A sun bear is perched on a thick, mossy tree branch, looking directly at the camera. The bear has dark brown fur and a lighter, tan-colored muzzle. The background is a dense, out-of-focus green forest canopy. The text 'BASELINE STUDY OF SUN BEARS IN BRUNEI DARUSSALAM' is overlaid in a white box at the bottom left.

BASELINE STUDY OF SUN BEARS IN BRUNEI DARUSSALAM



→ Omar Ali Saifuddien Mosque in Bandar Seri Begawan, the capital of Brunei Darussalam.
(© Yusei, Adobe Stock)

BASELINE STUDY OF SUN BEARS IN BRUNEI DARUSSALAM

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The compilation and editing process of this Baseline Study of Sun Bears in Brunei Darussalam was led by Borneo Futures and funded by International Association for Bear Research and Management (IBA).



In collaboration with the Forestry Department of Ministry of Primary Resources and Tourism (MPRT) and the Institute for Biodiversity and Environmental Research (IBER) of Universiti Brunei Darussalam (UBD).

Published by:
Borneo Futures

Date:
28th March 2024

Citation:
Ariffin, T., Khalid, S., Dennis, R., Said, S., Unus, N., Husaini, N., Carson, R. A., Meijaard, E. (2024).
Baseline Study of Sun Bears in Brunei Darussalam.
Bandar Seri Begawan, Brunei Darussalam

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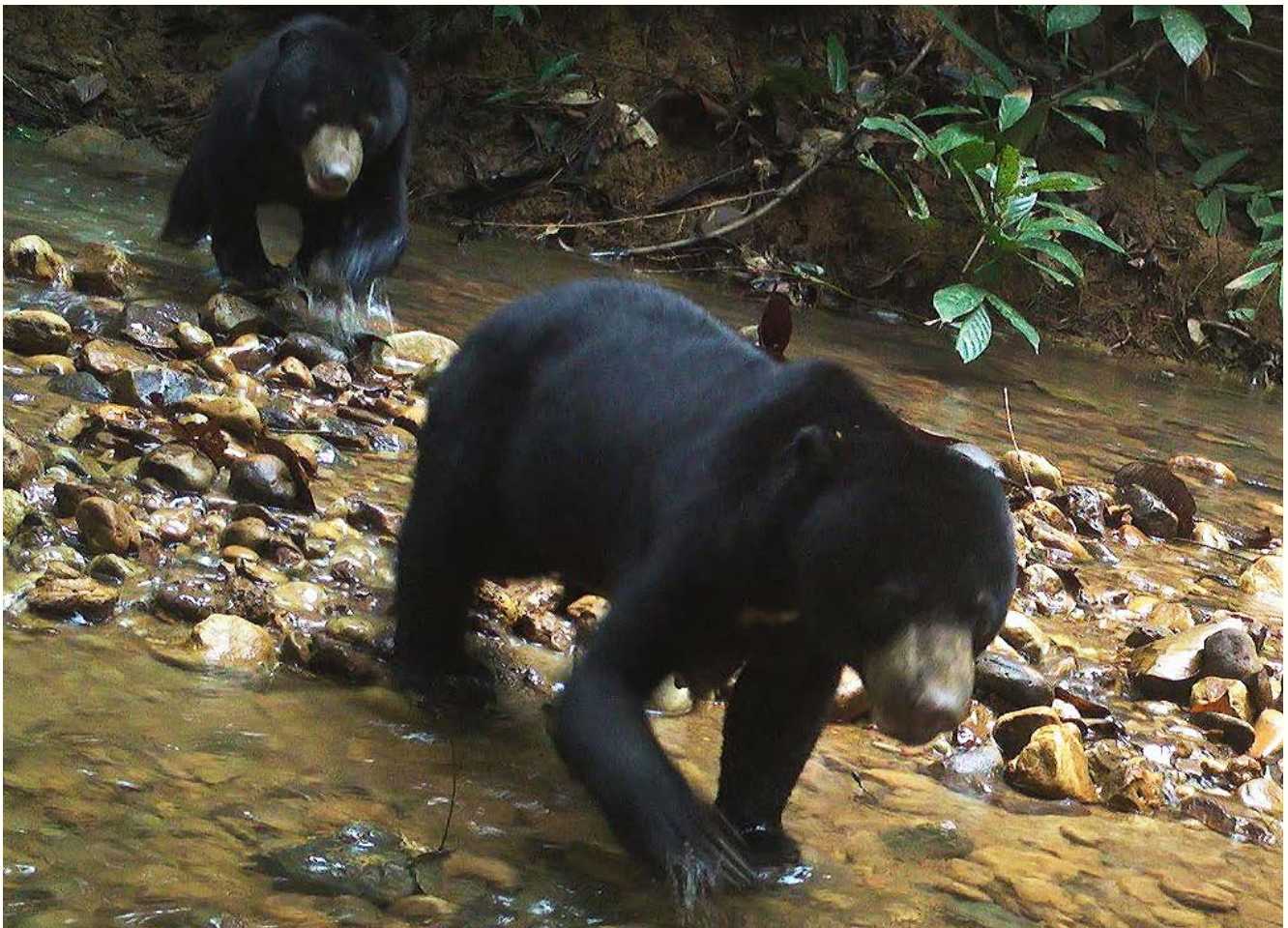
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FOREWORD

Sun Bears are an iconic species of Borneo's tropical rainforests, the conservation of which has been a long-standing focus of Borneo Futures. Like many other species on Borneo, Sun Bears are threatened by the loss and fragmentation of forest habitat and unsustainable hunting for its body parts. If we found effective solutions for conserving this large mammal species, it would benefit many other wildlife species that are similarly affected by habitat loss and overconsumption. Because we are based in Brunei Darussalam, it therefore made sense to us to positively respond to a request by international bear conservation groups to conduct a baseline study specifically for Brunei Darussalam. Through the collaboration with the Forestry Department and the Universiti Brunei Darussalam, we have generated an extensive interview-based dataset. It shows that bears are widespread in Brunei Darussalam and that unlike in many other parts of the Sun Bear's range, the species occurs close to urban areas and other human-dominated landscapes. This likely indicates low hunting pressure but also highlights where conservation action is most urgent. As Borneo Futures, we look forward to further collaboration with our Brunei Darussalam partners in further studying and creating an action plan for the species based on the evidence we have collected.

→ **Erik Meijaard**

Managing Director, Borneo Futures Sdn Bhd



→ **A Sun Bear mother and her subadult child crossing a stream in Ulu Belait.** (© S. Khalid & U. Grafe, IBER & FOS, UBD)

ABBREVIATIONS

IBA	International Association for Bear Research and Management
CITES	Convention of International Trade in Endangered Species of Flora and Fauna
IBER	Institute for Biodiversity and Environmental Research
IUCN	International Union for Conservation of Nature
MPRT	Ministry of Primary Resources and Tourism
NGO	Non-Governmental Organisation
UBD	Universiti Brunei Darussalam



ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the Forestry Department of Ministry of Primary Resources and Tourism Brunei Darussalam, the Institute for Biodiversity and Environmental Research of Universiti Brunei Darussalam, Dr. Wong Siew Te and team from Bornean Sun Bear Conservation Centre, Gabriella Fredriksson from Pro Natura Foundation and the IUCN SSC Bear Specialist Group, Brian Crudge from Free the Bears and the IUCN SSC Bear Specialist Group, Dr Andrew James Hearn and team from WildCRU, Department of Biology, University of Oxford, and everyone at Borneo Futures for their invaluable resources and unwavering support throughout this project.

Furthermore, we extend our heartfelt thanks to all the participants in this study for their generous contribution of time and invaluable insights. Without their involvement, this work would not have been possible. Finally, we would like to acknowledge the International Association for Bear Research and Management (IBA) for funding this project through their Research and Conservations Grant 2022, which has been instrumental in driving the Baseline Study of Sun Bears in Brunei Darussalam forward.

→ Thina Ariffin

Project Lead for the Baseline Study of Sun Bears in Brunei Darussalam

Brunei Darussalam's Focal Point for Sun Bears: Global Status Review & Conservation Action Plan 2019-2028

Environmental Analyst and External Engagement Coordinator at Borneo Futures

→ A Sun Bear resting on a tree in Sepilok, Borneo, Malaysia.

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EXECUTIVE SUMMARY



Recent surveys suggest that Brunei Darussalam might serve as a potential regional stronghold for Sun Bear (*Helarctos malayanus*). Sun Bears are found in Southeast Asia and are the smallest bear species (Meijaard 1999).

They are listed as Vulnerable by the International Union for Conservation of Nature (IUCN) and are mostly threatened by habitat loss and hunting. Their primary habitat is primary tropical rainforests, but they can also be found in secondary forests and, to some extent, in monocultural plantations, agroforestry and other human-dominated vegetation types.

We conducted a countrywide interview and questionnaire survey that indicated that Sun Bear populations occur throughout Brunei Darussalam, including in urban areas with forest fragments. There are no major threat of hunting for food or medicinal purposes, although some poaching may occur. The main threats to Sun Bear in Brunei Darussalam appear to be loss, degradation and fragmentation of remaining

habitats. While recent findings show that the species can adapt to habitat degradation especially in areas of low poaching pressure, ensuring sustained species viability requires conservation strategies focused on habitat health and connectivity (Guharajan et al. 2021).

