NATURAL SALT-LICKS AND MAMMALS IN DERAMAKOT:

THEIR IMPORTANCE AND WHY THEY SHOULD BE CONSERVED

Hisashi MATSUBAYASHI and Peter LAGAN

Sabah Forestry Department

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NATURAL SALT-LICKS AND MAMMALS IN DERAMAKOT:
Their importance and why they should be conserved
Hisashi Matsubayashi
Peter Lagan

Cover photo: A flanged male orang-utan at the natural salt-lick
Frontispiece: A mother and juvenile orang–utan at the natural salt-lick

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Large Flying Foxes (*Pteropus vampyrus*)

FOREWORD

Among the terrestrial ecosystems, the tropical rainforests of Borneo in which Sabah is located are now acknowledged as the most biodiversed habitat on Earth – places that still hold many secrets from modern science. Loss of biological diversity has been noted as an important global issue. Biodiversity is decreasing at an alarming rate in the history of the earth mostly due to human activities. Biodiversity is closely related to the soundness of an ecosystem, and the sustainable use of an ecosystem allowing maintenance of its biodiversity is fundamental.

As can only be expected, 21st century Sabah is a fast changing place. Logging has degraded a good deal of Sabah's Commercial Forest Reserves, where timber is the main contributor to the state's economy until recently. Conflicting forces are at work, and not all of them are bad news for the environment. Ecotourism in particular is set to play an important role in the country's economy with Sabah leading the way. Despite the fast pace of change, particularly in the forest landscape, the biodiversity remains intact. Therefore, it is crucial to ensure habitats for our iconic wildlife species such as the Orang-utan and Proboscis Monkey, the main attraction for visitors to Sabah.

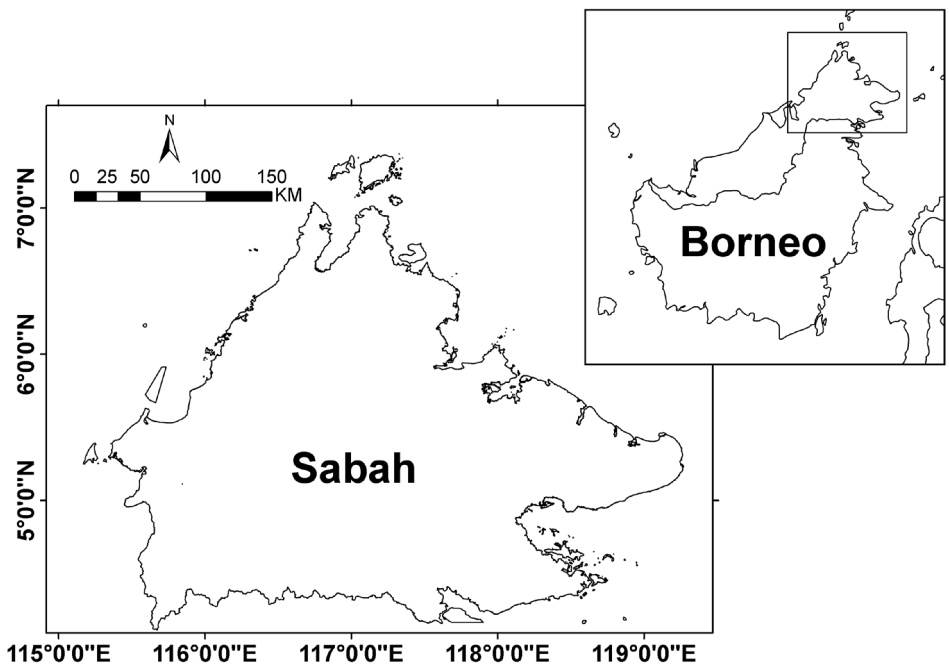
In **NATURAL SALT-LICKS AND MAMMALS IN DERAMAKOT: Their Importance and Why They Should be Conserved**, Wildlife Biologist Dr. Hisashi Matsubayashi and Sabah Forestry Department Officer Peter Lagan, joined forces to describe and illustrate in pictures the natural habitats of wildlife in Deramakot Forest Reserve. They affirm that RIL (Reduced Impact Logging) is compatible with wildlife conservation and that natural salt-licks are hotspots of biodiversity and important habitats for the endangered large mammals such as, Bantengs, Orang-utans and Asian Elephants and should be protected. They also stressed that responsible forest management of all permanent forest reserves in Sabah is critical to ensure the survival of wildlife. I offer my congratulations to the authors for such a seminal work. Thank you.

Datuk Sam Mannan
Director of Forestry

Mast flowering of the lowland dipterocarp forest in Deramakot Forest Reserve.

INTRODUCTION

This booklet consists of 4 chapters. **Chapter 1: "Forests and Mammals in Sabah, Malaysian Borneo"** provides a general overview of the forests and their inhabitants particularly the mammals and the role they play as seed dispersers in maintaining a healthy forest ecosystem. This chapter also briefly describes the impacts on the mammals with human presence and demonstrates that appropriate forest management is compatible with wildlife conservation. Thus, **Chapter 2: "Responsible Forest Management of Deramakot Forest Reserve (DFR)"** is about best practices being carried out in DFR, the first natural tropical rainforest in Southeast Asia to be certified under the Forest Stewardship Council™ certification scheme. Besides describing the various forest management activities in DFR, it also explains the importance of High Conservation Value Forests (HCVF). Natural salt-licks identified in DFR have significant biodiversity values and are categorized as areas within forests of critical temporal use by wildlife. **Chapter 3: "Natural Salt-Licks and Mammals"** presents a part of our study focusing on the use of natural salt-licks by mammals in DFR. **Chapter 4: "Natural Salt-Licks and Orang-utans"** provides new findings of habitat use by Orang-utans. Chapter 3 and 4 illustrate the importance of natural salt-licks for mammals. This booklet stresses the need for responsible forest management, and discusses why wildlife habitats should be managed and conserved to ensure the survival of mammals.



The forest in Deramakot after a torrential downpour.

CHAPTER 1

FORESTS AND MAMMALS IN SABAH, MALAYSIAN BORNEO

1.1 Forests and Mammals in Sabah

With a total area of almost 7.4 million hectares (73,610 km^2), Sabah which stretches from 4°8' to 7°2' north of the equator, is the second largest state in Malaysia and one of the two East Malaysian states located on the island of Borneo. Despite the extensive changes in its landscape, Sabah still harbours a rich biodiversity of flora and fauna. So what has been done towards the conservation of this astoundingly rich biodiversity that Sabah is endowed with?

About 60% of the state remains under forest: Permanent Reserved Forests (PRF; 87.4%), Parks and Wildlife Sanctuaries (6.6%), and Timber Plantation (5.9%) (Sabah Forestry Department 2012). In PRF of 3.6 million hectares, there are seven principal classes: Class I (Protection Forest), Class II (Commercial Forest), Class III (Domestic Forest), Class IV (Amenity Forest), Class V (Mangrove Forest), Class VI (Virgin Jungle Forest) and Class VII (Wildlife Reserve) (Fig. 1.1). Of the total PRF, 29% (1.03 million

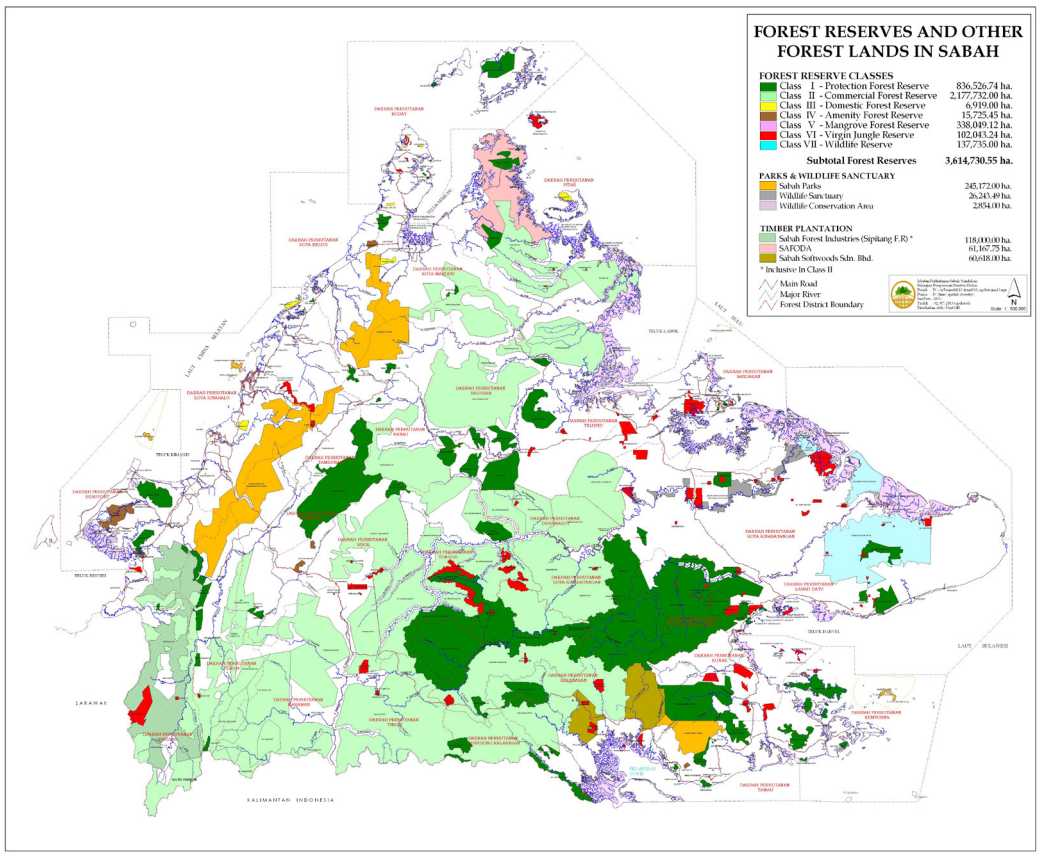


Fig.1.1: Forest Reserves and Other Forest Land in Sabah.

hectares) are classified as Protection Forests (Class I, IV, VI and VII) while the remaining 71% (2.6 million hectares) are classified as Production Forests (Class II, III and V).

