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CONTENTS

RESEARCH NOTES

(Davidson, 1991). In addition, as inhabitant of river valleys and adjacent flatlands, the habitat of this species is always the first to be cleared and settled by man, giving rise to hunting pressure (IUCN, 1995). The species is considered endangered and during the period 1995-1999, was accorded the highest conservation action priorities by the Pheasant Specialist Group of the World Pheasant Association, Species Survival Commision and Birdlife International (McGowan, 1995). The current knowledge of Green peafowl was reviewed recently and conservation strategies formulated for the recovery of the species (McGowan *et al.* 1998).

In 1991, a total of five pairs of Green peafowl were donated by the WPA and the Java Zoo to the Department of Wildlife and National Parks (DWNP), Malaysia for the captive breeding program. Of this, three males and two females were sent to the Melaka Zoo.

To date, there is no published report of a successful introduction or reintroduction of pheasants in Malaysia. The introduction of *Pavo muticus muticus* in the zoo's vicinity were undertaken to provide a better understanding of the adaptation, survivability and biology of the species as suggested previously (Lewin, 1989).

MATERIALS AND METHODS

The Melaka Zoo is 21.2ha in size and bordered by a trunk road and a forest reserve (Air Keroh Recreational Forest) in the north, a man-made lake and a golf course (Air Keroh Country Club) in the south, a disturbed forest and barren land in the west and a secondary forest and a cultural village (Mini Malaysia) in the east. At the time of study, the zoo consists of about 50% secondary forests (> 30 years old) and 50% developed areas, which includes animal enclosures, wet and dry moat exhibits, office buildings and a road system.

Breeding stock

In 1991, a group of 3.2 Green peafowl were acquired for the captive-breeding program at the zoo from the WPA and Java Zoo. In 1992, the first batch of four chicks was hatched naturally in a mixed aviary after a period of 28 days incubation from a clutch of five eggs and raised by the hen. The mixed aviary measures 20m long by 10m wide and 5m high and is made up of galvanised wire mesh (2.5 x 5cm). The nest was partially hidden and located on the ground in-between some clumps of *Heliconia* plants.

Introduction programme

At about seven months old, the four chicks and hen were moved into an individual pie-shaped enclosure located about 10m from the mixed aviary. The enclosure measures 4m at the widest curve, 6m long and 3.5m high. The enclosure is made up of 2.5X5cm galvanised wire mesh and perches provided at various levels of the cage. Entrance into the enclosure is only via a door that is situated at the rear. The birds were fed daily with a mixture of layer mash, boiled maize, boiled rice, mealworms, some fruits and vegetables. Clean drinking water was provided daily *ad libitum*.

After a period of one month, the birds were encouraged to move out via the rear door by baiting them with food. This was done in the morning. Similarly, foods and water were left in the enclosure daily for a few days and the door left open. The movements of the flock were randomly monitored and their roost, core area, feeding grounds and home range observed. The mortality and new hatchlings were also noted.

RESULTS

During the first few months after release, the flock would concentrate around the pie-shaped enclosure and the mixed aviary, often making contacts with the group within the mixed aviary. They would only venture as far as the gibbon islands (20-40m from the pie-shaped enclosure) and the embankment of the lake (20-30m from the pie-shaped enclosure) establishing a home range. The core area was established between the mixed aviary, the water bird open exhibit and the gibbon islands. They would feed on the grass, browse and insects around the aviaries and the gibbon islands and on the supplemental food including layer mash, maize, rice and vegetables from the open exhibit of the water bird. In the evening, the flock. would roost on the roof of the pie shaped enclosure.

In 1993, a year after introduction, one bird was found missing and another was predated leaving two sub adult males and one adult female. In 1994, the dominant male started to display to the adult female and in the same year, a flock of three new hatchlings, were observed. In 1995, two more additional hatchlings were observed from the same flock.

The home range increases gradually and after about a year, the birds were observed to utilized most of the zoo vicinity, stretching from the Ankole cattle (*Bos taurus*) exhibit (100m from core area) in the north, the

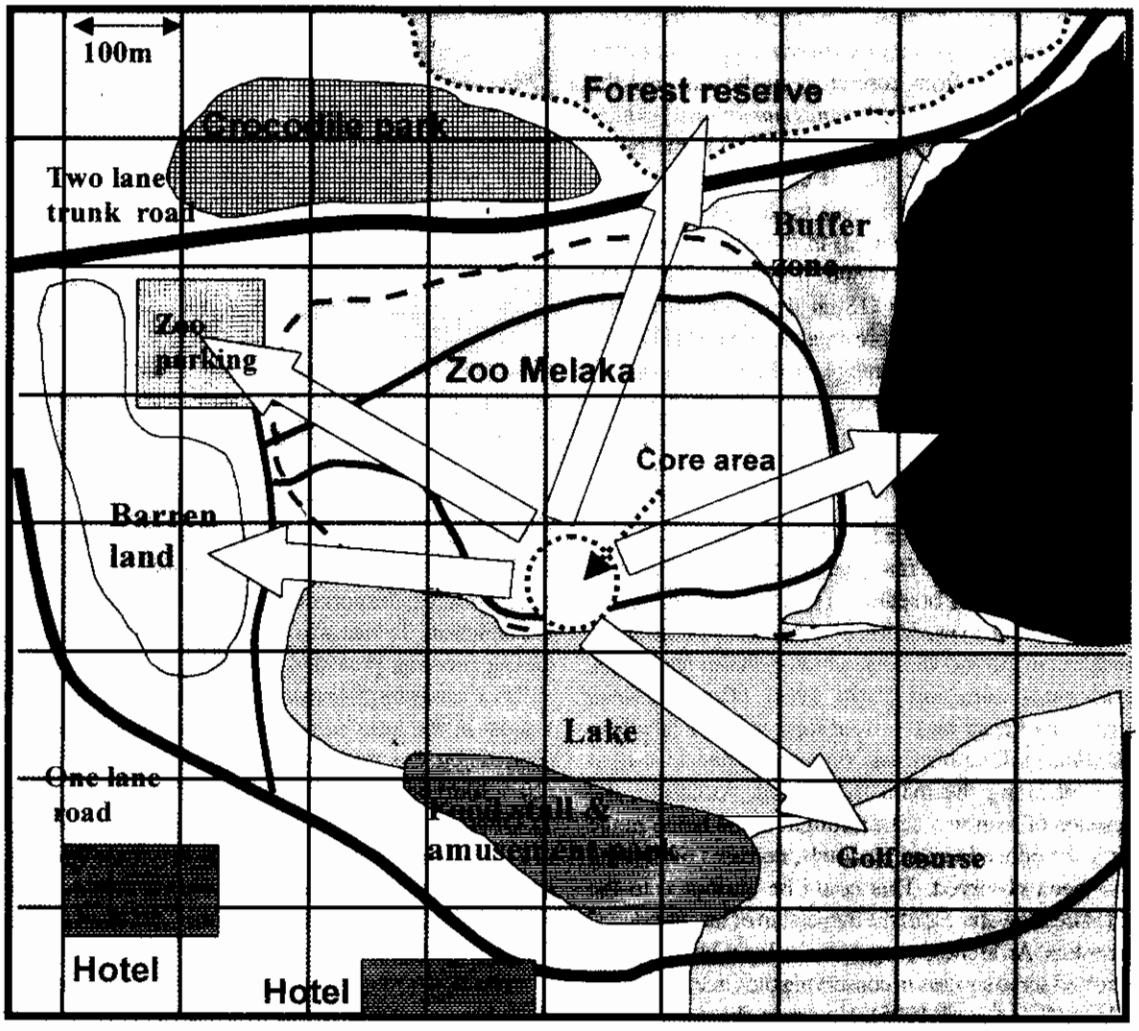

Figure 1. Home range of the Green peafowl flock (⇨) showing the core area (↗) and the various landmarks; Crocodile park, Forest reserve, Cultural village, Buffer zone, Lake, Golf course, Food stall/amusement park, Hotels, Barren land, Zoo parking and roads (———).

Table 1. The habitat and distance from "core area", utilised by the flock of Green peafowl introduced in the vicinity of Zoo Melaka

Location	Distance from "core area" (meters)	Habitat Type
Cultural village	180	Secondary forest and ornamental plants,
Golf course	150	Secondary forest and ornamental plants
Forest reserve	250	Secondary forest and ornamental plants
Zoo parking	200	Tarmac road with very few shade trees
Barren land	180	Grasses and scattered shrubs

lake embankment (20-40m from core area) in the south, the Indochinese tiger (*Panthera tigris corbetti*) enclosure (120m from core area) in the east and the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) exhibit (120m from core area) in the west. The home range continued to increase to include the recreational forest reserve (250m from core area) in the north, the golf course (150m from core area) in the south, the buffer zone and cultural village (180m from core area) in the east and the barren land (180m from core area) and parking lot (200m from core area) in the west (Figure 1 and Table 1). The home range of the Green peafowl flock averaged 192m (± 33m).

Plate 1: A Green peafowl roosting on a tree in the zoo vicinity.

DISCUSSION

The observation indicated a mortality of 40% and a growth of 100% in the first year of breeding and 33% in the second year of breeding. The cause of death was more likely due to predation by a substantial number of predators in the zoo vicinity, which includes feral dogs, feral cats, common palm civet (*Paradoxurus hermphroditus*) and reticulated python (*Python reticulatus*). One bird was reported killed in a road accident along the main trunk road. Although, the presence of man was seen throughout the home range of the introduced Green peafowls, no cases of hunting have been observed. This could be attributed to the widespread awareness of the ownership of the introduced pheasants. Awareness programs for local hunters have indicated some success in conserving the Green peafowls in Java (Balen *et al.* 1995). However, the short period of adaptation to the surrounding showed that these birds could survive and breed successfully in the semi wild environment. The preferred areas of Green peafowl include the forest edges, including flood damaged margins and sandbanks of large rivers, margins of agriculture, fire maintained scrub over peaty and sandy soils backed by forest (Glenister, 1951). The availability of sufficient browse, grass and insects around the release area and the zoo vicinity provided ample food for the pheasants. Similar feeding preferences was also observed previously (Josep, 1994).

The core area represents a favoured feeding place where the pheasants were conditioned during the introduction phase. However, throughout the introduction period, supplemental feed were acquired from the open exhibit of the waterbirds. In addition to feed, perches, roosts and security created an ideal core area, which is important during the initial stages of introduction. It was also observed that the security during roosting provided by the high roofing of the aviaries was essential prior to the birds selecting trees as a roost in the later part of their adaptation. This was seen when the peafowl started utilizing tall trees (20 – 30m) within the tiger exhibit for roosting (Plate 1). Often, around the zoo vicinity, these birds were seen in a flock or as solitary males. In the wild these birds live in small groups except during breeding season, when the male fight to defend their territory and band of hens (Wayre, 1969).

The home range of the introduced Green peafowl flock has an average radius of 192m (± 33m) from the core area, which included the low-lying areas near the lake, open grasslands, forest fringes, forests and barren land. The areas of the Crocodile Park, food stalls and amusement park were almost unutilised by these birds. This could possibly be due to the disturbance, particularly the visitors, the loud music and noise. In Johor, at the early twentieth century, these birds were common and widespread in the lowlands; especially forests along the riverine areas, coastal scrub and mature plantations. The birds were also reportedly found in open woodland and forest edges (Josep, 1994). In the wild, they usually forage in open grassland or in wooded areas (Jeyarajasingam & Pearson, 1999). The nest was built on the ground and in well-protected site as reported previously (Josep, 1994).

The basic information acquired by the captive bred Green peafowl introduction provided important data on feeding, home range, survivability, recruitment rate and mortality. The success of this introduction provided a possibility of a successful reintroduction of such species in the wild and maintaining them in its natural habitat. The recent DNA findings confirming that the Malaysia subspecies originated from Java have overcome the major barrier to the reintroduction program of Green peafowl in Malaysia (John Corder pers. com.). Apart from reintroduction into their natural habitat, the possibility of using plantation estates for the reintroduction of *P.muticus muticus* into the Malay Peninsular should also be investigated (IUCN, 1995). The selected site must be monitored at all times and secured. The smaller wildlife reserves should be utilised initially for reintroduction into the wild. The most ideal site would include the Sungai Dusun Wildlife Reserve (4160ha), situated 120km from the capital city and it is very secured. The presence of basic facilities including manpower, living quarters, laboratory, interpretative centres and trails are an added advantage. There are no history of poaching and encroachment into this reserve (Zainal-Zahari, 1999). However, human predation had been the cause of decline and extinction in the past and we should never overlook this problem even though the Melaka Zoo experience does not indicate such problem. The reintroduction project would require an extensive period of monitoring the released birds and modifying the strategies when appropriate with the ultimate objective of repopulating as many of the original home ranges as possible. With the current effort by the World Pheasant Association in collaboration with the Department of Wildlife and National Parks, Malaysia, the program to reintroduce Green peafowls in Wildlife Reserves in Malaysia would materialise very soon. However, further information on the introduced Green peafowls at Zoo Melaka should be acquired by the use of radio transmitters. The movements and home ranges of these birds should be marked and their reproduction monitored.

The involvement of the general public in any of these reintroduction programs would certainly benefit its survival in the wild. The reintroduction of Green peafowls into the wild should always be supported by the press campaign, public awareness and education program.

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WALLOWS AND WALLOW UTILIZATION OF THE SUMATRAN RHINOCEROS (*DICERORHINUS SUMATRENSIS*) IN A NATURAL ENCLOSURE IN SUNGAI DUSUN WILDLIFE RESERVE, SELANGOR, MALAYSIA

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Abstract:- A study on wallows and their utilization by the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) was carried out in a 10-acre natural enclosure from March 1998 to October 1999 at Sungai Dusun Wildlife Reserve, Selangor. Observations of a pair were also carried out to determine the wallowing period. Three active wallows were observed in April and May 1998 and September 1999. Two distinct periods of increased wallow construction were from March-July 1998 and March-Jun 1999. Twenty wallows were identified with three distinct networks located on a slope near the main trail and adjacent to a swamp. Wallowing starts between 1000H-1030H with a peak at 1400H-1430H and the wallowing period decreases gradually from 1400H to 1600H. The wallows or its contents should be changed every three months as observed during the study. Man-made wallows could be improved by selecting good quality mud of thick consistency. Further studies should also be carried out to determine the reason of animals abandoning a wallow after a period of time and the chemical elements in a wallow.

Key Words:-*Dicerorhinus sumatrensis*-Sungai Dusun-wallow-Sumatran rhinoceros-Zoo Melaka-artificial wallow

Abstrak:- *Kajian tentang kubang badak telah dijalankan di sebuah kurungan semulajadi yang bersaiz 10 ekar dari Mac 1998 hingga October 1999. Sepasang Badak Sumatera juga telah diperhatikan untuk menentukan waktu berkubangnya. Sejumlah 20 buah kubang telah dikenalpasti dengan tiga rangkaian berbeza yang dijumpai di lereng bukit, dekat dengan denai utama badak dan bersebelahan tempat berpaya. Aktiviti berkubang bermula dari pukul 1000H-1030H, dan memuncak pada 1400H-1430H. Badak akan berkubang selama 2-3 jam sebelum keluar untuk makan. Waktu berkubang akan berkurangan secara beransur-ansur dari 1400H hingga 1600H. Kubang adalah satu keperluan bagi seekor Badak Sumatera. Di dalam kurungan, adalah patut bagi air kubang ditukar setiap tiga bulan seperti yang diperhatikan dalam kajian ini. Kubang yang dibuat oleh manusia boleh diperbaiki dengan menggunakan lumpur yang lebih pekat. Lebih banyak kajian perlu dijalankan untuk mengetahui sebab badak meninggalkan kubang selepas satu masa tertentu dan untuk mengenalpasti komposisi kimia di dalamnya.*

INTRODUCTION

Wallows are mud pools formed in poor drainage areas where the soil remains wet for long periods. They are widely distributed and are found in swamps and on mountain ridges. Wallows often exist individually or in a network of up to 10 pits. Wallowing, in which the animal covers itself with a layer of mud, is an important daily activity for a Sumatran rhinoceros. The layer protects the rhino against attacks from biting insects (Tabanidae) and keeps the animal's skin moist and cool.

Captive Sumatran rhinoceroses (*Dicerorhinus sumatrensis*) that were not provided with adequate bathing facilities developed broken and inflamed skins with suppurations, eye problems, inflamed nails and hair loss (Anderson, 1961; Coenraad-Uhlig, 1933). Similarly, in the Melaka Zoo, pyoderma was observed in Sumatran rhinoceros caused by insufficient wallowing facilities (Zainal-Zahari *et al.* 1991). A young captive Sumatran rhinoceros that was not allowed to bathe for a week suffered a generalized cracked skin, and it died shortly

afterwards (Hubback, 1939). Although most facilities for captive rhinos now provide pools or constructed wallows, these are not enough. Problems of the integumentary system still recur.

Information on wallows and wallowing habits of the Sumatran rhinoceros is lacking, yet it is important for the health and survival of captive rhinos. This study looks at wallows in a natural enclosure and how Sumatran rhinoceros use and compares the information to that in previous reports.

MATERIALS AND METHODS

This study was carried out in a 10-acre natural enclosure within the Sungai Dusun Wildlife Reserve, Selangor The area is forested and enclosed by electric fencing. The enclosure is moderately undulating and has both the characteristics of a lowland dipterocarp and peat swamp forest. It is built on swampy terrain with an altitude of 40 m.

Sungai Dusun is a prime habitat for the Sumatran rhinoceroses, and a pair was released into the reserve. The width and length of each wallow was measured. Barriers including fallen trees, logs, trees and Bertam palms (*Eugeisonna triste*) that were found surrounding the wallows were noted. The wallows were classified as active (used) or inactive (not used) and as shaded, partially shaded or unshaded. Activity periods of each wallow were recorded from March 1998 to October 1999. During this period, the rhino pair was observed from 1000 to 1600 for 38 days to determine wallowing periods. Observations were only carried out during these periods as they coincide with the keepers work schedule. In addition, the rhinos would come to the feeding area for foliage. Sampling throughout the study was by spot check except between 1300 and 1400, when a one-hour focal sampling was used.

RESULTS

The average length and width of wallows were 2.57 m (±0.61) and 1.94 m (±0.68) respectively with an estimated area ranging from 2.5 to 14.8 m^2 (Table 1). The length of active time for each wallow ranged from 2 to 12 weeks with an average of 5.85 weeks (Figure 1). Three active wallows were the maximum observed, these in the months of April and May 1998 and September 1999. The rhinos made their wallows in two distinct periods, between March and July 1998 and between March and June 1999 (Figure 2).

The rhinos made all their wallows under open canopy, mostly in forest gaps. Half were completely shaded by Bertam palms, 25% were partially shaded and 25% were in the open. The barriers observed during the study were mainly Bertam palm, trees and logs. A total of 20 wallows were identified in three distinct networks, consisting of 4, 6 and 10 wallows. Network 1 was located in a swampy region while networks 2 and 3 were found at an elevation of 5 and 20 m respectively (Figure 3).

The animals customarily wallowed continuously for 2 or 3 hours before coming out to feed. Spot checks indicated that frequency of wallowing increased in the morning hours until 1130, decreased at midday before reaching a maximum at 1300H and gradually decreasing again from 1400H to 1600H (Figure 4).

DISCUSSION

Wallow shape varied from elongate to irregular ovoid, often conforming to the shape of the rhinoceros. Wallows increased in size as the rhinoceros continued to use them, because the animal would scrape mud from the wall of a wallow to reconstitute the contents. The Sumatran rhinoceros prefers mud that is thick and viscous enough to stick to the skin after it wallows. The dimension of wallows varies from location and within a network. The length and width observed were within previously reported dimensions of 2 to 4 m by 1 to 2.1 m (Talbot, 1960; van Strien, 1985). However, wallows of up to 8 m in diameter have been recorded (Kurt, 1970). Of the three networks of wallows identified during the study, two were located near the main trail (at 5 and 20 m altitude) and one near a swamp. Each network consisted of 4 to 10 wallows. Studies in Gunung Leuser indicated 10 wallows within a network located along the main rhinoceros trails. Within the network of wallows, only one or two were active. These findings are similar to those from previous studies (van Strien, 1975; 1985). Wallows are more frequented than salt licks and are often found near streams and low saddles on ridges (Foenander, 1944). In Sungai Dusun, the wallows were located under open canopy, 75% of them completely or partially shaded by Bertam palms. The barriers surrounding the wallows include Bertam palms, fallen logs and trees. However, in Gunung Leuser, wallows often bordered fallen tree trunks and cavities left by uprooted trees (van Strien, 1985). The areas surrounding the wallows were intact except for the trails that led into them, which ranged from 1 to 4 in number.

Table 1: Dimensions and estimated area of wallows in a 10-acre enclosure

Wallows	Length (m)	Width (m)	Estimated area (m^2)
1	2.20	1.20	2.64
2	2.50	1.40	3.50
3	3.00	1.80	5.40
4	2.20	1.30	2.86
5	4.00	3.70	14.8
6	2.10	1.90	3.99
7	1.25	3.00	3.75
8	2.10	1.20	2.52
9	2.20	1.30	2.86
10	2.50	2.00	5.00
11	2.00	1.80	3.60
12	3.50	2.70	9.45
13	3.20	2.40	7.68
14	3.20	2.80	8.96
15	2.70	1.90	5.13
16	2.70	1.70	4.59
17	2.60	2.10	5.46
18	2.20	1.20	2.64
19	2.50	1.80	4.50
20	2.80	1.60	4.48

For location of wallows, refer to the numbers in Figure 3.

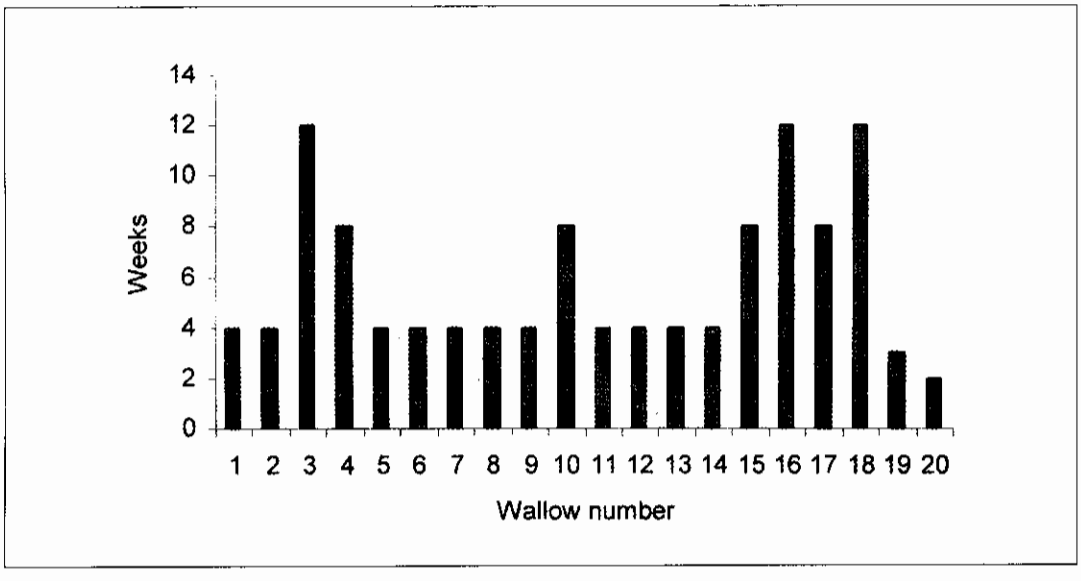

Figure1. Length of active time in weeks for each of the wallows in the 10-acre natural enclosure. Numbers indicate location of wallows, as shown in Figure 3

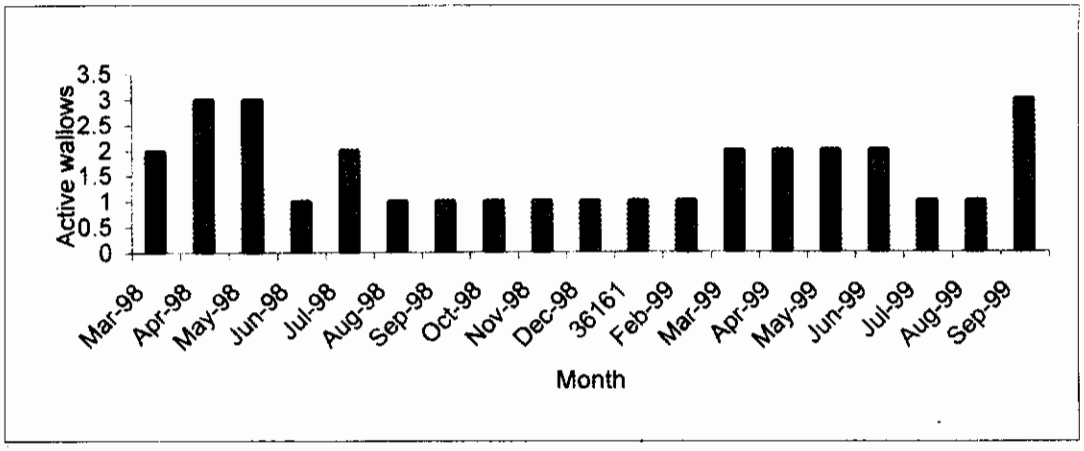

Figure 2. Number of active wallows used by the pair of rhinos for each month of the study period.

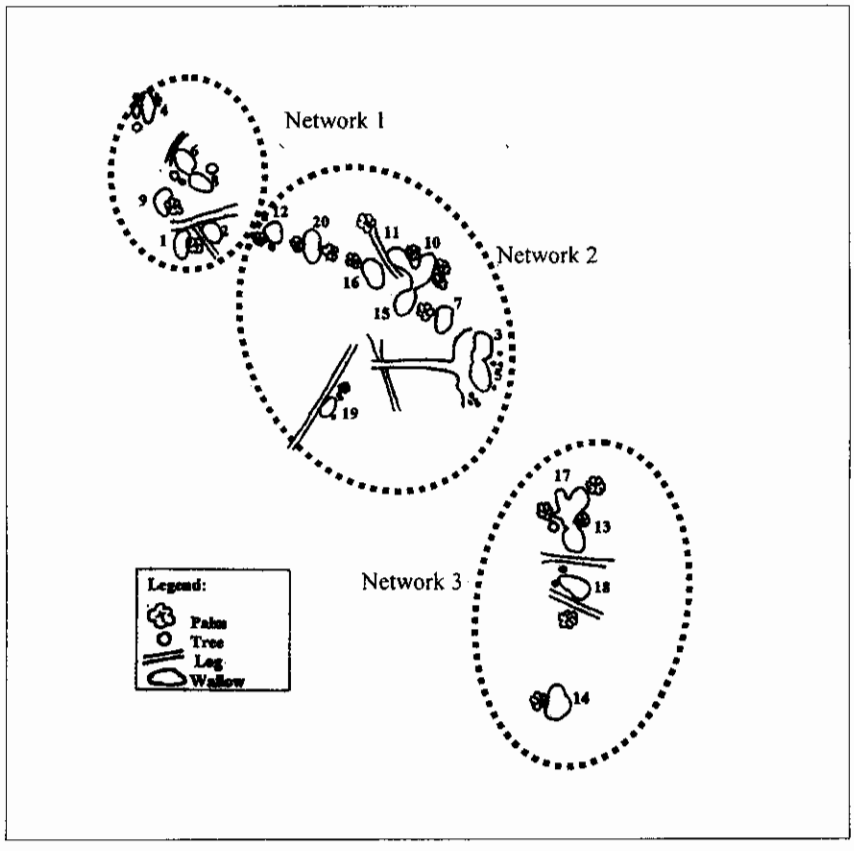

Figure 3. Location of wallows and wallow network in the 10-acre enclosure.

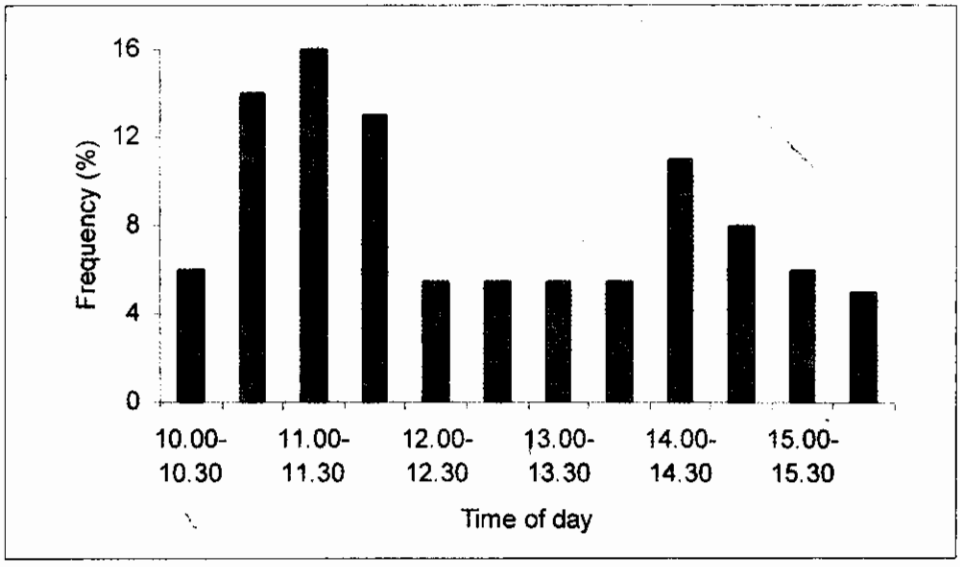

Figure 4. Frequency of wallowing per half-hour period, in percentage of the total number of observations.

These trails were clear of vegetation. Previous studies have shown that surrounding areas of 10 to 35 m around the wallows were cleared of vegetation (Kurt, 1970).

There is no past study that shows the length of active time for a wallow. However, van Strien (1985) found wallows reopened that had not been used for many years. Inactive wallows are watery, clear and usually filled with, algae, dead branches, twigs and feces, unlike the soft, rich, creamy-looking mud in active wallows. This is similar to studies carried out in Gunung Leuser (van Strien 1985). Of the 20 wallows, wallows 3, 16 and 18 were active for a maximum period of 12 weeks each ($n = 20$; $\mu = 5.85$ weeks). The physical size, shape and type of barrier are not correlated to the length of time a Sumatran rhinoceros uses a wallow. Some possible factors influencing the usage time are the consistency of mud and the chemical composition.

During the study, a season when wallowing increased was distinctly marked. Three active wallows were observed in April 1998, May 1998 and September 1999 as compared with an average of 1.63 per month throughout most of the study period. Two distinct periods when the rhinos increased their wallow making were during March to July 98 and March to June 1999. These periods coincide with the dry season. This is similar to previous findings that wallowing frequency increased during the dry period (Borner, 1979; Richard *et al.* 1990). In Gunung Leuser, Sumatran rhinoceros were observed wallowing in both dry and wet periods.

Wallowing occurred throughout the observation period, with a peak time between 1100 and 1130; it then decreased gradually towardsevening. Similarly, in Zoo Melaka, wallowing was observed between 1100 and 1500 with increased frequency during hot weather. In these artificially made wallows or concrete pools at Zoo Melaka, the duration of wallowing ranged from 3 to 4 minutes on a cool day and 45 minutes during hot weather (Richard *et al.* 1990). In contrast, the study in Sungai Dusun indicated that the rhinoceros spends between 80 and 300 minutes daily (an average of 166.32 minutes) in wallowing. This is similar to the observations in Gunung Leuser, where the Sumatran rhinoceros spends hours wallowing (van Strien, 1985).

CONCLUSION

Wallows are essential in any management of the captive Sumatran rhinoceros. Whenever possible, the wallow or its contents should be changed every 3 months, according to the length of time a wallow was used as observed during the study. Although artificial wallows or pools cannot substitute for natural wallows, their

quality can be improved by selecting good-quality mud or clay with a thick, creamy consistency.

The wallows observed were made where there were natural barriers like palm trees or logs. The enclosure for the captive animals should therefore simulate such things. During the dry season, the management of the facility should ensure that the wallows for the rhinoceroses are sufficient in number.

Further studies should be carried out to find out why the animals abandon a wallow and what the chemical elements in a wallow are.

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DISPLACEMENT OF ASIAN ELEPHANTS *ELEPHAS MAXIMUS*, SUMTRAN RHINOCEROSES *DICERORHINUS SUMATRENSIS* AND MALAYAN TAPIRS *TAPIRUS INDICUS* IN PENINSULAR MALAYSIA

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Abstract :-This paper presents the findings on the trend of displacement of three species, namely Asian elephant (*Elephas maximus*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and Malayan tapir (*Tapirus indicus*). Data were obtained from the Department of Wildlife and National Parks, the local zoos and reports from the general public. There is a strong correlation between home range and species displaced. The correlation by states indicated that more displacement of elephants occur in states with a larger percentage of forest reserves, wildlife reserves or forest. Two trends were observed in the displacement of large mammals in Peninsular Malaysia. The first trend indicated that displacement of large mammals is related to its size and its home range. The second trend of displacement showed an increase in the number of displaced animals, reaching a peak followed by a decrease. Habitat loss is the main reason for displacement of animals. Few recommendations were made to overcome this problem

Key Words:-Displacement- *Elephas maximus* –*Dicerorhinus sumatrensis*- *Tapirus indicus* – fragmentation-habitat loss

Abstrak:- *Data pemindahan gajah Asia, badak Sumatera dan tapir diperolehi dari Jabatan Perlindungan Hidupan Liar dan Taman Negara, zooo tempatan dan lapuran orang awam. Terdapat korelasi yang kukuh diantara kawasan lingkaran dan spesies yang terpindah. Lebih banyak pemindahan gajah Asia berlaku didalam negeri – negeri yang mempunyai reseb hutan, reseb hidupan liar dan hutan yang luas. Perbadingan antara pemindahan dan tahun menunjukkan korelasi yang kukuh diantara badak Sumatera dan gajah Asia. tinggi. Pemindahan spesies besar adalah berkaitan dengan saiznya dan kawasan lingkaran. Peningkatan pemindahan spesies akan mencapai nilai tertinggi dan seterusnya diikuti dengan penurunan. Kehilangan habitat melalui pembukaan dan perpecahan hutan adalah punca utama pemindahan hidupan liar. Beberapa cadangan diberi untuk mengatasi masalah ini.*

INTRODUCTION

Home range is an area covered by an animal in its day-to-day activity (Gopal, 1993). It may include several territories, apart from areas used for other activities such as roaming and foraging. Under normal condition, a larger species would need to eat more food and in general, they would require a bigger home range (Krebs & Davies, 1993). The estimated home range of the Asian elephant is 167km" (Hassan & Udadin, 1985). In the Sumatran rhinoceros and the Malayan tapir, the estimated home range sizes are 15 to 30km" and 13 km^2, respectively (Williams, 1978; van Strien, 1985). Habitat reduction directly reduces the food source of an area although in some instances, food source or young saplings are more abundant in a secondary forest as compared to a primary forest. Similarly, habitat fragmentation would result in a break in a home range of some species. These disturbances of a habitat can result in a species being displaced out of its home range either directly by reduction of the habitat or indirectly by human encroachment. This displacement of a species would be from a natural habitat into one that is unnatural including plantation, villages, logging areas, roads and highways. In the Asian elephants, conflict with humans arise when crops and plantations are being raided by the elephants for food due to restriction of their feeding areas. Similarly, the establishment of oil palm plantation provides an excellent alternative for the Asian

elephant and resulted in these crops being raided (Hassan &Udadin, 1985).

Over the past two decades, land conversion from forest to agriculture and development has been dramatic enough to cause a number of species to be displaced. The rapid clearing of lowland forest for agriculture purposes and timber has resulted in massive losses of wildlife habitat. This is because the lowland forest is most fertile, very rich in timber tree and wildlife (Mohd Khan, 1982).

This study was done to establish a trend of displacement of Asian elephant (*Elephas maximus*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and Malayan tapir (*Tapirus indicus*) in Peninsular Malaysia over the past 25 years. The paper describes displacement of animals as those individuals that are forced out of their natural habitat into an unnatural habitat by deforestation or encroachments or individuals that are attracted out of the natural habitat by food source. The unnatural habitat would include villages, plantations, orchards and logged areas.

MATERIALS AND METHODS

Data of the three displaced species (Asian elephant, Sumatran rhinoceros and Malayan tapir) were obtained from the Department of Wildlife and National Parks (DWNP), the local zoos and reports from the general public. These also include animals that were poached outside their natural habitat and those that were rescued or captured and subsequently translocated into zoos or into forest and wildlife reserves. Due to their large sizes, poached individuals outside their natural habitat were easily detected. A statistical analysis was done to determine the correlation between each species by years and states and their trend of displacement. An assumption was also made on the current estimates of Asian elephants, Malayan tapir and Sumatran rhinoceros in Peninsular Malaysia and compared against their home range sizes and displacement.

RESULTS

Based on the current estimated populations of Malayan tapir (3500 individuals), Sumatran rhinoceros (50 individuals) and Asian elephants (2000 individuals), their home ranges of 13 km^2, 23 km^2, 167 km^2 respectively and total displacement, it was found that there is a strong correlation between home range and species displaced (0.998 at p=0.038).

The total number of displaced Asian elephants for the past 25 years (1975 - 1999) were 455 animals. The number increased gradually during the period 1975 – 1979, from 29 to 45 animals in 1980 – 1984. This is followed by a sharp increase to 140 animals in 1985 – 1989 and reaching a peak of 155 animals in 1990 – 1994, before decreasing to 88 animals between the periods 1995 – 1999 (Figure 1).

The first report of a Sumatran rhinoceros being displaced was in 1975. Irregular displacements of Sumatran rhinoceros were reported from the periods 1980 – 1999, ranging from 2 – 18 individuals in each of the five-year period. A sharp increase in the number of Sumatran rhinoceros displaced occurred from the period 1980 – 1984, from 2 to 18 animals during the period 1985 – 1989. This is followed by a sharp decrease to three animals each during the periods from 1990 – 1994 and 1995 - 1999 (Figure 2). The total number of displaced Sumatran rhinoceros from 1975 – 1999 was 27 animals.

The displacement of Malayan tapir was first reported in the year 1991. The total displaced Malayan tapirs for the periods 1991 – 1999 were 28 animals. Six animals were displaced from the period 1990 –1994 followed by a sharp increase of 22 animals from 1995 – 1999 (Figure 2).

The annual rate of displacement for the Asian elephant from 1975 – 1999 is 18.2±12.7 animals. This is followed by 3.1±3.1 animals per year for the Malayan tapir over a period of nine years. The Sumatran rhinoceros has the lowest displacement rate of 1.6±1.9 animals per year over a 16 years period.

Comparing by the years and the displacement, a strong positive correlation (0.478) was observed between the Asian elephant and Sumatran rhinoceros. However, the correlation between the Asian elephant and Malayan tapir and between the Sumatran rhinoceros and Malayan tapir are weak, 0.175 and -0.021 respectively.