Based on the countrywide interview surveys and consideration of threats, species ecology, conservation needs and locally determined risk to populations we identified several recommendations. The recommendations spell out key steps that are required to protect Brunei Darussalam's healthy Sun Bear populations based on the international conservation plan for the species and adapted to Brunei Darussalam's context.

→ A Sun Bear inspecting a tree branch.
(© Don Fink, Shutterstock)



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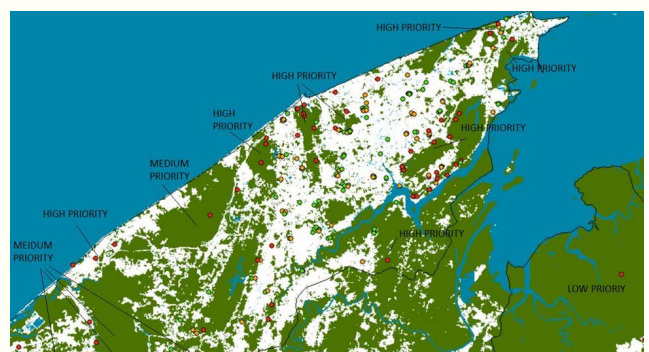


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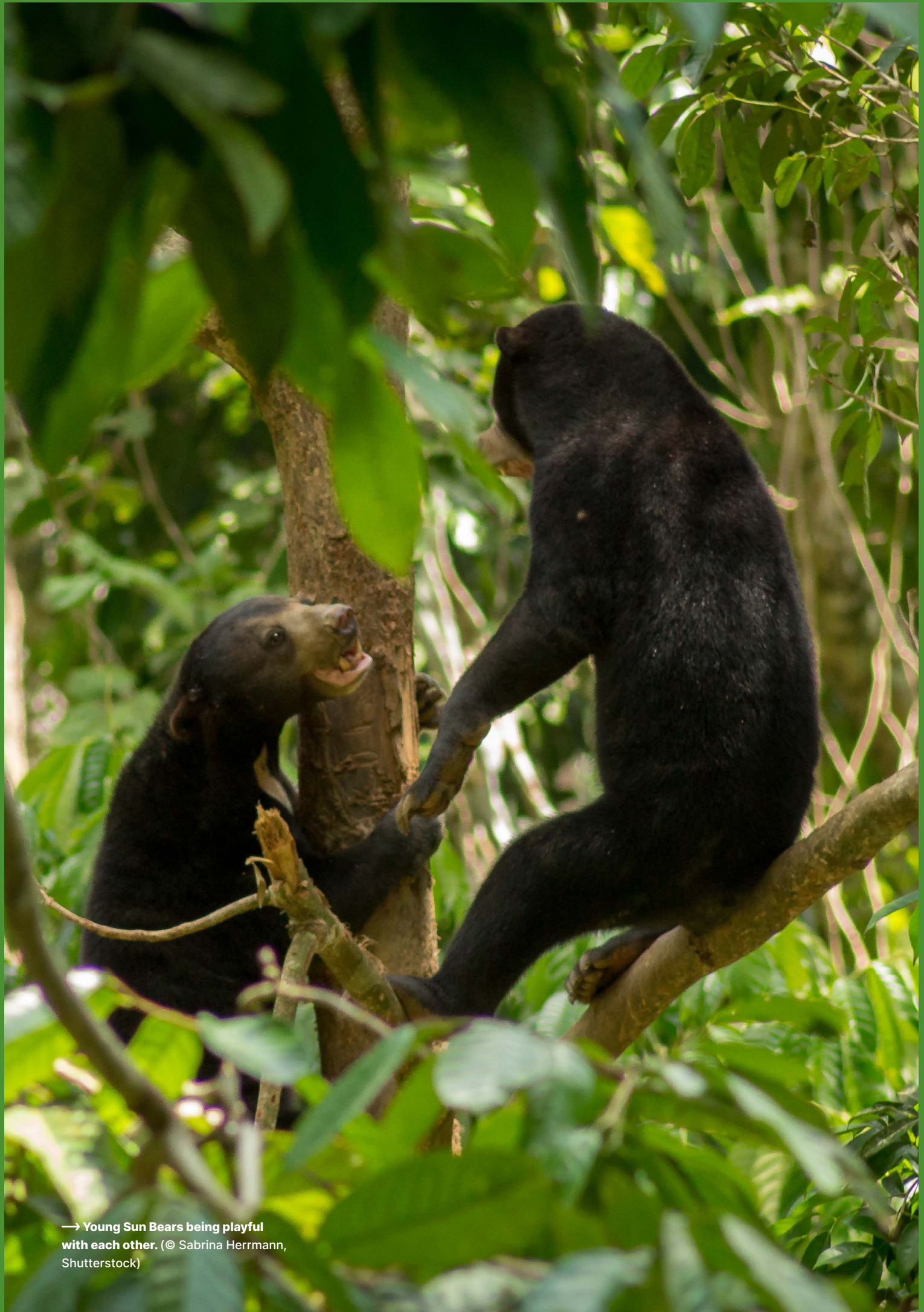
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→ Young Sun Bears being playful
with each other. (© Sabrina Herrmann,
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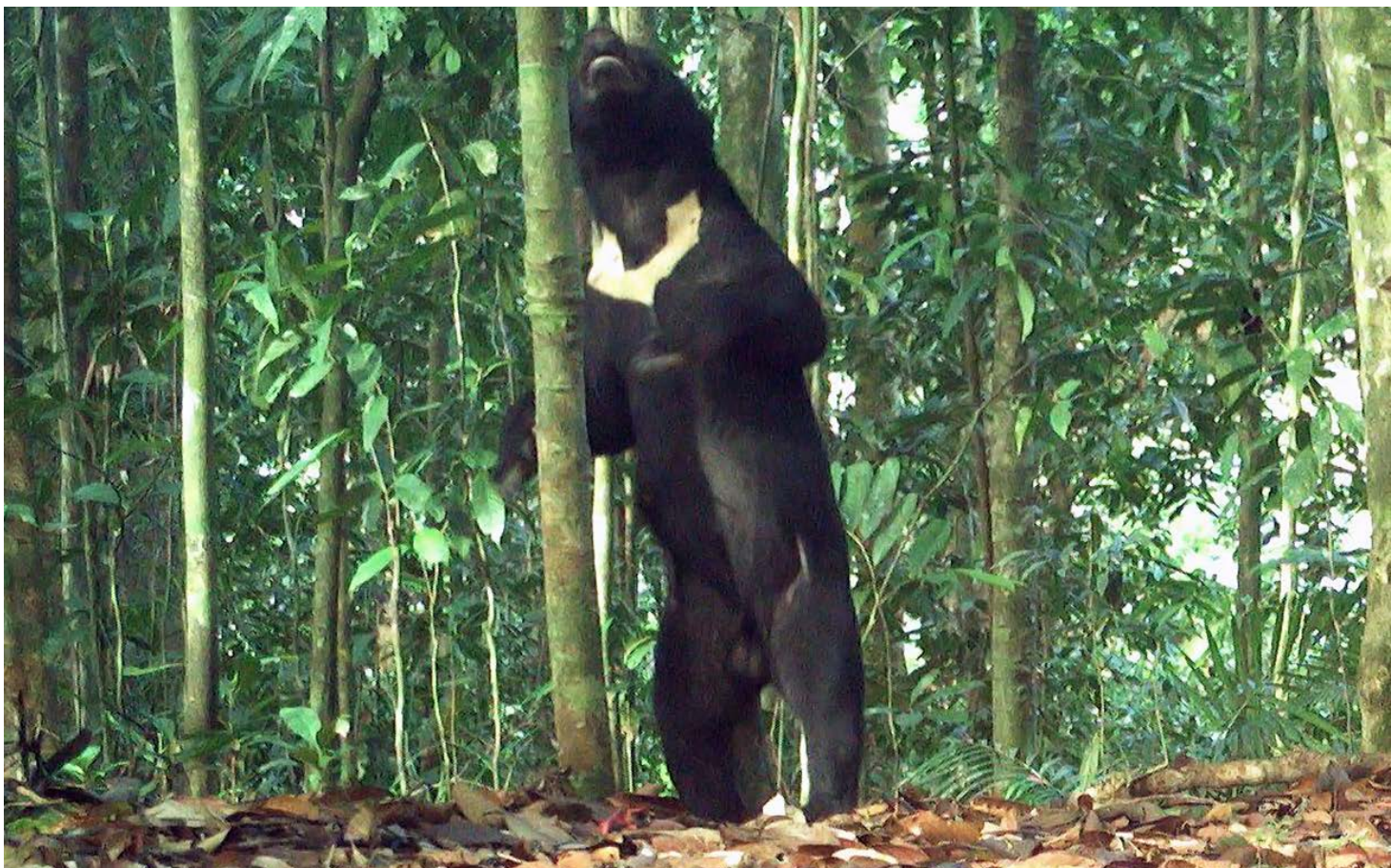
Introduction

The Sun Bear (*Helarctos malayanus*), the smallest in the bear family, populates the dense lowland forests of Southeast Asia, where it is threatened by habitat loss and poaching. They are listed as Vulnerable by the International Union for Conservation of Nature (IUCN) and are mostly threatened by **habitat loss and hunting**.

Their primary habitat is primary tropical rainforests, but they can also be found in secondary forests and, to some extent, in monocultural plantations, agroforestry and other human-dominated vegetation types.

