porcupine | Vulnerable | Protected | 2 | 7 |
| *Lutrogale perspicillata* | Smooth-coated otter | Vulnerable | Not protected | 1 | 0 |
| | | | | | |
| *Manis javanica* | Pangolin | Near threatened | Protected | 1 | 0 |
| *Presbytis melalophos* | Banded langur | Near threatened | Protected | 1 | 0 |
| *Macaca fascicularis* | Long-tailed macaque | Near threatened | Not protected | 1 | 2 |
| | | | | | |
| *Nycticebus coucang* | Slow loris | Least concern | Protected | 1 | 0 |
| *Prionailurus bengalensis* | Leopard cat | Least concern | Protected | 95 | 37 |
| *Cervus unicolor* | Sambar | Least concern | Protected | 2 | 0 |
| *Muntiacus muntjak* | Muntjac | Least concern | Protected | 1 | 0 |
| | | | | | |
| *Tupaia glis* | Common tree shrew | Least concern | Not protected | 1 | 1 |
| *Paradoxurus hermaphroditus* | Common palm civet | Least concern | Not protected | 45 | 7 |
| *Callosciurus prevostii* | Prevost's squirrel | Least concern | Not protected | 2 | 0 |
| *Echinosorex gymnura* | Moon rat | Least concern | Not protected | 2 | 0 |
| *Sus barbatus* | Bearded pig | Least concern | Not protected | 4 | 11 |
| *Sus scrofa* | Pig (wild) | Least concern | Not protected | 22 | 303 |

### Species distribution within oil palm

Plotting the location of photographs taken during the study (Figure 19) further highlights the limitation of oil palm for most species. Of all the species detected just five (13% of species in the area) were detected in the centre of the oil palm habitat. These were the four species that were regularly recorded; common and bearded pigs, leopard cats and palm civets and also the moon rat which was probably common but was at the size limit for regular detection by the methods used. All other records of species in oil palm consisted of occasional evidence on the fringes of the oil palm.

**Figure 19** - Distribution of species recorded in oil palm, showing the only five species to be found beyond the oil palm fringe

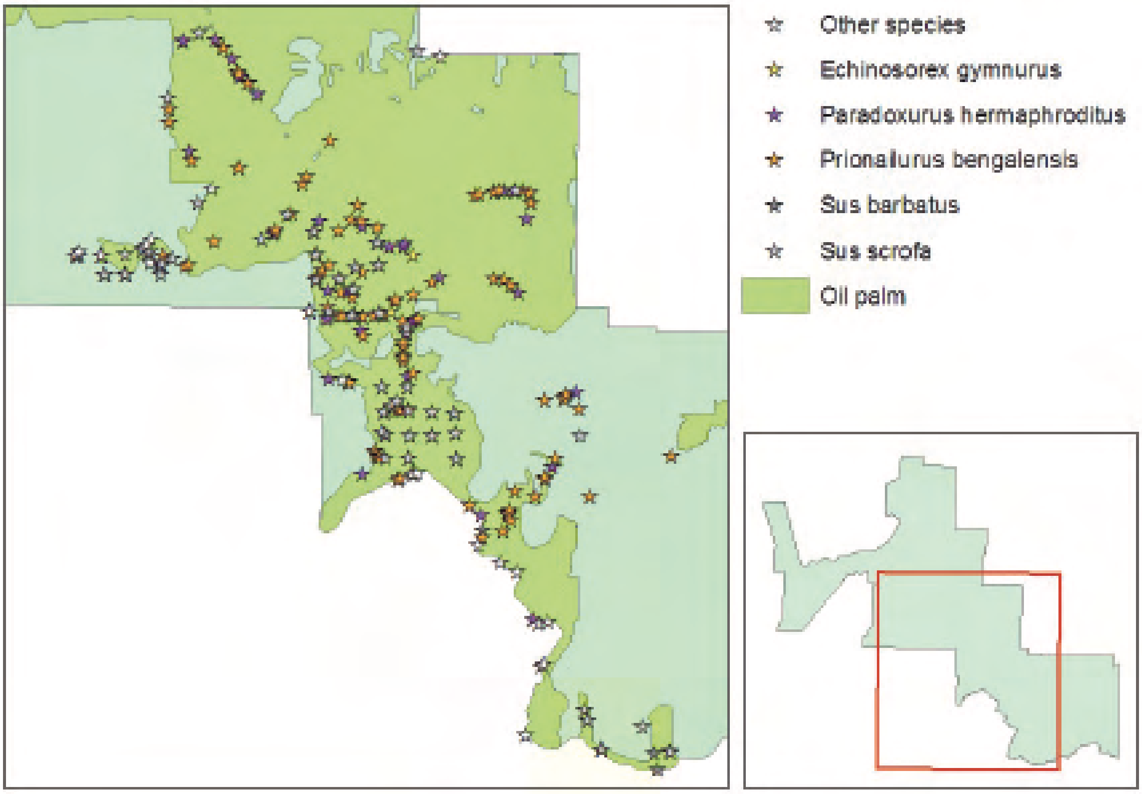



**Figure 20** - Species commonly detected in oil palm. From left to right: wild pig, bearded pig, leopard cat and common palm civet

**Figure 21** - Species protected by Indonesian law that occasionally occur in oil palm. From left to right: East Asian porcupine, pig-tailed macaque, sun bear and pangolin

## Behavioural responses to oil palm crop

Individual species responses to oil palm were investigated by trapping species occurring close to the oil palm crop and using radio tracking to follow their movements. During the study, radio collars were fitted to one Sumatran tiger (adult male), one sun bear (young male), one tapir (adult female) and two wild pigs (young adults). All individuals were released at their trapping point, with the exception of the bear which was caught in a plantation village as part of a conflict resolution operation with Jambi BKSDA and translocated to the neighbouring forest.

The results (Table 10 and Figure 22) show ranging areas for all but the bear. Results for the pigs and tiger might not be complete since collars came off all three individuals after a relatively short period (pigs; two weeks, tiger; 5-6 months), however the tapir data were collected over two years. These data show that both pigs moved through non-oil palm and oil palm habitat. In both cases the oil palm habitat was young, newly planted oil palm and both collars were found in, or very close to, oil palm when the pigs managed to free themselves.

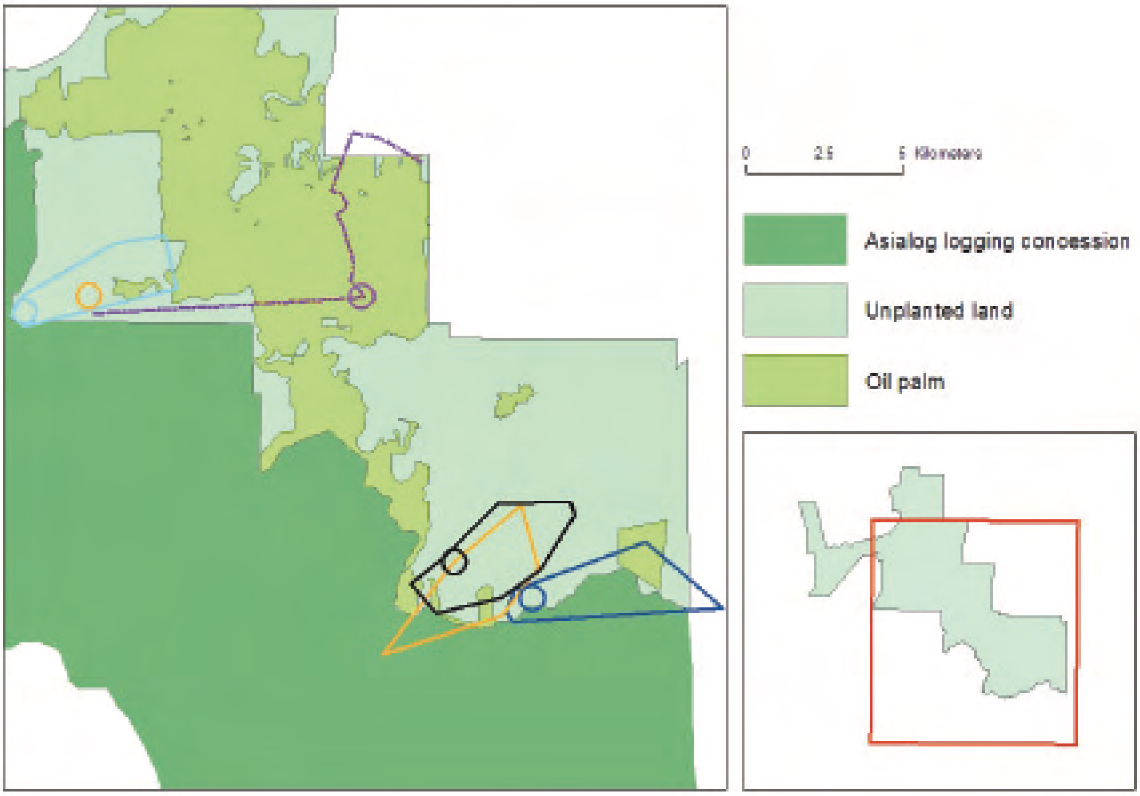
The bear also showed a tolerance for oil palm to some degree. Because of the unusual capture circumstances, no normal ranging behaviour was demonstrated. Instead, the translocated bear headed straight from his release site back to the village he was caught in. After staying there for several days he then moved on of his own accord, disappearing from his trackers in village lands north of the plantation. Whilst not showing much with regards to range overlap with oil palm, the experience did demonstrate that sun bears can move through oil palm if need be. However, due to the ease of radio tracking in oil palm, the bear could be located fairly accurately whilst crossing the plantation, sometimes supported with visual sightings. Because of this we know that on every occasion he was located the bear was always in a patch within the oil palm crop – within river buffer zone vegetation or isolated patches of unplanted land. Whilst it is evident he had travelled through the oil palm to get there, in the daytime he was always hiding in the better cover afforded by these areas.

The tapir and tiger on the other hand showed no evidence of any tolerance to oil palm. In nearly three years the tapir was never recorded within the oil palm, although she was always very close. Interestingly she also never crossed into the forest, remaining in the highly degraded and treeless scrub within the plantation concession. It is possible the tiger moved through a strip of oil palm when crossing to the forest concession, but this oil palm was neglected and heavily overgrown at the time of the study. Furthermore, just before the tiger was captured, a tiger was witnessed crossing the boundary road in that area from a point that was unplanted on both sides. The tiger was also caught a long way from its apparent normal range with oil palm between the two locations. Although the signal was lost in the few weeks it took to move from one area to the other, we were fairly confident it moved through the forest, since the signal could be checked for regularly in the accessible oil palm but was difficult to check in the relatively inaccessible forest.

