Sunda Clouded Leopard Action Plan for Sabah

Sponsor:

Sime Darby YAYASAN

Partners:

Danau Girang Field Centre

WILDCRU Wildlife Conservation Research Unit

2019 - 2028

Sabah Wildlife Department
Ministry of Tourism, Culture and Environment

SUNDA CLOUDED LEOPARD ACTION PLAN FOR SABAH

The compilation and editing process of this Sunda Clouded Leopard Action Plan was led by the Director of Sabah Wildlife Department and supported by the Species Action Plan Committee Members.

Published by
Sabah Wildlife Department
5th Floor, Block B, Wisma MUIS Complex
88100 Kota Kinabalu

With assistance from
Danau Girang Field Centre and WildCRU

And funding from
Yayasan Sime Darby

December 2018
Citation: Sabah Wildlife Department 2019. Sunda Clouded Leopard Action Plan for Sabah 2019-2028. Kota Kinabalu, Sabah, Malaysia.

Front cover photo: A male Sunda clouded leopard photographed in the Danum Valley Conservation Area. © Charles Ryan

ISBN: 978-967-16787-0-1

Printed in Kota Kinabalu

EXECUTIVE SUMMARY

The Sunda Clouded Leopard Action Plan designed for Sabah is a comprehensive document that emphasises the need for immediate, practical and adaptive conservation actions in order to ensure the long-term survival of the Sunda clouded leopard. This document results from an extensive consultation process initiated during the "International Workshop on Sunda Clouded Leopard Conservation in Sabah" (Kota Kinabalu, 12-16 June 2017).

It is estimated that about 750 Sunda clouded leopards are found in Sabah. However, the distribution of Sunda clouded leopards is currently unclear, with only a few protected areas that have been surveyed with camera-traps, leaving several large forests that have never been intensively surveyed but that are likely important areas for the long-term survival of the species.

In Sabah, Sunda clouded leopard decline is directly attributed to low population density, habitat loss and fragmentation, hunting and indirect snaring, pet trade and road development (such as the Pan Borneo Highway that would lead to an increase of road kills).

The vision of this action plan is to secure the continued existence of a viable population of Sunda clouded leopards in Sabah.

The 10-year goals of this SCLAP are to identify, develop and implement strategies and actions that will address the threats of the species in all management units that have been identified in Sabah by providing guidance to key players that will implement these strategies.

The main objectives of this SCLAP are the following:

1. Increase enforcement by supporting and strengthening Sabah Forestry Department‟s enforcement team „Protect‟ and the „Forest Ranger‟ initiative, Sabah Wildlife Department‟s "Enforcement team‟ and the „Honorary Wildlife Warden‟ initiative, and Sabah Parks‟ „Enforcement team‟ and the „Park Ranger‟ initiative.
2. Establish SMART patrols across all Sunda clouded leopard ranges and standardise the reporting system and the data base (real time monitoring).

3. Ensure that a specific enforcement plan is included in all Sustainable Forest Management Licence Agreements to make sure that patrolling is carried out regularly and there is an annual work plan and a budget to implement the activities.
4. Halt loss and degradation of habitat used by Sunda clouded leopards.
5. Establish and maintain landscape connectivity throughout the range of the Sunda clouded leopard.
6. Evaluate the status of the Sunda clouded leopard in areas that have not been surveyed.
7. Monitor population changes for the duration of the plan.
8. Assess the risk of disease transmission by domestic animals (dogs, cats) to the Sunda clouded leopard.
9. Improve awareness about Sunda clouded leopard in the vicinity of protected areas.
10. Cryopreserve Sunda clouded leopard gametes.
11. Set up an Endangered Species Conservation Unit (ESCU) to monitor the implementation of all action plans on totally protected (Schedule 1) terrestrial species in Sabah: banteng, elephant, Malayan sun bear, orangutan, proboscis monkey, Sunda clouded leopard and Sunda pangolin.

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1) INTRODUCTION

1.1. Origin and taxonomy

The clouded leopards (*Neofelis,* Gray 1867) belong to the big cats in the subfamily Pantherinae (Pocock 1917). Molecular data suggest a common ancestor some 5.67 million years ago (Li et al. 2016). The clouded leopards represent the earliest divergence from this lineage. Until recently, *Neofelis* was regarded as a monospecific genus (Wozencraft 2005). Recent morphological and molecular studies have however, confirmed that there are two species of *Neofelis* (Buckley-Beason et al. 2006; Kitchener et al. 2006; Wilting et al. 2007; Christiansen 2008):

1. Mainland clouded leopard ***Neofelis nebulosa*** (Griffith 1821)
2. Sunda clouded leopard ***Neofelis diardi*** (Cuvier 1823).

The two species likely split in the Mid-Pleistocene roughly between 1.4-2.0 million years ago (Buckley-Beason et al. 2006; Wilting et al. 2011; Li et al. 2016). The Mainland clouded leopard occurs in Mainland Asia from Nepal, Northeast India, China, Southeast Asia, Taiwan and Hainan, whereas the island populations are likely to be extinct today. It is characterized by large cloud-like markings with generally fewer spots inside them. Its sister species the Sunda clouded leopard is restricted to the Sunda Islands of Borneo, Sumatra, and the Make every efforts to increase the current population size and minimise fragmentation. Batu Islands, though on the Batu Islands it is likely to be extinct. It has smaller cloud-like markings with generally many small spots inside them.

A recent molecular and morphological analysis of *N. diardi* showed that Bornean and Sumatran animals are sufficiently distinct to warrant recognition as separate subspecies:

1. Sumatran clouded leopard ***Neofelis diardi diardi*** (Cuvier 1823)
2. Bornean clouded leopard ***Neofelis diardi borneensis*** (Wilting et al. 2011).

The type locality for the new subspecies *N. d. borneensis* is Baram, Sarawak (Holotype: BMNH 1903.4.9.2 female skin and skull). The Bornean subspecies differs from the nominal subspecies in Sumatra in

some craniomandibular, dental and pelage characters and some fixed molecular differences (Wilting et al. 2011). In a recent revision of the taxonomy of felids both Sunda clouded leopard subspecies were regarded as strongly supported subspecies and thus accepted by the IUCN Cat Classification Task Force (Kitchener et al. 2017).

Although data on the evolutionary history of both subspecies is sparse (Wilting et al. 2011), due to the lack of fossil records and the limited sequencing effort and sampling sizes of both subspecies, Wilting et al. (2011) found some support that Sunda clouded leopards from Borneo colonized Sumatra during the Late Pleistocene. At this time sea level was at least 40 m below its present level, thereby exposing a land bridge between Borneo and Sumatra. Wilting et al. (2011) hypothesized further that the evolutionary history of Sunda clouded leopards was impacted by the catastrophic „super-eruption" of the Toba volcano in Sumatra around 73.5 kyr (e.g. Rampino and Self 1992). This was the second largest explosive eruption known in the Phanerozoic history (Ambrose 1998) and an order of magnitude larger than any other known Quaternary volcanic eruption (Dawson 1992; Huff et al. 1992; Rose and Chesner 1990). Based on the severe consequences of the Toba volcano on Sumatra, in contrast to Borneo which was much less affected, it has been speculated that Toba wiped out the ancestral clouded leopard population on Sumatra and that post-Toba this island was recolonized with Sunda clouded leopards from Borneo. Such an extinction of clouded leopards in Sumatra and likely Peninsular Malaysia could have also facilitated the split between the two clouded leopard species (Mainland and Sunda clouded leopard).

1.2. Legal status and legislation

The Sunda clouded leopard (*Neofelis diardi*) is protected by law throughout its range (Sumatra and Borneo) and is included in Appendix 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, prohibiting all international commercial trade. While *Neofelis nebulosa* is included in Appendix 1, *Neofelis diardi* is not and it is recommended to contact CITES in order to address the issue. The species is listed as Vulnerable (A2c) on the IUCN Red List (Hearn et al. 2015), with a declining population trend. The Bornean clouded leopard is listed as Endangered (C1) on the IUCN Red List.

In Sabah, the Sunda clouded leopard is currently totally protected under Schedule 1, Section One of the Wildlife Conservation Enactment (WCE) 1997. Totally protected animals under Schedule 1 cannot be hunted. For those killing Sunda clouded leopards and/or possessing Sunda clouded leopards products (skin, teeth, bones) and found guilty of an offence under Section 25 WCE 1997, the penalty is a minimum fine of RM50,000 and maximum of RM250,000 plus imprisonment for no less than six months and up to five years.

1.3. Ecology and behaviour

The Sunda clouded leopard is one of the least studied of the world"s larger felids (Brodie 2009); consequently our knowledge of their ecology and behaviour remains sparse. Until recently, our understanding of the natural history of this species stemmed largely from incidental observations (e.g., Selous and Banks 1935; Davis 1962; Rabinowitz et al. 1987), but in the last decade the application of new research techniques, such as camera trapping and VHF and satellite telemetry have begun to provide valuable insights into the ecology of this elusive species.