The tropical rainforests of Sabah, include mangrove forests, peat swamp forests, fresh water swamp forests, limestone forests, Dipterocarp forests, montane and sub-alpine forests. These forests are the habitats of more than 3,000 tree species, over 1,500 orchid species and a plethora of other plant species, including the largest flower on earth, the *Rafflesia*.

They are also habitats for more than 220 species of terrestrial mammals which are dominated by the chiroptera (bats; 92 species; 41%) and rodentia (rats; 62 species; 28%) (Payne *et al*., 1998).

- Eulipotyphla: Moonrat, Lesser Gymnure, Shrews
- Scandentia: Treeshrews
- Dermoptera: Flying Lemurs
- Chiroptera: Fruits bats and Insectivorous bats
- Primates: Lorises, Tarsiers, Monkeys, Bornean Gibbons, Bornean Orang-utans
- Pholidota: Sunda Pangolins
- Rodentia: Squirrels (Flying squirrels), Rat and Mice, Porcupines
- Carnivore: Bears, Martens, Weasels, Badgers and Otters, Civets and Mongooses, Cats
- Proboscidea: Elephants
- Perissodactyla: Rhinoceros
- Cetartiodactyla: Pigs, Mousedeer, Barking deer, Sambar deer, Banteng

Endangered large mammals in Sabah are the Sumatran Rhinos, Bantengs, Asian Elephants, Sunda Clouded Leopards, Sun Bears, Proboscis Monkeys and Bornean Orang-utans (hereinafter, orang-utan) (Fig. 1.2). The Sumatran Rhino is considered as one of the most endangered mammalian species in the world and is on the brink of extinction on the island of Borneo. The populations of these endangered mammals in Sabah were estimated to be less than 30 for the Sumatran rhinos, 1,500 Asian elephants, 6,000 proboscis monkeys, and 11,000 orang-utans. Those of Banteng, Sun bears and Sunda Clouded Leopards are still unknown, though past report estimated the population of the Banteng to be between 330 and 550 in Sabah (Davis & Payne, 1982). Furthermore, our study on Banteng shows that the Bornean Banteng diverged genetically from other Banteng subspecies and that the wild Bornean Banteng are pure strains and have high conservation value (Matsubayashi *et al*., 2014). Habitat management and a captive breeding program are necessary to ensure their existence.

Conservation efforts are being carried out by the Sabah Wildlife Department and assisted by Sabah Forestry Department, local and international NGOs such as Borneo Rhino Alliance (BORA), HUTAN and Bornean Sun Bear Conservation Centre (BSBCC). BORA helps to support and unite the combined efforts of the various government agencies and NGOs involved and, the international rhino conservation network serves to ensure that the remaining rhinos are secured within the protected areas that are actively

patrolled by the Rhino Protection Unit (http://www.borneorhinoalliance.org/). HUTAN conducts orang-utan and other wildlife research and conservation (http://www.hutan.org.my/) and BSBCC helps to provide for the care, rehabilitation and release of orphaned and captive sun bears, as well as to address the lack of knowledge and awareness of this little-known bear, both in Malaysia and internationally (http://www.bsbcc.org.my/).

Fig.1.2: Photo of (a) Banteng, (b) Sumatran Rhinoceros, (c) Sun Bear, (d) Sunda Clouded Leopard, (e) Asian Elephant, (f) Orang-utan, and (g) Proboscis Monkey.

Sunda Pangolin - an Endangered Species (IUCN Red List)

Sunda Pangolins (*Manis javanica*) are ant/termite eaters that are endangered species. This animal uses its developed claws and long tongue for feeding on ants and termites. They sleep in burrows which they excavate in the soil and/or in hollows of dead trees. They often climb trees to access ant nests. The species is highly sought after for its meat and, its scales which are purportedly said to have medicinal properties. Its population is decreasing due to illegal hunting/trade. Captive breeding of this animal is needed.

Juvenile male Pangolin and a radio tagged (circled) individual.

A Pangolin climbing a tree to feed on ants (left) and its nesting site (right).

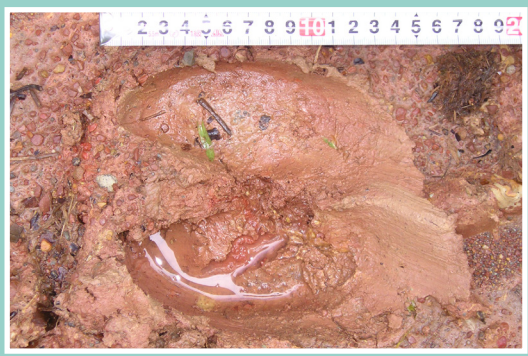
Foot Prints of Ungulates

Forest dwelling animals are elusive and often difficult to spot. But they leave behind imprints of their hooves on the ground which are easily recognizable. Eight species of ungulates which are, the Bearded Pig, Mousedeer (two species), Barking Deer (two species), Sambar Deer, Banteng (wild cattle) and Sumatran Rhino inhabit the forests of Borneo. Footprints of six species out of the eight can be easily identified by the size and shape of their hooves. Footprints of the two species of Mousedeer and/or the two species of Barking Deer are quite difficult to identify.

Mousedeer (little finger size).

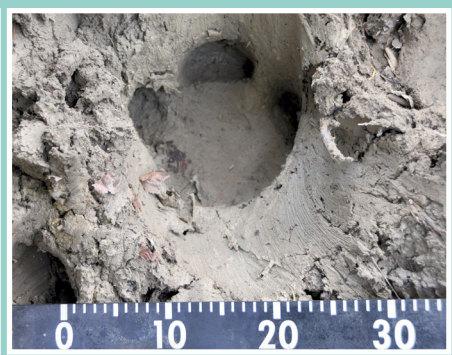
Barking Deer (thumb size).

Sambar Deer (elongated).



Banteng (circular).

Bearded Pig (main cloven hooves + side smaller hooves).



Sumatran Rhino (three hooves).

1.2. Mammals as Seed Dispersers

Some mammalian species have important ecological function as seed dispersers (Fig. 1.3). Here, we look at some representative seed dispersers, such as Sun Bears, Civets, Asian Elephants and Bantengs.

Fig.1.3: Seeds from faeces.

Sun Bear

The Sun Bear is the smallest bear in the world and weighs around 50kg. However, it is the largest order of Carnivora in Borneo. It often climbs trees to feed on honey from the stingless bees. Its population is decreasing because it is illegally hunted for its gall bile or captured and kept as pets.

Sun Bear and their bark prints. Hollow on the tree stem gouged by the sun bear will eventually become nesting places for flying squirrels and/or hornbills.

Faeces of Sun Bear with longan seeds, *Dimocaptus longan*. Ninety seeds were found in the faeces.

Fig.1.4: Signs left by the Sun Bear.

Civets

Sabah has eight species of civets (Fig.1.5). Habitat preference and feeding habits vary according to each species. In Tabin Wildlife Reserve, in the eastern part of Sabah, 108 out of 111 fecal samples collected from gravel roads were identified as belonging to the common palm civet. The seeds belonging to 30 different plant species were identified in the faeces (Nakashima *et al*., 2010).

Fig.1.5: Common Palm Civet (left) and Masked Palm Civet (right).

Asian Elephant and Ungulates

Large herbivores can disperse large seeds over long distances. Fig.1.6, 1.7 and 1.8 show seed dispersal by large herbivores, Asian Elephant, Sambar Deer and Banteng.

Fig.1.6: Seeds ingested by Asian Elephants and seeds germinating from their faeces.

Fig.1.7: Regurgitated seeds ingested by the Sambar Deer and its footprint (circled).

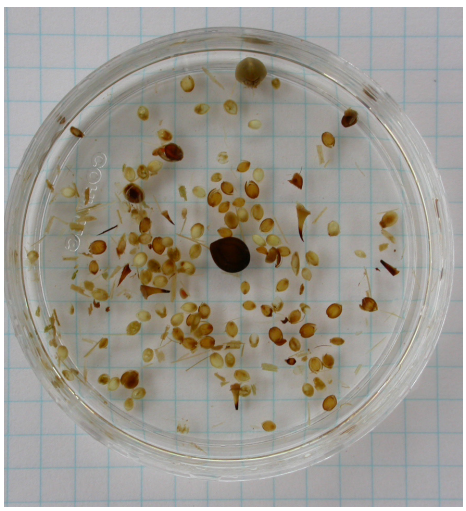


Fig.1.8: Herbal seeds from Banteng faeces (left) and the seeds that have germinated from its faeces (right).

1.3. Human Impacts on the Mammals

Impacts on wildlife can either be natural or human-caused. The former is related to geography, climate and biology. The latter consists of threats from mainly hunting and habitat loss brought about by development. Here, we focus on the human impacts.

At present, hunting is the most negative impact on wildlife. Humans hunt them for bush meat, pets and medicine. In Sabah, hunting ungulates, such as bearded pig, mousedeer, barking deer and sambar deer are allowed with an approved hunting license outside of forest reserves. However, pangolins (scales and meat), sun bears (gall bile), and Sumatran rhinos (horn) are still snared or shot and their body parts are either consumed or illegally traded. Unregulated hunting can cause the extinction of the local populations and/or species. A forest which has lost its animals to hunting is called an "Empty Forest" or a "Green Desert". In the tropical rainforest ecosystem, mammals have various ecological roles, though in most cases, the extend to which they influence the ecosystem are still unknown.

Fig. 1.9, 1.10 and 1.11 show the different mode of timber transportation. The word "logging" always has a negative connotation because of its impacts to biodiversity. Here, we highlight on three main issues on the impacts of logging and these are: changes in the forest canopy structure, changes in vegetation type and increase in hunting pressures (Meijaard *et al*., 2005).