**Table 10** - Home ranges (95% MCP) for three tiger prey species from radio tracking data

| Species | Name | 95% MCP ($km^2$) |
|---|---|---|
| Sun bear | Arsat | - |
| Tiger | Slamet | 12.2 |
| Tapir | Shergar | 6.2 |
| Wild pig | Chrispy Bacon | 5.4 |
| Wild pig | Sausage | 6.6 |

**Figure 22** - Ranges for two wild pig (light and dark blue), tapir (black), tiger (orange) and sun bear (purple) from radio tracking fixes. Circles denote capture points for each species.




## Species focus: Sumatran tigers and oil palm

As the most endangered and high profile species found to occur on the plantation, effort was concentrated on monitoring the local Sumatran tiger population and attempting to determine how tigers were surviving so far from any protected areas. Results are presented on various aspects of population dynamics, ranging ecology and explanations of population change. They show tiger densities around the plantation set-aside areas comparable to those in protected areas at the beginning of the study, with tigers apparently using the plantation as part of their ranges which also extended into the forest concession. However, tiger sign declined sharply in 2004, coinciding with conflict over the conservation areas and the start of clearing by local settlers. A large scale survey of the entire landscape conducted in 2005 found no evidence of tigers in the plantation, no evidence of the original plantation tigers in the forest concession and overall occupancy of the landscape was estimated at under 10% with only three individuals recorded on camera.

## Tigers on the plantation 2001-2002

### Population size

At the beginning of the study, tiger evidence was abundant. Within the first two years of the study, 113 photographs of 11 different tigers were taken in two areas of about $50km^2$ each, with evidence of a further 5 cubs from direct sightings (cubs rarely appeared on camera due to the delay built in to all camera-traps that means only the first tiger in a group is usually photographed). Four tigers represented nearly 80% of the photographs and these were considered resident. Converting trapping rates to densities according to the methods of Carbone (Carbone *et.al.* 2001) estimated similar densities of 10-17 tigers / $100km^2$ over the two years. Results are summarised in Table 11 and Table 12.

**Table 11** - Summary of all known tigers in and around the plantation 2002-4

| ID | Status | Sex | Age | Area | Notes |
|---|---|---|---|---|---|
| Flash | Resident | Male | Adult | Jammer Tulen, NW Asialog | Probably father of Wendy's cubs. Not been photographed since March following regular photographs previously. |
| Wendy | Resident | Female | Adult | Jammer Tulen, palm border, NW Asialog | Bred at least twice. Often near oil palm habitat. |
| - | Wendy cub A1 | | Unknown | | 1st litter present when project began. Photographed once whilst with mother. |
| - | Wendy cub A2 | | Unknown | | 1st litter present when project began. Photographed twice whilst with mother. By Nov 01 looked fully grown but still with mother. |
| - | Wendy cub B1 | | Unknown | | 2nd litter born ~ April 2002. Seen by scouts in August 2002 but no camera-trap records. Tracks indicate not all three survived? |
| - | Wendy cub B2 | | | | 2nd litter born ~ April 2002. Seen by scouts in August 2002 but no camera-trap records. Tracks indicate not all three survived? |
| - | Wendy cub B3 | | | | 2nd litter born ~ April 2002. Seen by scouts in August 2002 but no camera-trap records. Tracks indicate not all three survived? |
| Shakira | | Female? | Young adult? | NW Asialog | Possibly Wendy cub A1. Definitely not A2. Stripe patterns similar to Wendy |
| Subuh | | Female? | Unknown | Jammer Tulen | Photographed once in 2001. Stripes similar to Wendy and seen in her area. Cub from previous litter? |
| Unidentified 1 | | Female | Young adult? | Jammer Tulen | Possibly other side of Shakira – stripes similar |
| Unidentified 2 | | Unknown | Unknown | Jammer Tulen | Can't match but poor quality |
| Slamet | | Male | Adult, 6-7 yrs | Bungin, NE Asialog, at least once in Jammer Tulen | Radio collared in May 2003. Lost collar in Dec 2003 / Jan 2004 |
| Tiga Jari | Resident | Female | Adult | Bungin, prob. NE Asialog | Three toes on one foot |
| Eve | Tiga Jari cub A1 | Female | Sub adult | Bungin | Originally seen associated with Tiga Jari in Bungin – probably her cub. |
| Mambo | Tiga Jari cub A2 | Unknown | Sub adult | Bungin, Jammer Tulen | Originally seen associated with Tiga Jari in Bungin – probably her cub. Last seen in Jammer Tulen. |
| Mo | Resident? | Female | Adult? | Asialog, south of Bungin | Never seen inside the plantation. Seen on a camera-trap that Slamet also appears on within 24 hours of one another. |

**Table 12** - Estimated tiger densities from photo-trapping rates 2001-2

| Year | Tiger photos | Trapping effort | Photos/trap night | Trap nights/photo | Density (tigers/100 sq.km) |
|---|---|---|---|---|---|
| 2001 | 14 | 214 | 0.0700 | 15 | 11.98 |
| 2002 | 22 | 251 | 0.0700 | 11 | 16.66 |

## Ranging patterns

Ranging patterns were investigated using camera-trap data for all individuals and radio tracking from a single, adult male captured in 2003 and tracked for six months before his collar slipped off. Both methods showed extensive use of the plantation concession and forest concession by almost all resident tigers, the exception being Tiga Jari who lived on the border with the forest but was never detected outside the plantation concession. Calculated ranges were similar for both methods for the other three, showing tigers were ranging over at least 14km$^2$. However, these results are likely to be highly limited by camera placement (which was not designed to measure home range) and tracking ability in forest (where the signal was never picked up) and these are not considered to represent complete ranges (Figure 23, Table 13).

**Figure 23** - Tiger ranges (calculated from camera-trap data and radio tracking fixes where available) for the four most photographed individuals