The Sunda clouded leopard appears to be an adaptable yet rare species, apparently able to tolerate some degree of anthropogenic disturbance of their forest habitat. Records of Sunda clouded leopards stem from a diverse range of forest types, and elevations, including both pristine (Brodie and Giordano 2012) and selectively logged lowland dipterocarp forests (Wilting et al. 2006; 2012; Cheyne et al. 2016; Haidir et al. 2013; Sollmann et al. 2014; McCarthy et al. 2015; Hearn et al. 2016b, 2017), hill dipterocarp and submontane forest (Hearn et al. 2017), mangroves (Selous and Banks 1935; Davis 1962) and peat swamp forest (Cheyne and Macdonald 2011; Cheyne et al. 2013). Hearn et al. (2018a) detected the Sunda clouded leopard across much of the elevational range that they surveyed (17 to 1452 m). While the occurrence of Bornean mammals in oil palm plantation habitats has been poorly studied, camera trap surveys in Sabah (Yue et al. 2015; Hearn et al. 2018a) and Sumatra (Maddox et al. 2007) failed to detect this species. Bernard et al. (2014) found no evidence of these felids in a number of small forest patches embedded within an oil palm plantation, despite recording them in the adjacent, large (>1000 km^2), selectively logged forest, and an absence of camera trap detections from a small, isolated forest patch in eastern Sabah (Kabili-Sepilok Forest Reserve) led Hearn et al. (2017) to conclude that this

forest no longer supports the species. Such observations thus support earlier predictions that forest loss and conversion to oil palm plantations present one of this felid‟s greatest threats (Rabinowitz et al. 1987; Hearn et al. 2016a).

A recent multiscale analysis of the factors that influence distribution of the Sunda clouded leopard in Sabah showed this species selected areas with high levels of dipterocarp forest at relatively fine spatial scales, within broad landscapes with low levels of human footprint, plantations and scrub lands (Hearn et al. 2018a). This analysis also highlighted that Sunda clouded leopards are positively associated with higher elevation forest, which accords with the findings from studies of these felids in Sumatra (Haidir et al. 2013; McCarthy et al. 2015; Sunarto et al. 2015). Hearn et al. (2018a) showed that both sexes were positively associated to ridgelines and males were positively associated with logging roads, as also shown by Wearn et al. (2013).

The records of Sunda clouded leopards from selectively logged forests suggest that these disturbed habitats, now the dominant form of remaining forest cover on Borneo (Gaveau et al. 2014, 2016), form an important habitat for these felids (e.g., Wilting et al. 2006). Exactly how the selective logging process influences these felids, however, is unknown. The first insight into the responses of these felids to such habitat disturbance came from Brodie et al. (2015), who used camera traps to survey several forested areas in Sarawak and Sabah and showed that Sunda clouded leopards‟ local scale abundance was lower in logged forest sites compared to unlogged sites.

Hearn et al. (2018b) used satellite telemetry to explore the effects of multiple landscape features on Sunda clouded leopard movements in a human dominated landscape – the Lower Kinabatangan Wildlife Sanctuary (LKWS) – and showed that their movements are closely associated with forest habitats and strongly resisted by plantation habitats. One individual male clouded leopard‟s path trajectory traversed several sections of plantation of up to 1.19 km in length, on five occasions, which it used as a shortcut between contiguous areas of forest, or to move to an isolated forest patch (Hearn et al. 2018b; in prep). On one occasion, this same individual was recorded leaving the forest and following a sharp, grass-covered ridgeline for approximately 2 km, before continuing to move in the same direction through an oil palm plantation for a further 2 km. These observations, although restricted to a small number of individuals, suggest that oil palm

plantations do not necessarily form a hard barrier to their movement. The maximum distance these felids are willing to move across oil palm plantation habitats, however, remains unknown.

There have been no quantitative studies of the Sunda clouded leopard's diet preferences, but field observations suggest that their prey is diverse and includes terrestrial birds, porcupine (Gordon & Stewart 2007), primates (Yeager 1991; Matsuda et al. 2008; Morino 2010; DGFC unpublished observations) and ungulates (Davis 1962; Rabinowitz et al. 1987; Mohamed et al. 2009). The species appears to exhibit a large degree of sexual dimorphism, with males reaching weights of around 24 kg whereas females are around 12 kg (e.g., Nájera et al. 2017), and these physical differences may manifest into intersexual differences in prey preference (Hearn et al. 2018a). In a recent analysis of camera trap data from multiple forested areas in Sabah, both male and female Sunda clouded leopards showed significant temporal activity associations with sambar (*Rusa unicolor*) and greater mouse deer (*Tragulus napu*). While adult sambar may exceed 200 kg, juveniles and subadults fall within the mass range that clouded leopard males are likely to take based on predator/prey mass allometries (e.g. Carbone et al. 1999). Such theory predicts, however, that only calves would be taken by female Sunda clouded leopards. Mohamed et al. (2009) reported that a juvenile sambar weighing an estimated 30–35 kg was killed and partially consumed by a Sunda clouded leopard. These data suggest that sambar may indeed constitute an important resource for these felids. Ross et al. (2013) showed that greater mouse deer and bearded pigs (*Sus barbatus*) exhibited shifts in temporal activity in a forest devoid of Sunda clouded leopards (Kabili-Sepilok), which suggests that they too may be important prey for Sunda clouded leopards. Mohamed et al. (2009) detail an observation of a presumed male Sunda clouded leopard killing and subsequently dragging a 20–25 kg bearded pig up to the first story of a wooden observation tower.

1.4. Current distribution and population trends

The Sunda clouded leopard is restricted to the islands of Borneo and Sumatra (Buckley-Beason et al. 2006, Kitchener et al. 2007, Wilting et al. 2007, 2011). Clouded leopard fossils have been found on Java, however it has probably been extinct there since the Holocene (Meijaard 2004). The Sunda clouded leopard's Borneo-wide distribution was modelled as part of the Borneo Carnivore Symposium

in 2011 (Hearn et al. 2016b). More recently, multiscale modelling approach was used to develop a map of Sunda clouded leopard predicted occurrence for Sabah (Hearn et al. 2018a). This predictive model (Figure 1) suggests that Sunda clouded leopard occurrence reaches a maximum within the higher elevation areas of the main contiguous forest block region in central Sabah, whereas the vast, heavily disturbed coastal areas and oil palm plantation dominated areas in the east presented the lowest predicted probability of occurrence for these felids. These predictions of distribution are broadly similar to that developed from presence only maximum entropy modelling (Hearn et al. 2016b).

The current distribution of Sunda clouded leopards across Sabah is unclear. Wilting et al. (2006) list the protected areas and commercial forest reserves in Sabah known to support clouded leopards, but the records are now over a decade old, and a new assessment would be of great value.

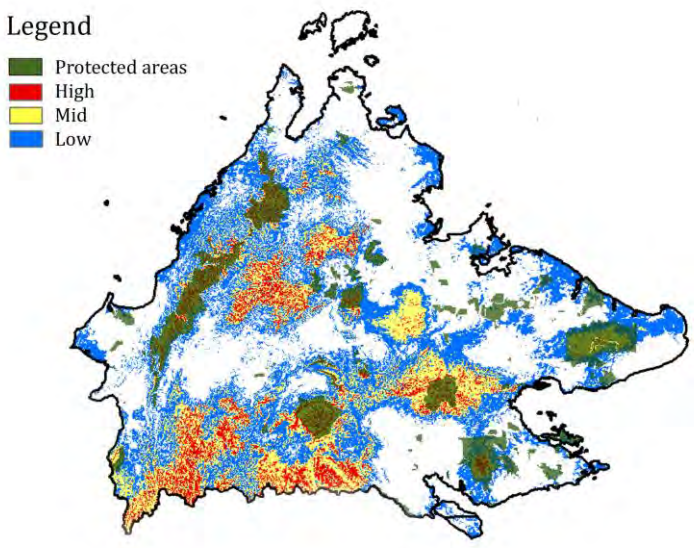

Figure 1. Current predicted distribution of the Sunda clouded leopard in Sabah, based on multi-scale habitat modelling of camera trap data. Map modified from Macdonald et al. (in review).

The elusive nature and low site density of the Sunda clouded leopard make abundance estimation particularly challenging for this species. However, advances in survey equipment and study methodologies have led to the first robust insights into the variation of the population density of the Sunda clouded leopard across their whole range. Most studies of the abundance of this felid stem from Sabah, where surveys of nine forest areas have yielded density estimates ranging from 0.84 to 3.10 individuals per 100 km^2 (Brodie and Giordano 2012; Wilting et al. 2012; Hearn et al. 2017; Table 1[1]). The Sabah estimates in Table 1 are comparable with those from the Indonesian province of Central Kalimantan (0.72–4.41: Cheyne et al. 2013) and Sumatra (0.8–1.6: Sollmann et al. 2014). Low detection rates observed in a recent survey of Indonesian Borneo (Cheyne et al. 2016) suggest these felids may be less abundant in south and eastern Kalimantan compared to Sabah. Additional surveys are urgently required both to enable the robust assessment of this felid"s conservation status and to contribute to our knowledge of this felid"s responses to habitat disturbance.

It is worth pointing out that it is dangerous to use the data from Table 1 to make inference about where density is higher or lower. First of all, the estimation methods (and confidence interval calculation) were different across the three studies. Second of all, the confidence intervals tend to be pretty wide, and if they overlap the point estimate of another site, then statistically we cannot say that the two sites are different. For example, the highest point estimate is from Ulu Segama. But the confidence interval at that site includes the mean density estimate for almost all of the other sites, so we really cannot say that the density at Ulu Segama is higher than anywhere else (except maybe Segaliud Lokan and Tangkulap).

Table 1. Population density estimates derived from Spatially Explicit capture recapture analysis of camera trap data, from a range of forest types in Sabah. Densities (individuals per 100 km^2) represent means and associated upper and lower 95% confidence intervals. Data derived from: [1]Hearn et al. (2017); [2]Brodie and Giordano (2012); [3]Wilting et al. (2012).