In 2019, the comprehensive “Sun Bears: Global Status Review & Conservation Action Plan 2019-2028” was developed during the 1st International Symposium

on Sun Bear Conservation & Management that was attended by country representatives from the species range. This is the first global conservation action plan for a bear species. Its implementation will require adoption by countries which host Sun Bear populations, some of which may develop complementary country-specific strategies.



→ Sun Bear, standing upright – possibly scent-marking – and showing its clear U-shaped ventral patch, captured through camera trapping. (© S. Khalid and U. Grafe, IBER & FOS, UBD)



Figure 1 IUCN Red List Rating for Sun Bear (link: <https://www.iucnredlist.org/>).

The aforementioned plan details 19 objectives and 63 actions aimed at attaining 5 main goals:

- 1 Eliminating illegal exploitation;
- 2 Protecting and restoring habitats and populations;
- 3 Devising and employing reliable monitoring methods;
- 4 Maximising ex-situ contributions to conservation;
- 5 Increasing cross-sectoral support and collaboration for sun bear conservation.

The study aims to execute “Action 9.1 Identify where sun bear populations exist” by conducting a Brunei-wide interview and questionnaire survey that indicated that Sun Bear populations occur throughout Brunei Darussalam, including in urban areas with forest fragments.



→ A Sun Bear sketch by Horsfield (1825).

Taxonomy and Morphology



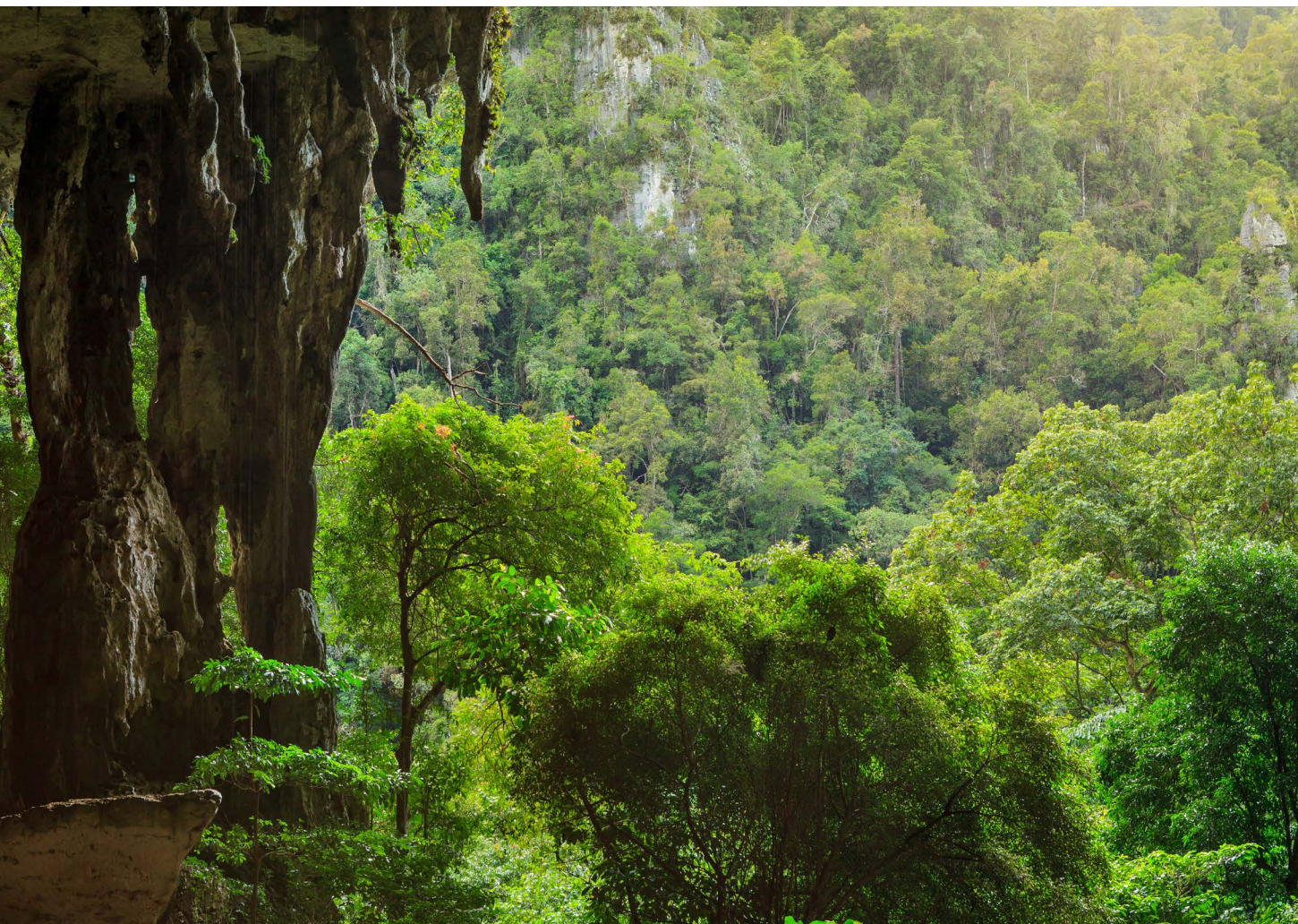
Scientific classification

Kingdom:	Animalia (animals)
Phylum:	Chordata (vertebrates and some invertebrates)
Class:	Mammalia (mammals)
Order:	Carnivora (carnivorous mammals)
Family:	Ursidae (bears)
Genus:	<i>Helarctos</i>
Species:	<i>Helarctos malayanus</i> (Sun Bear)

The Sun Bear is the only species in the genus *Helarctos*, which belongs to the family Ursidae, the group of mammals that includes all species of bears. Sun Bears are closely related to other bear species, such as the American Black Bear (*Ursus americanus*), the Asiatic Black Bear (*Ursus thibetanus*), and the Brown Bear (*Ursus arctos*). They are divided into two subspecies; Malayan Sun Bears (*Helarctos malayanus* spp. *malayanus*) and the Bornean Sun Bear (*Helarctos malayanus* spp. *eurypilus*), the latter subspecies being endemic to Borneo.

Sun Bears are the smallest species in the bear family Ursidae, with the Bornean subspecies of Sun Bears typically being smaller than the Asian mainland form. The weight of Sun Bears also varies depending on food availability (Wong et al. 2005, Fredriksson 2012).

Sun Bears that have access to oil palm fruits tend to be heavier, weighing an average of 75-80 kg. In contrast, those that rely on fruiting seasons and experience periods of fruit scarcity are



→ Lush rainforest in Niah National Park, Malaysian Borneo. (© Juhani Viitanen, Adobe Stock)

often thin and may even starve to death, with some food-starved males in Borneo weighing an average of 40 kg and females weighing an average of 25 kg (Crudge et al. 2019).

Ecology and Behaviour

Sun Bears are found in Asian seasonal and aseasonal tropical and subtropical forests (Augeri 2005). Their range and habitat use may be limited by competition with other bear species, such as the Asiatic Black Bears (*Ursus thibetanus*) whose range is sympatric with the Sun Bear's range across mainland Southeast Asia to about 9°N latitude (in peninsular Thailand), south of which Asiatic Black Bears do not occur, and by human activities such as hunting and habitat disturbance. On Borneo, only one bear species occurs. Sun Bears are found in various forest types, including primary lowland dipterocarp forests, peat swamps, freshwater swamps, limestone/karst hills, and lower-to-sub-montane forests. The average home range size for Sun

Bears in Borneo and Peninsular Malaysia is estimated to be 7 km² and 27 km², respectively, and their daily movements are influenced by food availability (Wong et al. 2004, Fredriksson 2012, Cheah 2013).

Sun Bears are observed in the far north of north-eastern India in mountainous areas with a subtropical climate (Higgins 1932, Chauhan and Singh 2006, Choudhury 2011). Their range may be restricted further north by the cold climate and unsuitable ecological conditions in the Himalayan subregion and limited further northwest due to competition with Sloth Bears (*Melursus ursinus*; Steinmetz 2011). Northeast of India, in Bangladesh and across the rest of the mainland range, including Myanmar, Thailand, Lao PDR, Cambodia, and Vietnam, Sun Bears coexist with Asiatic Black Bears and inhabit seasonal ecosystems that have a long dry season of 3-7 months, with less than 100 mm of rainfall per month (Nguyen Xuan Dang 2006, Scotson 2010, Steinmetz 2011, Gray and Phan 2011). These ecosystems typically consist of a mosaic of semi-evergreen, mixed deciduous, dry dipterocarp,

and montane evergreen forests. Sun Bears and Asiatic Black Bears in Thailand share similar habitats and diets. In montane forests above 1,200 m elevation, with limited ground cover, Asiatic Black Bears are more prevalent than Sun Bears, possibly due to the scarcity of invertebrate food sources (Vinitpornsawan et al. 2006, Steinmetz et al. 2011).