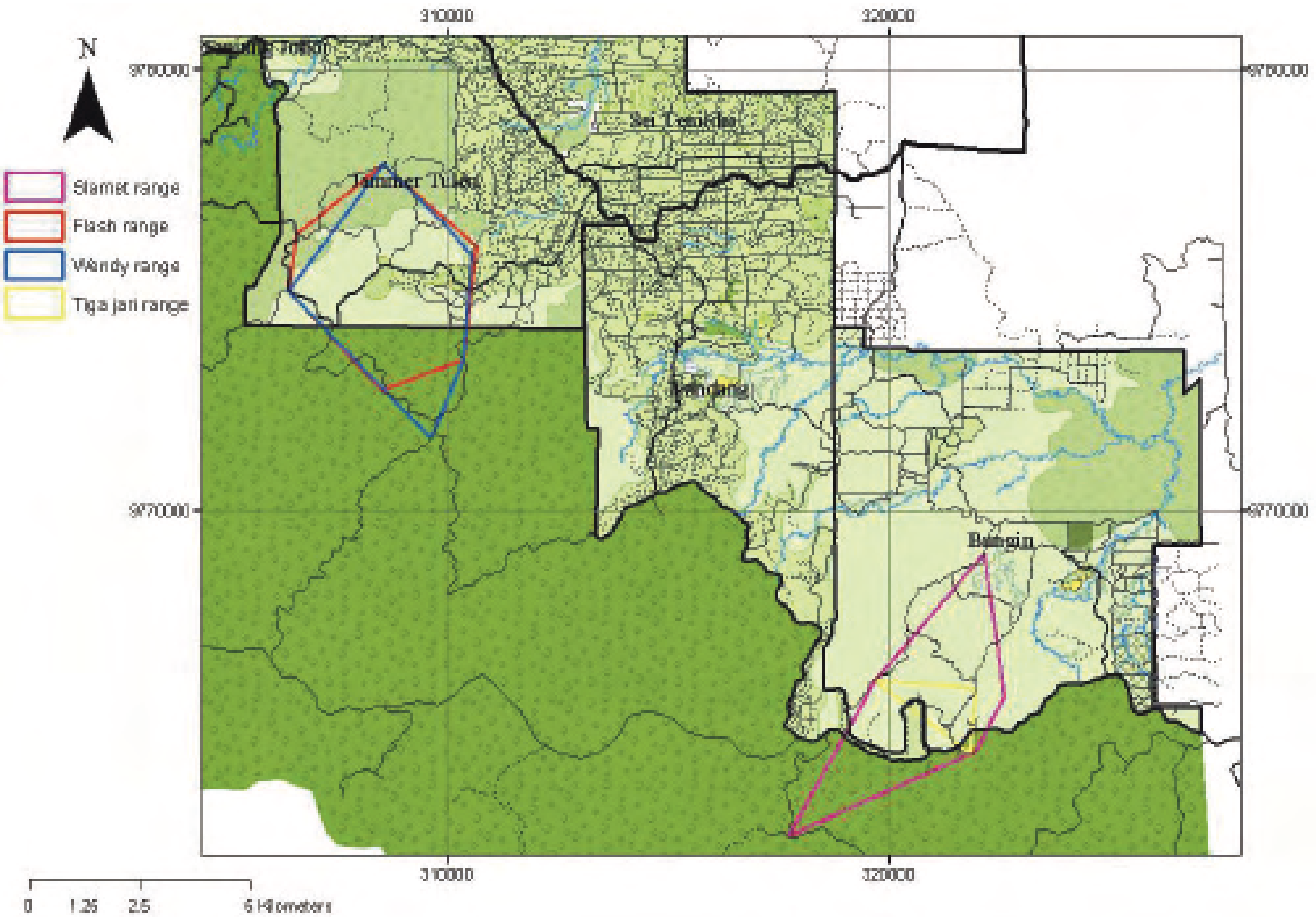


**Table 13** - Tiger ranges as calculated from camera-traps and radio tracking data

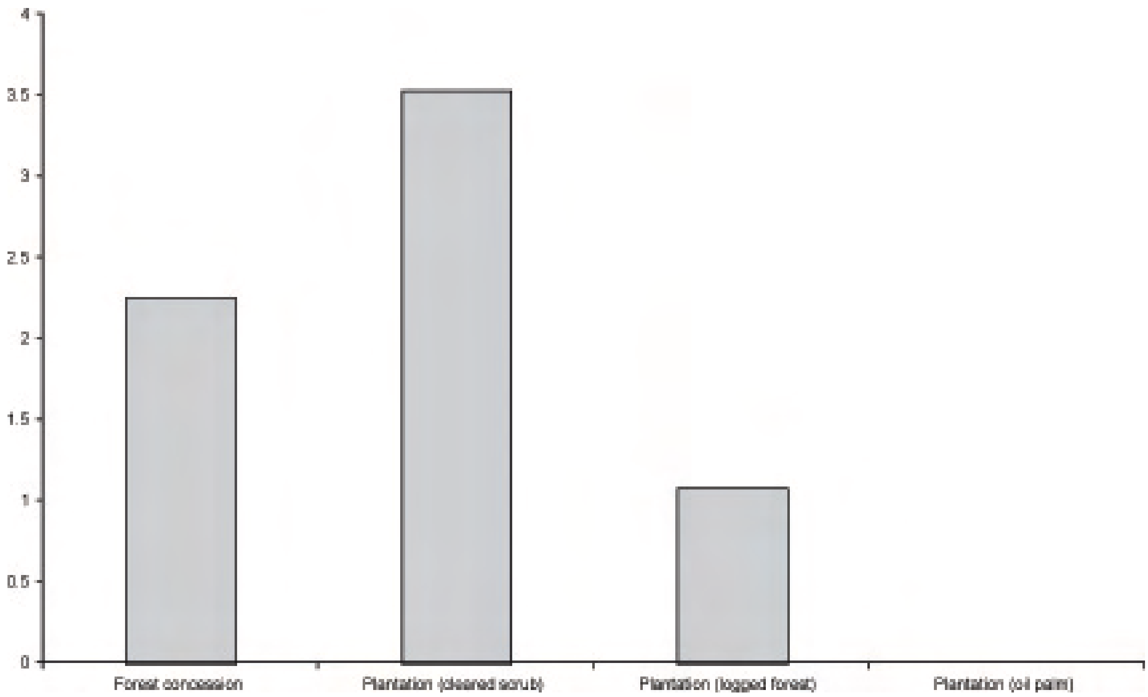
| Individual | Sex | Area ($km^2$) |
|---|---|---|
| Slamet | Male | 12.2 |
| Tiga Jari | Female | 1.7 |
| Flash | Male | 14.2 |
| Wendy | Female | 14.0 |

Despite ranges extending across the concessions, tigers were photographed more often in habitats within the plantation. Using data from 'tiger' (non-random) cameras only (random cameras never took a photograph of a tiger) photo-trapping rates were calculated for each of the three broad habitat types within the plantation and compared with trapping rates in the forest concession. The results show that tigers were actually photographed more often inside the plantation concession than in the forest concession. However, tigers appeared to avoid the oil palm crop - neither camera-traps or radio tracking ever showed a tiger ranging into the oil palm (Table 14 and Figure 24).

**Table 14** - Trapping rates (photos/100 trap nights) for tigers in different habitats

| Region | Habitat | Non random cameras |
|---|---|---|
| Forest concession | Forest | 2.26 |
| Forest total | | 2.26 |
| | | |
| Plantation | Forest | 1.08 |
| | Palm | |
| | Scrub | 3.54 |
| Plantation total | | 3.08 |
| Total | | 2.90 |

**Figure 24** - Camera-trapping rates in different habitats from "tiger" cameras only



## Tigers on the plantation 2003-2006

### Population decline

Although tiger evidence was abundant in 2001-2002, from 2003-2004 signs of tigers decreased dramatically and photographic records of several individuals stopped abruptly in mid – late 2003 (Table 15). The decline in terms of photo-trapping rates, and correlated density estimates, described a rapid decline in the local population and no tiger has been recorded on the plantation concession since late 2004.

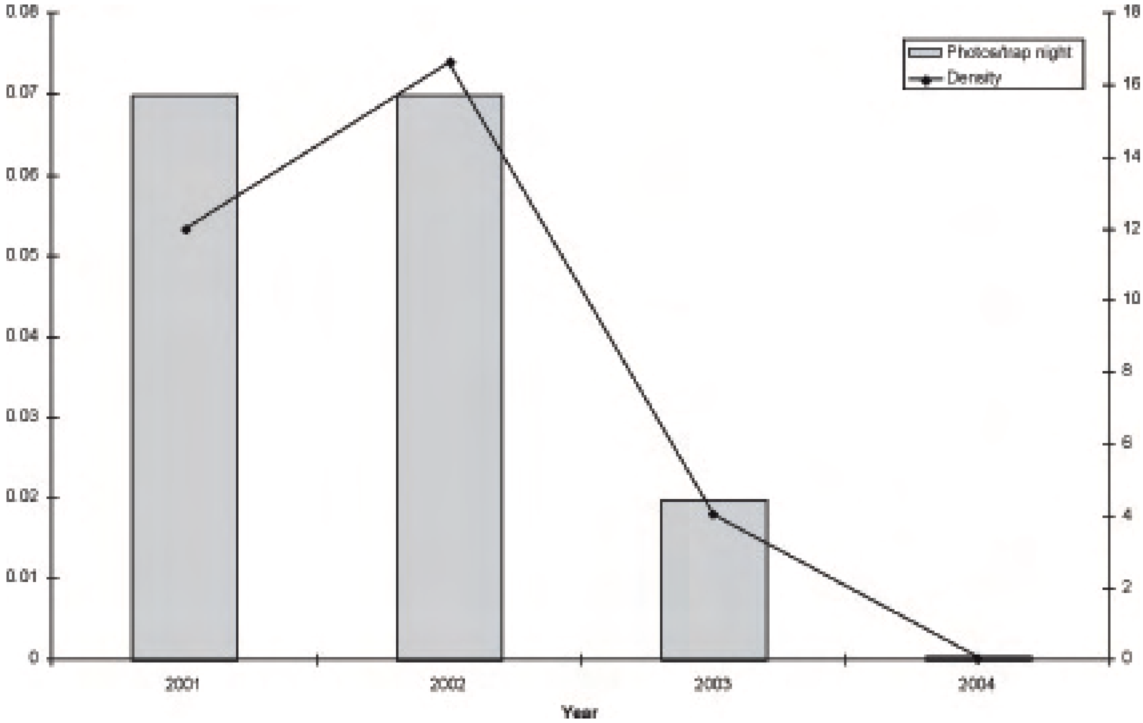
**Table 15** - Composition of tiger photographs taken by camera-traps

| Tiger | Side photographed | | Sex | Age | Last seen | % total |
|---|---|---|---|---|---|---|
| | Left | Right | | | | |
| Wendy | 17 | 9 | F | Adult | 12 August 2003 | 26.53% |
| Slamet | 9 | 13 | M | Adult | 19 September 2003 | 22.45% |
| Tiga Jari | 8 | 8 | F | Adult | 11 July 2003 | 16.33% |
| Flash | 6 | 6 | | Adult | 16 March 2003 | 12.24% |
| Mambo | 6 | 1 | U | Young adult | 11 August 2004 | 7.14% |
| Eve | 2 | 4 | U | Young adult | 25 March 2003 | 6.12% |
| Unidentified | 4 | 0 | | | | 4.08% |
| Mo | 0 | 2 | F | Adult | April 2006 | 2.04% |
| Shakira | 1 | 0 | F | Adult | 08 February 2003 | 1.02% |
| Subuh | 0 | 1 | F | Young adult | 2002 | 1.02% |
| Wendy cub A1 | 1 | 0 | U | Cub | 2002 | 1.02% |
| | | | | | | |
| Grand Total | 54 | 44 | | | | 100% |

**Table 16** - Estimated tiger densities from photo-trapping rates 2003-4

| Year | Tiger photos | Trapping effort | Photos/trap night | Trap nights/photo | Density (tigers/100 sq.km) |
|---|---|---|---|---|---|
| 2003 | 67 | 2700 | 0.0200 | 40 | 4.05 |
| 2004 | 1 | 1814 | 0.0004 | 1814 | 0.06 |
| Overall | 104 | 4979 | 0.0209 | 48 | 3.34 |

**Figure 25** - Decline of photo-trapping rate for tigers 2002-4

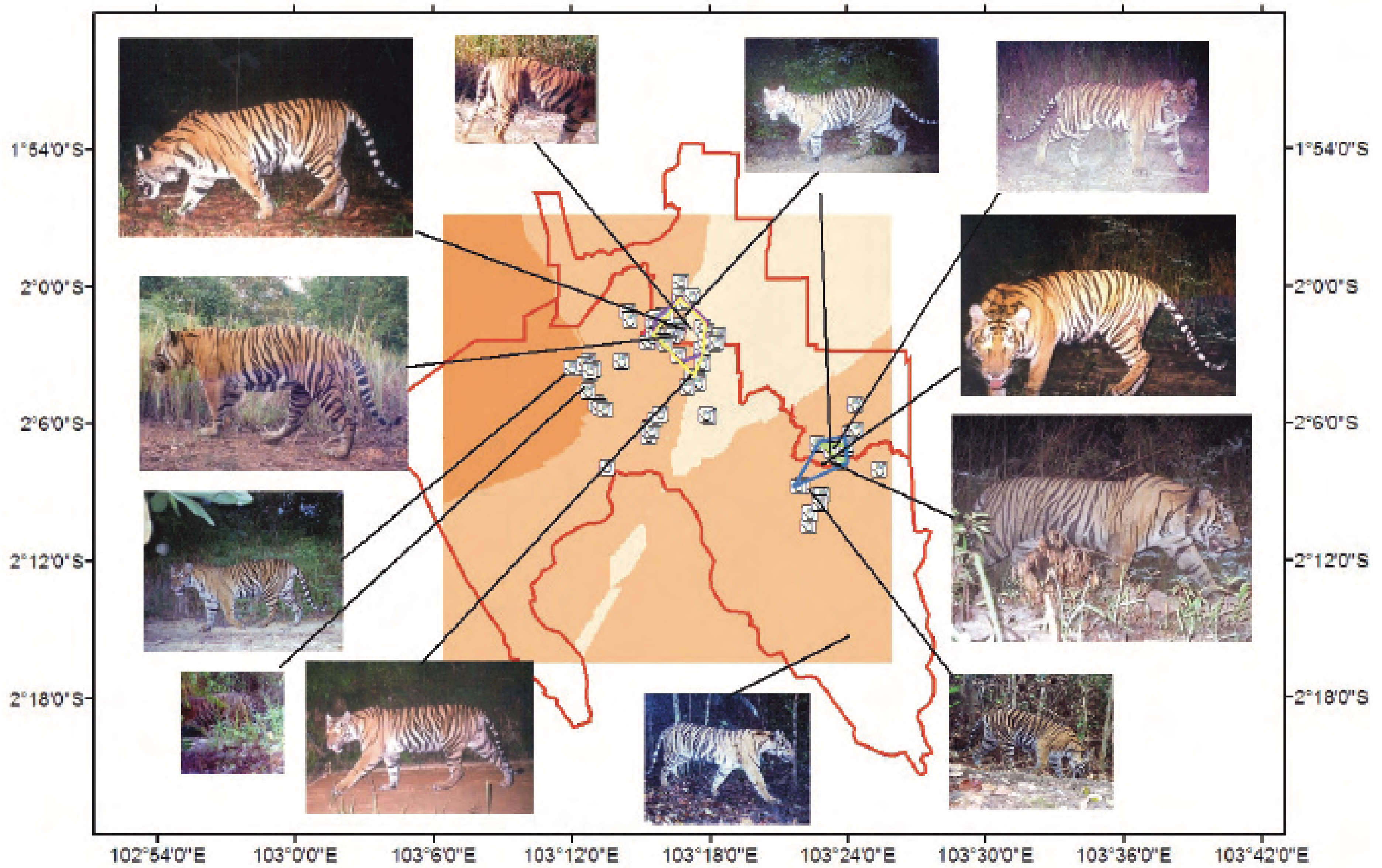


### Landscape occupancy

In a response to the disappearance of tigers on the plantation, a rapid occupancy survey of the entire plantation and logging concession landscape was conducted in 2005, with one of the objectives being to determine whether the original plantation tigers had moved or disappeared. The results revealed no tiger evidence within the plantation concession and none of the tigers recorded in 2001-4 were photographed in the forest concession[1]. A further three individuals were photographed and occupancy of the landscape was estimated at 9% (+/- 5%). Mapping of tiger sign encounters revealed two areas of the forest concession where tigers were still detected, but no sign of tigers occurred near the plantation (Figure 23).

