ZSL Conservation Programmes

LIVING CONSERVATION

PIGS, PALMS, PEOPLE AND TIGERS

SURVIVAL OF THE SUMATRAN TIGER IN A COMMERCIAL LANDSCAPE

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JAMBI TIGER PROJECT

LIPI — The National Fish and Wildlife Foundation Save the Tiger Fund — 21st Century Tiger giving wild tigers a future — PT. ASIATIC PERSADA

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SUMMARY

A key strategy for ensuring the survival of the Sumatran tiger is to work on their survival outside the protected area system. Non-protected areas represent a far larger area of land, do not exclude people and therefore reduce the potential for land use conflict, and can provide connectivity between the core protected areas. Potential for coexistence between tigers and commercial land use has been shown in an oil palm plantation, PT Asiatic Persada (AP), in Sumatra. A combination of the plantation's readiness to adopt a management system sympathetic to tiger conservation and the Zoological Society of London (ZSL)'s belief in the importance of engagement with industry for conservation has resulted in the formation of the Jambi Tiger Project, a unique partnership between a conservation NGO, the Indonesian Institute of Science (LIPI), a commercial agricultural company and the Indonesian government (through the KSDA – the local branch of the PHKA or Indonesian Department of Forestry) that aims to establish how tigers survive with oil palm and what can be done to ensure the situation persists in a sustainable manner. Between 2001-2 the plantation created a 15 man conservation team which, with advice from ZSL, demonstrated without doubt the existence of at least four adult and breeding tigers on site as well as a large variety of other species. In 2003 the project expanded, with ZSL receiving a research permit from LIPI, funding from the Save the Tiger Fund (STF) and 21st Century Tiger and permanent field staff. Onsite infrastructure was established and programmes for monitoring species presence, relative abundance and any immediate threats were expanded. A total of 20 hard working and enthusiastic staff are now in place dedicated to tiger conservation and research. The ZSL and Asiatic staff share the workload, assisting each other with the patrols and scientific survey efforts as necessary. Co-operation has been fostered with the Jambi branch of the KSDA and the adjacent logging concession PT Asialog (which is also used by the tigers), both of whom are keen to find a solution to conflict between industry and conservation. Research objectives for 2003 targeted understanding the relationship between tigers, their probable main prey (wild pigs, *Sus scrofa*) and the role of prey species as pests on the plantation. In addition, tiger research was expanded, gathering more detailed information on the number of tigers present and starting a study of their ranging patterns within the landscape. Species diversity results were primarily based on 5717 sightings from 3532 camera trap nights and 1180 track records. Results show more than 30 medium and large sized mammals using the oil palm dominated site, with other mammals of conservation interest including dhole (*Cuon alpinus)*, sun bear (*Helarctos malayanus),* Malayan tapir (*Tapirus indicus)*, clouded leopard (*Neofelis nebulosa)* and fishing cat (*Prionailurus viverrinus)*. Use of the oil palm habitat itself is limited and almost all species are restricted to the unplanted habitats bordering the oil palm crop or the Asialog forest concession. However, the degraded scrub habitats showed higher presence of many species than the apparently less degraded forest concession, including the Sumatran tiger. The prey studies were based on nearly 400km of night transects and 1051 trap nights from randomly placed camera traps. These confirmed wild pigs (*Sus scrofa*) to be the dominant ungulate and likely tiger prey present, with abundance far outweighing any other species, although at least 19 potential tiger prey species exist on site. Line transects estimated density within the oil palm and scrub habitats to be around 2.5 pigs/km^2 and agreed with camera trapping studies that densities in the forest were negligible in comparison. These densities are comparable to other pig studies but much lower than the only other oil palm study where predators were absent. Pigs were also one of the few species to show equal abundance inside the oil palm crop compared to outside in the scrub. However, studies of abundance were not as complete as hoped with the failure of capture mark recapture studies following unsuccessful trapping attempts. Line transects are thought to be underestimating true densities and further work estimating absolute density is also required for calibrating camera trap results. Consequently, these estimates are only considered to be preliminary results. As a result of problems capturing pigs, other aspects of the prey study were also delayed and planned assessments of pig impact on the plantation were only initiated towards the end of the year. Research on the tigers however was more successful. Individual recognition of camera trap photos show that a minimum of nine and possibly even sixteen

tigers have used the plantation concession and bordering areas within the last two years, suggesting densities comparable to some protected areas. At least four of the tigers are breeding residents living within the plantation concession. Furthermore, one tiger was successfully captured and radio collared, the first ever in Sumatra. Despite some complications receiving the signal in certain habitats, the collared individual is now being tracked on a regular basis as he ranges over the eastern portion of the concession and the current estimate of his range is about 50km^2. This report concludes with project's aims for 2004.

INTRODUCTION

THE IMPORTANCE OF COMMERCIAL LANDSCAPES AND OIL PALM

Whilst much attention is rightly placed on species in protected areas, very little is placed on their survival outside reserves, despite the vast majority of land being unprotected and the obvious limitations on increasing protected land (Western 1989). For large carnivores in particular, it is clear that protected areas in isolation will never be sufficient for long-term conservation needs, both because of size limitations and because of the “edge” effects (Woodroffe & Ginsberg 1998) which cause surrounding areas without any wildlife management to act as a “sink” for the “source” inside the park. Undoubtedly, human-dominated landscapes have highly detrimental effects on a range of species; however, in many cases coexistence of even the most unlikely species is possible (Maddox 2002). In Indonesia, massive habitat losses are occurring outside protected areas. Forest cover has fallen from 162 million hectares to 98 million hectares between 1950 and 2000 with the current loss rate at 2-2.4 million hectares per year, a rate that should wipe out lowland diptocarp forest in Sumatra by 2005 (Glastra *et al*. 2002). In its place remains a patchwork of production forests, plantations and human habitations, now becoming the dominant landscape type in Sumatra.

Of particular importance is the rapidly expanding oil palm sector. Oil palm (*Elaeis guineensis*) is a palm native to West Africa, producing fruit rich in oil from which food and non-foodstuffs can be manufactured and the demand for its production increases at a rapid rate. The fact that the fruit quickly degrades results in large monoculture plantations being established around a central mill. 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 with Sumatra being one of the main producers (Potter & Lee 1999), (Wakker 1999). Oil palm is therefore a vital part of the Indonesian economy, bringing in 1.4 billion US$ of foreign exchange in 1997 and accounting for 31% of agricultural exports (Casson 1999). Furthermore, although already a major component of the current Sumatran landscape, oil palm coverage is set to increase further. Between 1975 and 1995 output of crude palm oil increased ten times, making it one of the fastest growing sections of the Indonesian economy, whilst consumption increases between 1990 and 1996 were higher than any other edible oil (Potter & Lee 1999). Global demand for palm oil is already at 22.5 million tonnes per year and this is predicted to rise nearly 100% in 20 years, to 40 million by 2020 with Indonesia and particularly Sumatra expected to provide at least 50% of the increase (Glastra *et al*. 2002). Consequently, 8.7 million hectares are already allocated for oil palm in Indonesia and a further 32 million hectares were under application in 1999 (Wakker 1999). By 2012 “Oilworld” predicts oil palm will become the leading vegetable oil source (Casson 1999).

Since oil palm plantations require high rainfall, relatively flat land and an altitude of below 200m they are directly and indirectly responsible for the clearance of large areas of lowland dipterocarp rainforest. In addition, fires used for land clearance on oil palm concessions has been blamed for many of the destructive forest fires that have blighted Indonesia in recent years. Consequently the oil palm industry has traditionally clashed with conservation interests, and groups such as the Worldwide Fund for Nature (WWF) are working hard to limit future habitat destruction (Potter & Lee 1999). But the fact that oil palm plantations are already present and will continue to be present in increasing numbers whilst market demand continues to expand cannot be ignored. It is therefore vital to work with existing plantations in order to mitigate their environmental impact and determine how they may be able to coexist with wildlife. For plantations already in existence, potential for coexistence with conservation is not a lost hope.

TIGERS AND OIL PALM

Tigers are currently facing a variety of threats throughout their range and many predictions for the future make grim reading, even in their core protected areas. For example, the Sumatran tiger (*Panthera tigris sumatrae*) is listed as "Critical" by the IUCN and is on CITES Appendix I and is the last remaining subspecies in Indonesia following the shooting of the last Balinese tiger in 1937 and the extinction of the Javan in the early late 1970s / early 1980s (Seidensticker & Suyono 1980). The number thought to remain in the wild is about 400 in protected areas, with a further 100 estimated in other forested areas (Franklin *et al*. 1999). However, whilst many populations in protected areas are monitored, almost no research has been carried out in areas outside protected areas and the accuracy of these figures is unknown. Inside the National Parks, tigers face a daily risk of habitat loss, prey depletion and direct poaching and are surrounded by a sea of agricultural plantations, increasing human populations and decreasing forest coverage. On first appearances the future looks bleak. However, tigers are a surprisingly adaptable species (Sunquist *et al*. 1999) and apparently inhospitable cleared or agricultural land does not necessarily represent a barrier to tigers (Seidensticker 1987). Tigers therefore can and do survive in even the most unlikely environments, including an oil palm-forest matrix (Zoological Society of London 2003a). However, how tigers survive in such a landscape and to what extent is still largely unknown. If the future of Indonesia's last tiger subspecies is to be ensured, its survival in the unprotected matrix of commercial forests, plantations and inhabited areas that already dominate its last refuges must be understood. If the conditions that allow their survival can be identified and their persistence ensured, the fragile populations in protected areas may suddenly look more hopeful as they are interlinked by their little understood cousins in Sumatra's commercial landscapes.

THE NEED FOR CONSERVATION ACTION IN COMMERCIAL LANDSCAPES

NGOs need to take a lead in the development of conservation in commercial landscapes in Indonesia for three reasons. Firstly the development of commercial landscapes is a problem for the Indonesian government, torn between the need to earn revenue and develop a country still suffering from the impact of the economic crash in the late 1990s and concern about loss of natural resources and international opinion. The resulting dilemma means the future of the patchwork of forest and agriculture that covers Sumatra is still very much in the balance and the government is actively looking for viable solutions, although few are available. Second, the key government organisation responsible for wildlife protection in such areas (the KSDA) is seriously under-funded and frequently overlooked in favour of their higher profile colleagues working in better known reserves and National Parks. Whilst tiger areas in Sumatra such as Kerinci-Seblat National Park and Leuser National Park have been the focus of multi-million dollar funding programmes, the less glamorous KSDA struggles to operate on a minimal budget despite operating in a far larger and possibly more difficult area. Thirdly, an understandable hesitancy on the part of conservation organisations to engage with commercial organisations is restricting the search for solutions and despite the importance of understanding how tigers and other species survive outside protected areas this field is still relatively unexplored. Consequently there is little experience and few guidelines on how to develop the conditions that enable coexistence between wildlife and human interests and this forms a clear management void. It is therefore essential to raise the profile of wildlife in commercial landscapes through such projects as this, demonstrating that the two are not completely incompatible and developing guidelines for other areas to follow.

PROJECT GOALS AND OBJECTIVES

The immediate goals of the Jambi Tiger Project are to understand how tigers, their prey and other species of conservation importance are currently surviving in a commercial landscape matrix and how their future can be ensured. In the longer term we would like to feed the results of this work into the growing body of information that will enable the conservation community to guide development of oil palm plantations and other commercial landscapes so as to minimise their impact on their environment.

Although different aspects of the project are being funded by different organisations, all objectives lead towards the common project goals and almost all overlap substantially. This report is designed to summarise the first year's work towards the overall project goals and thus encompasses all objectives that have been individually funded. We hope that by presenting a single report rather than individual reports tailored to each supporting organisation we can show how each of our objectives fit into a wider context and also how all support has enabled success throughout the project.

Currently the project can be divided into two primary sections. Firstly there is an anti-poaching and monitoring component, the first aspect of the project to be set up and currently predominantly funded and run by the plantation. Secondly there is a research component, funded by STF, 21st Century Tiger and ZSL. The research component is aided by the conservation scouts but also employs three full time researchers. For the initial phase of the project, the research team is focussing upon four primary objectives:

Objective 1: Establish the infrastructure and foundations for a long-term tiger research project

Any successful conservation research project has to have a solid foundation from which to work, both to facilitate and extend field capabilities in the short term but also to form the basis for continuation of the work if and when the outside influence of ZSL is reduced. In the first year the project operated with few staff and little equipment. One of the first aims of 2003 was therefore to expand the Indonesian representation on site and equip the project with the logistical support required to carry out the research and conservation goals.

Objective 2: Establish a programme for monitoring basic species diversity and abundance within the plantation

Although it is envisaged that the project will include a number of yearly objectives, there is also a need for an underlying monitoring programme. This should provide continuous data on the tigers and other species present even when specific research objectives are not focussed upon them. Such data should also form the basis of any assessment of longer term change and fluctuations. There were two specific aims:

1. Estimate current species diversity and relative abundance in different habitats within the plantation
2. Set up a monitoring programme that will constantly update species information within the study site.

Objective 3: Determine the tiger prey status and assess potential conflict with the plantation

Prey availability has been shown to be one of the key factors in determining tiger success (Karanth & Stith 1999) with a close relationship between prey and tiger density (Sunquist *et al*. 1999). Initial data from 2001 suggested that the oil palm supports a particularly high density of wild pig (*Sus scrofa*) which benefit from eating both fallen fruit and sapling trees (Ickes 2001). Since wild pig are a common prey item for tigers in other studies it has been hypothesised that their high density around oil palm is key to the survival of tigers in this study area. However, pigs are also a key species because they are perceived as a major pest for the plantation who consequently would like to see their numbers as low as possible. This may lead to conflict between tiger requirements and commercial requirements. Prey studies are therefore being concentrated on the pig population, trying to determine population size and extent of damage to the plantation. Assessment of tiger prey status is covered with three main aims:

1. Calculation of the population size of pigs and other potential tiger prey using the plantation habitat by using a novel camera trapping method, with calibration against traditional capture-mark-recapture and transect methods.

2. Estimate the losses to oil palm production due to pigs through feeding on fallen fruit and damage to young palms and experiment with methods to reduce these losses.

3. Produce guidelines on the likely impacts of pig-control on tiger populations together with recommendations for the reduction of conflict.

Objective 4: Determine the tiger population size and how they are using the landscape

Determining the basic population parameters of a tiger population is clearly an essential first step when beginning a tiger study. However, we are also particularly interested in *how* the tigers are surviving in a commercial landscape. Such information is key if we are to ensure their survival is continued. The fourth objective therefore attempts to estimate the number of tigers using the area and also to trap, radio-collar and track a subsection of the population to determine how they use the oil palm and surrounding habitats.

1. Estimation of the number of tigers using the plantation from camera trap data.

2. Attempt to trap and radio collar a subsection of the tiger population, and use radio telemetry to investigate ranging patterns and habitat use.

3. Use ranging data to advise the plantation on priority areas for future conservation

FUNDING AND SUPPORT

- The project is hosted by PT Asiatic Persada (AP), an oil palm plantation with a majority share holding by Pacific Rim Palm Oil (PRPOL). AP provide most of the infrastructure on site.