Over the period of 25 years (1975 – 1999), 510 animals (455 Asian elephants, 27 Sumatran rhinoceros and 28 Malayan tapirs) were displaced. The displacement of animals was highest in Pahang with a total of 196 animals of which 190 were Asian elephants, followed by Perak (104 animals), Johor (102 animals) and Terengganu (69 animals). The least number of animals displaced was in the state of Kedah (one animal). It should also be noted that Johor has the highest number of displaced Sumatran rhinoceros and Malayan tapir with a total of 12 and nine animals, respectively (Table 1). There is a strong correlation

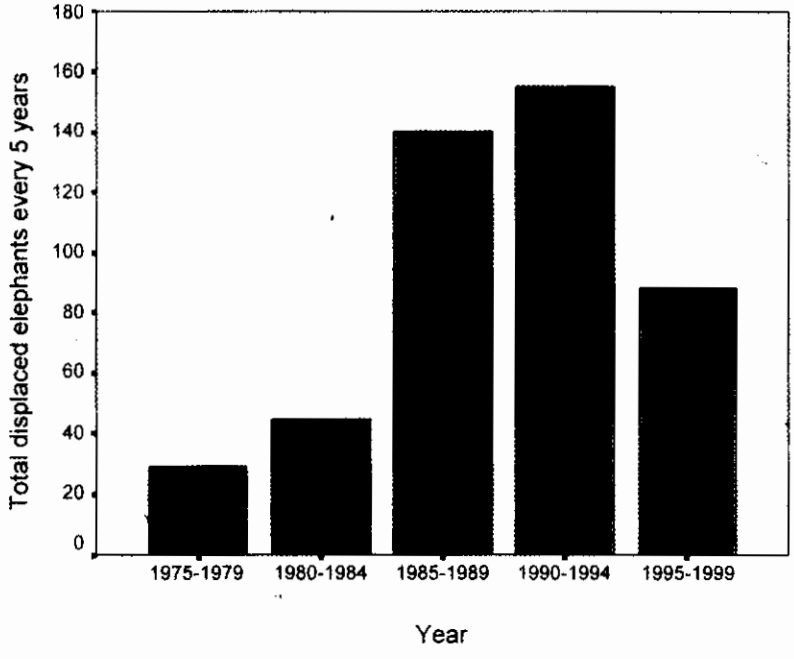

Figure 1. Displacement of elephants from 1975 - 1999 in Peninsular Malaysia

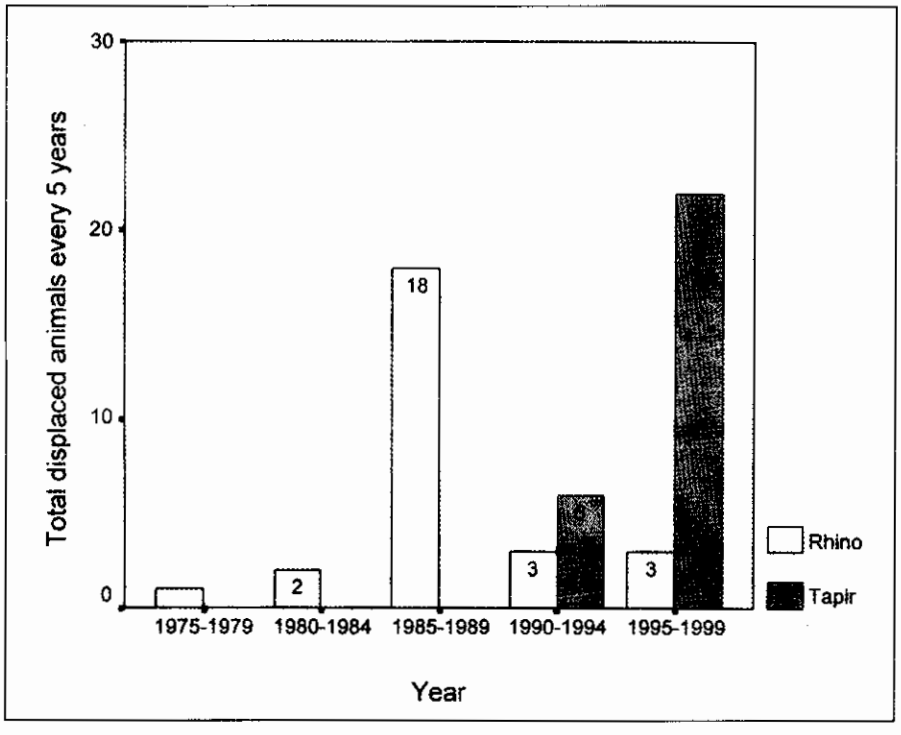

Figure 2. Displacement of the Sumatran rhinoceros and Malayan tapir from 1975 - 1999 in Peninsular Malaysia

Table 1. Displaced animals according to states in Peninsular Malaysia from 1975 - 1999

State	Asian Elephant	Sumatran Rhinoceros	Malayan Tapir	Total
Pahang	190	2	4	196
Perak	95	3	6	104
Terengganu	67	0	2	69
Johor	81	12	9	102
Selangor	12	7	3	22
Negeri Sembilan	4	0	2	6
Perlis	3	0	0	3
Kelantan	1	3	0	4
Melaka	1	0	2	3
Kedah	1	0	0	1
Total	**455**	**27**	**28**	**508**

Table 2. Declared terrestrial Protected Areas in Peninsular Malaysia

State	Peninsular	Total Forested Area		Wildlife Reserve			
	Area (km²)	ha	%	FD		DWNP	
				Total area (ha)	% of state	Total area (ha)	% of state
Johor	18 986	550 715	29.0	48 795	2.6	159 195	8.4
Kedah	9 426	350 281	37.2			2	0.0
Kelantan	14 943	1 027 736	68.8	108 783	7.3	80 377	5.4
Melaka	1 650	8 931	5.4			82	0.0
Negeri Sembilan	6 643	216 727	32.6				
Penang	1 031	7 516	7.3				
Pahang	35 965	2 113 210	58.8	361 130	10.0	394 588	11.0
Perak	21 005	1 044 140	49.7	7 413	0.4	3 167	0.2
Perlis	795	7 110	8.9	68	0.1	68	0.1
Selangor	7 956	181 961	22.9	7 644	1.0	10 428	1.3
Terengganu	12 955	735 220	56.8	77 507	6.0	103 083	8.0
Kuala Lumpur	244	1.0				423	1.7
Total	**131 599**	**6 243 801**	**47.4**	**611 340**	**4.6**	**751 413**	**36.1**

Abbreviations:
FD - Forest Department
DWNP - Department of Wildlife and National Parks
Source: Anon (1996)

between states with a displacement of Malayan tapirs and those where the Asian elephant (0.632 at $p = 0.027$) and Sumatran rhinoceros (0.787 at $p=0.002$) are displaced.

The correlation by states indicated that more displacement of elephants occur in states with a larger percentage of forest reserves (0.667 at $p=0.018$), wildlife reserves (0.744 at $p=0.006$) or forest (0.872 at $p=0.000$).

DISCUSSION

Two trends were observed in the displacement of large mammals in Peninsular Malaysia. The first trend indicated that displacement of large mammals is related to its size and its home range. This trend is shown with the displacement of the Asian elephant in 1975, followed by the Sumatran rhinoceros in 1984 and the Malayan tapir in 1990. The reason for this trend is that a bigger animal has a bigger home range and thus, covers a larger

area (Krebbs & Davies, 1993). The probability of a species losing its habitat due to land conversion is highest in one with a larger home range. This is reflected in the total number of Asian elephants displaced (455 animals) being larger than the Sumatran rhinoceros (27 animals) and the Malayan tapir (28 animals). In addition to it being the largest species and having the largest home range, the Asian elephant is known to be a social species. In Peninsular Malaysia, the Asian elephants were reported to exist in small herds within their distribution limits (Mohd Khan, 1985). This factor further increases the size of their home range depending on the herd size.

The second trend of displacement showed an increase in the number of displaced animals, reaching a peak followed by a decrease. This is seen in the Asian elephant and Sumatran rhinoceros. The Malayan tapir's pattern of displacement is predicted to follow in the coming years. The decrease in the number of displaced animals after the peak could be related to the availability of adequate habitat to support the remaining animals in the wild. However, the possibility of localised extinction is equally high.

Habitat loss is the main reason for displacement of animals. By 1990, in Peninsular Malaysia, records indicate that native forest covers 62, 363 km^2 or 47.4% of the total land area. This figure has declined as much as 7.6% or 10 028 km^2 from the year 1974. Most of this forestland has been converted to oil palm plantation, rubber estates, urban areas and mixed horticulture farms (DOA, 1995). However, habitat loss is not only through the opening up of forest but also through degradation and fragmentation of the forest. Logging and plantation roads enhance accessibility for human encroachment into the animal's habitat. The buffer zone between man and animal is steadily being reduced.

Kelantan has the highest proportion of forest cover (68%) in its state (Table 2) and a low development pressure. This explains the low number of displaced animals in this region. Pahang, Perak and Johor have the highest number of displaced animals and the most extensive oil palm and rubber plantation. The decline of forest cover has been most evident in Pahang, Johor and Terengganu where it has been matched with an increase in oil palm plantation. The total area of oil palm plantation has expanded most in Johor compared to the rest of the states in Peninsular Malaysia (Anon., 1996). This may explain of why Johor has the highest number of displaced Sumatran rhinoceros and Malayan tapir. During the period 1933-1993, a total of 369,076ha were designated as Protected Areas. However, in 1941-1993, a total of 56.6% of this, were degazetted leaving 159, 95ha. Degazettment have flourished mainly in the year 1975 and between 1988 and 1990, where a large proportion has been converted to FELDA settlements (Anon., 1996). States including Penang (7,516ha forested area), Perlis (7,110ha forested area) and the Federal Territory (254ha forested area) do not have the large mammals to be displaced due to its small size of forested areas. However, Kedah with a fairly large forested area of 350,281ha had the least number of large mammals displaced (1 elephant). This could be due to the signs of rampant poaching observed in the survey of Ulu Muda, in 1989 (DWNP, 1989). In addition, unreported cases of culling/poaching by the locals and immigrants occurred within the state.

Displaced animals are usually confused animals, seeking to establish another home range or using their old home range that has been converted agriculture land. In the process, some individuals are at risk of being poached, snared or run down by automobile. Subsequently, these snared animals (mainly elephants and tapirs) are sent to zoos and DWNP breeding centres. In addition, the Sumatran rhinoceros that were reported displaced and in threaten areas were also captured by DWNP for the captive-breeding program. During the past 25 years, 455 Asian elephants were displaced and 22.6% or 103 individuals died. The mortality during capture was 41% and due to post – capture stress and injuries was 26%. A total of 28% were shot dead while the remaining 5% were found dead, mainly from poisoning. A total of 27 Sumatran rhinoceros individuals were displaced, of which 37% were poached, 41% rescued by DWNP and 22% with unknown status. Displaced animals that are rescued were taken to Melaka Zoo and the Sumatran Rhinoceros Conservation Centres, Selangor. Post capture mortality amounted to 36%, although this mainly occurred in the 1980's. The displaced Sumatran rhinoceros are easy targets for poachers as they frequently used established trails for long periods. All Sumatran rhinoceros displaced in Johor between the periods 1988 - 1989, were poached. It was observed that Sumatran rhinoceros are more sensitive to any form of disturbances and are more easily forced out of a forest. In the Sungai Dusun Wildlife Reserve and the adjacent forest reserve, all 6 – 7 individual Sumatran rhinoceros were displaced between the periods 1986 – 1988. This is closely related to the extensive deforestation and development around the region. The Sumatran rhinoceros are poached for their valuable horn, skin and hooves.

It is concluded that there is a very clear trend of displacement of species from the larger to the smaller individuals. The current displacement of the Malayan tapir follows the same trend, observed in the Asian elephants and Sumatran rhinoceros as indicated by the strong positive correlation between the two latter species. Similar trends of displacement are expected to occur in smaller species including the Malayan tiger (*Panthera tigris*), Malayan sunbear (*Helarctus malayanus*) and the Black panther (*Panthera pardus*). An indication of how many viable wildlife habitats remains, may be estimated by looking at where large animals still exist. The rationale is that if the biggest animal (umbrella species) still survive within a region, then there is still enough wilderness left to support most of the smaller inhabitants of the ecosystem, as smaller species generally requires less range (Anon., 1996). However, if the development trend in this country remains unchanged, there may not be enough forest left to support our wildlife in the coming years. There would be a time when there are no animals displaced because there are no more left in their natural habitat, to be displaced. This is seen clearly with the Sumatran rhinoceros and the same will be seen with the Malayan tapir.

It is essential that measures are taken to reduce the displacement of animals. Forest and wildlife reserves should be protected and increased in number and size. Small unviable wildlife reserve in prime areas within the capital city could be traded for areas in the vicinity of other larger wildlife reserves. Currently, a proposal have been submitted by DWNP to the state government to replace the portion of Sungai Bukit Putih Wildlife Reserve in the Federal Territory, taken up for development, with the forest adjacent to the Sungai Dusun Wildlife Reserve. There must always be a balance between development and conservation to sustain the rich biodiversity of Peninsular Malaysia. It is necessary to stop fragmenting indigenous forests and provide green corridors to connect them to larger, more viable forest. In addition, land conversion must also be thoroughly examined in the future. This is to ensure the future of viable population of many species; especially those that live in solitude like the Sumatran rhinoceros and Malayan tapir are secured.

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HOME-RANGE SIZE OF CAPTIVE-BRED SAMBAR DEER (*CERVUS UNICOLOR*) IN THE WILD AT SUNGKAI WILDLIFE RESERVE, PERAK.

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ABSTRACT:-A study on the home range of the captive-bred sambar deer (*Cervus unicolor*) in the wild was conducted in Sungkai Wildlife Reserve, Perak, from May to November 2000. The mean monthly home range size for the male and female were 1.80 ± 0.83 km^2 and 2.68 ± 1.33 km^2, respectively. The 95% harmonic mean estimation gave 2.71 ± 0.87 km^2 and 3.82 ± 1.15 km^2, respectively. The difference between the male and female monthly home range size was not significant (Mann-Whitney U-test; $\alpha = 0.05$). The study also indicates that the individual male took five months to stabilize its home range whilst the female took four months and the ideal monthly home range size for sambar deer is probably about 2.5 km^2. The overlapping home range between the male and female was 29.1 %. The male used 20.1% of its monthly home range per day whilst the female used 29.2%.

Key Words:- ***Cervus unicolor*** **– Sambar deer- Sungkai – Captive breeding –radio collared**

ABSTRAK:*-Kajian tentang saiz kawasan keliaran rusa sambar (Cervus unicolor) yang dibiak ternak dalam kurungan di habitat liar telah dijalankan di Rizab Hidupan Liar Sungkai, Perak dari Mei hingga November 2000. Purata saiz kawasan keliaran bulanan jantan adalah 1.80 ± 0.83 km^2 manakala betina adalah 2.68 ± 1.33 km^2 dianggarkan menggunakan kaedah Poligon Cembung Minimum. Kaedah Min Harmonik 95% memberi nilai 2.71 ± 0.87 km^2 and 3.82 ± 1.15 km^2 masing-masing. Perbezaan saiz antara jantan dan betina adalah tidak signifikan (Mann-Whitney U-test; $\alpha = 0.05$). Tempoh lima bulan diperlukan oleh individu jantan untuk kawasan keliarannya menjadi stabil manakala betina memerlukan tempoh empat bulan dan saiz kawasan keliaran yang sebaik mungkin adalah sekitar 2.5 km^2. Pertindihan kawasan keliaran antara individu jantan dan betina adalah sebanyak 29.1%. Jantan menggunakan 20.1% daripada kawasan keliaran bulanannya sehari manakala betina menggunakan 29.2%.*

INTRODUCTION

Sambar deers (*Cervus unicolor*) are the largest and most widely distributed among five species of cervids in Malaysia. They have a wide range of distribution covering from eastern Philippine, Indonesia, Malaysia, Thailand, western China and Burma towards India (Medway, 1978; Whitehead, 1972; Lekagul & McNeely, 1977; Anderson, 1979). There are two subspecies of sambar deer in Malaysia, sambar Malaya (*Cervus unicolor equinus*) and sambar Borneo (*Cervus unicolor brookei*). The sambar Malaya is confined to Peninsular Malaysia while the sambar Borneo is confined to east Malaysia and some parts of Borneo (Payne *et al.* 1985).

Since the last few years, the population of sambar deer in Malaysia is declining probably due to two main reasons, namely natural habitat destruction due to the clearing of larges areas of forest and poaching (Habsah, 1983). For the purpose of replenishing forested areas with low population densities of deer, the Department of Wildlife and Parks (DWNP) has set up three deer breeding centres at Sungkai in Perak, Jenderak in Pahang and Gua Musang in Kelantan (Habsah, 1985; Pan & Sabri, 1989). Since the DWNP has successfully bred the animals, efforts must be focussed on the reintroduction of these animals into the wild. Before such action is to be implemented and large numbers of individuals are released, it is crucial to assess the effectiveness of the reintroduction program.

This paper is focussed on the home range size of captive-bred sambar deer in the wild. Previous studies on home range size of deer in the wild had been carried out on the red deer (*Cervus elaphus*) (Catt & Staines, 1987), sika deer (*Cervus nippon*) (Borkowski & Furubayashi, 1998), fallow deer (*Dama dama dama*)

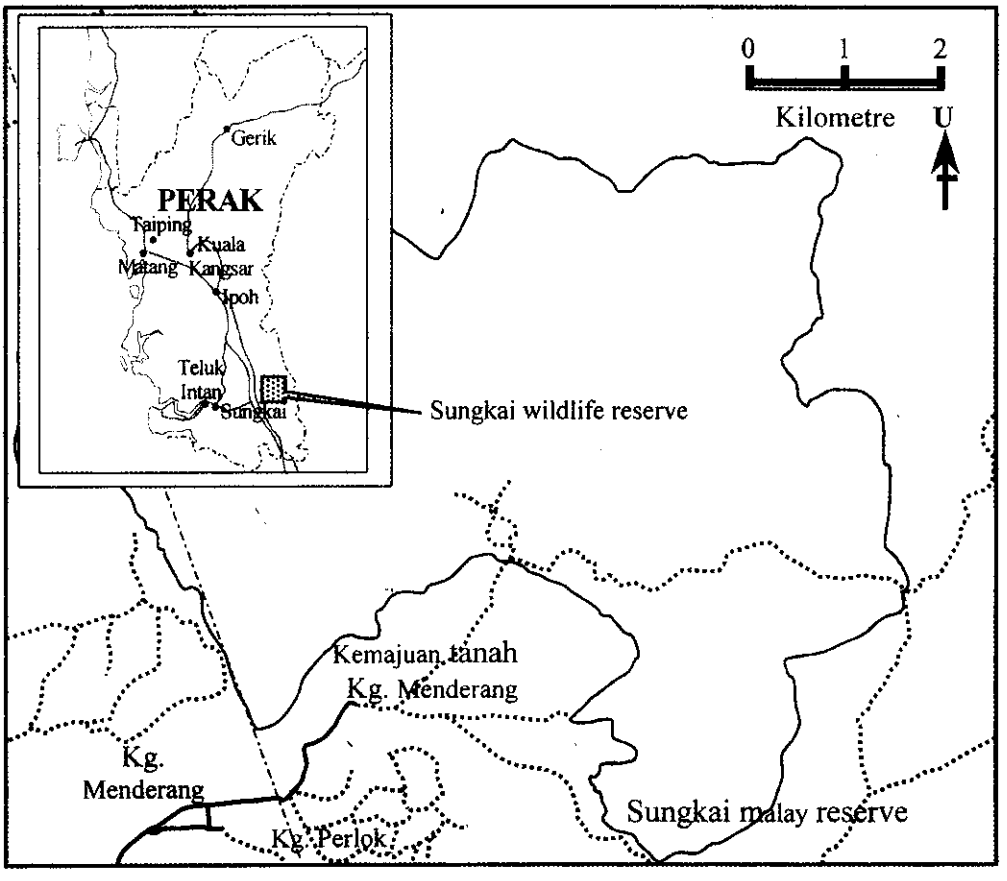

Figure 1. Map of Sungkai Wildlife Reserve, Perak

(Nugent, 1994), roe deer (*Capreolus capreolus*) (Tufto *et al.* 1996) and Columbian black-tailed deer (*Odocoileus hemionus columbianus*) (Livezey, 1991) all of which are wild deer's and not captive-bred. Unfortunately so far no studies have been conducted to investigate the home range of sambar deer in the wild, neither for captive-bred nor wild individuals.

MATERIALS AND METHODS

The study was conducted from May 2000 to November 2000 at Sungkai Wildlife Reserve (4° 0' to 40 3' N and longitude 101° 20' to 101° 24' E), which is situated at the western part of Perak (Figure 1). Sungkai Wildlife Reserve covers an area of 2,904 hectares of primary dipterocarp forest, more than 50 % out of which has been subjected to selective logging. The reserve was established in 1931 and gazetted as the Wildlife Reserve on 23 July 1937.

Field survey was made in this reserve to evaluate the status of the wild deer population, the existence of other wildlife species and food abundance. This is important to ensure that the area is inhabited by wild deer and thus suitable as a release site.

The selection of individuals for this study was made by the DWNP from the herd in Jenderak Wildlife Breeding Centre in Pahang. Two individuals one adult male and one adult female were chosen and radio-collared. The individuals were sedated before radio-collared using a mixture of 20 ml (2.25 mg/ml) Immobilon (acepromazine maleate) and 0.2 ml (100 mg/ml) Rompun (xylazine hydrochloric). The drug was delivered in 3cc Palmer-type Capchur darts using a Palmer long-range Capchur gun (Teleinject USA. Inc). Collars fitted with a radio transmitter (425g weight, 154.00 to 155.00MHz, Sirtrack, New Zealand) were attached to the necks of each individual. Finally a similar volume of diprenorphine hydrochloride (large animal revivon) was administered

via the auricular vein for recovery. The individuals were then transferred to Sungkai Wildlife Reserve with transport provided by the DWNP and released on the same day.

The location of the radio-collared sambar deer was obtained by triangulation methods using a TL-4 receiver (Telonic Inc. USA), hand held 3-element Yagi antenna (Sirtrack, New Zealand) and a global positioning system (Magellan USA, GPS 2000 XL). For a fix station, an antenna was mounted on a tall mast and was attached to the receiver by a long lead-in cable. The data for the location of each individual was recorded every hour with 8 hours interval of reading and a rest for 5 days a week, twice a month.

Data for home range size was then calculated using the computer program Home Range Ver. 2.00 (University of Idaho). The home range size was estimated with two home range estimators that are the Harmonic Mean (HM) and 95% Minimum Convex Polygon (MCP) estimators.

RESULTS

The tracking period for the male *C. unicolor* was seven months and the female was six months. The monthly home range data is summarized in Table 1. Values are given together with mean and standard deviations. The mean of the male monthly home range size was 1.80 ± 0.83 km^2 whilst the female home range size was 2.68 ± 1.33 km^2 estimated using the minimum convex polygon. The 95% harmonic mean estimation gave 2.71 ± 0.87 km^2 and 3.82 ± 1.15 km^2, respectively. The difference between the male and female monthly home range size was not significant (Mann-Whitney U-test; $\alpha = 0.05$). Monthly home range size within the individual could change from month to month.

There were some displacements of home range during the tracking period. In August 2000 the male home range was displaced to the west from the earlier location in the middle part of the reserve whilst the female home range was displaced to the south in September 2000 from the earlier location in the middle part of the reserve. From the monthlyhome rang data, it shows that the male took 5 months to stabilized its home range whilst the female took 4 months to stabilized and the ideal home range sized for sambar deer is probably around 2.5 km^2. The monthly home range data can be divided to three phases that is the lost phase for the first two months, search phase from third to fourth months and stable phase after the fourth month. The overlapping home range between the male and the female was 29.1 %.

The daily home range data is summarized in Table 2. All the daily home range data of each animal were not taken on consecutive days. The daily home range covers a small part of their total monthly home range. The mean of the male daily home range size was 0.41 ± 0.22 km^2 whilst the female home range size was 1.07± 0.67 km^2 estimated using the minimum convex polygon. The 95% harmonic mean estimation gave 0.47 ± 0.29 km^2 and 0.70 ± 0.50 km^2, respectively. On average, the male used 20.1% of its monthly home range per day whilst the female used 29.2% of its monthly home range per day. The large daily home range might have been influenced by the need of big amount of food per day by the deer because sambar deer is a big mammal.

Table 1. Monthly home range size of *C. unicolor* calculated by MCP (minimum convex polygon) and HM (95% harmonic mean) from May 2000 until November 2000

	Monthly home range size (km^2)							
	May	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Mean**
Male								
MCP	2.25	3.16	0.84	1.91	1.20	1.02	2.21	1.80 ± 0.83
95% HM	2.93	4.31	1.86	3.14	1.76	2.45	2.51	2.71 ± 0.87
Female								
MCP	1.27	3.69	4.07	3.81	1.19	2.07	-	2.68 ± 1.33
95% HM	3.05	5.10	4.77	4.69	2.79	2.56	-	3.82 ± 1.15

Table 2. Daily home range size of *C. unicolor* not taken on consecutive days calculated by MCP (minimum convex polygon) and HM (95% harmonic mean)

	Daily home range size (km²)								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
Male									
MCP	0.37	0.22	0.39	0.63	0.17	0.19	0.73	0.61	0.41 ± 0.22
95% HM	0.20	0.34	0.15	0.73	0.20	0.84	0.79	0.48	0.47 ± 0.29
Female									
MCP	0.28	0.25	1.01	1.74	1.69	1.13	0.56	1.87	1.07± 0.67
95% HM	0.08	0.18	0.82	1.10	1.10	0.44	0.39	1.48	0.70 ± 0.50

DISCUSSION

The variation in home range size has long been an attraction in ecology (Tufto *et al.* 1996). It has always been related to body-size-dependent metabolic requirements (McNab, 1963). According to Ahmad (1994) the size of home range for mousedeer (*Tragalus sp.*) a small cervid was related to its body size. Individuals of larger species should exhibit larger home ranges since they need more energy per individual per unit time and perforce must cover a larger area to get it (Damuth, 1981). The mean of home ranges size for sambar deers in this study was between 1.8 to 3.8 km². This is a moderate size for a big mammal like the sambar deer compared to red deers (*Cervus elaphus*), which is almost the same size, but with a bigger home range size at around 10 to 30 km² (Catt & Staines, 1987) and this was almost three times larger than sambar deer home range size.

There are other factors that can also influence home range size such as food abundance, forest cover and habitat type. Malaysia has a thick and dense type of forest with a variety of plants and has abundant food that can be consumed by sambar deers. When food abundance is high the deer do not need to go too far to find enough food for its daily need. That is probably why sambar deer uses only 20 to 30% of its monthly home range per day. Large mammal herbivores are less selective in feeding on more abundant but less nutritious foods, which are high in plant fibre (Damuth, 1981). Sambar deers consume the most variety of plant than other ungulates except the gaur in Kandahar National Park, India (Schaller, 1967). The thick and dense cover of our forest makes visibility low and this reduces the risk of predation thereby increasing survival. This will also increase the home-range size because the animal can move freely on the forest floor. Habitat type also plays an important role in home range size because different habitats have different resources of food and cover (Tufto *et al.* 1996) thus the home range size are also difference (Larter & Gates, 1994).

The differences between the male and female home range in this study is not significant. In some cervidae species, the difference in home range size is associated with gender. Nugent (1994) found that in fallow deer (*Dama dama dama*) the male home range was bigger than the female. Larger home range size in male ungulates is usually associated with the polygamous behaviour of males Their ranges also overlap with the home range of several females (Ahmad, 1994). In this study the overlapping home range between the male and the female is 29.1%.

This study also shows that human disturbance can also influence home range sizes. The study site is situated not far from human settlements and a logging track. The loud sound coming from vehicles transporting logs as well as people passing by probably scare the animals away. Human disturbance, which is often associated with open agricultural landscapes, is known to influence home range size (Zejda & Bauerova, 1985). Future research studies must take into account such factors in the choice of sites.

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BREEDING PERFORMANCE OF THE MALAYSIAN CAPTIVE GAUR

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Abstract :-The main objective of this study was to assess the performance of the gaur captive breeding project undertaken by the Department of Wildlife and National Parks (DWNP) at Jenderak Breeding Centre in Pahang. The study was carried out based on secondary information from annual reports and office records available at the centre. Primary data were gathered from interviews with the officials and staff of the centre. The population of the captive gaur was generally increasing. Although planned mating has been practiced, with only five (3 males and 2 females) wild founders, certain degree of inbreeding cannot be avoided in the fourth generation.

Abstrak :- *Tujuan utama kajian ini adalah untuk menilai prestasi pembiakan seladang dalam kurungan yang dijalankan oleh Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) di Pusat Pembiakan Hidupan Liar Jenderak, Pahang. Kajian ini dijalankan berdasarkan kepada maklumat sekunder daripada laporan tahunan Jabatan PERHILITAN dan rekod-rekod yang terdapat di pusat berkenaan. Data primer dikumpul daripada temubual dengan pegawai dan kakitangan di pusat tersebut. Populasi seladang dalam kurungan pada amnya adalah meningkat. Walaupun pengawanan terancang diamalkan, dengan bilangan induk seladang liar yang hanya lima ekor (3 jantan dan 2 betina), kemungkinan berlakunya "inbreeding" tidak dapat dielakkan sepenuhnya pada generasi ke empat.*

Key Words : Gaur – Captive Breeding – Endangered Animals – *Bos gaurus hubbacki* - Jenderak

INTRODUCTION

The distribution of the Gaur (*Bos gaurus*) or locally known as Seladang is from Nepal South through the Indian sub-continent and extended throughout mainland South-East Asia (Lekagul & McNeely, 1977). It is endangered across its entire range (Brennan, 1995). The Malaysian population was estimated at 503 (inclusive of 255 of unconfirmed historical records by Brennan (1995), 549-577 by Sahir (1999) and based on reports collected by staff from various states. Gaur was categorised as "Totally Protected" animal under the Protection of Wildlife Act (1972) and listed under Appendix 1 of the CITES (Convention on International Trades in Endangered Species of Flora and Fauna) lists. The Department of Wildlife and National Parks (DWNP) established the gaur captive breeding project in 1982, in response to the growing concern that the survival of the gaur in wild may be threatened by severe habitat reduction (Conry & Ebil, 1979; Ebil, 1981; Zulkifli, 1983).

Captive breeding programme as an ex-situ conservation technique requires extensive capital in providing facilities, construction of infrastructures and maintaining the daily running of the breeding centres. It could increase from 10-folds to 10,000-folds compared with the passive protection in natural habitat (Conway, 1989). Realising the substantial amount of funds involved in captive breeding, the existing captive breeding centres should be managed cautiously to achieve the objectives of the establishment.

To justify the continuance, the captive breeding programme should comply with certain standard guidelines. Firstly, the captive breeding should be for a long-term conservation objective that would involve reintroduction into or replenishment of the former habitat. Secondly, the founders should be of known genetic origins. Thirdly, each individual animal bred in captivity should have a sound studbook record and fourthly, the genetic and demographic consideration should be incorporated into the overall management of the breeding programme. This study attempts to gain some insight whether the DWNP gaur captive breeding programme has been effective in reintroduction and replenishment of captive population into the wild by

examining the current management practice, demographic characteristics and the breeding performance of the captive population.

The specific objectives of this study are:-1) To assess the performance of the captive breeding programme of gaur by the DWNP. In this assessment the agreement between the stipulated objectives of the captive breeding establishment and the management systems executed was scrutinized, 2) To rectify weaknesses in the management of gaur captive breeding projects. An important element in this assessment is human resource development, particularly of officers that are proficient in carrying out the tasks of captive breeding projects. Efficiency in the various aspects of management, such as simple animal husbandry and characteristic behaviour of the captive animals will be examined through interviews and 3) To recommend remedial actions toward designing appropriate conservation programmes.

MATERIALS AND METHODS

Interview

Interviews were carried out to gather information on the present management of the gaur in the captive breeding project. The officers and staff directly involved with the daily operation of the captive breeding were interviewed to obtain information about:

1. The level of knowledge on inbreeding and the considerations made in pairing animals for propagation.
2. The origin of the founder animals
3. Health problems and causes of death
4. The amount, types and time of food given
5. How they transport the animals
6. Breeding performance

Secondary Data

Other information on gaur were obtained from secondary sources such as the DWNP annual reports, records and notes available at the wildlife conservation centre in Jenderak. Information gathered were date of birth (for the captive born), date of death, date of transfer to other places, locality of capture, male and female parents, local identification number (ID) and other useful information. These records were kept and updated since the beginning of the captive breeding project in 1982.

RESULTS

Present Management

At the breeding centre at Jenderak the gaurs are placed in 0.25 hectare paddocks. A breeding unit comprising of a male, one or more females and their calves occupied each paddock. The captive gaurs depend on natural seedlings, undergrowth and pasture as their food sources. They were also supplemented with a variety of leaves such as the favoured "mengkirai" (*Trema angustifolia* and *T. tomentosa*), jackfruit (*Arthocarpus sp.*) and fig (*Ficus spp.*) daily. Processed food pellets were also part of the dietary requirements of the gaurs. Drinking water for the gaur was obtained from the same source as that for the domestic uses which is supplied by the Local Water Board. From a health perspective, treatments such as deworming, tick prevention and vitamins were dispensed when necessary, more so when symptoms of infection or health deterioration were detected.

Captive Identity

The captive gaurs were not tagged or marked for identification but were identified by their characteristic features. This method was feasible as the number of captive gaur was small, numbering only 26 (at the time this report). The placement of the 26 gaurs in 12 different paddocks has further helped to keep track of each individual's identity.

Mating Strategy

Potential breeding partners were identified when the gaurs reached sexual maturity at the age of two years. Suitability of partners was selected based on health and family pedigree with an objective of producing physically and genetically sound progenies. The limited number of wild founders (3 males and 2 females) has restricted the choice of suitable partners being distantly related. With the small number of wild founders, mating between relatives cannot be avoided in the third generation thus producing inbred offspring.

In the present system, pairs with breeding performance (consistently reproducing healthy offspring), were maintained throughout their reproductive stage. The least performing males or females were re-matched with different partners.

Breeding Performance

Population Growth

Figure 1 shows the growth of the gaur population at the captive breeding centre since 1982 until April 2000. The

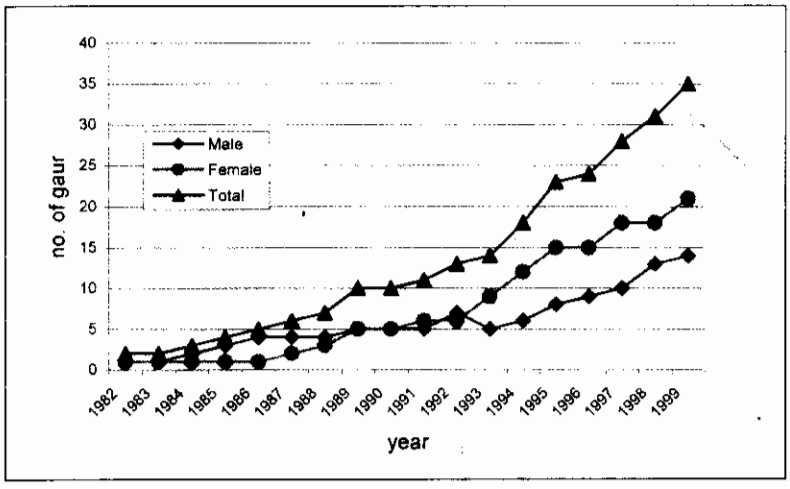


Figure 1. Population growth of gaur from 1982 to 1999 at Jenderak, Pahang

Table 1. Demographic parameters of gaur population from 1982 to 1999

Year End	BR (%)	IR (%)	DR (%)	DRn (%)	ER (%)	RC
31 Dec 1999	35	0	23	36	0	1.129
31 Dec 1998	29	0	18	62	0	1.107
31 Dec 1997	25	0	8	17	0	1.167
31 Dec 1996	22	0	17	40	0	1.043
31 Dec 1995	33	0	6	17	0	1.278
31 Dec 1994	36	0	7	0	0	1.286
31 Dec 1993	15	8	15	0	0	1.077
31 Dec 1992	36	0	18	75	0	1.182
31 Dec 1991	10	0	0	0	0	1.100
31 Dec 1990	10	0	10	0	0	1.000
31 Dec 1989	29	14	0	0	0	1.429
31 Dec 1988	17	0	0	0	0	1.167
31 Dec 1987	20	0	0	0	0	1.200
31 Dec 1986	25	0	0	0	0	1.250
31 Dec 1985	33	0	0	0	0	1.333
31 Dec 1984	0	50	0	0	0	1.500
31 Dec 1983	0	0	0	0	0	1.000
31 Dec 1982	0	0	0	0	0	0.000

Explanatory Notes

BR - Birth rate = number of birth over total number (%).
IR - Import rate = number of animal imported into the captive over total population size(%).
DR - Death rate = number of death over total population (%).
DRn - Death rate of neonates = death rate of the newborn.
ER - Export rate = the rate (%)of animal exports out of the breeding programme.
RC - Rate of change = actual observed annual growth rate.

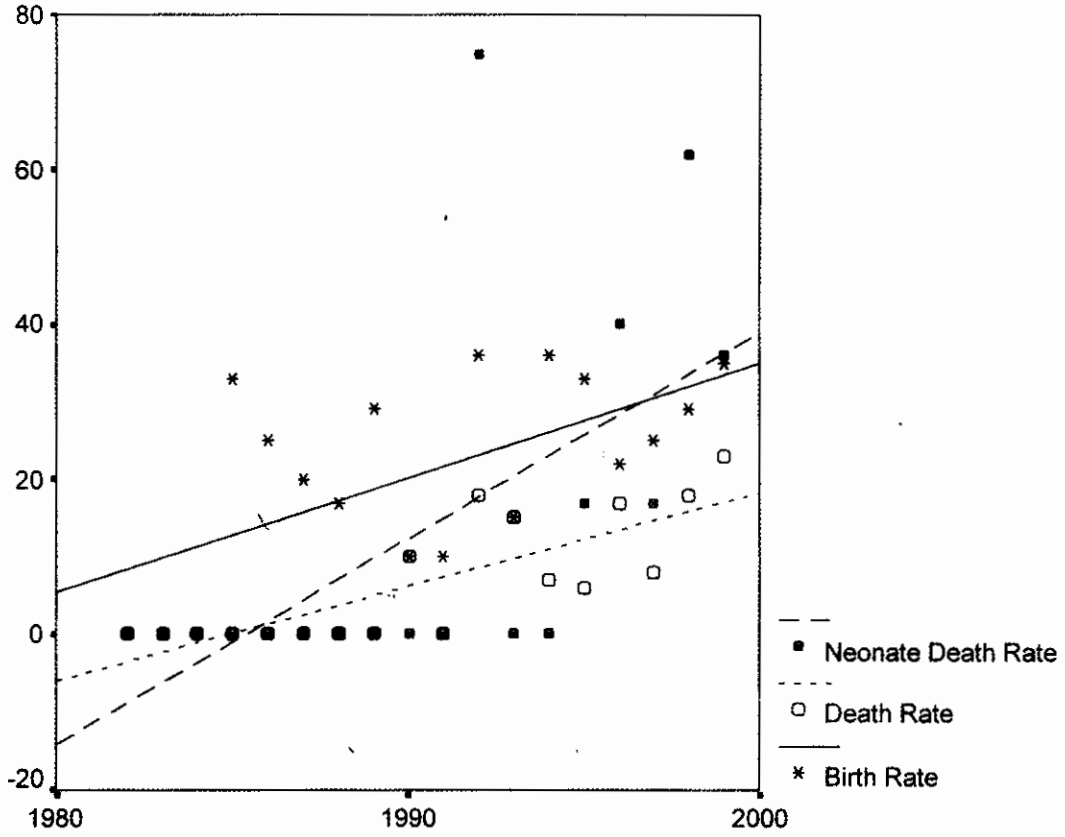


Figure 2. Graph of birth rate (BR), death rate (DR) and neonate death rate (DRn)

gaur captive population grew from one pair to 35 individuals in 1999, inclusive of those transferred to other zoos. Before 1989, the number of males was more than the females. However since 1992, the females have proportionally increased faster than that of males.

Demographic Parameters

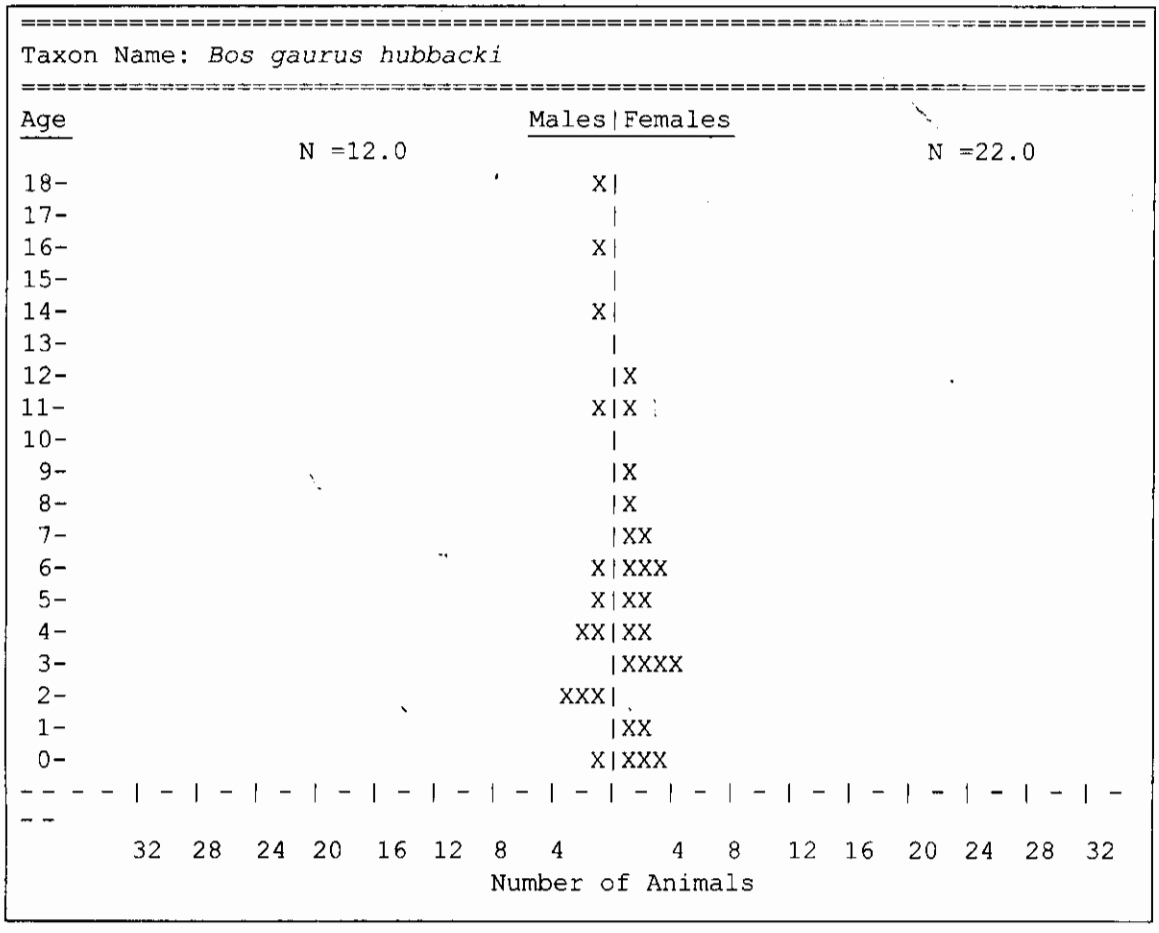
Table 1, shows the birth rate, import rate, death rate, death rate of neonates (natal death), export rate and rate of change (actual annual growth rate). The important parameters from the table are the birth rate (BR), death rate (DR) and neonatal death rate (DRn). The table showed that the birth rate varied between 10% and 35%, while death rate and the neonatal death rate peak at 23% and 75%, respectively. From Table 1, the variations seem occurred randomly but linear regression analysis using SPSS showed a very strong upward trend in all the three parameters (BR: $y = -2915 + 1.48$, ($p = 0.006$); (DR: $y = -2405 + 1.21$, ($p = 0.006$); and (DRn: $y = -5288 + 2.66$ DRn, ($p = 0.009$). Diagrammatic upward trend of BR, DR and DRn is shown in Figure 2.