1. **Changes in the forest canopy structure**

   An increase in the intensity of gaps following harvesting and development of logging road will alter the forest canopy from one being continuous to one of being discontinuous (habitat fragmentation). The arboreal species that uses the forest canopy to move from one forest to another to forage and procreate will be significantly more affected than the terrestrial species. The energy demand of them for niche competition and/or ground movement will increase.

2. **Changes in vegetation type**

   An increase in gap area following harvesting will dramatically alter a species rich climax forest to a forest that is dominated by pioneers, such as *Macaranga* spp. Thus, food repertoire will be decreased.

3. **Increase in hunting pressures**

   When the forest is made accessible with the development of logging roads, illegal activities such as poaching/hunting follow. Populations of high economic value species, such as ungulates and carnivores will decrease drastically.

Fig. 1.9: Transporting harvested logs down river in a barge at upper Kinabatangan River.

Fig.1.10: Log rafting, another means of timber transport.

Fig. 1.11: Hauling of timber overland with logging trucks.

Over development has also serious impact on wildlife. The establishment of large scale oil palm plantations involves clearing of forests, which without a doubt, is a clear example of habitat loss.

So, what are the characteristics of a logging-intolerant species? Though most of the ecological information of mammals in tropical rainforest is inadequate, we can infer from Meijaard & Sheil (2008) and Meijaard *et al*., (2008), the three factors that make up the characteristics of a logging-intolerant species. These are:-

1. Ecological characteristics
Small niche species, such as specialists, species with biased feeding habits (↔ generalists, such as omnivores) and users of specific forest layers, especially arboreal species (e.g., Bornean Gibbons and Leaf Monkeys).

2. Biogeographical characteristics
Endemic species (species with restricted distribution), such as Bornean Bay Cats and the Tufted Ground Squirrels (↔ species of wide distribution).

3. Evolutionary characteristics

Those with early period of divergence, such as the Sunda Clouded Leopards and Sumatran Rhinos. There are two major periods of species divergence, Miocene or Early Pliocene, and late Pliocene or Pleistocene. The latter experienced dramatic changes in climate because of repeated glacial and interglacial periods. Therefore, diverged species of the late Pliocene or Pleistocene are thought to be more adaptable than the diverged species of the Miocene or Early Pliocene.

Humans exploit the forest for its timber resources and wildlife needs the forests for their habitats. At present, Protection Forests in Sabah stands at 29% of Permanent Reserved Forests, while Production Forests account for 71% of PRF. This indicates that appropriate forest management will determine the future of wildlife. The next chapter presents one of many challenges of the Sabah Forestry Department.

Fig. 1.12: Rigid boundary between forest and oil palm plantation.

Fig. 1.13: Canopy differences of well-managed forest (top) and (bottom) conventionally logged forest with heavy logging intensity (note the creeper domination).

Paliu (*Antianis toxicaria*). The sap of this tree is highly toxic. It is used to coat the tip of blow darts of traditional blowpipes for hunting.

Certified logs from Deramakot which have been measured, graded, numbered and sorted for auction. Peter Lagan on the right.

CHAPTER 2

RESPONSIBLE FOREST MANAGEMENT OF DERAMAKOT FOREST RESERVE

2.1. Deramakot Forest Reserve

Deramakot Forest Reserve (DFR) lies north of the Kinabatangan River and is in the middle of Sabah (Fig. 2.1). It occupies about 25% of the Lokan peneplain, an elevated plain that has been eroded over time by rivers so that it is now an endless maze of ridges and meandering streams. Most of these 250,000 hectares of peneplain have been converted into oil palm plantations. DFR remains the last large tract of lowland dipterocarp forest that once entirely covered the Lokan peneplain.

Here, we are actually referring to part of the Forest Management Unit No. 19 (Lagan *et al*., 2007). This is a unique Commercial Forest Reserve (Class II). It is the first and longest tropical rainforest entity in the world to be certified under the Forest Stewardship Council™ and the Malaysia Criteria and Indicators for best practices. This area which is now managed wholly by the Sabah Forestry Department has been cited for

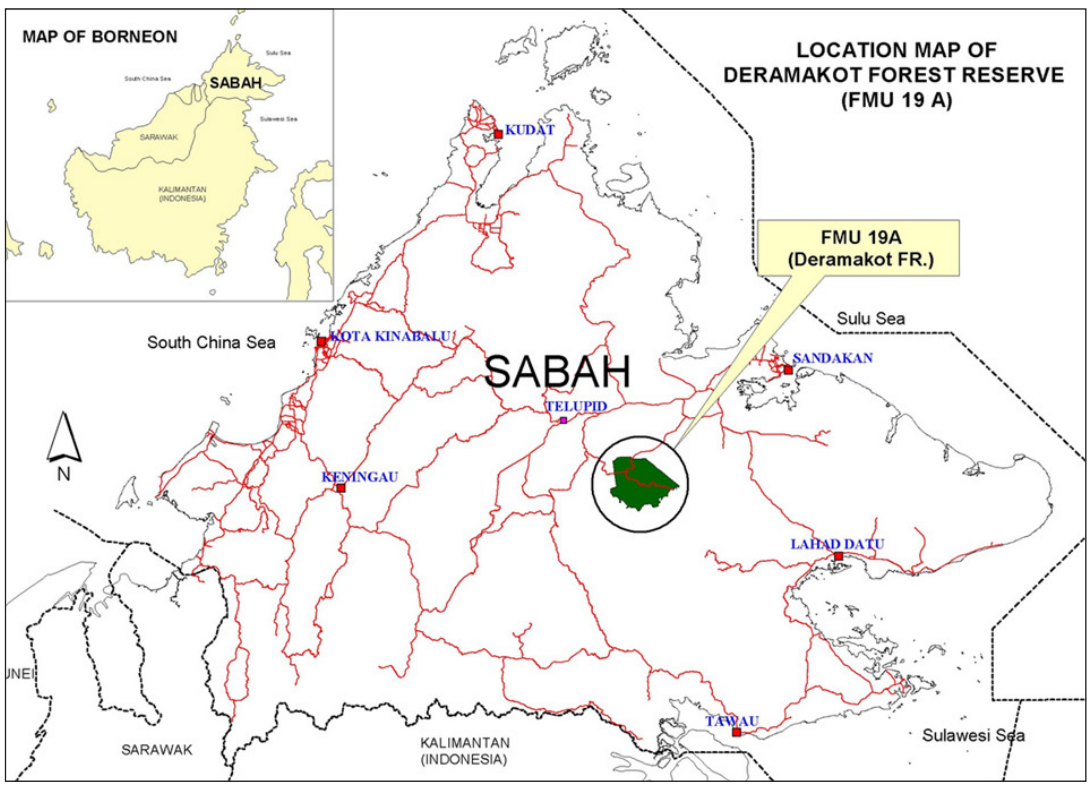


Fig. 2.1: Location of Deramakot Forest Reserve.

Exemplary Forest Management by the Food and Agriculture Organisation of the United Nations (FAO) and the Regional Community Training Centre for Asia and the Pacific (RECOFTC).

The objective of this project is to apply an ecologically and scientifically acceptable forest management programme to logged-over Commercial Forest Reserves of Sabah. This programme was designed to manage the commercial forest reserves in a way that mimics natural processes to produce a low volume of high quality, high-priced timber products. In other words, the aim is to produce sustainable timber within the rainforests and not simply deplete the rainforests of their timber resources. Sustainability here does not just refer to continued timber production, such as those found in timber plantations but is defined in terms of a balance of nutrient cycles, forest structure, biodiversity, forest function and socio-economic needs.

Selective logging was first recorded in this area in 1956 but the first logging licence was not issued until 1959. In 1961, it was gazetted as a Class II – Commercial Forest Reserve. Logging ceased in 1989 to make way for the initiation of the Sustainable Forest Management project in collaboration with the government of the Federal Republic of Germany through GTZ. Responsible forest management was implemented in 1995 following the adoption of a 10-year Forest Management Plan. In July 1997, DFR was certified as "well managed" under the FSC Principles and Criteria and the national standard, Malaysia Criteria and Indicators (MC & I). Collaboration with GTZ of Germany ended in 2000 and the project has been managed by the Sabah Forestry Department since that date.

DFR is composed of 55,507 hectares (equivalent to 66,000 soccer fields) of mixed lowland dipterocarp forest. This has been divided into 135 compartments of manageable sizes ranging from about 100 ha to 900 ha. Through forest zoning, approximately 51,000 hectares are set aside for log production under a carefully controlled management plan that features reduced impact logging (RIL), and the remaining 4,000 hectares are divided into 17 conservation designated compartments.

The forest has been placed in 4 categories or "stratum" on the basis of the number of emergent trees per hectare identified in aerial photos, ranging from "Good Forest" with more than 16 emergent trees per hectare to "Very Poor Forest" with less than 5 emergent trees per hectare. The boundaries of the 118 compartments for timber production under the management plan do not coincide with the boundaries of the different forest stratum (Fig. 2.2).