- The project is sponsored in Indonesia by LIPI-Biology and is running under a research permit issued by LIPI (the Indonesian Institute of Sciences).

- Support for the radio collaring was given by the PHKA whilst two members of the Jambi KSDA have been seconded to the project.

- Funding for prey research for 2003 was granted by the Save the Tiger Fund

- Funding for tiger ranging research for 2003 was granted by 21st Century Tiger

- Additional funding and support for aspects of tiger ranging in 2003 was given by the Tufton Charitable Trust, BSI Travel and the International Zoo Veterinary Group.

STUDY AREA BACKGROUND

PT ASIATIC PERSADA

PT Asiatic Persada (AP) is an oil palm plantation company originally formed in 1979 under the name of PT Bangun Desa Utama, (PT BDU). It subsequently acquired two subsidiaries, PT Maju Perkasa Sawit (MPS) and PT Jammer Tulen (JT) which were added in 1985 and 1986 respectively, taking the total concession size to 27,000 hectares after which the company changed its name to Asiatic Persada in 1988. Initial oil palm plantings took place in the same year with the final plantings in 1996. In 1994 a central processing mill was placed on site and production started in 1997. Pacific Rim Palm Oil Limited, (PRPOL), acquired a majority holding of 51% in AP in early 2000 and took over management in February 2000. Major forest fires in 1997, destruction of young plantings by wild pigs and poor maintenance of plantings during the economic crisis reduced the original area of cultivated land to approximately 9000ha. PRPOL's initial work has been to concentrate on the rehabilitation of existing areas prior to extending plantings. However, the plantation plans to increase production in the coming years from 45,000 tonnes of crude palm oil (CPO) to 63,000 tonnes in 2004. Between 2002-6 the area under cultivation is expected to rise to a final planted area of 22,953 ha (85% of the concession). It is within the context of this expansion that developing management practices conducive to conservation are so important.

AP and PRPOL have already demonstrated a commitment to environmental issues. AP operates under ISO 9000 and was recently awarded ISO 14000. As a company, PRPOL are committed not to develop natural forest with the ability to regenerate, specialised ecosystems or vegetation that serves important environmental functions. They also aim to promote forest regeneration, genetic diversity and intend to create a series of interlinking conservation areas constituting 15% of the concession with unplanted buffer zones along all rivers. Furthermore, PRPOL have stated they intend to reduce hunting and trapping and implement specific management schemes for endangered species (PRPOL 2003).

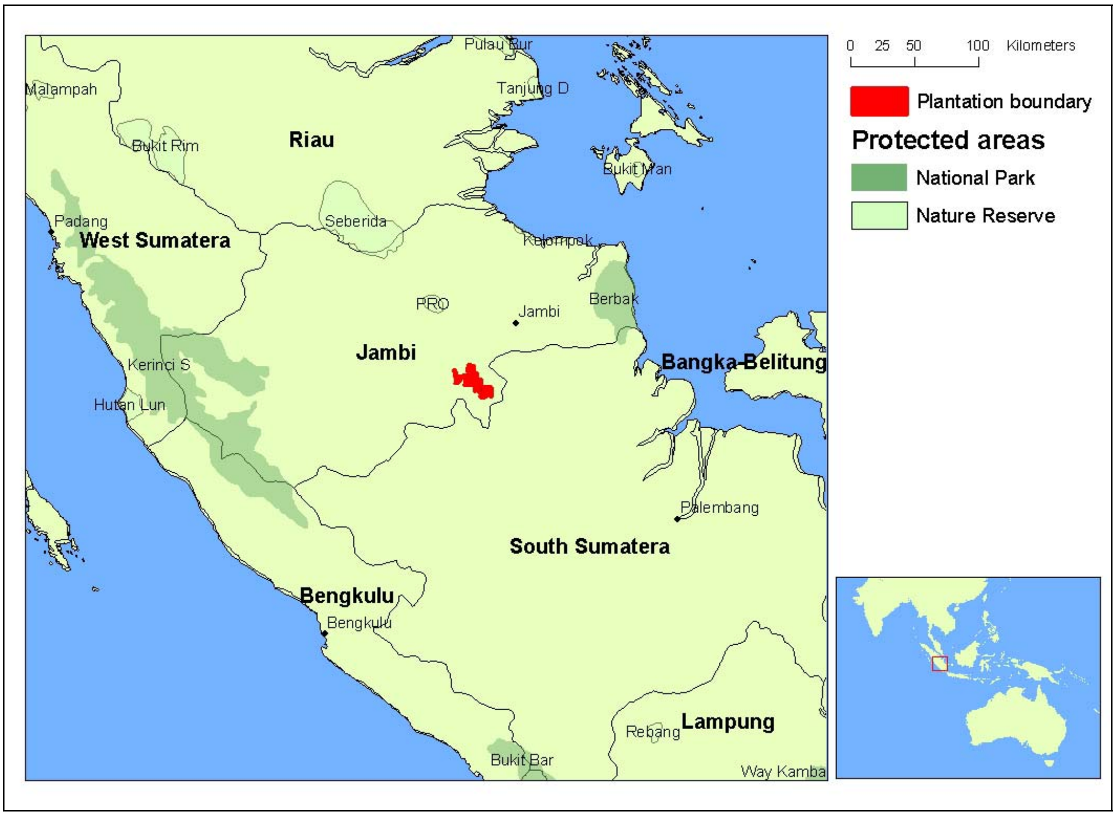
THE ZSL / AP CONSERVATION COLLABORATION

In 2000 an environmental audit conducted for PRPOL by LTS International Ltd. identified 30 species of conservation concern likely to be present on site including tigers, clouded leopards, sun bears, Malay tapirs and crested firebacks. AP then actively approached the conservation community for help and advice specifically for the tiger issue and the options of translocation, compensation or *in situ* conservation were discussed. Chris Carbone of the Zoological Society of London (ZSL) then visited the site in 2001 and a policy of *in situ* conservation was established. Initially a team of Indonesian conservation scouts was recruited on site and joined by a British researcher, Robert Gordon. Together they conducted low level camera trapping, funded by AP and ZSL, which confirmed the existence of at least four adult tigers within the concession and began an anti-poaching programme, removing snares and patrolling tiger habitats. The success of the first year led to applications for further funding and research permission, a ZSL field project manager (Dr. Tom Maddox) was appointed and research activity began in late 2002.

LOCATION

The study is located within and around the 27,000 hectare oil palm concession owned by AP in Jambi Province on the island of Sumatra, Indonesia, approximately 90 km from the city of Jambi. The nearest protected areas are Berbak National Park (119km) and Kerinci-Seblat National Park (170 km).

Figure 1 - Location of study site within Sumatra



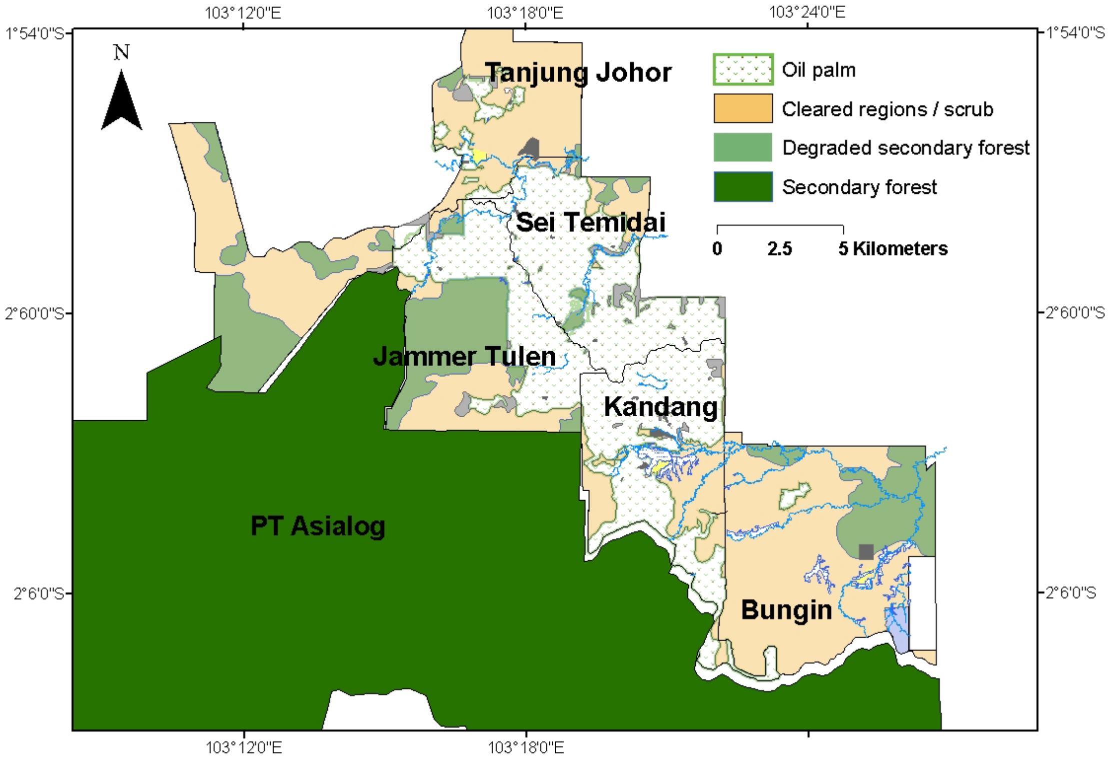
HABITAT TYPES

As noted above, not all of the AP concession is covered by oil palm crop. At time of writing, oil palm covered about 10,000 ha, or approximately 40% of the concession. The remaining 60% consists of two main habitat classes:

- "Degraded secondary forest" – areas previously belonging to a logging concession and since unused. These areas are a macaranga-dominated low canopy with a thick under story of gingers, bamboos and palms
- "Scrub" - areas cleared in the past for planting, but since re-covered in thick, bamboo-dominated scrub

Most of the non-oil palm habitat is concentrated in two of the five estates; Jammer Tulen and Bungin (see Figure 2). The current tiger research is based in these two estates, although reports of tiger activity have also been made in Tanjung Johor estate. The Asialog concession consists of secondary forest, with a relatively thick undergrowth and broken canopy, but the height of the canopy is noticeably different from areas within the plantation. Please see Appendix I for photographs.

Figure 2 - PT Asiatic Persada and adjoining forest concession showing the five estates and broad habitat types[1]



[1] The Asialog and AP border do not match perfectly in this figure because the boundaries have been taken from different sources

METHODS

CAMERA TRAPPING

Camera trapping is an increasingly widely used technique used for monitoring elusive prey in habitats where visibility is poor, based on cameras that can be left in the field and are triggered to take a photograph when passed by an animal. The resulting photographs can either give a rough indication of relative abundance (Carbone *et al*. 2001), an estimate of minimum population size based on individual recognition or sophisticated estimates of density based on capture mark recapture if data are sufficient (Karanth 1995). Cameras are already in use for tiger research *e.g.* (Karanth & Nichols 1998) but are also used for a variety of other species including bears (Mace *et al*. 1994), small carnivores (Moruzzi *et al*. 2002) and ungulates (O'Brien *et al*. 2003). In this study, 44 "Camtrakker" cameras were used with passive sensors (*i.e.* they are triggered by a combination of heat and movement). However, due to various problems with the cameras (see *Problems with "Camtrakker" camera traps* p.53) there were rarely 44 in cameras in operation simultaneously. The results from the cameras were used to help achieve all of the project objectives.

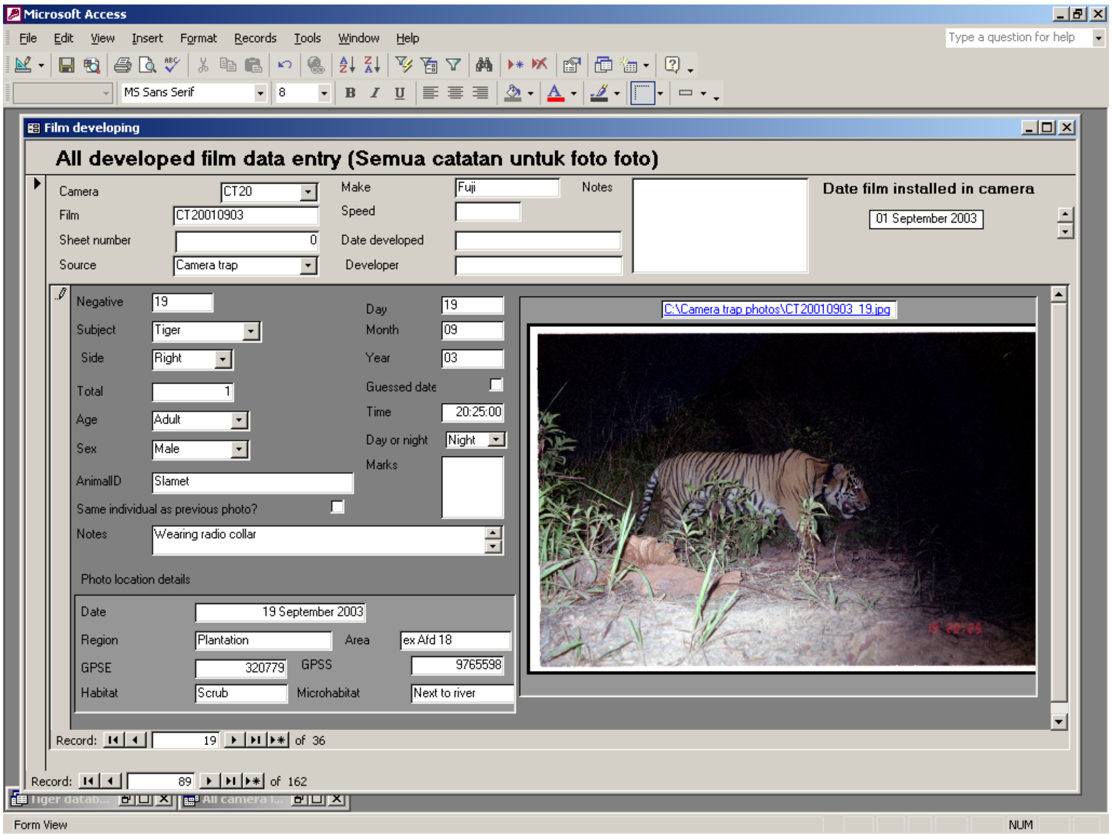
Cameras were set up in one of two ways. Some cameras, referred to in the text as "Tiger cameras" were used to target tigers and were set up on tracks with known tiger activity, particularly at junctions to maximise the chances of a tiger passing. Ideally such cameras should be set up in pairs to allow both sides of recognisable animals to be photographed (Karanth & 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. Other cameras, referred to as "Prey" or "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 this leeway. In general, cameras placed within the oil palm could almost always be placed at the exact random point due to the openness of the habitat, whereas cameras in the thicker scrub often had to be placed away from the pre-chosen point due to accessibility.

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.