Age Pyramid

Table 2 shows the number of the captive gaurs in the respective ages arranged in hierarchical order forming a pyramid shape. A broad-based triangular shaped pyramid would usually represent a normal healthy population, reflecting a higher number of young and gradually being reduced as they grow.

The asymmetric shape of the pyramid in Table 2 was due to the unequal number of gaurs of different sex, while the tapered shape was a result of a relatively small population size.

Table 2. Age pyramid of gaur population at Jenderak, Pahang



X >>> Specimens of known sex...
? >>> Specimens of unknown sex...

Table 3. Inbreeding coefficient within the gaur captive population

Inbreeding coefficient (%) affected	No. of individual affected	No. of male affected	No. of female died	No. of individual died	% of inbred population
0	52 (84%)	20 (86.7%)	32 (80%)	23(79.3%)	44
6.25	6 (9%)	2 (8.7%)	4 (10%)	3(10.3%)	50
12.5	1 (1.6%)	0 (0%)	1 (2.5%)	1(3.4%)	100
18.75	4 (6%)	1 (4.3%)	3 (7.5%)	2(6.8%)	50
	63 (100%)	**23 (100%)**	**40 (100%)**	**29(100%)**	

Inbreeding Depression Symptoms

Table 3 shows the inbreeding situation of the captive gaurs population. As of the fifth of April 2000 (the last record of birth), 11 gaurs (16.6% of the population) were found to have incurred between 6.25% to 18.75% coefficients of inbreeding. Eight (20%) of female and 3 (13%) of male gaurs were inbred. Out of 29 deaths in the captive gaur population since the beginning of the project, however, only 6 (20.7%) were found inbred.

Breeding Management

In gaur programme a studbook was well maintained, recording historical information and events that have taken place for each gaur. The application of "sparks" software version 1.42 (extended), (developed by ISIS 12101 Johnnycake, Apple Valley, MN, 555124, USA) in the gaur management allowed us to trace the pedigree (family lineage) of each individual. Such information is important in formulating a strategic breeding plan together with decision making by the management.

The population of the captive gaur has grown steadily from one pair in 1982, (subsequently increased to 3 males and 2 females of wild-caught origin) to 35 by the end of 1999 with 10% to 35% birth rate annually (Table 1). Comparatively, the population of the captive gaur in the North American zoos has grown from four pairs in 1958 to 160 in 1994 (AZA, 2000).

DISCUSSION

The performance of the breeding project has been encouraging, indicating that gaur is well adapted to the captive environment. Such high adaptability of gaur to artificial environments has been observed in the North American zoos which have bred Indian gaur (*Bos gaurus gaurus*) in captivity since 1958 (Brennan, 1995).

The mortality rate was also quite high especially in 1998 and 1999 with 18% and 23%, respectively. Neonatal mortality was also high at 75% in 1992 and 63% in 1998. Neonatal mortality is usually linked with fitness and inbreeding (Wharton, 1982) and therefore genetic analysis to determine the genetic variation may be required for the gaur captive population. Although the studbook analysis indicated that no inbreeding occurred (especially in 1992 that recorded 75% neonatal mortality), the actual genetic variation in the captive population is not known. There is a possibility of that inbreeding occurring in the gaur captive population as the first and second captive males (the founders) were caught from the same area. They could be from the same herd and closely related. Brennan's (1995) finding on the lack of variability in the mtDNA should be regarded seriously although that does not necessarily reflect the degree of genetic diversity in the nuclear genome.

With only three males and two females of the wild founders (considering the present captive population was not inbred), inbreeding occurrence cannot be avoided in the long run. Even with the execution of planned mating, inbreeding could only be prevented from occurring at the F3 generation. Half of the genetic heterozygosity will be lost in each generation, which means the fourth generation of gaurs would certainly carry at least 6.25% of the inbreeding coefficient, bases this on the theoretical loss of genetic heterozygosity. The only way to delay the occurrence of inbreeding is by increasing the number of wild-caught into the captive population (preferably from different herds). The introduction of new animals will definitely improve the genetic variation of the captive population of the gaur.

Although the Malaysian captive gaur began with only five wild founders, with the practice of planned mating, inbreeding has been avoided, such avoidance can only be maintained up to the third generation. Inbreeding cannot be prevented in the fourth generation thus requires injection of alien genes from the wild.

Based on the conservation status and the performance of the breeding programme, there is no doubt that the gaur captive breeding should be continued. It should be a long-term conservation programme until the population is out of the danger of extinction, irrespective of where should the population be maintained, remain in captivity or released in the wild. Why should the option of retaining the gaur in captivity be considered? This is because gaur requires a substantially large tract of forest that possesses certain characteristics to survive in the wild (Sahir, 2000). Based on the home range size of 78 km^2 of a female (Conry, 1981; 1989), average size of herd 5.95 $\pm$ 2.03 (Sahir, 1999), even the Krau Wildlife Reserve, Pahang with approximately 63,000 hectares could possibly maintain only 23 gaurs, with an assumption that only about half of the area is unsuitable for gaur because of hilly terrain.

Too few animals living within a protected area or reserve will not survive without active management. Even in a suitable habitat small population may become increasingly vulnerable to both demographic stochasticity

(Goodman, 1987) and genetic forces such as inbreeding and genetic drift (Senner, 1980; Soule, 1980; Ralls & Ballou, 1983). Conservation efforts must link the management of wild herds with the management of captive herds (Brennan, 1995). The captive bred stocks can be continuously introduced into wild population and vice-versa in order to maintain the co-adapted gene complexes that may be important to the survival of the animals in both captive and wild population.

Prevention of inbreeding in the captive population should be given priority. Efforts should be made to introduce new genes into the population. One of the options of getting new genes is through capture operation. However, the survival rate of the wild-caught animals has been very low (Brennan, 1995) because of the difficulty in safely tranquillising gaur in the wild due to their size and temperament (Weigun, 1972; Conry, 1987; Ebil, 1990). Capture efforts have been targeted to calves less than six months of age that are less susceptible to capture myopathy that often ends in animal's death. As the wild herds of this animal are getting smaller and isolated, the chances of encountering herds with calves are slimmer, therefore, requiring more intensive capital efforts. The option of using advance technologies such as semen collection from the tranquillised males in the wild should be explored. Artificial reproductive techniques such as embryo transfer, artificial insemination using frozen semen, transvaginal ultrasound oocyte aspiration and transcervical embryo collection that have been developed for cattle industry have been successfully applied to gaur in the United State (Brennan, 1995). Understandably, there is no expertise within the DWNP that can undertake such delicate works, thus local availability of such technologies should be explored, and consultation and cooperation should be sought from the local institutions. Wildlife conservation is not an issue only within the DWNP, but it is also a national and international issue. Captive breeding in particular, is a multi-disciplinary subject (IUCN, 1995), and as such the responsibility should be shared with other agencies, either government, non-government of institute of higher learning, the universities.

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BREEDING PERFORMANCE OF THE MALAYSIAN CAPTIVE PHEASANTS

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Abstract:-The main objective of this study was to assess performance of the pheasant captive breeding project undertaken by the Department of Wildlife and National Parks (DWNP) at Sungkai Wildlife Breeding Centre in Perak. The study was carried out based on secondary information from office records and notes available at the centre. The population of captive pheasants was generally growing with the exception of green peafowl and crestless fireback pheasant. Inbreeding was not expected in pheasant except the green peafowl. Hatching success was not consistent among the pheasants, fluctuating between 0% and 91%, while their mortality ranged between 0% and 100%. The ability to produce and hatch eggs indicates the adaptability of the pheasants to the captive environment while the fluctuations in egg production, hutching success and mortality reflect a lack of supervision.

Key Words :- Captive breeding – pheasants – partridge – Sungkai Wildlife Breeding Centre –Great argus

***Abstrak**: -Tujuan utama kajian ini adalah untuk menilai prestasi pembiakan burung kuang dalam kurungan yang dijalankan oleh Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) di Pusat Pembiakan Hidupan Liar Sungkai, Perak. Kajian ini dijalankan berdasarkan kepada maklumat sekunder daripada rekod dalam fail dan nota-nota yang terdapat di pusat berkenaan. Populasi burung kuang yang dibiakkan pada amnya semakin bertambah kecuali merak hijau dan merak mata. Sementara itu "inbreeding" dijangka tidak berlaku pada burung kuang yang dibiakkan kecuali pada merak hijau. Kejayaan penetasan didapati tidak tetap di kalangan burung kuang yang dipelihara, turun naik antara 0% dan 91%, manakala kematian berkisar antara 0% hingga 100%. Keupayaan untuk menghasilkan dan menetaskan telur menandakan keupayaan penyesuaian terhadap suasana dalam kurungan manakala ketidak mantapan pengeluaran telur, penetasan dan kematian menggambarkan penumpuan dan penyeliaan terhadapnya.*

INTRODUCTION

Sahir (1998) gave an overview of the background on the galliformes captive breeding programmes at the Sungkai Breeding Centre, Perak. A thorough review on each of 10 species of captive pheasants in the centre; green peafowl (*Pavo muticus*), great argus (*Argusianus argus*), crested argus (*Rheinardia ocellata*), Malaysia peacock (*Polyplectron malacense*), Mountain peacock (*Polyplectron inopinatum*), Crested fireback (*Lophura ignita*), crestless fireback (*Lophura erythropthalma*), bulwers pheasant (*Lophura bulwerii*), crested wood partridge (*Roullulus roulroul*) and red-breasted wood partridge (*Artoroplila hyperythra*) was also described. He found amongst the 10 species, only three species *A. argus* (Great argus), *P. malacense* (Malaysian Peacock) and *P. inopinatum* (Mountain Peacock) were showing very encouraging breeding results, while the rest were not performing as expected. The poor breeding performance was attributed to some animals being beyond reproductive age, having incompatible mate, or housed in non-conducive environments, and also partly to poor management. Based on his observations, in this paper a reassessment of the breeding programme is made to rectify weaknesses in the management and to recommend remedial actions toward designing a better programme for the centre.

MATERIALS AND METHODS

Data on pheasants were gathered from records that were kept at the Sungkai Wildlife Conservation Centre. The data gathered can be used to estimate egg production and hatching success from artificial or natural incubation. The data available here was collected as early as 1986.

Data analysis

Reproductive pattern is a monthly variation of egg production in a complete season of a year. The primary objective of the studying reproductive pattern is to determine the influence of seasonal change on egg production. For this purpose, the data gathered were sorted and tabulated according to species, months and years. The number of eggs produced by each species was calculated according to months and years to observe the monthly pattern over 14 years (1986-1999) period.

Hatching success is the number of egg hatched alive, calculated in percentage over the total number of eggs incubated. The data gathered were analysed to obtain monthly and annual fluctuations of hatching success for each species.

Mortality is the death of individuals in a population, usually presented in percentage. In this study the available death records hatchlings (one month after hatched) were sorted and analysed. Mortality was calculated in percentage of the death of hatchings over the number of hatchlings hatched up to the age of one month.

Chi-square goodness of fit test was applied to compare the behavioural patterns among species, between sexes among different age classes.

RESULTS

Population Growth

Population growth of the six pheasants, crestless fireback, crested fireback, Malaysian peacock, mountain peacock, great argus and green peafowl bred in captivity in the breeding centre at Sungkai in shown in Figure 1. Of the six, Malaysian peacock and mountain peacock shared an increasing trend while the others showed a fluctuating pattern from 1981 to 1998.

Reproductive Pattern

Figure 2, 3, 4, 5, and 6 showed the monthly production of eggs of crestless fireback, crested fireback, Malaysian peacock, mountain peacock, great argus and green peafowl from 1989 to 1999. All the six species, except green peafowl, were seen breeding throughout the year, with high frequency in the early half of the year and decreasing toward the later. Crested fireback, did not produce eggs in the months of October and November consistently from 1989-1996 and 1999, while green peafowl did not produce eggs in the months of May and July to December.

Hatching Success

The hatching success for pheasants in the breeding programme in 1992-1995 and 1999 is presented in Table 1. Generally, the hatching successes have inconsistence variations of between 0% and 75%, with more failures in most of the years. However, the hatching success of crested fireback and Malaysian peacock has shown to be more competent.

Mortality

Based on the 1988 - 1990 records as shown in Table 2, mortality of the young, proportion of infertile eggs and hatching success in pheasants varies between species and within species at different years. Hatching percentage varies between 15% (crestless fireback in 1990) and 91% (Malaysian peacock in 1989), while egg infertility varies between 3% (crestless fireback in 1988) and 81% (green peafowl in 1990). The highest mortalities (100%) of the young birds occurred for Malaysian peacock (1988) and crestless fireback (1990).

DISCUSSION

Pheasants Reproductive Pattern

Five species of the pheasants under the study, crestless fireback, crested fireback, Malaysian peacock, mountain peacock and great argus, have been observed breeding throughout the year, except for green peafowl, with a higher frequency in the early half of the year and decreasing toward the later. In general, there were two breeding peaks, which occur in December-February and June-July. The two breeding peaks could be coincided with wet condition of the rainy season, which may trigger egg production.

The general trend of high egg production in the first half of the year in crestless fireback and other pheasants has been reported by Medway and Nisbet (1967), Chasen (1969), Javis and Medway (1969) and Davison (1978).

Their observations of these species from the wild and in captivity concur with our study at the breeding centre.

In crestless fireback, earlier records showed that nests were found in April (Chasen, 1939) and June (Medway & Nisbet, 1967). In captivity Jarvis and Medway (1969) observed one female laid eggs in February. Davison (1978) had observed captive females laid eggs in December (twice), January, February, March and June (twice). The past records and the recent findings, confirmed that crestless pheasants favoured the first half of the calendar year for breeding.

Table 1. Hatching success of six species of pheasants at the Sungkai Breeding Centre

SPECIES		YEAR				
		1992	**1993**	**1994**	**1995**	**1999**
Crestless fireback	no of egg incubated	26	4	30	3	12
	no. of chick hatched	3	0	1	0	2
	Percentage	**11.5**	**0**	**3.3**	**0**	**16.7**
Great argus	no of egg incubated	4	2	13	2	2.0
	no. of chick hatched	3	0	0	0	0.0
	Percentage	**75**	**0**	**0**	**0**	**0.0**
Mountain peacock	no of egg incubated	3	1	3	0	30.0
	no. of chick hatched	0	0	0	0	8.0
	Percentage	**0**	**0**	**0**	**0**	**26.7**
Crested fireback	no of egg incubated	15	14	13	3	32.0
	no. of chick hatched	6	7	3	1	4.0
	Percentage	**40**	**50**	**23.1**	**33.3**	**12.5**
Malaysian peacock	no of egg incubated	5	4	13	1	42.0
	no. of chick hatched	2	1	4	0	15.0
	Percentage	**40**	**25**	**30.8**	**0**	**35.7**
Green peafowl	no of egg incubated	10	0	0	0	17.0
	no. of chick hatched	0	0	0	0	1.0
	Percentage	**0**	**0**	**0**	**0**	**5.9**

Table 2: Pheasants' egg infertility, hatching rate and mortality (1988 – 1990)

SPECIES	No. of birds			No. of Egg produced			Infertile Egg (%)			Hatched (%)			Young Mortality (%)		
	88	**89**	**90**	**88**	**89**	**90**	**88**	**89**	**90**	**88**	**89**	**90**	**88**	**89**	**90**
Malaysian peacock	4	10	10	8	12	11	63	8	9	33	91	80	100	30	25
Mountain peacock	1	5	7	0	0	2	-	-	50	-	-	-	-	-	-
Crestless fireback	13	13	7	29	35	60	3	34	45	71	52	15	20	17	100
Crested fireback	8	10	9	0	42	27	-	26	23	-	19	47	-	67	67
Great argus	7	9	9	12	27	10	-	19	20	67	32	63	50	43	0
Green peafowl	4	5	5	0	13	27	-	38	81	-	25	40	-	50	50

Hatching

Generally, based on Table 1 and Table 2, all of the six species under study have shown successful hatching in one or more years, indicating that they can be successfully bred in captivity. For example great argus has shown good hatching success in 1988 (67%), 1989 (32%), 1990 (63%), 1992 (75%), but 0% in 1993-1995 and 1999. A similar trend has been displayed by green peafowl with hatching success in 1989 (25%) and 1990 (40%) but 0% hatching success in 1992-1995. The inconsistency of hatching success in some of the species could be due to: (1) young age of the breeding pairs, (2) incompatibility of partners, (3) incubator inefficiency, (4) power failure and (5) human error. Therefore further investigations need to be carried out to find a better technique that can consistently produce high hatching success.

Mortality

Based on the 1988 - 1990 records as shown in Table 2 the mortality of young pheasants was shown to vary from year to year. This variation could be due to human

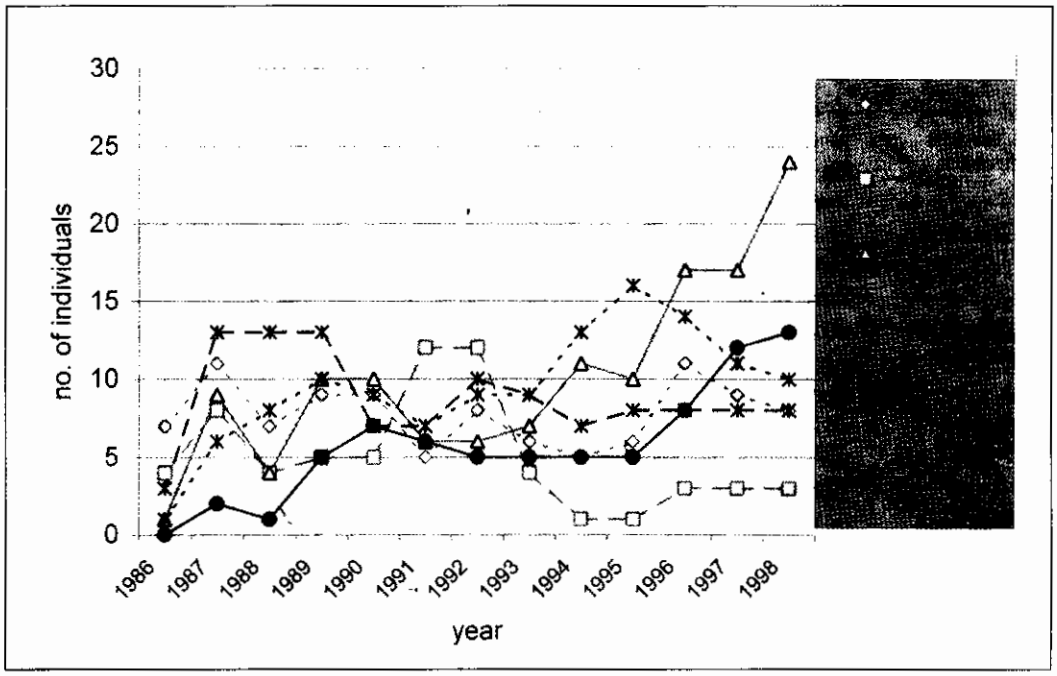

Figure 1. Population growth of six species of pheasants in captivity at Sungkai, Perak

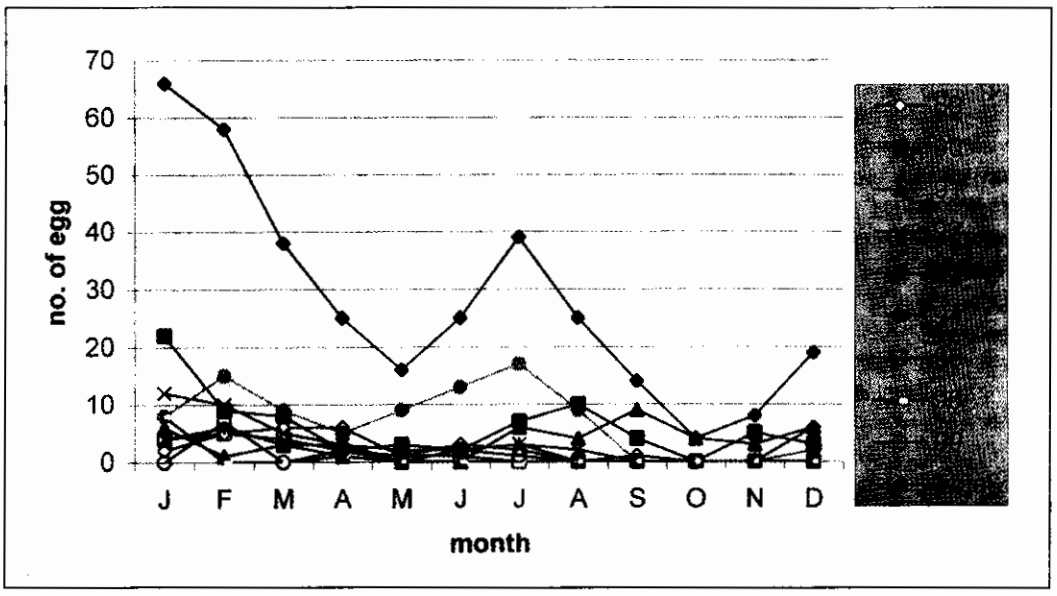

Figure 2. Pattern of monthly egg production (1989-99) of crestless firebac

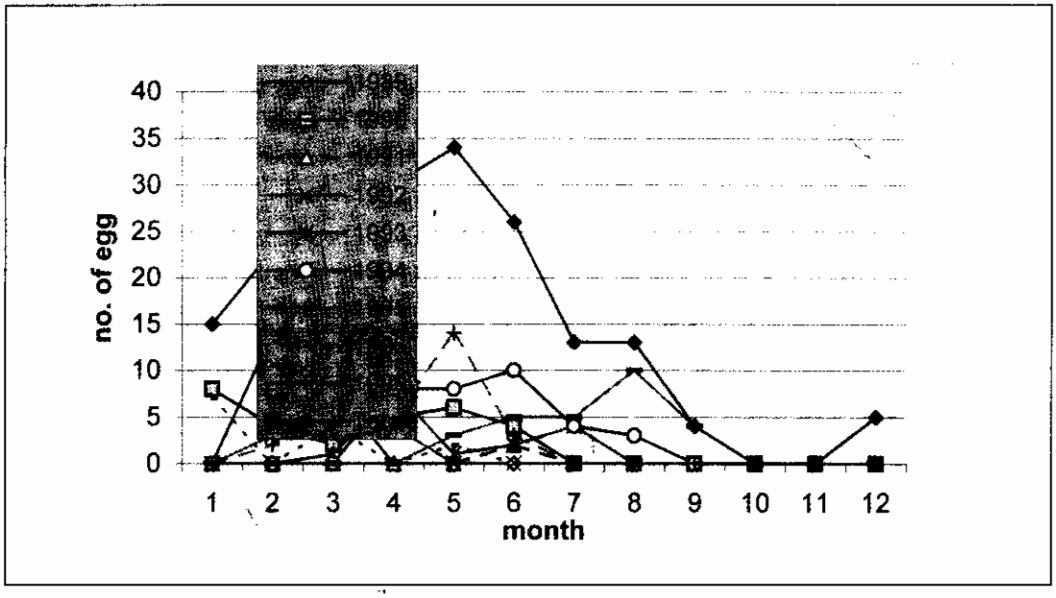

Figure 3. Pattern of monthly egg production (1989-99) of crested fireback

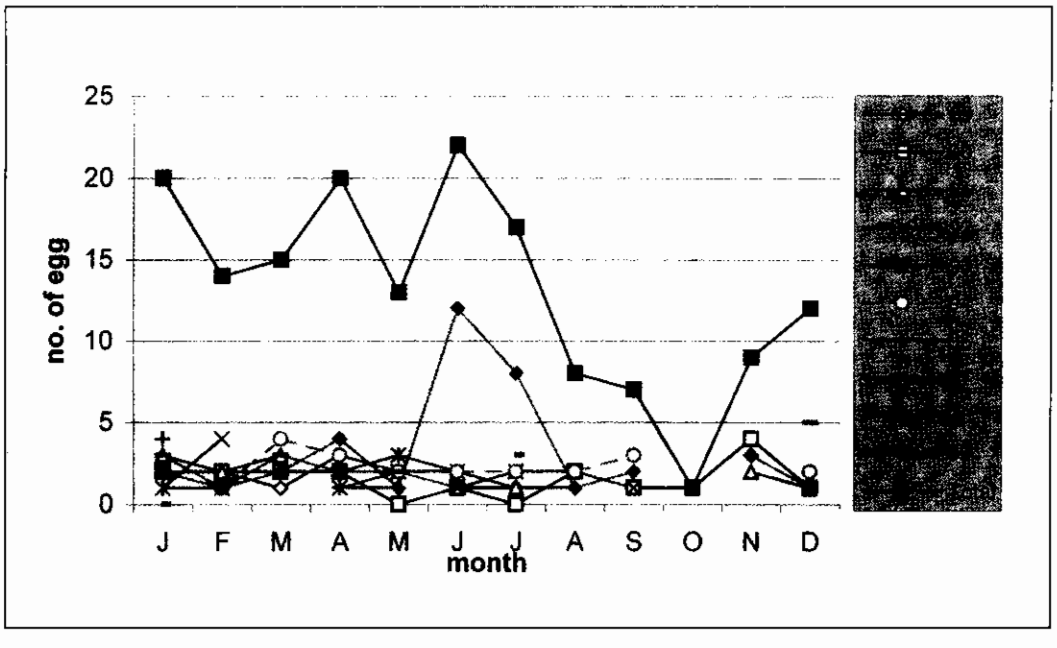

Figure 4. Pattern of monthly egg production (1989-99) of Malaysian peacock

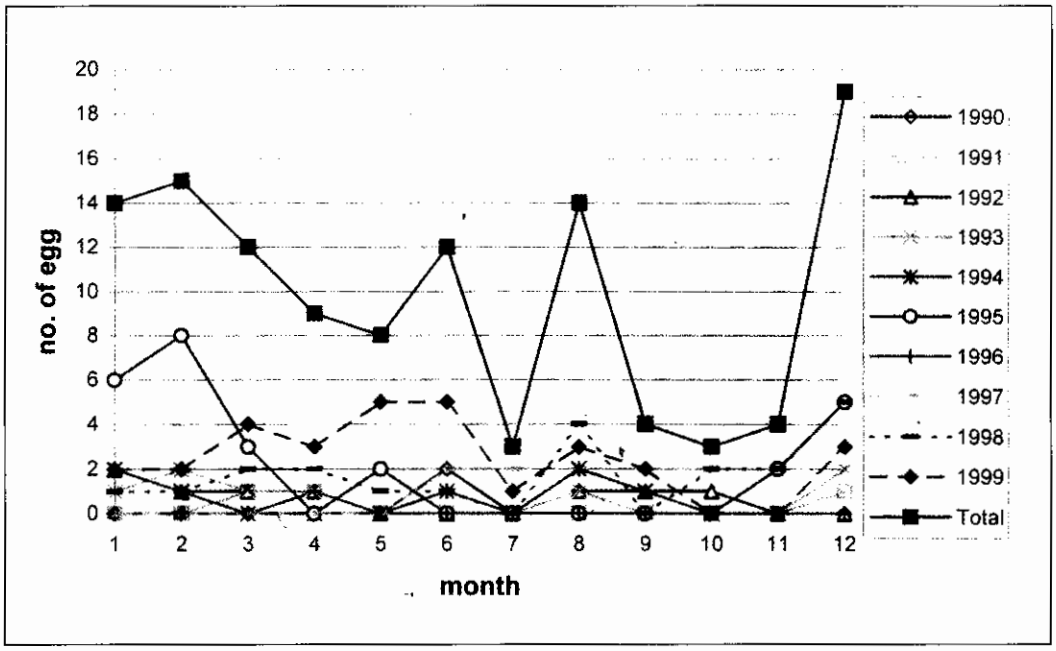

Figure 5. Pattern of monthly egg production (1989-99) of mountain peacock

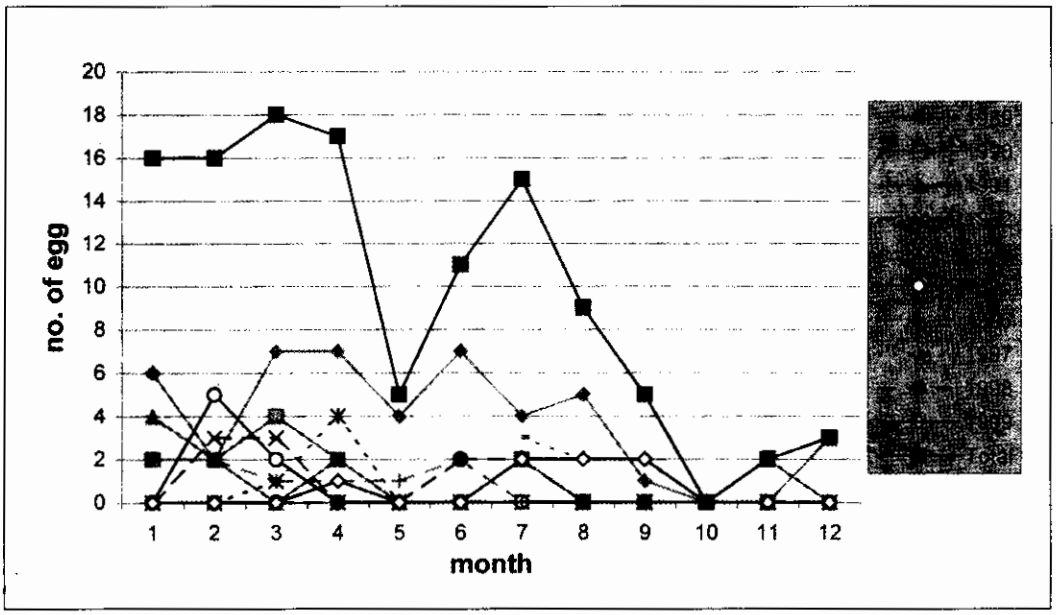

Figure 6. Pattern of monthly egg production (1989-99) of great argus

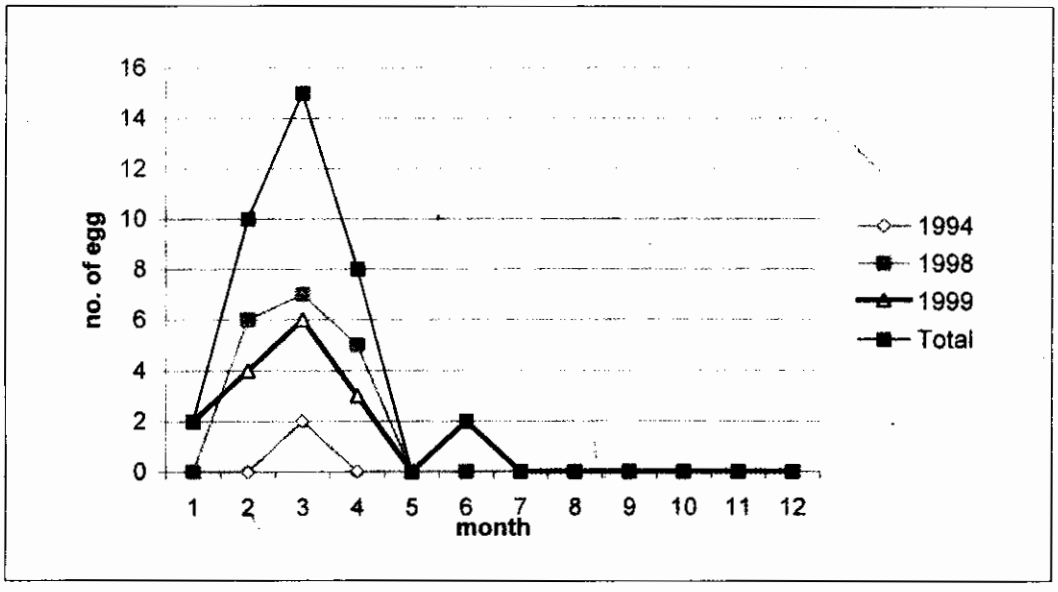

Figure 7. Pattern of monthly egg production (1989-99) of green peafowl

factor such as lack of supervision of the birds. As such the performance can be improved by improving the management system from year to another.

The genetic variation in the pheasant captive population is expected to be better than other captive bred sambar deer undertaken by the DWNP because the origin of the founders were known with the exception of the green peafowl obtained from the United Kingdom. They were either of the Indonesian or Thailand origins or a hybrid of the two subspecies. Founders of the other five species of the pheasants investigated in this study were of the Peninsular Malaysian origin, caught from the wild at different localities. Selection of pairs for breeding purposes was made with consideration in avoiding mating between closely related individuals. This was possible because the identity of each bird was known through the use of tag and documentation. Although there was not any investigation into the genetic variation of the pheasants, I believe that inbreeding has not yet existed in the pheasants' captive population (with the exception of *P. muticus*), based on two factors: (1) the founders were caught from the wild and they were paired selectively to avoid closely relatives, and (2) there wasn't any symptoms of inbreeding occurring.

CONCLUSION

The endangered status of the birds nationally and internationally warrants capital-intensive conservation programmes to be commenced. In this respect, the DWNP's efforts in breeding them in captivity should be appreciated and supported.

The inconsistency in the egg production, hatching success and survival rate were the reflection of human factors. The techniques of rearing the birds need to be improved in order to gain maximum results. The best way to improve the breeding techniques is by undertaking scientific research. Behavioural observation is one of the ways to understand their adaptation to the captive conditions. Production of infertile eggs for instance could be due to unsuccessful copulation or may be due to food related problems.

Records keeping should be improved. Although records are available, I faced some difficulty in sorting the information as it was not designed and administered systematically. I strongly suggest that "SPARKS" studbook software (developed by ISIS 12101 Johnnycake, Apple Valley, MN, 555124, USA) be used for each of the captive pheasants species because analysis can be performed, which is important for breeding management, apart from systematic data management.

P. malacense has been breeding successfully but it does not indicate the success of captive breeding as a conservation measure until a successful reintroduction is achieved. For that matter reintroduction of *P. malacense* should be carry out as there are enough specimen available.

For a better management and research, I strongly suggest that one or more research officers to be assigned to carry out research on the pheasants captive breeding. In addition, university students should be encouraged to study and accumulate more data.

Lack of partners in *P. muticus, A. argus, P. inopinatum,* and *L. erythrophthalma* should be overcome either by getting suitable partners from the wild or through exchange agreement with other local and international zoos in order to improve their breeding performance.

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MEASURING THE ENVIRONMENTAL LITERACY OF MALAYSIAN SECONDARY SCHOOL STUDENTS

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Abstract: - This paper presents the findings of the level of the Environmental Literacy (EL) of secondary school students in Peninsular Malaysia. A modified version of the Florida EL Survey instrument was used to determine the EL of secondary school students who attended the Environmental Education Center (EEC) in Lanchang, Pahang. It can be concluded that, environmental education program at the centre of this study yielded neither the desired curriculum outcomes based on the ecology component of the course standards for biology nor the desired learning based on the 1993 curriculum frameworks. Environmental education delivered through science content does not engage the expressed intentions of the "awareness to action" model for environmental education. The current delivery media of science education do not facilitate achieving EL. The findings of this research suggest a need for systematic, comprehensive assessment of the EL of Malaysia's secondary school students to determine if the level of EL of the general population of secondary school is as low as that suggested by this sample.

Key Words:-Environmental Literacy- environment education-Florida Environmental Education Survey instrument- ecological literacy-Lanchang

Abstrak:*-Kajian bagi mengetahui tahap EL terhadap pelajar sekolah menengah di Malaysia telah. Alat pengukuran survei yang digunakan bagi mengukur tahap EL pelajar-pelajar ialah "Florida EL" yang telah diubahsuaikan. Adalah dirumuskan bahawa program alam semulajadi di Pusat Pengajian Alam semula jadi di Lanchang, Pahang agak kurang berjaya menyediakan bentuk kurikulum berdasarkan komponen ekologi yang diperlukan dan juga tiak selari dengan kehendak asas pembelajaran yang dibuat pada kerangka kurikulum dalam tahun 1993. Pengajian alam semula jadi yang diterapkan melalui kandungan sains tidak berupaya untuk menyampaikan kehendak model "maklum untuk beraksi". Salah satunya ialah corak penyampai pembelajaran sains tyanf kurang berkesan untuk mencapai EL yang lebih baik. Keputusan kajian ini mencadangkan satu penilaian yang komprehensif dan berjadual terhadap program alam semula jadi dan tahap EL memandangkan tahap EL pelajar sekolah menengah berada pada tahap yang rendah*

INTRODUCTION

At the national level, the federal government had recognized that environmental education (EE) is critical for maintaining the delicate relationships among all forms of life and to preserve the earth's capability to sustain life in the most healthful, enjoyable and productive environment possible. Individual governmental agency is encouraged to be involved seriously with the same matter. This involvement is limited to the school students. In this context, the Ministry of Education (MOE) had formulated the curriculum that promoted the importance of environmental education in the school educational system, from primary through the upper secondary levels. This action acts as the primary delivery system to create environmentally literate citizens. Among the most prominent agencies working closely with the MOE to help create environmental awareness is the Department of Wildlife and National Park of Malaysia (DWNP). The DWNP has three Environmental Education Centers (EEC), which provide opportunities to the students on environmental education. At this level the DWNP in charge with the responsibilities (in part) to: (a) implement and assess environmental education needs offered at the EECs, (b) assist with environmental education comprehensive plans, and c) evaluate the success of student and in-service training (DWNP, 1996).

Within this context, an evaluation of the EE curriculum in EEC at Lanchang, Pahang was conducted. The purposes of the evaluation were to provide: (a) an

indication of the impact of the previous years' environmental educators' efforts on the knowledge and attitudes of students, (b) a data-based indication of needs against which program proposals can be measured, and (c) a baseline to serve researchers in the decades ahead. It should be noted that prior to the 1974, EE was formerly taught primarily to match the request of the individual school. Curricula, when present, varied widely and depended on the interests of individual students, teachers, and the capacity of the DWNP to conduct the EE.

EL (EL) can be briefly defined as the ability to comprehend and critically evaluate: 1.Basic principles that govern natural systems, (2) Linkages among living organisms and the physical environment and (3) Consequences of human activity on natural systems.

At global level the EL should follow the basic functional education for all people, which will be able to provide them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development (UNESCO, 1985). However at national level it must suit the social, economical and political preferences. In this manner EL should entail an understanding of thè fundamental relationships between healthy ecosystems and human well being, leading to policies and practices that foster ecological integrity of that nation. The goal is to educate students across disciplines to be environmentally conscious decision-makers and action-takers.

The need for expanding EE in Malaysia is very much needed as it entering the new millennium. It is better to have some influences of the previous writing. For example, writing in 1896, Woodrow Wilson described the effects and spirits of the American College experience:

> "America has never yet had a season of leisured quiet in which students could seek a life apart without sharp rigors of conscience, or college instructors easily forget that they were training citizens as well as drilling pupils... when all is said, it is not learning but the spirit of service that will give a college place in the public annals of the nation. It is indispensable... that the air of service be admitted to all its classrooms. I do not mean the air of party politics, but the air of the world's transactions... the sense of the duty of man toward man... of the significance of truth for guidance as well as for knowledge."