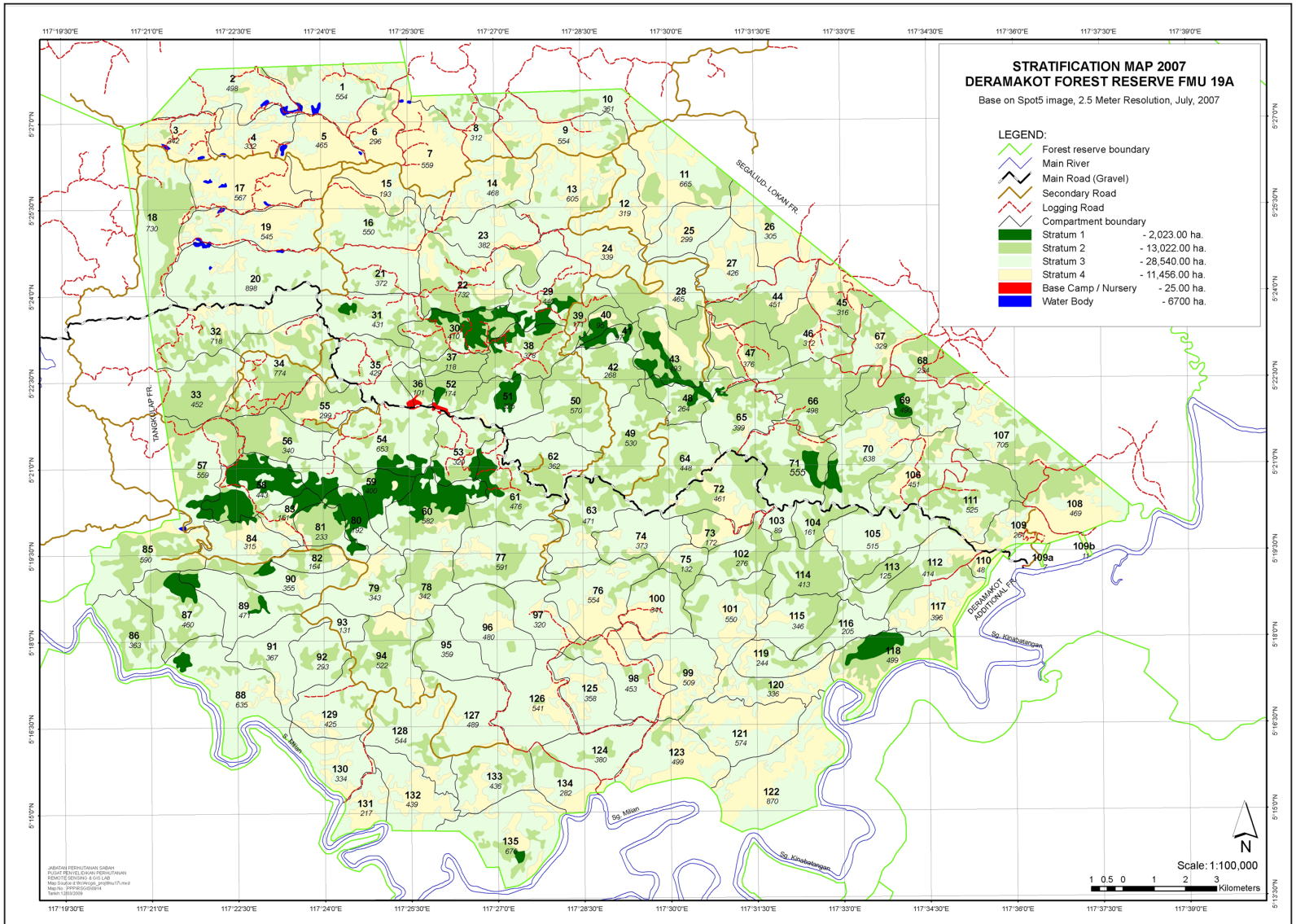


Fig. 2.2: Stratum map of Deramakot (2007).

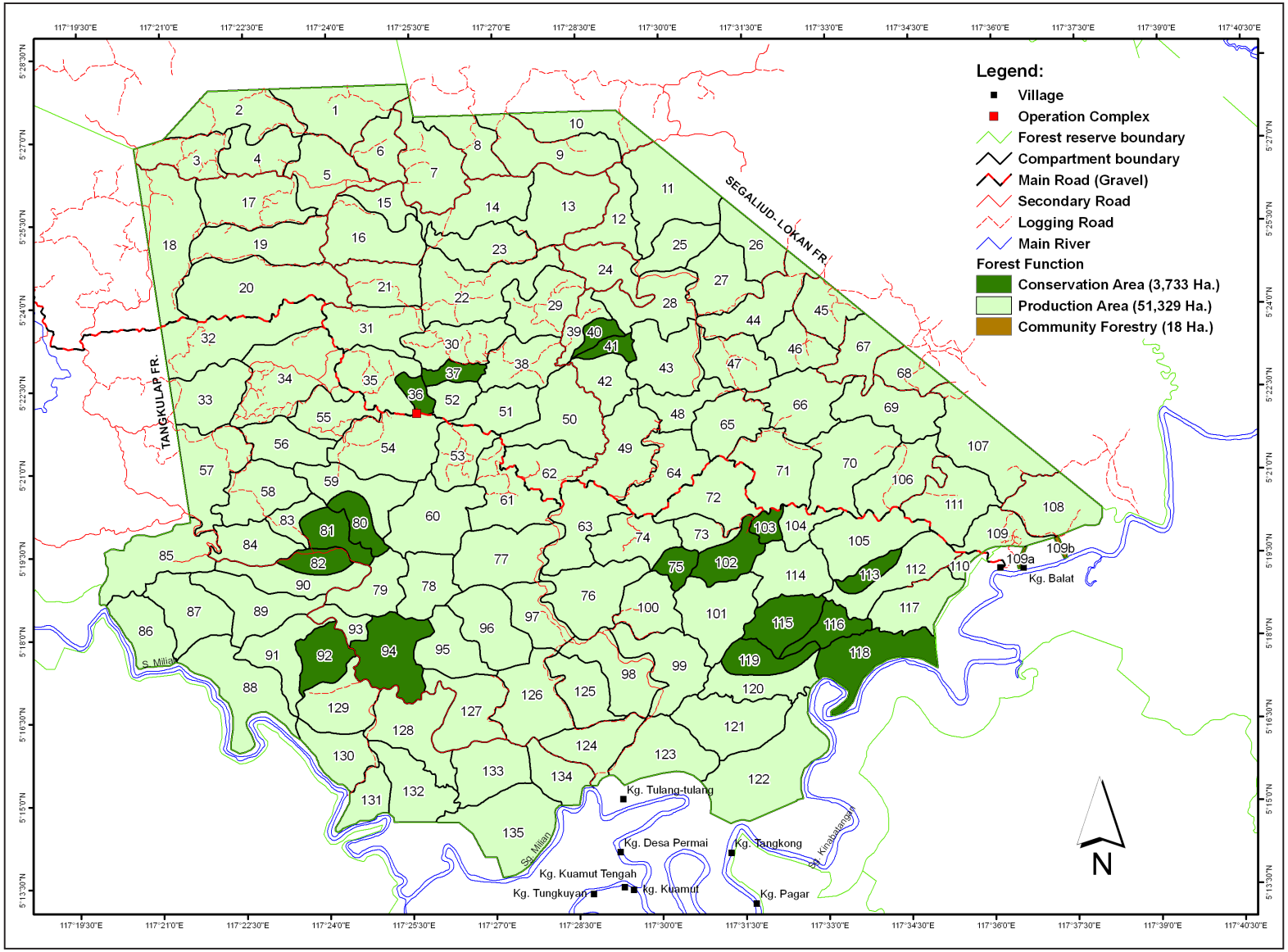


Fig. 2.3: Forest Zoning of Deramakot.

The conservation compartments are not contiguous (Fig. 2.3). There are two important facts here to note. One is that this is a contiguous forested area of over 55,507 hectares so that while some species of wildlife may prefer to live within the conservation areas, they can still migrate from one conservation compartment to another through some level of forest cover. The other is that the conservation areas will provide planting stock of endemic species for the commercial operations as well as to provide a reservoir of endemic plants and animals.

2.2. Harvesting and Other Forest Management Activities

This management programme has several major facets:

i. Harvesting – Reduced Impact Logging

Pre-harvest planning is done at the compartment level and according to the Reduced Impact Logging (RIL) guideline which includes marking of trees to be harvested, alignment of extraction routes (feeder roads and skid trails) and identification of High Conservation Values (mineral-licks, riparians, fruit trees, steep areas, etc). Information on the ground is then mapped and documented in the CHP (Comprehensive Harvest Plan; Fig. 2.4), designed to remove selected trees with minimal impact on soil and the surrounding forest environment. Harvesting is limited to the annual growth under a management cycle of 40 years (Sabah Forestry Department, 2009).

Selected trees for felling are marked with a white ring. Senior Forest Ranger Edward Thomas (right) with a timber feller.