Details on the date of installation, film name and location were recorded, the camera secured against theft with a chain and a polite notice requesting finders not to disturb was nailed above the camera. Cameras were generally left 1-2 weeks before checking on the film and battery status, although this varied for cameras expected to run out sooner. In total, "Prey" cameras were left in position for one month, giving a maximum of 496 trap nights (16x31), if every camera worked for every night. "Tiger" cameras were more permanent and left indefinitely when a successful location was identified.

Once films were finished they were developed in Jambi and the negatives scanned into a central database. Details of every *individual* on each photograph are entered into the database and all records linked with the scanned image.

Figure 3 - Data entry page from photograph database



LINE TRANSECTS

A group of methods commonly used for estimating wildlife density and abundance are quadrat-based methods, such as strip transects or point transects, whereby all individuals within a set distance from a transect line or point are counted and densities estimated by dividing the total count by the area surveyed (*e.g.* see Caro 1999 or Bergstrom & Skarpe 1999). However, such methods assume that all individuals within the surveyed area are recorded, an assumption rarely met and impossible to test using the survey data (Thomas *et al*. 200). Furthermore, such methods are wasteful since to increase the probability of recording all individuals the surveyed area has to be very small, thereby discarding up to 60-80% of observations (Anderson *et al*. 2001). An extension of quadrat-based methods are line and point transects in which the perpendicular distance to the sighting is recorded (Buckland *et al*. 1993). Assuming that objects are spaced randomly with respect to the transect and that detection probability at distance 0 is 100%, the increasing number of missed sightings with increasing distance can be modelled using a detection function and thus the proportion of missed sightings estimated. In this study, line transects were primarily used for the prey biology objective, since they have been previously used to determine a pig population index in Australia (Choquenot *et al*. 1993) and to estimate pig density in lowland rainforest in Malaysia (Ickes 2001). However, spotlight transects were also useful for monitoring overall biodiversity around the plantation.

Transects in this study were all conducted by road since large distances needed to be covered to obtain any sightings but also because animals are frequently less concerned by vehicles compared to humans on foot. Ideally, in order to meet the assumption sightings are distributed independently from the transect, transects should not be conducted by road since many animals move away from roads (and a few move towards roads) (Buckland *et al*. 1993). However, random transects were not an option even in the relatively open oil palm so man made tracks had to be used. The use of small tracks has been shown not to give significantly different density estimates in other studies (Maddox, *in prep.*). Since pigs appeared to be primarily active at night, transects were driven in the dark both in the evening and early in the morning. Each transect was driven at a speed of about 15kph with two observers on the vehicle roof with one 1.5 million candle power spotlight each. For each transect, the distance driven, time and habitat type were recorded and the perpendicular distance from the transect to each sighting group noted (Buckland *et al*. 1993). Distance estimation was made by eye.

Ideally, transects would be placed in the same areas as alternative survey methods such as the 2x2 km trapping areas used for random camera traps (above) and CMR (below). However, these areas were too small to allow transects to be conducted completely within them therefore transect surveys were conducted at a larger scale and driven throughout the plantation in oil palm, scrub and forest habitats. Placement of transects was heavily biased to oil palm habitats since few roadworthy tracks were available in other habitats. The line transects are therefore used primarily to support and calibrate other survey methods used in the oil palm, although some comparisons of densities in other habitats could also be drawn.

Data from transects were entered into a database and analysed using *Distance* software (Laake *et al*. 1998).

SECONDARY SIGN SUREYS

Secondary sign surveys are conducted by foot along the tracks and footpaths in the areas of interest. Marked routes are walked by a minimum of two and a maximum of four scouts with a patrol pack consisting of datasheets, mammal track guide and a tape measure. During the transect data are collected on:

- Direct observations of all species of interest (recording species, number in group and perpendicular distance to the centre of the transect line (Buckland *et al*. 1993))
- Animal footprints, faeces or other secondary sign (recording footprint measurements and collecting all carnivore and pig faeces for dietary analysis) (Karanth & Nichols 2002)
- Any signs of illegal activity (such as snares, bird trapping, forest clearance with the relevant authorities informed if necessary). If possible, traps *etc.* are removed immediately.

Secondary sign data were collected as part of "patrol transects". These are a combination of the secondary sign surveys and the regular anti-poaching patrols conducted by the AP conservation team. They are primarily conducted by the AP scouts with supervision by ZSL and collaboration from the Asialog conservation unit and the KSDA. A daily monitoring / patrol programme was developed by ZSL and the head of the AP scouts, covering almost all non-palm areas within Asiatic Persada and bordering areas of Asialog. The patrol transects cover a network of over 170 km of mapped tracks and paths. Each transect patrol has been classified according to priority, with high priority transects visited every two weeks and low priority transects once per month.

All data are collated weekly and entered into a central computer database by ZSL staff.

Figure 4 – AP Scouts, ZSL staff, Asialog scouts and KSDA members on a patrol transect in Asiatic

CAPTURE-MARK-RECAPTURE

The method of choice for density estimation is capture mark recapture (CMR) since if sufficient data are collected CMR generally provides good, quantitative population estimates (Sutherland 1996). In this study, CMR was the first choice method for the prey population survey, specifically targeting the pigs. CMR techniques have been used successfully in the past to estimate feral pig populations (Caley 1993), (Sweitzer *et al*. 2000). Generally CMR studies are conducted by making a number of trapping "rounds" within a discrete period, with captures being marked either on the first or on each capture round (depending on the analysis method required) (White & Burnham 1999). However, pigs are intelligent animals and hard to live-capture on repeated occasions because they rapidly learn to avoid traps (Sweitzer *et al*. 2000). Therefore, this study planned to physically capture pigs on the first trapping round only, marking them with standard agricultural pig ear tags and then "recapturing" them in subsequent rounds with automatic "Camtrakker" cameras set up in the trapping area that take a picture when triggered by heat and movement (thus a photograph of a marked pig would count as a capture, but only pigs caught on the initial trapping round could be marked). Trapping and recapturing was to be focussed within several 2x2km^2 areas marked out in both planted and non planted habitats of the plantation. The initial physical capture round was one month long, capturing as many pigs as possible within the trapping area. A grid of 16 Camtrakker cameras were then set up in the same area as described for "prey cameras" above ("Camera trapping", p.15). It could be argued that CMR studies rely on maximising recaptures, therefore random camera placement was not the most efficient solution (Karanth & Nichols 2002). However, in our situation we also wanted to use the camera grids for other purposes therefore a compromise had to be taken.

Two methods were implemented to capture pigs physically. Firstly, pigs were to be captured using local hunters. These hunters hunt pigs for the Chinese market, capturing pigs alive and selling them in the Jambi market, and their success had been witnessed on previous visits to the plantation. To capture pigs they use funnel-shaped wire traps placed in large numbers in gaps in the vegetation. Pigs are then driven by the hunters (sometimes with dogs) to where they get caught in the traps, have their trotters bound and can be safely handled and marked without the need for anaesthetic. The hunters are frequently welcomed to oil palm plantations where they are seen to control the pigs which are thought to destroy the crop.

Figure 5 - Local pig hunter and trap (left) and the results of a successful trapping session (right)

The second capture method used was a panel trap method (Sweitzer *et al*. 1997) whereby large pen traps are used, capable of trapping more than one pig in each trap. Four of the traps were placed in the 2x2 trapping sites at sites thought to maximise captures and a variety of baits were used including fruit and vegetables, fish, peanut butter and scraps from the plantation canteen. When captured, pigs can be isolated one at a time in the trap "neck" and anaesthetised using Zolatil at 4mg/kg before marking and releasing.

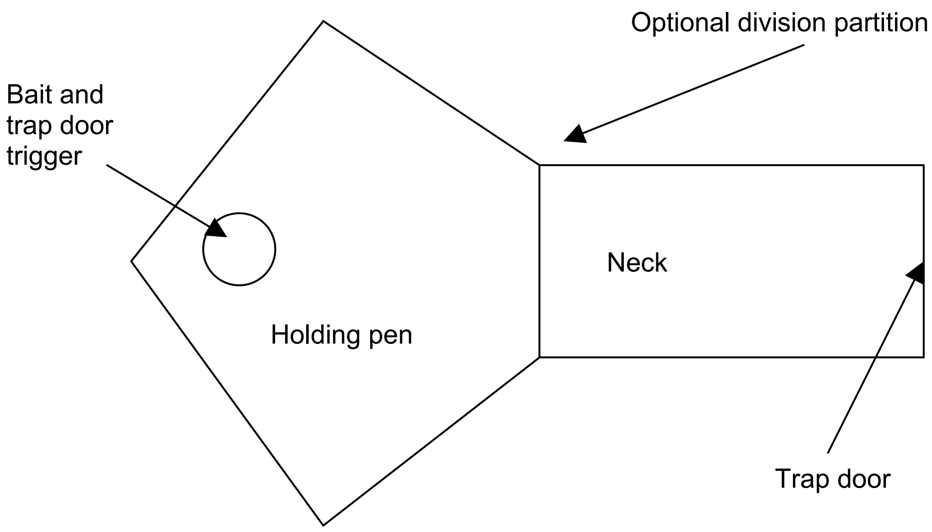


Figure 6 - Setting the bait in a panel pig trap

PREY DAMAGE ASSESSMENT

Fallen fruit losses are being estimated using exclusion experiments. These require small fences to be built around sub sections of the pig survey plots to ensure some areas are free from pig predation. Fallen fruit is then counted on a daily basis within the enclosures and compared to plots of the same size outside. Although fruit inside the enclosures will still be taken by rodents and other small mammals the differences should show the extent of pig impact.

Sapling losses will be calculated by supplementing current plantation monitoring methods. Plants in the nurseries are already checked daily and pig damage recorded. In addition, project staff will make regular checks on newly planted palms. Newly planted palms will be subdivided according to their protection level: some plants will be protected by small, wooden fences whilst others will be left open. By collecting these records over time an estimate of number of trees lost per month can be calculated. These will be cross-referenced with pig density estimates for each plot and costs per unit of pig density calculated.

TIGER CAPTURE METHODS

REMOTE DART GUN

Two capture methods were attempted in 2003. The first was a remote-controlled video dart-gun, developed by KORA (a Swiss group dealing with the conservation and management of carnivores in Switzerland) who kindly provided one on loan. This device consists of a modified dart gun complete with a motion sensor, video monitor, aiming controls and infra-red light, and reduces the stress experienced by the animal during capture to a minimum. The apparatus is controlled from a hide approximately 200 metres away by a hidden operator. If any animal walks in front of the device, the motion sensor alerts the operator who can then fire the dart using the video camera and remote controls to adjust the aim. Experience in Switzerland has shown that the darted animal, unaware of a human presence, quickly falls asleep, usually within metres of the target site.

The remote dart gun was set up between 18:00 and 8:00 the following morning on a total of 14 nights with three to four people monitoring the gun area from the hide using the video monitor. It was first tested in the Jammer Tulen part of the plantation, then moved to Asialog. To attract tigers to the site, the team tried a variety of baiting methods including non-living bait (variously fresh meat, offal, fish and durian fruit), live bait (a young wild pig in a tiger-proof crate), bait trails (1 km blood trails) and an audio predator caller playing recordings of a piglet and a distressed adult pig.

LEG-HOLD TRAPS

The second method used was the humane leg-hold trap; the most widely used and successful capture method in radio-telemetry studies of tigers in Russia. 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 small spring. They are triggered when weight is placed on a trigger in the middle of the loop. Triggering the leg-hold was not painful and was usually tested on a human foot.

To minimise stress in any capture, the leg-holds were modified, firstly by padding the foot-loop with plastic tubing and secondly by attaching a weight between the loop and the tree. The weight then acted as a shock absorber, ensuring that any tiger caught could not jar its weight against the tree. Most importantly, all leg-holds were also fitted with trap transmitters. These gave off a signal when the trap was triggered and ensured the capture team could respond as quickly as possible and minimise the time the tiger spent in the trap. All leg-holds were also modified so that although any animal could trigger one, only something with a paw the size of a tiger would be caught.

Up to thirteen leg-holds were set at any one time, remaining open for up to 24 hours a day. All were placed in the Jammer Tulen area of the plantation on small tracks. Monitoring of the trap transmitter signals was carried out 24 hours a day by at least two people from a hill that provided coverage of all transmitters. No attempts were made to attract tigers to the leg-hold traps (although “cat lure” scent was used at some leg-hold sites in the hope that it might interest a passing tiger). Instead, leg-holds were placed on tracks known through track records to be used by tigers, and branches were used as makeshift road barriers to guide the tigers over the trap site.

Figure 7 – Remote dart gun (left) and setting a leg hold trap (right)

SURVEY EFFORT

CAMERA TRAPPING

Between November 2002 and November 2004 cameras were placed in 174 different positions around the study area. The number of days in position ranged from 1 (generally cameras that were found to be faulty after set up) to 232 (for one camera taking regular tiger photos). The average time in position was 44 days. The distribution of effort in each habitat is summarised in Table 1. Effort could only be calculated from cameras with records of dates set up, taken down and location, therefore all effort from 2001-2 cannot be included in this table.

Table 1- Camera trapping effort summary Nov 2002-2003

		Number of trap nights Nov 2002 - Nov 2003		
Region	**Habitat**	**Tiger**	**Random**	**Total**
Forest concession	Forest	530	96	626
	Palm[2]	0	0	0
	Scrub[2]	0	0	0
Forest concession total		530	96	626
Plantation	Forest	370	0	370
	Palm	0	554	554
	Scrub	1581	401	1982
Plantation Total		1951	955	2906
Total		**2481**	**1051**	**3532**

The camera trapping photograph dataset available for analysis consists of two main parts:

- Data from 2001-2003 were collected using 4-6 camera traps on an opportunistic basis, primarily to confirm the presence or absence of tigers. Few details were recorded on camera trap location or dates thereby restricting the use of these data for any detailed analysis.
- From 2003 funding was used to purchase a further 38 camera traps which arrived in late January. Data were recorded on the positions and dates of use for these cameras and form the basis for most of the analysis in this report.

At time of writing, 3693 negatives had been taken from camera traps and electronically scanned. From these, 5717 sightings had been entered into a database (a sighting being defined as one individual on an image, for example a photograph of three pigs would represent three sightings). 4057 (70%) of these sightings had sufficient supplementary information to allow them to be geo-referenced (*i.e.* using the date on the negative to match to the camera location at this time). Photographs that could not be geo-referenced were generally those taken in 2001-2 when few locations and dates were recorded. However, some photographs taken in 2003 were also lost due to bleaching of the date (see “Problems with “Camtrakker” camera traps” p.53). 3925 (96%) of the geo-referenced photos were taken in 2003 between January and November. Results from December 2003 are not yet ready for analysis. These geo-referenced photographs form the basis for the analysis in this report unless stated otherwise.

[2] These habitats do not exist in the forest concession areas surveyed at this point

LINE TRANSECTS

76 line transects covering a total of 390.3 km were conducted over approximately 40 hours. Habitat types for each transect were divided into four habitats rather than three since a large proportion of transects were driven along the forest / oil palm border road.