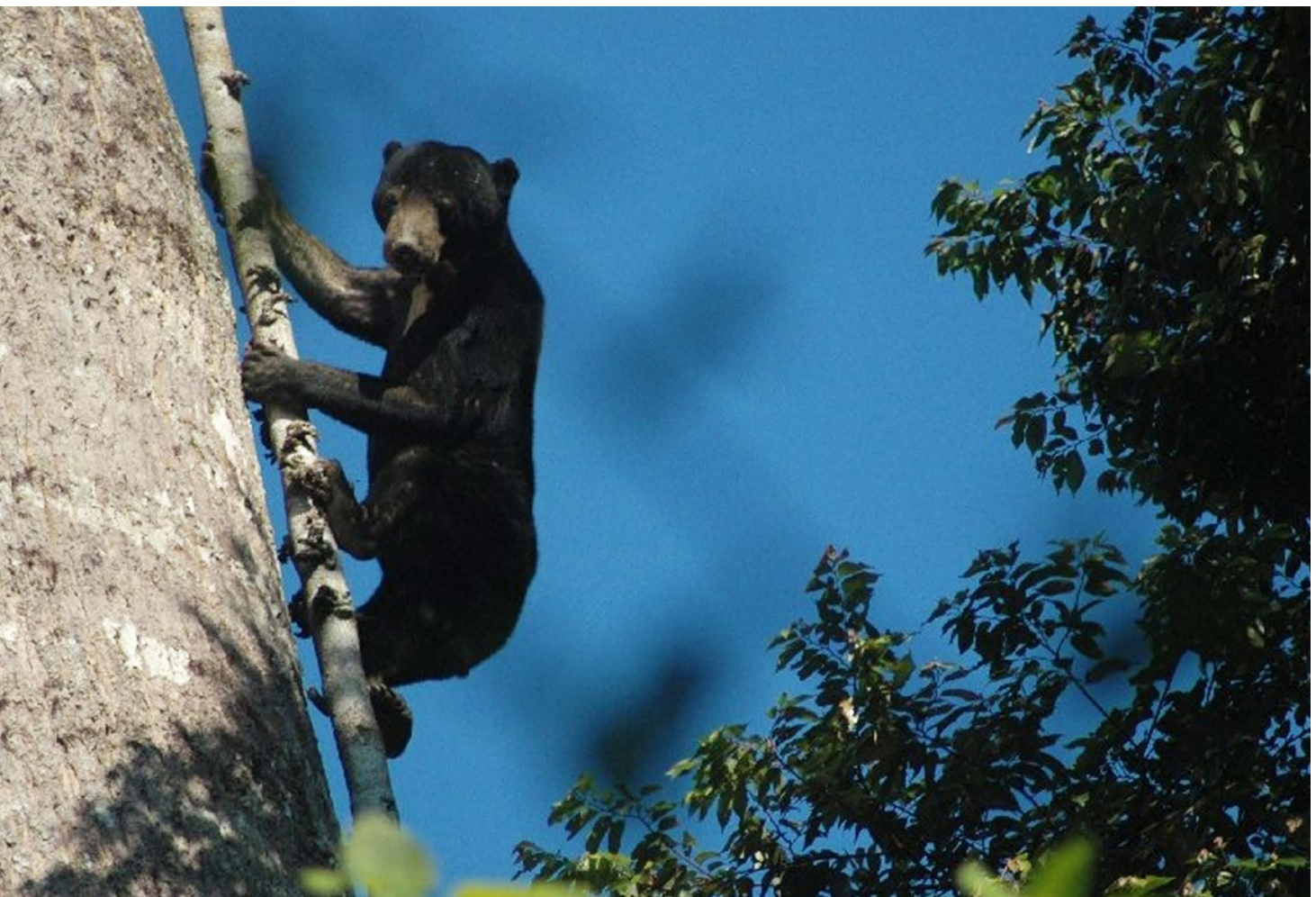
Sun Bears in southern Thailand and Peninsular Malaysia reside in tropical evergreen forests and lowland or hill dipterocarp forests (Kawanishi and Sunquist 2004, Nazeri et al. 2014). Tropical evergreen rainforests, with low climatic variability and high annual rainfall that is evenly distributed throughout the year, form the primary habitat for Sun Bears in Borneo, Sumatra, and Peninsular Malaysia.

The Sundaic (Borneo and Sumatra) tropical evergreen rainforest is home to a diverse range of forest types utilized by Sun Bears. On-site monitoring and camera trap records have determined that, among these habitats, Sun Bear populations in Borneo and Sumatra were highest in primary lowland dipterocarp forests

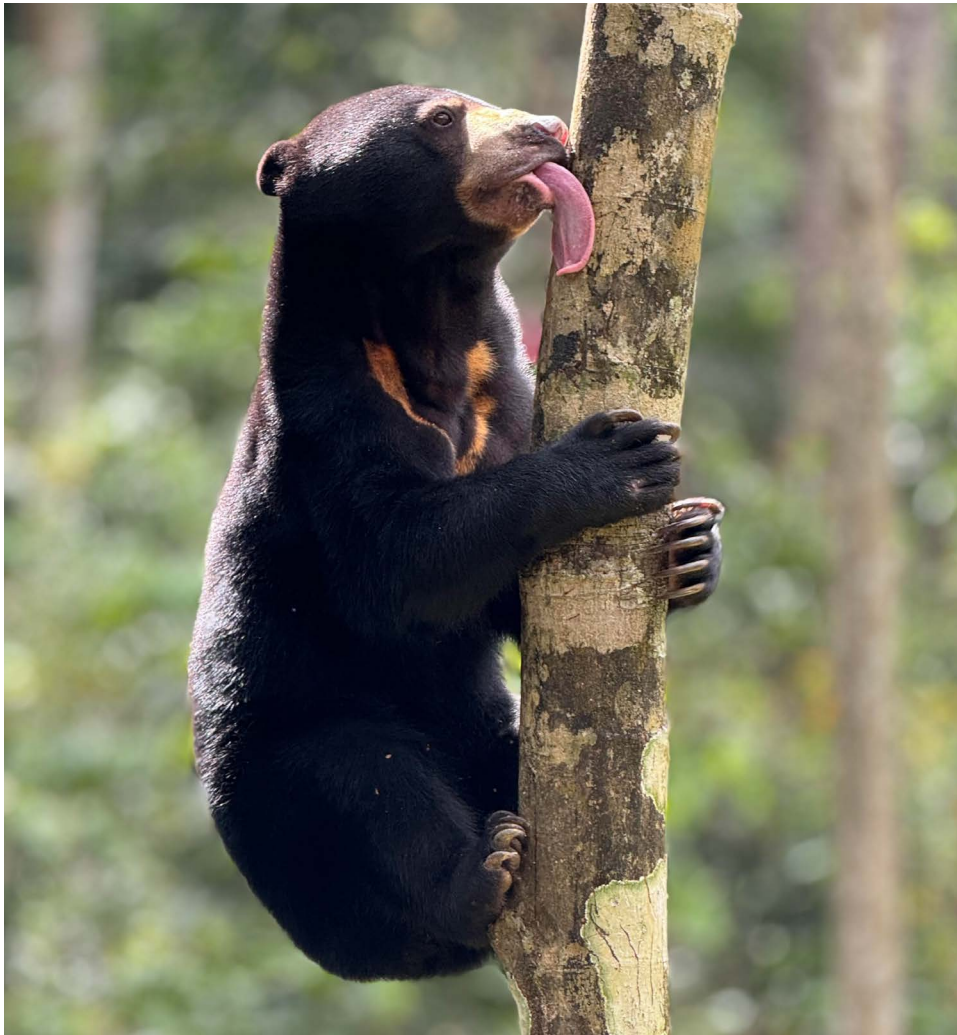
(Davies and Payne 1982, McConkey and Galetti 1999, Wong et al. 2002, Fredriksson 2005, Augeri 2005, Linkie et al. 2007, Wong and Linkie 2013). Although Sun Bears also occupy mangrove forests, their presence is likely dependent on proximity to other preferred habitats (G. Fredriksson, pers. obs).

The population density of Sun Bears across their elevational range varies, although the species generally seems to be more abundant at lower elevations (Augeri 2005, Steinmetz 2011). Some studies have found them at higher altitudes in India, western Thailand, Myanmar, Lao PDR, Indonesia and Sarawak, Malaysia, but this may be due to habitat degradation at lower levels (Choudhury 2011, Karanth et al. 2009, Vinitpornsawan et al. 2006, Htun 2006, Steinmetz et al. 1999, Wong and Linkie 2012, Nazeri et al. 2014, Brodie et al. 2015b).

Sun Bears are more likely to adapt to highly disturbed landscapes where their populations are affected by factors such as hunting and deforestation, rather than environmental factors such as food availability.



→ Sun Bear climbing tree. (© Chandra Boer)



→ Sun bears use their remarkably long tongues to extract insects and various types of fruit.

(© Wong Siew Te, Bornean Sun Bear Conservation Centre)

In Thailand's Dong Phrayayen-Khao Yai forest complex, for instance, illegal logging of rosewood trees may cause Sun Bears to avoid the interior forest due to frequent disturbance by armed loggers (Brodie et al. 2015b). Sun Bears typically prefer interior primary forests, demonstrated by a positive correlation between population density and distance from roads and human settlements (Linkie et al. 2007, Nazeri et al. 2012, Wong and Linkie 2013). While they have also been known to use selectively logged areas (Wong et al. 2004, Meijaard et al. 2005, Linkie et al. 2007), their presence in newly logged forests less (<10 years old) is significantly lower compared to forests that were logged farther in the past (Brodie et al. 2015b).

Sun Bears have been observed in agricultural landscapes such as those for industrial oil palm and sugar palm production and small-scale farming for crops, as well as forest periphery areas (Nomura et al. 2004, Augeri 2005, Fredriksson 2005, Wong et al. 2012, Chea 2013, Sethy and Chauhan 2013, Scotson et al. 2014). They may be considered pests in these areas and have been known to raid crops,

particularly during harvest time and in areas where crops are planted along the forest edge (Santiapillai and Santiapillai 1996, Fredriksson 2005). There are also reports of predation on livestock and chickens (Wong et al. 2015, Fredriksson 2005). However, there is no evidence that Sun Bears can survive longterm in deforested or agricultural areas in the absence of nearby forests (Augeri 2005). They can derive some nutritional benefits from consuming oil palm fruits (Nomura et al. 2004, Chea 2013). Still, it is unlikely that they could subsist on this alone without other foods and services provided by nearby natural forests.