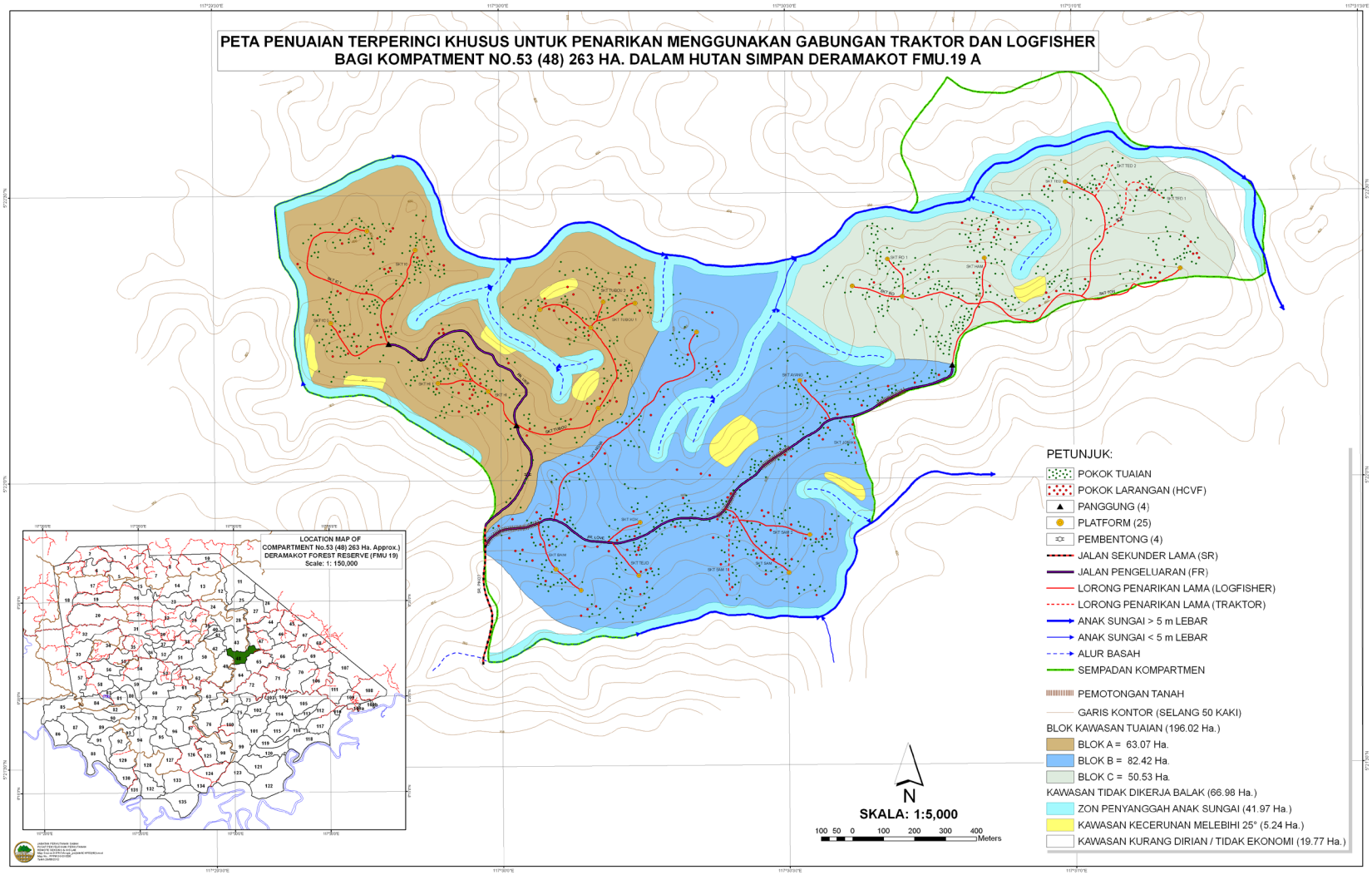


Fig. 2.4: A CHP map of compartment number 53.

ii. Silviculture

Timber stand improvement or commonly known as Silviculture serves to enhance the forest ecosystem. Past forest management practises have resulted in a mosaic of very heterogeneous forest stand types and different stocking conditions. Maintenance and enhancement of the forest through planting and selective removal of competing vegetation (e.g. woody vines and creeping bamboos) are essential because about 20% of DFR is considered well stocked and more than 30% is covered by very poor forest with virtually no mature growing stock left (Fig. 2.5).

Fig. 2.5: Selective removal of competing vegetation.

iii. Wildlife Conservation

DFR is not about timber per se. Wildlife management is part of responsible forest management in DFR (Lagan *et al*., 2007; Matsubayashi *et al*., 2007a, 2007b, 2011; Samejima & Ong, 2012 ; Samejima *et al*., 2012). The richness in biodiversity of DFR is astounding. As planned in the management plan, approximately three quarters of DFR remains undisturbed or closed to forest management activities at any given time. This means all forest management activities (silviculture, forest restoration and harvesting) are focused on a small portion (10,000 ha) of DFR staggered over a period of 10 years, which translates to a management cycle of about 40 years. This is planned primarily to encourage plant succession without disturbance, and at the same time, the undisturbed areas act as sanctuaries for wildlife that thrive in DFR.

DFR is home to some globally and locally threatened large mammal species, including Orang-utans, Bantengs, Asian Elephants, Sunda Clouded Leopards, Sun Bears and Proboscis Monkeys. While most people would consider these large species to be the most important and perhaps obvious forms of endemic wildlife, there are also myriads of other species that form the basis of the food chain. DFR is about more than the big things that most people search for first in a rainforest habitat. It is about the ecosystem as a whole.

2.3. High Conservation Value Forests (HCVF)

The FSC stresses that identification of an HCVF does not automatically mean that the forest should be a protected area. It infers that special management approaches are needed to ensure that the High Conservation Values (HCVs) are not degraded.

About 4,000 hectares of forests (17 compartments) within DFR which are steeply dissected (with slope gradient above 25^0) are permanently set aside for conservation. This means no management is undertaken in these compartments and their main functions are primarily for conservation of the forest eco-systems (forest resources, soil, water and biodiversity of both flora and fauna).

However, areas (51,000 ha) that are zoned for natural forest management in DFR but do exhibit attributes of HCVs, are also mapped out and protected. There are six identified HCV attributes based on the HCVF Toolkit for Malaysia developed by WWF-Malaysia, and these are:

- **HCV 1 – Biodiversity Values** (e.g. endemism, rare, threatened and endangered species, salt-licks, fruit trees, nesting/roosting sites and forest areas legally gazetted as Protected Areas).

- **HCV 2 – Landscape-level Forest** (e.g. forest areas that form a linkage or connectivity between large fragmented forests or wildlife corridors for movement of animals).

- **HCV 3 – Ecosystems** (e.g. rare and threatened ecosystems such as lowland dipterocarp forest, peat swamps and limestone habitats).

- **HCV 4 – Services of Nature** (e.g. watershed and catchment areas, riparian areas and steep areas).

- **HCV 5 – Basic Needs of Local Communities** (e.g. areas identified for collection of minor forest produce such as rattan and medicinal plants, and services for basic subsistence/health needs).

- **HCV 6 – Cultural Identity of Local Communities** (e.g. burial sites and places of worship).

HCVs 1, 2, 3 and 4 are identified at the pre-harvest planning level. These are documented during the preparation of the Comprehensive Harvest Plan (CHP). HCVs 5 and 6 require close consultation with the local communities living in or adjacent to DFR. All identified HCVs are mapped, buffered and excluded from harvesting. The mapped HCVs provide a focus for monitoring. So, where are the HCVs in the forest? In the following chapter we look at natural salt-licks which are identified as areas or sites within forests of critical temporal use under HCV 1.

Social - Meaningful Engagement with Local Communities

Functional handicraft making by local community of the Balat village.

Engagements with the local communities are managed through a committee called "The Deramakot Social Forestry Committee (DSFC)". Periodic consultations with the local communities are held every 4 months. There are no communities inside the reserve, but 4 villages (20 - 50 household) located on the southern fringe of DFR have been identified. In DFR, meaningful engagement with local communities is about:

- Providing training and developing skills, such as producing functional and decorative handicrafts to ensure local communities of a livelihood.
- Providing basic amenities such as clean water, schools, etc.
- Providing jobs, in line with the government policy to eradicate rural poverty.

All these efforts came to fruition with the assistance of the local and international non-governmental organisations (NGOs) such as WWF, HUTAN, HSBC, RALEIGH INTERNATIONAL, etc.

MERCY-Malaysia (Sabah Chapter) providing free medical services to locals (top). Providing environmental education to school children of the local communities (bottom).

One of many signages that can be seen in Deramakot. A reminder to all of us that it is very expensive to correct what is wrong.

An adult female Asian Elephant at a natural salt-lick.

CHAPTER 3

NATURAL SALT-LICKS AND MAMMALS

3.1. Natural Salt-Licks

Natural salt-licks are known as sodium-rich places. Although most essential elements (nitrogen, phosphorus, potassium, calcium, and magnesium) are common in plants and animals, sodium is essential primarily for animals only. Moreover, plants of inland terrestrial ecosystems do not contain much sodium because of the distance from the sea. And tropical soils are known to be depleted in major cations (Jordan, 1985). Therefore, plant-eating mammals, especially in tropical rainforests, need another source of the minerals (particularly sodium) that are deficient in plants. Natural salt-licks are one such place where animals can supplement their diet with these minerals. Many studies on the relationship of the chemical properties of natural salt-licks and mammals have been conducted, and the roles of natural salt-licks and species diversity of visiting mammals were reported (Emmons & Stark, 1979; Kreulen, 1985; Izawa, 1993; Moe, 1993; Clayton & MacDonald, 1999; Krishanmani & Mahaney, 2000; Montenegro, 2004).

Sabah has two types of natural salt-licks: mud volcanoes and salt springs (both types known locally as "Tagai" in the Sungai dialect). The famous large mud volcanoes are

Fig. 3.1: Mud volcano in Tabin Wildlife Reserve – gas and salt-water emanating from the center of the dark grey area.

Fig. 3.2: Asian Elephants and Bearded Pigs visiting the mud volcano.

located at Tabin Wildlife Reserve, on the eastern part of Sabah (Fig. 3.1). Gas and salt-water emanating from the mud volcano very likely originated from the Tertiary sediments. Many animals were recorded at the mud volcano such as Asian Elephants and Bearded Pigs (Fig. 3.2). But unfortunately, this place is too vast to detect all visiting species. Salt springs, are comparatively smaller than mud volcanoes. Fig. 3.3 shows salt-springs, a type of natural salt-licks in Deramakot Forest Reserve.

Fig.3.3: Natural salt-licks in Deramakot.

Most of the natural salt-licks observed in Deramakot measure approximately $1m^2$ (Fig. 3.3a-c), except for the one shown in (Fig. 3.3d). A small amount of water is continuously and steadily supplied all year round through seepages from the soil and fissures in the rocks. Four natural salt-licks were selected for our study.

We compared concentrations of the minerals in the water (sodium, calcium, magnesium and potassium) of the natural salt-licks using streams or watercourses as controls in the vicinity of the study area. The results showed high concentration of minerals (Table 3.1). We also analysed the various mineral content of soils at the natural salt-licks, and they were very low, especially that of sodium (Table 3.2).

Table 3.1: Mineral concentrations and pH of the water at the natural salt-licks.

Locations (No. of Samples)	Minerals (µg/ml)				pH
	Ca	Mg	Mg	Na	
D1 (4)	45.8±4.5	9.5±0.9	20.1±6.1	154.3±4.6	8.4
D2 (3)	28.2±2.0	5.9±1.5	28.8±14.4	106.7±9.2	7.5
D3 (4)	67.3±7.7	24.2±5.9	10.4±1.6	46.8±12.1	8.1
D4 (4)	125.6±51.2	30.8±10.7	21.5±9.0	2622.7±1177.2	7.7
Control (3)	10.7±7.7	2.5±0.9	1.3±0.4	17.6±12.3	7.6

Table 3.2: Mineral concentrations and pH of soils at the natural salt-licks.