Table 2 - Summary of line transect effort

Habitat	Distance driven (km)	Number of transects conducted
Forest	15.3	3
Oil Palm	242.5	37
Oil palm/Forest	89.4	18
Scrub	43.1	18
Total	**390.3**	**76**

SECONDARY SIGN SURVEYS

Secondary sign surveys are conducted on a continuous basis as part of regular patrols covering approximately 170km of roads and tracks in the Asiatic area. During 2003 2025 faecal records were collected, 1180 records of tracks were made and 145 direct sightings recorded.

CAPTURE-MARK-RECAPTURE

Unfortunately capture mark recapture studies for pigs were not successful in 2003. See *Objective 3: prey population Biology* p.35 for further details.

PREY DAMAGE ASSESSMENT

Three 10x10 grids of 100 sapling oil palms have been marked in a newly planted area. Monitoring of damage was started on a weekly basis in November.

TIGER CAPTURE METHODS

All trapping effort took place on the Asiatic Persada Jammer Tulen estate and bordering areas of Asialog. Jammer Tulen consists primarily of secondary forest/scrub habitat with some oil palm. A total of 621 trapping nights took place in 18 different locations within the plantation. At any one time, a maximum of thirteen leg-holds were set. (The maximum number was limited by the number of transmitters available). The chance of a leg-hold being triggered was on average 4.6%, and a number of different species triggered the traps. Since the traps were designed not to hold anything smaller than a tiger, no other species was caught; however, tracks around the traps were examined to determine which species triggered the mechanism.

OBJECTIVE 1: ESTABLISHMENT OF PROJECT INFRASTRUCTURE

ZSL RESEARCH TEAM MEMBERS

The field research team has been headed by Dr. Tom Maddox, with supervision by Sarah Christie and Dr. Chris Carbone in London and by Dr. Jito Sugardjito in Bogor, Indonesia since August 2002. In November 2002 Satrio Wijamukti of UNAS University in Jakarta was appointed as the onsite research counterpart with a one year contract. In August 2003 the project hired Elva Gemita, formerly of the Kerinci-Seblat Integrated Conservation and Development Project, to work as research assistant. In November 2004 Satrio was replaced by Adnun Selampassy of Lampung University and formerly a fieldworker for the World Conservation Society (WCS).

COLLABORATIONS AND PARTNERSHIPS

PT ASIATIC PERSADA

The primary collaboration is with PT Asiatic Persada, and in particular with their 15 man conservation team headed by Volta Bone. The ZSL team is now fully integrated with the Asiatic conservation team, with a daily programme combining both research, monitoring and anti-poaching carried out by both ZSL and Asiatic personnel. Asiatic Persada have shown a strong concern for the tigers that use their concession and their commitment to helping the research has been invaluable.

KSDA JAMBI

Close links have also been formed with the Jambi KSDA (a subsidiary of the Department of Forestry). Until March 2003 this involved the permanent secondment of one KSDA staff member to the ZSL team, participating in all aspects of research. With the change in management in Jambi this arrangement was temporarily postponed, but negotiations are underway to increase the secondment to two KSDA staff members; one specialising in anti poaching and law enforcement and the other specialising in research. Furthermore, the KSDA had a strong involvement in the capture period held between March and May 2003 (see separate report), with several members attending a training workshop held jointly by Flora and Fauna International and ZSL which included specialist training in the use of their capture equipment from Dr. John Lewis of the International Zoo Veterinary Group. KSDA participation continued when the capture period began, with several members visiting the study site when capture attempts were started.

PT ASIALOG

Links have also been established with the conservation unit within PT Asialog, the owners of the forest concession neighbouring the plantation. The tigers that use the plantation land frequently move into this forest area. Asialog also have a conservation team and one member of their team was seconded to the ZSL team between October 2002 and mid 2003, contributing to all research activities. Furthermore, with the support of the Asialog conservation manager, ZSL have expanded many of their research activities into Asialog, with regular transect and camera trap surveys carried out in areas bordering the plantation.

LOCAL RESIDENTS

The term “local residents” could be used to cover a wide range of people inhabiting the area. Presently, ZSL is concentrating on building relationships in particular with the Orang Bathin Sembilan (OBS) people who live and work both within the plantation and also within the forest concession. The OBS are commonly acknowledged as the indigenous community. Several

OBS members are presently employed within the conservation team by Asiatic Persada, two of whom work primarily with ZSL. Furthermore, regular trips are made to OBS dwellings in an attempt to learn more about their lifestyle and needs as preparation for future community conservation plans.

OTHER ORGANISATIONS

Over the past year ZSL have been building relationships with several other Indonesian and Asian-based conservation organisations. These include Flora and Fauna International with whom a joint veterinary training workshop was held in March 2003 in Jambi, WWF Indonesia and Malaysia (with a visit to the Malaysian WWF tiger-oil palm project in 2002) and Conservation International who have agreed to collaborate on a camera trapping study. ZSL has also been in regular communication with Birdlife Indonesia and Birdlife International who also have interests in the Jambi area.

TRAINING

Tom Maddox spent two weeks on an intensive Indonesian language course in August 2002 and is currently continuing a self-taught language course. He also received training in animal handling and anaesthesia in UK zoos from the International Zoo Veterinary Group.

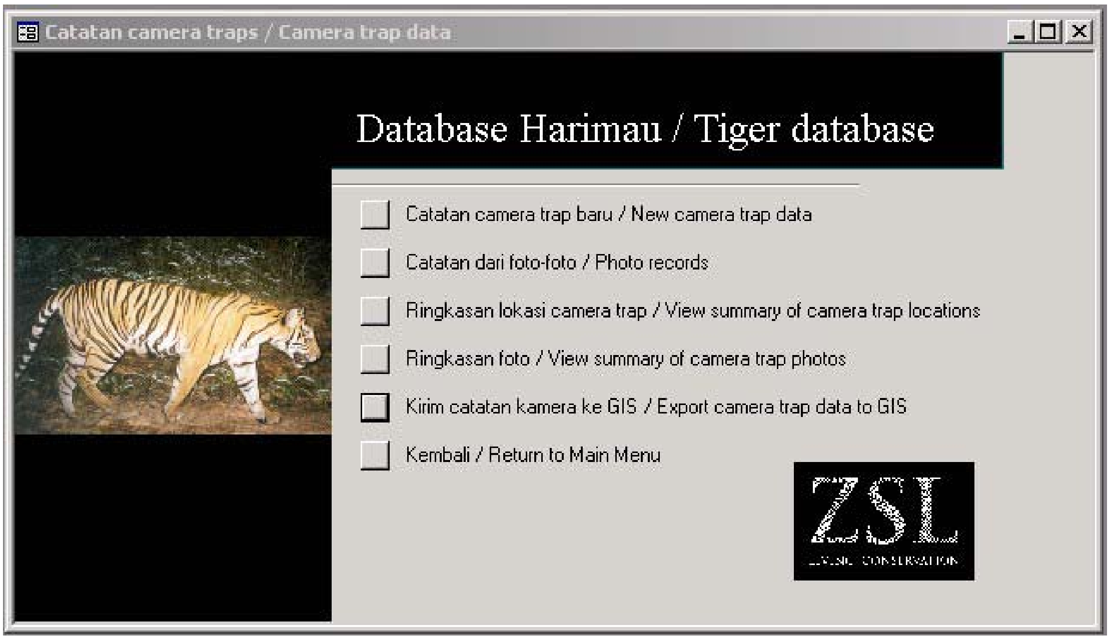
Satrio Wijamukti underwent a 3 month English language course in early 2003.

Tom Maddox, Satrio Wijamukti, Elva Gemita and three Asiatic scouts all underwent training in animal handling and basic anaesthesia with lectures and demonstrations by the International Zoo Veterinary Group and Taman Safari Indonesia at the Veterinary Training for Wildlife Professionals Workshop held in Jambi in March 2003.

DATA MANAGEMENT

During 2003 an Access database was created to hold all data collected. The database uses a series of bilingual electronic forms for ease of data entry and is linked to both a GIS database and all records of scanned images from camera traps. The database can be queried for daily monitoring purposes (*e.g.* it will show a table summarising where cameras are currently located, how long they have been in place and the number of days since the batteries / film was last changed as well as a map of current locations) or it can be queried for analysis purposes, and it forms the basis for most summaries presented in this report.

Figure 8 - Tiger database



FIELD LOGISTICS

The ZSL project is now fully established in the field, with one 4x4 vehicle, two motorbikes, 44 Camtrakker camera traps, two computers, a VHF radio network and a fully equipped tiger capture and anaesthesia kit. Accommodation is provided for all project staff by the plantation.

Figure 9 - The ZSL jeep

OBJECTIVE SUMMARY

Objective 1 has progressed well in 2003 ad the project now has the underlying infrastructure to proceed on a long term basis. Areas that still need developing include the Asiatic scouts, who do not have sufficient transport and equipment to maximise their potential, and also transport for the ZSL team which can be limiting, especially when the jeep is in the workshop or stuck in mud.

OBJECTIVE 2: SPECIES DIVERSITY AND ABUNDANCE IN AND AROUND OIL PALM

SPECIES DIVERSITY

Basic monitoring of the diversity of species within the study area is carried out using the results from the camera traps, line transects and secondary sign surveys. The results show that despite being a working, commercial landscape, the oil palm / scrub / forest matrix is still able to support a wide range of mammal species including several endangered species including the tiger, clouded leopard, fishing cat and dhole. Camera traps recorded twenty-four non-human mammal species and one reptile, secondary sign surveys recorded 26 non-human mammals and four reptiles. Cameras also recorded six bird species. Line transects recorded fourteen mammals species. In total the three methods have produced a species list of thirty-three mammals on or around the plantation site. In general, camera traps were good at recording species presence for medium and large sized mammals, however they failed to record most of the arboreal species which were either picked up by line transects or secondary sign surveys. Secondary sign surveys also picked up most species, but could not be used to distinguish between some species (such as the three civet species) and missed most arboreal species. Line transects recorded the fewest species but were useful for adding arboreal, nocturnal species. A summary of all species recorded through these methods during 2003 is shown in Table 3. At this stage, efforts were only made to record the diversity of mammals, however, species of reptile and birds recorded during the surveys are included for interest.

Table 3 - Complete list of species recorded since the project started

Subject	Latin name	Camera traps		Line transects		Secondary signs	
		Total of individuals	% of total	No. on line transects	% of total	Direct sightings	Tracks / faeces
Agile gibbon	*Hylobates agilis*	0	0.00%	0	0.00%	Y	N
Banded leaf monkey	*Presbytis melalophos*	1	0.02%	0	0.00%	Y	N
Banded palm civet	*Diplogale derbyanus*	1	0.02%	0	0.00%	N	N
Bearded pig	*Sus barbatus*	155	2.71%	0	0.00%	Y	Y
Binturong	*Artictis binturong*	0	0.00%	0	0.00%	N	Y
Black flying squirrel	*Ratufa bicolour*	0	0.00%	1	0.58%	N	N
Clouded leopard	*Neofelis nebulosa*	0	0.00%	0	0.00%	N	Y
Common palm civet	*Paradoxurus hermaphroditus*	39	0.68%	45	26.01%	Y	Y
Dhole	*Cuon alpinus*	11	0.19%	0	0.00%	Y	Y
Domestic cat	*Felis cattus*	0	0.00%	17	9.83%	Y	Y
Domestic dog	*Canis familiaris*	36	0.63%	1	0.58%	Y	Y
East Asian porcupine	*Hystrix brachyuran*	107	1.87%	0	0.00%	Y	Y
Fishing cat	*Prionailurus viverrinus*	0	0.00%	0	0.00%	Y	Y
Giant red flying squirrel	*Petaurista petaurista*	0	0.00%	4	2.31%	N	N
Greater mouse deer	*Tragulus napu*	10	0.17%	1	0.58%	N	Y
Large tree shrew	*Tupaia tana*	1	0.02%	0	0.00%	Y	N
Leopard cat	*Prionailurus bengalensis*	152	2.66%	75	43.35%	Y	Y
Long tailed	*Macaca fascicularis*	67	1.17%	1	0.58%	Y	Y

macaque							
Malay Civet	*Vivera tangalunga*	14	0.24%	3	1.73%	N	N
Malayan tapir	*Tapirus indicus*	35	0.61%	0	0.00%	N	Y
Moon rat	*Echinosorex gymnurus*	0	0.00%	0	0.00%	N	Y
Muntjac	*Muntiacus muntjak*	56	0.98%	1	0.58%	Y	Y
Pangolin	*Manis javanica*	2	0.03%	0	0.00%	N	N
Pig (wild)	*Sus scrofa*	1189	20.80%	19	10.98%	Y	Y
Pig tailed macaque	*Macaca nemestrina*	352	6.16%	0	0.00%	Y	Y
Plantein squirrel	*Calosciurus notatus*	8	0.14%	0	0.00%	N	N
Prevost's squirrel	*Calosciurus prevostii*	0	0.00%	0	0.00%	N	Y
Rodent (unknown species)	*Rattus sp.*	1	0.02%	1	0.58%	Y	N
Sambar	*Cervus unicolor*	25	0.44%	0	0.00%	Y	Y
Short tailed mongoose	*Herpestes brachyurus*	10	0.17%	0	0.00%	N	Y
Slow Loris	*Nycticebus coucang*	0	0.00%	3	1.73%	N	N
Smooth otter	*Lutra perspicillata*	0	0.00%	0	0.00%	Y	Y
Sun bear	*Helarctos malayanus*	22	0.38%	0	0.00%	N	Y
Tiger	*Panthera tigris*	98	1.71%	0	0.00%	Y	Y
Yellow throated marten	*Martes flavigula*	2	0.03%	1	0.58%	N	N
Reptiles[1]							
Monitor lizard		4	0.07%	0	0.00%	Y	Y
Python		0	0.00%	0	0.00%	Y	N
Blood python		0	0.00%	0	0.00%	Y	N
Mangrove snake		0	0.00%	0	0.00%	Y	N
Birds[1]							
Emerald Dove		3	0.05%	0	0	Y	N
Greater coucal		1	0.02%	0	0	Y	N
Jungle fowl		104	1.82%	0	0	Y	Y
Partridge		4	0.07%	0	0.00%	N	N
White breasted water hen		13	0.23%	0	0	Y	N
Wreathed Hornbill		1	0.02%	0	0	Y	N
People[1]							
Person (conservation)		308	5.39%	0	0	0	0
Person (plantation)		123	2.15%	0	0	0	0
Person (unknown)		502	8.78%	0	0	0	0
Motorbike (non-plantation)		8	0.14%	0	0	0	0
Motorbike (plantation / conservation)		40	0.70%	0	0	0	0
Vehicle (non-plantation)		3	0.05%	0	0	0	0
Vehicle (plantation / conservation)		27	0.47%	0	0	0	0

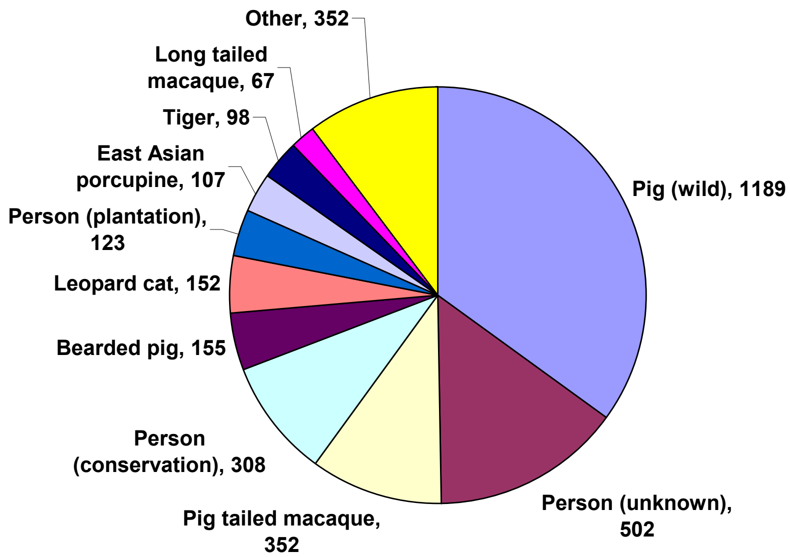
Other photographs						
Accidental photo	222	3.88%	0	0	0	0
Misfire (no subject)	889	15.55%	0	0	0	0
No exposure	829	14.50%	0	0	0	0
Out of focus	67	1.17%	0	0	0	0
Test card	174	3.04%	0	0	0	0
Unknown	1	0.02%	0	0	0	0
Grand Total	**5717**	**100%**	**173**	**100%**	**0**	**0**

[1] Recorded from camera traps / opportunistically – not intended to be a comprehensive species list

SPECIES DISTRIBUTION AND ABUNDANCE

Firstly, analysis of basic photograph frequency can be carried out. Looking at the top ten most photographed mammals only, Figure 10 shows that wild pig were the most photographed species, with tigers the ninth most commonly photographed.