	Crocker Range[1]	Danum Valley[1]	LKWS[1]	Maliau[2]	Segaliud Lokan[3]	Tabin[1]	Tangkulap[3]	Tawau Hills[1]	Ulu Segama[1]
Density	1.39	1.73	1.54	1.90	1.04	2.66	0.84	2.23	3.10
lower CI	0.77	0.81	0.41	0.70	0.29	0.79	0.25	1.35	1.26
upper CI	2.21	2.78	2.90	5.40	2.55	4.74	1.83	3.27	5.32

Hearn et al. (2017) estimated that the Sunda clouded leopard population size in Sabah is currently around 750 (95% posterior interval 300–1300) individuals. This estimate was based on the extrapolation of a weighted mean population density of 1.8 individuals per 100 km^2, derived from the nine current estimates (Table 1), extrapolated to an estimate of current available habitat based on Gaveau et al."s (2014) measure of forest cover across the state. It should be noted, however, that this estimate does not include a minimum patch size or measure of proximity to other patches in its calculation, however, such data are currently lacking. Therefore, the estimate of available habitat may be slightly inflated, and with it, the Sunda clouded leopard population estimate.

1.5. Major threats in Sabah

1.5.1. Low population density

Hearn et al. (2017) showed that Sunda clouded leopard numbers in Sabah are, with c. 750 individuals, very low. Due to fragmentation the population is likely split into several subpopulations with no or little connection. This makes the Sunda clouded leopard one of the most threatened species in Sabah and any additional threats described below greatly increase the risk of local extinctions of Sunda clouded leopards.

1.5.2. Habitat loss and related degradation and fragmentation

Sabah is a global hotspot of forest loss and degradation due to timber and oil palm industries. Very few forest ecosystems remain intact and

nearly 80% of the land surface was impacted by high-impact logging or clearing operations from 1990 to 2009 (Bryan et al. 2013). Unfortunately, the protected area (National Parks, Wildlife Sanctuaries and Class 1 Forest Reserves) network in Sabah will likely be too small and/or too fragmented to ensure on its own the long-term survival of the Sunda clouded leopard. Therefore, non-protected areas that are exploited and transformed by various types of production such as forestry and agriculture need to get integrated in the conservation management of Sunda clouded leopards. Further riparian buffers play an important role for connectivity (Hearn et al. 2018b), particularly in highly fragmented areas such as the Kinabatangan.

The increasing prevalence of oil palm plantations across Sabah will likely decrease further the low population size of Sunda clouded leopard and increase the fragmentation of the remaining populations. Hearn et al. (in review) and Kaszta et al. (in review) extrapolated a local scale model of landscape resistance and connectivity developed in the Lower Kinabatangan (Hearn et al. 2018b) to predict the population connectivity for Sunda clouded leopards across Sabah (Figure 2). The models predicted that the large, contiguous Central Forest block in Sabah exhibited the highest levels of connectivity, population size and genetic diversity. The studies also identified a number of isolated fragments of internally connected habitat, including the LKWS, Tabin Wildlife Reserve and Tawau Hills Park as patches of habitat predicted to have extant Sunda clouded leopard populations, but predicted to be isolated from other clouded leopard populations. All three of these areas are important protected areas, yet given their small size and potential isolation, the Sunda clouded leopard populations that they support are potentially threatened by both isolation and low populations sizes. Despite some limitations of the models due to the limited data available about Sunda clouded leopard movement, the findings and existing data on habitat use by Sunda clouded leopards highlight the importance of forested corridors between isolated, but important forest patches.

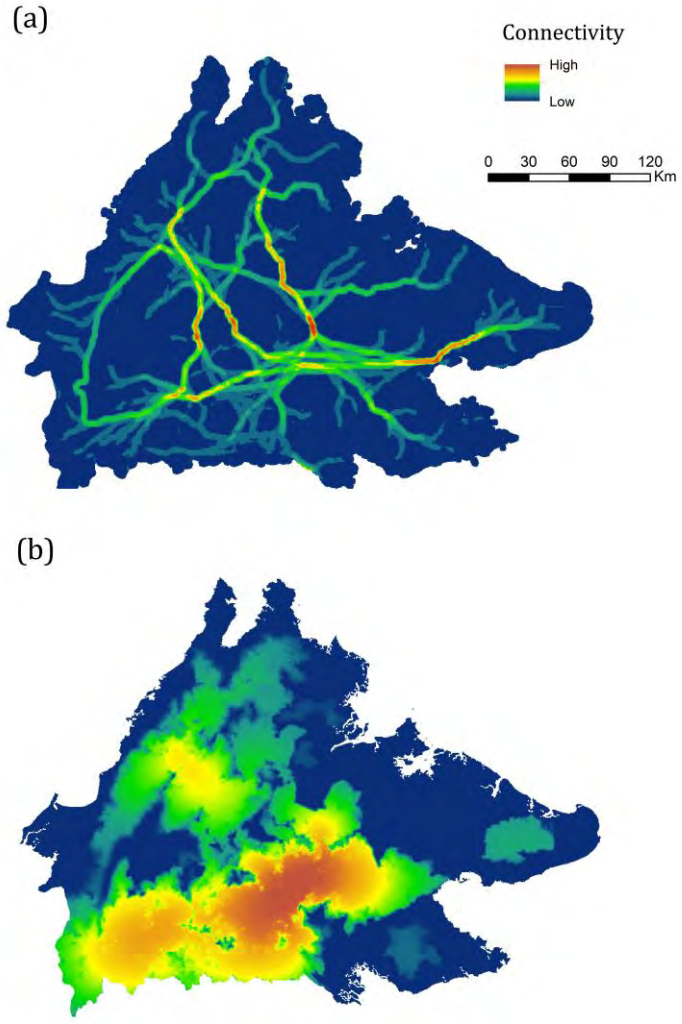

Figure 2. The predicted population connectivity for Sunda clouded leopards across Sabah, based on a preliminary model of clouded leopard movement (Hearn et al. 2018b). The maps show connectivity based on two different analytical methods, (a) Factorial least cost paths (b) resistant kernels. Maps modified from Hearn et al. (in review) and Kaszta et al. (in review).

1.5.3. Poaching/hunting and illegal killing

The potential impact of hunting and poaching on Sunda clouded leopards in Sabah remains unclear, although it is conceivable that Sunda clouded leopards are targeted for the international trade of wild felids. Further, Sunda clouded leopards have been reported to be kept as pets (SWD unpublished data). In November 2015, a man was caught in possession of a young clouded leopard and was prosecuted and fined 50,000 RM. Social media is heavily used by traders and should be monitored closely by wildlife authorities. Often hunting of Sunda clouded leopards might also be incidental, as shown by a killed Sunda clouded leopard in Ulu Segama in 2009, or by the indiscriminate snaring. Snares often target species such as sambar deer, bearded pig, porcupines and ground birds, such as various pheasants, but are indiscriminate in what they catch, thus Sunda clouded leopards might also be directly affected (Gray et al. 2018).

Brodie et al. (2015) found that local abundance of clouded leopards was negatively related to poacher presence, and Hearn et al. (2017) demonstrated that their population density in Sabah was lower in more heavily poached areas. Macdonald et al. (in review) reported that Sunda clouded leopard camera detection probabilities decreased sharply when even a few poachers were detected in Sumatra and Sabah. Indeed, the abundance of Sunda clouded leopards is directly affected by prey density. Ungulates are a key resource for Sunda clouded leopards. The dense network of logging roads and skids present in production forests and some of the totally protected forest reserves facilitates greater access and thus hunting opportunities for poachers, of which ungulates are a favoured quarry. As such, hunting can significantly decrease ungulate populations, even if Sunda clouded leopards are not targeted by poachers their numbers would indirectly be decreased by the hunting. Based on the results from different commercial forest reserves in Sabah, Hearn et al. (2017) concluded that the overriding priority is to reduce poaching pressure, both on clouded leopards and their prey, by reducing access to the forest interior along logging roads.

1.5.3 Other emerging threats

1.5.3.1. Disease transmission (domestic cats and dogs)

Domestic dogs and cats are potential carriers of some important infectious diseases such as feline panleukopenia virus, canine distemper virus and canine parvovirus, all highly contagious and able to cause mortality in Sunda clouded leopard populations. Infectious diseases transmitted to wild felids and canids from domestic animals have resulted in the population decline in African lions (*Panthera leo*) by canine distemper virus (Lafferty and Gerber 2002; Cleaveland et al. 2007) and in Ethiopian wolves (*Canis simensis*) by rabies (Sillero-Zubiri et al. 1996). More recently, the loss of Amur tigers (*Panthera tigris altaica*) was due to higher rates of exposure to a multi-host pathogen such as canine distemper thought to be transmitted by domestic species (Gilbert et al. 2014). Land use changes in Sabah has increased the potential risk of contact between domestic and wild carnivores, placing the Sunda clouded leopard populations in potential risk. In order to specify the needed activities to prevent further disease transmissions the risks must be assessed in areas where it is known that domestic carnivores occur within the current Sunda clouded leopard distribution range.

1.5.3.2. Feral dogs in competition with Sunda clouded leopards

Feral dogs in protected areas can compete with Sunda clouded leopards for food. Feral dog packs likely entering the forest from neighbouring oil palm plantations have been camera-trapped several kilometres away from the plantations, likely in their search for food.

1.5.3.3. Road and rail development

Sealed asphalt highways and rail lines that intersect forest (e.g. Maliau/Sapulut, Paitan/Sugut, Kinabatangan Widlife Sanctuary/Pin Suput FR) and unsealed gravel roads that traverse forest (e.g. Sapulut) may reduce population connectivity (Kaszta et al. in review) and increase the likelihood of Sunda clouded leopard road kills (Nájera et al. 2013). Brodie et al. (2015) found that high road density in Borneo was associated with reduced local occurrence of Sunda clouded leopards. The presence of roads also allows poachers to access remote parts of forests by foot, motorcycle, and 4-wheel drive unnoticed. Sunda clouded leopard males are known to be positively associated with gravel forest roads, thus increasing their chances of coming into contact with poachers. Indeed, a Sunda clouded leopard

was shot and killed along a road in the Ulu Segama Forest Reserve, in 2009.