Of significantly more importance, primary and secondary education could provide all students with the intellectual tools and practical skills to become caring and competent stewards of the planet - in other words, with "EL," or "ecological literacy." Orr (1992). He divides the literacy concept into three basic elements: "the knowledge necessary to comprehend inter-relatedness," "an attitude of care or stewardship," and "the practical competence required to act on the basis of knowledge and feeling." An environmentally literate person recognizes that human actions have complex ecological and normative consequences. He or she has the motivation and education to investigate and pursue courses of action that contribute to a more sustainable future.

These are attributes, which the great majority of students have lacked until now, and the results have not been neutral. EL is not just about developing citizens who will create environmental solutions; it is also about preventing the ignorance and negligence that lead to ecological damage. Too many "well-educated" graduates with important positions in society share these shortfalls. Without any conscious intention of ruining humanity's home, many otherwise admirable people have by their actions unwittingly helped create a legacy of environmental destruction.

Promoting EL is critically important for the sake of all society. But it is also important simply for higher education. If colleges and universities do not offer a thorough treatment of ecological questions, they will considerably decrease their relevance. Environmental study is an essential component of a liberal or vocational education for the 21st century.

MATERIALS AND METHODS

Sample

Three hundred and seventy students (n=370) participated from 14 secondary schools in Peninsular Malaysia. Overall sample were selected because the need to identify their EL with respect to: (a) geographical region, (b) represent urban and rural demographic regions, and (c) offer EE nature center programs employing the expertise and services of facilitators, wildlife rangers/facilities. Fourteen schools were randomly sampled from a total of 29 schools. The student sample was obtained using a systematic random sample of the total groups. The survey was carried out between May 7 1997 and July 30 1997.

Survey Instrument

The Florida Environmental Literacy Survey (FELS) was modified and tested using a pilot study for the Malaysian perspectives. This modified version built upon the concepts presented in the "Conceptual Frameworks for Environmental Education in Florida, USA" (East Central Florida Environmental Education Service Project, 1990) and the Seminar on the making of National Curriculum of the Environmental Education in Malaysia (DWNP, 1996). These frameworks encompass the ideas delineated in the "awareness-to-action" model for interdisciplinary EE. In this model, the environmentally literate individual is conceptualised as one who (a) commands cognitive and affective knowledge about his or her biological and physical surroundings, (b) possesses political know-how (Bogan & Phillips, 1989), and (c) displays a willingness to engage in responsible environmental behaviors (Hines, Hungerford & Tomera, 1987). Specifically, the FELS was designed to measure EL. It was defined as (a) knowing the scientific principles of ecology, (b) being aware of the potential magnitude of human impact on the biosphere, (c) showing concern for all living species, (d) valuing responsible environmental behaviours, and (e) participating in political action strategies that lead to planetary well being (Hammond, 1988; McClaren, 1989; NASSP, 1990). The FELS is divided into six sub-tests, as follows: (1) the Knowledge Assessment Sub-test (KAS), consisting of 23 items (score range = 0 - 25, with higher scores representing greater knowledge), is a measure of students' knowledge of the principles of ecology as offered through Science's (Fleetwood, 1974); (2) the 27-item Attitude Survey (ATT), with a score range of 27 to 135, is a measure of general ecological attitudes (Asche, 1972); (3) the Necessary Environmental Behaviours (NEB) sub-test (score range = 5 - 25, with higher scores indicating greater recognition of necessary environmental behaviours) was designed to measure the degree to which students perceive that five specific environmental behaviours (conserving water/ energy; planting vegetation; political activism for environmental concerns) are necessary for planetary health; (4) the Active Environmental Behaviours (AEB) sub-test (score range = 5 - 25, with higher scores representing greater participation in necessary environmental behaviours) is a self report on students' participation in these specific environmental behaviours; and (5) the Political Action Rating (PAR) is a constructed-response measure of students' political action knowledge, with a score range of one to five.

In the PAR, students were asked to read a newspaper article (1 paragraph in length) that suggested that a nearest wildlife reserve was logged. Students were asked to recommend political action strategies that they might employ to gain public support for an environmental problem. The sixth and final part of the FELS was an open-ended question designed to measure students' perceptions of Malaysia's most critical environmental concerns. The KAS and ATT sub-tests were adapted from previously developed instruments (Asche, 1972), while the remaining components of the FELS were modified for this study.

Validation Procedures

A validation of the content of the survey instrument was undertaken by a panel in order to suit with the Malaysian perspectives. A panel consisting of two environmental biologists and zoologists, two secondary science teachers, and one EE specialist review the test content. Minor adaptation of the test content (substituting Malaysian species for the exotic species) was made where necessary.

Similarly, a panel of 3 environmental educators in U.S.A and 1 environmental educator in Malaysia reviewed the ATT. Minor modifications of items to reflect changes in the knowledge base on environmental issues were made. Following the revisions to the instruments, the entire FELS was pilot tested using a sample of 56 high school students. Based upon the pilot results, three items were deleted from the Attitude Survey because of low item-total correlations. However, the results of the pilot test indicated acceptable levels of internal consistency and inter-rate agreement for the six components.

Reliability estimates were generated for each sub-test of the FELS. The estimates of internal consistency were adequate for each component of the FELS. The KR-20 for the KAS was 0.81, and Cronbach's alpha coefficients for the ATT, NEB, and AEB were 0.83, 0.76, and 0.75, respectively. Reliability for the PAR was estimated using generalizability analysis, yielding an estimated G-coefficient of 0.95.

Data Analysis

The survey data were analysed using measures of central tendency and dispersion to provide information about the level of environmental literacy of the high school sample. In addition, correlational statistics were used to explore relationships between participants' knowledge, attitude and behaviours.

Table 1. Means and standard deviations of Students' scores on the Malaysia Environmental Literacy Survey

Sub-scale	Mean	Standard Deviation
Knowledge Assessment	8.45	4.67
Attitude Survey	102.05	11.31
Necessary Environmental Behaviours	21.54	2.86
Active Environmental Behaviours	16.68	3.71
Political Action Rating	1.54	1.24

Note: N = 369

RESULTS AND DISCUSSION

Means and standard deviations for the first five sub-tests of the FELS are presented in Table 1. These data are described below, for each sub-test.

Knowledge Assessment (KAS).

For the 23-item KAS sub-test, the high school sample obtained a mean of 8.45 and a standard deviation of 4.67. With a possible range of scores from zero to 23, these data suggest an overall low level of ecology knowledge. Only 19% of the students answered more than one-half of the items correctly. Nine students (2.4% of the sample) achieved a score of 80% or higher on the knowledge sub-test. These scores are comparable to those obtained by Fleetwood (1972).

Overall, student knowledge of the principles of ecology was very limited. These results may be, in part, a result of the length of time between the students' completion of a EEP and the time of this assessment. These findings may also indicate that the curriculum content of EEP measured by the KAS was not taught or that students' did not retain the information from the curriculum.

Attitude Survey (ATT).

For the 27-item ecological attitude sub-test, the secondary school students obtained a mean of 102.05 and a standard deviation of 11.31. With the items on the ATT scored on a 5-point scale, the possible score range is 27 to 135. The obtained sample mean suggests that students, on average, have a positive attitude towards the environment.

Necessary Environmental Behaviours (NEB).

The five NEB items were scored one through five, in a "strongly agree" to "strongly disagree" scale. The secondary school sample yielded a sample mean 21.54, and a standard deviation of 2.86. With a possible range of 5 to 25, these data indicate that the students in the sample value environmentally sound behaviours.

Active Environmental Behaviours (AEB).

The self-report on participation in environmentally sound behaviours contained five items, scored on a one to five scale identical to the scoring of the NEB. The AEB sub-test yielded a sample mean of 16.68, with a standard deviation of 3.71. The average student response was only slightly higher than the neutral response (a score of 15 for the five items). Twenty-six percent of the students in the sample scored 14 or less on this sub-test, indicating that they tended to not actively participate in environmentally sound behaviours. *Political Action Rating (PAR).*

The open-ended responses to the PAR were evaluated thoroughly using the following criteria: (a) data had to be collected to validate the environmental allegations, (b) a report had to be written based on the data collected in the investigation, (c) the media had to be used to apprise students of the situation, (d) the government had to be intervened in the situation and (e) a strategy to ameliorate the situation had to be proposed. Participants accumulated one point for each of the five strategies mentioned.

Students demonstrated limited facility in knowledge of political action strategies. Twenty-two percent of the students in the study did not or chose not to respond to the item; 4.3% gave no response, which fit the evaluation criteria. Twenty-one percent of the students suggested the validation of the newspaper's allegation that the forest was damaged. Once gathered, said data would be committed to a written report by only 2.7% of the respondents. Only 16.5% of the survey participants suggested governmental intervention. An especially troubling finding was that the suggested governmental interventions cited were controlling or punitive in nature. Fifty-seven percent of the students indicated that

the media should be used to inform publics of the impending problem. Approximately 48% of the students reported a mechanism through which the pollution problem could be ameliorated. Very few students presented a multifaceted strategic approach to the scenario. Raters agreed that three of the 369 participants (less than 1%) offered a response that fit the entire evaluation criteria. Nine participants (less than 3%) offered four of the five elements of an effective political action strategy.

Areas of Critical Environmental Concern for Malaysia.

Students were asked to select three environmental problems from a list of eight that they felt were of most critical concern to the Malaysian environment. In addition, students had the option to add to the list of concerns. As a group, the sample of high school students perceived a need to: (a) educate the public (62%), (b) manage wildlife habitat (53%), (c) monitor environmental pollution (53%), and (d) manage water resources for human consumption (34%). Because more than 50% of the respondents indicated that monitoring environmental pollution is of critical concern to Malaysia, these students may seem more aware of general environmental problems.

Additional concerns about Malaysia's environment included (a) public indifference towards environmental concerns (31%), (b) the influx of human population into the city (29%), (c) land use management practice for the human population (19%) and (d) lack of a sufficiently support from local citizen on environmental concerns (17%).

Students did not cite the rise in human population as one of Malaysia's most critical concerns. They did not connect the human population as underlying extent environmental problems. Even though all other problems are directly dependent on the human population, 71% of the students did not consider the influx of the human population to be of critical concern to the Malaysia environment.

Findings in this area are consistent with findings reported by other investigators. For two decades, scholars in the field of environmental education have investigated environmental attitudes and knowledge and their influence on human behaviour (Perkes, 1973; Bruvold, 1973; Schmidt & Buys, 1974; Passineau, 1975; Kellert, 1978). Studies that focus on specific content areas (dealing with attitudes towards wildlife, growth management, and the human-wilderness interface) indicate that respondents do not connect the science of ecology with either the human behaviors needed to protect habitats or with environmental policy development. On the other hand, research participants typically indicate great concern for maintaining environmental quality (Duda, 1987; LaHart, 1978). The high school students who participated in the current study appear to be following this pattern.

Correlational Analyses

Zero-order correlations for the sections of the Malaysia Environmental Literacy Survey is presented in Table 2. The highest correlation was that observed between the environmental attitude measure (ATT) and recognition of necessary environmental behaviors (NEB) sub-tests ($r = 0.60$, $p < 0.01$). Moderate levels of correlation were

Table 2. Zero-order Correlations between sub-scales of the FELS

	ATT	NEB	AEB	PAR
Knowledge Assessment	0.38 **	0.12 *	0.09	0.37*
Environmental Attitude	0.60 **	0.26**	0.35**	
Necessary Environmental Behaviours	0.25**	0.13*		
Active Environmental Behaviours	0.08			

Notes: *p<0.05; **p< 0.01.
ATT - Environmental Attitude
NEB - Necessary Environmental Behaviors
AEB - Active Environmental Behaviors
PAR - Political Action Rating

observed between the KAS and ATT sub-tests ($r = 0.38$, $p < 0.01$), between the KAS and PAR sub-tests ($r = 0.37$, $p < 0.01$) and between the ATT and PAR sub-tests ($r = 0.35$, $p < 0.01$). Additional bivariate correlations were more modest, although statistically significantly different from zero: a correlation of 0.26 ($p<.01$) between ecological attitude (ATT) and active participation in environmental behaviours (AEB), a correlation of 0.25 ($p<0.01$) between recognition of environmental behaviours and participation in these behaviours (NEB and AEB), a correlation of 0.13 ($p<0.05$) between NEB and PAR scores, and a correlation of 0.12 ($p<0.05$) between KAS and NEB scores correlation of 0.12 ($p<0.05$) between KAS and NEB scores

The environmental attitude sub-scale is one component in three of the four obtained correlations larger than 0.30. These findings suggest the importance of attitude in the assessment of EL, and in the development of EL curricula. Congruent with the awareness-to-action model, simple awareness and knowledge about the environment may not drive individual action about the environment. Within the limits of correlation research, these findings suggest the importance of considering the influence of attitudes when developing curriculum process models for EE.

CONCLUSION

The efforts in EE at the EEC in Lanchang, Pahang of this study yielded neither the desired curriculum outcomes based on the ecology component of the course standards for biology nor the desired learning based on the 1993 curriculum frameworks. EE delivered through science content does not engage the expressed intentions of the "awareness to action" model for EE. The current delivery media of science education do not facilitate achieving EL. The good intentions of the legislative mandates are therefore unlikely to be achieved in this manner.

At the DWNP level, the course standards that integrate disciplines should be developed. Such integration facilitates the creation of and development of important links and connections across subject-specific content areas. Cross-disciplinary curriculum activities that encourage participants to define their personal views and the basis for these views should be presented in the EE classroom since attitudes play an important part in actuating behaviour. Students should participate in: (a) non-threatening values clarification forums to gain an understanding of belief and knowledge-based attitudinal biases about environmental issues, (b) community action projects, working with elected officials, and (c) active reflective writing (Bogan *et al.* 1994).

The findings of this research suggest a need for systematic, comprehensive assessment of the EL of Malaysia's secondary school students to determine if the level of EL of the general population of secondary school is as low as that suggested by this sample. If these results are verified by such an assessment, curricular alternatives can be generated and tested in an attempt to ameliorate this apparent level of illiteracy. Determinations of the efficacy of EE programs should be routinely conducted. Longitudinal studies will be required to effectively assess EL. Researchers in EE should strive to answer the question, "How do we become environmentally literate?" The interdisciplinary nature of EE necessitates the pursuit of systematic research programs that allow for the development of an understanding of the complexities that content, attitude, and action present.

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A PRELIMINARY STUDY ON VISIT DENSITY AND CROWDING PERCEPTIONS AT FRIM'S CANOPY WALKWAY IN KEPONG, SELANGOR

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Abstract: Site surveys were conducted on users of a canopy walkway located in the grounds of the Forest Research Institute Malaysia (FRIM). Questionnaires were distributed to find out visitors' perceptions and preferences on visit density and crowding at the walkway. The results found that visitors expected to see a median of 13.5 people at the canopy walkway before their visits. Actual encounters had a median of 5.5 persons. Most of the visitors (a mode of 63.2%) perceived the number of visitors encountered to be normal. The majority of users (35.3%) indicated four people as the maximum number for comfortable visit. The study showed that encountered number of visitors was lesser (40.7%) than that was expected. Although visitors did not perceived the number of visitors on the walkway to be too many, visitors prefer to have a much smaller number around them for a comfortable visit. More than half of the users (51.5%) are willing to pay more than the current fees if less people were to share the canopy walkway experience at the same time.

Key Words: FRIM- canopy walkway - recreation - visit density - crowding

Abstrak: *Borang soal selidik telah diedarkan kepada pengguna titian kanopi Institut Penyelidikan Perhutanan Malaysia (FRIM) untuk mengetahui persepsi terhadap tahap kepadatan dan kesesakan di titian tersebut. Nilai median menunjukkan pengunjung menjangka akan melihat 13.5 orang pengguna sebelum lawatan, tetapi telah mendapati 5.5 orang sebagai bilangan sebenar yang telah ditemui. Ragam pengunjung (mod = 63.2%) menyatakan bahawa bilangan pengunjung yang mereka temui di titian kanopi adalah normal. Sebahagian besar pengunjung (35.3%) menyatakan empat orang sebagai bilangan maksima untuk keselesaan lawatan. Secara am, kajian ini mendapati bilangan sebenar pengunjung adalah kurang (40.7%) daripada jangkaan sebelum lawatan. Walaupun pengunjung tidak menganggap bilangan pengunjung ke titian kanopi sebagai terlalu ramai, mereka lebih suka bilangan yang lebih kecil untuk keselesaan lawatan. Lebih separuh daripada jumlah pengunjung (51.5%) sanggup membayar lebih daripada harga semasa, sekiranya bilangan pengunjung yang berkongsi pengalaman di titian kanopi dipastikan dalam jumlah yang kecil.*

INTRODUCTION

The grounds of the Forest Research Institute of Malaysia (FRIM) are accessible to the public for nature education and for other recreational purposes. Located less than 20 km north of the capital city, Kuala Lumpur, FRIM is a forested area popular among residents and tourists in the vicinities of Kuala Lumpur. Some of the popular activities in FRIM include jogging, trekking and swimming in the river. One of the most popular nature attractions in FRIM is the canopy walkway system. Minimal fees of RM5.00 for adults and RM 3.00 for students are charged for the use of the walkway.

In Malaysia, canopy walkways accessible to the public are found in Poring, Sabah; Taman Negara, Pahang; Ayer Keroh, Melaka; Commonwealth Park and FRIM, Selangor. All of these canopy walkways are the suspension cable type. The walkway system and the platforms are vantage points for which one experiences a panoramic view of the forests.

The canopy walkway in FRIM was completed in 1992 and officially opened to the public in 1993. The walkway is also utilized by scientists for conducting research on the forest canopy. Constructed 20-30 meters above ground with initial length of 200 meters, the canopy walkway was originally supported by 5 trees, one *Pterocymbium javanicum* (Melembu) tree, two *Intsia palembanica* (Merbau) trees, and two *Chukrasia tabularis* (Surian batu) trees. Four trees were used for anchoring, namely, *Chukrasia tabularis* (Surian batu, two trees), *Artocarpus scorthechinii* (Terap), and *Shorea*

pauciflora (Meranti nemesu) (Hottges, 1995).

A thunderstorm in 1998 resulted in destruction of one supporting *Chukrasia tabularis* tree and 50 meters of the canopy was removed. Nevertheless, being about 300 meters above sea level, the canopy walkway still gives commanding view of the surrounding forests and the skyscrapers of Kuala Lumpur.

Research on visitors to canopy walkways in Malaysia, was conducted in Taman Negara by Suryani (1999) on willingness to pay and Mazura (1999) on participation duration. Irene (1999) conducted a study on participation analysis on the canopy walkway visitors in Poring, Sabah. In FRIM, a preliminary study on the canopy walkway users found that the most quoted reason for visiting the canopy walkway was to experience the thrill of walking on the suspension bridge. Other reasons were to see vegetation at high level of the rainforest and to enjoy the scenery of the city at a distance (Syamsul *et al.* 2001). As many as 11,000 visitors were received at the walkway annually where visits are especially heavy during weekends and mid-term school holidays.

Density is defined as the number of people per unit space while recreational crowding is the term used for the subjective evaluation of density (Stankey *et al.* 1976). The "satisfaction model" by Heberlein and Shelby (1977) assume inverse relationship between use density and satisfaction where increased density causes decreased satisfaction.

However, relationships between density and satisfaction have not always found to be strong, because according to normative definition of crowding, density is only interpreted negatively as crowding until it is perceived to interfere or disrupt the visitors' objectives or values (Manning, 1986). Factors that could affect crowding norms include personal characteristics of visitors', characteristics of others encountered and situational variables (Manning, 1986). Results of crowding studies can be applied in management prescriptions, for example, crowding standards were used by Tarrant and English (1996) to develop a crowding based model of social carrying capacity for whitewater boating use.

This study forms a part of a preliminary survey on FRIM's canopy walkway, conducted to understand user characteristics and preferences on this visitor attraction. This paper describes visitors' perceptions including awareness and preferences towards visit density and crowding.

MATERIALS AND METHODS

Sixty-eight visitors were interviewed at the canopy walkway in FRIM, Kepong, Selangor from May to July 2001. Questionnaires were given at random, in method classified by Ahmad Mahdzan (1991) as the systematic random sampling where every 4th visitors were approached as they exited the canopy walkway.

Several types of questions were asked which include multiple choice for demographic factors, open ended questions to know crowd expected, crowd encountered and maximum number of visitors for comfortable visit. A dichotomous choice was given to assess visitors' willingness to pay if visitors' number is limited. Likert Scale choices of 1 to 5 were applied to evaluate visitors' perception towards the number of other users around them.

RESULTS

Expected and Perceived Crowd

Visitors were asked how many people they expected to encounter before their visit to the canopy walkway. The highest percentage of visitors (13.2%) quoted four visitors (Table 1) and a median was obtained at 13.5 people (Table 2). A wide range of 0-3000 was found, contributing to a high mean of 132.6 (Table 2). Visitors were also asked on how many visitors they thought were encountered during the canopy walkway visit. The range of response was 0 to 150, giving a mean of 16.6 persons and a median of 5.5 persons (Table 2). The most quoted answer with 32.4% of respondents was four (Table 1).

Perception on visitor's number seen

Perceptions towards the number of visitors encountered, showed that a majority of visitors (63.2%) considered that the crowd is normal. Figure 1 describes the distribution of respondents according to perceptions ranked in categories. The median and mode were obtained at 3 persons (Table 2). The mean of 2.6 reflects that the response was between "little" and "normal".

Maximum number for comfortable visit

Visitors were asked to suggest the maximum number of people encountered before they feel uncomfortable at the walkway. The range was 0-30 with a mean of 6.2. The most quoted answer (35.3% of respondents) was four (Table 1) followed by five (17.6%). The median was also found at four persons, similar to the mode (Table 2).

Table 1. Frequency percentage of visitors response on visitor density at FRIM's canopy walkway

Expected Visitors (N = 68)		Encountered Visitors (N = 68)		Maximum Number for Comfortable Visit (N = 68)	
No. of Visitors	**(%)**	**No. of Visitors**	**(%)**	**No. of Visitors**	**(%)**
0	1.5	'0	2.9	(0)*	2.9
2	1.5	1	2.9	1	2.9
3	4.4	3	5.9	2	4.4
4	13.2	4	32.4	3	7.4
5	8.8	5	5.9	4	35.3
6	4.4	6	5.9	5	17.6
7	1.5	8	1.5	6	4.4
10	11.8	9	1.5	7	4.4
12	2.9	10	5.9	8	4.4
15	4.4	11	1.5	10	8.8
20	7.4	12	1.5	(15)**	2.9
22	1.5	14	1.5	(30)**	4.4
30	5.9	15	2.9		
40	1.5	16	2.9		
45	1.5	18	1.5		
50	2.9	20	4.4		
60	1.5	30	1.5		
80	1.5	(40)*	5.9		
100	10.3	(45)*	1.5		
(300)**	1.5	(50)*	4.4		
(400)**	4.4	(56)**	1.5		
(1000)**	4.4	(60)**	1.5		
(3000)**	1.5	(100)**	1.5		
		(150)**	1.5		
Total	100	Total	100	Total	100

Note: Outliers (*) and extremes (**) are included to illustrate actual answers although the means were much affected by these numbers (Table 2). For discussion and conclusion purposes, the medians are used to indicate central tendencies for these variables.

Table 2. Visitors' response on visit density at FRIM's canopy walkway

	Visitors expected (N = 68)	**Actual visitors seen** (N = 68)	**What do you think of the number of visitors using the w/way *** (N = 68)	**What is the maximum number** (N = 68)
Mean	132.6	16.6	2.6	6.2
Median	13.5	5.5	3.0	4.0
Mode	4	4	3	4

Note: * Based on ordinal data where "too little" = 1, "little" = 2, "normal " = 3, "many" = 4 and "too many" = 5.

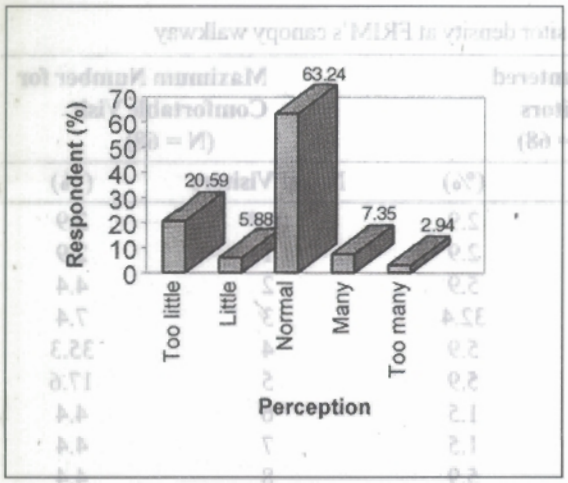

Figure 1. Perception on visitor's crowd seen

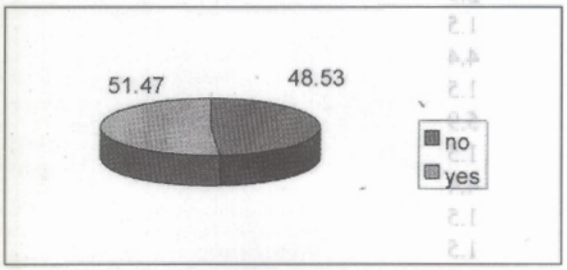

Figure 2. Willingness to pay more for solitude

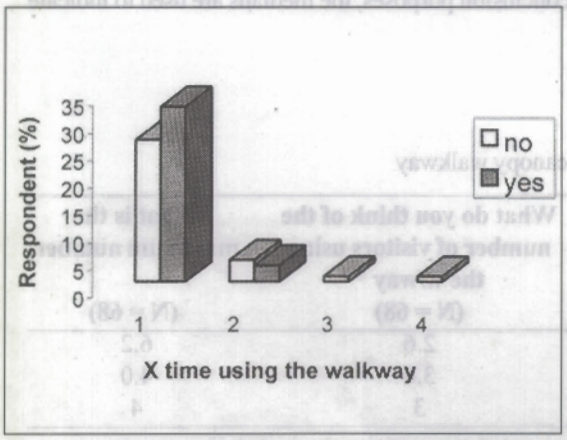

Figure 3. Willingness to pay for solitude by number of previous visit

Willing to pay more for solitude

On question of willingness to pay more if limited number of visitors is ensured, 51.5% (Figure 2) answered with "yes" while 48.5% answered "no" (Figure 2).

Willingness to Pay by Number of Visit Experience

Comparing first time visitors and repeated visitors, the study found that the visitors who are first timers (86.6% of visitors fall into this category), have the highest percentage of people (47.8%) who are willing to pay extra for solitude (Figure 3). Second time visitors are not as willing to pay more (6.0%) for the entrance fee as those who visit the canopy walkway for the first time. In addition, none of the visitors who have more than one previous experience was willing to pay more for solitude.

DISCUSSION

From the results on visit density it was found that differences are found especially on the ranges of the different questions posed. The wide actual range of answers for expected density (0 to 3000) could be explained by the fact that 86.6% of respondents were visitors who came for the first time, hence resulting in the variety of expectations including the extreme values found. The findings from this section can contribute towards framing of categories for expected visitors in future studies. The median value indicated that 13.5 visitors were expected to be seen at the canopy walkway

The range of actual encounter was much smaller at 0 to150 people, but considering that the canopy walkway never receive a group of more than 50 visitors at any one time during the study period, indicated that visitors report were not always accurate. The ambiguity of the question could also contribute to the inaccuracy because respondents were not clear on whether the question only meant the walkway or along the whole trip including before the entrance hut. For future studies, questions such as these have to be made clear. The median indicated that 5 people were seen, which is much less (40.7%) than the expected density. The discrepancies between expected and encountered visitors perhaps contribute to the fact that visitors found the number of visitors to be "little" to "normal" (a mean of 2.6) indicating that crowding effect was not felt. Manning (1986) explained this by suggesting that personal characteristics including visitor expectation can affect perceptions of crowding.

The question of the maximum number of people preferred to be encountered on the canopy walkway for comfortable visit, yielded answers in a small range of 0 – 30. The median and mode of 4.00 found as the results, indicated that visitors actually preferred a smaller number of people than is currently allowed at the canopy walkway. Technically, the walkway can safely supports four adults or eight school children on each platform at any one time, totalling to a maximum of 20 adults or 40 school children for the three platforms.

A question on willingness to pay showed that more than half (51.5%) of the total respondents are willing to pay more if the number of visitors is limited. On the other hand, it was shown that visitors with previous experience is not as willing to pay more for less number of people on the walkway. It is perhaps due to the fact that a visitor without previous experience, appreciate the views more and the presence of many visitors reduced the opportunity to take their own time. New visitors may also feel uncomfortable when the walkway swayed from the weight of other users, while a visitor with previous experience would be used to the effect.

CONCLUSION

The study found that respondents expected a much higher number of visitors than they encountered during the visit on the walkway. Visitors preferred to have a small number of visitors (four) at the canopy walkway although they perceived the existing crowd to be normal where not too few, neither too many users was perceived to be encountered. The study also found that many visitors (51.42%) were willing to pay extra if limited numbers of visitors are ensured, indicating the importance placed on small numbers of visitors on the walkway.

One aspect of the study should be improved, which is on the construction of questions on perceived crowding, to ensure that visitors really understand what was meant. The study can also benefit from more points for the Likert scale questions so that relationships between variable can be better analysed. However, the findings and weaknesses of this study could be learned from in future studies related to the sociological carrying capacity of the walkway, which perhaps be taken up for consideration by the management.

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THE IMPACT OF LOGGING ON LARGE MAMMALS IN SUNGAI LALANG FOREST RESERVE

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Abstract:- A study on the impact of logging on tapir (*Tapirus indicus*), wild pig (*Sus scrofa*), barking deer (*Muntiacus muntjac*) and sambar deer (*Cervus unicolor*) was carried out in Sungai Lalang Forest Reserve, Selangor. The results suggest that there were no major differences in the diversity of large mammal fauna between logged and unlogged. Suggestion on mitigation measures is also discussed.

Key Words:- logging-Sungai Lalang-*Cervus unicolor-Tapirus indicus-Sus scrofa-Muntiacus muntjac*

Abstrak:- *Kajian kesan pembalakan ke atas tapir (Tapirus indicus), wild pig (Sus scrofa), barking deer (Muntiacus muntjac) dan sambar deer (Cervus unicolor) telah dijalankan di Hutan Simpan Sungai Lalang, Selangor. Hasil kajian menunjukkan tiada perbezaan kepelbagaian mamalia besar antara hutan primer dan hutan yang telah dibalak. Beberapa cadangan untuk pemuliharaan dibentangkan.*

INTRODUCTION

Studies of the impact of commercial logging on wildlife have been conducted at several sites in Latin American, Africa, and Asia. Most entail comparisons between unlogged and logged forests in which mature trees of commercial timber species have been cut and hauled out by heavy machinery (Anderson & Katz, 1993; Basuta & Kasenene, 1987; Johns, 1985; 1987; 1992; 1995; Karanth, 1987; Williams & Petrides, 1980). In Malaysia, most studies have examined the effects of logging on primates and birds, (Dahaban, 1996; Hussein , 1994; Johns, 1983; Johns & Skorupa, 1986; Yong 1975). Large ungulates such as tapir and sambar deer have been studied only in general (Khan, 1992; Kemper, 1988; Kitchener, 1961; Medway, 1974; 1983; Payne, 1992; Williams, 1979) and the importance of their role as dispersers and grazers stimulating plant diversity in unlogged and logged forest has not been studied in detail. Detailed studies that examine the impacts of logging on large terrestrial mammals (tapir, wild pig, muntjac and sambar) have not been conducted in tropical rain forest. Such information is needed to refine the accuracy of predictions concerning their survival, persistence and resilience in logged forest. Knowledge gained from such studies will be very important in the development of effective management plans for large mammals in general and tapir, wild pig, sambar and barking deer in particular.

In this study the overall objective was to assess the presence/absence of large mammals in general and on tapir, wild pig, sambar, and barking deer in particularly in primary and logged forests. The specific aims of this study are:- (1) To determine the presence of tapir, wild pig, barking and sambar deer in logged and unlogged forest, (2)To examine their relative occurrence using indirect methods of detection in forests that had never been logged and that had been logged 9 and 4 years ago and (3) To suggest some measures pertaining to their management in logged forest.

STUDY AREA.

This study was conducted in Sungai Lalang Forest Reserve (17,591 ha) in the Langat River Basin (LRB). The forest reserve contains one virgin jungle reserve (VJR sub-compartment 24). The VJR is a truncated parallelogram, sloping roughly northeast from a peak at the southern tip to Sungai Lanjut running southeast to northwest on the northern boundary. The Forest Reserve (FR) makes up part of the water catchment area for Sungai Lanjut which flows into the Sungai Semenyih reservoir (Sungai Semenyih is a tributary of Sungai

Langat) (Laidlaw, 1994). The choice of the site was based on the availability of logged and unlogged forest and their accessibility, the area was a site of research for the forestry and wildlife students from Universiti Kebangsaan Malaysia (UKM) and Universiti Putra Malaysia (UPM) and this research formed part of an integrated program of research into the impacts of logging on large mammals' in tropical rain forests.

MATERIALS AND METHODS

Three sites were chosen within the Sungai Lalang Forest Reserve (Figure 1). Two sites were logged nine and four years previously, and one has never been logged. The two previously logged compartments were in C33 (logged in 1989 with area of 387 ha) and C18 (logged between 1993-95 of 237 ha). The unlogged portion of compartment 24 with a total area of 82 ha was chosen as the unlogged forest study site. The presence of tapir, wild pig, barking and sambar deer were assessed in all these compartments.

Surveys were normally conducted along nine freshly cut transects three in each compartment. All transects in logged forests (C18 and C33) were of 1.5 km long, while those of unlogged forest were of 1.2 km long, due to constraints imposed by the small size and the undulating topography (terrain) which characterized this compartment. These transacts were approximately of the same length so that sampling effort at each site was the same. Transects ran roughly through the centre of each study site and were made as straight as was possible. Each transect was measured using a metre tape and marked with a numbered red ribbon attached to trees at the intervals of 0.02 km. Existing logging roads, compartment boundaries and other forest trails were not used for surveys.

The study sites were visited on several occasions during which time three days were spent in each compartment. On each day one transects was surveyed. Thus the total number of observations in each compartment represented the result from period of surveying. Survey walks began as soon as weather conditions permitted, frequently it was necessary to wait for mist to clear and was light enough to be able to detect animal tracks. Surveys began between 8:30 and 9:00 hours and all were completed in about four hours. Transects were worked in one direction and a maximum of 10 minutes was spent determining the identity of a sign or animal when encountered.

Most records of species occurrences were based on indirect observation of tracks, faeces, and vocalization. Direct sighting was recorded only when possible. Most species under investigation are cryptic or are very wary of the presence of observer. At each encounter with sign or animal the time, species, exact location on the transect direction; ground condition, topography and weather were recorded in a data sheet.

The presence of tapir was identified by the distinctive three hoofed tracks in the ground (mud or wet ground), near water stream or in association with chewed vegetation (e.g. banana tree) and faeces. The occurrence of sambar, barking deer and wild pig was confirmed by their tracks. Wild pig tracks were distinguishable from deer tracks by the rounded tracks with more pointed dewclaws, which extend farther out to the side. Rooting and wallows were other evidence of the occurrence of wild pigs.

During the survey period chance encounters with direct observation of primates and their vocalization were also recorded. However, because of difficulties involved in identified cat species on the basis of tracks, residents (Orang Asli) around the site (C33) were asked to provide information concerning cat species found in the area. They stated that for the last few years neither tiger (*Pathera tigris)* nor leopard (*Pathera pardus*) was seen, however, the clouded leopard (Neofelis *nebulosa*) is present. Thus, cat tracks were assumed to be that of the clouded leopard (*Neofelis nebulosa)*.

Limitations

Indirect methods, which are dependent on some evidence on the presence of deer and other ungulates within an area (e.g. tracks, faeces and browsed twigs), have been used to index their occurrence, abundance, and habitat use in North America and African savannah (Bull, 1981; Connolly, 1981; Overton, 1969). Under current study the method has shown some limitations, among these was the difficulties in reading tracks in forest litter or under growth and the difficulties in distinguishing the different individual tracks for species under investigation.

These limitations were minimized in two ways. Firstly data were collected from cleared ground or places without heavy vegetation cover along transects. Secondly the number of individuals per species were not taken into consideration, thus the abundance of tracks does not necessarily mean there are many different individuals especially with pigs.

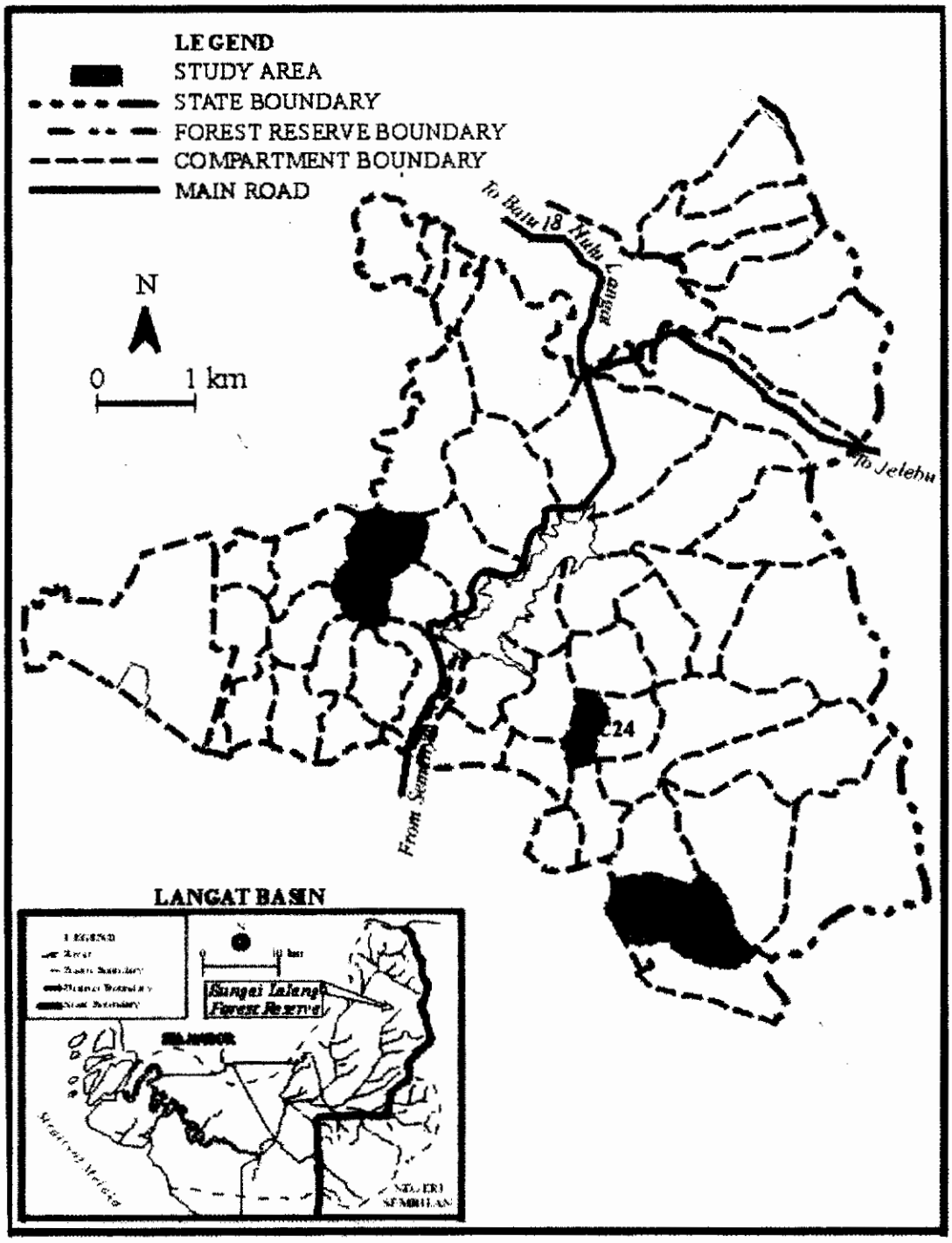

Figure 1. Location of study sites in Sungai Lalang Forest Reverse.

Data Analysis

Sample sizes were insufficient for statistical tests of significant differences between the study sites. Comparison were made based on the percentage frequencies for the animal's signs found within compartments and between compartments using the following equations (Lomnicki, 1988):

Within each compartment.

% Frequency = Number of signs for particular species in compartment X100
Sum of all signs encountered in compartment

Between compartments

% Frequency = Number of signs for particular species in compartment X100
Sum of signs encountered in three compartments.