Figure 10 - Top ten most photographed mammals (and number of photographs)



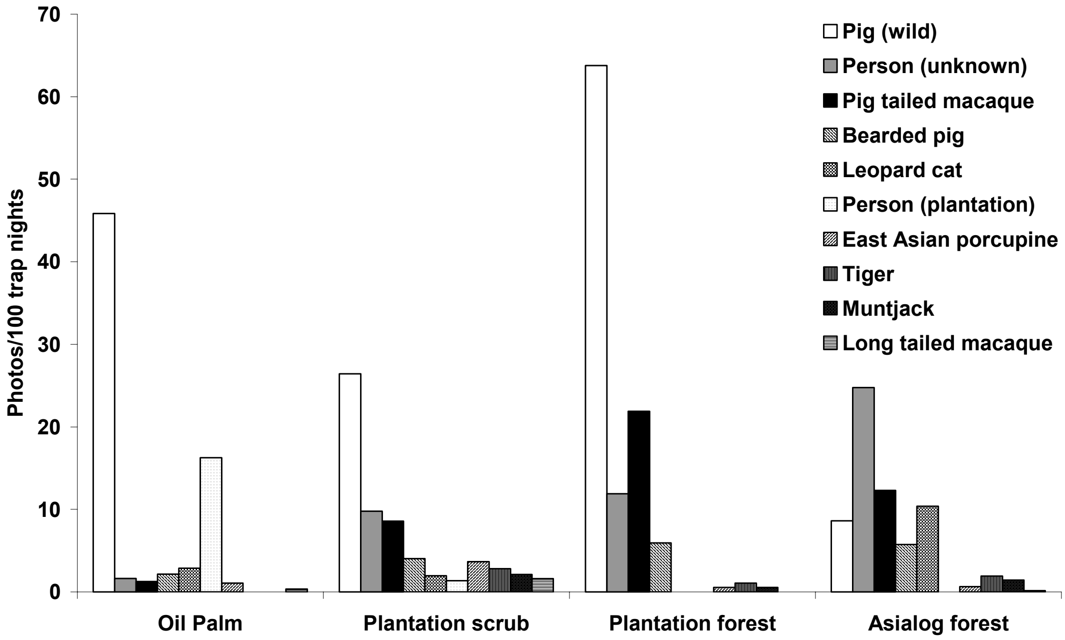
By classifying species seen from transects and camera traps into one of the broad habitat types, the distribution of species within and around the plantation can be analysed. Camera trap data could not be used to provide actual densities at this stage, but could provide relative abundance by calculating the number of photographs taken of each species per trap night. Ideally, analysis of sightings should only be carried out on independent sightings. At this stage, non-independent sightings have not been filtered and results are presented for all sightings. The results show that most of the species of conservation interest recorded are occurring within the plantation concession, although oil palm itself is only used to a high degree by wild pigs, leopard cats and common palm civets.

Table 4 - Trapping rates (individuals/100 trap nights) for top 15 most photographed subjects (not including accidental photos etc.) *using random and non-random cameras*

Position		Asialog	Plantation			
	Habitat (trap nights)	Forest (626)	Forest (370)	Palm (554)	Scrub (1982)	Overall (3532)
1	Pig (wild)	8.6262	63.784	45.85	26.438	30.238
2	Person (unknown)	24.76	11.892	1.625	9.7881	11.382
3	Pig tailed macaque	12.3	21.892	1.264	8.5772	9.4847
4	Bearded pig	5.7508	5.9459	2.166	4.0363	4.2469
5	Leopard cat	10.383	0	2.888	1.9677	3.3975
6	Person (plantation)	0	0	16.25	1.3623	3.3126
7	Jungle fowl	0.3195	0	0	4.3895	2.5198
8	East Asian porcupine	0.639	0.5405	1.083	3.6831	2.4066
9	Tiger	1.9169	1.0811	0	2.8254	2.0385
10	Muntjac	1.4377	0.5405	0	2.1191	1.5006
11	Long tailed macaque	0.1597	0	0.361	1.6145	0.9909
12	Common Palm Civet	1.4377	0.2703	0.722	1.0091	0.9626
13	Domestic dog	1.4377	0.2703	0.181	0.8073	0.7644
14	Malayan tapir	1.1182	1.3514	0	0.7064	0.7361
=15	Malay Civet	0.1597	0	0	0.555	0.3398
=15	Sambar	0.4792	0	0	0.4541	0.3398
=15	White breasted water hen	0	0	0	0.6054	0.3398

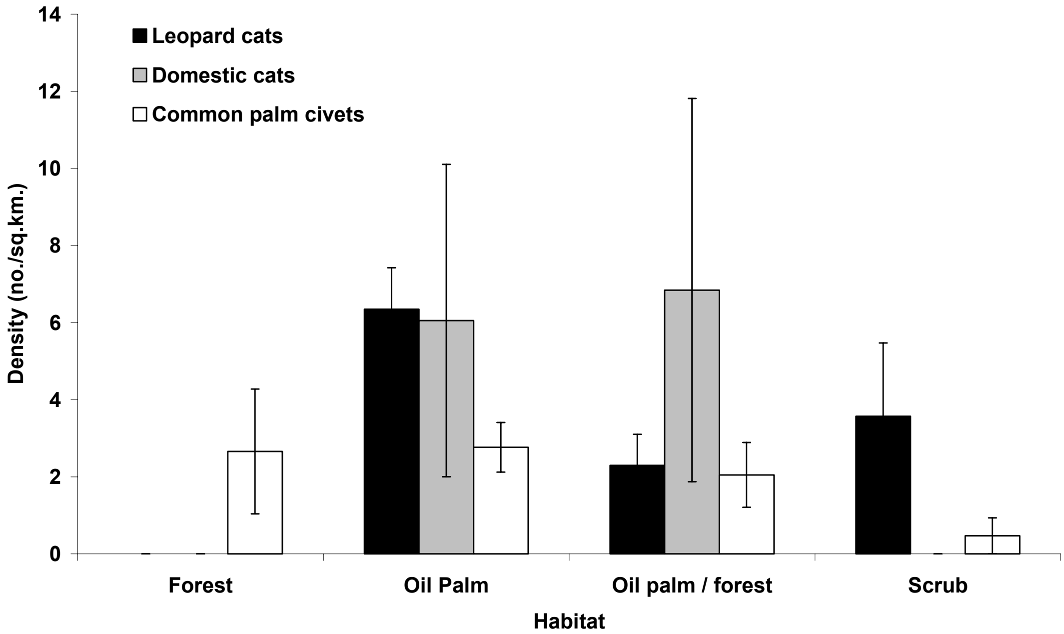
Figure 11 shows the top ten mammals from these results plotted against one another. The results show that with the exception of wild pigs, the oil palm crop itself is a poor habitat for most species. However, the non-planted habitats in the plantation do provide refuge for significant numbers of several species, including tigers, leopard cats, muntjacs and macaques. The camera results also show a high amount of human presence in the habitats favoured by most other species. Whilst the oil palm saw only high numbers of oil palm workers, other people were common elsewhere in the plantation and particularly in the Asialog concession.

Figure 11 - Relative densities of top ten most photographed mammals in different habitats in and around the plantation



For a minority of species, actual densities could be calculated from line transects. These could only be calculated for the most commonly sighted species (recommended to be >50 sightings (Buckland *et al*. 1993) but in this report analysis has also been carried out for species with fewer sightings since the results still had fairly low coefficients of variation) were analysed using Distance (Laake *et al*. 1998) to provide actual estimates of density for the most common species. Densities could be calculated for wild pigs, leopard cats, domestic cats and common palm civets. Since pigs are dealt with in a separate section, only the results for the small carnivores are presented here (Figure 12). Interestingly, the results for leopard cats differ from the relative estimates from camera traps, with line transects showing leopard cats to be *most* abundant in the oil palm crop and absent from the forest. This is likely to be a reflection of the difficulty of conducting line transects in forests where perpendicular visibility was almost nil.

Figure 12 - Estimated densities (+/- SE) of small carnivores inside and outside the oil palm crop, calculated from night transect data



OBJECTIVE SUMMARY

Objective 2 has progressed extremely well, with cameras and other methods collecting large amounts of data on a habitat almost completely unknown for its conservation potential. The areas around the plantation have been shown to shelter a large proportion of species expected to be exist in lowland Sumatran rainforest, with the only major exceptions appearing to be elephants (although reports state their presence in southern Asialog), the Sumatran rhinoceros and orang utans (historically absent from the area anyway). Presence of the some of the smaller carnivores, including several felid species, is also yet to be confirmed. However, which of these species exist despite the plantation and which derive any benefits from it is yet to be seen. Areas that need to be strengthened in this section are better use of secondary sign surveys; both calibrating with more robust methods to determine accuracy and making better use of the large number of staff assigned to conservation by the plantation.

Figure 13 - Non-tiger species of conservation interest with photographic evidence within the plantation concession clockwise from left – dhole, sun bear, bearded pig, Malay tapir.

OBJECTIVE 3: PREY POPULATION BIOLOGY

PREY AVAILABILITY WITHIN THE STUDY AREA

PREY DIVERSITY

Data presented under objective 2 demonstrated that there were a number of potential prey species available to tigers within the study area. Of the species recorded, wild pig, bearded pig, sambar, muntjac, porcupine, macaques, palm civet and even dhole are recorded prey species for tigers (Sunquist *et al*. 1999).

Figure 14 - Possible prey species existing within the study site

Subject	Latin name
Agile gibbon	*Hylobates agilis*
Banded leaf monkey	*Presbytis melalophos*
Banded palm civet	*Diplogale derbyanus*
Bearded pig	*Sus barbatus*
Binturong	*Artictis binturong*
Common palm civet	*Paradoxurus hermaphroditus*
Dhole	*Cuon alpinus*
Domestic cat	*Felis cattus*
Domestic dog	*Canis familiaris*
East Asian porcupine	*Hystrix brachyuran*
Greater mouse deer	*Tragulus napu*
Long tailed macaque	*Macaca fascicularis*
Malay Civet	*Vivera tangalunga*
Malayan tapir	*Tapirus indicus*
Muntjac	*Muntiacus muntjak*
Pangolin	*Manis javanica*
Pig (wild)	*Sus scrofa*
Pig tailed macaque	*Macaca nemestrina*
Sambar	*Cervus unicolor*

PREY ABUNDANCE

Studies of the prey and particularly pig densities were not entirely successful. The main failure in 2003 was the lack of success in completing a capture-mark-recapture study. Attempts to catch pigs with local hunters were carried out between November 2002 and February 2003, using a hunter from Jambi with a team of 5-6 men and fifty wire funnel traps. The traps were then set in lines between the oil palm and forest habitats and on animal trails within scrub habitat. Captured animals were then bound by the trotters before removing from the trap. They were then marked and released. However, despite a huge investment of time and limited capture success, this trapping period was deemed to be unsuccessful and was stopped in early February. There were two primary problems. Firstly and most importantly the methods used by local hunters were found to be less humane than first thought. Although used to capture pigs live for market, the funnel traps were found to be still highly stressful for the pigs and there were serious concerns about the long term impacts of capture and restraint – issues that are not usually considered for pigs due for slaughter at market. The concerns were partly due to the stress incurred by experiencing a capture and handling whilst conscious and partly because the requirement to mark pigs meant they were handled more extensively than pigs caught for market. The second problem was that the funnel capture technique was in fact far more restrictive in where it could be applied. The hunters capture the pigs by channelling them towards the traps. This works well in dense scrub where pig trails can be identified and blocked but in the more open habitats of forest and oil palm the undergrowth was not thick enough to be able to channel pigs towards the traps. Consequently, not all areas of interest could be surveyed using this technique. By February 2003 only six pigs had been caught using the funnel method. Only one adult pig was successfully marked and released and one pig died as a result of being captured (despite being in the trap for less than one hour). The hunters were being offered 200 000 Rp ($20) per pig successfully caught, marked and released but they decided it was not worth the effort or risk and the project in turn decided the method was too harmful to continue.

Following the failure of the first method, a single prototype panel trap was built by the plantation workshop between March and April. The trap was trialled and adjusted in May before being returned for modification and to act as a template for three more. Unfortunately the four traps were not ready until November 2003. So far, traps have not been set to catch as pre-baiting is still under way. Pre-baiting is an essential part of the trapping process (Sweitzer *et al*. 2000) and various baits have been trialled for effectiveness. These include fruits (jackfruit, durian, pineapple and banana), fish, maize, cassava, peanut butter and waste food from the plantation canteen. In the approximately one month the traps have been trialled no bait has been shown to be particularly effective. By clearing the soil around the trap the tracks of pigs approaching or entering the traps can be seen. To date only one pig has entered a trap, although several have been recorded outside. This may be a consequence of the high abundance of alternative food (loose oil palm fruit lies on the ground in most areas) or it may show the cautiousness of the pigs. The traps are currently in position, unbaited and unset. In March 2004 a renewed effort will be made to capture pigs in the hope that the traps will no longer be seen as suspicious.