1.5.3.4. Lack of knowledge and awareness

Local communities can be a key component to manage and conserve Sunda clouded leopard and other wildlife outside protected areas. However, some investment will be required to build capacity and influence wildlife use in favour of conservation objectives. For example, education programmes to raise hunters" respect for wildlife protection laws is necessary. It is unknown if Sunda clouded leopards in Sabah are currently traded or consumed at the local scale, as is the case with many other wildlife species in the region, but proactive monitoring and awareness efforts should be undertaken. Social media can play an important role as an awareness and hunting monitoring tool. More efforts should be expended into raising awareness, through social media, school programmes (through SEEN) and education centres (such as BSBCC) to educate the public on Sunda clouded leopards. Companies (logging, plantation and mining) need to be engaged as they are in charge of the management of the areas, thus they are the ones which, if they want, can make their managed areas better for Sunda clouded leopards.

1.5.3.5. Pollution associated to oil palm plantations, mining and development

So far, the threats of pollution caused mainly by (1) run-off from surrounding oil palm plantations where fertilisers and pesticides are commonly used and by (2) mining where chemicals (some toxic) are heavily used, have not been assessed with respect to Sunda clouded leopard populations.

2) DISTRIBUTION AND SITE DESCRIPTION

Viable management units (lowest number: 20-30 individuals)

2.1. Tabin Wildlife Reserve

Tabin Wildlife Reserve covers 120,500 ha and is situated in eastern Sabah in the Dent Peninsula, about 50 km northeast of Lahad Datu. The majority of Tabin (over 80% of the reserve) has been selectively logged between 1969 and 1989, resulting in a mosaic of forest types at different stages of recovery. Although the reserve is relatively large in area, it is effectively an isolated forest surrounded by oil palm plantations; the western boundary of the reserve is formed by a gravel road which separates it from adjacent oil palm plantations, however there is no physical barrier to either animal or people movement between the two areas. There is a rather tenuous linkage from Tabin"s northeast border to coastal mangrove swamps. There are several Virgin Jungle Reserves within the wildlife reserve that are comprised of primary forest; within these areas of primary forest are unusual mud volcanoes which are used as salt licks by some animal species. The population density was estimated to be 2.66 individuals/100 km^2 (Hearn et al. 2017).

Figure 3. Sunda clouded leopard photographed in Tabin Wildlife Reserve. ©AJ Hearn and J Ross

2.2. Kinabatangan

In 2005, the State Government of Sabah gazetted 27,000 ha of highly disturbed forests as a Wildlife Sanctuary (LKWS) along the Kinabatangan River. The ten forest blocks are linked to seven patches of protected forests (Virgin Jungle Forest Reserves, VJFR) totalling about 15,000 ha, and they are connected with 10,000 ha of state and private forests at various stages of degradation. The predominant vegetation consists of evergreen freshwater swamp forests that occur over a range of soil conditions, from permanently waterlogged swamps to zones with differing frequencies of flooding. Low-stature forests and grasslands occur in backswamp areas while riparian and mixed lowland dipterocarp forests are found in drier areas located along the banks of the rivers and higher terraces. Most of the surrounding dry lowland forest has been cleared for oil palm development and the remaining forests have been repeatedly logged over the past century. To the west and south of the LKWS lie the Segaliud Lokan, Malua and Ulu Segama forest reserves, and to the east lies an extensive chain of

protected coastal mangrove forest reserves. A sealed road (A6) runs north/south through the LKWS, bisecting the two blocks of the Pin Supu Forest Reserve, and another runs east/west to the north of the protected forested areas.

The density of clouded leopards in the LKWS has been estimated to be 1.54 individuals/100 km^2 (Hearn et al. 2017). Between May 2013 and September 2014, four (3 males and 1 female) Sunda clouded leopards were collared and movement data were used to develop predictions of this felid"s population connectivity in the region (see Hearn et al. 2018b). The authors predicted that that all of the core protected forest blocks in the LKWS remain functionally connected with each other and with adjacent forest blocks elsewhere in Sabah. The authors also predicted that connectivity in the region can be greatly enhanced through the protection of privately-owned forest patches and the reforestation of underproductive oil palm plantation areas (Abram et al. 2014), and creation of a forested buffer zone along the river. Conversely, Hearn et al. (2018b) showed that if the region's unprotected forests were to be converted to plantations then connectivity across the Kinabatangan floodplain would be significantly reduced.

Figure 4. Close up of a Sunda clouded leopard in Kinabatangan. ©DGFC/SWD

2.3. Tawau Highlands

The Tawau Highlands is a 90,000-ha isolated area of largely contiguous forest located in the southwest of Sabah, approximately 20 km northwest of Tawau city. The area includes three contiguous forests, the Tawau Hills Park (28,055.76 ha), Ulu Kalumpang FR (50,736 ha) and Mount Wullersdorf FR (8,137 ha). The area also includes a number of small forest fragments, the Madai Baturong FR (2,312.74 ha) and Kalumpang FR (3,768 ha), which are now separated from the main forest block due to plantation expansion.

Tawau Hills Park is one of the few remaining areas of primary forest in the state. The park was originally gazetted to protect water catchment resources for Tawau and the Semporna Peninsula, and it is now an important home for disturbance intolerant species. Like much of the Tawau Highlands, the terrain in the park is undulating with two main peaks: Gunung Magdalena (1310 m) and Gunung Lucia (1201 m). The dominant vegetation is lowland and hill dipterocarp forest. The parks entire northern border lies adjacent to the Ulu Kalumpang FR, whereas elsewhere oil palm, rubber and cocoa plantations surround the park. A camera trap survey of the park in 2013-2014 yielded a localized population density estimate of 2.23 individuals/100 km^2 (Hearn et al. 2017).

Figure 5. Sunda clouded leopard photographed in Tawau Hills Park. ©AJ Hearn/WildCRU

There are incidental observations of Sunda clouded leopards from Ulu Kulumpang FR, but the authors of this report are unaware of any formal surveys for this species. It is unknown if the species persists in other areas of the Tawau Highlands, but it seems likely that Sunda clouded leopards inhabit Mount Wullersdorf FR. The Tawau highlands are separated from the Ulu Segama FR by an extensive area of oil palm and timber plantations, managed by Sabah Softwoods. To support wildlife conservation in the area, Sabah Softwoods has retained a narrow corridor of riparian forest and recovering low scrub vegetation, which links Ulu Segama to Ulu Kulumpang FR, and the company is currently undertaking rehabilitation planting of this corridor in collaboration with WWF Malaysia. Given its small size, narrow width and long length, it is unlikely that Sunda clouded leopards use this area extensively, if at all, but it is certainly possible that the area could be used by dispersing animals, and is therefore a potential priority area, worthy of enhancement and protection.

2.4. Central Forest

The Danum Valley Conservation Area (4° 58‟ N, 117° 46‟ E) is a 43,800-ha area of primary lowland dipterocarp rainforest, officially gazetted in 1984 for the purposes of wildlife conservation. It is currently classed as Class 1 Protection Forest. A camera trap survey of the area yielded a localized population density estimate of 1.73 individuals/100 km^2 (Hearn et al. 2017).

Immediately to the east of Danum lies the 220,900-ha Ulu Segama FR (4° 59‟ N, 117° 52‟ E), which was subjected to selective timber extraction between 1977 and the mid-1990s on an annual coupe basis, resulting in a mosaic of recovering forests at different stages of regeneration. Within Ulu Segama, there is a 25,000-ha region which is in the process of being rehabilitated by the Innoprise and Forest Absorbing CO2 Emissions (FACE) Foundation Rainforest Rehabilitation Project (INFAPRO). Since 1993 approximately 11,500 ha have been rehabilitated through a combination of enrichment planting and liberation cutting to remove vines and bamboos. An extensive network of unsealed roads is maintained by the rehabilitation project; most are gated, thus providing limited access to poachers. The density of clouded leopards in Ulu Segama FR has been estimated to be 3.10 individuals/100 km^2 (Hearn et al. 2017).

The 34,000-ha Malua Forest Reserve (5° 08‟ N, 117° 40‟ E) shares its southern and eastern borders with Danum Valley and Ulu Segama, respectively. The western border is shared with the Northern Kuamut Forest Reserve, which at the time of the Sunda clouded leopard survey in 2013-2014 was undergoing selective timber harvesting. Malua has been repeatedly selectively logged since the 1960s, the most recent phase of timber extraction began in 2006 and ceased on 31st December 2007. The majority of Malua is now highly damaged and disturbed and virtually devoid of large dipterocarps, the canopy consisting of near pure stands of pioneer tree species. Associated with the last round of logging was a dense network of unsealed roads and logging skids which permitted extensive vehicular access to significant sections of the southern and central portions of Malua, although these roads are
now closed to vehicles they remained accessible for some time after logging ceased and thus poaching pressure at this time was significant.

The 58,800-ha Maliau Basin Conservation Area encompasses a circular sedimentary basin and a surrounding buffer zone. The Maliau Basin contains mixed lowland and hill dipterocarp rainforests and tropical heath forests surrounded by sedimentary mountains. Outside the basin but within the Conservation Area are stretches of dipterocarp forest that were selectively logged in the early-mid 1990s. Canopy cover in these logged forests is reduced and understorey and ground layers are thick and composed of grasses, forbs and ferns. The density of clouded leopards in Maliau Basin Conservation Area has been estimated to be 1.90 individuals/100 km^2 (Brodie and Giordano 2012).