Sun Bears are omnivores with a varied diet, primarily consisting of termites, ants, beetle larvae, bee larvae, honey, and a wide variety of fruit. They have a particular fondness for figs (*Ficus spp.*) when available (McConkey and Galetti 1999, Wong et al. 2002, Augeri 2005, Fredriksson et al. 2006a). They also consume growth shoots of certain palms and occasionally some species of flowers (Fredriksson et al. 2006a), but vegetation is generally not a significant part of their diet. They are sometimes referred to as "honey

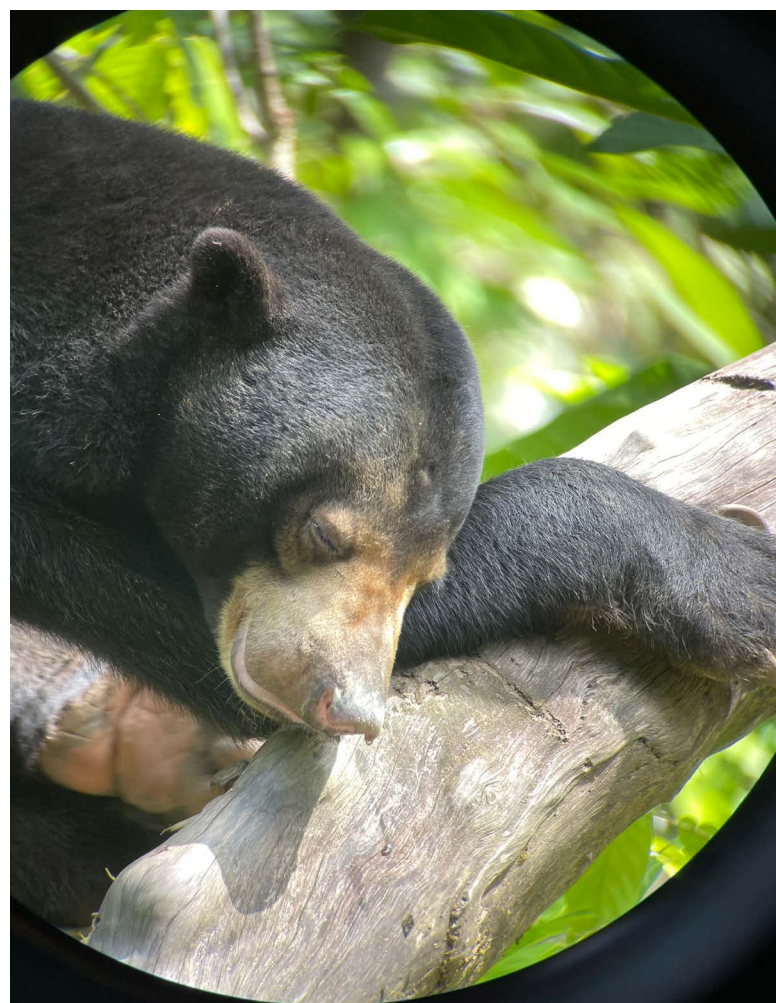
bears” in Indonesia because they are highly attracted to honey, and will climb tall trees to find this. With their strong jaw muscles and disproportionately large canines (Christiansen 2007, 2008), Sun Bears can chew through the bark of hardwood trees to access bee’s nests and honey. They use their long tongues to extract insects and their products from crevices and their sharp claws to dig into the ground and break into rotting logs (Wong et al. 2002). In the lowland forests of Borneo, fruits from the Moraceae, Burseraceae, and Myrtaceae families make up over 50% of their fruit diet (Fredriksson et al. 2006), while in western Thailand, fruits from the Lauraceae, Fagaceae, Leguminosae, Labiatae, and Sapindaceae families are the most commonly consumed (Vinitpornsawan et al. 2006, Steinmetz et al. 2013).

Sun Bears are not known to hibernate, likely due to food availability throughout the year. They also do not exhibit fasting behavior during the birthing process like other bear species. Female Sun Bears use cavities in standing or fallen trees as birthing sites. They have been observed engaging in both diurnal and nocturnal behavior (Wong et al. 2004, Fredriksson 2012, Cheah 2013). There is limited knowledge about Sun Bears’ social structure or reproduction. Wong, S.T. (personal communication, May 30, 2022) shared that Sun Bears are generally solitary but may be seen in pairs and gather around large fruiting trees. Results of the endocrine studies and supplementary confirmatory data collected from the wild conducted by Schwarzenberger et al. (2004) demonstrated that the sun bear is a polyestrous, nonseasonal breeder.

Although Sun Bears display a certain degree of tolerance towards habitat degradation (Guharajan et al. 2021), they generally avoid human interaction (Brodie et al. 2015a, b; Guharajan et al. 2018) by minimizing their activity during periods of high levels of human activity (Fredriksson 2005, Guharajan et al. 2017, Ross et al. 2017). Given their omnivorous diet and adaptability to varying habitats, recognizing the significance of preventing habitat degradation and modification is crucial for conserving the Sun Bear species (Hwang et al. 2021). On the other hand, from a financial perspective, natural forest timber concessions present a more cost-effective approach to conserving large forest areas (Wilson et al. 2010, Wilson et al. 2014).

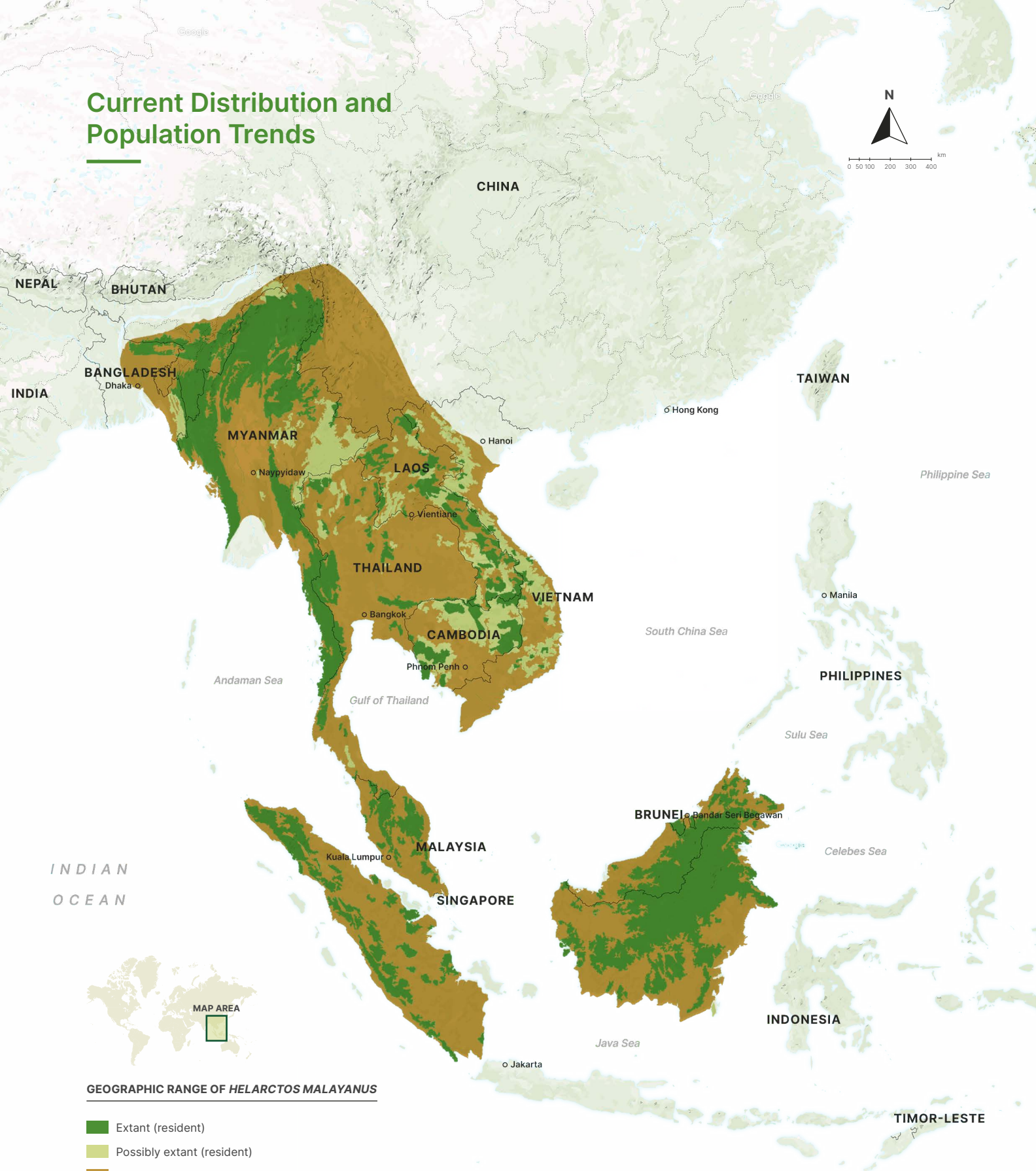


“In the lowland forests of Borneo, fruits from the Moraceae, Burseraceae, and Myrtaceae families make up over 50% of their fruit diet.”