[1] In 2006 a repeat of the occupancy survey revealed one of the original forest concession tigers, Mo, still surviving in the east of the forest concession

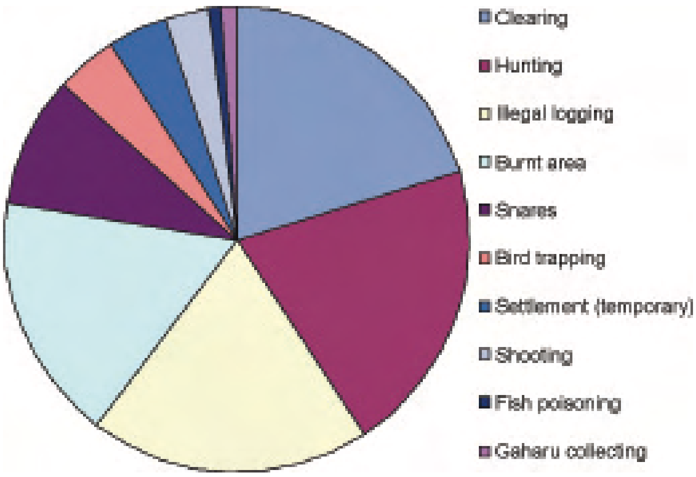
**Figure 26** - Summary of individual tigers photographed since 2002, minimum ranges of four residents in 2003 (coloured polygons), of pug marks recorded on transect patrols (track signs) and encounter rates in 2005 (orange shading: orange=1-2 signs/18 hours, pale orange=0-1, white=0)



## Reasons for tiger decline

The primary reason for the decline of tigers, and subsequently other species, from the plantation was almost definitely the encroachment of settlers that moved into the conservation areas from late 2003 onwards, claiming land, clearing and burning it and planting crops. From 2004 monitoring units recorded incidences of conservation threats encountered on routine patrols. The results for 2004 show that three-quarters of activities recorded consisted of clearing, hunting, logging and burning. Snaring was comparatively uncommon, but when the project was being set up snares were removed in large volume and hence local people knew they would be removed if found.

| Type | Proportion of reports |
|---|---|
| Clearing | 20% |
| Hunting | 20% |
| Illegal logging | 19% |
| Burnt area | 17% |
| Snares | 9% |
| Bird trapping | 4% |
| Settlement (temporary) | 4% |
| Shooting | 3% |
| Fish poisoning | 1% |
| Gaharu collecting | 1% |




These activities were overwhelmingly focussed in the unplanted areas set aside for conservation, the same areas favoured by the tigers (Figure 24, p.36). Unfortunately, camera-trap results could not accurately record this trend, partly because cameras in areas being cleared or burnt were frequently stolen or destroyed, thus losing all the records, but also probably because people actively avoided being photographed. Although encroachment was most intense in the conservation areas, it was a problem suffered across the plantation, and from 2004 onwards local authorities were repeatedly asked to intervene. Several clashes between plantation security, settlers and police occurred during this period, with solutions clouded by issues of genuine and fraudulent land claims, divided support from local government, police and army, local provocateurs and also the decline of security in the neighbouring forest concession. As a result it was the conservation areas, as the areas least obviously controlled by the plantation, and the neighbouring areas of the forest concession that suffered the hardest and at the time of writing little viable habitat remains in the western conservation area or across the border in the forest concession. The tigers had disappeared before research was forcibly halted by the impossibility of camera-trapping and direct threats to staff. The plantation tigers could not be found in subsequent widespread surveys of the area and their fate can only be guessed.

**Figure 27** - Examples of conservation threats recorded in the plantation: top – snare wounds on a tiger neck and bear paw, middle – snares collected from within the plantation and a hunter caught on a camera-trap, lower – settlers claiming and clearing land.

# Conclusions

## Oil palm is a very poor habitat for mammals

### The value of oil palm crop as wildlife habitat

The results of the study show that the oil palm crop is a very poor habitat for most mammals. Ninety-five percent of mammal species recorded in the area demonstrated a preference for non-oil palm habitats, 55% were never recorded in oil palm and only 10% showed any ability to survive within the oil palm crop on a long- term basis. Intolerance towards oil palm was strongest in the most endangered species (see p.55 for a summary).

### Tolerant species

The only mammal species other than rodents able to survive within oil palm over significant periods of time were wild pig, bearded pig, leopard cats and common palm civets, all of which appeared fairly successful. None of these are considered high value for conservation, although leopard cats are protected under Indonesian law and also restricted for trade under CITES, and bearded pigs are a poorly understood species with some research interest. The pattern of high biomass, low diversity seen in the oil palm mammals is likely to be repeated for other taxonomic groups. Several snake species were common in oil palm for example, as were some amphibians, and a small number of bird species also occur regularly; however, species diversity is almost certainly poor in all cases. These species are likely to survive by obtaining direct and indirect benefits from the crop that outweigh the disadvantages of living in the crop. Both pig species are generalists that are known to eat the high energy oil palm fruit and also young palms, although high levels of rooting evidence within the crop suggest that they also feed on alternative food sources such as invertebrates and roots. Pigs appear to use the unplanted areas bordering rivers and/or outside the crop for cover. Palm civets are also generalist omnivores and probably survive on a mixture of fruit, insects, amphibians and occasional rodents. They were almost always spotted sheltering in the palm canopy. Leopard cats on the other hand probably survive almost entirely on the high densities of the small number of rodent, amphibian and reptile species that occur in oil palm. Hunting these species would not require dense cover and leopard cats are small enough to shelter in the canopy or low-lying leguminous foliage if they need to hide.

### Species displaying limited tolerance

Survival for other species is probably limited within the oil palm by both the lack of cover and the lack of plant diversity within the crop. Oil palm plantations are monocultures, with trees planted at exactly 9 metres apart to maximise canopy cover. Beneath the mature canopy light levels are low. Low, leguminous ground cover is often encouraged and ferns are occasionally left on palm trunks, but beyond that there is almost no vegetative cover leaving a very open habitat, with little heterogeneity. In these circumstances most animal species would find survival very difficult because of vulnerability to predators (including humans), lack of cover for hunting (e.g. tigers, which rely on ambush hunting techniques), difficulties in moving through the habitat (primates in particular would find the dense, spiny canopy a barrier) or lack of food resources (whilst oil palm and a few associated species are abundant, little else is). Species showing limited tolerance to oil palm included sun bears, deer species and several primates, all of which were recorded very occasionally and usually on the edges of the oil palm or, in the case of the bear, crossing the oil palm. Unlike species thriving in oil palm, this group includes several taxa of conservation interest, including the bear, all primates and pangolins. Like species thriving in oil palm, these fringe species were probably feeding on oil palm fruit or oil palm related products (pig-tailed macaques were actually witnessed carrying fruit back to the forest). However, unlike the pigs, leopard cats and civets they showed no evidence of making anything more than occasional forays into the crop.

### Intolerant species

For other taxa, including the most endangered species in the area, intolerance of oil palm appears to be intractable. Tigers, clouded leopards, tapirs and gibbons were never detected within the oil palm even though there were possible benefits in the form of fruit or prey and despite all being recorded very close to the crop. For these species the disadvantages of threats, habitat structure or difficulties in hunting outweigh the potential benefits.

### Implications for land-use planning

The study results show clearly that the expansion of palm oil production is having a major impact on terrestrial mammal species. This effect is probably occurring at three levels. Firstly, conversion of any given site to oil palm means complete habitat loss for the 55% of mammals studied which had a complete aversion to oil palm, and significant impact on the further 35% which showed no ability to survive long term in the crop. Secondly, the severe intolerance various species demonstrate for this habitat means that palm oil crops also act as barriers to movement for these taxa, thus further exacerbating their impact on wildlife through effects on both the ranging patterns of individuals of larger species (*e.g.* tigers), and connectivity and hence gene flow between populations of smaller species. In addition, negative effects stemming from plantation activities such as pollution, pest control, and outsider access are also likely, but are beyond the scope of this report.

## Degraded habitats are still important for many species

### The value of degraded land

In contrast to the oil palm crop itself, the degraded forest and scrub habitats also found on and around the plantation study site were shown to have high conservation value for several mammal species, despite being long distances from the closest protected areas. The landscape as a whole included most of the terrestrial mammal species that might be found in a protected lowland Sumatran rainforest. Notable exceptions were Sumatran rhino (not recorded), some of the cat species (flat-headed and marbled cat were never recorded, golden and fishing cat only once each) and elephants (recorded just once on the fringe of the forest concession). Primate species, birds and smaller mammal species were also lacking, but the survey methods did not cover these comprehensively. Furthermore, at the beginning of the study even the most degraded habitats had significant conservation value; the heavily logged and cleared areas within the oil palm concession contained 90% of the species in the wider landscape including a healthy population of Sumatran tigers. Dhole also appeared to thrive in the most degraded forest areas and even the radio tracked tapir, of a species thought to be dependent on forest, spent its entire recorded life in an area with no trees.

## Implications for mitigation of oil palm effects

Most mammal species cannot survive within the oil palm crop itself. This is a major negative effect which cannot be overcome. However, the persistence of many mammal species in the other degraded habitats found around the crop, both on plantation concession land and in adjacent areas, indicates that steps can be taken to reduce the impact.