RESULTS AND DISCUSSION

Results are presented and discussed in this section. The discussion is laid out in two parts. The first part deals with the comparison of animal's signs within each compartment (C24; C18 and C33), the second part mainly discusses the comparison of animals and their signs between the three study compartments.

1. Animal Signs within Compartments

a. Compartment 24 (Unlogged Forest)

Results showing the presence of large terrestrial mammals (tapir, wild pig, muntjac and sambar), from such indicators as vocalization, footprints, wallow and rooting for sub-compartment 24 (VJR) are shown in Table 1.

Within compartment 24, signs demonstrating the presence of *Tapirus indicus* were less evident compared to wild pig and barking deer. Apart from the footprints, which were observed twice, no other evidence of its presence was found (Table. 2). This observation suggests that *Tapirus indicus* was either sparsely populated or their activity was severely restricted by the steeply sloping topography which characterized this compartment. The wild pig, *Sus scrofa* was the animal species whose signs in various manifestations were readily observed (Table 1). The most conspicuous signs attributable to this animal in the evaluated compartment were rooting and wallowing. These signs are strong reflections of the animal's behaviour, particularly in tropical climatic conditions. *Sus scrofa* engage in rooting during feeding while it carries out wallowing to bring down its body temperature. The strong presence (frequency 50%- Table 2.) of signs registered by *S. scrofa* in compartment 24 may therefore be attributed to its successful adaptation to most habitats type. This result is in agreement with the finding of Lim (1999) who reported that wild pigs (*S. scrofa)* were the most common species in Hulu Langat Forest Reserve.

The barking deer (*Muntiacus muntijac*) and sambar deer (*Cervus unicolor*) presence were evident from their footprints found in the vicinity. The footprints of the barking deer were in relative abundance (frequency 21.43 % - Table 2) as compared to the sambar deer whose footprints was encountered only once.

The presence of the primate species, *Hylobates lar* and *Presbytis femoralis* were noted from physical observations as well as vocalization. While *Hylobates lar* was both directly (twice physically seen) and indirectly (heard on 4 occasions) (Table. 1) identified, the presence of *Presbytis femoralis* was only heard but never seen. The frequency of detection of *lar* was higher than *femoralis* (Table. 2).

b. Compartment 18

Within compartment 18 (last logged in 1995), the presence of *Tapirus indicus* was obvious in this compartment. Tracks of the animal were seen at different locations within the compartment (Table 3). The numerous footprints of *Tapirus indicus* observed suggested that the animal exhibited some degree of activity here. Other evidence such as chewed vegetation and fecal droppings were however not encountered. That, the faeces of *Tapirus indicus* was not observed in this compartment may be due to the fact that in tropical rain forest, fecal dropping is quickly degraded by microbes and dung beetles and do not persist, heavy tropical rain also wash away dropping quickly. Previous studies in Malaysia have shown that logging aggravates soil erosion and runoff processes (Nor, 1990) and evidence of the occurrence of soil degradation by soil erosion was readily visible in this compartment.

The presence of the wild pig, *Sus scrofa* was evident from several signs including wallowing, rooting, tracks and fecal dropping (Table 3). Judging from the intensities of these signs, the wild pig may be regarded as one of the most active species in this compartment and probably offer some insights on its abundance. Its footprints surpassed other signs, which identified the presence of the animal in this compartment, followed by wallowing. Rooting was the least obvious manifestation of the wild pig (Table 3). The relatively high number of

Table 1. Record of Animal Signs in Three Transects in Compartment 24(VJR).

S.N0.	Species	Transect A (Mater)						Transect B (Mater)							Transect C (Mater)				
		180	240	260	430	920	980	100	120	125	220	360	480	560	140	160	165	380	1000
1	*Topirus indicus*	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	T	-	-
2	*Sus scrofa*	-	R	T	R	-	T	-	T	R	T	W	R	R	-	T	T	R	R
3	*M. muntijac*	T	-	-	-	T	-	T	T	-	-	-	-	-	T	T	-	-	-
4	*Cervus unicolor*	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-
5	*Hylobates lar*	-	-	V	-	-	V	V	-	-	-	-	-	-	V	2O	-	O	-
6	*P. femoralis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	V	-

T= Track, R= Rooting, W= Wallow. V= Vocalization. O= Observed, 2O= Two individuals observed.

Table 2. Percentage Frequency of Total Animal and Sign records in compartment 24.

S. No.	Species	Frequency	Percentage
1	*Topirus indicus*	2	7.14
2	*Sus scrofa*	14	50
3	*M. muntijac*	6	21.43
4	*Cervus unicolor*	1	3.57
5	*Hylobates lar*	4	14.29
6	*P. femoralis*	1	3.57

Table 3. Records of Animal Signs in three transects in Compartments 18.

S. No.	Species	Transect A (Mater)					Transect B (Mater)				Transect C (Mater)			
		240	580	740	920	960	40	300	620	1800	360	760	980	1360
1	*Topirus indicus*	-	T	-	-	T	-	-	-	T	T	T	T	-
2	*Sus scrofa*	-	W	R	-	T	-	FW	T	-	T	W	-	T
3	*M. muntijac*	T	-	-	Tr	-	-	-	-	-	-	-	-	T
4	*Cervus unicolor*	-	-	-	-	-	T	-	-	-	-	-	-	-
5	*Hylobates lar*	-	V	-	-	2O	-	-	-	-	-	-	-	-
6	*P. femoralis*	-	-	-	-	-	-	-	3O	-	-	-	-	-

FW= Faces and Wallow, 3O= three individuals observed. . Tr= Trail.

Table 4. Percentage Frequency of Total Animal and Signs records in Compartment 18.

S. No.	Species	Frequency	Percentage
1	*Topirus indicus*	6	28.57
2	*Sus scrofa*	9	42.86
3	*M. muntijac*	4	19.05
4	*Cervus unicolor*	1	4.76
5	*Hylobates lar*	4	4.76

Table 5. Records of Animal Signs in Three Transects in Compartments 33.

S.N0.	Species	Transect A (Mater)						Transect B (Mater)							Transect C (Mater)			
		140	400	680	880	960	1380	160	540	640	780	890	1260	1360	330	680	1000	1080
1	*Tapirus indicus*	-	T	T	T	Tc	Tf	T	-	T	-	T	T		T	T	T	T
2	*Sus scrofa*	T	TR	-	T	T	-	T	R	TW	W	T	W	TR	T	R	-	T
3	*M. muntijac*	T	-	T	-	-	T	-	-	T	-	-	T	T	-	T	-	T
4	*Cervus unicolor*	-	T	-	-	-	-	-	T	-	T	-	-	-	-	-	T	-
5	*Hylobates lar*	-	-	-	-	-	-	-	-	-	2O	-	-	-	2O	V	-	-
6	*P. femoralis*	-	-	V	-	-	-	-	-	-	-	-	-	-	-	-	3O	-
7	*Cat spp.*	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-

Tc= Tracks and Chewed Vegetation, Tf= Tracks and faeces. TR = Tracks and Rooting. 3O= Three individuals observed.

Table 6. Percentage Frequency of Total Animal and Signs records in Compartment 18.

S. No.	Species	Frequency	Percentage
1	*Topirus indicus*	15	31.91
2	*Sus scrofa*	17	36.17
3	*M. muntijac*	4	17.02
4	*Cervus unicolor*	1	2.13
5	*Hylobates lar*	1	2.13
6	*Cat spp.*	1	2.13

Sus scrofa were encountered more (9) than the other large terrestrial mammals (Table. 4).

Deer, comprising the barking (*M. muntjac*) and sambar deer (*Cervus unicolor*) were among the animal species whose signs was observed in this compartment (Table 3). The presence of the barking deer was obvious from the footprints, which was encountered 4 times (Table 4), the presence of the sambar deer was recognized by its track, which was encountered once. Signs of deer were generally few probably due the few number of individuals in this compartment.

Primate species, consisting of the *Hylobates lar* and the *Presbytis femoralis* were visually seen in groups of two and three individuals respectively. The vocalization of the former was also heard during the course of the investigation (Table 3).

c. Compartment 33

Within compartment 33 (last logged in 1989), *Tapirus indicus* was one of the animal species whose signs were frequently (31.91%) observed (Table 6). Numerous signs left behind by the animal such as tracks, chewed vegetation and its faeces (Table 5) provided readily visible evidence of the presence of the animal in this

demonstrated by three signs namely wallowing. Its footprints were the indicating its presence in this com Signs of this species occurred mor %) than any other within the compa

The presence of the deer in thi evident from their footprints. Signs (*M. muntjac)* were more frequer sambar deer (*Cervus unicolor*) with % and 8.51 % for the former and th (Table 6).

Recognition of the presence of followed similar trends as in Com animals were however, found in-gro for the *Hylobates lar* and *Pres* respectively (Table 5). These sp Frequency of occurrence of 2.13 % species was the least within the con

A pugmark of a cat was record to this compartment, as pugmarks v the other compartments. This solitar that the species did not occur at a hi study area.

2. Animals and Their Signs between Compartments

The comparison between the large herbivores fauna of virgin forest and logged forest indicates that there was not much difference in the total number of large herbivore species occurring in the forest compartments (Figure 1). However, the logged forest Compartment (C33) had the highest frequencies of all animals' species encountered (except *H. lar*) compared to unlogged forest (sub-compartment 24).

The frequencies of detection (of all records Figure 1) of wild pigs in all compartments were the highest than all other species (Figure 1). This is indicative of the pig being the commonest in all habitats. Wild pigs are highly adaptable and can subsist even in highly degraded forest and forest fringes (Diong, 1973).

The high detection of tapir sings (15.62- 6.25%) (Figure 1) in logged (C33 and C18) compared to unlogged forest could probably be due to the readily availability of young, fast growing herbs or early successional stage vegetation preferred by tapir. Yong, (1975), Fragoso, (1991), and Mattson (1980) suggested that as a non-specialized folivores, tapirs select for disturbed habitat with a higher proportion of regrowth with high nutritional value. Medway (1974) also reported the observation that one particular Malayan tapir that browsed on herbs, shrubs, and saplings colonizing an area disturbed by humans.

Fragoso (1991) reported that selective logging for a few species trees, at harvest intensity typical of selective logging practiced in Peninsular Malaysian forests should benefit tapirs, because this activity mimics natural tree falls by creating gaps in the forest. These gaps, and clear soil areas, permit the growth of colonizing (fast growing, short-lived) plants species (Chivers, 1974). Johns (1986) also found that, the flush of colonizing plants and new foliage resulting from selective logging increases food availability for non-specialized folivores. In contrast, William and Petrides (1980) reported that three Malay tapirs were denizens of undisturbed pristine forest. The observed difference may be due to differences in area sampled and method of study. Different methods can yield different results even in the same study site (Karanth, 1987).

The difference in the detection of tapir in the two logged forest study sites (C33 and C18)(Figure 1) could be explained on the basis that C33 may contain resources unavailable in C18: greater protection from predators, or cover and shade from the sun, that is, the open canopy of the compartment 18 would increase the exposure of tapir to direct sunlight and heat.

As expected the frequencies of detection of sambar deer (*Cervus unicolor)* and barking deer *(M. muntjac*) in logged (C 33) forest were the highest (Figure 1). This indicated that these species might have a preference for logged forest with greater abundance regrowth. The low frequency shown by sambar deer in all study sites could be related to other factors such as human activity (e. g. hunting).

H. lar, was more frequently sighted on the unlogged forest (VJR). By comparison however, *P. melalopos* are detected at equal frequencies in logged and unlogged forests compartments (Figure 1). The gibbons are dependent on an intact canopy because of its behaviour and mode of locomotion. *P. melalopos* may not be as badly affected by logging as are gibbons.

CONCLUSION

To ascertain the impact of logging on large wildlife fauna such as tapir, wild pig, sambar and barking deer ideally one should study the mammalian fauna before the primary forest is logged, and continue the investigation during and after logging. Nevertheless, in this study it was assumed that the logged and unlogged forests are similar in wildlife composition prior to logging and the impacts of logging on wildlife was evaluated indirectly by comparing the species composition in the virgin forest reserves and two previously logged forests.

As discussed above, the results suggested that the old and recently logged forest do support populations of the large terrestrial mammals namely, *Tapirus indicus, C. unicolor, M. muntijac* and *S. scrofa*. In addition leaf monkeys and the lar gibbon were also present in compartments that were logged as recently as 1993. Gibbons are territorial and live in family groups consisting of adult male with up to three immature offspring. The groups observed in the logged forest compartments could have survived the logging by selectively using unlogged portion of their territory during logging and returning to the logged portions after completion of logging.

By altering the distribution of early successional plant species, selective logging may play an important role in the ecology of tapir, barking and sambar deer. If these species maintain exclusive home range, and do better when there is secondary growth, selective logging could improve the home range quality of individuals dwelling in less preferred area. Therefore, a low quality home range becomes a preferred area, enhancing the biological fitness of the resident animals. Thus, it can be

recommended that when managing forests for tapir, barking and sambar deer, the availability of early successional plant communities should be considered in the management strategy. If these are not available, selective tree removal can be used to increase the availability of food plants preferred by these species.

Since Department of Wildlife and National Parks and Department of Forestry are not well staffed to fully oversee logging concessions. It can be recommended that, conservation biologists with locally grounded expertise could work collaboratively with foresters, wildlife managers and concessionaires to develop site-specific management plans and monitor the logging and other environment impacts. In the process, forests managed for timber may become a more viable complement to protected areas in the effort to conserve large terrestrial mammals and the biodiversity within forests.

Finally, it must be emphasized that a species not recorded in this study does not necessarily mean its absence from that locality. The presence of primates and cats show that the logged areas were not totally devastated and that the area is slowly regenerating. Thus if left alone for a few years it would probably recover some of its diversity and complexity. However, this may be more difficult to the area in close to developed areas and are easily accessible to local populations. Consequently, steps must be taken to ensure that this area will be protected from human interference and further disturbances to ensure that Sungai Lalang Forest Reserve will last for the next generation.

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CHECKLIST OF FISH SPECIES OF SUNGAI SUAR STREAM SYSTEM IN SUNGKAI, PERAK

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Abstract:-The stream fish checklist of Sungai Suar stream system in Sungkai, Perak revealed the presence of 27 species from 12 families of freshwater fish. Each species is assigned a category, either 'locally rare', 'common/ locally rare' or 'common' based on the percentage of individuals caught for each species. Seventeen species are considered 'locally rare', 4 species 'common/locally rare' while another 6 are considered as 'common'. The most common and the most abundant fish species were *Rasbora sumatrana* and *Systomus binotatus.*

Key Words:-checklist- Sungkai-freshwater fish-endangered species -ichthyofauna

Abstrak*:-Senarai rujukan spesis ikan anak sungai di sistem sungai Suar di Sungkai, Perak menunjukkan kehadiran 27 spesis dari 12 famili ikan air tawar. Setiap spesis diletakkan di bawah kategori 'jarang setempat', 'biasa/ jarang setempat' ataupun 'biasa' berdasarkan peratusan individu ikan yang ditangkap bagi setiap spesis. Didapati 17 spesis diletakkan di bawah kategori 'jarang setempat', 4 spesis di bawah kategori 'biasa/jarang setempat', manakala 6 lagi spesis dikategorikan sebagai 'biasa'. Spesis ikan air tawar yang paling biasa dan paling banyak dalam sistem sungai ini adalah Rasbora sumatrana dan Systomus binotatus.*

INTRODUCTION

According to World Resources Institute (WRI, 2000), about 34 percent of world's fauna species, mostly freshwater are threatened with extinction. The IUCN Red List unfortunately revealed that there is a large number of fish species, including freshwater fish species that are facing extinction (IUCN 1996). Even in Malaysia alone, World Conservation Monitoring Centre (WCMC, 2000) listed at least eleven Malaysian freshwater fish species are classified as either Vulnerable or Endangered. This list includes one species; *Betta persephone* that is classified as Critically Endangered and two species; *Probarbus jullieni* and *Sclerophagus formosus* that are classified as Endangered. Both *P. jullieni* and *S. formosus* are also protected against international trading by CITES (WCMC, 2000)

One of the biggest problems concerning freshwater fish is the lack of informative material that can be used to aid conservation effort. Naiman *et al* (1995) lists three factors that limit conservation efforts and maintenance of biodiversity in freshwater ecosystem. The first factor is the lack of baseline information for many groups of organisms and ecological processes. This is further supported by Pethiyagoda (1994), which revealed that the state of taxonomic knowledge of freshwater fishes in the Asian region is generally so poor that many extinctions may never be known. The second factor is the lack of identification of keystone species or keystone processes that plays a larger role than other species or ecological processes in maintaining diversity. Finally the effect of human activities, either by a direct biotic manipulation, accidental exotic invasion, physical manipulation or chemical enrichment is still under studied.

In the Malaysian scenario, Ahyaudin *et al* (1988) stated that since the Peninsular Malaysia is the centre of dispersal for Arctogaea fauna, it has a high diversity of freshwater fishes. This fact is further strengthened by Mohammad Mohsin & Mohd Azmi (1992) stating that Malaysia was considered as the evolutionary centre for the genus *Rasbora, Puntius* and *Betta.* Fish species endemism is also one of the characters for Malaysian ichthyofauna. All these statements may be quite overwhelming, yet the irony of the Situation is the fact that ichthyofaunal studies in Malaysia so far have been very limited.

Fish assemblages in many areas, especially in remote, restricted and hard-to-reach areas are still left unstudied. Due to this inadequacy, conservation efforts have also been limited by the lack of baseline data and

information regarding fish composition. While a number of conservation efforts has been focused on *P. jullieni* and *S. formosus*, many other fish species in Malaysia may face the threat of extinction even before they are studied or discovered.

This study was done on 25th to 29th of October 2001. It aims to provide a checklist of stream fishes of Sungai Suar stream system, which originates within the Sungkai Wildlife Reserve and flows downstream through human residence to finally end in Sungai Sungkai. It is hoped that all the data and information obtained from this study may be of great use for future studies on ichthyofaunal composition in Peninsular Malaysia. Ultimately, this may help contribute more baseline data so that the conservation status of Malaysian freshwater fish species may be determined. This is pivotal in planning any conservation effort thus brings about a better prospect of freshwater fish conservation in this country.

MATERIALS AND METHODS

Study Sites

The tributaries of Sungai Suar are located within the Sungkai Wildlife Reserve in Perak. These unnamed tributaries eventually converge to form Sungai Suar, which in the end flows into Sungai Sungkai. Throughout its course, the Sungai Suar stream system runs through a number of habitat types, namely riffles, pools and runs. Within this study, 4 sites in which, within each site, 5 stations are sampled.

Site 1 is located at the most upstream part of the stream system, and is consisted of two first order streams. These streams are shallow, mostly with gravels as their bottom substrate, and located in a highly shaded area ranging from 60% to 90% shade. Two of the five stations in Site 1 are located near a salt lick area where traces of fresh tiger and deer footprints can be found.

Site 2 of the Sungai Suar stream system is located near the deer paddock within the *ex-situ* conservation area of Sungkai Wildlife Reserve, and also at one point passes through a recreational area comprising a picnicking ground. Some segments of the stream even flows through the deer paddock. Habitat and bottom gravel types varies from one station to another. Shade ranges from 10% to 90%, with the highest shaded area occur upstream, while the lowest one is located within the deer paddock. Site 2 is a second order stream.

Site 3 is also located near the deer paddock. Its stations are located in areas with shade percentage ranging from 0% to 60%. Stations 3 and 4 of this site also include a few rapids. This site is also a second order stream.

Site 4, or Sungai Suar is a third order stream, which is located just outside the Sungkai Wildlife Reserve. The course of this stream pass through a rubber plantation area interspersed with forest. The stations are highly shaded with shade percentage ranges from 70% to 90%. Site 4 is also a larger and deeper stream as compared to site 1,2 and 3.

Sampling Methods

After determining the sampling sites and stations, the lower and upper ends of the area sampled were blocked with 1cm mesh stop nets. Next fish sampling was done by electrofishing the stream with the use of Electrofisher Model 15-D using Honda EX 350 Engine. Higher voltage was used for clear streams while lower voltage for the more turbid ones. Casting nets is very impractical due to the shallow nature of the stream while using scoop nets otherwise would be biased because only the visible fish would be captured. Due to the impracticality of on-site identification and measurements, all fish were taken back to the laboratory to carry out the task. Identification was done based on Inger and Chin (1962), Mills (1933), Mohammad Mohsin and Mohd Azmi (1992) and Millidge (1998).

RESULTS

The results of this study showed that twelve families of Ichthyofauna are represented in this stream system. The most represented family is Cyprinidae with ten species followed by Bagridae (3 species), Channidae (2 species), Claridae (2 species), and Cobiitidae (2 species). Families Homalopteridae, Akysidae, Siluridae, Hemiramphidae, Anabantidae, Synbranchidae and Mastacembelidae are all represented by one species.

In this segment, after the description of each species, the status of the species is stated. It must be noted that the status 'common', 'common/locally rare' and 'locally rare' is determined using the guideline used by Wong (1985) for birds. This is due to the lack of specific conservation guideline for fish species. According to Wong (1985), the value of 2 % (2% from the total individuals caught) could be used as a threshold value to determine rarity in a population. Therefore the status 'common' refers to species which constitutes much higher than 2% of the total fish catch,

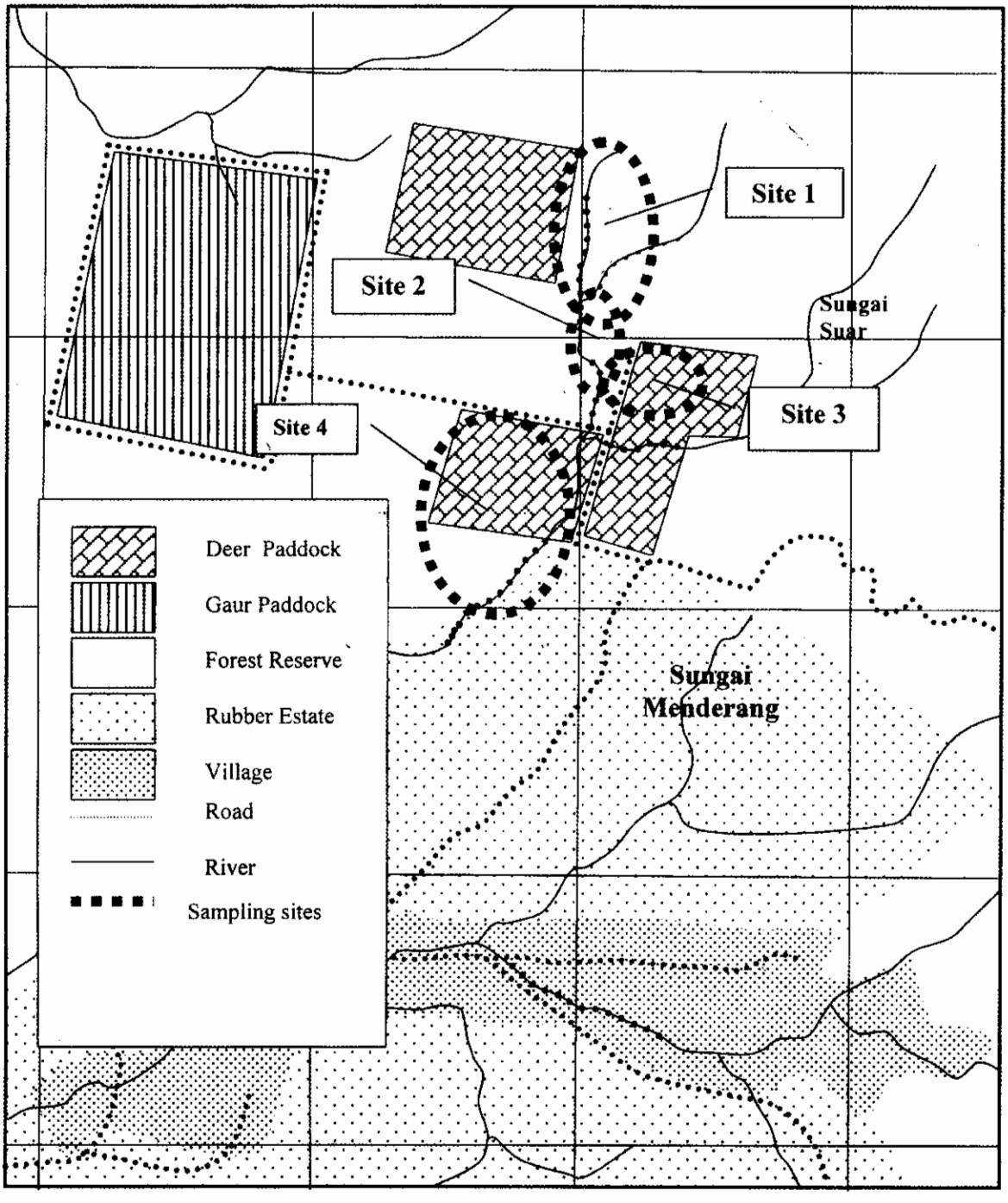

Figure 1. A map showing Sungkai Wildlife Reserve and the four sites studied in Sungai Suar

while 'locally rare' denotes species which the number of individuals catch accounts less than 2% of the total population. The status 'locally rare' is used rather than 'rare' to emphasize its status in that stream system alone without having to generalize into the Malaysian fish population. For example, *Clarias batrachus* may be a common fish in Peninsular Malaysia, yet in the Sungai Suar stream system, this species is rare, hence the term 'locally rare'.

Rasbora sumatrana Bleeker.
Common name: Seluang, Bada
R. sumatrana is the most abundant fish species found in Sungai Suar stream system. A total of 249 individuals were caught, comprising of 26.6% of the total fish caught. This fish is found in all stations therefore confirming its commonness in this area. This also confirms its status of common species in Malaysia by Mohammad Mohsin and Mohd Azmi (1992)
Status: common

Rasbora cephalotaenia Bleeker
Common name: Seluang, Bada
This beautiful fish species with a row of black spots and a row of red spots on its lateral side may make an excellent ornamental fish. Even though the description of our specimen is slightly different from the description by Mohammad Mohsin and Mohd Azmi (1992), this fish is still classified as *R. cephalotaenia* until further taxonomic identification is done. This fish is only found in Site 1 (3 individuals) and Site 3 (1 individual). All individuals were captured in the riffles area of the stream with either sand or gravels as substrate.
Status: locally rare

Hampala macrolepidota van Hasselt
Common name: Sebarau
Only 3 specimens of this species were obtained in this study. Two individuals were caught in Site 2 and another one in Site 3. All individuals were captured in the riffles segment of the stream system. With sand and gravel bottom substrate, suggesting the fish's preference for fast flowing waters. This fish is also a popular game fish and food item in Peninsular Malaysia
Status: locally rare

Systomus lateristriga Valenciennes
Common name: Baguh, Spanner Barb
The former genus name of *Puntius*, as used by Mohd Sham (2001), and Mohammad Mohsin and Mohd Azmi (1992) has been replaced by Amiruddin et al (2001). The attractive features of this fish have led Ahyaudin (1992) to suggest it as a potential aquarium species. Furthermore, Mills (1993) classified this fish as 'peaceful fish' also contributes to the prospect of this fish as an ornamental species. In the Sungai Suar stream system, 98 individuals (10.5%) were caught. This species was found in all stations
Status: common

Systomus binotatus Cuvier & Valenciennes
Common name: Tebal sisik, Putih
This is another abundant and common fish species found in the Sungai Suar stream system, comprising of 19.4 % (182 individuals) of the total individuals caught. According to Mohammad Mohsin and Mohd Azmi (1992), this species is morphologically variable, however within the Sungai Suar stream system, only one variant was observed.
Status: common

Accrosocheilus hexagonolopis McClelland
Common name: Tengas, Kejor
This species is only found at Site 3 of Sungai Suar stream system where the habitat type is classified as riffles with a mixture of sand and gravel as its bottom substrate. Mohammad Mohsin and Mohd Azmi (1992) stated that this species could be found in hilly streams where water flow is fast.
Status: locally rare

Osteochillus vittatus Cuvier & Valenciennes
Common name: Rong
This species is found in all stations except in Site 1, which consists of first order streams. This suggests the species' preference for large streams. Only 25 individuals are caught, representing only 2.7 % of the total individuals caught.
Status: common / locally rare

Labiobarbus lineatus Sauvage
Common name: Kawan
Although Ahyaudin *et al* (1988) found out that *L. lineatus* was one of the three most abundant riverine Cyprinids in Sungai Perak; the same was not true for the Sungai Suar stream system. With only 43 individuals caught, it comprises only 4.6% of total catch. However, this species can be found in all stations suggesting its widespread distribution.
Status: Common

Tylognathus caudimaculatus Fowler
Common name: Barb ekor berbintik
Throughout this study, only 3 individuals (0.3%) of *T. caudimaculatus* are caught. This species is only found in second order streams (Site 2 and 3) and third order stream (Site 4). Interestingly enough, this fish can be found in the riffle areas where the shade percentage is about 10% or less, which is located within the deer paddock. This suggests this species prefers open area with high water flow. Its subinferior mouth may indicate its bottom feeding nature.
Status: locally rare

Epalzeorynchus siamensis Smith
Common name: Selimang Siam, Siamese Flying Fox
This is another locally rare species only four individuals are caught. These individuals are found in the run area (Site 2 and 4) where it is a fast but non-turbulent segment of the stream with multi directional water flow. The bottom substrate of these sites is of sandy nature. This is in line with Mohammad Mohsin and Mohd Azmi's (1992) description of this species that prefers fast-flowing water with sandy/gravel bottom. This is another species with subinferior mouth.
Status: locally rare

Homaloptera orthogoniata Vaillant
Common name: Susuh batu, Putting beliung
All 15 individuals of *H. orthogoniata* are caught in Site 3 in an area where rapids present. According to Mohammad Mohsin and Mohd Azmi (1992), this species is uncommon in areas with gravel or boulder substrate. However, our study showed otherwise where *H. orthogoniata* is found near rapid areas where the substrate is composed of gravels of small boulders. On a common ground between these authors and the result of our study, it is found that *H. orthogoniata* prefers water with high velocity. This is compatible with the statement by Moyle and Chech (1982) which group fishes from the Homalopteridae family as specialized fish adapted to living in fast flowing waters at the riffles area by having developed suckers to anchor on substrate to prevent from being carried away and also having adapted to feeding algae living on rocks and boulders.
Status: locally rare.

Acantopsis choirorhynchus Bleeker
Common name: Pasir, Tali, Horsefaced Loach
This species is caught in all stations sampled indicating its commonness. 104 individuals (11.1%) are caught. This fish is especially abundant in an area with sandy bottom. This is due to its nature to burrow in the sand to avoid predators. It has elongated body with long and tapering head. This species is also one of the aquarium species featured by Mills (1993).
Status: Common

Botia hymenophysa Bleeker
Common name: Lali
This beautiful fish also has a potential as an aquarium fish. A total of 3 individuals are caught in Site 2 (two individuals) and Site 3 (one individual), both consists of second order streams with gravel or boulder substrate. Both sites also receive exogenous nutrient input; Site 2 from the weekend picnic area and Site 3 from the deer paddock.
Status: locally rare

Accrochordichnichthys inchnosoma Bleeker
Common name: Depu
Even though most of the description written by Mohammad Mohsin and Mohd Azmi (1992) suited our specimens, we cannot explain the yellow vertical stripe present at the caudal fin. However, until further detailed identification is done, our 2 specimens will be named *A. inchnosoma* temporarily.
Status: locally rare

Leiocassis leiacanthus Weber & de Beaufort
Common name: -
This species belongs to the Bagridae family, along with is the catfish group. Only two individuals are caught at Site 3 where boulders covered with moss and dead logs can be spotted. The bottom substrate is a mixture of sand and gravel.
Status: locally rare

Mystus nemurus Cuvier & Valenciennes
Common name: Baung, Catfish
This species is a local favourite as food item and is often caught using cast nets. Despite its popularity among villagers, we only manage to catch 13 individuals comprising 1.4 % of total fish catch
Status: locally rare

Mystus baramensis Regan
Common name: Baung, Catfish
The main difference between *M. baramensis* and *M. nemurus* is in its lighter dorsal coloration. Only one individual is caught, comprising only 0.1% of the total

catch. The presence of this individual in a first order stream puzzles us. No explanation can be given at this point. However, Mohammad Mohsin and Mohd Azmi (1992) stated that unlike *M. nemurus*, this species prefers clear water and stream with sand or gravel as bottom substrate.
Status: locally rare.

Clarias batrachus Linnaeus
Common name: Keli
This is one of the more common species in Peninsular Malaysia, and is more common in larger streams and rivers. However within the Sungai Suar stream system, this species can be considered locally rare because only 1 individual has been caught which is at Site 1, with lots of decomposing leaves. The area is also shaded by bertam palms. This facultative air breather is also prized as food fish among Malaysian population.
Status: locally rare.

Prophagorus nieuhofii Cuvier & Valenciennes
Common name: Keli Limbat
This species is found in all stations sampled albeit in small numbers. Only 20 individuals are caught, comprising 2.1% of total fish catch. Mohammad Mohsin and Mohd Azmi (1992) regard this as threatened species.
Status: common / locally rare

Silurichthys hasseltii Bleeker
Common name: Tapah Bemban, Selayar
The smaller relative of the popular Tapah (*Ompok* and *Wallago*), this fish is caught in all stations. Judging from its attractive and unique feature, this species has the potential to be a popular aquarium fish.
Status: locally rare

Hemiramphodon pogognathus Bleeker
Common name: Sember, Julung, Halfbeak
H. pogognathus is also one of the common fish species found in Sungai Suar stream system. This species occupy near the surface of the stream, feeding fallen insects. One of the distinguishing structured featured in this fish is its extended lower jaw.
Status: common

Channa striatus Bloch
Common name: Haruan, Snakehead, Toman Paya
This economically important fish species is also one of the most common predatory ichthyofauna in Malaysia. In the Sungai Suar stream system, *C. striatus* is present in all stations, confirming its status as one of the most important top predator in the system. The largest individual caught in this study measured 26.8 cm in standard length with a body weight of 139.6 gram. In larger rivers or in a lentic freshwater ecosystem, this species could grow larger. In every station, an average of 5 to 6 individuals are caught (totaling 22 individuals) suggesting that top predators do not present in high abundance.
Status: common / locally rare

Channa lucius Cuvier & Valenciennes
Common name: Bujuk, Toman Bunga
Of all the individuals caught that belongs to this species, about half of it (9 individuals) are from Site 4. This suggests that this predatory fish prefers larger stream. This species is also a common top ichthyofaunal predator in Malaysia. The distinguishing feature that differentiates this species from *C. striatus* is its more flattened head and a series of large spots across the sides of its body. The largest specimen we have caught has a 34.2 cm of standard length and weighed 407.3 grams.
Status: locally rare

Channa micropeltes Cuvier & Valenciennes
Common name: Toman
All 23 individuals caught are from Site 2 and they are all juveniles with beautiful yellow coloration and longitudinal black stripes. Juveniles make attractive aquarium fish. This fish could grow to a very large size, up to one meter in length (Mohammad Mohsin & Mohd Azmi 1992). This species is also a popular game fish. We believe that during our fish collection, the maternal adult of *C. micropeltes* must have fled leaving a brood of juveniles.
Status: locally rare

Betta pugnax Cantor
Common name: Pelaga, Sepilai, Sepilai Batu, Betta
This endemic species to Peninsular Malaysia is also considered threatened by Mohammad Mohsin and Mohd Azmi (1992). In the Sungai Suar stream system, *B. pugnax* is found in smaller streams and is absent in Site 4 which is a third order stream. The majority bulk of the individuals (22 out of 34 individuals) are found at second order streams (Site 2 and 3).
Status: common / locally rare

Monopterus albus Zueiw
Common name: Belut, Eel
Only 2 individuals are caught in the Sungai Suar stream system, comprising only 0.2% of the total catch, making it one of the locally rare species in this area. The most distinguishing feature of *M. albus* is its elongated and cylindrical body: almost snake-like.
Status: locally rare

Mastacembelus maculatus Cuvier & Valenciennes
Common name: Tilan, Spiny Eel
Nine individuals of *M. maculatus* are caught (0.96 %) making it another locally rare species. This species is found in larger streams with a mixture of sand and gravel as its bottom sediment. One of the most obvious features of this species is its elongated body with a muscular appendage at the end of its upper lip. Due to its attractive and unique feature, this fish is becoming increasingly popular among aquarium hobbyist.
Status: locally rare.

DISCUSSION

The list of stream fishes recorded in Sungai Suar stream system showed that a number of fish species corresponds to the endangered list by Mohammad Mohsin and Mohd Azmi (1992). If the list is used as a guideline to fish conservation, a whooping 10 out of 27 fish species caught (37%) in this area are considered endangered or threatened in Malaysia. These species include *Labiobarbus lineatus, Tylognathus caudimaculatus, Botia hymenophysa, Acrochordinichthys inchnosoma, Prophagorus nieuhofii, Channa lucius, Channa micropeltes, Betta pugnax, Monopterus albus* and *Mastacembelus maculatus.* These authors put up the list in 1992 and since nine years has passed, it could be conceivable that more species are included. This could only mean that maybe more species in Sungai Suar stream system are considered endangered or threatened in Malaysia.

This study could not give a generalized account on the conservation status of stream ichthyofauna in Malaysia *per se.* However, a more worrying conservation concern could be accounted by in Sungai Suar stream system. Out of the 27 fish species caught in this study, 17 species are considered as locally rare. This accounts to 63% of total fish species. Determination of a rare species either locally, or on a larger scale is important for conservation biologists because a rare species is highly vulnerable to extinction, especially local extinction (Meffe & Carroll 1994). With 17 species considered locally rare, these species may face local extinction. This means that without proper effort, the 17 species may be wiped out from the Sungai Suar stream system soon. To make things worse, another 4 species is considered as 'common/locally rare'. This term is created to consider fish species with the number of individuals caught which is still low even though it comprises more than 2% of the total fish catch. Ifthese species could regain an increase in population number, it can safely fall into the 'common' category. However, if the population number decreases, the species could sway into the 'locally rare' category in which local extinction may become inevitable.

Another major factor that is considered as vulnerable to extinction is keystone species (Meffe & Carroll 1994). One of the criteria of a keystone species is a top predator in the ecosystem. In the Sungai Suar stream system, the Family Channidae form one of the major top predators. However sad to say, *C. lucius* and *C micropeltes* are already considered as 'locally rare' while *C striatus* offers a small relief when it is categorized as 'common/locally rare'. The health of the ecosystem is often reflected by the healthy number of keystone species. Any unnatural drop in its number may indicate problems in the ecosystem. Therefore the status of *C. striatus, C. lucius* and *C. micropeltes* should worry conservationists because these species are the keystone species in the Sungai Suar stream system.

A more worrying aspect of the conservation of fish community in Sungai Suar stream system within the Sungkai Wildlife Reserve is the fact that this reserve do not meet the internationally recognized definition of a protected area (WCMC 2000), therefore is not assigned with any management category. This makes Sungkai Wildlife Reserve more vulnerable to change in land use. The area of this reserve has already shrunk from 3966 ha in 1940 to 2468 in 2000 (PERHILITAN 2000). Further forest conversion may affect the stream system in the reserve especially the Sungai Suar stream system that may promote local rarity and ultimately local extinction of stream fishes.

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Standardized Data Management System for Camera-trapping Studies in Malaysia

INTRODUCTION

Studies of rainforest fauna are difficult due to their secretive nature, inherently low-densities, and dense vegetation in which they occur. Consequently, ecology of many species is little known to scientists. The recent development in application of self-activated remote camera-traps has facilitated research on rainforest mammals throughout the world (Seydack, 1984; Griffiths & van Schaik, 1993; Kawanishi, 1995: Franklin *et al.* 1999). A remote camera system generally uses a flash-equipped camera triggered mechanically (trip/bait line) or electronically (weight pad or infrared sensor). It is the least intrusive method to obtain permanent records of presence of multiple taxa day and night for a long period of time. The occurrence of rare species such as the highly elusive Persian leopard (*Panthera pardus saxicolor*; Joslin 1988) or Javan rhino (*Rhinoceros sondaicus*; Coleman 1993) could be firmly established using this technique. The technique further provides technical standardization without sampling biases related to neither baits nor observational skills. The disadvantages of the method are relatively high cost of the equipment, technical difficulties associated with non-detection photographs caused by unknown environmental variables and mechanical errors such as flash or sensor malfunction (Mace *et al.* 1990; Bull *et al.* 1992; Kawanishi, 1995; Rice, 1995; UF-Malaysia Tiger Project unpublished data). Given the advantages of the technique that no other single sampling methodology can match, the trend to incorporate the camera-trapping in field research is likely to increase in forest ecosystems.