Other forest reserves and protected areas in Central Forest include Kalabakan FR, Gunung Rara FR, Northern Kuamut FR and Imbak Canyon Conservation Area for which population sizes of Sunda clouded leopards have not been estimated yet.

Figure 6. Male Sunda clouded leopard photographed in Northern Kuamut Forest Reserve during a camera trapping survey carried out in 2016. ©Leibniz IZW/SFD

2.5. Deramakot Forest Complex

Located north of the upper Kinabatangan the Deramakot Forest Complex comprises Class I and Class II FMUs. Class I protected areas are: FMU 17A (hereafter Tangkulap-Sg. Talibu FRs consisting of Tangkulap FR - 27,258 ha, Sg. Talibu FR - 20,881 ha and VJR Timbah - 292 ha), with the exception of one mosaic plantation and one industrial tree plantation. Tangkulap (50,100 ha) was licensed out to private concessionaires from the 1970s until 2002 and repeatedly logged using conventional selective logging techniques. Logging was ceased in 2001, management was taken over by the SFD, and in June 2011, the reserve received Forest Stewardship Council (FSC) certification. As a result of the more destructive logging practices, overall forest conditions are poorer compared to its neighbouring Deramakot FR. The second Class 1 area in this forest complex is Tawai FR (22,697 ha). Class II areas are Deramakot FR and Segaliud-Lokan FR. Deramakot is a sustainably managed forest that has been certified by the FSC since 1997, the first of its kind in the region. Similar to most currently logged forests in Sabah, only reduced impact logging is allowed within Deramakot. Segaliud-Lokan (57,200 ha) was heavily logged until 1982. In 1995, the current management company – KTS Plantation Sdn Bhd – took up logging operations using conventional logging practices, only switching to RIL in 1998. The reserve was certified in 2009 under the Malaysian Timber Certification Scheme (MTCS).

The current status of Sunda clouded leopard population in Tawai FR is unknown as so far, no camera-trapping study has been conducted there. It is, however, likely that Sunda clouded leopards occur in this protected area, as it is located next to Tangkulap-Sg.Talibu FR, although further studies need to empirically establish this.

Figure 7. Male Sunda clouded leopard photographed in Tangkulap-Sungai Talibu Forest Reserve during our camera trapping survey in 2015. ©Leibniz IZW/SFD

First Sunda clouded leopard density estimates from Tangkulap and Segaliud Lokan FR using spatial-explicit capture-recapture models revealed low densities of ~1 individual/100 km² (Wilting et al. 2012). More recent estimates for Tangkulap-Sg. Talibu FRs using a larger dataset but the same modelling approach (null model: treating all individuals the same) revealed a lower density of 0.4 individual/100 km² (Mohamed et al. unpublished data).

Density of Sunda clouded leopard in the more sustainable managed forest reserve Deramakot was higher with 0.9 individual/100 km². It needs to be noted that the dataset of this study by Mohamed et al. (unpublished data) was big enough to incorporate individual heterogeneity in the movement estimates of Sunda clouded leopard and that these mixed models produced two to three times higher densities (1.3 individuals/100 km² for FMU 17A and 2.8 individuals/100 km² for Deramakot). In light of these findings, it is possible that earlier studies (based on null models) of Sunda clouded leopards of this but

also of other areas underestimated the true density as they overestimated the movement.

In recent years SFD started tourism activities within Deramakot FR. Due to the good wildlife spotting opportunities the area has become well known particularly among mammal watchers.

2.6. Crocker Range

Crocker Range National Park was established in 1984 and is the largest totally protected terrestrial area in Sabah, covering 139,900 ha. It is located close to the west coast of Sabah on the southern section of the Crocker Mountain Range. Geologically and floristically it is part of the same mountain chain as Kinabalu National Park which is situated at the northern end of the range. Elevations within Crocker Range National Park range from 100 m to 1964 m at the highest point on Gunung (Mount) Alab. The vegetation consists largely of mixed dipterocarp forest; there are also pristine montane and upper montane moss forests on the peaks. Crocker Range is an important water catchment area, with the headwaters of several major rivers originating there. Several indigenous communities live close to, or in some cases, within the boundary of the park. Some ethnic groups consider the area to be their ancestral land, and are dependent on the forest for daily subsistence, and thus carry out various activities such as swidden agriculture and wildlife hunting within the park.

Figure 8. Sunda clouded leopard photographed in Crocker Range Park. ©AJ Hearn/WildCRU

In 2011/12, an intensive camera trap survey of the southwestern portion of the park yielded an estimated Sunda clouded leopard population density of 1.39 individuals/100 km^2 (Hearn et al. 2017). Extrapolation of this estimate suggests that the park may support in the region of 20 (11-30) mature animals. Owning to its relatively isolated status, its close proximity to the urban and suburban areas of the western coast, and the presence of several roads in the area, the park is easily accessed, which in turn likely facilitates increased poaching activities. The authors of the 2011/12 survey report that they photographed poachers at several sites and lost numerous camera traps to thieves.

Other management units (small, fragmented populations with unknown densities of clouded leopards)

Other potentially important management units have never been surveyed intensively with camera-traps. Therefore, the status of Sunda clouded leopards is currently unknown, but due to their size and the

large forest cover in some of these areas, they are likely important areas for the long-term survival of the species. We identified the following three forest complexes, which are partly connected to other complexes highlighted above:

2.7. Ulu Sungai Padas, Sungai Tagul and Pensiangan Forest Reserves

Ulu Sungai Padas FR (4°27'N/115°51'E) is a Class II and extensive montane forest reserve covering approximately 45,690 ha.

Sungai Tagul FR (4°35'N/116°09'E) is a Class II forest reserve covering approximately 105,770 ha.

Pensiangan FR is a Class I forest reserve covering approximately 62,230 ha.

None of these reserves have been surveyed, therefore the presence (or absence) of Sunda clouded leopard is unknown.

2.8. Trus Madi, Ulu Sungai Milian and Ulu Tungud Forest Reserves

The Trus Madi FR (FMU5, 5°32'N, 116°38'E), named after Mount Trus Madi (2,642 m), is located in central Sabah. A part of Trus Madi FR with an area of 74,736 ha was reclassified as Class I forest reserve in 2010 and later was renamed as Nuluhon Trusmadi FR Class I in 2014.

Ulu Sungai Milian FR (5°18'N, 116°36'E) is a Class II forest reserve of approximately 77,733 ha.

Ulu Tungud FR is a large reserve (95,010 ha, 5°53'N/117°00'E) classified as Commercial and managed primarily for rubber, but it also contains areas of natural forest managed as conservation areas. Ulu Tungud FR (FMU4) is managed by TSH Resources Bhd with a 100-year concession to implement ITP (rubber), and to carry out forest restoration and conservation activities to safeguard the biodiversity. A recent camera-trap survey carried out by DGFC from July to September 2016 did not record the Sunda clouded leopard in the reserve. A high number of illegal activities (hunting, gaharu harvesting) were recorded during the survey.

2.9. Kinabalu Park, Paitan, Sugut, Lingkabau and Bengkoka Forest Reserves

Kinabalu Park was established as one of the first national parks of Malaysia in 1964 and as Malaysia"s first World Heritage Site in 2000. It covers an area of 75,400 ha.

Paitan FR (6°30"N/117°15"E) is a Class II forest reserve of approximately 38,733 ha. Illegal activities recorded during a camera-trap survey by DGFC between April and August 2016 were relatively low. The presence of Sunda clouded leopard was recorded during the survey.

Sugut FR (6°23"N, 117°34"E) is a Class II forest reserve of approximately 23,327 ha and Trusan Sugut Forest Reserve is a Class I forest reserve of approximately 8,680 ha. Those two forest reserves comprise highly degraded secondary forest vegetation and are all prone to forest fires due to the desiccation of the vegetation. Part of Sugut FR is now ITP (oil palm). The number of illegal activity events recorded using camera traps and direct observations between February and July 2016 was relatively low. The Sunda clouded leopard was recorded during the survey (see Figure 9).

Figure 9. Sunda clouded leopard caught on camera trap in Sugut Forest Reserve in June 2016. ©DGFC/SWD

Lingkabau FR (previously Class II Forest Reserve) has been reclassified as several Class I Forest Reserves, namely Mensalong FR (7,968 ha), Gunung Menapod FR (3,971 ha), Lambiding FR (179 ha), Bukit Goitan FR (2,755 ha) and Sungai Sungai FR (566 ha).

Bengkoka FR (6°50'N, 117°09'E) is a Class II forest reserve of approximately 6,270 ha.