→ A Sun Bear enjoying an afternoon nap after a meal.
(© Thina Ariffin, Borneo Futures)

Current Distribution and Population Trends



Resident range states: Bangladesh; Brunei Darussalam; Cambodia; India; Indonesia; Laos; Malaysia; Myanmar; Thailand; Vietnam

Presence detected but residency uncertain: China

Extirpated: Singapore

Spatial reference

Name : GCS WGS 1984
GCS : GCS WGS 1984
Datum : WGS 1984
Map units : Degree

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Create date: 31 January 2023

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Figure 2 Range map of Sun Bears extracted (link: <https://www.iucnredlist.org/>).

Regional experts have reported a decline in Sun Bear populations in eight out of ten current range countries (trends in Brunei Darussalam and Bangladesh are unknown, Figure 2). There are few reliable estimates of Sun Bear population size, with limited records of quantified population trends (Davies and Payne 1981, Meijaard 2001, Garshelis 2002). Camera-based mark-recapture surveys in Thailand estimated population densities of 4.3 to 5.9 per 100 km² in two sites within Khao Yai National Park (Ngoprasert et al. 2012). In Southern Sumatra, in the Harapan Rainforest, a camera-based study estimated a density of 26 individuals per 100 km², which is 4-5 times higher than density estimates from Thailand (Lee 2014, unpublished data). The methods used to estimate density in Thailand and Sumatra differed. Still, if results are comparable, they suggest a substantially higher density of Sun Bears in the Sundaic portion of their range than in mainland Asia, where, in certain regions, they coexist and potentially compete with Asiatic Black Bears.

Major Threats

The primary threats to Sun Bears are habitat loss (i.e. deforestation) and commercial hunting, which occur to varying degrees throughout their range (Duckworth et al. 2012, Stibig et al. 2014). Deforestation is primarily caused by clear-cutting for agriculture, unsustainable logging practices, and forest fires. Protected areas are not immune to deforestation. Human-caused fires are especially destructive to habitat and food sources during El Niño-related droughts (Fredriksson et al. 2007, Harrison 2000).

Although less obvious in its impact, killing due to human-bear conflicts and active trade in wild Sun Bears and their body parts are additional significant threats to Sun Bear populations (Foley et al. 2011, Burgess et al. 2014). The rapid loss and fragmentation of forests bring bears closer to humans, increasing the likelihood of conflicts.



→ Line of bush fire at peatland jungle in Sabah, Malaysian Borneo. (© Lano Lan, Shutterstock)



Top:

→ **Log yard of rainforest tropical hardwood at the Mahakam riverbank, outback of Borneo, Indonesia.** (© Hilmawan Nurhatmadi, Adobe Stock)



Bottom:

→ **Deforestation caused by palm oil plantations in Thailand.** (© Richard Whitcombe, Shutterstock)

Commercial poaching of Sun Bears is a moderate to significant threat in all range countries except Brunei Darussalam (Meijaard 1999b, Nea and Nong 2006, Nguyen 2006, Htun 2006, Tumbelaka and Fredriksson 2006, Wong 2006, Krishnasamy and Shepherd 2014). In Thailand, local hunters estimated that commercial poaching reduced the Sun Bear population by more than 40% in 20 years (Steinmetz et al. 2006). Poaching pressure is increasing within some Thai protected areas based on encounter rates of poaching signs and poachers, although bears are not usually targeted as much as other species (Scotson et al. 2017). In north-eastern India, where Sun Bear populations occur naturally at low densities, bears are still caught, and poaching is said to have reached “critical” levels (Chauhan and Singh 2006,

Sethy and Chauhan 2012). In southern Lao PDR, sign surveys indicate that Sun Bear populations have been reduced to extremely low levels relative to other sites in Southeast Asia, with declines attributed to historically high poaching levels (Scotson 2012).

The widespread trend of wildlife snaring throughout much of the Sun Bear range has become a major concern. In north-eastern Lao PDR, hunters set up snares that specifically target bears, which threatens to wipe out local populations (Scotson and Hunt 2012). Snares meant for large and small mammals were spotted in numerous protected areas throughout the country, although not always explicitly targeting bears (Scotson and Brocklehurst 2013). Farmers also frequently set snares around the perimeter of crop

fields (Fredriksson 2005) and, in some instances, catch bears (Hunt and Scotson 2011, Scotson et al. 2014). In Peninsular Malaysia and Indonesia, camera traps increasingly record bears with missing paws from possible snare injuries. In a radio-collaring study in Peninsular Malaysia, three out of five captured Sun Bears had missing paws (Cheah 2013). This indicates high snaring pressure using cable snares. Limited enforcement of domestic and international wildlife laws has led to a prevalent illegal bear trade with low prosecution risk and high potential returns (Shepherd and Nijman 2008, Foley et al. 2011, Burgess et al. 2014). The value of bear parts on the illegal wildlife market has increased drastically since the late 1990s (Livingstone and Shepherd 2014).

Overall, based on the rate of deforestation and fragmentation of their habitat, many isolated populations of Sun Bears face a real threat of extinction.



“In Peninsular Malaysia and Indonesia, camera traps increasingly record bears with missing paws from possible snare injuries.”



→ Photo of a Sun Bear strolling at night taken at Kiudang on 16-07-2021. (© S. Khalid and U. Grafe, IBER & FOS, UBD)



→ View from the canopy walk in Ulu Temborung
National Park, Brunei Darussalam.
(© sabine_lj, Shutterstock)

Distribution in Brunei Darussalam

According to the Global Forest Resources Assessment (Food and Agriculture Organization of United Nations), **72.11%** of Brunei Darussalam's total land area remains forested, potentially providing significant areas of Sun Bear habitat.

After reviewing local scientific research, environmental impact assessment reports, and historical records in the national archive, our team concluded that there are minimal documented accounts of Sun Bears in Brunei Darussalam and no records of international trade. Exceptions are occasional presence records of the species occurring in different parts of the country, including under the summit of Bukit Udal, Ulu

Temburong (Bennett et al. 1987), Tanjong Samasta on the Brunei River, Batu Apoi, and Subok, near Bandar Seri Begawan (Payne and Sahat 1987), Temburong base camp and Bukit Retak (Brown 1979), and various locations reported by Yasuma and Abdullah (1997). This data are however 30 years old or older and may not be representative of the species' current distribution.

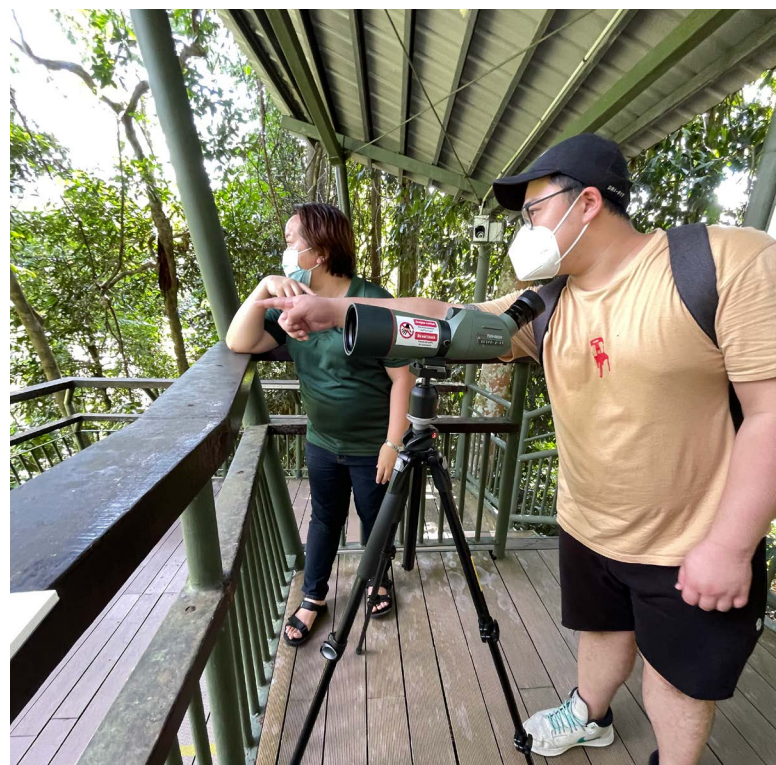


→ Photo of a Sun Bear strolling at night taken at Belalong on 15-12-2017. (© S. Khalid and U. Grafe, IBER & FOS, UBD)

Conservation action planning is complicated without comprehensive recent data on the distribution of Sun Bears in Brunei Darussalam. To address this, we conducted a nationwide interview-based survey to better understand the species distribution and conservation needs. Local Ecological Knowledge (LEK) is progressively seen as a vital source of information for an efficient and reliable means of assessing distribution and changes in the population of rare and elusive species, such as bears that often interact with people and leave distinctive signs and markings (Liu et al. 2009, Cano & Telleria 2013, Turvey et al. 2015, Nash et al. 2016).

To collect local ecological knowledge, we initially created an Online Survey via Google Forms, both in English and Malay, to gather Sun Bear information from the public between 19th January 2022 and 19th January 2023. The online survey provided initial information on species presence and threats, with a limited number of camera trapping footage from researchers providing additional insights (photos on page 9, 18, 20). Once the COVID situation settled, we built upon this initial dataset by interviewing respondents from all over Brunei Darussalam. To represent data from the primary forests, we conducted the interviews in accessible village areas by the forest edges. We also conducted interviews in forest fragments and forests surrounded by man-made structures and modified landscapes to determine whether the species can survive in such environments in Brunei Darussalam.