Firstly, the level of habitat loss caused by initial establishment of oil palm plantations can be limited. Currently, it is generally accepted that new plantations should not be sited in existing protected areas or forest, and both companies and governments frequently claim that new plantings only occur in 'degraded' land, unsuitable for any other purpose. The RSPO (Roundtable for Sustainable Palm Oil – see Figure 29) goes a step further and commits to no planting in any areas of High Conservation Value Forest (HCVF - initially a concept developed by the Forest Stewardship Council as part of the timber certification process – see Figure 30). Our results raise the question: what is degraded land and when can it be defined as suitable for conversion to oil palm? They show it is not enough to simply assume that land previously logged or even cleared has no conservation value. An area may be degraded in terms of tree flora, but it may represent an essential area for dhole. It may be degraded in terms of primates, but it might be a valuable corridor for tigers. Even using HCVF as a guideline in its current form implies that non-forest means non-value. It is therefore essential to know where the species are, not just where the assumed habitat is.

Secondly, the impact of existing concessions can be mitigated, provided that the company is prepared to set some land aside. The current general assumption seems to be that land that is already allocated or converted to oil palm plantations is a lost cause for conservation. Our results show this is not always true. Few, if any, oil palm plantations are completely covered with oil palm crop. Government regulations stipulate that buffer zones must be left unplanted to certain levels along all waterways for example. Similarly, land above a certain gradient cannot be planted with oil palm. Plantations also often include habitats that are not economic to plant such as swamps or poor soils and finally, some plantation companies make a deliberate commitment not to plant all of their concession as a contribution to conservation, with set-aside promises ranging from 15% of the concession (PACRIM, Sumatra) to a reported 30% in some African plantations. Plantations bordering or connecting established or potential wildlife areas therefore have the potential to mitigate their impact as landscape barriers by providing habitat corridors, which at the very least can be utilised by species with some level of tolerance to oil palm such as bears, macaques and deer. In other cases, and for other species, setting aside habitat as wildlife refuges within the plantation may be more effective, either as stepping stones for crossing the plantation (as demonstrated by the bear) or as habitat in its own right for smaller species.

## Conservation corridors are an essential part of land-use planning

The conservation potential of degraded land has significance not only for oil palm management but also for conservation and land-use planning on a much wider scale. Protected areas in Indonesia are already thought to be insufficient to protect many species. If degraded habitats can be made to retain conservation value for certain species, the added habitat and potential connectivity between protected areas could provide key linkages and greatly increase the potential for both the maintenance of ecosystem services and conservation of wildlife.. This has significant implications for many conservation and land use policies which prioritise by habitat quality.

Because conservation and land-use planning necessarily addresses big issues within limited timescales, conservation priority setting is often based on forest cover, on protected area locations, or on species data collected almost entirely from protected areas. Whilst this is an excellent start, the associated danger is of course that non-forest, unprotected or unknown areas are then automatically seen as having little or no conservation value. Evidence of this is frequently seen in government or industry references to 'unproductive land' which equates to land with no value. Rather than viewing wildlife habitat in only two categories as 'good/forest' or 'bad/non-forest', habitat value needs to be seen as a *scale* and criteria need to go beyond whether or not a habitat can be classed as "forest". Whilst pristine primary forest may contain the full complement of species expected within an area, this study clearly shows that various levels of degradation can be tolerated by different species, some of which may in fact, in some circumstances, survive better in degraded areas than in primary forest. Arboreal species depend on canopy structure for movement and have access to all of the resources locked up in the canopy; they are therefore particularly sensitive to changes in forest structure. Terrestrial species, on the other hand, are much less affected by canopy change. In fact, the increased heterogeneity introduced by limited change can release more of the resources from the canopy and actually benefit many terrestrial species.

Just because an area has been altered from its natural climatic state through logging, clearing or even agriculture does not mean that it has lost all of its value to wildlife. Many such areas will indeed have no, or very limited, conservation value. However, in some circumstances and locations such areas can fulfil essential functions connecting two areas of higher value. In other cases, the degraded habitats may contain high conservation value and be worthy of attention in their own right, particularly as they begin to regenerate. Recognising the existence and potential of these values and identifying where they are is an essential step for conservation planning.

## Conservation outside protected areas needs to be managed

Whilst the value of marginal habitats around oil palm may mitigate some of the negative impacts of the crop itself, the longer term picture for the study site showed a bleak situation. Species had endured massive habitat change over the previous decades as the forest concession was logged and the plantation established and yet they survived. But the final years of the study witnessed events that tipped the balance from a plantation that housed significant populations of endangered species to a plantation with little remaining wildlife value. The study focussed on tigers and demonstrated a rapid and complete decline in numbers, using the plantation and landscape level surveys which by the end of the study showed tigers to be restricted to two small areas of the landscape with no evidence of survival of the original plantation tigers. Similar declines are likely for other species. This was not due to any lack of effort on the plantation's part. Patrol teams were employed to check for hunters and remove snares and conservation of tigers on site was actively and financially supported by the plantation management as well as by external grants. However, protection measures and support from the authorities were insufficient to stop or reverse a large-scale illegal settlement of both the plantation land and the neighbouring forest concession, with the wildlife areas hardest hit.

The rights and wrongs of settlement in general, or the details of how the plantation attempted to deal with it in this particular situation, are outside the scope of this report. However, the experience provided two valuable lessons which we highlight here.

Firstly, conservation values outside protected areas have to be managed and protected – simply setting land aside or not developing it is insufficient. While people generally accept that land in protected areas is not available for development, the very act of setting land aside outside protected areas can be the stimulus for others to move in and develop it, despite the legal rights to its use being allocated elsewhere. In such circumstances, particularly if there are no markers laid down to identify the function of the area, set-aside is perceived as 'unused' land which is therefore up for grabs. This of course brings severe costs to both the conservation objectives and the landowners.

Second, individual effort is not enough. If conservation is to be effective outside protected areas it has to be carried out and coordinated at a landscape level. Putting in place a conservation set-aside programme at one site may be pointless if none of the neighbours follow suit, or if there is no support from local authorities to maintain the effort.

# Recommendations

## Mitigating the impacts of oil palm plantations on wildlife

### Mitigate impact of new planting through wildlife surveys

Minimising impacts by planting in low impact areas is already a recognised strategy, with the RSPO recommending no planting in areas of high conservation value (RSPO, 2006). However, the results from this study show that existing definitions of low impact areas or degraded habitats are failing to capture a great deal of conservation value. Rather than a simple choice of "forest/good" or "non-forest/bad", the conservation value of degraded land needs to be assessed on a sliding scale. It is not enough to simply say planting must not happen in protected areas or forest because many apparently degraded areas retain high value for some species and need urgent conservation attention.

The first recommendation is therefore that wildlife surveys are carried out before any planting is carried out or irrevocable decisions on land use are made. These have to be active field surveys, not surveys of existing data or expected results as can be sufficient for AMDALs (required environmental audits), and they must be carried out using scientifically robust methods. Initial surveys would not have to be lengthy or difficult – establishing presence/absence of various species would be sufficient. However, for areas where initial surveys indicate the presence of conservation values, more detailed work will be needed to determine the level of value.

Furthermore, it would also be important to have the results viewed by an independent body that can analyse them in a landscape context. Degraded land marked for development will more often have potential as connecting or transitional habitat than as high value habitat in its own right. However, evaluating the importance of an area in terms of connectivity is only possible from a landscape perspective, using information unlikely to be available to most plantations. The RSPO approach of avoiding HCVF is a strong step in the right direction. However, HCVF in its original form is a tool for forest certification, not for overall land-use planning, ie identifying areas suitable or unsuitable for oil palm and other agricultural or industrial development. It is therefore important that the HCV principle is applied to non-forest habitats, and that a clear and appropriate definition of HCV is incorporated into the RSPO guidelines.

### Mitigate impacts of existing plantations through management of unplanted land

**Wildlife refuges**

One option is to leave one or two parcels of land within the plantation (as opposed to on its boundaries/adjacent to other possible wildlife habitats) unplanted as wildlife refuges, or small conservation areas. This option is only likely to have value if the plantation contains areas of intrinsically high conservation value – a particular type of habitat or area used specifically by a certain species (such as a nesting site). The benefits of this practice are constrained by available space. Even if a plantation allocates a relatively generous 15% of its land to a single wildlife refuge, the area is rarely likely to exceed several hundred hectares. An isolated piece of habitat of this size is only likely to have a significant value for smaller mammal species such as pangolins, porcupines and other rodents, small primates, viveridae (civets, badgers) and also other small or mobile taxa such as birds, reptiles, amphibians and insects. Larger species with some tolerance to oil palm and hence the ability to move through it could also benefit by using such areas as temporary shelter within a larger range – deer species, bears or macaques could all benefit for example. However, the chances of supporting viable populations of large, oil palm intolerant species such as tapir and tigers within such areas are pretty much non-existent. Finally, if large tracts are to be left unplanted, they will be more vulnerable to various human threats (because they are accessible appear to be unused land) therefore must be adequately managed and protected, which as our study shows, can be problematic.

**Wildlife buffer zones**

Wildlife buffer zones are a valuable option for plantations directly bordering an important wildlife area because they can soften the hard boundary between oil palm and wildlife habitat. This 'hard' edge can be a problem when higher mortality can occur on the edge due to traffic collisions, hunting and snaring, with wildlife in adjacent habitat constantly moving over to fill the empty spaces. The plantation can therefore act as a 'sink', pulling wildlife species with some tolerance of oil palm out of the core habitat or 'source'. Furthermore, a hard edge makes it much easier for people to gain access to the wildlife habitat. A common problem seen in this study was people using the plantation boundary road to access the adjacent logging concession, clearing land along the road on the forest side and therefore removing local wildlife habitat but beyond control of the plantation. A buffer zone would be an area of unplanted, or possibly semi-planted, land within the plantation that breaks up the border. Regular presence of plantation workers would mean that wildlife would be discouraged from moving through, but without the risks associated with entering oil palm. Furthermore, any human activities such as land clearance would have to start in the plantation, making control and action much easier.

**Habitat corridors**

After habitat loss, one of the key impacts identified for oil palm was its role as a barrier to species remaining in the landscape, and it is here that the most potential exists for mitigation of the ill effects. Of course, this category of set-aside also requires regional scale land-use planning, involving more than one company and the local government, and hence presents the biggest challenge.

Oil palm appeared completely impermeable to most species identified, with only a small minority of species demonstrating the ability to move freely through it. This has important implications for large individuals such as tigers; it restricts their overall range and also prevents dispersal, the process by which young adults of many species, primarily males, move out from their area of birth to find their own territories and/or breeding partners. Isolating existing populations of such species with oil palm barriers will weaken them genetically and increase their vulnerability to extinction. However, permeability of oil palm is a problem that can be addressed using unplanted land. Unlike wildlife refuges, corridors are not expected to support large-bodied species of wildlife for any length of time, they simply provide a means of crossing the oil palm.