However, estimates of density were possible from camera traps and line transects. For this analysis, only photographs of potential prey taken by *randomly* placed cameras were used (as opposed to all cameras when looking at general diversity) (Figure 15). These were compared with estimates of actual pig density obtained from night transects (Figure 16). The results show that when using randomly placed cameras only, the difference in abundance between wild pigs and other potential prey species is even larger, possibly because pigs do not use the open tracks favoured by the carnivores. They also show that the estimate of pig abundance in the plantation scrub (the habitat with the highest rate of tiger photos) is higher than if calculated using all cameras, possibly showing that pigs particularly avoid the tracks in these areas. Estimates of relative abundance from cameras are in broad agreement with the line transects (Figure 16), showing low densities in the forest and the high densities in and around the oil palm. However, estimates from scrub habitats do not agree. It is suspected these results are confounded by the low sample sizes and consequent large error margins associated with the line transect data, caused by a lack of driveable tracks in these habitats.

Relatively few studies of pig density in comparable habitats have been published for comparison. However, one study in a topical woodland / agricultural landscape used transects to estimate densities of between 2.2 and 3.5 pigs per square kilometre (Caley 1993), estimates very similar to those in the oil palm and to some extent the scrub in this study. The only other study to look at pigs associated with oil palm also used line transects to calculate estimates of between 27 and 47 pigs per square kilometre across two years in a Malaysian forest / oil palm border (Ickes 2001). However, there were no reported predators in this study site. At this stage, the data from this project are not sufficient to draw too many conclusions from these comparisons, nor can good calibrations of camera trapping data be calculated. It is therefore important that the coming year provides better estimates of absolute density, either through capture mark recapture or by increasing line transect effort and success.

Figure 15 - Relative abundance of potential prey species from randomly placed cameras (plantation forest was not surveyed by this method)

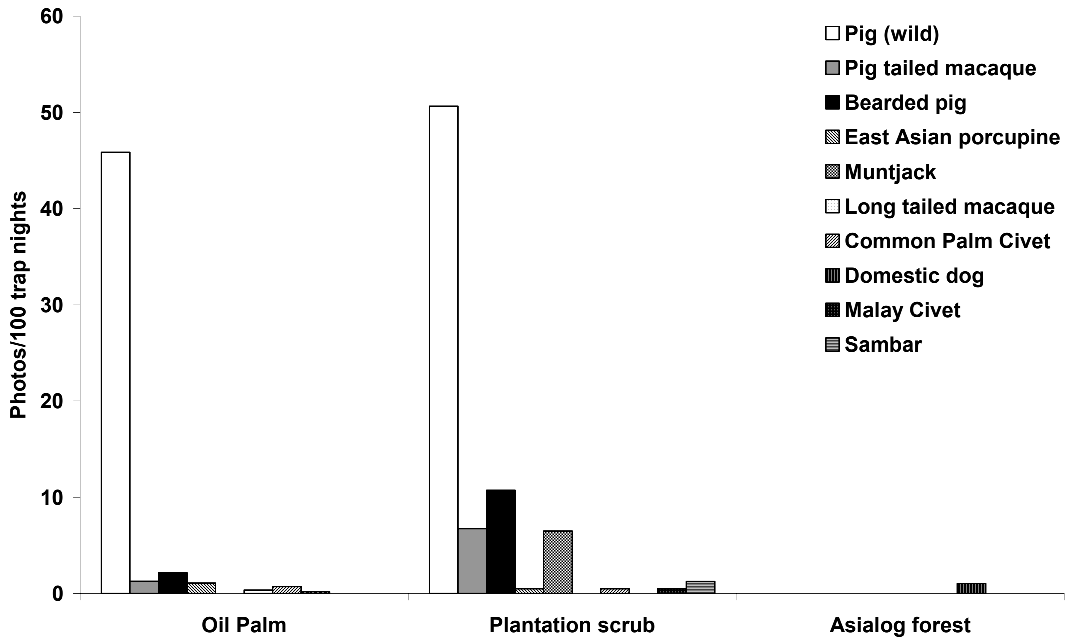
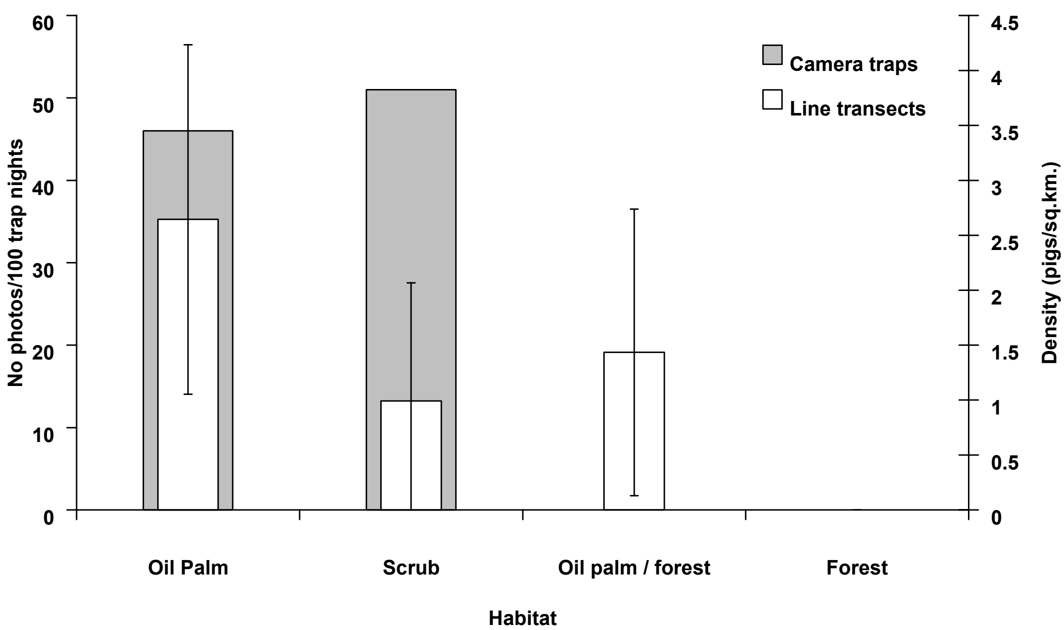


Figure 16 – Comparison of wild pig abundance estimates using night transects (open bars, +/- SE) and camera trap indices (filled bars)



Note: Oil palm / forest boundary habitat was not surveyed by camera traps

IMPACT ON THE PLANTATION

Studies of the impacts of pigs on fallen fruit and young palms have been delayed by the problems in pig surveying. The most important impact of pigs on the plantation according to the plantation management is predation of sapling trees. Young trees are stored in nurseries where fencing is a feasible control method, however the greater impacts are inflicted on saplings planted in the field which cover a large area and are spread about. Agreements have now been made with the plantation as to how to assess the impacts of predation. Impacts on nursery saplings are being assessed in coordination with a pilot electric fencing plan currently being installed around one nursery. Blocks of 100 saplings are being marked within and outside the electric fence in one nursery and throughout the unfenced nursery in another area. Photograph cards showing damage by pig as compared to small rodent, porcupine or disease are being made and nursery monitors are being asked to carry out weekly checks on the marked samples, recording the number of saplings lost and the cause of damage. Multifactorial analyses such as GLMs (Generalised Linear Models) will be used to assess the losses to pigs and the effects of the fencing, distance to scrub habitat, position of the palm in the grid on the scale of loss.

Similar methods are being used to assess sapling loss in the field. Two relatively uniform areas of newly planted palm have already been identified for the study:

1. 30 hectares of nine month old palms

2. 60 hectares of two year old palms

Blocks of 100 palms (there are about 143 per hectare) are again being marked and marked areas will be harvested as “best management blocks” whereby they are visited every week with plantation workers noting losses and causes using the same picture cards. Similar analyses will be used to investigate distance from the edge of non-palm habitats, rivers and use of wooden fencing placed around a subsection of the samples.

Both of these studies are incomplete and there are no results to present at this stage.

OBJECTIVE SUMMARY

The prey objective is still far from complete, with two major setbacks. Firstly, the various problems encountered when attempting to physically capture pigs have set the capture-mark-recapture plans back by several months. To our knowledge there is no other study that has developed a successful live capture technique for wild pigs and we are still developing alternative plans to the use of local hunters. Nevertheless, alternative abundance survey methods were more successful. Indirect estimates of abundance from random camera traps are forming a good picture of relative abundance and habitat use. These data will be even stronger once the results from camera grids completed in December as well as January and February in 2004 are included in the analysis, increasing the effort in forest and scrub habitats. Night transects are providing actual density estimates but at this stage we are exercising a little caution over the results since sightings are far less frequent than expected (especially considering the number of times pigs pass cameras) and consequently standard errors of estimates are still high. This is thought to be due to the lower visibility of pigs at night compared to species with highly reflective eyes (such as the leopard cats). As a result, the value of transects as a calibration for the camera trap results is limited. An interesting side project will be to look at the leopard cat data in more detail. These are the only species for which large datasets are available from both transects and cameras and their coats allow individual recognition. Calibration of both datasets should therefore be fairly easy and would be an interesting comparison with the pig data.

The second problem was simply the volume of work we undertook to complete within one year. The initial prey study proposal aimed to study the density of pigs through a variety of methods in different habitats as well as the impact of pigs on the plantation through predation of fallen fruit, impacts on nurseries and predation of young palms in the field. It also aimed to study the importance of pig in the tiger diet and relate all of the results to providing sets of guidelines to both plantation management and workers. Although progress has been made in all of these areas, we could not complete all objectives within one year. Discussions were held with the plantation who are particularly keen to see the results of the pig damage survey. Consequently plans have been made to coincide with availability of suitable palm areas for study and the plantation is actively helping with monitoring and data collection. However, so far only two sites are under surveillance and results are not yet available. Tiger faeces have also been collected and links made with a unit in Indonesia with the necessary microscopy equipment and hair reference collections that should be able to help carry out analysis to determine the importance of pig in the diet, however this part of the study has not proceeded further due to the still relatively small dataset (only 8 tiger faeces were found in 2003). In short, the prey study has suffered from problems with one key component and over-ambitious goals for one year. We consider the prey to be the key component of the research and efforts to further this objective will be redoubled in 2004.

OBJECTIVE 4: TIGER POPULATION AND RANGING ECOLOGY

TIGER POPULATION ESTIMATE

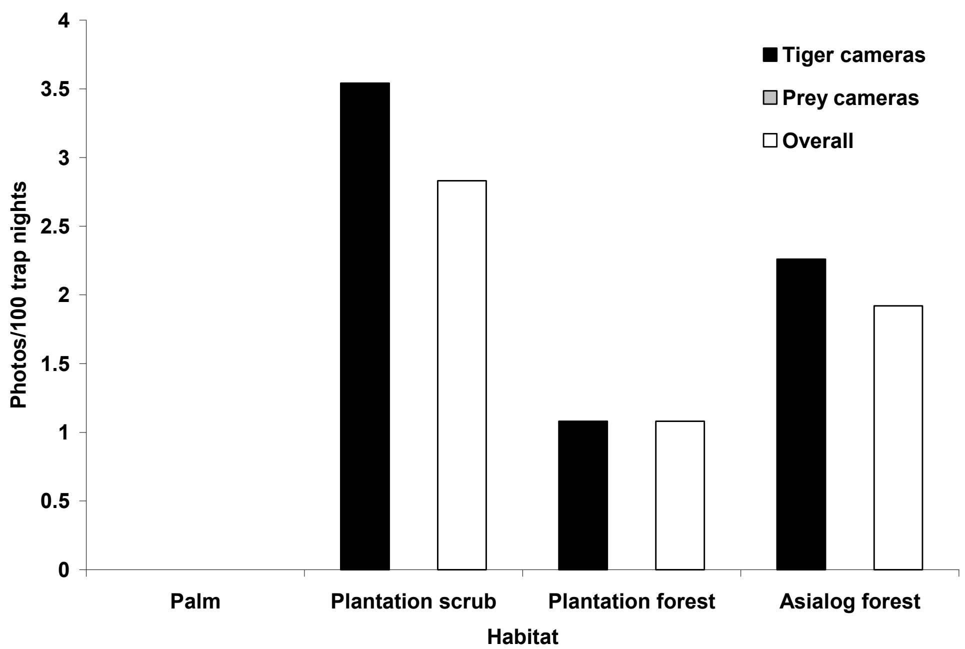
Of the various methods employed during the study, only camera trapping and secondary sign surveys showed tiger presence. This analysis focuses upon the camera trapping results. In 2003, most camera traps were dedicated to prey surveys with only 5-10 positioned to maximise tiger photographs. Nevertheless, reasonable photo trapping rates could be calculated whilst combination with historical data provided a fairly comprehensive dataset for individual recognition. At this stage, tiger camera trapping rates assume every photograph is independent. Future analyses will take individual identification into account and present camera trapping rates for individual tigers. This should not affect the results greatly since, unlike some species, tigers do not generally walk back and forth in front of a camera or cause multiple shots of the same individual.

CAMERA TRAPPING RATES

Table 5 - Trapping rates (photos/100 trap nights)for tigers inside and outside the plantation using two camera placement methods

Region	Habitat	Non random cameras	Randomly placed cameras	Overall
Forest concession	Forest	2.26	0.00	1.92
Forest total		2.26	0.00	1.92
Plantation	Forest	1.08		1.08
	Palm		0.00	0.00
	Scrub	3.54	0.00	2.83
Plantation total		3.08	0.00	2.06
Total		2.90	0.00	2.04

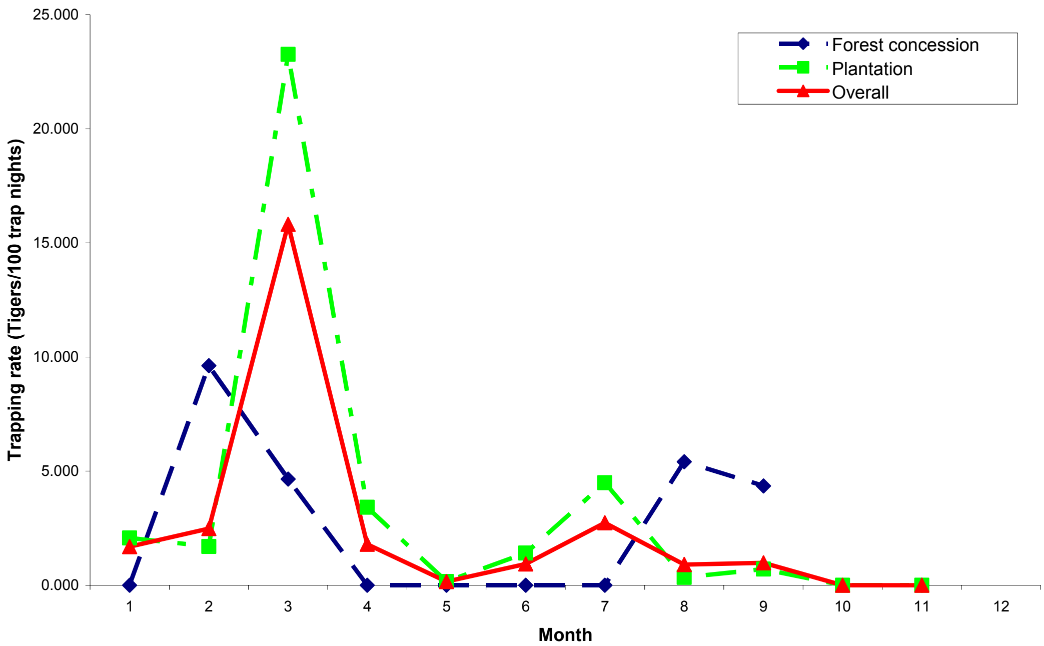
Figure 17 - Camera trapping rates in different habitats from "tiger" cameras only



The results show that most tiger photos are taken inside the plantation in the scrub habitats, one of the two habitats with the highest density of pigs. However, tigers were never photographed inside the oil palm crop where pig densities were also high. Furthermore, tigers were never photographed from the randomly placed or "prey" cameras, substantially reducing the number of trap nights from which data were available.