3) NON SITE-SPECIFIC PRIORITY ACTIONS

OBJECTIVE 1. LAW ENFORCEMENT AND PATROLLING
Action 1.1: Combat wildlife poaching and eradicate wildlife trafficking
Rationale: There is a need to increase the capacity and effectiveness of the State"s agencies in combatting wildlife poaching and eradicating wildlife trafficking and pet trade.
Resources available: 1. Existing PROTECT team at SFD. 2. Network of Honorary Wildlife Wardens (under SWD). 3. Enforcement unit at Sabah Foundation focusing on DaMaI Rainforest Complex. 4. SWD wildlife and enforcement officers. 5. Conservation units by concession holders upholding existing protocols on forest management. 6. Network of researchers collecting data in the field. **Resources not available:** 1. Increase the capacity of PROTECT team with additional rangers and one crime analyst (intelligence unit using the SMART intelligence platform). 2. Increase the capacity of DaMaI enforcement unit. 3. Improve efficiency of HWW network (systematic HWW training could be given to security personnel of private sector companies whose properties are within clouded leopard ranges). **Measures to be taken:** 1. Establish SMART patrols across all Sunda clouded leopard ranges and standardise the reporting system and the data base (real time monitoring). There should be a centralised person that collects and analyses all the data (based at SWD or SFD headquarters). Ensure proper training in SMART data entry is given to at least one enforcement officer per site. 2. Hire and train crime analysts, investigators and intelligence gatherers to use the SMART intelligence platform and train a certified forensic technician at the Sabah Wildlife Health, Genetic and Forensic Laboratory. 3. Enforcement of gate use and increase of security at access points by setting up camera traps and increasing the presence of armed guards. Keys for gates which border forest reserves (i.e. Tabin) should not be provided to oil palm estates. Access pass could be issued monthly/yearly and controlled by the authorities.

4. Assess the level of hunting in Sabah by gathering all poaching information. For example share data on poaching collected during camera-trapping surveys. The centralised information should be provided to the enforcement authorities to target anti-poaching sctivities.
5. Carry out undercover operations in bushmeat markets.
6. Enforce a zero snaring policy in Sabah"s protected areas, forest reserves, forest plantations and oil palm plantations.
7. MoU between oil palm plantations adjacent to protected areas and enforcement agencies (SFD, SWD) stipulating „no hunting" must be signed and enforced.
8. Pay reward to valid informants leading to prosecution of poachers.
9. Active training programme on self-defence and firearms training to empower officers and checkpoint personnel or reinstall confidence.
10. Ensure that at least one officer at each site is equipped with a firearm and the firearm license is continuously updated and kept valid.
11. Ensure that a specific enforcement plan is included in all SFMLAs to make sure that patrolling is carried out regularly and there is an annual work plan and a budget to implement the activities.
12. Increase joint patrolling by District-level anti-poaching task force and constantly update on poachers" activities via Whatsapp group.
13. Identify trade routes and modus operandi of poachers/traders and establish strong collaboration between State Level Wildlife Trade Task Force and Transboundary Enforcement Network (HoB).

Priority:
1. One person at SFD or SWD headquarters to compile all SMART data.
2. Two years for PROTECT and DaMaI enforcement units to be operational and confident in the use of SMART to document all patrols.
3. Two years to train a crime analyst and an intelligence gathering team in the use of SMART for queries and the SMART intelligence platform.
4. Two years for at least one officer at each site to be familiar and confident in the use of SMART for data entry.
5. Three years to train a forensic technician at SWHGFL.

Lead agencies: SFD (PROTECT), SWD (Enforcement team), SF (DaMaI)

Partners: WWF-Malaysia (Enforcement team), NGOs (HWW), Oil Palm Plantations, SWHGFL, DGFC

Success measure/indicator:
1. Decrease of poaching and trade in Sabah.
2. Increase of prosecutions of wildlife criminals in Sabah.
3. SMART database established.
4. Data base on enforcement operations established for each department and shared between departments.
5. Appointment and training of forensic technician for laboratory.
6. Biannual training on firearms and defence.

OBJECTIVE 2. HALT LOSS AND DEGRADATION OF HABITAT USED BY SUNDA CLOUDED LEOPARDS

Action 2.1: Prevent any further loss and degradation of suitable habitat for the Sunda clouded leopard. Any of the key conservation areas for Sunda clouded leopards must be managed sustainably.

Rationale: Slowing the current rate of habitat destruction can drastically improve the future prospects of the Sunda clouded leopard, although the species has been detected in highly disturbed commercial forest reserves.

Priority: 10 years

Lead agencies: SFD, SF, SP

Partners: Land and Survey, FMUs

Success measure/indicator: No more forest loss and degradation in clouded leopard habitat.

OBJECTIVE 3. ESTABLISH AND MAINTAIN LANDSCAPE CONNECTIVITY THROUGHOUT THE RANGE OF SUNDA CLOUDED LEOPARD

Action 3.1: Identify potential connectivity within and between Sunda clouded leopard habitats and establish connectivity within and between regional management units

Rationale: Small population sizes are at greater risk of extinction; establishing and/or maintaining connectivity among populations increases likelihood of persistence, allows for rescue of declining populations through immigration and promotes long-term genetic viability. Although factors that influence the movements and dispersal abilities of Sunda clouded leopards remain poorly known, available evidence suggests that such movements are facilitated by forest cover and restricted by oil palm plantations.

Priority: 10 years **Lead agencies:** SFD, SF, SP **Partners:** FMUs, Oil palm estates, Research organisations **Success measure/indicator:** Major clouded leopard sub-populations are re-connected.
OBJECTIVE 4. RESEARCH
Action 4.1: Evaluate the status of Sunda clouded leopards in the areas that have not been surveyed.
Rationale: In 50-70% of Sabah we have no idea about the status of Sunda clouded leopards. Therefore, the assessment of these unstudied areas is of prime importance. These areas are: Ulu Sg. Padas, Sg. Tagul and Pensiangan Forest Reserves, Trusmadi FR, Ulu Sg. Milian FR and Ulu Tungud FR, Kinabalu NP, Paitan FR, Sugut FR, Lingkabau FR and Bengkoka FR. This information would be of direct conservation value as it helps to set priorities.
Priority: 3 years **Lead agency:** SWD **Partners:** SFD, SP, SF, WildCRU, IZW, DGFC, HUTAN **Success measure/indicator:** All Sunda clouded leopard management areas have been surveyed and population sizes are estimated.
Action 4.2: Long-term monitoring of Sunda clouded leopard populations.
Rationale: Assessing the population status every five years in all key sites is needed to inform conservation actions. Being aware of population crashes is very important for a species with such low densities.
Priority: Surveys carried out in 2023 and in 2028. **Lead agency:** SWD **Partners:** SFD, SP, SF, WildCRU, IZW, DGFC, HUTAN **Success measure/indicator:** Population trends are estimated for Sunda clouded leopards in key sites.
Action 4.3: Study the factors that influence Sunda clouded

leopard movement and connectivity.
Rationale: The increasing prevalence of oil palm plantations across Sabah is likely resulting in the decrease in size and increase in fragmentation of Sunda clouded leopard habitat. To ensure the conservation of this felid, therefore, it is essential to gain an understanding of the factors that influence the movements and dispersal abilities of Sunda clouded leopards residing in fragmented habitats. Current models of landscape resistance for this species are based on an extremely small sample size, and from a single study site. Movement data are needed from a range of habitats, and ideally from dispersing animals.
Priority: 5 years **Lead agencies:** SWD, SP, WildCRU, DGFC, UMS and other Malaysian universities **Success measure/indicator:** Better understanding of clouded leopard movement ecology.
Action 4.4: Study adaptability to disturbed/altered habitat and fragmentation.
Rationale: We have a limited understanding of how Sunda clouded leopards respond to anthropogenic habitat modification, such as selective logging, forest fragmentation and forest conversion. Few studies focused on monocultures (i.e. oil palm plantations). Knowledge about how Sunda clouded leopard uses these areas is limited. Therefore, research should move beyond protected areas and scientists should turn their attention to non-protected areas that are exploited and transformed by various types of production such as forestry, agriculture or mining, and that are fragmented and further degraded by roads and human settlements.
Priority: 10 years **Lead agencies:** DGFC, UMS and other Malaysian universities, WildCRU, IZW, SaBC **Success measure/indicator:** Better understanding of clouded leopard ecology in disturbed/altered habitat.
Action 4.3: Carry out a risk assessment of the threat of domestic animals (cats, dogs, etc) to Sunda clouded leopard.
Rationale: Dogs and cats are potential carriers of some important infectious diseases. Transmission of pathogens such as viruses,

bacteria and parasites can occur in either one of two ways, or even both: 1) dogs and cats incursions move their pathogens into the forest; the contact with susceptible species can occur and spread the disease to wildlife; and 2) small and generalist carnivores (i.e. civets, leopard cats, etc.) venture into human settlements looking for easy food or comfortable shelter. This increases their chance to be in direct contact with dogs and cats and to become carriers of diseases such as feline panleukopenia virus (FPV), canine distemper virus (CDV), and canine parvovirus (CPV), all highly contagious and able to cause considerable mortality and morbidity in susceptible carnivore populations, and share several parasites species including: *Giardia* spp., *Cryptosporidium* spp., *Toxoplasma* spp., *Echinococcus* spp., *Ancylostoma* spp. and *Toxocara* spp., among others. Both cases represent a potential risk for clouded leopard and other forest specialist carnivores; of specific note are the potential zoonotic human health implications of some of these parasites.

Strategy:

- Demography and influence of domestic carnivores within clouded leopard distribution range

a) Census domestic dogs and cats within the clouded leopard distribution range,

b) Study habitat use and home range of free ranging dogs and cats.

- Domestic and wild carnivore interactions and population health assessment

a) Health assessment of populations of domestic dogs and cats within clouded leopard distribution range,

b) Prioritise sites to carry out infectious disease surveys of domestic and wild carnivores in the boundaries between human settlements and protected areas in the Sunda clouded leopard core areas and corridors.

- Domestic carnivores management: identification of the problems and response strategy

a) Elucidate which wildlife species are these domestic species targeting when they venture into the forest, how often do they go into the forest and how much time they spend there (satellite tracking),

b) Community-based birth control of domestic cats and dogs and preventive medicine program,

c) Inter-institutional collaboration to establish domestic animal health programs and sentinel program in order to detect early epidemic outbreaks that could spread into the wild.
d) Feral dogs and cats should be eradicated in all protected areas.