Habitat corridors could take several forms. The most obvious are those that already exist in most plantations – river buffer zones, required by law to protect watershed functions, although these are not designed for wildlife use and will frequently be too narrow for many species. In this study, tigers were never detected using river buffer zones for example. Furthermore, establishment of river buffer zones is often not seen as a high priority and rules are often flouted. Increasing the width of river buffer zones might, in some circumstances, be an effective use of a company's designated percentage of set-aside land. However, habitat corridors do not have to follow rivers and do not necessarily need to be contiguous strips of land. They could be also consist of a string of habitat islands that species move between when they consider it safe, or a combination of the two.

At present, very little is known about the best structure for habitat corridors. It is likely to vary with species, with corridor width, composition, management and arrangement (for example a chain of habitat stepping stones compared to a ribbon of unbroken habitat). Answering such questions is a priority for the research community.

**Figure 28** - River buffer zone legislation is often flouted

**Management of unplanted areas**

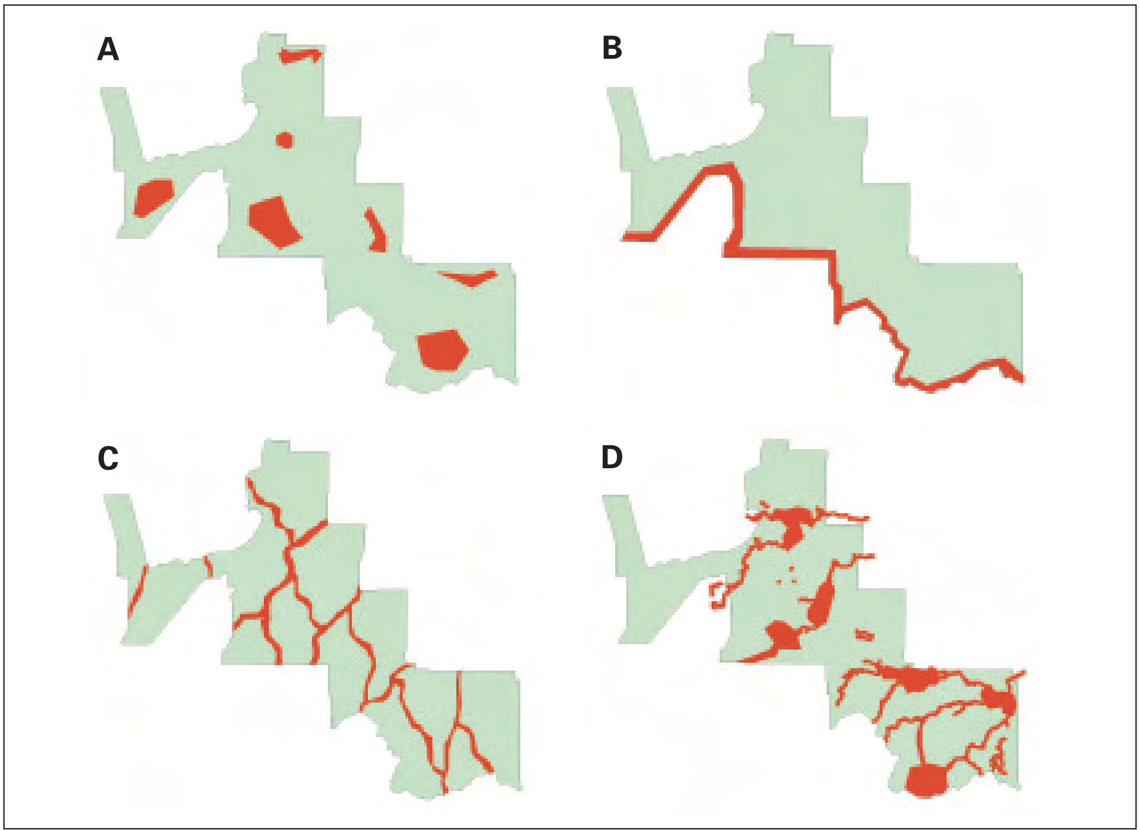
Management of unplanted areas requires various decisions. Firstly, how much land is required for conservation? Unfortunately, there is no magic number that is required to achieve conservation success. It may be the case that certain sizes of refuge or corridor are required for certain species to utilise them, but at this stage such values remain unknown. In general, the more land left unplanted, the more the negative effects of oil palm will be mitigated and the higher the perceived commitment to mitigating effects. In previous cases, plantations have left 15-30% of land unplanted for conservation purposes. As a rule of thumb, we would suggest at least 10% *above the legal minimum* (*i.e.* not including land that is already legally ineligible for planting such as river buffer zones or steep slopes) of the concession should be left unplanted and actively managed for conservation purposes.

The second decision is where to leave land unplanted. Decisions should first be determined by existing habitat characteristics. If the concession includes areas with existing conservation value, these areas should be prioritised. Beyond this, the best placement for unplanted areas will depend upon the plantation location. Plantations bordering important wildlife areas (particularly but not exclusively protected areas and tracts of forest) should use their set-aside to buffer the wildlife area and also focus on increasing plantation permeability through provision of habitat corridors. More isolated plantations (for example plantations surrounded by more plantations) should still implement habitat corridors, although the value and placement will depend on action by neighbours and hence on overall landscape planning at a regional scale. Such plantations should also focus on provision of blocks of habitat refuges for smaller and mobile species which have little alternative in the area. Naturally, management of unplanted land in existing concessions will also depend upon where the remaining unplanted land is. The most economical method of allocating land to conservation is to take it from areas not yet planted and this needs to be accepted by conservationists. However, this should not rule out the possibility of replacing existing oil palm with conservation land if it is deemed that a habitat corridor is vital between two specific areas.

The third management decision is whether to modify or restore the conservation areas once established. This study provides no information on whether conservation habitats should be actively modified. Until such information is available it is probably safe to assume that no habitat modification or restoration is required – many species can survive in very degraded habitats but few are so tolerant of human activity. The one exception where habitat restoration may be favourable is in areas threatened by illegal settlement. As this study showed, leaving land fallow can be interpreted as unwanted and encourage settlement. Active habitat modification such as tree planting is one activity that can clearly demonstrate management and ownership and which may also benefit conservation.

The final decision is how to manage the areas on a day to day basis. This study showed that active management and protection is *essential* and should be integrated into routine plantation management. Whilst excessive ranger presence may be counterproductive, scaring animals away from using corridors for example, it is important to clearly mark conservation areas and to regularly patrol them, demonstrating ownership, preventing hunting and snaring and stopping illegal clearing or settlement before it gets too advanced. Plantations generally require robust security departments and entry procedures for other purposes. Protection of areas allocated to conservation needs to be incorporated into security personnel briefing to the same extent as fruit theft and mill protection, and this can be done with little extra cost. Daily management does not have to be restricted to protection either. It will be in most plantations' interests to demonstrate patterns of use of conservation habitats too, both to justify their existence and to maximise the benefits. Simple monitoring protocols can be established to monitor presence of key species whilst a small investment in automatic cameras can provide highly visible results. Supporting green credentials with a photograph of endangered species using plantation conservation areas could have an immediate impact.

**Figure 29** - Options for setting aside 10% of a concession for conservation: A) wildlife refuges B) wildlife buffer zone, C) wildlife corridors, D) a mixture of refugia accounting for 10% of the area in addition to riverine buffers required by law




## Offsetting residual impacts through action offsite

Responsible planting, responsible management of oil palm and responsible management of unplanted land can all reduce the negative impacts of oil palm plantations on wildlife species. However, even a plantation employing all of these methods will still have a considerable residual impact on its environment. If the palm oil industry seriously wants to counter its total impact in conservation terms, then biodiversity offsetting is the only feasible option.

Biodiversity offsets are a concept currently receiving increasing acceptance in the mineral extraction industries. With limited options to reduce the impact of the actual mining process, a substantial residual impact is unavoidable. Biodiversity offsetting requires the calculation of this residual impact, and paying to offset it elsewhere. Oil palm plantations have a similar problem. Like a mine, the environmental footprint of the oil palm crop can only be reduced by a limited amount using the mitigation measures described above. The residual impact of even the best-run oil palm plantation will still be significant. Companies that are serious about negating the residual impact need to consider offsetting it by protecting land of an appropriate area offsite.

## Frameworks for action

It is essential that changes within the oil palm industry are coordinated, both within the industry itself and with other land-use planning in the region. For wildlife conservation, this is important because most of the issues of concern are landscape-level issues. Action at isolated sites may benefit individual companies in terms of reputation and even local ecosystem health, but for most species and for overall ecosystem services, local action will be insufficient. Few plantations will ever provide valuable habitats in their own right – their key role is in coordinating to reduce the collective impact on species, therefore changes have to be applied at a coordinated, landscape level. Such coordination will also directly benefit the industry. Conservation suffers from the 'tragedy of the commons' – when the resources are shared by all, no single person or organisation is willing to be the only one to make sacrifices for the greater good. Local environmental degradation may be harmful for a plantation, but if the benefits that are obtained from action don't outweigh the costs involved, most businesses do not act. Coordination and collaboration, ensuring that sacrifices are shared and even, is the only way large scale action is possible. Furthermore, it is important that action taken is universally recognised and rewarded. Companies are not going to be willing make sacrifices for conservation if one sets aside 30% of its concession for conservation whilst another leaves the legal minimum yet both claim equal credit. Nor are they going to act if the range of available options presented are contradictory and unfocused. Coordination, as well as further research, is required to define such issues as what does set-aside mean, what are the criteria for responsible planting, and what is meant by a wildlife corridor.

Fortunately such frameworks already exist. The Round Table for Sustainable Palm Oil (RSPO, see box 1, p.50) brings together the palm oil industry and non governmental organisations and is attempting to define how palm oil can be produced with minimum negative environmental and social impact, which in turn is intended to allow access to premium prices on foreign markets. Several of the RSPO Principles and Criteria (P&C) relate directly to wildlife conservation, in particular 5.1 (identifying and mitigating environmental impacts including vegetation clearance and new planting) and 5.2 (identifying endangered species affected by the plantation and taking steps to conserve them, including impacts on neighbouring populations and species and habitats within the concession). It is strongly recommended that all conservation findings and advice on palm oil production are channelled through the RSPO and it is hoped that these findings can contribute specifically to the wildlife commitments within the P&C. However, there remains a need for research to be better represented within the RSPO, providing the information required to take the steps towards more sustainable palm oil.