Locations	Minerals (mg/g)				pH in H^2O
	Ca	Mg	Mg	Na	
D1	3.3	5.2	5.7	0.5	7.0
D2	2.1	8.6	10.6	0.6	6.4
D3	4.4	5.6	4.6	0.5	6.5
D4	0.7	1.2	1.3	0.2	6.0
Control1	2.9	3.2	4.2	0.3	5.4
Control2	0.3	1.7	3.2	0.2	5.2

Fig. 3.4 shows the locations of the identified natural salt-licks. Distribution of the natural salt-licks in Deramakot is dispersed and located more on the eastern area.

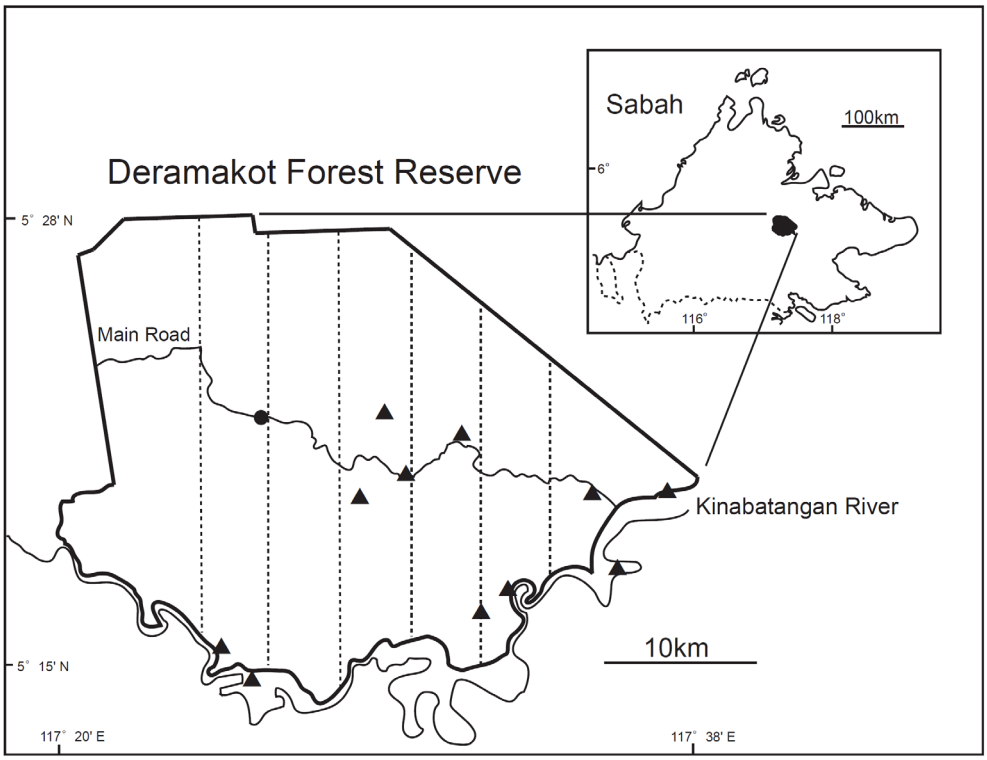


Fig.3.4: Locations of the identified natural salt-licks (▲) and base camp of the Deramakot District Forestry Office (●)

3.2. Natural Salt-Licks for the Mammals

Natural salt-licks are known as mineral-rich places. But, the function of natural salt-licks for the mammals is not only in supplying minerals.

There are five hypotheses for natural salt-lick visitation and geophagy by vertebrates, and these are:

- Mineral supplementation of diet, especially with sodium and calcium
- Detoxification of plant secondary compounds, especially alkaloids
- Acquisition of soil to supplement mechanical grinding for digestion of plant fibre (as observed in other avian species?)
- Zoopharmacognosy, with particular reference to internal parasites and alleviation of diarrhea
- Buffering of gastric pH

Table 3.3 shows the mean concentration of minerals in the major food plants of herbivores, such as Sambar Deer and Banteng, that are frequent visitors to the natural salt-licks. In addition to a lack of sodium, the high content of potassium in plants has a diuretic effect. Thus, sodium is easily lost through excretion.

Table 3.3: Mean concentration of minerals in the major diets of herbivores. (Matsubayashi *et al.*, 2007a).

The diets (Scientific name)	Minerals (mg/g)			
	Ca	Mg	K	Na
Creeping herb (*Mimosa pudica*)	3.3	2.2	17.0	0.1
Herbaceous vine (*Mikania scandens*)	1.5	1.5	17.1	0.4
Grass (*Paspalum conjugatum*)	1.91	2.6	20.5	0.1
Young leaf (*Macaranga* sp.)	5.3	4.1	16.6	0.1
Fruit 1 (*Ficus* sp.)	14.7	2.0	21.6	0.2
Fruit 2 (*Neolamarckia cadamba*)	2.1	1.1	15.8	0.11
Bark of the tree (*Pterospermum* sp.)	15.4	0.8	7.1	0.3
Mean ± SD	**6.3±6.1**	**2.1±1.1**	**16.5±4.7**	**0.2±0.1**

To understand visiting mammal frequency of the species, camera traps with an infrared triggering device (Field note, Japan; Cuddeback, USA; Bushnell, USA) were set up targeting natural salt-licks (Fig. 3.5a & 3.5b). Poles of wood or iron were used to attach the camera above the ground at 2 to 3 m distance from a natural salt-lick. As the animal tends to stay at natural salt-licks longer than at other places, such as on corridors or trails, the time delay was set to 15 minutes to reduce flash impact on animals and to extend battery life. Maintenance involved replacement of the batteries of the cameras at every two months.

Fig. 3.5a: Camera trap saddled on tree trunk.

Fig. 3.5b: Saddled camera trap (right circle) and natural salt-lick (left circle).

Natural Salt-Licks for Humans

Back in the days when salt was scarce, the local communities depended on natural salt-licks to obtain salt. They protect the natural salt-licks from erosion or collapse by lining the spring walls with Belian (Borneo iron wood) slabs. Until now, water is still gushing from this ancient natural salt-lick located near Kampung Balat (below left). Salt is extracted through the process of boiling and evaporation (below right).

Wallowing Places

Animals such as Bearded Pigs, male Sambar Deer and Sumatran Rhinos immerse in wallows to reduce body heat, to remove external parasites and possibly to put on a scent. Wallowing places are quite similar to natural salt-licks. But wallows do not contain high concentrations of minerals and the water in it dries out quickly over a short period of drought.

3.3. Recorded Species at the Natural Salt-Licks

In total, 28 medium- to large-sized mammalian species were recorded at the 4 natural salt-licks (Table 3.4). It is 70% of the total recorded species (40 species) in DFR. Although a natural salt-lick is just a small area in the forest landscape, it is undoubtedly a hot spot of species diversity.

Table 3.4: Medium- to large-sized mammal fauna in Deramakot.

Order	Family	Species (Scientific name)	IUCN Red List Category
Eulipotyphla	Erinaceidae	Moonrat (*Echinosorex gymnura*)	LC
Primates	Cercopithecidae	Red Leaf Monkey (*Presbytis rubicunda*)	LC
		Silvered Langur (*Trachypithecus cristatus*)	NT
		Proboscis Monkey (*Nasalis larvatus*)	EN
		Long-tailed Macaque (*Macaca fascicularis*)	LC
		Pig-tailed Macaque (*Macaca nemestrina*)	VU
	Hylobatidae	Bornean Gibbon (*Hylobates muelleri*)	EN
	Hominidae	Bornean Orang-utan (*Pongo pygmaeus*)	EN
Pholidota	Manidae	Sunda Pangolin (*Manis javanica*)	EN
Rodentia	Sciuridae	Tufted Ground Squirrel (*Rheithrosciurus macrotis*)	VU
	Hystricidae	Long-tailed Porcupine (*Trichys fasciculata*)	LC
		Malayan Porcupine (*Hystrix brachyura*)	LC
		Thick-spined Porcupine (*Hystrix crassispinis*)	LC

... continued on next page

... continued from previous page (Table 3.4)

Order	Family	Species (Scientific name)	IUCN Red List Category
Carnivora	Ursidae	Sun Bear (*Helarctos malayanus*)	VU
	Mustelidae	Yellow-throated Marten (*Martes flavigula*)	LC
		Malay Weasel (*Mustela nudipes*)	LC
		Small-clawed Otter (*Aonyx cinerea*)	VU
		Hairy-nosed Otter *(Lutra sumatrana*)	EN
	Mephitidae	Malay Badger (*Mydaus javanensis*)	LC
	Viverridae	Malay Civet (*Viverra tangalunga*)	LC
		Otter-civet (*Cynogale bennettii*)	EN
		Binturong (*Arctictis binturong*)	VU
		Masked Palm Civet (*Paguma larvata*)	LC
		Common Palm Civet (*Paradoxurus hermaphroditus*)	LC
		Banded Civet (*Hemigalus derbyanus*)	VU
	Prionodontidae	Banded Linsang (*Prionodon linsang*)	LC
	Herpestidae	Short-tailed Mongoose (*Herpestes brachyurus*)	LC
		Collared Mongoose (*Herpestes semitorquatus*)	DD
	Felidae	Sunda Clouded Leopard (*Neofelis diardi*)	VU
		Borneo Bay Cat (*Pardofelis badia*)	EN
		Marbled Cat (*Pardofelis marmorata*)	VU
		Flat-headed Cat (*Prionailurus planiceps*)	EN
		Leopard Cat (*Prionailurus bengalensis*)	LC
Proboscidea	Elephantidae	Asian Elephant (*Elephas maximus*)	EN
Cetartiodac-tyla	Suidae	Bearded Pig (*Sus barbatus*)	VU
	Tragulidae	Lesser Mousedeer (*Tragulus kanchil*)	LC
		Greater Mousedeer (*Tragulus napu*)	LC
	Cervidae	Bornean Yellow Muntjac (*Muntiacus atherodes*)	LC
		Sambar Deer (*Rusa unicolor*)	VU
	Bovidae	Banteng (*Bos javanicus*)	EN

Underlines indicate those recorded at the natural salt-licks.
DD: Data Deficient ; **LC**: Least Concern; **NT**: Near Threatened; **VU**: Vulnearable; **EN**: Endangered

Fig. 3.6 shows the frequency of the visitation by species and the rank of the top 15 most photographed species at the natural salt-licks. The most frequent visitors to the natural salt-licks were Sambar Deer and Bearded Pigs, which are comparatively common in DFR (Fig. 3.7). So, there is a possibility that this result can also reflect "animal density". But what is more surprising is, endangered species such as Banteng, Orang-utans and Asian Elephants were also ranked in the top 15 (Fig. 3.8). This suggests that the result of visitation frequency reflects not only "animal density" but also "physiological demand".