Priority: 5 years

Lead agencies: SWD, DVS, UMS, SWHGFL, DGFC, WildCRU, SaBC

Success measure/indicator: Potential pathogens detrimental to clouded leopard are identified.

Action 4.4. Assess the threat posed by hunting and poaching activities.

Rationale: Almost nothing is known about the threat posed by poaching on Sunda clouded leopard populations and Sunda clouded leopard prey in Sabah. By using pooled data from SMART surveys, as well as targeted remote survey techniques (covert cameras, audio sensors) in key areas, we can have a better understanding of hunting pressure on Sunda clouded leopard and their prey. Surveys of markets can be used to assess which species are targeted, and that can be linked indirectly back to Sunda clouded leopards.

Priority: 5 years

Lead agency: SWD

Partners: SFD, SP, SF, UMS, DGFC, WildCRU, IZW, SaBC

Success measure/indicator: A better understanding of the impact of hunting on Sunda clouded leopard prey.

OBJECTIVE 5. EDUCATION AND AWARENESS

Action 5.1: Disseminate awareness materials on Sunda clouded leopard to relevant stakeholders in the vicinity of the protected areas (local communities, oil palm workers).

Rationale: The level of awareness about Sunda clouded leopard and wildlife conservation within the local communities and oil palm workers in the vicinity of protected areas is very low. It is important to disseminate information about wildlife laws within local communities and oil palm estates.

Priority: 10 years

Lead agencies: SWD, SFD, SF, SEEN, DGFC, BSBCC, HUTAN,

PACOS Trust

Success measure/indicator: 1. Community outreach/education programmes contain up-to-date information, images and props on clouded leopards and their conservation. 2. The number of community outreach programmes in areas containing clouded leopards are increased. 3. New locations are targeted by the outreach programme (communities, schools, and oil palm company management).

Action 5.2: International Clouded Leopard Day.

Rationale: International Clouded Leopard Day is celebrated on 4 August. Sabah must use that day to recognize the national conservation efforts to protect the Sunda clouded leopard and its habitat.

Priority: 10 years, every year

Lead agencies: SEEN, SWD, SFD, SF

Success measure/Indicator: International Clouded Leopard Day is celebrated every year in Sabah with special events organized at that occasion.

OBJECTIVE 6. CRYOPRESERVATION

Action 6.1: Cryopreservation of gametes and cell culture

Rationale: To provide a source of genetic material that can help sustain genetic diversity long-term. Semen and embryos produced in vitro can be cryopreserved in liquid nitrogen. Cell culture can also be developed and maintained, with samples cryopreserved.

Priority: 2 years

Lead agency: SWD

Partners: UMS, BORA, SaBC

Success measure/indicator: Sunda clouded leopard tissue is cryopreserved.

OBJECTIVE 7. MONITORING

Action 7.1: Set up an Endangered Species Conservation Unit (ESCU) that will monitor the implementation of all action/conservation plans on totally protected (Schedule 1) terrestrial species in Sabah: elephant, banteng, proboscis monkey, orangutan, Sunda clouded leopard, Malayan sun bear and Sunda pangolin.

Rationale: Sabah Wildlife Department, the custodian of wildlife in Sabah, need assistance to implement these endangered species action plans. ESCU will provide manpower and expertise to monitor the implementation of the action plans, meet with the different stakeholders and prepare the annual reports and mid-term reviews for each action plan.
Priority: 10 years **Lead agency:** SWD **Partners:** NGOs, DGFC **Success measure/indicator:** The action plan is implemented. A short review is carried out every year by ESCU. A mid-term review is drafted after 5 years by ESCU.

4) SITE-SPECIFIC PRIORITY ACTIONS

4.1. Tabin Wildlife Reserve

Action 1. Enhance connectivity between Tabin WR and Kulamba FR.

Action 2. Prevent poaching by increasing coordinated enforcement and SMART patrols, especially along core road and road bordering the plantation.

Action 3: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.2. Kinabatangan

Action 1. Re-establish connectivity using underproductive oil palm and private/state land (see Hearn et al. 2018b). SFD and SWD to work with NGOs and oil palm estates to recover those lands.

Action 2. Prevent poaching by increasing coordinated enforcement and SMART patrols, especially boat patrols.

Action 3: Empower the local community (follow the examples of MESCOT and HUTAN) in the vicinity of the sanctuary to protect their natural resources and contribute to the protection of the Sunda clouded leopard.

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

Action 5: Restrict the Pan-Borneo Highway to two lanes and implement mitigation (e.g. speed cameras) for reducing speed through areas where Sunda clouded leopards may be crossing. Government and developers should work with NGOs to minimise the impacts of this highway on wildlife.

Action 6: Investigate the possibility to set up an Eco-bridge linking the two sides of Pin Suput Forest Reserve (left and right of the road). Eco-bridges have been successfully implemented in Peninsular Malaysia.

4.3. Tawau Highlands

Action 1. Prevent poaching. Poaching activity is known to occur within the park boundaries, and although there is no direct evidence for targeted hunting of Sunda clouded leopards in the park, incidental killings may occur. Poachers known to access along plantation borders. Extensive road network constructed for the geothermal project facilitates entry by poachers. Sabah Parks employ an enforcement team but may require additional support.

Action 2: Establish connectivity with Ulu Segama Forest Reserve, via riparian corridor through plantation. Support enforcement and planting activities undertaken by Sabah Softwoods, and monitor corridor for wildlife and poachers.

Action 3: Assess the status of Sunda clouded leopards in Ulu Kalumpang FR. and assess the threats in this Class 1 area.

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.4. Central Sabah

Action 1. Prevent poaching by increasing coordinated enforcement and SMART patrols.

Action 2. Reduction of vehicular access could be achieved through the installation of gates and the destruction of bridges following the cessation of logging activities. Currently, SFD"s enforcement efforts (patrols and roadblocks) are focused on roads. To aid in this, SF"s concessions that have gates on the main roads must record the information of drivers (name/IC), vehicles (plate number, car type) that pass through the gates, as well as purpose of using the road. This should be done regardless if the vehicle is private or belongs to a certain government agency.

Action 3. Re-establish and enhance connectivity between Central Sabah and Deramakot/Tangkulap.

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.5. Deramakot Forest Complex

Overall the Deramakot Forest Complex is a core conservation area for the Sunda clouded leopard in Sabah, as it is connected through Northern Kuamut to the Central Forest Complex south of the upper Kinabatangan and Milian rivers. Further Segaliud Lokan is likely the only link of the Sabah"s central forests to the Lower Kinabatangan Wildlife Sanctuary. However, Sunda clouded leopards and other mammals currently face two major threats within the landscape: poaching and to a lesser extent habitat degradation.

Action 1. Prevent poaching. Although there is no evidence for targeted hunting of Sunda clouded leopards in the landscape, hunters might kill Sunda clouded leopards opportunistically or incidentally. To prevent poaching several important actions are needed:

a) Increased and more structured and coordinated enforcement. Each forestry district within this forest complex needs to have at least one person in the enforcement unit familiar with the SMART software (for data entry). At the HQ level there needs to be a centralised collection of SMART data from districts (for running queries). This will ensure that intelligence records are timely and easily available. The SMART data model used in all districts must be exactly the same for ease of comparisons. SMART data must be reviewed every ~2 months at the HQ level to decide where to focus patrols in the districts based on data.
b) Preliminary data from Deramakot FR and Tangkulap-Sg. Talibu FRs has revealed two distinct kinds of poachers: short-term wildlife poachers and agarwood (*gaharu*) collectors. Short-term wildlife poachers use vehicles and motorbikes, and typically do not walk too far into the forest. Gaharu collectors, spend much longer in the forest. They usually hunt for their own subsistence while in the forest and they use guns, but also set snares.
c) To reduce the amount of poaching, the following actions are needed:
    a. A change in the way current vehicle and boat patrols are conducted. These patrols have the advantage of being mobile and can discretely park in certain areas to

conduct observations of known entry points. SMART must be used to database all data, and an emphasis must be placed on not just driving around but also actively looking for poaching signs (rubbish, suspicious vehicles, etc.) while on the move. Car patrols in Tangkulap-Sg. Talibu FRs must not focus too much time on the main road (Maxland road) but can spend more time on the side roads that lead from the main road deeper into the forest. From preliminary data it seems that one of the hotspots is from gate 8 along the Maxland road that leads into Tawai Forest Reserve.

b. An increase in foot patrols. A preliminary SMART patrolling effort revealed the highest detection rate of illegal activities by foot patrols (compared to car and motorbike patrols; Guharajan unpublished data). These will be useful in detecting gaharu collectors. Foot patrols should be done along rivers (to detect camps) and old logging roads no longer accessible by car. SMART must be used to database all the data and an emphasis must be placed on actively looking for poaching signs (rubbish, cut trails, etc.). Gaharu collectors leave distinctive marks on trees and these should be photographed as they are unique to each gang.
c. Spot-checks should be conducted at the logging and silviculture camps to ascertain if poaching of wildlife by logging/silviculture workers are being carried out. Similarly, these spot-checks should be done at the two companies that are licensed to conduct mosaic and ITP plantations in Tangkulap-Sg. Talibu FRs.
d. When active poacher/gaharu collector camps are found, every piece of evidence must be photographed and recorded (including food). Special attention must be given to things like purchase receipts (in order to know where supplies are bought from and where they come from).
e. All security gates need to have better documentation of car models/makes/plate numbers. This needs to be done only when noticing suspicious vehicles (especially those with coolers in the truck bed). The K-9 Unit could also conduct random checks on vehicles using the sniffer dog.