We used semi-structured interview questionnaires which we provided to Village Heads (*Ketua Kampung*), after which we conducted one-on-one interviews with Village Heads, or people recommended by the Village Heads through snowball sampling, whereby the Village Heads or interviewees recommend other people in the village to interview who had knowledge of the forest or encounters. We believe that interview surveys are suitable for determining broad patterns of absence and presence. The Sun Bear is the only bear species on Borneo and, provided care is taken in selecting interviewers and interviewees, is unlikely to be confused with any other species. However, binturongs (*Arctictis binturong*) or the Sunda stink-badger (*Mydaus javanensis*) could be mistakenly identified (Mohd-Azlan et al. 2013).



Top & bottom:
→ Photos during meeting and interview survey.
(© Richard Carson & Thina Ariffin, Borneo Futures)

Table 1 Breakdown of sighting points according to categories and districts

No.	District	Presence	Absence	Inconclusive	Total
1.	Brunei-Muara	47	106	58	211
2.	Belaït	64	29	17	110
3.	Tutong	56	16	7	79
4.	Temburong	43	4	2	49
5.	Unspecified	4	4	2	10
Total		214	159	86	459

We had a total of 353 respondents from all four districts in Brunei Darussalam, that provided us with 459 records over the course of the study (Table 1). Most records were from Brunei-Muara (48%), followed by Belaït (22%), Tutong (17%) and Temburong (11%); 2% of respondents were unspecified (Table 1). It is interesting to note that a significant number of sightings were reported nearby settlements and urbanised area especially in Brunei-Muara, deemed as the capital district of Brunei Darussalam (Ng et al. 2020) which further supports the Sun Bears ability to survive in small patches of possibly degraded or secondary forest.

It is important to note that the data entry points are limited to areas near developments and where humans have ventured into; many parts of Brunei Darussalam are untouched and are primary forests. Limited information is available from Temburong and Tutong as these areas are lowly populated but have high forest coverage. Therefore, in-depth studies are necessary to assess the presence and viability of Sun Bear populations in the country and design accurate maps of distribution at the national level.

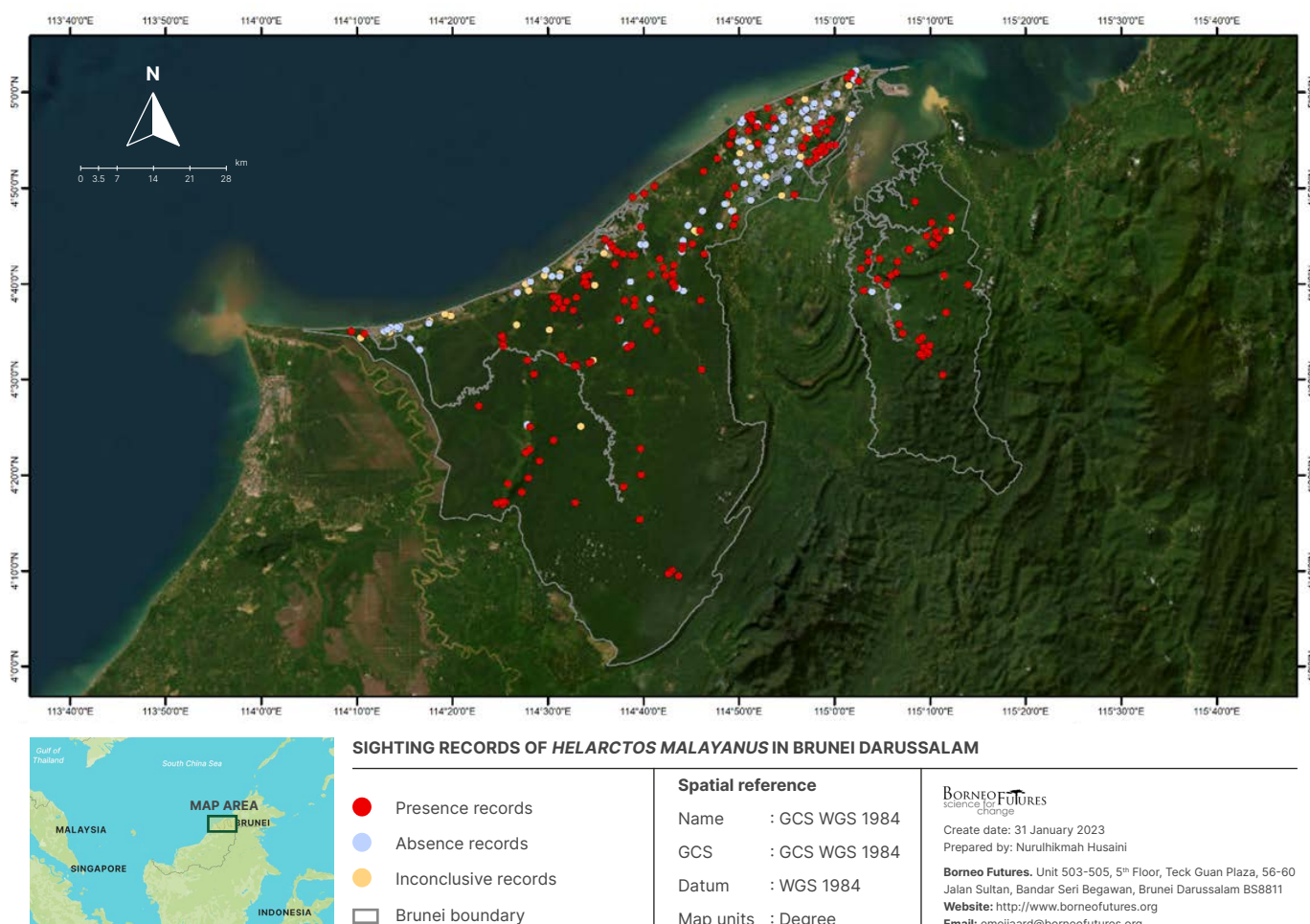


Figure 3 Sighting records of Sun Bears in Brunei Darussalam (link: <https://www.iucnredlist.org/>).

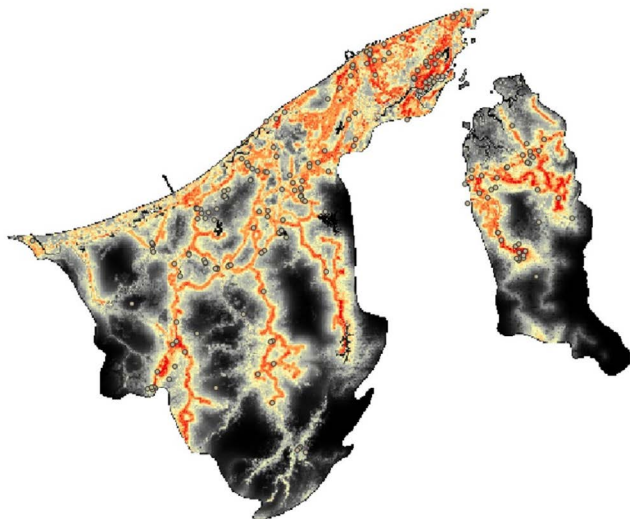


Figure 4 Map showing the habitat suitability model using MaxEnt based on locally collected questionnaire, interview and camera trap data.

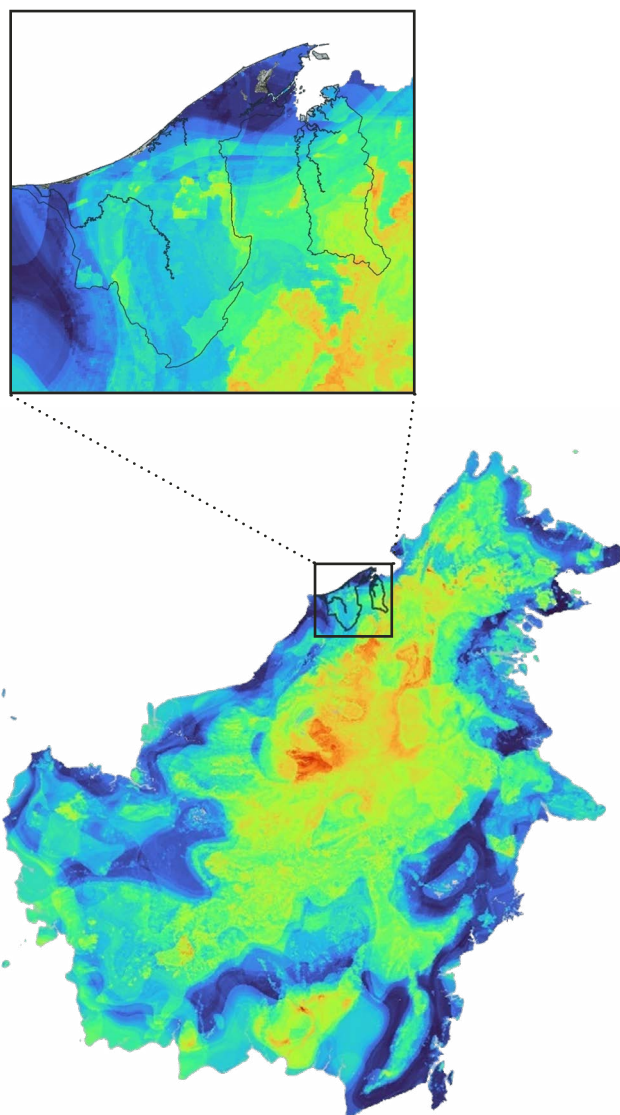


Figure 5 Map showing the habitat suitability model using GLM (courtesy of Wildlife Conservation Research Unit (WildCRU), Department of Zoology at the University of Oxford in England).