Secondly, the HCVF framework exists as a concept for valuing land in terms of conservation (see Figure 30). Whilst designed as a forest management tool rather than a way of identifying conservation values across the landscape, the HCVF approach has important features that make it a strong candidate for adaptation to wider conservation value assessments. Firstly it is a universal system that can be applied in theory anywhere in the world. Secondly, it is already an established, tested and recognised method, albeit not beyond the forestry sector. Thirdly and crucially, it has already been recognised by the RSPO as the tool for identifying where oil palm can and cannot be planted. The HCVF framework is therefore by far the strongest contender for developing the tool that can assess landscapes for palm oil development suitability, as long as it can be adapted to also recognise the key marginal habitats and not just forests.

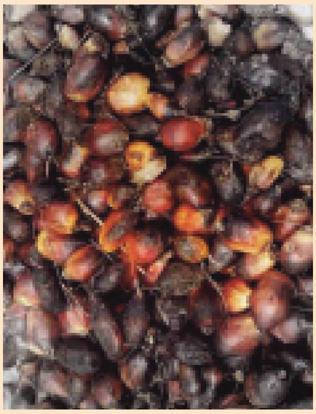
**Figure 30**

## Information Box 1: The RSPO

Potential for sustainable palm oil was initially investigated in 2001 by the Worldwide Fund for Nature (WWF) resulting in an informal collaboration between WWF and a small number of companies and groups with interests in the palm oil industry; Aarhus United UK Ltd., Golden Hope Plantations, Migros, the Malaysian Palm Oil Association, Unilever and Sainsburys. Following preliminary meetings in the UK and Switzerland these groups went on to form the organising committee for the first official roundtable meeting in Malaysia in 2003, at which a statement of intent was agreed.

In 2004 the Roundtable for Sustainable Palm Oil (RSPO) was officially formed with the following objectives:

1. Research and develop definitions and criteria for the sustainable production and use of palm oil;
2. Undertake practical projects designed to facilitate implementation of sustainable best practices;
3. Develop solutions to practical problems related to the adoption and verification of best practices for plantation establishment and management, procurement, trade and logistics;
4. Acquire financial resources from private and public funds to finance projects under the auspices of the Roundtable on Sustainable Palm Oil;
5. Communicate the Roundtable's work to all stakeholders and to a broader public.



By 2007 the RSPO comprised 152 members representing seven sectors with an interest in palm oil production (Oil Palm Growers, Palm Oil Processors and/or Traders, Consumer Goods Manufacturers, Retailers, Banks and Investors, Environmental/Nature Conservation NGOs, Social/Developmental NGOs). Eight Principles and 39 Criteria (P&C) for what constitutes sustainable palm oil were agreed in 2005 (RSPO, 2006), but the verification process for compliance is still in progress.

See www.rspo.org for further information

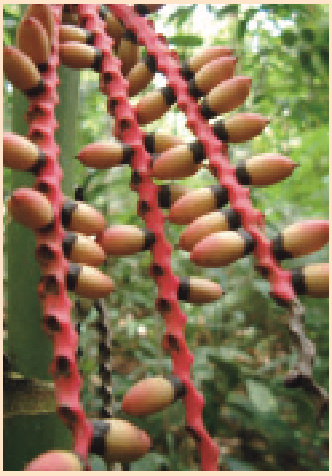
**Figure 31**

## Information Box 2: HCVF

High Conservation Value Forest (HCVF) is a concept originally developed by the Forestry Stewardship Council (FSC) for use in forest management certification. It is based on the identification of significantly high conservation values (HCVs).

Definitions of HCVs were divided into six categories, covering ecological, social, local and landscape values:

1. Forest containing a significant biodiversity value
2. Forest with a significant landscape importance
3. Forest containing rare or threatened ecosystems
4. Forest providing essential ecosystem services
5. Forests essential to local communities
6. Forests critical to local community identity



HCVF is then defined as the area of forest that is required to maintain the identified HCV. This does not mean HCVF is closed to development, it simply means that only activities that do not damage the HCV are permitted.

HCVF was designed for a specific, forest management purpose. However, one of its key advantages is that, by focussing on HCVs rather than specific forest characteristics, it can be applied to any forest in the world and consequently has become an internationally recognised standard. As a result, its potential for being a more universal system for identifying conservation value is currently being explored.

See www.fscoax.org for further information

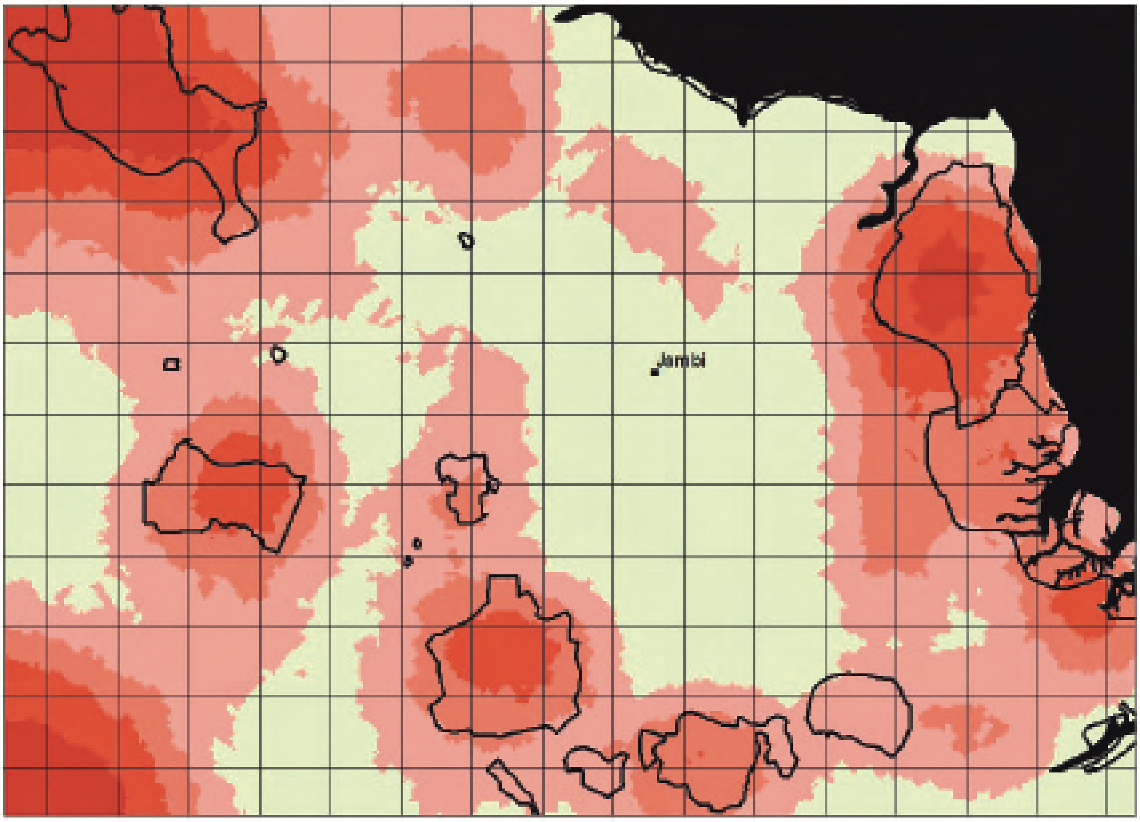
# Integrating oil palm management into a collaborative landscape approach to conserving unprotected areas

## The need for a landscape approach to conservation

The results and recommendations of this report show the high negative impact oil palm production has on the majority of wildlife species studied and a variety of methods for reducing these impacts. It is clear that oil palm plantations will never be wildlife sanctuaries, but they can mitigate their impact by becoming more sensitive to wildlife distributions and the survival requirements of local wildlife populations. However, isolated actions by individual plantations will not be sufficient to bring large scale change to the crisis currently facing wildlife in Indonesia. Sparing wildlife populations through responsible planting is pointless if those same populations are then left isolated and unprotected. Setting aside wildlife refuges is pointless if there are no species of wildlife left to utilise them. Buffer zones are pointless if the protected areas they are buffering are unprotected. Habitat corridors are pointless if they have nowhere to connect to. *Action within the oil palm industry must therefore be carried out as part of a landscape approach to biodiversity conservation at the regional level.*

The need for a landscape approach can be best illustrated using a landscape map. Figure 31 shows an area of approximately 50,000km$^2$ around Jambi, Sumatra from conservation perspective. About 12% of the area is legally protected. Eight percent is classed as core protected area (Taman Nasional) with the remainder represented by a range of semi-protected areas (such as suaka marga satwa, hutan lindung and kawasan essensial). This is fairly representative of Indonesia as a whole where approximately 12% of the area is protected to some degree, although only about a quarter of this is national parks. Outside the various protected areas lie a range of land uses – oil palm, mining, forestry, agriculture and settlements.

**Figure 32** - Landscape planning for conservation in eastern Sumatra. Polygons represent protected or semi-protected areas. Red shades represent likely conservation value from high (dark) to low (pale)



with wildlife could make an important contribution to the hypothetical situation represented in the map. Areas fully planted with oil palm crop would be recorded as no value on the example landscape map. Such areas at best reduce the area available to wildlife, at worst break existing connections. However, actions taken by responsible oil palm plantations could result in the status of some areas of their concession land increasing from no value to low or even medium value. Such action would only be effective if applied collaboratively throughout the landscape. Building corridors is useless if there is nothing to connect, setting land aside is pointless if it is immediately occupied by illegal settlers and sacrificing profits for conservation will never be economically viable if the effort goes unrecognised. For this reason, action within the palm oil industry has to happen within the context of a collaborative landscape approach to conservation. If this is done, potential exists for significant improvements in both species survival and ecosystem benefits across the landscape.

## Implementing a landscape approach towards conservation

### Identify priorities

The first step in a landscape approach is to identify the priorities. The map presented above represents a likely but theoretical situation. Maps of real conservation value distribution need to be produced. Protected areas that require more work to maintain their value, existing connections that have to be maintained, connections requiring restoration and areas needing new connections all need to be identified. Furthermore, better understanding of how conservation values can be maintained outside protected areas is needed. Our study is a good start, but further data are needed on how species survive in low value areas, what their key requirements are for survival, how they adapt in order to survive, and what can be done to increase the chances of survival?

### Engaging landscape stakeholders

The second step is to use the information obtained to make improvements in the landscape, engaging with key stakeholders to persuade them to use their collaborative influence to bring change. Most important of these is government which has to take a leading role if any significant impact is to be expected. Support is essential from local land planning agencies to understand conservation priorities and to consider them in land use plans, allocating concessions to users most compatible with intrinsic conservation values and encouraging heterogeneity in the landscape to minimise the impacts that are unavoidable. Furthermore, government support is essential to drive through change amongst all landscape users. Existing environmental laws need to be enforced and action supported; companies need to know that if they don't leave river buffer zones they will be prosecuted, but if they do make sacrifices above the legal requirement they will be recognised, not penalised. Local communities need to know that hunting protected species is illegal, and that areas set aside for conservation will be recognised and protected.