In Malaysia, since the incursion of camera-trapping technique to assess the occupancy and activity patterns of tigers (*Panthera tigris*) and some potential prey species by Department of Wildlife and National Parks (DWNP) and Wildlife Conservation Society (Laidlaw & Wan Shaharuddin, 1998) in 1997, the technique has become a great asset to field research. In Taman Negara alone, three research projects on elephants (*Elephas maximus*) by DWNP Elephant Unit, on mountain peacock pheasant (*Polyptectron inopinatum*) by DWNP Bird Unit, and on tigers by University of Florida in cooperation with DWNP (Kawanishi *et al.* 1999) have been conducted using this method.

One of the superior features of the camera-trapping technique is that detectable wildlife is not limited to specific taxa. For example, University of Florida Tiger Project has captured a total of 54 vertebrate species on film (Kawanishi *et al.* 1999, UF-Malaysia Tiger Project unpublished data) to date. Camera-traps used by the Elephant Unit (pers. comm. Salman Saaban) and the DWNP Bird Unit (pers. comm. Siti Hawa Yatim) recorded at least 5 vertebrate species in the year 2000. Unfortunately, however, data on non-target species are often discarded. These auxiliary data, when combined, can be of great addition to the existing DWNP wildlife database. Photographs alone can be highly informative, yet without appropriate supporting data, they are useless in analysis. It would be for the benefit of research, thus management and conservation of the Malaysian fauna if those who employ the technique were advised to use a standardized data management system. This will facilitate DWNP scientists to compile all data collected in various studies throughout Malaysia and synthesize results of interests.

Many DWNP staff have been exposed to the camera-trapping technique through above mention research activities, and the method to set-up camera-traps (CamTrakker manufactured by CamTrek South Inc., Georgia, USA) has been described (Laidlaw, 1998). Here I propose a simple data management system that can be used as a standard for camera-trapping studies in Malaysia. Specifically, the methods to collect, record, and manage vital information required for scientific analysis will be described, and sample datasheets will be presented. The sample datasheets can be improved by additional requirements set by DWNP. The finalized standardized datasheet must be simple and general where minimal yet vital information is recorded. This can be further modified to fit specific objectives of each study. However, I strongly recommend that the portion of the data transferred to the DWNP Management Information System (MIS) be in the standardized format so that the process of compiling the transferred data does not become an added burden to the MIS.

As an institution responsible for wildlife management and overseeing research activities on endangered species or in the protected area system in Malaysia, DWNP may request all researchers employing

camera-trapping technique to submit data in the standardized format to DWNP MIS. All researchers should be required to submit a final report, which includes detailed methodologies, as well as copies of publications resulted from wildlife research conducted in Malaysia. As an appendix of the final report, I also recommend researchers to submit digital copies of representative photographs to enhance the collections of the MIS digital library. Since MIS database is in the dBase format, researchers are advised to use the same or other easily transferable formats (e.g., Excel or denominated text file). Errors and efforts are minimal if the data are transferred over Internet. Data may be e-mailed to a person responsible or an address specifically designated for the data transfer in MIS. Using a File Transfer Protocol (FTP) as a method of the data transfer may be convenient especially when the data and graphic files are memory intensive, but caution needs to be taken as an access to the data needs to be restricted to DWNP personnel and not to be in the public domain.

Two types of datasheets are proposed and described below, and sample datasheets are included in the Appendices. These are 1) Camera Trapping Check-Sheet, and 2) Camera Trapping Result. Researchers are requested to submit only the latter datasheet to DWNP. Thus, only the Camera Trapping Results datasheet needs to be standardized by DWNP. The Camera Trapping Check-Sheet is to help researchers organize and manager the camera traps and data, and also to aid in calculation of the total trap-nights, which is part of the vital information required in the Camera Trapping Results. The Camera Trapping Check-Sheet included herein is an example used in the UF-Malaysia Tiger Project, and can be further modified to suite objectives of specific studies. Another example check-sheet used in the DWNP/DANCET/WCS Krau Project is also included in the Appendices with a courtesy of Dr. Ruth Laidlaw.

Information entered in the both check-sheets is similar except that the Krau project check-sheet requires more details. The major difference between two check-sheets is that the UF check-sheet is trap-location specific whereas the Krau Project check-sheet is not. In other words, data from only one trap location can be entered in the same sheet of the UF check-sheet, whereas data from all trap locations are entered at once in the Krau Project check-sheet. For a long-term study where camera traps are maintained at same locations for more than several months, the data are more easily managed using the UF check-sheet. For a study where camera-trap locations are moved all the time or maintained in the same location for a short period of time (e.g., less than a few months), the Krau Project check-sheet may be more practical. Below I provide instructions for the datasheet used in the UF Project.

1. Camera Trapping Check-sheet (optional)

This datasheet is used to better organize and manage the camera-traps and data. The use is recommended for a long-term, large-scale study where a large number of camera-traps are managed, but otherwise optional. It helps to keep track of equipment and trapping schedule, and most importantly facilitates the calculation of a total trap-night, which is one of the most critical informations required to derive a relative abundance index based on a number of photographs.

Numbers of observed animals, encountered tracks, calls or scats of animals or photographs collected with camera traps are all called 'count statistics'. Count statistics are useful in estimating a population if all animals are counted with the observability (detectability or capture probability) of 100% or with partial count with known or estimated observability in sampled areas. Count statistics can be translated into relative abundance index if 1) the functional relationship between the count statistics and absolute abundance is known or assumed, and 2) the observabilities remain constant over time, among areas, or among species, depending on what the index is used for (Lancia *et al.* 1994; Thompson, *et al.* 1998). In other words, in case of camera-trapping sampling, the number of photographs *per se* cannot be used to derive a population estimate or compare abundance of specific species among studies unless all individual animals in a sampling area are photographed and identified based on some sort of body markings. When it is expressed in a unit effort (e.g., No. Photo/ 100 trap nights or No. Trap-nights/1 photo), a relative abundance of species of interest can be compared among studies (see Kawanishi *et al.* 1999), assuming a positive functional relationship and constant capture probabilities. Although the second assumption is unrealistic, the normalized abundance indices are better than the unrealistic assumption of count statistics = population size.

An absolute abundance or population estimate can be derived using mark-recapture estimation models based on individually identified animals on photographs (Mace et al. 1994; Karanth & Nichols, 1998; UF-Malaysia

Tiger Project unpublished data). Although relevant to camera-trapping sampling technique, this discussion of population estimation based on photographs is beyond the scope of this paper, thus will not be elaborated any further.

Although this datasheet does not need to be submitted to DWNP, the total trap-nights from every study must accompany the Camera Trapping Result (Appendix 2) for the data to be useful. A trap-night is a 24-hour period during which a camera-trap is functional.

Calculation of Total trap-nights (TN)

$Total\ TN = \Sigma_{i=1}\ tn_i$

Where *i* is a trap location and *tn* is a trap-night at *i*th location; thus, total TN is a summation of trap-nights from 1st to the last trap locations. This simply means that the first thing to determine is the number of 24-hour periods the camera trap was active for each trap location. Then by adding up all the trap-nights from all trap locations, the Total TN is determined.

Caution needs to be taken to accurately determine the trap night for each trap location. If the camera trap was determined to be functional by test shot (see Laidlaw & Wan Shaharuddin, 1998) when it was visited after certain days (say 30 days), regardless of number of exposures, the number of trap nights for the location is the number of the 24-hour period during which the camera trap was functional (in this case 30). This is why it is critical to record the success or failure of a test shot. If there is no test shot, then the date of the last photograph taken becomes the last day of trapping. This method underestimates the actual trap nights, but probably provides the best guess.

Example 1. A study used 5 camera-traps at 5 trap locations for 30 days. The individual camera-traps were functional for 10, 10, 30, 30, and 30 days respectively for the 5 locations.

Therefore,
Total TN = 10 + 10 + 30 + 30 + 30 = 110 trap nights.

Example 2. A study used 6 camera-traps at 5 trap locations for 30 days. Camera traps at the first two locations were set to be activated only at night, say 1900 – 0700 hrs (thus 0.5 trap-night per day) to avoid heavy vehicular traffic during the day time. The individual traps were functional for 10, 10, 30, and 30 for the first 4 locations respectively. A camera-trap at the 5th trap location was damaged by elephants on 10th day (hence 9 trap-nights at that point), and replaced with another camera and it was functional for 20 more days.

Therefore,
Total TN = (0.5 x 10) + (0.5 x 10) + 30 + 30 + (9 + 20) = 99 trap nights.

The exposure and battery status fields would help determine how long a camera trap can be left at the location without changing film or batteries. Possible reasons for premature termination of trapping can also be inferred from the battery or film status. If there was no test shot when the batteries and film were still okay, the equipment needs to be checked for its functionality.

Other fields are self-explanatory. A brief instruction for each field is provided as follow.

Status	When a camera trap is first set-up, the status field would be 'S' (set-up). Subsequently when it is visited, it would be 'C' (check), then 'S' again if it is reset until the trapping is terminated, thus 'T' at the location.
Date	Month/date/year.
Time	24-hr military time.
Camera ID	Each camera trap should carry a unique number.
Exposure	Determined from the camera LCD.
Battery	Recorded separately for the sensor and camera. ✓ - new, OK – old but okay, L – low, D – dead.
Test Shot	✓ - yes, X – no.
Film	When setting up: ✓ - installed When checking: ✓ - removed.
Remarks	Description of damage, malfunction, and any anomalies are recorded.

2. Camera Trapping Result

This is the data that are to be submitted to, and compiled by, DWNP. The first 10 lines contain information regarding the source of the data.

1	Name (person responsible for the data and to be contacted if necessary)
2	Contact address
3	Telephone and fax number
4	Email address
5	Date of data submission
6	Title of the project
7	General area of data collection
8	Sampling period
9	Total trap-nights (for the submitted portion of the data)
10	Addition Information

The 11th line or row contains heading for the data to follow. Brief description and instruction of each heading are provided below. Refer to an attached example of filled datasheet.

Project ID	Code specified by DWNP. This column can be left blank and filled out later by DWNP or project Principal Investigator (PI) may request the code at the beginning of the study. This information will expedite DWNP in identifying the data source when later combined data are manipulated, and thus each datum loses the critical source information (the first 10 lines described above). This becomes especially useful where multiple studies are conducted at the same location over time.
Location ID	Unique combination of letters and numbers specified by the project PI. This information facilitates communication between DWNP and PI on particular trap locations on interests (e.g., trap location of critically endangered or rare species for a follow-up study).
GPS (EEEENNNN)	Using the standard topographic map based on the Malayan Rectified Skew Orthomorphic Projection, the West Malayan grid codes are sometimes easier to determine locations than conventional latitudes and longitudes in degrees and minutes. The UF project uses 8 digits (4 digits each for easting and northing) for positioning to the nearest 100 m for two reasons: 1) 8 digits are easier to handle and memorize than 12 digits (6 digits each for easting and northing, thus to the nearest 1 m), and 2) when inevitable errors in geographic positioning are taken into an account (e.g., poor satellite geometry, imperfect satellite orbits, variable iono spheric conditions, and errors in map), an accuracy of <100m seems sometimes difficult to achieve. DWNP MIS uses 6 digits (3 digits each for easting and northing). Given that many rangers are not equipped with GPS, for the purpose of the nationwide wildlife database man agement, the positioning to the nearest 1 km may be sufficient. If however, positioning to the nearest 100m was achieved with GPS or landmark on maps, there is no reason to discard the fine-scale data. Such data will facilitate pinpointing the location of the occurrence of a criti cally endangered species, or repeating the study with identical trapping locations for a monitoring purpose.
Elevation	In meters above mean sea level, determined either by an altimeter or topographic map.
Habitat Code	Following DWNP habitat codes (Appendix 3).
Date	Month/date/year.
Time	24-hr military time.
Species	Use of the most recent scientific name is suggested to avoid confusion. After compilation, MIS will assign a species code for each datum according to DWNP standardized codes.

Number	Number of individual animals photographed at once. Although in most cases it would be one, this information is valuable in investigating a social behavior of otherwise difficult to observe species or a minimum surviving number of critically endangered species.
Remarks	Any other pertinent or peculiar information that may be useful in an assessment of the compiled data or for future research.

Note: The sex of animals is excluded from this datasheet although such information is important and thus included in MIS wildlife database. The photographic capture does not require direct handling of animals, thus the sex determination based only on images could be subjective and ambiguous. Absence of a penis or descended testis may be attributed to poor light and an angle from which the photograph was taken or age of the animal. Only when the genital is clearly shown on the image or for sexually dimorphic species, the positive identification of sex could be included in the remarks.

FURTHER CONSIDERATION

External researchers may decline to submit raw data before results are published since DWNP does not own the intellectual right to the data. In that case, some of the vital information for DWNP to further understand the ecology of species or better manage endangered species is not available for some years. This time lapse may be critical for some of highly endangered or allegedly extinct species. To mitigate the possible conflict of the data ownership, DWNP may request to reserve the right to include the unpublished data in its annual internal report to inform the management staff and decision making bodies of the available critical information, but refrain itself from publishing them in external journals.

When the unpublished data constitute a minor portion of the data for publication, DWNP may request consent from the Principal Investigator for the use of unpublished data accompanied by an appropriate credit. The issue of the authorship needs to be clarified and agreed among all parties before the initiation of the research. In any case, the external data must be accompanied by a proper credit and in no case released to a third party without consent of PI. I suggest DWNP draft a letter of an agreement on the use of the data and have PI sign the letter before the initiation of the research. The finalized version of this standardized data management protocol shall be handed to PI with the letter. The letter should include 1) the objective of compiling all the external data into MIS, 2) anticipated completion date of the proposed research, 3) anticipated date of the data submission, 4) how the unpublished data shall be credited, 5) to what extent the PI agrees the data to be used by DWNP, and 6) other conditions requested by PI. Perhaps DWNP may put a hold on the approval of a research until both parties reach the agreement. This will prevent an unfortunate case such that after a completion of a research the foreign researcher leaves the country with all data that were often collected in cooperation with DWNP and never return anything back to DWNP. I will be willing to assist DWNP in drafting the letter of agreement.

When transferring the data, the project ID can be used as a file name. When there are multiple files to be transferred, each file should be numbered (e.g., UF1.xls, UF2.xls, etc.). Backup copies of submitted data should be made immediately and kept externally in CDROM or other large-memory backup disks. Working copies are to be managed only by authorized personnel and may be made available to participating researchers upon request followed by an agreement on proper usage of the data.

Camera trapping is a powerful yet expensive technique to detect rainforest wildlife. No data should be discarded because they are not of the target species of a specific study. When the data management technique is standardized, it takes a little extra effort to record vital information for all photographs collected, which contributes to a larger purpose than wildlife photography. I encourage DWNP Research and MIS Divisions to take an active role in advising and coordinating camera-trapping studied in Malaysia, and in maintaining and making the best use of data gathered by collective research efforts for better management and conservation of Malaysian fauna.

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APPENDICES

1. Camera Trapping Check-Sheet
   a. Camera trapping checklist: The English version used in the UF-Malaysia Tiger Project
   b. Camera trapping checklist: The Malay version used in the UF-Malaysia Tiger Project
   c. Camera trapping checklist: datasheet used in DWNP/DANCET/WCS Krau Project
2. Camera Trapping Results
   a. Camera Trapping Results (English version)
   b. Camera Trapping Results (Malay version)
3. DWNP Habitat Code

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CAMERA TRAPPING RESULTS (EXAMPLE)

Kae Kawanishi
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30 July 2000
University of Florida – Malaysia Tiger Project
Taman Negara, Merapoh (Sg. Relau) ~200 km^2
4 April 1999 – 6 May 2000
4192 trap-nights
TrailMaster active infrared and CamTrakker passive infrared camera-traps were used at 43 trap locations. Not all cameras were functional throughout the sampling period

Project ID	Location ID	GPS (EEEE/NNNN)	Elevation (meter)	Habitat Code	Date (mm/dd/yy)	Time	Species	No	Remarks
UF	MP1	45895165	123	HB	04/04/99	0357	Panthera tigris	1	Female
UF	MP1	45895165	123	HB	04/04/99	2300	Bos gaurus	1	
UF	MP1	45895165	123	HB	04/10/99	1239	Argusianus argus	2	Mating dance
UF	MP2	45575183	345	HB	04/06/99	1220	Muntiacus muntjac	1	
UF	MP3	45615161	234	HB	04/20/99	1544	Sus scrofa	3	Piglets

Appendix 1a. Camera trapping checklist: The English version of the datasheet used in UF-Malaysia Tiger

CAMERA TRAPPING CHECK SHEET

RECORDED BY: PAGE NO: of

LOCATION: GPS: ELEVATION:

SITE DESCRIPTION:

Total Trap-nights =

Status	Date	Time	Camera ID	Exp. No.	Battery (S)	Battery (C)	Test Shot	Film	Remarks

Status: **S** - setup, **C** - check, **T** - terminated.
Battery: ✓ - new, **OK** - old but okay, **L** - low, **D** - dead for sensor (S) and camera(C).
Test Shot: ✓ - yes, **X** - no.
Film: ✓ - installed (setting)/ removed (checking).

Appendix 1b. Camera trapping checklist: The Malay version of the datasheet used in UF-Malaysia Tiger

CAMERA TRAPPING CHECK SHEET

PENCATAT: NO MUKASURAT : of

LOKASI: GPS: KETINGGIAN:

PENGGAMBARAN LOKASI:

Jumlah malam-penangkapan (trap-night) =

Status	Tarikh	Masa	ID kamaera	No.Exposi	Bateri (S)	Batteri(K)	Gambar Cubaan	Filem	Nota

Status: **S** - Pemangsangan, **R** – Pemeriksaaan, **B** - Batal.
Bateri: ✓ - baru, **L** – lama tetapi baik, **R** - rendah, **M** – mati untuk sensor (S) dan kamera (K).
Gambar cubaan: ✓ - **ada, X - tiada**
Filem: ✓ - pemasangan (persediaan)/pengeluaran (pemeriksaan)

Appendix 1c. Camera trapping checklist: datasheet used in DWNP/DANCED/WCS Krau project

					No. lokasi
					Kamera no.
					Who numbered/Siapa buat tanda
					RSO Easting/GPS
					RSO Northing/GPS
					Topografi
					Altitude/Ketinggian
					Date set/Tarikh di mulakan
					Time set/Masa di mulakan
					Beteri Kamera OK
					Beteri infrared OK
					Dua switch OK
					Tarikh & masa OK
					Flash berfungsi
					Infrared berfungsi
					No. photos registered/No. gambar di daftar
					Date collected/Tarikh di kumpul
					Time collected/Masa di kumpul
					Who collected/siapa ambil
					Flash berfungsi
					Infrared berfungsi
					No. photos registered/No. gambar di daftar
					No.nights in forest/Bilangan malam di hutan
					Remarks/Nota

Appendix 2a. Camera Trapping Results (English version)

<Name> Fill in the information in Column A then remove <...>.
<Address>
<Telephone and fax number>
<Email address>
<Date of submission>
<Title of the project>
<General area of data collection>
<Sampling period>
<Total trap-nights>
<Addition Information>

Project ID	Location ID	GPS (EEEENNNN)	Elevation (meter)	Habitat code	Date (mm/dd/yy)	Time	Species	No.	Remarks

Appendix 2a. Camera Trapping Results (Malay version)

<Nama>
<Alamat>
<No. Telepon dan Fax>
<Alamat e-mail>
<Tarikh akhir penghantaran borang data>
<Tajuk Projek>
<Kawasan pengumpulan data>
<Jangkamasa pengumpulan sampel>
<Jumlah tangkapan malam (trap nights)>
<Informasi Tambahan>

ID Projek	ID Lokasi	GPS (XXXXYYYY)	Ketinggian (meter)	Kod habitat	Tarikh (bb/hh/tt)	Masa	Spesis	No.	Nota

Appendix 3. Habitat Codes used by DWNP

Code	Malay	English
-	**HUTAN TANAH KERING**	**DRY LAND FOREST**
PD	Hutan Tanah Pamah Dipterocarp	Lowland Dipterocarp Forest
BD	Hutan Bukit Dipterocarp	Hill Dipterocarp Forest
MD	Hutan Tanah Tinggi Menengah Dipterocarp	Upper Hill Dipterocarp Forest
GO	Hutan Gunung Oak	Montain Oak Forest
GE	Hutan Gunung Eraceous	Montain Eraceous Forest
HH	Hutan Kerengas	Heath Forest
BK	Hutan Batu Kapur	Limestone Forest
UB	Hutan Ultrabasic	Ultrabasic Forest
HP	Hutan Pantai	Coastal Forest
-	**HUTAN TANAH LEMBAB**	**WETLAND FOREST**
HR	Hutan Riparian	Riparian Forest
PT	Hutan Paya Air Tawar	Freshwater Swamp Forest
HG	Hutan Paya Gambut	Peat Swamp Forest
HB	Hutan Bakau	Mangrove Forest
-	**LADANG DAN KEBUN**	**PLANTATION AND GARDEN**
LH	Ladang Hutan	Plantation Forest
LG	Ladang Pokok Getah	Rubber Plantation
KS	Ladang Pokok Kelapa Sawit	Oilpalm Plantation
LC	Ladang Koko	Cocoa Plantation
LK	Ladang Kelapa	Coconut Plantation
DB	Dusun Buah-buahan	Fruit Orchard
SP	Sawah Padi	Padi Field
SS	Kebun Sayur-sayuran	Vegetable Farm
LN	Ladang Nenas	Pineapple Plantation
-	**TANAH ATAU TEMPAT YANG DIUBAHSUAI ATAU TERGANGGU**	**DEVELOPNED OR DISTURBED AREA**
B	Belukar	Scrub
PR	Padang Rumput	Grass Field
TL	Tanah Lapang	Bare Field
BB	Bandar	Town
KI	Kawasang Industri	Industrial Area
P	Perkampungan	Village and Aborigine Settlement
-	**PERSISIRAN PANTAI**	**COASTLINE**
PB	Pantai Berbatu	Rocky Coastline
PP	Pantai Berpasir	Sandy Coastline
PL	Pantai berlumpur	Muddy Coastline

Appendix 3. – cont.

Code	Malay	English
-	**HABITAT BERAIR**	**AQUATIC**
T	Tasik	Lake
S	Sungai	River
AP	Air Paya (Brakish Water)	Peat Swamp (brackish water)
L	Laut	Sea
LO	Lombong	Mine
-	**BAWAH TANAH**	**SUBTERRANIAN**
G	Gua	Cave
R	Rongga Batu atau Tanah	Subterranean under rocks or earth

Refer to *Definasi dan Petunjuk Borang Inventori Hidupan Liar* (DWNP) for a definition of each habitat.

Tiger Conservation and the Department of Wildlife and National Parks (DWNP), Peninsular Malaysia

INTRODUCTION

Fifty years ago the population of Indo-chinese tigers (*Panthera tigris*) was estimated to be approximately 2,990 individuals throughout ten of the eleven states of Peninsular Malaysia. Only the State of Penang no longer had tigers in 1952 (Locke, 1952). By 1990, this estimate had drastically reduced to approximately 500, with tigers present in eight states only (Topani, 1990). This dramatic decrease in numbers and reduction in its distribution and range was due to a loss of habitat in all states from forest conversion and forest fragmentation. It was also due to wide spread hunting of tigers up until 1976 and poaching of prey species, in particular from the forest edge and from forests opened up by logging. Extinction of the species has occurred in the smallest, but most populated states first (Penang, Melaka and Perlis), with Negeri Sembilian and Selangor, approaching extinction.

Tigers in Peninsula Malaysia are predominantly found in remaining lowland and hill forest, but they have occasionally been found in montane forest (pers. obs. and DWNP unpublished records). The home-range size of the Indo-chinese tiger both in Malaysia and elsewhere is currently unknown. t is conceivable, however, that a male Indo-chinese tiger could range up to or above 100 km^2, given that in Nepal a male Bengal tiger can have a territory of 50-100 km^2 (McDougal, 1996) and in Sumatra a male Sumatran tiger has been shown to have a home-range of 116 km^2 (Franklin *et al.* 1999).

The Department of Wildlife and National Parks (DWNP) was set up in 1936 and at that time it was known as the Game Department. DWNP's current role is as the legal guardian of wildlife resources and protected areas in the Peninsula, with the main emphasis on natural forest, which covers 47,300 km^2 (DWNP, 1992). DWNP has a force of 714 people (DWNP/ DANCED, 1996) to undertake this huge responsibility. The principal DWNP activities which relate to tiger conservation are protected area management, tiger-human conflict resolution, law enforcement, research, captive breeding, public awareness and advisor to the Government. These activities are discussed below with special reference to tiger conservation in Peninsular Malaysia

1.Protected Area Management

There are 39 protected areas under DWNP management, which cover 7,514 km^2 or 5.7% of the Peninsula land area. Approximately 170 DWNP staff is permanently assigned to the protected areas (DWNP/DANCED, 1996).

Of the 39 protected areas under DWNP management, only six areas are greater than 100 km^2 in size (Table 1). All of the protected areas under DWNP management in the Peninsula were created in the 1920s and 1930s, only Tasek Bera (Pahang) has been gazetted since the 1930s (Table 1). In terms of long-term and global tiger conservation status, only Taman Negara and Krau are categorised as part of the Level 1 Tiger Conservation Unit (TCU) in Peninsular Malaysia (Dinerstein *et al.* 1997). Although Taman Negara is still very much part of a larger forest block, Krau is increasingly being isolated.

The protected areas in Johor are legally gazetted as such, but they also have an overlapping Forest Reserve gazettement. This dual gazettement can lead to conflicts in management between the federally managed DWNP and the State managed Forestry Department of Johor. This issue has been recognized by both Departments, but needs the joint action of the Federal and State

Governments to resolve it (DWNP/DANCED 1996, 2000). From the point of view of tiger conservation, these areas with conflicting management are particularly worrying, since DWNP is not in a position to implement conservation measures on the ground in these places.

In the 1960s, the Federal Government realised that protected habitat for wildlife was insufficient for long-term wildlife conservation. Most of the wildlife was (and still is) found outside of the protected area system. In 1968, therefore, the Federal Government sought the assistance of the Food and Agricultural Organisation of the United Nations (FAO) to strengthen wildlife conservation in Peninsular Malaysia (Stevens, 1968). One of the recommendations was to create new protected areas and this recommendation was incorporated into the Third Malaysia Plan 1976-1980 (Prime Minister's Department 1976 - Table 2).

In order to legally create new protected areas, there are two pieces of Federal legislation, namely the

Table 1. Protected areas >100 km² managed by DWNP in Peninsular Malaysia

Protected Area	Area (km²)	No. of DWNP staff	Year Gazetted	Location
Taman Negara	4,315	112	1938/9	Kelantan, Trengganu & Pahang
Tasek Bera	200*	0	1970	Pahang
Krau	624	10	1923	Pahang
Endau Kluang	525	0	1933	Johor
Endau Kota				
Tinggi West	369	0	1933	Johor
Segamat	122	0	1937	Johor
Total	6,155	122		

Source: DWNP/DANCED 1996
*approx. land area only

Table 2. Areas >100 km² proposed as protected areas in the Third Malaysia Plan (1976-1980).

Proposed Areas	Area (km²)	Current Managers	State
Ulu Muda	1600	Forest Department	Kedah
Ulu Trengganu	1166	Forest Department	Trengganu
Grik	680	Forest Department	Perak
Selama	223	Forest Department	Perak
Sungai Nenggiri	379	Forest Department	Kelantan
Total	4,048		

Source: DWNP/DANCED (1996).

Protection of Wildlife Act 1972 and the National Park Act of 1980. The State Governments, however, have to take the initial step of gazetting state lands as protected areas under either one of these legislations, but the State Governments are reluctant to do so. They perceive this as giving up their land rights and they do not get compensated by the Federal Government for potential loss of revenue.

The Federal Government, however, has been encouraging the State Governments to create their own State protected areas. So some States have used alternative State legislation to gazette some identified areas as protected areas (Table 3) (DWNP/DANCED, 1996; Elagupillay, 1998). For example, lately, the State Government of Perak has publicly announced that Belum has been declared a State Park (see Table 3). In addition, the Federal Government also has in principal agreed that the area that borders the Malaysia-Thailand boundary, Ulu Muda, will be turned into a transboundary protected area (Elagupillay, 1998).

If all of the above proposed areas (Table 2) could be turned into either Federal or State protected areas, then together with existing protected areas (Tables 1 & 3), there would be a total of 12,264 km² of protected areas greater than 100km², *i.e.* 9% of Peninsular Malaysia. This would help ensure the long-term survival of a significant portion of the Malaysian tiger population and its habitats.

2.Tiger-Human Conflict Resolution

As reflected by DWNP research activities (see Section 4), resolving conflict between tigers and humans has been, and is, the single biggest issue for DWNP, where tiger conservation is concerned. Conflict between tigers and humans is largely confined to the eastern states of Peninsular Malaysia (see Table 4). These states in addition to having a large portion of forested land, are also experiencing considerable changes in landuse, especially from forestry to agriculture. Forest fragmentation has resulted in a decrease in habitat for

both tigers and their prey. Prior to 1989, most forested areas were classified as black areas due to presence of communist insurgence. After the formal ending of this conflict, however, the black areas were opened for public access without restrictions, *e.g.* for recreation, road construction, *etc.* This elimination of black areas has brought about more human impact on tiger habitats, including introduction of livestock at forest fringes and loss of prey due to poaching.

Between 1988 and 1997, there have been 108 cases of reported tiger incidents with humans in four out of six states, and 503 reported tiger-livestock incidents in six states (see Table 4). These cases mostly occurred on the forest edge, where tiger territory has been converted into agricultural land or where livestock has been introduced into forest fringes. Tigers are largely territorial animals and when part of their territory is disturbed and wild food supplies impoverished, they are forced to supplement their diet by predating on livestock. The main livestock affected are cattle, which may be left to roam close to the forest unattended both by day and by night, making easy pickings for a hungry tiger.

Livestock loss means loss of revenue for villagers, who view these tigers as pests. If the problem persists the villagers tend to take their own action, rather than leaving the problem to be resolved by DWNP. Should villagers do the former and the tiger is not killed outright then the outcome can be tragic. In 1998 a tiger that had been shot and badly injured, became a man-eater in Sungai Siput, Perak, killing two villagers within one week. DWNP had to take the decision to kill the animal. This decision, however, was not well received by the public. Generally, when DWNP is contacted by villagers, rangers are dispatched to the area to assess the situation. If the situation is considered serious then the tiger is trapped and if caught brought to Melaka Zoo, where it enters the captive breeding programme (see Section 5).

Resolution of human-wildlife conflict makes up a significant part of State DWNP routine work. From time to time, when tiger depredation on livestock has been particularly frequent for various reasons, then specific State Tiger Management Units (STMUs) have been set up. These STMUs were first formed in Terengganu in 1976 and then in Kelantan, Perak, and Pahang from 1977 until 1985, partly to resolve tiger-human conflict, and also partly to assist the Tiger Research Unit (TRU) in DWNP HQ with research (see Section 4). In 1985, these four tiger Management Units were absorbed into Wildlife Management Units, due to a decrease in livestock depredation combined with the lack of a tiger co-ordinator at the TRU (see Table 6). Due to an increase in tiger-human conflict, however, the STMUs were revived in Terengganu and Kelantan in 1994. These Units continue to exist although the staffs also perform other tasks. In 1997, similar Units were also reestablished in Pahang and Perak to assist in tiger-human conflict and also in tiger research. The STMUs would benefit from a specific officer to co-ordinate their activities at State level and additional resources to carry out their activities.

3.Law enforcement

Under the Protection of Wildlife Act 1972 (Act 76), the tiger is a totally protected species. This Act was first written in 1972 and it was later amended in 1976. The relevant part of the Act (Part VI, Chapter 1, Section 64A) is as follows:

Notwithstanding anything in this Act, every person who unlawfully shoots, kills or takes a sumatran rhinoceros, a tiger or a clouded leopard or part thereof is guilty of an offence and shall on conviction be liable to a fine not exceeding fifteen thousand ringgit or to a term of imprisonment not exceeding five years. (Anon, 1994).

One of the principle responsibilities of DWNP is to enforce this Act. At the state level, most of the staff are routinely involved in law enforcement activity co-ordinated through the Enforcement Division at HQ. Malaysia, however, is not considered to be a significant trader of tiger derivatives (Mills & Jackson, 1994) and the number of law enforcement tiger offenses apprehended and fined between 1990 and 2000 is few (Table 5).

4.Research

Tiger research is an integral part of tiger conservation. Without knowledge of its distribution, abundance and behavioural-ecology in the Peninsula, it is not possible to encourage conditions where the tiger can survive in the long term.

Depending on availability of professional staff, DWNP has been involved in tiger research since 1976 under the supervision of the DWNP Research and Conservation Division. This Division is made up of Units devoted to specific species. The Tiger Research Unit in HQ was established in 1976, the same year that the Indo-chinese tiger became a totally protected species in Malaysia. From time to time, there has been no full-time TRU co-ordinator in HQ (see Table 6). This has been due to a lack of professional DWNP staff at the time to

Table 3. Other protected areas >100 km² not managed by DWNP

Protected Areas	Area (km²)	Managers	Year Gazetted	State
Belum State Park	1,170	State Government	2001	Perak
Endau Rompin State Park	489	State Government	1993	Johor
Rompin Endau Wildlife Reserve	402	State Government	1986	Pahang
Total	2,061			

Source: DWNP/DANCED (1996)

Table 4. Cases of reported tiger attacks on humans and livestock between 1988 to 1997 in six states in Peninsular Malaysia.

	State						Total
	Phg	Kn	Tg	Jh	Pk	Kd	
Human	36	47	2	23	0	0	108
Livestock	256	80	90	37	30	10	503
Total	292	127	92	60	30	10	611

Source: Wan Meriam binte Wan Mansor (1998), from DWNP unpublished records
Phg = Pahang, Kn = Kelantan, Tg = Terengganu, Jh = Johor, Pk = Perak, Kd =Kedah

Table 5. Law enforcement tiger offences apprehended and fined either by court or DWNP from 1990-2000.

Type of offences	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Stuffed tiger	1	0	1	0	0	0	0	0	0	0	0	2
Tiger skin	2	0	2	0	1	0	0	1	0	0	0	6
Tiger bones	1	1	2	0	0	1	0	0	0	0	0	5
Tiger claws	3	1	3	0	0	0	1	0	1	0	0	9
Tiger tooth	1	0	3	0	0	0	1	0	0	0	0	5
Tiger penis	0	0	0	3	0	0	0	0	0	0	0	3
Illegal tiger import	0	0	0	0	0	1	0	0	0	0	0	1
Total	8	2	11	3	1	2	2	1	1	0	0	31

Source: DWNP unpublished records

co-ordinate and implements the research programme on tigers. The total number of professional staff allocated to DWNP for research is about a dozen; therefore DWNP is not mandated to carry out research on a long-term basis. DWNP is, however, mandated to protect and manage Malaysian wildlife species, including CITES related species, therefore DWNP has to reallocate its research staff as other conservation and management issues arise. As a result, the day-to-day management of tigers is left in the hands of the State DWNP and research can only be carried out when there is a research officer assigned in DWNP HQ. In addition, the extent to which research activities can be carried out has also been limited by the availability of support staff and in-house funding for research (DWNP/DANCED, 1996).

The focus of research work has largely been on tiger mortality and livestock depredation (Table 6). In 1995, however, as part of an international initiative, DWNP

Table 6. Main DWNP Tiger Research Unit activities since establishment in 1976.

Year	TRU Co-ordinator	Main Focus/Action	Reference
1976 – 1980	Richard Blanchard, Peace Corp Volunteer	Tiger mortality and livestock depredation in Trengganu and Kelantan	Blachard 1977a,b
1980 – 1982	Mohd Ismail, Deputy Wildlife Officer, Trengganu	Founder population for captive breeding programme established in Zoo Melaka	
1982 – 1985	Sivananthan Elagupillay, DWNP, Head Quarters, Kuala Lumpur	Liverstock depredation in Pahang and Perak	Khan 1987
1985– 1988	Nil	Tiger issues coordinated by Mohd Khan Momin Khan, Director General of DWNP	Khan 1987
1988 – 1990	Rahmat Topani, DWNP, Head Quarters, Kuala Lumpur	Distribution of tigers in the Peninsula	Topani 1990
1991 – 1997	Nil	• Tiger issues coordinated by Sivananthan Elagupillay (1994-1997), Head of Wildlife Management Unit, DWNP • National tiger strategy drawn up	Elagupillay 1994 Zailnal 1995
1997 – present	Wan Saharudin Wan Noordin, DWNP Head Quarters, Kuala Lumpur	• Implementation of DWNP Tiger Action Plan • Baseline camera trapping data collection with technical support from WCS • Tiger research library set up in TRU • Tiger DNA finger printing by Shabrina Shariff	• Jasmi Abdul & Elagupillay 1998 • Laidlaw 1998 • Laidlaw & Wan Shaharuddin 1998 • Wan Shaharuddin 1998 • Elagupillay & Wan Shaharuddin 1999 • Carbone et. al 2001 • Baseline data contributed to DWNP/ DANCED Management Plan for KWR 2001

Table 7. Zoos in Peninsular Malaysia holding pure Indo-chinese tigers.

Zoo	Female	Male	Cub	Total
Zoo Melaka	10	10	0	20
Zoo Taiping	4	4	3	11
Zoo Negara	2	0	0	2
Zoo Temerloh	1	0	0	1
Total	17	14	3	34

Source: DWNP unpublished records

drew up a Tiger Action Plan (Zainal, 1995), which is a strategy for the conservation of tigers in Peninsular Malaysia. In 1998, funding was secured and implementation of the DWNP Tiger Action Plan began through the TRU and the STMUs, with technical support from WCS (Table 6). Implementation also began through Melaka Zoo (see Section 5). In addition to internal tiger research work, DWNP currently also supports Ph.D. level tiger research work by Kae Kawanishi from University of Florida who is looking at tiger ecology in Taman Negara National Park. Furthermore, DWNP is also collaborating with WWF-M in studying ways to reduce tiger-livestock conflict (see Section 2) in Jerangau Berat, Terengganu.

Although there are many interest groups carrying out research work on the tiger, the capacity of DWNP has to be further strengthened, especially the TRU. The TRU, in addition to giving sound advice to decision makers, must also be able to lead, co-ordinate and facilitate so that all the above research findings can be incorporated into management practices at State and District levels. At the same time, the STMUs need to be likewise strengthened in order to implement the management practices that have been recommended to conserve the tiger and its habitat.

5.Captive Breeding

DWNP's goal for tiger conservation in Peninsular Malaysia is to maintain a healthy, thriving population of tigers in the wild. Captive breeding is both expensive and labour intensive and can never replace the inherent value of *in situ* conservation. However, *ex situ* conservation, *i.e.* captive breeding is considered an important aspect of conservation, (Tilson & Christie, 1999). The idea being that captive breeding provides for the worst case scenario in terms of conservation, which is the extinction of tigers in the wild. Should this happen and should there be a healthy captive bred population of tigers, plans can be made to rehabilitate the habitat and release some of the captive stock into the wild.

Melaka Zoo is the main *ex-situ* site for captive breeding Indo-chinese tigers in Peninsular Malaysia (see Table 7). From this captive breeding programme, other programme have been started in other zoos both within and without the country. The stud book records kept in Melaka Zoo shows that since the programme began in 1981, a total of 84 individual tigers have been recorded in this programme, which has included 25 wild caught tigers (30%) (Noorazlan & Carlsen, 2000). Most of the wild born tigers in the programme have been captured from tiger-human conflict areas and taken to Melaka Zoo to add new blood to the stock (see Section 2). Prior to 1976, tigers in conflict with humans were ultimately killed.

In 1998, the programme received funding from the STF to expand its captive breeding facility to accommodate more captive tigers. Although *ex situ* conservation is supposed to assist *in situ* conservation efforts, there is no proven world-wide experience in successful reintroduction of captive tigers into the wild. Currently, DWNP have no plans to release tigers into the wild, since most of the major suitable forested areas have their own existing wild tiger population and it would be "extremely complicated, very expensive and face strong local opposition" (IUCN Cat Specialist Group chair, Peter Jackson in Tilson & Christie 1999).

The tiger is a prominent, national symbol in Malaysia and DWNP is under pressure from the public to save all individual tigers including those that get into conflict with humans. As a result, more and more effort and resources are going into managing the tigers that get into conflict with humans and the captive management of tigers, than into the overall management of the wild tiger population. To relieve this pressure more effort has to be put into reducing the tiger-human conflict. This means the habitat has to be kept intact, and fragmentation and disturbance should be reduced. In addition, the management of livestock husbandry by the local communities has to be improved too. More work needs to be done at the State and Local Government levels and with other relevant stake holders to create transitional landuse areas between tiger habitats and areas of human use which are free of livestock and yet can also provide corridors for tiger movement. The STMUs have to be strengthened in order to carry out these tasks (see Section 4).