f. All major checkpoints along Maxland road need to be manned 24 hours (specifically those that are manned by contractors from Maxland). Currently these gates are left open after 10 pm.

i) Better collaboration with the neighbouring oil palm estates, especially those where there is already evidence of plantation staff poaching (as is the case with Deramakot Forest Reserve), to minimize the chance that any encroachment happens from the oil palm estates.

ii) Patrols along Kinabatangan and Milian rivers. Gaharu collectors and wildlife poachers have been recorded using the rivers as an easy way to enter Deramakot and Tangkulap-Sg. Talibu FRs.

iii) Covert cameras can be placed in known poacher entry points (Deramakot and Tangkulap-Sg. Talibu FRs currently have three operating; these are PoacherCams from Panthera and are available for SFD to purchase). Cameras need to be checked at minimum once a week. With better understanding of when poachers are entering, vehicles can target these areas more frequently (to discourage poachers) or a team on foot can be on site to make an arrest. Images of poachers from the cameras must be databased (using the SMART Intelligence platform) at the HQ level. If at present this is too much work, then perhaps an NGO can assist with databasing of poacher images. This database can be useful in prosecutions.

iv) In Deramakot, better protection along the northern border. Most poaching activities have been documented in the northern part of Deramakot. Vehicle patrols can station themselves discretely along the border to observe if any poachers are entering the area.

v) Place a clear chain of communication in place, so that during an active incursion by poachers (identified either from covert cameras or from patrols) the relevant enforcement unit from the district, K-9 Unit, MCEE Sandakan, PROTECT, relevant NGOs, Kinabatangan Wildlife Office, and Royal Malaysia Police are on alert and understand what is going on.

vi) Shift the responsibility of patrolling from solely on SFD to the collective responsibility of the Tongod Anti-

poaching Task Force. Task force members must be able to patrol independently, with SFD providing them with the high-risk areas based on SMART data or intelligence. Not all task force members (such as Royal Malaysia Police and Sabah Wildlife Department) will be able to collect SMART patrol data, but the areas to patrol must be based on SMART data or intelligence. This will alleviate the burden of enforcement from solely being on SFD.

vii) Conduct joint operations by the whole Tongod Anti-poaching Task Force in places that have been highlighted from SMART data as high-risk areas, in addition to the current practice of roadblocks. These should be done once every ~3 months, if possible.

viii) Involve the Malaysian Army and Royal Malaysia Police General Operations Force in the Tongod Anti-poaching Task Force. If poachers notice a large presence of enforcement personnel, it will disrupt their operations. The 1MBEON initiative in Peninsular Malaysia is an example of this, where the Malaysian Army conducts patrols in the Taman Negara landscape.

ix) SFD district level enforcement units need to continue to cultivate informant networks among the estates and villages (Kg. Balat, Kg Karamuak, Kg. Kenang-Kenangan, etc.). Gaharu collectors rent boats from villagers to transport themselves into Deramakot, so having informants from villages is essential. Informant proxy identities and information can be databased in the SMART Intelligence platform by the district-level SMART user.

x) Equip all SFD vehicles in the districts with radio communication.

Action 2: Reduce further degradation through sustainable logging practices. Continue the good forest management practices in Deramakot and ensure the sustainable management in Segaliud-Lokan. Monitor the recovery of FMU17A and minimize the impacts of the ITP areas in al commercially used areas.

Action 3: Maintain and increase connectivity. Along the upper Kinabatangan the expansion of oil palm plantations decreased the connectivity between Deramakot FR and Malua and Northern Kuamut

Forest Reserve. Further fragmentation needs to be prevented and the link between north and south of the upper Kinabatangan river and the Milian river needs to be maintained. In the east Segaliud Lokan is the only potential connection the LKWS.

Action 4: Tawai Forest Reserve. Assess the status of Sunda clouded leopards in Tawai Forest Reserve and assess the threats in this Class 1 area.

Action 5: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.6. Crocker Range

Action 1. Maintain and increase connectivity with Kinabalu National Park (Eco-Link project), Trusmadi and Sipitang.

Action 2. Prevent poaching. Poaching activity is known to occur within the park boundaries, and although there is no direct evidence for targeted hunting of Sunda clouded leopards in the park, incidental killings may occur.

Action 3. Empower the local community in the vicinity of the park to protect their land and resources and contribute to the protection of the clouded leopard in the park.

Action 4. Establish a clear boundary of the park.

Action 5: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.7. Ulu Sungai Padas, Sungai Tagul and Pensiangan Forest Reserves

Action 1: Assess the status of Sunda clouded leopards in Ulu Sungai Padas, Sungai Tagul and Pensiangan FR (data are deficient).

Action 2. Prevent poaching by increasing coordinated enforcement and SMART patrols.

Action 3: Maintain and increase connectivity between Ulu Padas, Sungai Tagul and Pensiangan FR.

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.8. Trus Madi, Ulu Sungai Milian and Ulu Tungud Forest Reserves

Action 1. Assess the status of Sunda clouded leopards in Ulu Padas and Sg Tagul Pensiangan (data are deficient).

Action 2. Assess connectivity between Trusmadi and Ulu Tungud and involve the local community in establishing/maintaining connectivity between the two sites.

Action 3. Prevent poaching by increasing coordinated enforcement and SMART patrols (i.e. only half of Trusmadi is protected).

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

4.9. Kinabalu Park and Paitan, Sugut, Lingkabau and Bengkoka Forest Reserves

Action 1. Assess the status of Sunda clouded leopards especially in Lingkabau and Bengkoka (data are deficient).

Action 2: Gather potential information on presence/absence of Sunda clouded leopards from researchers working in those areas (especially Kinabalu, Paitan and Sugut).

Action 3. Prevent poaching by increasing coordinated enforcement and SMART patrols (heavy poaching is happening in the areas).

Action 4: Monitoring of Sunda clouded leopard population in this landscape. Repeat camera-trapping surveys every ~5 years to monitor Sunda clouded leopard population and ensure population stability.

5) IMPLEMENTATION, MONITORING, EVALUATION AND BUDGET

5.1 SCLAP implementation

This is a 10-year action plan (2019-2028). In order for this plan to achieve its ultimate objective of securing the future of the Sunda clouded leopard in Sabah, all recommendations should be evaluated by SWD and endorsed by the Sabah State Cabinet.

The implementation of the SCLAP remains the responsibility of SWD. However, assistance from other relevant government departments such as SFD, SF and SP will be provided.

It is proposed that a SPECIES ACTION PLAN COMMITTEE led by Ministry of Tourism, Culture and Environment is created, consisting of members from relevant NGOs, research institutions and government departments that will assess the implementation for each species action plan (elephant, orangutan, proboscis monkey, Sunda clouded leopard, Bornean banteng and any future action plans (sun bear, pangolin,…)). The relevant NGOs in Sabah are namely: HUTAN, LEAP, WWF-Malaysia, SET, PACOS, BSBCC…. The relevant research institutions in Sabah are namely: UMS, SEAARP and DGFC. The relevant government departments in Sabah are namely: SFD, SF, SP, SLSD, DID, MAFI.

5.2 SCLAP monitoring and evaluation

On a yearly basis, an overview and analysis of progress will be produced by SWD and circulated to the relevant government departments and stakeholders. A mid-term review will be carried out at the end of 2023 (five years) by SWD with the assistance of the main stakeholders. The plan will be fully reviewed and rewritten at the end of 2028 (10 years). SWD will be assisted by the ENDANGERED SPECIES CONSERVATION UNIT that will be set up in 2019, providing that funding is obtained.

5.3 SCLAP budget

Endangered Species Conservation Unit	RM10,000,000 for 10 years
Enforcement unit	RM20,000,000 for 10 years

6)LIST OF ABBREVIATIONS

BORA	Borneo Rhino Alliance
BSBCC	Bornean Sun Bear Conservation Centre
DaMaI	Danum Valley-Maliau Basin-Imbak Canyon
DGFC	Danau Girang Field Centre
DID	Department of Irrigation and Drainage
DVS	Department of Veterinary Services
EPD	Environment Protection Department
ESCU	Endangered Species Conservation Unit
EIA	Environmental Impact Assessment
FMU	Forest Management Unit
FR	Forest Reserves
FSC	Forest Stewardship Council
HoB	Heart of Borneo
HWW	Honorary Wildlife Warden
ITP	Industrial Tree Plantation
IZW	Leibniz Institute for Zoo and Wildlife Research
JKR	Jabatan Kerja Raya (Malaysian Public Works Department)
KOCP	Kinabatangan Orang-utan Conservation Programme
LEAP	Land Empowerment Animals People
MAFI	Ministry of Agriculture and Food Industries
PHVA	Population and Habitat Viability Analysis
SaBC	Sabah Biodiversity Centre
SEAARP	South East Asia Rainforest Research Partnership
SEEN	Sabah Environmental Education Network
SET	Sabah Environmental Trust
SFI	Sabah Forest Industries
SFD	Sabah Forestry Department
SF	Sabah Foundation
SFM	Sustainable Forestry Management
SFMLA	Sustainable Forest Management Licence Agreement
SLSD	Sabah Lands and Surveys Department
SP	Sabah Parks
SWD	Sabah Wildlife Department
SWHGFL	Sabah Wildlife Health, Genetic and Forensic Laboratory
UMS	Universiti Malaysia Sabah

WildCRU	Wildlife Conservation Research Unit
YSD	Yayasan Sime Darby

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Figure 10. Some members of the Sunda Clouded Leopard Action Plan Committee.

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