Species compositions were heavily biased to herbivores/frugivores (Matsubayashi *et al.*, 2007a) as we expected. But some carnivore species such as Short-Tailed Mongooses, Leopard Cats and Malay Civets were also recorded at the natural salt-licks and its surroundings. As natural salt-licks are mostly linked to animal corridors and trails used by large terrestrial animals, there is a possibility that they are just passing through. But we suspect that these species come to the natural salt-licks to prey on other animals because humans also use them for hunting. In this case, we can say that the natural salt-lick is vital not only for plant-eating mammals, but also for predatory mammals. Further studies are needed.

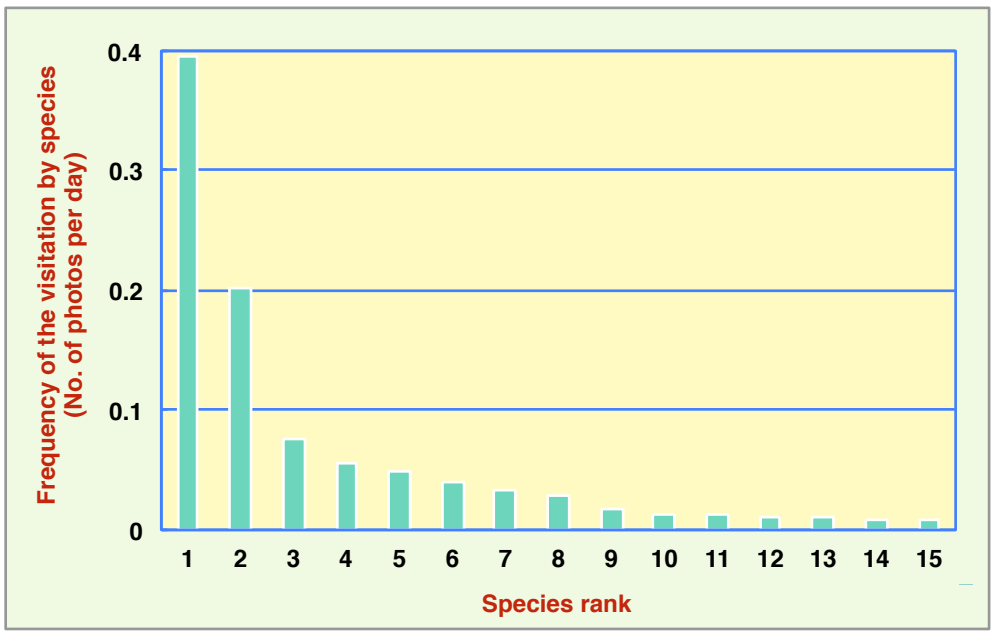
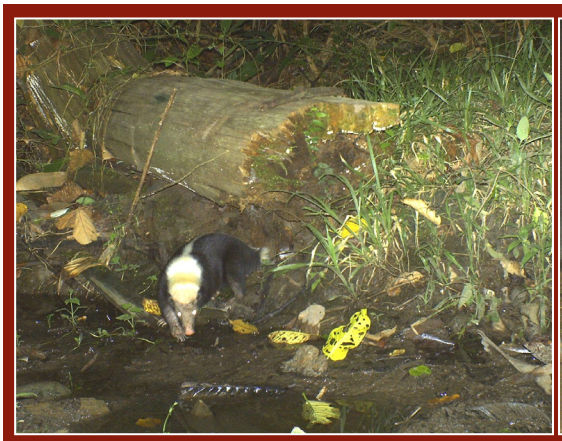


Fig. 3.6: The frequency of the visitation by species and the species rank of the 15 most photographed species at the natural salt-licks are (1)Sambar Deer, (2) Bearded Pig, (3) Lesser Mousedeer, (4) Malay Badger, (5) Orang-utan, (6) Malayan Porcupine, (7) Banteng, (8) Moonrat, (9) Pig-tailed Macaque, (10) Short-tailed Mongooses, (11) Common Palm Civet, (12) Asian Elephant, (13) Bornean Yellow Muntjac, (14) Leopard Cat, (15) Malay Civet. (Modified Matsubayashi et al. 2007a).

Fig. 3.7: Frequent visitors, Sambar Deer (top) and Bearded Pigs (bottom).

Fig. 3.8: Endangered species captured through camera trapping: Orang-utans (female with infant; top), Banteng males (middle) and Asian Elephants (female with juvenile; bottom) at the same natural salt-lick.

Here are some photos of camera trapped mammals at the natural salt-licks (Fig. 3.9). For IUCN Red List, please refer to Table 3.4.



Malay Badger

Sun Bear

Leopard Cat

Banded Civet

Short-tailed Mongoose

Collared Mongoose

Fig. 3.9: Camera trapped mammals at the natural salt-licks ... (continued)

Malayan Porcupine

Tufted Ground Squirrel

Lesser Mousedeer

Bornean Yellow Muntjac

Sunda Clouded Leopard and their footprint. The footprint is recorded on an animal trail that is linked to a natural salt-lick.

... (continued from previous page) **Fig. 3.9**: Camera trapped mammals at the natural salt-licks

Leeches in the Natural Salt-Licks

A very interesting observation was seen at some of the natural salt-licks in DFR with the presence of large colonies of leeches. The leeches seem to have adapted to living in the water that these natural salt-licks hold. When an unsuspecting animal comes to lap up the mineral water, they will cling to their muzzle and suck their blood. However, the leeches have not been recorded in Malua Forest Reserve which is located adjacent to DFR across the Kinabatangan River. Their ecology and how they have evolved to adapt in such an environment for survival is intriguing.

Juvenile and adult female Banteng at a natural salt-lick in Deramakot.

Juvenile and adult female Orang-utan with infant.

CHAPTER 4

NATURAL SALT-LICKS AND ORANG-UTANS

4.1. Use of Natural Salt-Licks by the Orang-utans

The Orang-utan, a representative arboreal species in Borneo, was seldom thought to descend to the ground. Even to drink water, they use pooled water collected on tree boughs and tree hollows. But our study revealed otherwise. The orang-utan is a high-frequency visitor of the salt-licks which means that they do come down to the ground often (Matsubayashi *et al*., 2007a, 2011). Why do they come to the natural salt-lick in spite of the high risk of being preyed on by predators? What is the relationship of natural salt-licks to the Orang-utans? To investigate natural salt-licks used by orang-utans in detail, we divided the Orang-utans into three classes (flanged male, female with infant, and others such as unflanged male or female without infant) (Fig. 4.1).

Fig. 4.1: Three classes of Orang-utans at the natural salt-licks.

Previous studies reported that flanged males generally spend more time on the forest floor than females and younger individuals, especially females with infants because of their wariness of ground predators (Cant, 1987; Galdikas, 1988). So, we anticipated most of the orang-utans that visit the natural salt-licks will be flanged males. However, the result was different. Fig. 4.2 shows visiting proportion of each orang-utan class. The flanged male was only 31%, and others accounted for more than half (52%). Even females with infants make up 17%. This result indicates that natural salt-licks are very important for all Orang-utan classes. Next, we focused on the duration of the visits and their behavior at the natural salt-licks.

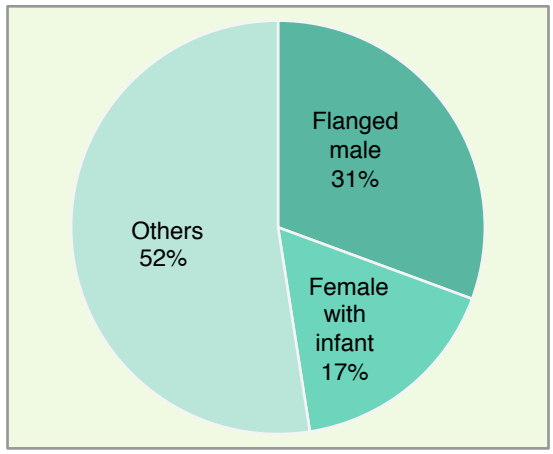


Fig. 4.2: Visiting proportion of Orang-utan class to the natural salt-licks.

Fig. 4.3 shows duration of the visits by each orang-utan class. Visits of female with infant and others were not long (i.e. less than 15 minutes). On the other hand, flanged males stayed at natural salt-licks much longer, where 45% of visits were with duration of more than 15 minutes and 9% for more than one hour, were recorded. The longest stay was 2 hours 27 minutes.