One interesting pattern to emerge from the trapping data was the variation in trapping rate over time. Figure 18 shows how the numbers of tigers photographed severely dipped in the middle of the year. During this time the camera traps also appear to have collected an increased number of human photographs as people moved into the concession to collect fruits, suggesting that the reduction in tiger photographs could have been a response to increased disturbance. However, trapping effort also drastically reduced about this time as cameras were switched to prey surveys, therefore the dip may also be an anomaly as a result of small sample size. This question needs further exploration in the coming year.

Figure 18 - Variation in tiger trapping rate by cameras over time



INDIVIDUAL RECOGNITION

Estimates of tiger abundance can be taken one step further using individual recognition. Using stripes to identify individuals (Franklin *et al.* 1999), eight individuals have been positively identified for each side. Using photographs from just one side of each tiger show that at least eight individual tigers have been photographed on site. These are thought to represent at least nine tigers (since one of the "left only" identifications is almost certainly different from one of the "right only" photos) (Table 6). Four of the tigers are resident, permanent adults (two males, two females) that regularly use land within the oil palm concession and account for the vast majority (78%) of tiger photographs. The others likely form a mixture of dependent cubs from the resident females and rarely sighted independent adults who are suspected to be from previous litters. However, search effort has been restricted to the non-palm plantation habitats (about 15000 ha) and only a small strip of the forest concession bordering these areas. It is therefore probable that several more exist deeper in the forest. Furthermore, with two exceptions, photographs of mothers with cubs have not been obtained, presumably because the cameras cannot be set with less than a 20 second delay, meaning cubs walking close behind their mother are missed. Older cubs (such as “Mambo” and “Eve”), however, walk a few minutes behind their mother and do get photographed. Therefore, based on track records and on scout sightings, several more tigers are known to have used the plantation since the start of the project, but have not been captured on film. In summary, a minimum of eight tigers have been photographed on one given side, but evidence of at least 16 adults and cubs has been collected over the last two years. A summary of all tigers known and their suspected relationships is presented in Table 7.

Table 6 - Composition of tiger photographs taken by camera traps

Tiger	Side photographed Left	Right	Sex	Age	Last seen	% total
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	04 April 2003	7.14%
Eve	2	4	U	Young adult	25 March 2003	6.12%
Unidentified	4	0				4.08%
Mo	0	2	F	Adult	30 August 2003	2.04%
Shakira	1	0	F	Adult	08 February 2003	1.02%
Subuh	0	1	F	Young adult	No date	1.02%
Wendy cub A1	1	0	U	Cub	No date	1.02%
Grand Total	54	44				100%

Table 7 - Summary of all known tigers in the Asiatic Persada area in the last two years. Permanent residents within the oil palm are highlighted.

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		Second litter born ~ April 2002. Seen by scouts in August 2002 but no camera trap records. Tracks indicate not all three survived?
-	Wendy cub B2				Second litter born ~ April 2002. Seen by scouts in August 2002 but no camera trap records. Tracks indicate not all three survived?
-	Wendy cub B3				Second 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
Tiga Jari	Resident	Female	Adult	Bungin, prob. NE Asialog	Three toes on one foot
Eve	Tiga Jari cub A1	Female	Sub adult	Bungin	Probably just separated from mother based on recent tracks
Mambo	Tiga Jari cub A2	Unknown	Sub adult	Bungin	Probably just separated from mother based on recent tracks
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

EFFECT OF CAMERA TRAPPING METHOD

Since tigers have never been photographed by randomly placed cameras, a brief analysis was carried out to see if any other species were equally sensitive to the camera trapping methodology. The results are presented in Table 8. Although the comparison is limited by the difference in trap nights, an interesting point of note is that the lack of photographs on random cameras is universal for all of the large mammals on suggesting that they rarely venture far from the tracks and highlighting the importance (stated in (Karanth & Nichols 2002) of *not* placing cameras randomly for tiger studies, however more theoretically scientifically robust it may be to do so.

Table 8 - Comparison of species recorded from cameras placed randomly (1051 trap nights) and for tigers (2481 trap nights)

	"Tiger" cameras		**"Random" cameras**	
Subject	**Forest concession**	**Plantation**	**Forest concession**	**Plantation**
Banded leaf monkey	No	Yes	No	No
Banded palm civet	Yes	No	No	No
Bearded pig	Yes	Yes	No	Yes
Common Palm Civet	Yes	Yes	No	Yes
Dhole	No	Yes	No	No
Domestic dog	Yes	Yes	Yes	Yes
East Asian porcupine	Yes	Yes	No	Yes
Emerald Dove	No	Yes	No	No
Greater coucal	Yes	No	No	No
Greater mouse deer	Yes	Yes	Yes	No
Jungle fowl	Yes	Yes	No	Yes
Large tree shrew	Yes	No	No	No
Leopard cat	Yes	Yes	No	Yes
Long tailed macaque	Yes	Yes	No	Yes
Malay Civet	Yes	Yes	No	Yes
Malayan tapir	Yes	Yes	No	No
Monitor lizard	No	Yes	No	No
Motorbike (non-plantation)	Yes	Yes	No	No
Motorbike (plantation / conservation)	Yes	Yes	No	Yes
Muntjac	Yes	Yes	No	Yes
Pangolin	No	Yes	No	No
Partridge	No	No	No	Yes
Person (conservation)	Yes	Yes	Yes	Yes
Person (plantation)	No	Yes	No	Yes
Person (unknown)	Yes	Yes	Yes	Yes
Pig (wild)	Yes	Yes	No	Yes
Pig tailed macaque	Yes	Yes	No	Yes
Plantein squirrel	No	Yes	No	No
Rodent	No	No	No	Yes
Sambar	Yes	Yes	No	Yes
Short tailed mongoose	No	Yes	No	Yes
Sun bear	Yes	Yes	No	No
Tiger	Yes	Yes	No	No
Vehicle (non-plantation)	No	Yes	No	No

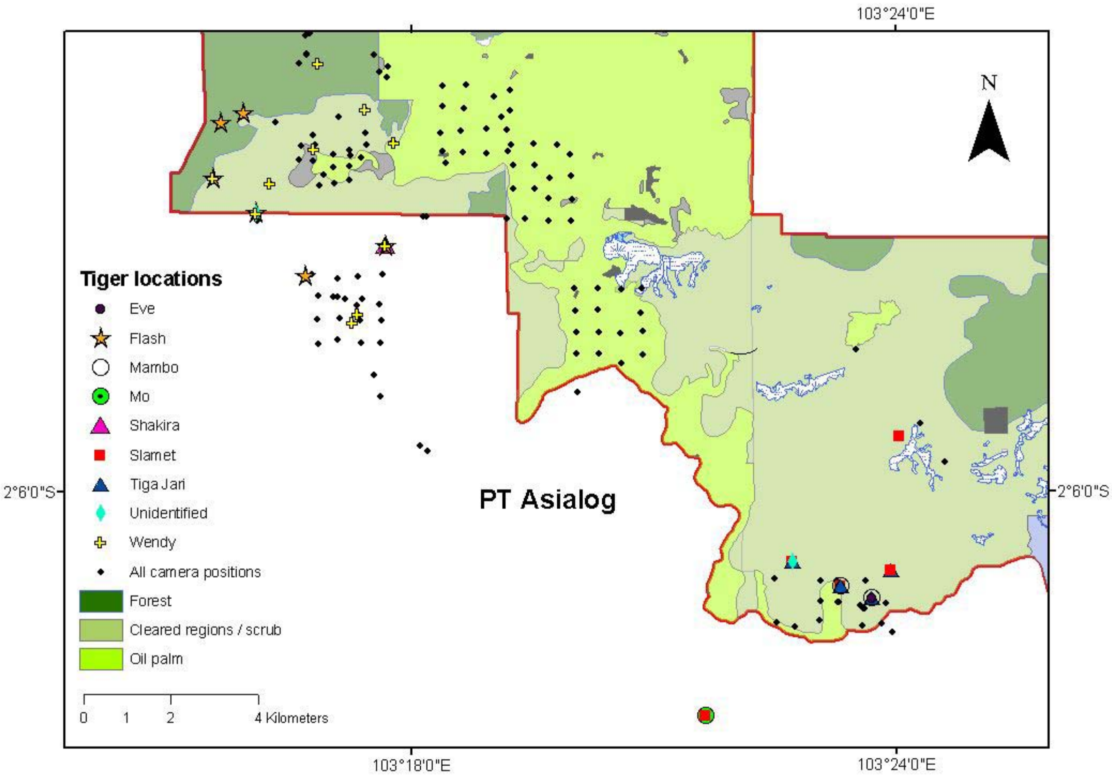
Vehicle (plantation / conservation)	Yes	Yes	No	Yes
White breasted water hen	No	Yes	No	No
Wreathed Hornbill	Yes	No	No	No

RANGING PATTERNS

Ranging patterns as determined by camera traps

The areas each of these individuals utilise can be seen to some extent by camera trap records, although cameras were not used specifically to determine ranges. The locations of all tiger photographs are shown in Figure 19. All camera trap locations used have also been mapped for comparison. Although camera distribution has been limited, the results do show the minimum areas used by each tiger. Furthermore, the lack of photographs from within the palm indicate that although tigers may benefit indirectly from the palm fruits, they do not actually use the oil palm areas. However, the limitations of using camera traps for determining ranging patterns was illustrated by the capture of Slamet (see below) for radio collaring. Despite never having been photographed in Jammer Tulen, Slamet was physically captured in the middle of the area where Flash and Wendy are normally photographed.

Figure 19 – Photographed locations of tigers. All camera trap positions used during the study are shown for comparison.

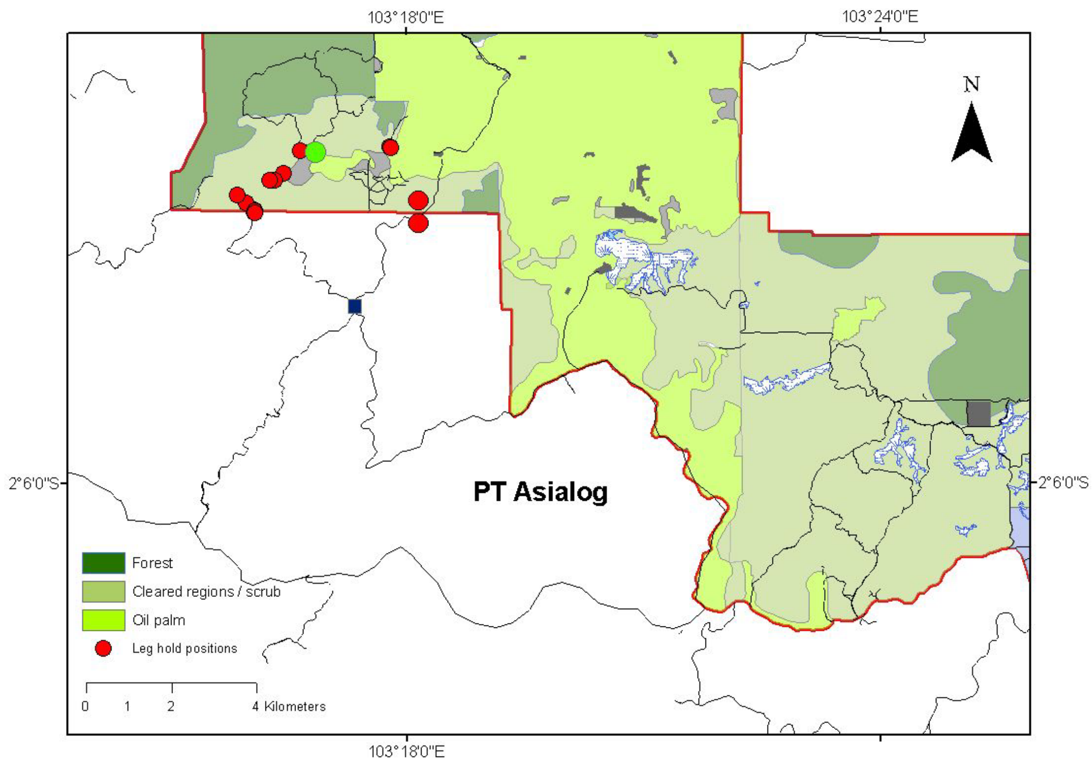


Ranging Patterns as determined by radio tracking

Full details on the radio tracking component of the project are provided in a separate report (Zoological Society of London 2003b), therefore only summary details and updated location data are provided here. To date, the project has carried out one capture period from March to May 2003.

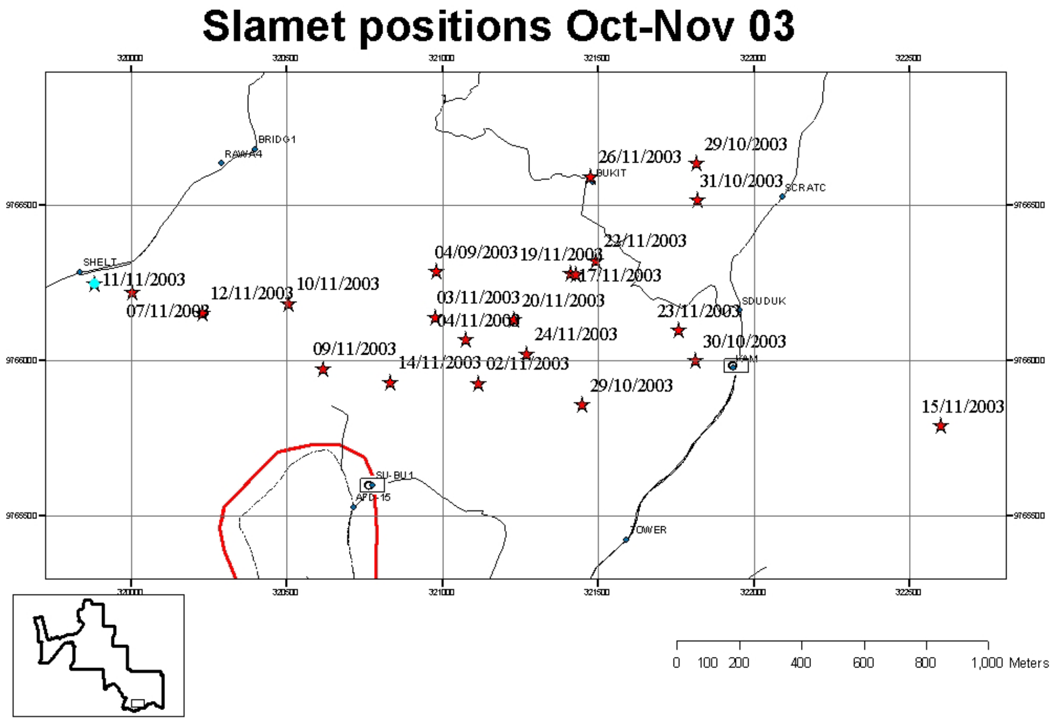
During this period an expert tiger trapper and/or a veterinarian were present to supervise proceedings. Two methods were used. Firstly a remote dart gun was trialled. This consisted of a standard dart gun loaded with an anaesthetic dart linked to a video camera, infra red light and remote control. This allowed the operator to see the target, aim and fire the gun from approximately 200 metres away which should have significantly reduced the stress experienced by the target. The remote dart gun was used for 14 nights in conjunction with an audio predator attractant and a variety of baits. The second method used was a number of leg hold traps fitted with trap transmitters to alert monitoring team when a trap was triggered. 621 trap nights were set between the two months on trails known to be used by tigers. A team then monitored the traps 24 hours per day allowing an immediate response as soon as a trap was triggered. Traps were set so they could only catch animals with a foot the size of a tiger. Triggering a trap was not painful and all were tested on a human foot.