6.Public Awareness

DWNP has a public awareness programme and tigers are included as part of general on-going wildlife and conservation awareness. This task is undertaken by the Training and Education Division which has 18 staff (DWNP/DANCED, 1996). The majority of the programme activities take place in three DWNP centres, Lanchang in Pahang, Wang Pinang in Perlis and Kuala Atok in Taman Negara. The main target audiences are school children and university students, while other audiences include the general public, people

local to the centres and private companies. Lately, Orang asli living in and beside protected areas have also been included in the awareness building programme.

Other specific species-related public awareness activities tend to be handled by the relevant Divisions. For example:

- DWNP Research and Conservation Division collaborated with the Malaysian Nature Society (MNS) and the Global Survival Network in 1998 to launch the Asian Conservation Awareness Programme Malaysia (ACAPM) focusing on the use of tigers and four other species in traditional medicine (MNS, DWNP, WildAid 1998).
- DWNP, through the Research and Conservation Division, developed a working relationship with WCS and WWFM to support the DWNP Tiger Action Plan (see Section 4) in terms of research, capacity building and public, as well as local community, awareness, which included the production of a brochure, "Tigers Alive" (DWNP, WCS, WWFM 1998).
- Camera-trapping outputs from the Research and Conservation Division TRU (see Table 6) were used:
  - As an exhibition (i) during the launch of the National Policy on Biological Diversity bythe Minister of Science, Technology and the Environment in National Science Centre, in 1998; (ii) during the visit of Prince Philip, Duke of Edinburgh from the U.K. for the Commonwealth Games at Hong Kong Bank H.Q., in 1998; (iii) at a Malaysian International Chamber of Commerce dinner, in 1998; (iv) during a DWNP/ DANCED organised protected areas workshop in DWNP HQ, in 1999;
  - In talks to create awareness of tiger conservation work to MNS, to the Universiti Sains Malaysia, and internally to DWNP, in 1999;
  - In a pamphlet for senior decision makers, outlining the benefits Belum can provide as a protected area (Ministry of Science, Technology and the Environment 1999);
  - By the Training and Education Division in their routine work.

Judging from the number of articles and letters that get published in the main stream mass media there is a lot of interest in tiger conservation in the general public. DWNP should be able to mobilise public support. A well planned public awareness programme, however, is needed to do this. The outcome of the research activities that are currently being carried out (see Section 4), in addition to being utilised by the STMUs, can also be used by the Training and Education Division for enhancing public awareness on tiger conservation.

7.Government Advisor

DWNP is the legal guardian of wildlife in Peninsular Malaysia (DWNP, 1992). DWNP, therefore, is the principle avisor on wildlife matters to the Federal Government through the Ministry of Science, Technology and the Environment and also to the State Governments. This leadership role could be further enhanced so that decision makers at federal and state government levels could take into consideration the continued survival of the tiger and its habitat in the midst of the nations development. If needed major issues related to the tiger could be brought to the Federal Cabinet, while those related to land/habitat to the respective State Government Executive Committees (EXCO), so that vital policy or wildlife legislation may be enacted for better protection and management of wildlife resources. The Ministry of Science, Technology and the Environment being the focal agency in the implementation of the National Policy on Biodiversity may want to use the tiger as an umbrella species for the overall protection of the nations rich biological resources as envisaged in the policy.

CONCLUSION

Although DWNP's mandate is to protect and conserve the diverse wildlife heritage of Peninsular Malaysia, DWNP needs the joint support of the Federal and the State Governments to ensure that wildlife habitats are also protected. As a result of the Malaysian Government's commitment in the form of the National Policy on Biological Diversity, the time has come for a greater number of stakeholders from the Federal and State Governments and from NGOs to come together to embark on a long term goal to strengthen their conservation efforts in order to strengthen the Malaysian tiger population in different natural habitats for future generations.

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Vertebrate fauna of Compartment 14, Sungai Lalang Forest Reserve, Selangor

This paper presents results on the diversity of vertebrate fauna during a period of 58-day/night observations in the study area. The study site is located in Compartment 14 (C14) of Sungai Lalang Forest Reserve, Selangor. This forest reserve is located on the southeastern part of Selangor and it is about 50 km from Kuala Lumpur. C14 is situated at 3° 05' N 101° 52' E is an unlogged hill dipterocarp forest and has been proposed as a Virgin Jungle Reserve.

Botanical Plot

A one kilometre line transect of width 20 m at a bearing of 295° N was established at the NNE end of C14 (Figure 1). The transect was marked at every 20 m intervals with pvc poles. Another four of 250 m line transects of similar width at a bearing of 205° branches off at 90 degree angles from the main transect at 400, 600, 800 and 1000 m (Figure 1). The size of the botanical plot was 4 ha. All trees that are equal and more than 10 cm dbh were tagged and identified to species levels.

Three main trails (Figure 1) were used during the survey in C14. First was the main 1-km baseline of the botanical plot, hereafter called Line 1 or L1. The four 250-m lines that branched off from the main baseline were named Line 2 (L2), Line 3 (L3), Line 4 (L4) and Line 5 (L5). Second was the main trail going to the base camp, which started from the border of the compartment near the logging road heading south of the compartment. The length of this trail was about 700 m and is called main trail (MT). There was another transect line going to the south of the compartment used by the small mammal team. The length of the transect was 1.8 km and referred as small mammal trapping trail or SMT. Part of the MT was also SMT.

Survey Period

In 1999, seven consecutive surveys were carried out for the mammalian fauna in C14: (1) 19 to 23 April, (2) 10 to 16 May, (3) 15 to 24 June, (4) 12 to 18 July, (5) 2 to 7 August, (6) 2 to 11 September and (7) 5 to 8 October. The survey period for bird were carried out over the following periods : (1) 14 to 18 June, (2) 12 to 18 July, (3) 6 to 9 September, (4) 27 to 29 September and (5) 5 to 8 October.

Mammals

The botanical plot was used as a transect trail to assess the diversity of mammalian taxa in the area. In addition, the logging tracks and main trail (MT) were used too. Any animals seen and heard were recorded. Tracks of animals (i.e. footprints, faeces and any dead carcasses) were noted as well. Observations of mammal were aided with 10 X 42 binoculars. Whenever opportunities arise, night observations were also conducted especially from the base camp to the main trail. Powerful flashlights and binoculars were used during the nocturnal observation.

Birds

The same botanical plot was also used for the bird study. A slow walk made along Line 1 between 0700 and 1100 hours to assess the diversity of birds. Other trails such as the main trail (MT) and logging road were used too. Identification of the bird species was made by direct observation using a 10 X 42 binoculars and also through vocalisation. Playback of vocalisation was also made to lure difficulty-to-net-or-see birds from their hiding.

Herpetofauna

Any amphibians and reptiles encountered during mammal or bird surveys were collected.

RESULTS AND DISCUSSION

MAMMALS

Twenty-three mammal species from 13 families belonging to seven order were recorded in the study are (Table 1). Following are the mammal recorded according to their respective order and families.

DERMOPTERA

Cynocephalidae

An individual of Flying lemur was sighted on an emergent dead tree along the logging road at night. This species is categorised as Totally Protected under the Wildlife Protection Act (1972).

SCANDENTIA

Tupaiidae

Of the three species of treeshrews in this family, only one species, the Common treeshrew (*Tupaia glis*) was recorded in the area. An individual was sighted traveling

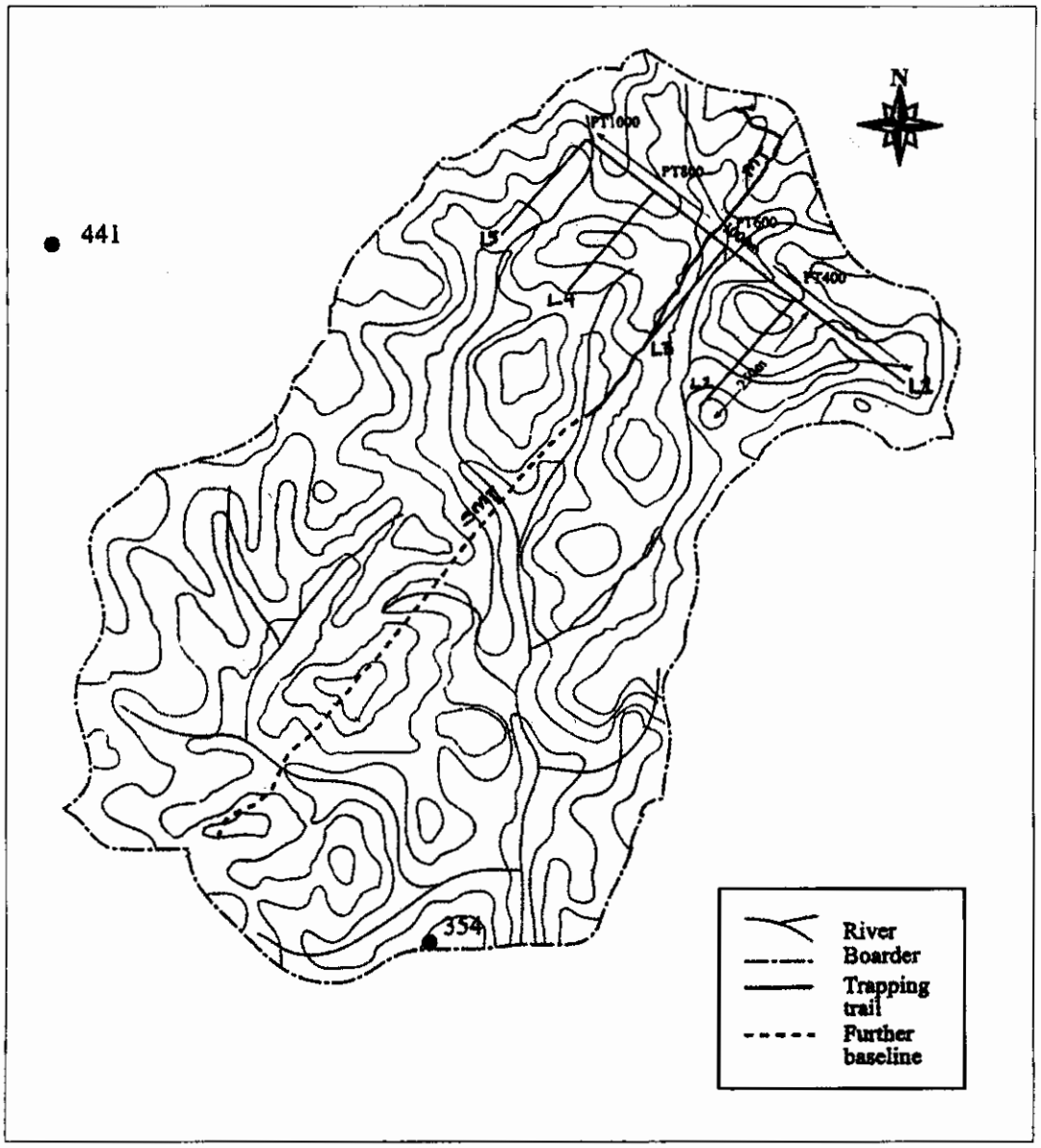

Figure 1. Map showing the trails used for vertebrate survey.

on the ground near the waterfalls at the base camp. This treeshrew is listed under Appendix II by CITES.

PRIMATES

Cercopithecidae

Three species of monkeys were recorded in the area. A large troop of Pig-tailed macaque (*Macaca nemestrina*) was sighted at 900 m of L1, MT and SMT trail at different times and days. Two species of leaf monkeys that are commonly seen in the study area are the Banded leaf monkey (*Presbytis femoralis*) and Dusky leaf monkey (*Trachypithecus. obscurus*). All the monkey species are listed as Protected under the Protection of Wildlife Act 1972 and under Appendix II by CITES.

Hylobatidae

The White-handed gibbon (*Hylobates lar*) is common in the area. Most frequent sighting of this gibbon was found at 200 to 300 m and 800 to 900 m of the botanical

plot. This species is Totally Protected and categorised under Appendix 1 by CITES.

RODENTIA

Sciuridae

Seven species of the total 14 diurnal squirrels, representing 50 % of the diurnal squirrel fauna reçorded in Peninsular Malaysia (Medway 1983). These are two species of giant squirrels (*Ratufa affinis* and *R. bicolor*), two *Callosciurus* spp. (*Callosciurus prevostii* and *C. notatus*), two *Sundasciurus* spp. (*Sundasciurus tenusi* and *S. lowii*) and *Rhinosciurus laticaudatus*. The two giant squirrels and *C. prevostii* are categorised as Totally Protected under the Protection of Wildlife Act 1972. The first two species are listed in Appendix II by CITES.

Pteromyidae

Only two flying squirrels were sighted in the area. One individual of the Red giant flying squirrel (*Petaurista petaurista*) was sighted at night foraging on tree along the logging road. An individual *Hylopetes* sp., probably *H. spadiceus* (Lim Boo Liat, pers. comm) was seen during the day. The Flying squirrels are listed as Totally Protected Animals by the Protection of Wildlife Act 1972.

Hystricidae

An individual of Brush-tailed porcupine (*Artherurus macrourus*) was seen inside a hole of dead fallen log. This porcupine is classified as Protected Animals under the Protection of Wildlife Act 1972.

CARNIVORA

Ursidae

Claw marks of Sun bear (*Helarctos malayanus*) were found on a tree trunk. The bear is classfied as a Totally Protected Animal under the Protectiom of Wildlife Act 1972, as Vulnerable in the IUCN Redlist and listed under Appendix I by CITES.

Viverridae

An individual of Masked palm civet (*Paguma larvata*) was sighted crossing the logging road at night. This species is listed as Totally Protected under the Protection of Wildlife Act 1972.

PERISSODACTYLA

Tapiridae

Members of the botanical team sighted a young individual of Tapir (*Tapirus indicus*) during their work of setting up the plot. This species is a Totally Proected Animal, Endangered under the IUCN Redlist and listed under Appendix I by CITES.

ARTIODACTYLA

Suidae

No Wild pig (*Sus scrofa*) was sighted but numerous rooting sites were noted along the trails. This species is categorised as Protected Animals under the Protection of Wildlife Act 1972.

Tragulidae

An individual of Lesser mouse deer (*Tragulus javanicus*) was commonly seen on the ridge near the base camp. Another mouse deer species, *T. napu* was sighted resting near bertam plant at night. Both species are listed as Protected Animals under the Protection of Wildlife Act 1972.

Cervidae

Footprints of Barking deer (*Muntiacus muntjak*) was found by team members at the muddy area above the waterfalls near the base camp. This species is also categorsied as Protected Animals under the Protection of Wildlife Act 1972.

BIRDS

A total of 105 bird species from 32 families (Table 2) were recorded in the study area. Names and order of listing follow King *et al.* (1975). Majority of the bird species were identified through their vocalisation. Sound or birdcalls that were undetermined or unfamiliar were recorded on tape for later identification. Of the 105 species, 64 species (61%) are considered as insectivorous while 22 species (21%) are frugivorous, 14 species (13%) are partly frugivorous and insectivorous, and only three species (3%) are birds of prey and two (2%) are partly insectivorous and nectivorous (Table 2). One hundred bird species are residents, two species are migrant, two are resident-and-migrant and only one species that is locally-migrant (Table 2).

Most of the birds listed in Table 2 were recorded in the botanical plot (L1) except for nine species, which were sighted at the logging road. Two species, the Reddish scops-owl and Gould's frogmouth were caught in the mist net set up for the bat study in the area. All the birds species recorded in the study area are Totally Protected under the law.

HERPETOFAUNA

Only twelve amphibians (caecilian, frogs and toads) in addition to five species of lizards, one species of each of skink, snake, turtle and monitor lizard (Table 3) were

recorded in the area. Following are brief information on the locations of animals were found in the study area described under their respective families.

AMPHIBIANS

Caecilidae

Two individuals of the Yellow-banded caecilian (*Caudacaecilia nigroflava*) were recorded in the area. One was found at L1 200 m and the other was found on the ground near the base camp during rain.

Pelobatidae

Three species from two different genera under this family was found to be common in the area. *Leptobrachium hendricksoni* (Spotted litter frog) and *Megophrys nasuta* (Horn toad) were abundant and common near the small stream by the base camp. An individual of the latter species was found to be residing inside a "bertam" plant near the base camp most of the time. One unidentified *Megophrys* sp. was collected from the MT.

Bufonidae

Two *Bufo* spp. were recorded in the area. The most commonly sighted on the stream banks was *Bufo parvus* and the mating season is recorded to be in May. Young individuals of *B. asper* were found more often on the trails than near the stream. Another species from this family that is found in the area is *Leptophryne borbonica*.

Ranidae

Four species, *Rana chalconota*, *R. hosii*, *Limnonectes blythii* and *L. malesianus* were recorded. The first species is the most commonly seen among the three.

Rhacophoridae

A single individual of *Polypedates leucomystax* was found inside a ditch near a fallen tree at L1 600m.

REPTILES

Agamidae

Five species of agamid lizards comprised two species of crested lizards, *Gonocephalus grandis* and *Bronchocoela cristatella* and three flying lizards, *Draco melanopogon*, *D. quinquefasciatus* and *Draco* sp. One *Draco* sp. was not identified yet. The Great angle-head lizard (*G.grandis*) was seen at night, resting on a twig of a small tree at L1 600 m. The Green crested lizard (*B. cristatella*) is more commonly seen basking on tree branch during the day. The three flying lizards were more frequently seen during the day.

Gekkonidae

Three gecko species were found in the area and they are *Cyrtodactylus consobrinus*, *Gecko smithi* and *Ptychozoon lionotum*. The presence of *Gecko smithi* in the area was based on its frequent vocalisation during most surveys. A specimen of the Smooth-backed gliding geckos (*P. lionotum*) was given to us by the Orang Asli. The third species, *C. consobrinus* was seen at night, on a tree trunk going inside the tree hole.

Scincidae

The Sun skink (*Mabuya multifasciata*) was commonly seen going through forest litter and fallen logs near the base camp.

Varanidae

A species of Monitor lizard (*Varanus* sp.) was sighted near stream at L2 80 m.

Colubridae

An individual of the Red tail racer (*Gonyosoma oxycephalum*) was seen resting near a bertam plant of the main trail at night. Other few snakes were encountered during the day surveys, unfortunately the identification to specific species was undetermined.

Emydidae

One species of turtle was recorded in the study area. The Hill spiny turtle, *Hoesemys spinosa* was sighted three times. The first sighting was in May, where it was found inside a small ditch near the small stream near the base camp. In June, an individual was seen travelling on the ridges at L1 400 m near a "bertam" plant. Three months later, another individual was seen travelling on ridge of L1 800 m going underneath a fallen log.

ACKNOWLEDGEMENTS

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Table 1. List of mammals recorded in C14 of Sungai Lalang Forest Reserve, Selangor

TAXA/Family/Species	Conservation Status
MAMMAL	
DERMOPTERA	
Cynocephalidae	
1. *Cynocephalus variegatus* – Flying lemur	TP
SCANDENTIA	
Tupaiidae	
2. *Tupaia glis* – Common treeshrew	Appendix II
PRIMATES	
Cercopithecidae	
3. *Macaca nemestrina* – Pig-tailed macaque	P and Appendix II
4. *Presbytis femoralis* –Dusky leaf monkey	P and Appendix II
5. *Trachypithecus. obscurus* – Banded leaf monkey	P and Appendix II
Hylobatidae	
6. *Hylobates lar* – White-handed gibbon	TP and Appendix I
RODENTIA	
Sciuridae	
7. *Ratufa affinis* – Cream coloured giant squirrel	TP and Appendix II
8. *R. bicolor* – Black giant squirrel	TP and Appendix II
9. *Callosciurus notatus* – Plantain squirrel	NP
10. *C. prevostii* – Prevost's squirrel	TP
11. *Rhinosciurus laticaudatus* - Long nose ground squirrel	NP
12. *Sundasciurus lowii* – Low's squirrel	NP
13. *S. tenuis* – Slender squirrel	NP
Pteromyidae	
14. *Petaurista petaurista* – Red giant flying squirrel	TP
15. *Hylopetes spadiceus* (?) – Red-cheeked flying squirrel	TP
Hystricidae	
16. *Arthurus macrourus* – Brush-tailed porcupine	P
CARNIVORA	
Ursidae	
17. *Helarctos malayanus* – Sun bear	TP, Appendix I and Vulnerable
Viverridae	
18. *Paguma lavarta* – Masked palm civet	TP
PERISSODACTYLA	
Tapiridae	
19. *Tapirus indicus* – Tapir	TP, Appendix I and Endangered
ARTIODACTYLA	
Suidae	
20. *Sus scrofa* – Wild pig	P
Tragulidae	
21. *Tragulus javanicus* - Lesser mouse deer	P
22. *T. napu* – Large mouse deer	P
Cervidae	
23. *Muntiacus muntjak* – Barking deer	P

Notes: Conservation Status : TP = Totally Protected; P = Protected

Table 2. List of birds species recorded in C14 of Sungai Lalang Forest Reserve, Selangor

Family/Common Names	Scientific names	Location sighted	Status
ACCIPITRIDAE			
Crested serpent-eagle	*Spilornis cheela*	L1	R
Changeable hawk-eagle	*Spizaetus cirrhatus*	L1	R
PHASIANIDAE			
Black wood-partridge	*Melanoperdix nigra*	MT	R
Great argus	*Argusianus argus*	L1	R
COLUMBIDAE			
Thick-billed pigeon	*Treron curvirostra*	L1	R
Little green-pigeon	*Treron olax*	L1	R
Jambu fruit-dove	*Ptilinopus jambu*	L1	R
Green-winged pigeon	*Chalcophaps indica*	L1	R
PSITTACIDAE			
Blue-rumped parrot	*Psittinus cyanurus*	L1	R
Blue-crowned hanging-parrot	*Loriculus galgulus*	L1	R
CUCULIDAE			
Indian cuckoo	*Cuculus micropterus*	L1	R/M
Banded bay cuckoo	*Cacomantis sonneratii*	L1	R
Rusty-breasted cuckoo	*Cacomantis variolosus (sepulchralis)*	L1	R
Black-bellied malkoha	*Phaenicophaeus diardii*	LR	R
Chestnut-bellied malkoha	*Phaenicophaeus sumatranus*	LR	R
Green-billed malkoha	*Phaenicophaeus tristis*	LR	R
Raffles's malkoha	*Phaenicophaeus chlorophaeus*	L1	R
Red-billed malkoha	*Phaenicophaeus javanicus*	LR	R
Chestnut-breasted malkoha	*Phaenicophaeus curvirostris*	LR	R
STRIGIFORMES			
Reddish scops-owl	*Otus rufescens*	Net	R
PODARGIDAE			
Gould's frogmouth	*Batrachostomus stellatus*	Net	R
TROGONIDAE			
Red-naped trogon	*Harpactes kasumba*	L1	R
Diard's trogon	*Harpactes diardii*	L1	R
Scarlet-rumped trogon	*Harpactes duvaucelii*	L1	R
ALCEDINIDAE			
Rufous-backed kingfisher	*Ceyx rufidorsus*	L1	R
Banded kingfisher	*Lacedo pulchella*	L1	R
MEROPIDAE			
Red-bearded bee-eater	*Nyctyornis amictus*	L1	R
Blue-throated bee-eater	*Merops viridis*	LR	LM

Table 2. cont.

Family/Common Names	Scientific names	Location sighted	Status
BUCEROTIDAE			
Bushy-crested hornbill	*Anorrhinus galeritus*	L1	R
Wreathed hornbill	*Rhyticeros undulatus*	L1	R
Rhinoceros hornbill	*Buceros rhinoceros*	L1	R
Helmeted hornbill	*Rhinoplax vigil*	L1	R
CAPITONIDAE			
Gold-whiskered barbet	*Megalaima chrysopogon*	L1	R
Yellow-crowned barbet	*Megalaima henricii*	L1	R
Blue-eared barbet	*Megalaima australis*	L1	R
Brown barbet	*Calorhamphus fuliginosus*	L1	R
Red-throated barbet	*Megalaima mystacophanos*	LR	R
PICIDAE			
Crimson-winged woodpecker	*Picus puniceus*	L1	R
Checker-throated woodpecker	*Picus mentalis*	L1	R
Buff-rumped woodpecker	*Meiglyptes tristis*	L1	R
Buff-necked woodpecker	*Meiglyptes tukki*	L1	R
Great slaty woodpecker	*Mulleripicus pulverulentus*	L1	R
White-bellied woodpecker	*Dryocopus javensis*	L1	R
Maroon woodpecker	*Blythipicus rubiginosus*	L1	R
Orange-backed woodpecker	*Rheinwardtipicus validus*	L1	R
EURYLAIMIDAE			
Dusky broadbill	*Corydon sumatranus*	L1	R
Banded broadbill	*Eurylaimus javanicus*	L1	R
Black-and-yellow broadbill	*Eurylaimus ochromalus*	L1	R
Green broadbill	*Calyptomena viridis*	L1	R
PITTIDAE			
Garnet pitta	*Pitta granatina*	L1	R
CAMPEPHAGIDAE			
Large wood-shrike	*Tephrodornis virgatus (gularis)*	L1	R
Lesser cuckooshrike	*Coracina fimbriata*	L1	R
Fiery minivet	*Pericrocotus igneus*	L1	R
Scarlet minivet	*Pericrocotus flammeus*	L1	R
CHLOROPSEIDAE			
Lesser green leafbird	*Chloropsis cyanopogon*	L1	R
Greater green leafbird	*Chloropsis sonnerati*	L1	R
Blue-winged leafbird	*Chloropsis cochinchinensis*	L1	R
PYCNONOTIDAE			
Black-headed bulbul	*Pycnonotus atriceps*	LR	R
Scaly-breasted bulbul	*Pycnonotus squamatus*	L1	R
Grey-bellied bulbul	*Pycnonotus cyaniventris*	L1	R

Table 2. cont.

Family/Common Names	Scientific names	Location sighted	Status
PYCNONOTIDAE –cont.			
Cream-vented bulbul	*Pycnonotus simplex*	L1	R
Red-eyed bulbul	*Pycnonotus brunneus*	L1	R
Yellow-bellied bulbul	*Criniger phaeocephalus*	L1	R
Hairy-backed bulbul	*Hypsipetes criniger*	L1	R
Buff-vented bulbul	*Hypsipetes charlottae (olivacea)*	L1	R
Ashy bulbul	*Hypsipetes flavala*	L1	R
DICRURIDAE			
Bronze drongo	*Dicrurus aeneus*	L1	R
Greater racket-tailed drongo	*Dicrurus paradiseus*	L1	R
ORIOLIDAE			
Dark-throated oriole	*Oriolus xanthonotus*	L1	R
Asian fairy-bluebird	*Irena puella*	L1	R
CORVIDAE			
Black magpie	*Platysmurus leucopterus*	L1	R
PARIDAE			
Sultan tit	*Melanochlora sultanea*	L1	R
SITTIDAE			
Velvet-fronted nuthatch	*Sitta frontalis*	L1	R
TIMALIIDAE			
Black-capped babbler	*Pellorneum capistratum*	L1	R
Short-tailed babbler	*Trichastoma malaccensis*	L1	R
Moustached babbler	*Malacopteron magnirostre*	L1	R
Scaly-crowned babbler	*Malacopteron cinereum*	L1	R
Rufous-crowned babbler	*Malacopteron magnum*	L1	R
Chestnut-backed scimitar-babbler	*Pomatorhinus montanus*	L1	R
Rufous-fronted babbler	*Stachyris rufifrons*	L1	R
Grey-headed babbler	*Stachyris poliocephala*	L1	R
Chestnut-rumped babbler	*Stachyris maculata*	L1	R
Striped tit-babbler	*Macronous gularis*	L1	R
Brown fulvetta	*Alcippe brunneicauda*	L1	R
White-bellied yuhina	*Yuhina zantholeuca*	L1	R
Malaysian rail-babbler	*Eupetes macrocerus*	L1	R
TURDIDAE			
White-rumped shama	*Copsychus malabaricus*	L1	R
Rufous-tailed shama	*Copsychus pyrropygus*	L1	R

Table 2. cont.

Family/Common Names	Scientific names	Location sighted	Status
SYLVIIDAE			
Flyeater	*Gerygone sulphurea*	L1	R
Arctic warbler	*Phylloscopus borealis*	L1	M
Dark-necked tailorbird	*Orthotomus atrogularis*	L1	R
MUSCICAPIDAE			
Grey-chested flycatcher	*Rhinomyias umbratilis*	L1	R
Asian brown flycatcher	*Muscicapa dauurica*	L1	M
Verditer flycatcher	*Muscicapa thalassina*	L1	R
Pale blue flycatcher	*Cyornis unicolor*	L1	R
Grey-headed flycatcher	*Culicicapa ceylonensis*	L1	R
Rufous-winged flycatcher	*Philentoma pyrhopterum*	L1	R
Asian paradise-flycatcher	*Terpsiphone paradisi*	L1	R/M
LANIIDAE			
Tiger shrike	*Lanius tigrinus*	L1	M
STURNIDAE			
Hill myna	*Gracula religiosa*	L1	R
NECTARINIIDAE			
Purple-naped sunbird	*Hypogramma hypogrammicum*	L1	R
Little spiderhunter	*Arachnothera longirostra*	L1	R
DICAEIDAE			
Yellow-breasted flowerpecker	*Prionochilus maculatus*	L1	R
Crimson-breasted flowerpecker	*Prionochilus percussus*	LR	R
ZOSTEROPIDAE			
Everett's white-eye	*Zosterops everetti*	L1	R
TOTAL NO OF SPECIES : 105			

Status:- R = Resident; M = Migrant; LR = Local migrant
Conservation status: All species are Totally Protected

Table 3. List of herpetofauna recorded in C14, Sungai Lalang Forest Reserve, Selangor

Taxa/Family/Species
Ampibians
Ichthyophiidae
1. *Caudacaecilia nigroflava*
Pelobatidae
2. *Leptobarachium hendricksoni*
3. *Megophrys nasuta*
4. *Megophrys* sp.
Bufonidae
5. *Bufo asper*
6. *B. parvus*
7. *Leptophryne borbonica*
Ranidae
8. *Limnonectes blythii*
9. *L. malesianus*
10. *R. chalconota*
11. *R. hosii*
Rhacophoridae
12. *Polypedates leucomystax*
Lizards, gekkos, skink & monitor lizard
Gekkonidae
13. *Cyrtodactylus consobrinus*
14. *Gecko smithii*
15. *Pthychozoon lionotum*
Agamidae
16. *Bronchocoela cristatella*
17. *Gonocephalus grandis*
18. *Draco melanopogon*
19. *D. quinquefasciatus*
20. *Draco* sp.
Scincidae
21. *Mabuya multifasciata*
Varanidae
22. *Varanus* sp.
Snakes
Colubridae
23. *Gonyosoma oxycephalum*
Turtles
Emydidae
24. *Heosomys spinosa*

Bird checklist of Bukit Rengit, Lanchang, Pahang

National Conservation Biological Training Centre (NCBTC) of the Department of Wildlife and National Parks (DWNP) is situated at the southern part of Krau Game Reserve, at an elevation of 100m above sea level. Bukit Rengit (671m) and Bukit Tapah (778m) are the two nearby hills at north. Primary vegetation surrounds this area is comprised lowland and hill dipterocarp forests. NCBTC can be accessed through a 17Km road from Lanchang, a small town along the Karak - Mentakab main road.

This paper presents the results of the avifauna surveys conducted in the surrounding area of NCBTC, from 26 - 28 March and 2 - 4 June 2001. Bird species from the following areas were surveyed and included in this checklist:

1. Forest trail behind the staff quarters (within 2Km from NCBTC), which includes the interpretive trail and the trail connected to Kuala Gandah.
2. Forest trail along Sungai Rengit.
3. Forest along the road 500m before the NCBTC front gate.
4. Area within the NCBTC compound and its surrounding forest edge.

All records were obtained from opportunistic bird watching. Both active searching and prolonged watches at more productive site (e.g. flowering and fruiting trees) were applied on field. Observations made by using 10 x 42mm binoculars and also 28-75 x 80mm spotting scope. Birds were identified by sight and by bird calls identification.

A total of 132 species from 38 bird families were recorded in the survey (see Table 1). Ten of these were open country species, found mainly at the forest clearing around NCBTC. Three were aerial feeders, hunting insects above NCBTC as well as over the forest canopy. One species (i.e. the White-breasted Waterhen *Amaurornis phoenicurus*) was observed only around the pond area at NCBTC. The remaining 118 species were observed only in the forest and / or near the forest edge. Dark-sided Flycatcher *Muscicapa sibirica* was the only confirmed migrant species recorded. None of the bird species from the *Phasianidae* family (Partridges and Pheasants) were recorded during the survey, which would normally found in this type of forest habitat.

Among the 132 species recorded, nine were classified as globally near threatened species (see Table 2) based on N. J. Collar *et al.* (1994).

Although effort had been made to record as many bird species as possible during the surveys, more species would undoubtedly be added by further observation. In order to document bird species found in NCBTC area completely, more future survey trips are therefore recommended.

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Table 1. List of bird species recorded from 26th to 28th March and 2nd to 4th June 2001.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: ACCIPITRIDAE (2 Species)					
CRESTED SERPENT-EAGLE *Spilornis cheela*	Helang Kuik / Lang Berjambul	R	F,S	1	
BLYTH'S HAWK-EAGLE *Spizaetus alboniger*	Helang Hindek Gunung / Lang Hantu	R	F	4	3 seen flying above NCBTC on 27-March.
Family: FALCONIDAE (1 species)					
BLACK-THIGHED FALCONET *Microhierax fringillarius*	Helang Rajawali	R	Fc,S	4	
Family: RALLIDAE (1 species)					
WHITE-BREASTED WATERHEN *Amaurornis phoenicurus*	Ruak-Ruak	MR	P	4	Seen only at the pond area at NCBTC.
Family: COLUMBIDAE (2 species)					
PEACEFUL DOVE *Geopelia striata*	Merbuk	R	S	4	Prefers open country habitats.
GREEN-WINGED PIGEON *Chalcophaps indica*	Punai Tanah	R	F,S	1	
Family: PSITTACIDAE (2 species)					
BLUE-RUMPED PARROT Psittinus cyanurus	Serindit Gajah / Puling	R	Fc	2,3	Globally near threatened.
BLUE-CROWNED HANGING-PARROT *Loriculus galgulus*	Serindit	R	Fc	3	
Family: CUCULIDAE (12 species)					
INDIAN CUCKOO *Cuculus micropterus*	Sewah India	MR	Fc	1,2,3,4	Common, recorded daily.
BANDED BAY CUCKOO *Cacomantis sonneratii*	Burung Takuweh	R	Fc	1	

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
PLAINTIVE CUCKOO *Cacomantis merulinus*	Burung Mati Anak	R	S	4	Prefers open country habitats.
RUSTY-BREASTED CUCKOO *Cacomantis sepulcralis*	Sewah Dada Oren	R	F,S	4	
VIOLET CUCKOO *Chrysococcyx xanthorhynchus*	Sewah Ungu / Sewah Rembah		MR	Fc	3
DRONGO CUCKOO *Surniculus lugubris*	Burung Hamba Kera / Sewah Sawai		MR	Fc	1,2,3,4
BLACK-BELLIED MALKOHA *Phaenicophaeus diardii*	Cenuk Perut Hitam	R	Fm	4	
RAFFLES'S MALKOHA *Phaenicophaeus chlorophaeus*	Cenuk Kerak	R	Fm	1,2,3,4	Common, recorded daily.
RED-BILLED MALKOHA *Phaenicophaeus javanicus*	Cenuk Api	R	Fm	3	1 seen at forest edge on 4-June.
CHESTNUT-BREASTED MALKOHA *Phaenicophaeus curvirostris*	Cenuk Birah	R	Fm	4	
SHORT-TOED COUCAL *Centropus rectunguis*	Bubut Rimba	R	Fg	2	Globally near threatened.
GREATER COUCAL *Centropus sinensis*	Bubut Besar	R	Fg,Ri,S	3,4	Prefers open country habitats.
Family: STRIGIDAE (2 species)					
COLLARED SCOPS-OWL *Otus lempiji*	Jampuk Kubur / Burung Hantu Reban	R	F,S	4	
BROWN HAWK-OWL *Ninox scutulata*	Pungguk / Burung Hantu Betemak	R	Fc,Fm,S	3,4	Regularly heard calling from forest edge at 2000 hrs.
Family: BATRACHOSTOMIDAE (1 species)					
JAVAN FROGMOUTH *Batrachostomus javensis*	Burung Segan Jawa	R	Fm,Fw	4	Globally near threatened.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: CAPRIMULGIDAE (1 species)					
MALAYSIAN-EARED NIGHTJAR *Eurostopodus temminckii*	Taptibau	R	A	4	Regularly seen at dawn and dusk. Aerial insectivores.
Family: APODIDAE (1 species)					
SILVER-RUMPED SWIFT *Rhaphidura leucopygialis*	Layang-Layang Ekor Pendek	R	A	4	Common, recorded daily. Aerial insectivores.
Family: HEMIPROCNIDAE (1 species)					
GREY-RUMPED TREESWIFT *Hemiprocne longipennis*	Layang-Layang Berjambul Kelabu	R	A	4	Common, recorded daily. Aerial insectivores.
Family: TROGONIDAE (2 species)					
DIARD'S TROGON *Harpactes diardii*	Kesumba Bukit	R	Fm	1	
SCARLET-RUMPED TROGON *Harpactes duvaucelii*	Kesumba Puteri	R	Fm	1,2,3	
Family: ALCEDINIDAE (5 species)					
BLUE-EARED KINGFISHER *Alcedo meninting*	Binti-Binti / Pekaka Bintik-Bintik	R	P,Ri	4	
ORIENTAL DWARF KINGFISHER *Ceyx erithacus*	Pekaka Api	MR	Fw	2	1 rufous-backed morph sighted on 27-March.
BANDED KINGFISHER *Lacedo pulchella*	Pekaka Riang Rimba / Kaing-Kaing Bukit	R	Fm	1,4	
WHITE-THROATED KINGFISHER *Halcyon smyrnensis*	Pekaka Belukar / Dada Putih	R	P,S	4	Prefers open country habitats.
RUFOUS-COLLARED KINGFISHER *Actenoides concretus*	Pekaka Rimba Besar	R	Fw	1	

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: MEROPIDAE (1 species)					
RED-BEARDED BEE-EATER *Nyctyornis amictus*	Beberek Tunggal / Janggut Merah	R	Fc	1,2	
Family: CORACIIDAE (1 species)					
DOLLARBIRD *Eurystomus orientalis*	Tiong Batu	MR	S	4	Prefers open country habitats.
Family: BUCEROTIDAE (4 species)					
WREATHED HORNBILL *Rhyticeros undulatus*	Enggang Gunung	R	Fc	1,4	
BLACK HORNBILL *Anthracoceros malayanus*	Burung Kekek / Burung Gatal Birah	R	Fc,S	1,3	Globally near threatened.
RHINOCEROS HORNBILL *Buceros rhinoceros*	Enggang / Enggang Badak	R	Fc	1,4	
HELMETED HORNBILL *hinoplax vigil*	Enggang Tebang Mentua	R	Fc	1,3,4	Globally near threatened.
Family: MEGALAIMIDAE (5 species)					
GOLD-WHISKERED BARBET *Megalaima chrysopogon*	Takur Pipi Kuning / Takur Jambang Emas	R	Fc	1,2,3,4	Common, recorded daily.
RED-THROATED BARBET *Megalaima mystacophanos*	Takur Raya / Takur Leher Merah	R	Fc	1	
YELLOW-CROWNED BARBET Megalaima henricii	Takur Kepala Kuning	R	Fc	4	
BLUE-EARED BARBET *Megalaima australis*	Takur Pipi Biru / Takur Akar	R	Fc	1,2,3,4	Common, recorded daily.
BROWN BARBET *Calorhamphus fuliginosus*	Takur Dahan	R	Fc	3,4	

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: PICIDAE (8 species)					
RUFOUS WOODPECKER *Celeus brachyurus*	Belatuk Biji Nangka	R	F,S	1,2,3,4	
CRIMSON-WINGED WOODPECKER *Picus puniceus*	Belatuk Sayap Merah	R	F	3	Common, recorded daily.
CHEQUER-THROATED WOODPECKER *Picus mentalis*	Belatuk Ranting	R	F	2,3	
OLIVE-BACKED WOODPECKER *Dinopium rafflesii*	Belatuk Rimba	R	F	4	
BUFF-NECKED WOODPECKER *Meiglyptes tukki*	Belatuk Tuki-tuki / Leher Kuning	R	F	2	
GREAT SLATY WOODPECKER *Mulleripicus pulverulentus*	Belatuk Kelabu	R	Fc	1,2,4	Common, recorded daily.
WHITE-BELLIED WOODPECKER *Dryocopus javensis*	Belatuk Gajah / Hitam-Putih	R	Fc	2,4	
MAROON WOODPECKER *Blythipicus rubiginosus*	Belatuk Punggur	R	F	2	
Family: EURYLAIMIDAE (4 species)					
DUSKY BROADBILL *Corydon sumatranus*	Takau Besar / Takau Rimba Hujan	R	Fm	1,3,4	
BANDED BROADBILL *Eurylaimus javanicus*	Takau Rimba	R	Fm	4	Common, recorded daily.
BLACK-AND-YELLOW BROADBILL *Eurylaimus ochromalus*	Takau Hitam-Kuning	R	Fm	1,3,4	Common, recorded daily.
GREEN BROADBILL *Calyptomena viridis*	Burung Seluwit / Takau Hijau	R	Fm	1,2,3	