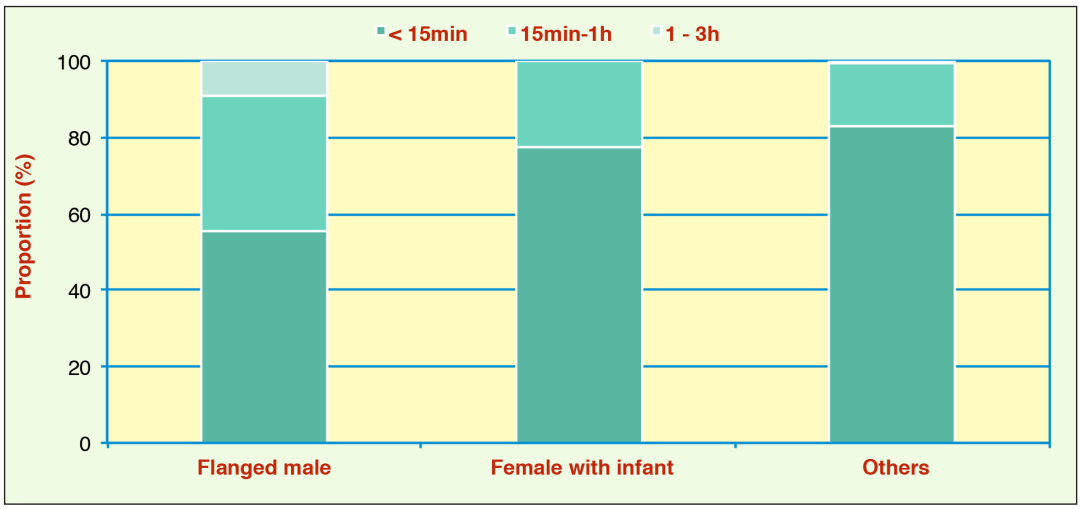


Fig. 4.3: Duration of the visits by each Orang-utan class.

Their behaviors as portrayed at the natural salt-licks are also different. Flanged males drank the water without wariness or vigilance. On the other hand, females with infants and others, especially young individuals and unflanged males, appeared restless. This vigilant behavior might be directed not only to predators but also to flanged males. Young individuals and unflanged males are usually dominated by flanged males.

4.2. Natural Salt-Licks as Communication Sites

Orang-utans are basically solitary animals. However, we have recorded instances where several individuals visited the natural salt-licks at the same time and staying on for about 15 minutes (Fig. 4.4). A female with infant was also recorded coupling with an adult male at the natural salt-lick (Fig. 4.5). Therefore, we suspected that the natural salt-licks are also used by Orang-utans to procreate (Matsubayashi *et al*., 2011).

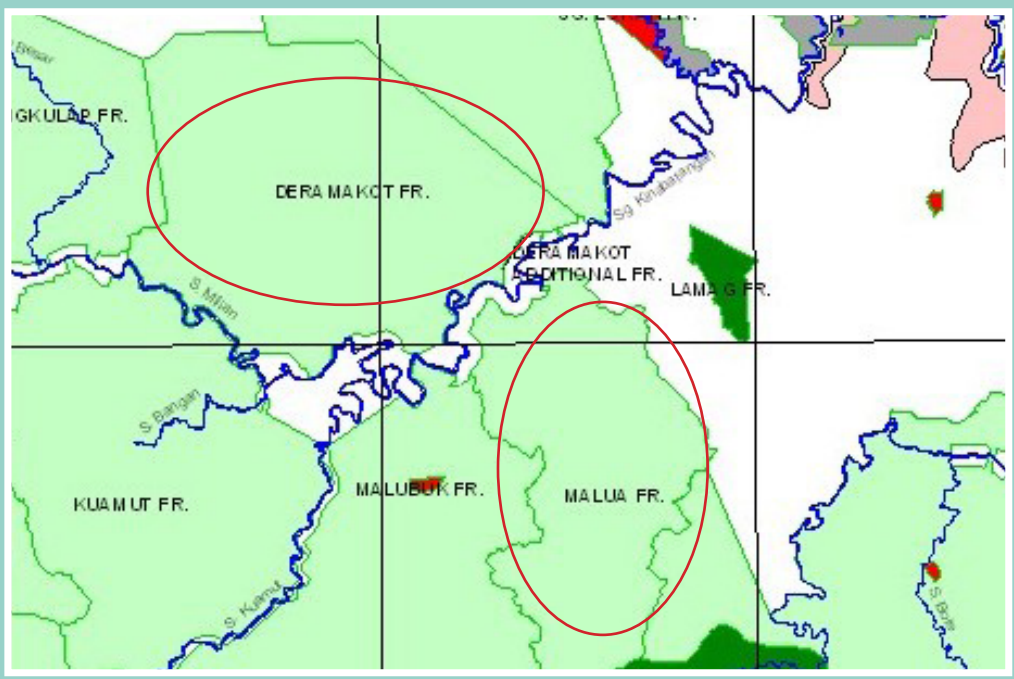
Fig. 4.4: Several individuals visiting the natural salt-lick.

Fig. 4.5: A female with infant were recorded coupling with an adult unflanged male.

Locality of Natural Salt-Licks Used by Orang-utans

The behaviors of animals are not the same at each habitat due to their home-range size, group size, feeding habits (ex. cambium feeding and insect feeding) and the environment. Therefore, studies on the use of natural salt-licks by orang-utans in DFR can be representative to that forest reserve only. Thus, we decided to carry out a comparative study to investigate the use of natural salt-licks by Orang-utans at different forest reserves.

The upper Kinabatangan and Segama Rivers hold the largest concentration of Orang-utans in Sabah (Ancrenaz, *et al*., 2005). Genetic studies on Orang-utans showed that the Kinabatangan River poses a natural barrier to gene flow of the Orang-utan populations (Jalil *et al*., 2008). Thus, the Malua Forest Reserve (33,969 ha) located across the Kinabatangan River from DFR was selected as a suitable comparative study site.



Four natural salt-licks were identified. As in DFR, all of them were located near streams. Mineral concentrations of the natural salt-licks in Malua Forest Reserve, especially sodium, were significantly higher than that of DFR. One site in particular, which is about the size of a plate, had a puddle of water tasting like seawater.

The top five species of frequent visitors to the natural salt-licks in Malua Forest Reserve were Asian Elephants, followed by Sambar Deers, Bearded Pigs, Orang-utans and Barking Deer (664 camera-days, 2008-2009). So, we can now confirm that the use of natural salt-licks by Orang-utans is a common behavior in Sabah.

Natural salt-licks in Malua Forest Reserve.

Tiny spring water, but the sodium concentration is the highest among the natural salt-licks.

Camera trapped Orang-utans (female with infant; top), Banteng male (bottom left) and Asian Elephants (female with juvenile; bottom right) at the natural salt-licks, in Malua Forest Reserve.

4.3. Importance of natural salt-licks for Orang-utans

McNaughton (1988) reported that the mineral content of food was an important determinant of the spatial distribution of animals within the Serengeti National Park, Tanzania. Therefore, from our results, we can deduce that the distribution of natural salt-licks may reflect the ranging patterns of Orang-utans. We conducted a study in corroboration with the Tokyo University of Agriculture and attempted to demonstrate that the distribution of natural salt-licks may somehow have a behavioral effect in the ranging patterns of the Orang-utan.

The location and distribution of natural salt-licks in DFR are already known. Next, we located and recorded the distribution of Orang-utan nests by aerial survey using GPS. We also took into account other environmental factors such as, distance from plantations, roads, villages and harvested compartments which we consider as human impacts. Whilst, distance from the rivers, natural salt-licks and altitudes are taken as natural impacts. The effects of the environmental factors on the presence/absence and density of Orang-utan nests were calculated by using statistical models (decision tree model). The results showed that Orang-utans preferred to build their nests in trees located close to natural salt-licks and at higher altitudes (particularly ridges which has high biomass) with low human impacts (far from plantations and major roads). Again, this result also showed the importance of natural salt-licks for Orang-utans. Therefore, in order to conserve Orang-utan habitats in commercial forests, it is vital that natural salt-licks are totally protected (Takyu *et al*., 2012).

A flanged male Orang-utan bending over a natural salt-lick.

Orang-utan as a good indicator of forest health

The Orang-utan is a good indicator of forest health because of following reasons:-

1. Easy to know their distribution

In tropical rainforests, it is difficult to understand the distribution of animals because of the invisible environment and rapid decomposition of their faeces. But in the case of Orang-utans, we can easily know their distribution from their arboreal nests, using aerial surveys.

2. Sensitive to habitat changes

The Orang-utan is a representative arboreal species that is sensitive to changes in their habitat brought about by logging (Felton *et al*., 2003; Knop *et al*., 2004; Caldecott & Miles, 2005; Ancrenaz *et al*., 2008; Husson *et al*., 2009).

3. Attract people's interest

As the Orang-utan is a very popular animal (iconic), it is easy to attract people's interest to forest management.

More than 60 % of orang-utans living in Sabah are found in commercial forests (Ancrenaz *et al*., 2005) and responsible forest management is compatible with the conservation of Orang-utans.

CONCLUSIONS

Sabah is located on the northern tip of the island of Borneo which has been identified as one of the 12 most mega biodiverse places on earth. A lot of wildlife inhabit the commercial forests which account for more than 70% of the Permanent Reserved Forest in Sabah, and their future depend entirely on the management of these forests. Therefore, responsible management of the forest is crucial. A managed forest is a protected forest. It is protected against poaching, encroachment, habitat fragmentation and habitat loss.

In this booklet, we introduce Deramakot Forest Reserve, which is certified as a "Well Managed Forest" by the Forest Steward Council (FSC). Even in this forest reserve, wildlife management considerations in forest management are inadequate. Here, we solely focused on long-term monitoring of natural salt-licks with camera traps carried out since 2003, and the results clearly indicated that wildlife, particularly mammals, have a high dependency on the natural salt-licks. Based on this finding, the Sabah Forestry Department has taken the initiative to identify and conserve natural salt-licks which is incorporated into forest management planning of high conservation value forests (HCVF) since 2008.

Ecological studies on mammals inhabiting tropical rainforests are very few and, most of these studies were conducted in protection forests. However, it is necessary and we hope that more studies will be done on mammals in commercial forests so that best practices in forest management can be developed for the conservation of wildlife. Remember! The forests are not about timber alone.

Road signages of wildlife crossings at Deramakot.

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