After government, industry is possibly the most important actor in this landscape, with single companies controlling large tracts of land. Change can come quickly, if incentives are sufficient, and environmental responsibility is a major concern for most industries. The oil palm industry is a key player with a rapidly increasing stake, and is perhaps the most challenging for compatibility, but other industries also have equally important influence. For example, the forestry industry still represents the dominant land use in Sumatra and also the land use with most potential for compatibility with conservation if managed correctly. The mining industry can also operate with a relatively small local environmental footprint, but with major environmental concerns.

Local communities represent the third landscape stakeholder, with particular difficulties stemming from the problems in implementing large scale change. Engaging the wider community in the importance of conservation outside protected areas is important for raising the awareness that drives change on a local level (for example, change in the palm oil industry is largely due to pressure from palm oil consumers). Engaging communities on a local level is also essential for bringing change, raising awareness on the importance of conservation success, on the impacts (and legality) of hunting and land clearance and the potential role people have in conserving their own environment and ecosystem services.

Finally, non governmental organisations have to be involved in the collaborative process. Research institutions and universities are required to provide the raw information needed for change, lobbying specialists are needed to provide pressure for change and to highlight the failures and commend the successes, and social specialists are essential for work with communities.

**Protecting what is left**

The final step in a comprehensive approach to landscape-level conservation would be to protect what is left. Most wildlife research is based in protected areas where rapid biodiversity loss is reported almost daily. Outside conservation areas the situation is barely known, but rates of loss are assumed to be even faster; data from this report show how quickly a significant population of one of Indonesia’s endangered species can reach local extinction outside protected areas. Conservation protection in Indonesia falls under the remit of the PHKA (Perlindungan Hutan dan Konservasi Alam) within the Department of Forestry and essentially comprises two approaches: law enforcement and conflict mitigation. However, when considered across the entire landscape, both are immense tasks and require substantial input from external sources if they are to have any chance of success.

## Summary of recommendations for mitigation of damaging impacts of oil palm plantations on wildlife

1. When a new plantation is to be established:
    a. Detailed wildlife surveys must be carried out beforehand by capable and independent bodies, preferably using approved standardised methodology, not only at all potential locations but over the whole surrounding area.
    b. New plantations should be established only on areas shown by these surveys to be of low conservation value (bearing in mind that high conservation values can occur in areas not classified as forest).
    c. The results of the surveys for the whole area should be examined by government at a regional level and priority given to retaining habitat linkages in the overall mosaic of land uses as well as to ensuring the area selected for the concession has low conservation value.
2. When an existing plantation wishes to minimise its impact on local wildlife:
    a. Their major focus should be on the siting and management of unplanted areas on the concession land.
    b. A minimum of 10% of concession land (over and above what is already legally required to be left unplanted such as river buffer zones) should be set aside for wildlife conservation purposes.
    c. Placing of these conservation areas should be decided with consideration given to the nature of the areas surrounding the plantation and the species of wildlife present in the area:
        i. When a plantation concession constitutes a barrier between two areas with high conservation value, a habitat corridor between the two should be put in place.
        ii. When a plantation borders areas with high conservation value, buffer zones along these borders should be put in place.
        iii. When a plantation does not connect with high conservation value areas, wildlife refuges (islands of habitat within the plantation concession) should be put in place to provide habitat for smaller species and stepping stones for any larger species that are sufficiently tolerant of oil palm to use them.
    d. All such set-aside areas should be actively managed; if this is not done they will be perceived as available for settlement and lost to both the plantation and the wildlife. Management should involve:
        i. Marking the areas with signs or plantings.
        ii. Active protection by security patrols.
        iii. If possible, also monitoring of the wildlife using the areas - which will provide promotional material for the plantation as well as a record of the usefulness of the set-aside.
    e. Due consideration should also be given to minimising environmental pollution eg from pesticides and processing (details of this are outside the scope of this report).
3. When a plantation wishes to fully compensate for its environmentally damaging effects on wildlife:
    a. This is not possible through set-aside and management.
    b. Plantations should therefore offset the remaining impacts by supporting off-site conservation efforts.
    c. This may be done by financing avoidance of deforestation elsewhere, by financing active conservation projects elsewhere, or by other relevant mechanisms.
4. All action taken by the oil palm industry to mitigate the effects of the industry on wildlife should:
    a. Be conducted within existing frameworks (RSPO, HCVF) to ensure transparency, accountablity and compatibility.
    b. Be conducted as part of a landscape-scale conservation programme to ensure the small contributions each individual plantation is able to make combine to produce a significant impact on a larger scale.
5. All wildlife survey data collected by plantations and collaborating agencies should be preserved and made widely available through the RSPO and/or other suitable bodies.

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# Appendix I

Summary of mammal species diversity across the landscape

| Latin name | Common name | Red list category | Indonesian status | Occur in the landscape | Occur in the concession | Occur in oil palm | Persist in oil palm |
|---|---|---|---|---|---|---|---|
| *Elephas maximus* | Asian elephant | Endangered | Protected | Y | N | N | N |
| *Neofelis nebulosa* | Clouded leopard | Vulnerable | Protected | Y | N | N | N |
| *Prionailurus viverrinus* | Fishing cat | Vulnerable | Protected | Y | N | N | N |
| *Symphalangus syndactylus* | Siamang | Near threatened | Protected | Y | N | N | N |
| *Mydaus javanensis* | Malay badger | Least concern | Protected | Y | N | N | N |
| *Hemigalus derbyanus* | Banded palm civet | Least concern | Not protected | Y | N | N | N |
| *Panthera tigris ssp. Sumatrae* | Tiger | Critically Endangered | Protected | Y | Y | N | N |
| *Cuon alpinus* | Dhole | Endangered | Protected | Y | Y | N | N |
| *Catopuma temminckii* | Golden cat | Vulnerable | Protected | Y | Y | N | N |
| *Tapirus indicus* | Malayan tapir | Vulnerable | Protected | Y | Y | N | N |
| *Hylobates agilis* | Agile gibbon | Near threatened | Protected | Y | Y | N | N |
| *Aonyx cinereus* | Small-clawed otter | Near threatened | Not protected | Y | Y | N | N |
| *Lutra sumatrana* | Hairy-nosed otter | Data deficient | Protected | Y | Y | N | N |
| *Arctictis binturong* | Binturong | Least concern | Protected | Y | Y | N | N |
| *Tragulus napu* | Greater mouse deer | Least concern | Protected | Y | Y | N | N |
| *Herpestes brachyurus* | Short-tailed mongoose | Least concern | Not protected | Y | Y | N | N |
| *Martes flavigula* | Yellow-throated marten | Least concern | Not protected | Y | Y | N | N |
| *Petaurista petaurista* | Red giant flying squirrel | Least concern | Not protected | Y | Y | N | N |
| *Trichys fasciculate* | Long-tailed porcupine | Least concern | Not protected | Y | Y | N | N |
| *Viverra tangalunga* | Malay Civet | Least concern | Not protected | Y | Y | N | N |
| *Presbytis cristata* | Silvered langur | Not listed | Not protected | Y | Y | N | N |
| *Helarctos malayanus* | Sun bear | Vulnerable* | Protected | Y | Y | Y | N |
| *Macaca nemestrina* | Pig-tailed macaque | Vulnerable | Protected | Y | Y | Y | N |
| *Hystrix brachyura* | East Asian porcupine | Vulnerable | Protected | Y | Y | Y | N |
| *Lutrogale perspicillata* | Smooth-coated otter | Vulnerable | Not protected | Y | Y | Y | N |
| *Manis javanica* | Pangolin | Near threatened | Protected | Y | Y | Y | N |
| *Presbytis melalophos* | Banded langur | Near threatened | Protected | Y | Y | Y | N |
| *Macaca fascicularis* | Long-tailed macaque | Near threatened | Not protected | Y | Y | Y | N |
| *Nycticebus coucang* | Slow loris | Least concern | Protected | Y | Y | Y | N |
| *Cervus unicolor* | Sambar | Least concern | Protected | Y | Y | Y | N |
| *Muntiacus muntjak* | Muntjac | Least concern | Protected | Y | Y | Y | N |
| *Paradoxurus hermaphroditus* | Common palm civet | Least concern | Not protected | Y | Y | Y | N |
| *Callosciurus prevostii* | Prevost's squirrel | Least concern | Not protected | Y | Y | Y | N |
| *Tupaia glis* | Common tree shrew | Least concern | Not protected | Y | Y | Y | N |
| *Echinosorex gymnura* | Moon rat | Least concern | Not protected | Y | Y | Y | Y |
| *Prionailurus bengalensis* | Leopard cat | Least concern | Protected | Y | Y | Y | Y |
| *Sus barbatus* | Bearded pig | Least concern | Not protected | Y | Y | Y | Y |
| *Sus scrofa* | Pig (wild) | Least concern | Not protected | Y | Y | Y | Y |

# Appendix II

Birds recorded opportunistically on the plantation

| Latin name | Common name | Indonesian legal status | Red list category | CITES Appendix |
|---|---|---|---|---|
| *Argusianus argus* | Argus pheasant | Protected | Near threatened | II |
| *Buceros rhinoceros* | Rhinoceros Hornbill | Protected | Near threatened | II |
| *Aceros undulatus* | Wreathed hornbill | Protected | Least concern | II |
| *Ictinaetus malayensis* | Black eagle | Protected | Least concern | II |
| *Spilornis cheela* | Crested serpent eagle | Protected | Least concern | II |
| *Halcyon smyrnensis* | White throated kingfisher | Protected | Least concern | Not listed |
| *Lophura erythrophthalma* | Crestless fireback | Not protected | Vulnerable | III |
| *Lophura ignita* | Crested fireback | Not protected | Near threatened | III |
| *Rollulus rouloul* | Crested partridge | Not protected | Near threatened | III |
| *Amaurornis phoenicurus* | White breasted waterhen | Not protected | Least concern | Not listed |
| *Centropus sinensis* | Greater coucal | Not protected | Least concern | Not listed |
| *Chalcophaps indica* | Emerald Dove | Not protected | Least concern | Not listed |
| *Eurystomus orientalis* | Dollar bird | Not protected | Least concern | Not listed |
| *Gallus gallus* | Jungle fowl | Not protected | Least concern | Not listed |

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Registered Charity no. 208728