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: PITTIDAE (2 species)					
GIANT PITTA *Pitta caerulea*	Burung Pacat Besar	R	Fg	2	Globally near threatened. 1 heard calling on 28-March.
BANDED PITTA *Pitta guajana*	Burung Pacat Bukit / Berjalur	R	Fg	2,3	
Family: CAMPEPHAGIDAE (4 species)					
BLACK-WINGED FLYCATCHER-SHRIKE *Hemipus hirundinaceus*	Rembah Batu / Rembah Sayap Hitam	R	Fc	3	
LARGE WOOD-SHRIKE *Tephrodornis virgatus*	Rembah Kayu Besar	R	Fc	4	
LESSER CUCKOO-SHRIKE *Coracina fimbriata*	Burung Kelabu Sayap Hitam / Sewah Kecil	R	Fc	2,3,4	
SCARLET MINIVET *Pericrocotus flammeus*	Burung Matahari / Mas Belukar	R	Fc	4	
Family: CHLOROPSEIDAE (2 species)					
GREEN IORA *Aegithina viridissima*	Burung Kunyit Hijau	R	Fc	1,4	
LESSER GREEN LEAFBIRD *Chloropsis cyanopogon*	Burung Daun Kecil	R	Fc	4	
Family: PYCNONOTIDAE (11 species)					
BLACK-HEADED BULBUL *Pycnonotus atriceps*	Merbah Siam	R	Fc,Fm	4	
GREY-BELLIED BULBUL *Pycnonotus cyaniventris*	Merbah Kelabu / Perut Kelabu	R	F	4	
STRIPE-THROATED BULBUL *Pycnonotus finlaysoni*	Merbah Luris Leher / Merbah Kunyit	R	S	4	Prefers secondary growth near forest edge.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
YELLOW-VENTED BULBUL *Pycnonotus goiavier*	Merbah Kapur	R	S	4	Prefers open country habitats.
CREAM-VENTED BULBUL *Pycnonotus simplex*	Merbah Mata Putih	R	F	4	
RED-EYED BULBUL *Pycnonotus brunneus*	Merbah Mata Merah	R	F	3,4	Common, recorded daily.
SPECTACLED BULBUL *Pycnonotus erythropthalmos*	Merbah Mata Merah Kecil	R	F	3,4	
GREY-CHEEKED BULBUL *Criniger bres*	Merbah Sampah	R	Fm,Fw	1,2,4	
YELLOW-BELLIED BULBUL *Criniger phaeocephalus*	Merbah Perut Kuning	R	Fm,Fw	1,2,3	Common, recorded daily.
HAIRY-BACKED BULBUL *Hypsipetes criniger*	Merbah Bulu Tengkuk	R	Fm,Fw	1,2,3	Common, recorded daily.
BUFF-VENTED BULBUL *Hypsipetes charlottae*	Merbah Riang	R	F	3,4	
Family: DICRURIDAE (2 species)					
BRONZE DRONGO *Dicrurus aeneus*	Cecawi Tembaga / Keladi	R	Fc,Fm	3,4	
GREATER RACQUET-TAILED DRONGO *Dicrurus paradiseus*	Hamba Kera / Cecawi Anting-Anting	R	Fc,Fm	1,2,3,4	Very common in the forest and at forest edge.
Family: ORIOLIDAE (2 species)					
DARK-THROATED ORIOLE *Oriolus xanthonotus*	Burung Kunyit Leher Hitam / Dedang Senja	R	Fc	1,3	
BLACK-NAPED ORIOLE *Oriolus chinensis*	Burung Kunyit Besar / Dendang Selayang	MR	S	4	Prefers open country habitats.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: IRENIDAE (1 species)					
ASIAN FAIRY-BLUEBIRD *Irena puella*	Murai Gajah / Dedang Gajah	R	Fc	2,3,4	
Family: CORVIDAE (3 species)					
CRESTED JAY *Platylophus galericulatus*	Burung Menjerit / Gagak Jerit	R	Fm,Fw	1,2	
BLACK MAGPIE *Platysmurus leucopterus*	Gagak Kambing / Burung Temenggang	R	Fc	1,4	Globally near threatened.
SLENDER-BILLED CROW *Corvus enca*	Gagak Rimba / Paruh Lampai	R	Fc	1	
Family: PARIDAE (1 species)					
SULTAN TIT *Melanochlora sultanea*	Serai Raja / Sultan	R	Fc	3	2 sighted on 28-June morning.
Family: TIMALIIDAE (20 species)					
BLACK-CAPPED BABBLER *Pellorneum capistratum*	Rimba Kepala Hitam	R	Fg	1,2,3	Very common in the forest.
SHORT-TAILED BABBLER *Trichastoma malaccensis*	Rimba Ekor Pendek	R	Fg	1,2	
FERRUGINOUS BABBLER *Trichastoma bicolor*	Rimba Sampah	R	Fw	1,2,3	Globally near threatened.
HORSFIELD'S BABBLER *Trichastoma sepiarium*	Rimba Hutan	R	Fw	1,2,3	Prefers dense vegetation near stream / river.
ABBOTT'S BABBLER *Trichastoma abbotti*	Rimba Riang	R	Ri	3	Prefers dense vegetation near stream / river.
MOUSTACHED BABBLER *Malacopteron magnirostre*	Rimba Bermisai	R	Fm	1,2	Very common in the forest.
SOOTY-CAPPED BABBLER *Malacopteron affine*	Rimba Tinjau Belukar	R	Fm	1,2	Very common in the forest.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
SCALY-CROWNED BABBLER *Malacopteron cinereum*	Rimba Tua Kecil	R	Fm	2	
RUFOUS-CROWNED BABBLER *Malacopteron magnum*	Rimba Tua Besar	R	Fm	1,2,3,4	Very common in the forest.
STRIPED WREN-BABBLER *Kenopia striata*	Rimba Hujan Berjalur / Tanda Hujan	R	Fg	1	
LARGE WREN-BABBLER *Napothera macrodactyla*	Rimba Hujan Besar	R	Fg,Fw	2	Globally near threatened.
RUFOUS-FRONTED BABBLER *Stachyris rufifrons*	Rimba Api	R	Fm	1	
GREY-HEADED BABBLER *Stachyris poliocephala*	Rimba Kepala Kelabu	R	Fw	2,3	
CHESTNUT-RUMPED BABBLER *Stachyris maculata*	Rimba Rembah Besar	R	Fm	1,2,3	Very common in the forest.
WHITE-NECKED BABBLER *Stachyris leucotis*	Rimba Rembang	R	Fw	1	
BLACK-THROATED BABBLER *Stachyris nigricollis*	Rimba Bertam	R	Fw	2	
CHESTNUT-WINGED BABBLER *Stachyris erythroptera*	Rimba Merbah Sampah	R	Fw	1,2	Very common in the forest.
STRIPED TIT-BABBLER *Macronous gularis*	Rimba Berjalur	R	F,S	1	
BROWN FULVETTA *Alcippe brunneicauda*	Rimba Murai Coklat	R	Fm	1	
MALAYSIAN RAIL-BABBLER *Eupetes macrocerus*	Rimba Sintar / Malaysia	R	Fg	4	Heard 1 calling from forest edge on 3-June.
Family: TURDIDAE (4 species)					
ORIENTAL MAGPIE ROBIN *Copsychus saularis*	Murai Kampung	R	S	3,4	Prefers open country habitats.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
WHITE-RUMPED SHAMA *Copsychus malabaricus*	Murai Rimba / Murai Batu	R	Fw	1,2,3,4	Common, recorded daily.
RUFOUS-TAILED SHAMA *Copsychus pyrropygus*	Murai Rimba Ekor Kuning / Oren	R	Fw	1	
WHITE-CROWNED FORKTAIL *Enicurus leschenaulti*	Cegar Dahi Putih / Murai Cegar Belukar	R	F,Ri	2	Prefers habitat along the forested stream.
Family: SYLVIIDAE (3 species)					
COMMON TAILORBIRD *Orthotomus sutorius*	Perenjak Pisang	R	S	4	Prefers open country habitats.
DARK-NECKED TAILORBIRD *Orthotomus atrogularis*	Perenjak Belukar / Leher Hitam	R	F	3,4	
RUFOUS-TAILED TAILORBIRD *Orthotomus sericeus*	Perenjak Rimba / Ekor Merah	R	F,S	3	Prefers area near opening in the forest & forest edge.
Family: MUSCICAPIDAE (5 species)					
GREY-CHESTED FLYCATCHER *Rhinomyias umbratilis*	Sambar Batu	R	Fw	1	
DARK-SIDED FLYCATCHER *Muscicapa sibirica*	Sambar Siberia	M	Fc,Fm	4	Migrant, 1 seen at forest edge on 27-March.
RUFOUS-CHESTED FLYCATCHER *Ficedula dumetoria*	Sambar Dada Oren	R	Fw	2	
PALE BLUE FLYCATCHER *Cyornis unicolor*	Sambar Biru Rimba	R	Fc,Fm	1,2	
GREY-HEADED FLYCATCHER *Culicicapa ceylonensis*	Sambar Pacat / Kepala Kelabu	R	Fm	1,2	
Family: RHIPIDURIDAE (1 species)					
SPOTTED FANTAIL *Rhipidura perlata*	Murai Gila Berbintik / Gila Bukit	R	Fm	1,2,3	

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: MONARCHIDAE (4 species)					
BLACK-NAPED MONARCH *Hypothymis azurea*	Kelicap Ranting / Sambar Uban Hitam	R	Fm	1,3	
MAROON-BREASTED MONARCH *Philentoma velatum*	Sambar Ungu / Dada Ungu	R	Fm	2	
RUFOUS-WINGED MONARCH *Philentoma pyrhopterum*	Sambar Sayap Merah / Paya	R	Fm,Fw	1,2,3	
ASIAN PARADISE-FLYCATCHER *Terpsiphone paradisi*	Murai Ekor Gading / Sambar Ekor Panjang	MR	Fm	1,2,3	Common, recorded daily.
Family: STURNIDAE (1 species)					
HILL MYNA *Gracula religiosa*	Tiong Emas	R	Fc,S	3,4	Common, recorded daily.
Family: NECTARINIIDAE (7 species)					
PLAIN SUNBIRD *Anthreptes simplex*	Kelicap Kelabu	R	F	4	
RUBY-CHEEKED SUNBIRD *Anthreptes singalensis*	Kelicap Pipi Merah / Belukar	R	F,S	3	
PURPLE-NAPED SUNBIRD *Hypogramma hypogrammicum*	Kelicap Rimba	R	F	1,2,3	
LITTLE SPIDERHUNTER *Arachnothera longirostra*	Kelicap Jantung Kecil	R	F	1,2,3,4	Common, recorded daily.
LONG-BILLED SPIDERHUNTER *Arachnothera robusta*	Kelicap Jantung Paruh Panjang	R	F	3	
SPECTACLED SPIDERHUNTER *Arachnothera flavigaster*	Kelicap Jantung Besar	R	F	4	
GREY-BREASTED SPIDERHUNTER *Arachnothera affinis*	Kelicap Jantung Bukit	R	F	4	Common, recorded daily.

Common & Scientific Name	Local Name	St	Ha	Ao	Remark
Family: DICAEIDAE (2 species)					
YELLOW-BREASTED FLOWERPECKER *Prionochilus maculatus*	Sepah Puteri Raja	R	F	3	
CRIMSON-BREASTED FLOWERPECKER *Prionochilus percussus*	Sepah Puteri Pelangi	R	F	1,3,4	
Family: ESTRILDIDAE (1 species)					
WHITE-RUMPED MUNIA *Lonchura striata*	Pipit Tuli	R	S	4	Prefers open country habitats.

Status (St):

(M) Passage migrant or winter visitor, not breeding in West Malaysia.
(MR) Resident, but may also occurred as passage migrant or winter visitor.
(R) Resident species.

Habitats (Ha):

(A) Aerial.
(F) Forest / Forest edge.
(Fc) Forest, but prefers upper storey or canopy level.
(Fg) Forest, but prefers the ground level.
(Fm) Forest, but prefers the middle storey level.
(Fw) Forest, but prefers the lower storey level.
(P) Pond and its surrounding vegetation.
(Ri) Habitat along stream / river / riverbank vegetation.
(S) Scrubs / secondary growth.

Area of Occurence (Ao):

(1) Recorded at forest trail behind the staff quarters (within 2Km from NCBTC), which includes the interpretive trail and the trail connected to Kuala Gandah. Terrain undulating with altitude range from 100m to 70m from sea level.
(2) Recorded at the forest trail along Sungai Rengit.
(3) Recorded at the forest edge along the road 500m before the NCBTC front gate.
(4) Recorded within NCBTC compound and its surrounding forest edge.

Note: The local bird name is based on Abdul Rahman (1981) and Jeyarajasingam & Peason (1999). Scientific and common names based on Lekagul & Round (1991), Inskipp *et al.*(1996), King *et al.*(1975), Medway & Wells (1976) and Wells (1999)

Table 2. List of globally near threatened bird species based on Collar *et al* (1994)

Common Name	Scientific Name	Local Name
BLUE-RUMPED PARROT	*Psittinus cyanurus*	Serindit Gajah / Puling
SHORT-TOED COUCAL	*Centropus rectunguis*	Bubut Rimba
JAVAN FROGMOUTH	*Batrachostomus javensis*	Burung Segan Jawa
BLACK HORNBILL	*Anthracoceros malayanus*	Burung Kekek / Burung Gatal Birah
HELMETED HORNBILL	*Rhinoplax vigil*	Enggang Tebang Mentua
GIANT PITTA	*Pitta caerulea*	Burung Pacat Besar
BLACK MAGPIE	*Platysmurus leucopterus*	Gagak Kambing / Burung Temenggang
FERRUGINOUS BABBLER	*Trichastoma bicolor*	Rimba Sampah
LARGE WREN-BABBLER	*Napothera macrodactyla*	Rimba Hujan Besar

Amphibians Checklist of Bukit Rengit, Lanchang, Pahang

This paper presents the checklist of amphibian recorded from the National Conservation Biological Training Centre (NCBTC) of the Department of Wildlife and National Parks (DWNP) at Bukit Rengit, Lanchang in Pahang. Sampling periods were from 20 to 22nd November 2000 and 26 to 27th March 2001. Amphibians collected were fixed in 10% formalin and later transferred to 70% ethanol. Identifications were based on Berry (1975). Repository of the vouchers were at the: - (1) wet museum collection (catalogued as DWNP) of the Headquarters of the DWNP, Kuala Lumpur and (2) the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research at the National University of Singapore. The sites surveyed included:- (1) the man-made pond in front of the guest houses, (2) the interpretive trail and the trail connected to Kuala Gandah, (3) Sungai Rengit and (4) NCBTC compound and its surrounding forest edge.

Eighteen species of frogs and toads belonging to five families (Table 1) were recorded from the study area. Of these, 11 species were ranids, three bufonids, two microhylids, one rhacophorid and one megophyrids. Commensal species such as *Rana erythraea*, *L. limnocharis*, *Phrynoglossus laevis*, *Polypedates leucomystax*, *Microhyla butleri*, *M.heymonsi*, *Bufo melanostictus* were more confined to the man-made pond. *M. heymonsi* was also collected along stream bank of Sungai Rengit, which is approximately 500 metres from the access road. Other species collected form the pond included *Rana miopus* and *R. nicobariensis*. *Bufo parvus* and *Megophrys nasuta* were collected from the path of the interpretive trail while *B. asper*, *Limnonectes laticeps*, *Rana chalconota*, *Rana hosii* and *R. glandulosa*, were found either in or along the stream.

Previous report of the amphibian fauna in the area revealed five species (*Polypedates leucomystax*, *Microhyla heymonsi*, *Bufo melasnostictus*, *Rana blythii* and *Limnonectes limnocharis*) by Salman *et al.* (1999). These species were also recorded in this study. Based on the wet collection at the DWNP, two species, *Bufo parvus* (DWNP.A.0168) and *Leptobrachium nigrops* (DWNP.A.0042) were collected from Bukit Rengit. Thus, the total number of species for the area is 19 species.

The NCBTC is located at the southern part of the Krau Wildlife Reserve, and amphibian is one of the least known taxon from this protected area. Extensive sampling and longer sampling period are highly recommended for the area, due to various habitat types available. The checklist compiled thus far will be useful as baseline for future studies.

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Table 1. Checklist of amphibian collected from the NBCTC, Bukit Rengit, Lanchang, Pahang

No.	Family/Species	Voucher Numbers
	Bufonidae	
1.	*Bufo asper*	DWNP.A.0421
2.	*B. parvus*	DWNP.A.0202-0205,0419-0420, ZRC.1.7952
3.	*B.melanostictus*	DWNP.A.0157
	Ranidae	
4.	*Limnonectes blythii*	DWNP.A.0422-0423
5.	*L.laticeps*	DWNP.A.0425
6.	*L. limnocharis*	DWNP.A.0948-0950
7.	*Phrynoglossus laevis*	DWNP.A.0412
8.	*Rana chalconota*	DWNP.A.0424
9.	*R. erythraea*	DWNP.A.0382, 0394-0402, ZRC.1.7959
10.	*R. glandulosa*	ZRC.1.7956-7957
11.	*R. hosii*	DWNP.A.0417
12.	*R. nicobariensis*	DWNP.A.0957-0958, ZRC.1.7955
13.	*R. miopus*	DWNP.A.0837-0838
14.	*R. signata*	DWNP.A.0416
	Microhylidae	
15.	*Microhyla butleri*	DWNP.A.0413-0415
16.	*M. heymonsi*	DWNP.A.0403-0406, ZRC.1.7953-7954
	Rhacophoridae	
17.	*Polypedates leucomystax*	DWNP.A.0407-0410, ZRC.1.7960-7961
	Pelobatidae	
18.	*Megophrys nasuta*	DWNP.A.0418, ZRC.1.7958

The distribution and food habits of *Pardofelis marmorata* in Peninsular Malaysia

The Marbled cat (*Pardofelis marmorata*) is the least known among the wild cat in Peninsular Malaysia. It is larger than a domestic cat. Its distribution range extends from Nepal, North India through Burma to Thailand, Indochina, Malaysia, Sumatra and Borneo (Lekagul & McNeely, 1977; Medway, 1983).

The head and body length of adult ranges from 45 to 55 cm and with a tail of about 110% longer than the head and body length, and can weigh between 3-6 kilograms. The Marbled cat is equally as colourful and distinctive as the Clouded leopard (*Neofelis nebulosus*) from which it is distinguished by its smaller size. Adult of this cat is orchraeous brown and buff below as compared with young specimen. The general pattern of the coat consists of black stripes on the head, neck and back with large black-edged blotches making the so-called marbling on the flanks. The tail is long and thick spotted with darkish blotches of stripes throughout and the limbs are covered with black spot. The ears are black with a white spot behind. Though smaller in size, the Marbled cat resembles the Clouded leopard in colour and patterns, infact the young Clouded leopard can be easily mistaken with the latter species. Nevertheless, the young of both these species can be distinguished by the presence of darkish stripes from the eye back to head in the Marbled cat as compared to spots only in the Clouded leopard. This paper presents the findings on the stomach content and body measurements of the Marbled cat based on four specimens. In addition, the distribution of this species is also discussed.

The Marbled cat is seldom seen or exhibited in zoos in Peninsular Malaysia. During the last 50 years of small mammal studied by the author, he had only come across four of these animals (Table 1).Both the shot animals (001 –002) were examined by the author. The third live animal (003) was trapped by the Orang Asli at the 22nd milestone, Ulu Gombak Forest Reserve at about 800 m.asl. The fourth live animal (004) was held by the Wildlife Department at Perlis. Both these live animals died after less than a month in captivity, and the cause of death was due to viral infections as well as stress ad diagnosed by the Veterinarian at Zoo Melaka, Melaka.

Two animals were sighted. One was sighted at Fraser Hills, Pahang in 1971 by Mr. Louis Ratnam of the Wildlife Department and the other was at the Sungai Dusun Game Department, Selangor in 1976 by Mr. Mohd Samsudin Mohd Suri of the Wildlife Department. It is quite possible that it had been sighted or capture elsewhere as well unknown to the author.

The mean measurement (in mm) of the four animals was 658.3 for head and body, 736.4 for tail, 119.5 for hindfoot, 47.8 for ear and 2375 g for weight. This compared with the mean measurement of four large individuals (3♂, 1♀) of *Prionailurus bengalensis* showed that the Marbled cat is comparatively larger than the latter species (Table 2). The much longer tail of the Marbled cat is the most distinct character between the two species.

Post mortem of two shot specimens revealed remnant of skins and skeletal remains of a squirrel and a small felid were recovered in a specimen (001), and the remains of a porcupine and bird feathers in specimen (002). The partial skin and tail remains of the squirrel was identified as belonging to the genus *Callosciurus* and the young felid was determined as *P. bengalensis* by part of the skull and skin remains, while the quills and part of the external tail remains were that of a Long-tailed porcupine (*Trichys lipura*). The bird feather were that of the ground bird, probably of the partridge family as identified by D. Molesworth, an ornithologist. Judging from the freshness of the food remains in the stomach of both these animals suggest that the prey victims were preyed upon quite recently before they were shot. Although little is known of the habits of this animal in its wilderness, but based on the identification of these prey species, it confirmed that the Marbled cat is both arboreal as well as ground stalker, both at night and during the day.

All the animals recorded were from forest reserves of pristine habitas, and all except one was captured or sighted in the lowland of less than 800 m.a.s.l. The exceptional one was sighted in hill forest above 1000 m asl at Fraser Hills. This confirms that the habitat range of the species is between low and hill forest terrain. The local distribution, based on current records (Table 1) extends from northern, central and the southern parts of the Peninsula.

Ixodid ticks (two individuals) were recovered from one of the two dead animals examined. They were

Table 1. Marbled cat from four localities

No.	Sex	Date	Locality	Remarks
001	♂	6/8/1964	Bukit Lagong Forest Reserve, Selangor	Shot by Orang Asli
002	♀	17/1/1961	Kota Tinggi Forest Reserve, Johor	Shot by Orang Asli
003	♂	16/4/1995	Ulu Gombak Forest Reserve, Selangor	Live- caught by Orang Asli
004	♂	June 1995	Perlis	Wildlife Department of Perlis

Note: all specimens were adult

Table 2. Comparison body measurements between Marbled and Leopard cat

	Pardofelis marmorata *						*Prionailurus bengalensis* **					
No	Sex	HB	T	HF	E	Wt	No	Sex	HB	T	HF	E	Wt
001	♂	645	740	120	45	1800	006	♂	602	265	116	39	1130
002	♀	665	725	118	47	2100	013	♀	655	235	100	43	1485
003	♂	668	735	120	50	2500	019	♂	614	239	117	43	1345
004	♂	655	745	120	49	3100	012	♂	625	237	118	44	1448
Total		2633	2945	478	191	9500	Total		2496	976	451	169	5405
Mean		658.3	736.5	119.5	47.8	2375	Mean		624	244	112.8	42.3	1351.3

Note: * measurements obtained from Melaka Zoo, Melaka
** Lim (1999)

identified as *Haemaphrysalis koningsbergeri* (Audy *et. al* 1960). No helminths of medical and public health importance were found in the two animals.

The Marbled cat based on authenticated records in the last 50 years, appears to be the least common among the wild felids in Peninsular Malaysia. Three of the six recorded individuals were from surrounding forest in Selangor and one each from Johor, Pahang and Perlis. The higher number captured in Selangor was more incidental, which probably was the results of greater past and current, small mammal research activities carried out in Selangor by various research institutions and universities in the state than any other states in the Peninsula. The scanty number recorded from other states does not necessary mean that the animals is more localised, but rather due to lack of information.

The animal, unlike all the other wild felids (tiger, panthers, clouded leopard, leopard and golden cat) which were also opportunistic visits of agricultural and human environments for farmed animals, the Marbled cat based on present records, seemed to be more restricted to pristine habitat.

Little is known of the species in Peninsular Malaysia, thus it is hard to ascertain the rarity of this animal in the country. There were examples of certain species of animals, take the Flat-headed cat (*Prionailurus planiceps*), the Long-tailed porcupine (*Trichys parvus*) which once thought to be very rare, were found otherwise though greater research efforts for them was carried out (Lim & Muul, 1975; Muul & Lim, 1970). Thus it is quite possible that the Marbled cat is more widely distributed throughout the Peninsula if greater research efforts are being made on this animal. This species however is a Totally Protected Animal.

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Effects of Selective Logging on Nocturnal Prosimians in Danum Valley, Sabah

Studies illustrating the effects of selective logging on primates in Southeast Asia have shown that many species appear to be responding fairly well to disturbance (Wilson & Wilson, 1975; Marsh & Wilson ,1981; Wilson & Johns, 1982; Johns, 1986; Marsh *et al.* 1987; Dahaban, 1996). Although the degree of responses varied in the beginning from a reduction in abundance to changes in foraging strategies, subsequently, most populations became stabilised and some even increased in numbers. Nevertheless, selective logging results in drastic changes in habitat structure and food resource abundance and distribution (Johns, 1986). In his study, Johns (1983) suggested that logged forests are characterised by a lower fruit production and a higher dispersion of food sources. The responses of the animals, then, would be to diversify their diets and forage more widely to search for scattered food resources. Other animal species, especially the ungulates, welcomed the changes in logged forest and took opportunities of the abundance of young leaves and shoots of pioneer species (Wilson & Wilson, 1975). Since virtually every tropical rain forests face periods of food scarcity (Terborgh, 1986), the effects of logging on animals will no doubt intensify the difficulty in foraging for food. The assaults to the remaining rainforests at present, however, remain unabated. Studies on the abilities of animals to survive in disturbed habitats are, therefore, more important than ever. The nocturnal prosimians, however, are a group of primate that has received little attention in population or ecological studies due to the difficulties involved in conducting night surveys. Thus, this study illustrates the potential of a selective logged forest to maintain nocturnal prosimians in Danum Valley: the slow loris (*Nycticebus coucang*) and the western tarsier (*Tarsius bancanus)*, with emphasis on the density of the western tarsier between primary and a 12-year-old logged forest.

The Danum Valley Conservation Area (4° 57' 40"N, 117° 48' 00"E), located in the upper catchment of the Segama River, within the Ulu Segama Forest Reserve, is 91% moist, evergreen, lowland dipterocarp forest, while the rest is lower montane forest (Marsh & Greer, 1992). It covers an area of 438 km^2 and is surrounded by various ages of logged secondary forests within the Yayasan Sabah (Sabah Foundation) Concession Area of 972,804 sq. km.

Sabah experiences two monsoon seasons with a wetter period affected by the north-east monsoon (December – March) and a drier period by the south-east monsoon (May – October). The average annual rainfall at DVFC for 14 years from 1986 to 1999 is 2677.3 $\pm$ 107.7 mm. The maximum annual rainfall for Danum Valley Conservation Area (DVFC) was 3294.1 $\pm$ 79.1 mm in 1995, while the minimum was 1913.4 $\pm$ 56.1 mm in 1997. The mean temperature at DVFC from 1986 to 1993 was 26.7°C, with a mean maximum of 30.9°C and mean minimum of 22.5°C. Daily temperature fluctuations are noticeably more pronounced than the year-to-year fluctuations. Mean annual relative humidity at DVFC was 94.5% at 0800h and 72% at 1400h.

In the PF, five line-transects of one km long each, were randomly chosen from the existing permanent forest trails (Figure 1). There were four line-transects established in the LF, running eastward and ranging from 0.7 to 1.3 km in lengths. Two line-transects were located in Coupe 88, one in Coupe 89, while the other overlaps both coupes (Figure 1). Selective logging, which involved tractor yarding and high lead lines, took place in both coupes in October 1988 in three stages and lasted for 11 months. Major disturbance affected the forest to the north of the line-transects in Coupe 89, while in Coupe 88, the disturbance was more pronounced.

Night surveys were done on 10 randomly-selected days every month (except when it rained) from December 1997 – May 1999. Observations started at about 1900h and ended at about 2200h. Observations were aided by a powerful 10 x 40 Zeiss binocular, distances were measured using a digital rangefinder or a measuring tape, sighting angles and height were measured using precision compass and clinometers, and night observations were aided by using powerful spotlights. Total sampling effort throughout the study duration in the PF and LF was 90 km and 72 km, respectively. Prosimian species, number of animals, sighting bearings, height of the animal in the tree, direct distance from the observer to the animal, and other parameters were recorded for each sighting.

Density estimates were obtained using DISTANCE v3.5 (Buckland *et al.* 1993). Individual densities were estimated for each species from pooled data of all line-transects in each forest type. This procedure was

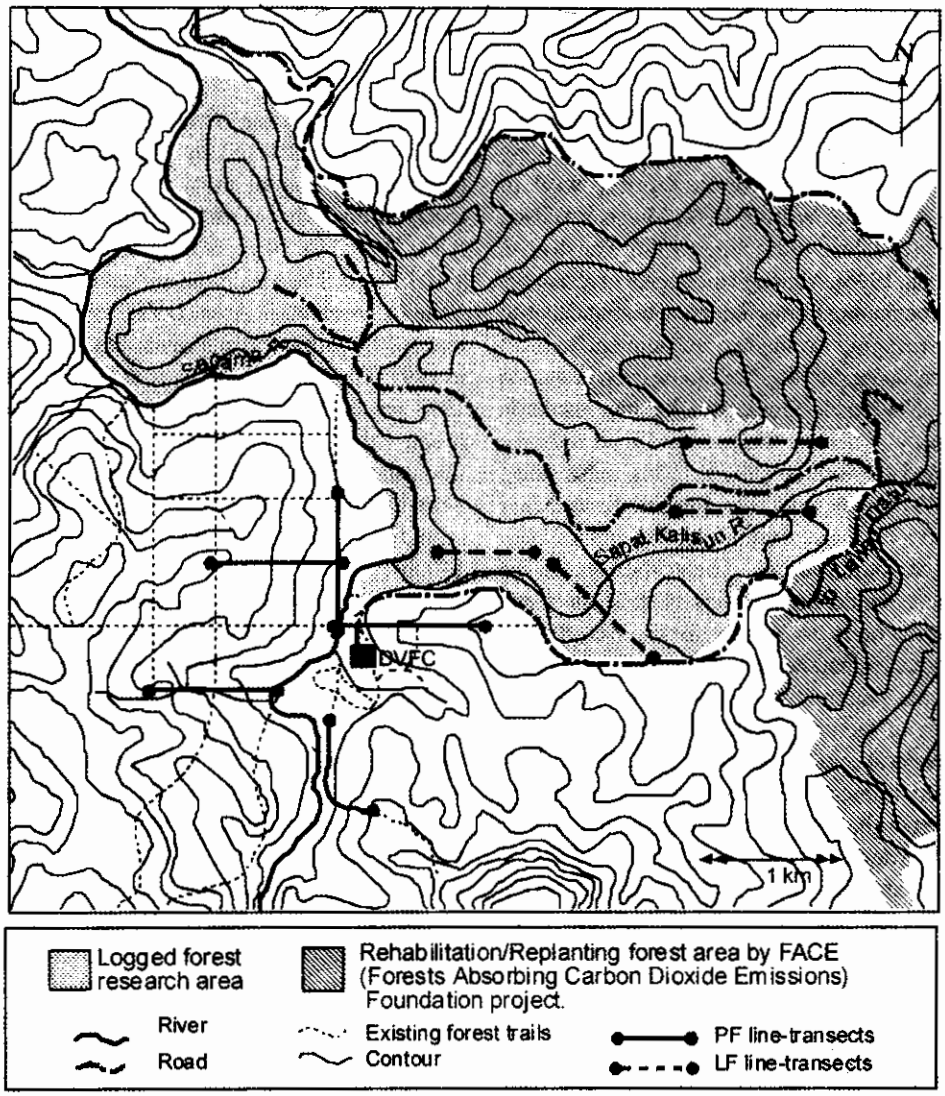

Figure 1. Location of the line-transects (bold lines in the PF) and dotted lines in the LF) in Danum Valley, Sabah, Malaysia.

Table 1. Number of individuals of prosimians recorded in the PF and LF sites, Danum Valley, Sabah

Taxa	No. individuals			Locomotion	Diet	SocialOrg.	Wt *
	PF	LF	**Total**				
Lorisidae							
N. coucang	1	1	**2**	A	C	S	0.42
Tarsiidae							
T. bancanus	15	14	**29**	A	I	S	0.11
Total Night	**16**	**15**	**31**				

Locomotion: A=Arboreal, T=Terrestrial; **Diet**: C=Carnivorous, I=Insectivorous, O=Omvivorous, F=Frugivorous, Fo=Folivorous; **Social Organization**: S=Solitary, G=Group, M=Monogamous pair;
* **Weight**=Average of adult male and female weight in kg following Payne *et al.* 1985.

Table 2. Parameters of abundance estimated for *Tarsier bancanus* in PF and LF at Danum Valley, Sabah

Forest type	Distance surveyed (km)	No. sightings	ER	D	SE
		Present study			
PF	90	16	0.17	4.9	± 1.64
LF	72	15	0.19	9.8	± 4.07
		Heydon (1994)			
PF	49.4	19	0.39	15.2	8.8 – 26.0
LF	72.3	16	0.22	8.2	4.5 – 14.7

ESW=effective strip width (m), n/L=encounter rate (ind/km), DS=Cluster density (cluster/km^2), E(S)=Cluster size (n/cluster), D=estimate of density of animals (ind/km^2)

Table 3. Distribution of primates in the vertical zonation of the PF and LF, Danum Valley, Sabah. Numbers in brackets are proportion of the total number of sightings.

Taxa	**Primary Forest**					**Logged Forest**				
Level	**1**	**2**	**3**	**4**	**Total**	**1**	**2**	**3**	**4**	**Total**
N. coucang		1			1		1			1
		(1.8)			(1.8)		(4.2)			(2.3)
T. bancanus		15			15		14			14
		(26.8)			(26.8)		(32.6)			(32.6)

Level: 1=ground level (0 m), 2= understorey level (1 – 10 m), 3= canopy level (10-25 m), 4= emergent level (> 25 m)

justified since between-site variances in perpendicular distances (which could have resulted from potential differences in habitat-dependent detectability) were no greater than those within sites (ANOVAs, P>0.05).

Thirty-one prosimians of two species were observed (*Nycticebus coucang*: one in each forest; *Tarsius bancanus*: n=16 in the PF and n=15 in the LF, Table 1). There was little information on the slow loris because they were very shy, cryptic and would quickly take cover in the dense vegetation upon contact. Due to limited data, density estimation for this species was not attempted. The tarsiers were more abundant in both forest types and data were sufficient enough for density analysis. Generally, social primates are more easily detected than solitary animals, but for the western tarsiers, which usually occurred solitarily, they are easy to detect because they normally forage or rest in small trees of the understorey. According to Chivers (1991), the tarsier lacks a tapetum lucidum (the reflective layer behind the retina that gives off the red eyeshine). The eyeshine, however, was clearly visible, despite other contradicting reports (Payne et al. 1985).

The density of *T. bancanus* was 4.9 individuals/km^2 in the PF, compared to 9.8 individuals/km^2 in the LF (Table 2). There was, however, no significant difference between individual density for *T. bancanus* in the PF and LF ($t=1.14$, $t_{0.05,\,df=27}=2.05$, P>0.05).

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Rafflesia in Krau Wildlife Reserve, Pahang

The rare, parasitic plant *Rafflesia* has been located growing within Krau Wildlife Reserve (KWR). On 13 September 2001, a large mammal survey team was setting up camera-traps in north-eastern part of the Reserve in the Sungai Terboi catchment area, when they came across the giant flower. It was growing out of a vine stem at waist height above the ground (see Figure. 1). The site was about 8km in from the edge of the Reserve, at an approximate altitude of 380m, and about 10m from a tributary of the Terboi river, called Sungai Rumput. The exact point was not georeferenced but the approximate location, using the Malayan Rectified Skew Orthmorphic Grid, is VE 4635 WMR 4203. The flower was photographed and has subsequently been identified from a photograph as *Rafflesia cantleyi* Solms-Laubach, known locally as *bunga pakma*, by the Forest Research Institute Malaysia (FRIM). This is the first time that the presence of *Rafflesia* in KWR has been documented. The species has, however, previously been encountered once in the vicinity of KWR (pers.comm. Saw Leng Guan, FRIM), and its presence in the Reserve is well known amongst the local communities, particularly, apparently, in the north-eastern part of the Reserve (pers.comm. KWR Local Community DWNP/DANCED Rangers).

Rafflesia cantleyi is only found in Peninsular Malaysia and the occurrence of this species is now restricted to a small number of localities principally in Perak, Kedah, Kelantan, and Pahang (Wong & Latiff, 1994; Meijer, 1997; Nais, 2001). The type specimen of *R. cantleyi* was collected in 1881 in Peninsular Malaysia by M.Cantley, the curator of the Singapore Botanic Gardens at that time, and was later described in 1910 by H.Graft Solms-Laubach (Nais, 2001). Only two other species of *Rafflesia* are known to occur in Peninsular Malaysia, but not exclusively so, namely *Rafflesia hasseltii* and *Rafflesia kerrii* (Meijer, 1990, 1997; Nais, 2001). All three species display extreme host specificity and are obligate parasites on the *Tetrasigma* vine of the grape family Vitaceae (Mat Salleh, 1991; Nais 2001), with *R. cantleyi* showing a marked preference for the species *Tetrasigma leucostaphylum* (Nais, 2001). The distribution of *Tetrasigma* vines does not coincide with the distribution of *Rafflesia* species, and vines infected with *R. cantleyi* are generally found growing in lowland dipterocarp forest near streams and rivers at an altitude of about 470-610m (Nais 2001), as was the case in KWR.

The finding of *Rafflesia cantleyi* inside a protected area is a valuable find, as only about 15 nature reserves throughout the whole of the West Malesian region of Borneo, Sumatra, Java, Peninsular Malaysia, Thailand and the Philippines are thought to contain *Rafflesia* species (Meijer, 1990). The conservation status of *Rafflesia cantleyi* is listed as "Vulnerable" according to IUCN criteria (IUCN, 1997), because the species has a highly restricted distribution, which has been further reduced by logging operations and especially by forest conversion, and by the silvicultural practice of climber cutting. It is also listed as "Vulnerable" due to over-collection of *R. cantleyi* buds for their alleged medicinal properties, in particular as a tonic for women after childbirth (Meijer, 1990; Nais, 2001). In KWR, *R. cantleyi* is protected from forest conversion and logging activities. The species is, however, collected for sale, with one kilogramme of buds reportedly fetching a price of RM5 (pers.comm. KWR Local Community DWNP/ DANCED Rangers).

Recommendations for the protection of *Rafflesia* species both inside and outside conservation areas, especially mechanisms to control over-visitation by visitors, have been strongly advocated (see Mat Salleh, 1991; Meijer, 1990; and in particular Nais 2001). Recommendations include working with local communities, heightening conservation awareness,

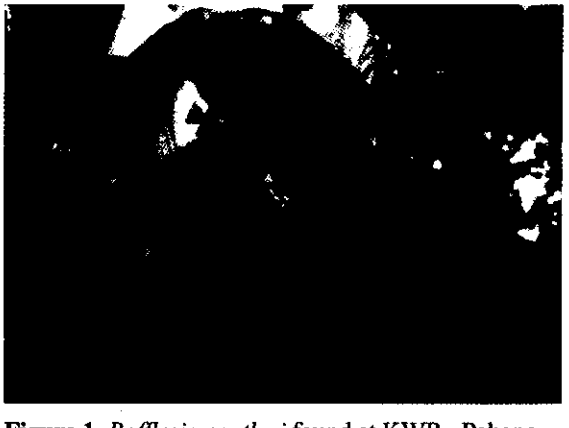

Figure 1. *Rafflesia cantleyi* found at KWR, Pahang

protecting plants from trampling by visitors and encouraging scientific research, particularly for academic and educational purposes, as much is still unknown about the ecology and life-history of *Rafflesia* plants. With the confirmed presence of *Rafflesia cantleyi* in KWR, KWR is well placed to implement such recommendations, as it is an internationally renowned research location and has a proactive management regime.

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