Figure 20 - Locations of trapping methods. Red circles represent leg hold traps, the blue square represents the dart gun site and the green circle represents the site used for monitoring the leg hold transmitters



During the capture period, no tigers were caught by the remote dart gun, which was almost certainly due to the failure of all the techniques expected to attract a tiger to the site, but one tiger was caught using the leg hold traps after 553 trap nights. This was fairly quick compared to a comparable capture attempts in Russia where tigers were caught once every 2730 trap nights (Goodrich *et al*. 2001). The captured tiger was Slamet, an adult male usually photographed at the other side of the plantation. He was successfully anaesthetised, fitted with a VHF radio collar and released without any problems. For details on the anaesthesia, measurements and samples taken and all medical notes, please refer to the separate report.

Figure 21 - positions for "Slamet" calculated by triangulation of radio telemetry fixes



Following his capture the tiger was initially tracked without any problems as he moved around the area he was captured. Following this he disappeared for approximately two months before reappearing in the area he had been initially photographed (Figure 21). He has since been tracked daily for long periods, with breaks when he moves into forested areas to the north of Bungin and south into Asialog. A camera trap positioned in Asialog confirms he is moving around Asialog but we have yet to pick up the signal. Using a combination of radio tracking and camera data a rough estimation of ranging extent can be calculated (Figure 22). Not including the excursion to the trapping point, Slamet's range so far covers about $50km^2$. However, these data are preliminary since, judging from the difference in capture site and the area of general activity, we still have much to learn. Positions are calculated by recording bearings to the signal from at least three known locations using a directional Yagi antennae. The signal is strong through secondary forest vegetation or scrub at up to two kilometres, however in the thicker forest of Asialog the signal breaks up. Experiments with practice collars show that the signal can be extremely variable depending on both the surrounding vegetation and the collar position. In the right conditions we can obtain a signal from 4 km. At other times reception can fall below 500m. Slamet is also still monitored using camera traps and consequently we know he is still looking fit, healthy and well fed (Figure 23).

Figure 22 - Minimum convex polygon for tiger "Slamet" based on radio tracking fixes and camera traps (red polygon), and original capture position (red circle!)

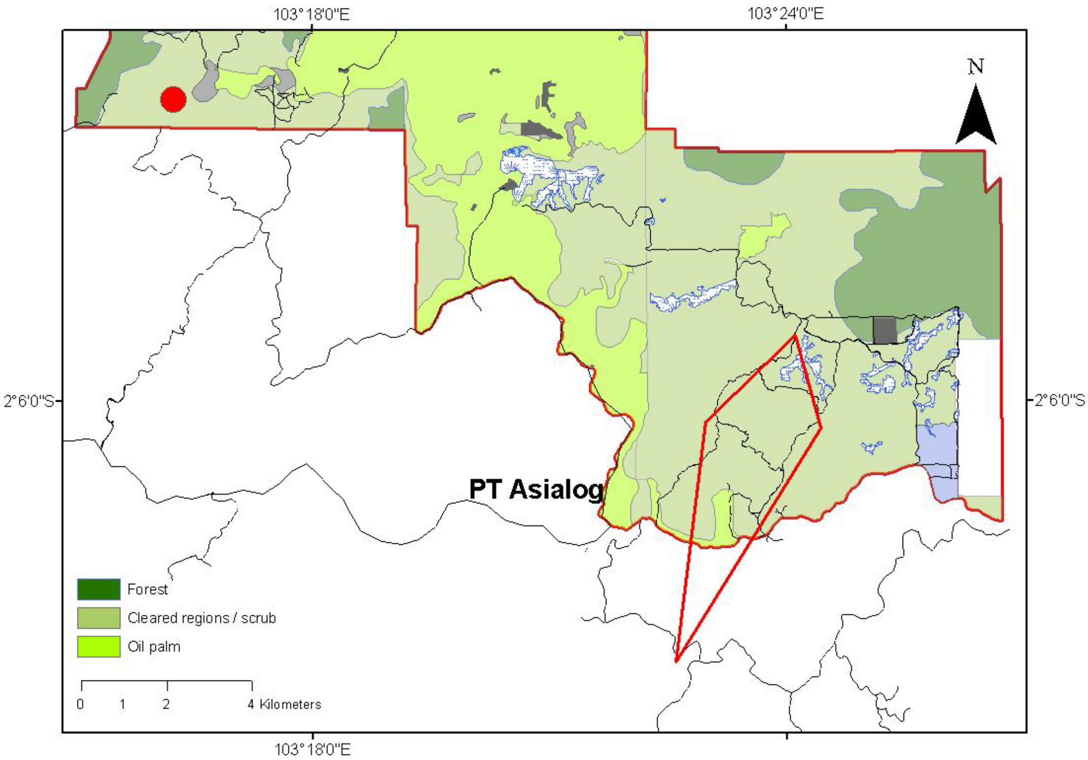


Figure 23 - "Slamet" wearing a radio collar

Activity patterns as determined by camera traps

Tigers around the oil palm are primarily active at night, however there is still significant activity during the day when humans are also active, with 60% of photographs taken at night, 40% in the day. Activity periods have so far been similar between males and females (based on 24 samples), although there is a slight tendency for females to be active earlier in the night and males later. Times for daylight photographs are unrepresented since the date stamp is frequently bleached out from the negative.

Table 9 - Times tigers are photographed

	18:00-22:00	22:00-02:00	02:00-06:00	06:00- 10:00	14:00-18:00	Total
Female	43%	21%	7%	21%	7%	100%
Male	40%	0%	30%	20%	10%	100%
Total	42%	13%	17%	21%	8%	100%

OBJECTIVE SUMMARY

Although capturing and radio-collaring the first ever Sumatran tiger was a great success there is still a long way to go before achieving this objective. Camera traps are extremely limited for determining ranging patterns and the only realistic way forward is to increase the sample size of radio-collared individuals. If permission is granted, the following year should see further tigers collared and the creation of a scientifically valid dataset on the movements of tigers within a commercial landscape. Once such results are being achieved, and can be considered in conjunction with data on tiger prey, the project will be able to advise both the local and other Sumatran plantations on which areas are most important for tiger survival and thus where conservation effort should be focussed.

FUTURE WORK

Plans for 2004 aim to build on the work of 2003. Firstly, the project infrastructure will be further developed and strengthened. In particular, an application has been made for funding to develop the AP conservation team through training and equipping, improving their capabilities as both an anti poaching unit but also providing a valuable role in data collection and continuous monitoring. Ideally, the unit will represent the model on which other plantations can base their own conservation efforts but also have the ability to continue conservation efforts within and around the plantation for the foreseeable future. In addition, a dedicated project base camp unit of offices, storerooms and accommodation is being constructed on the plantation with support from CDC Capital Partners, the ultimate owners of PT Asiatic Persada.

A primary goal for 2004 will be the continuation of the prey studies, both continuing to attempt to complete a CMR study but also making a major push on determining pig impacts. Camera trap prey studies and transects will continue as per 2003. It is also hoped that a Ph.D. student will start work at the end of the year (with a funding application currently under way), building on the initial data and developing the tiger-prey-plantation relationship study further. The plantation is also making plans to begin pig control work. ZSL are being included in the planning process and, if plans are implemented, it is hoped that the results can be used as part of a removal experiment designed to estimate density. A proposed extension to the prey studies is to investigate the ranging patterns of the pigs, with similar objectives to the tiger study, using radio collars to answer questions such as do pigs move between oil palm and scrub habitats?

Tiger density studies will also continue, but with expansion further into the neighbouring forest concessions, using a camera sweep method (Karanth & Nichols 2002) and capture-mark-recapture analysis ((Karanth & Nichols 1998)) to determine densities both close to and far from the plantation. There are also plans to expand the radio collaring study, with an intensive capture period planned for June-August including the trialling of GPS collars, which will only be fitted to captured tigers if they can first be shown to work properly in the project habitats.

Determining the relationships between relative and actual survey methods for both prey and tigers is also a priority for 2004, enabling the value of rapidly conducted track surveys or similar methods to be evaluated against more confident abundance estimates. This is important to develop the potential for expanding the results to other plantations or commercial sites which are unlikely to have the facilities or inclination for time consuming and expensive quantitative capture mark recapture or transect surveys.

Finally, as in 2003 the project expects to continue working closely with other conservation and research organisations. Firstly, interest in the neighbouring areas by Birdlife Indonesia is strongly supported by the Jambi Tiger Project and any data or logistical assistance required will be gladly supplied. Secondly, closer ties with the PKHA and the Jambi KSDA will be established, hopefully expanding the initial secondment schemes of 2003 into more permanent MoU-based collaborations. Thirdly, close links will be maintained with the University of Brighton in the UK who are currently undertaking collaborative research on site looking at some of the smaller felids and their prey base, whilst the funding proposal for developing the AP conservation team plans for collaborations with The Sumatran Tiger Conservation Programme and Flora and Fauna International.

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APPENDIX

PROBLEMS WITH "CAMTRAKKER" CAMERA TRAPS

One of the main problems of 2003 was the reliability of the camera traps chosen for the research. "Camtrakkers" are a well known brand of camera trap. They were selected partly for their increased security compared to other cameras but also because they used by various other conservation bodies in tropical conditions, despite being primarily designed for the American hunting market. Considering they are one of the most expensive models on the market their performance was particularly disappointing. The problems came in three main areas:

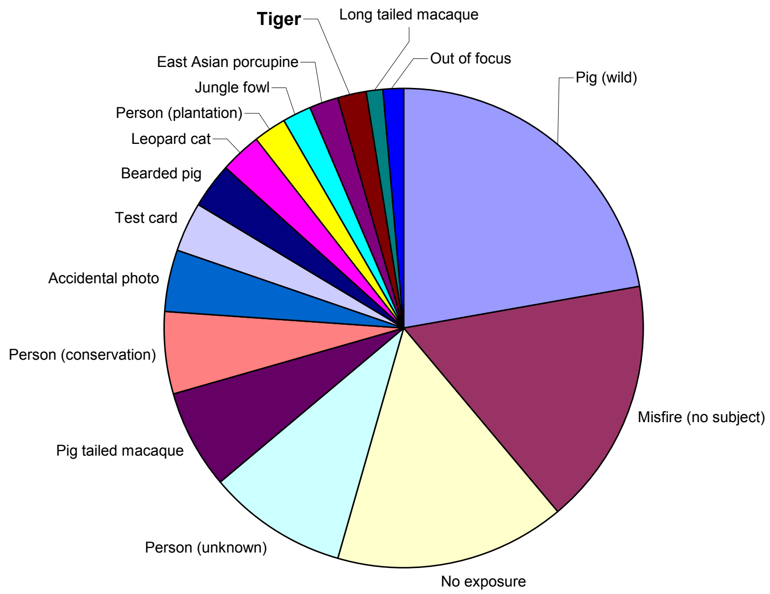
Reliability:

- Of 6 cameras bought in the last two years, 5 of 6 (83%) have broken beyond use. The last camera is extremely insensitive and cannot be triggered deliberately, but occasionally still takes photos in the field..
- From the shipment of 38 cameras that arrived in January 2003, 9 cameras (23%) were not working on arrival.
- One year later, 13 (35%) have now needed to be returned for repair. However, taking into account the fact we have had 8 stolen, the failure rate of the remaining cameras is 43%.
- Of the repaired and returned cameras, a further 1 was not working on arrival.
- Of 38 cameras only 4 have caused no problems within the first year. However, two of these were stolen within a few months. Removing the 8 stolen cameras from the calculation leaves the result that only 2 (6%) of our shipment has worked satisfactorily for one year.
- Of 44 cameras we are left with 16 working in the field and 4 "assumed working" (*i.e.* newly returned but no films yet developed)

"Misfiring":

- On some occasions "misfires" (photographs with no apparent subject) could occur due to vegetation warming and moving in the wind or due to an animal passing by too fast to photograph. However, the former is usually easy to spot whilst the latter is not thought to occur regularly (we frequently photograph motorbikes driving by for example – there can't be many animals moving much faster than this). Most misfires appear to be caused by a camera malfunction, with the camera taking photographs until the film ends at regular or fairly regular intervals. Sometimes entire films are used up within a few hours of set up and on occasion cameras rapidly take a succession of photos (with no delay) whilst being set up despite being turned off! This appears to be an issue with only certain cameras despite some of these being extremely difficult to trigger deliberately.
- 889 of 5113 negatives contain no subject
- This accounts for over 17% of all photographs taken and is our second most common reason for a camera to be triggered (Figure 24)

Figure 24 – Proportion of photographs accounted for by misfires and non-exposures compared to the main other subjects



Time / Date stamp:

- The time/date stamp is our only reference matching photographs to records of where cameras were placed at the time. Without it, the location of most photographs cannot be determined and thus the use of the image for most of our research questions is highly restricted.
- Of films where the date appeared at least once (*i.e.* the time/date stamp was turned on), 1195 of 5113 or 23% of negatives have the time/date stamp bleached out. This does not include photographs for which the date could be worked out based on previous and subsequent photographs.
- Date bleaching most often occurs in photographs taken during the day. 43% of photographs taken in the day have no time/date stamp.
- Bleaching is not dependent on the developer and occurs at developers in the UK and Indonesia equally.

Insensitivity:

- After setting up, cameras are tested by a human holding a sign showing the date and location. If the camera cannot be triggered manually (taking into account the 10 minute "warm up" period mentioned in the instructions) it is recorded as insensitive.
- 12 of 16 cameras (75%) currently working in the field have caused problems when trying to test.
- Insensitivity is of particular importance when comparing "trapping" results from different areas. At present we have no way of knowing whether a relative lack of photographs from one area represents a low density of tigers or whether it simply shows where we put our poorest cameras!