We also note that Sun Bears are known for being elusive, which is why sightings of them in the wild are quite rare; only 53 individuals reported sightings of the bear. They avoid human contact and are elusive in their behaviour, making it difficult for people to observe them. Sun Bears are solitary creatures that are territorial, which also contributes to their rarity in sightings, even on camera traps. However, despite their nature, they do leave evidence of their presence through the claw marks they leave on tree trunks and branches, which is how most people become aware of their presence in an area.

To better understand Sun Bear habitat suitability in Brunei Darussalam, we used Maximum Entropy (MaxEnt) models (Phillips et al. 2006) to map the potential distribution of Sun Bear in Brunei Darussalam (Figure 4). MaxEnt models have become an extremely popular tool to model the potential distribution of rare or threatened species of conservation concern (Kramer-Schadt et. al. 2013). The MaxEnt method used the presence-only data as a sample and environmental factor classes as environmental variables for modelling in the study area.

The environmental variables used for modelling include:

- 1 **Forest Type:** refers to the group of forest ecosystems that exist within Brunei Darussalam (Anderson and Marsden 1984);
- 2 **Digital Elevation Model (DEM):** depicts the Earth's bare ground topography;
- 3 **Roads:** digital representation of national road network;
- 4 **Waterbodies:** spatial dataset of mapped watercourses and water bodies.

We also used a second modelling approach based on availability of Sun Bear data from across Borneo but excluding Brunei Darussalam. This used GLM modelling developed by Chiaverini et al. (2022) as part of a biodiversity hotspot paper (Figure 5).

While both models have their advantages, weaknesses, differences and similarities, broad similarity in spatial outputs indicates that the predictive models are accurate. We do note an important difference between the models based on data from within Brunei Darussalam (Maxent) and outside Brunei Darussalam (GLM) in that the former picks up potential habitat in the more densely settled parts of Borneo near the coast, which according to the GLM model is not

suitable. This likely relates to the fact that, while in Brunei Darussalam areas frequently used by people can still contain Sun Bears, in other parts of Borneo the species would likely have been hunted out in such fragmented, human-dominated landscapes. We include these habitat suitability models for illustration in the report, but emphasize that the scientific analysis is ongoing and will be published independently in a peer-reviewed scientific journal.

Legal Status and Legislation

Brunei Darussalam's laws and regulations do not specifically list Sun Bears in First Schedule Part A: "Protected Animal" in the "Wildlife Protection Act 1984", but the species is listed in First Schedule Part B: "Other Animals the Export of Which is Forbidden Except Under Licence". Additionally, the prevention of import and export of all species listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), including Sun Bears which were included on Appendix I in 1979, without licence and certification is further supported by the "Wild Fauna and Flora Act 2007". Furthermore, killing, poisoning, or maiming any

animal, not specifically Sun Bears, is punishable according to Brunei Darussalam's "Penal Code 2016".

Biodiversity and Environmental Awareness

During the interviews we asked respondents not just about Sun Bears, but also about nine other species to determine how well the respondents knew the wildlife present in the country. This provides us both with a verification method to ascertain the accuracy of responses, but also as a way to establish the public's local biodiversity knowledge. Interestingly, less people think they have seen Sun Bears than Orangutans which are not present in Brunei Darussalam (Table 2).

Only 4% of the questionnaire respondents knew that the Sun Bear is not considered a protected species in Brunei Darussalam's Schedule 1 of the Wildlife Protection Act 1978 (Figure 6). The majority believes that the law should protect Sun Bears with the main reasons for the protection related to the fact that the species is vulnerable, to prevent extinction, to maintain the ecosystem, and to defend animal rights.



→ The tropical rainforest in Brunei Darussalam is a home not only to sun bears, but also to other native species as well such as the Oriental Pied Hornbill. (© Francesco Veronesi, Flickr)

Table 2 Respondent's response (from the online survey) when asked in regard to 10 species that may or may not be found in Brunei Darussalam.

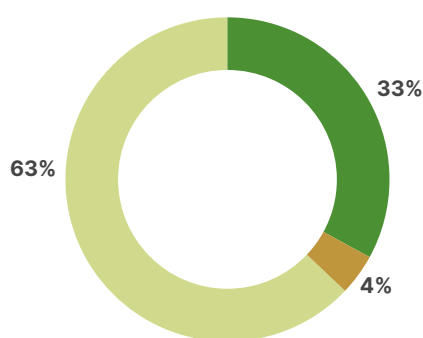
No.	Species	Response			
		Yes	No	Maybe	Unclear/ Unanswered
1.	Sun Bear (<i>Helarctos malayanus</i>)	22	175	0	5
2.	Bornean Orangutan (<i>Pongo pygmaeus</i>)	64	132	1	5
3.	Sunda Clouded Leopard (<i>Neofelis diardi</i>)	15	180	2	5
4.	Flat-headed Cat (<i>Prionailurus planiceps</i>)	10	185	2	5
5.	Malayan Tapir (<i>Acrocodia indica</i>)	5	193	0	4
6.	Oriental-pied Hornbill (<i>Anthracoceros albirostris</i>)	163	32	4	3
7.	Helmeted Hornbill (<i>Rhinoplax vigil</i>)	15	180	1	6
8.	Sunda Pangolin (<i>Manis javanica</i>)	78	118	2	4
9.	Silver Leaf Monkey (<i>Trachypithecus cristatus</i>)	91	102	6	3
10.	White-bellied Sea Eagle (<i>Haliaeetus leucogaster</i>)	70	111	18	3



* Note: From the list, only the Bornean Orangutan and Malayan Tapir are not found in Brunei Darussalam. The purpose of this section is to gauge the respondent's knowledge of wildlife present in the country.

IS THE SUN BEARS PROTECTED BY THE LAW?

Yes No I don't know



DO YOU THINK SUN BEARS SHOULD BE PROTECTED BY THE LAW?

Yes No I don't know

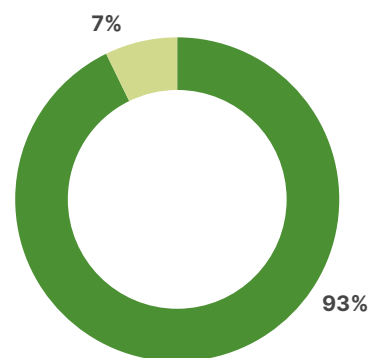


Figure 6 Respondent's response when asked in regard to the Sun Bears' law protection in Brunei Darussalam.

THE IMPORTANCE AND ROLES OF FORESTS IN BRUNEI DARUSSALAM

Strongly Agree Agree Neutral Disagree Strongly Disagree

The forest holds special cultural or spiritual significance for me and my family



The forest is important for my family's livelihood



Forests provide clean water sources



Forests provide buffers from floods



Forests provide diverse habitats for biodiversity



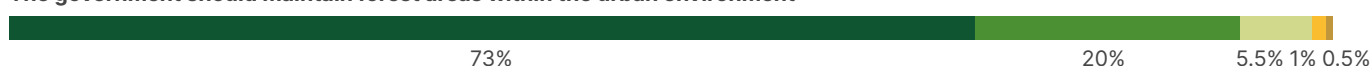
Management of forest by the government is important



Management of biodiversity by the government is important



The government should maintain forest areas within the urban environment



The government should allow deforestation and make the land available for non-forest purposes



Cutting down forest for development (> 10 hectare or equivalent to 10 soccer fields) is okay if it benefits the community

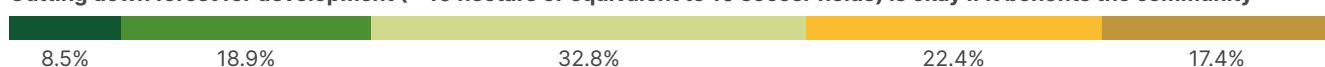


Figure 7 Respondent's response when asked in regard to the importance and roles of forests in Brunei Darussalam.



→ Sun Bear killed at Mabohai Highway, Brunei Darussalam on 27-11-2014. (© 1StopBorneo)

Crossings and Road Kills

Roads can have significant negative impacts on wildlife populations and their habitats. The use and development of roads can restrict animal movement, cause habitat fragmentation, and facilitate access to previously remote areas, leading to increased human activities such as hunting, logging, and habitat destruction (Bennett 2017). Furthermore, roads can lead to direct mortality of animals through vehicle collisions. In our survey, there are six instances where a Sun Bear was seen on the road, of which one was found to be dead (photo above). Assessing road kill statistics can help identify where roads are built on animal pathways. Depending on the animal, culverts or arboreal bridges can be considered to minimize road kills and also protect the public from accidents. To reduce the future impact of roads on wildlife, road design needs to consider the needs of wildlife, such as installing wildlife crossings or reducing road speeds in areas with high wildlife density. Road closures or re-routing may also be necessary to protect critical habitats and reduce the mortality of threatened or endangered species. It is important for environmental consultants to consider the impact of roads on wildlife populations and habitats and to provide recommendations for minimizing this impact in their assessments and planning processes.

Hunting

Five of the 353 interview respondents mentioned trading, hunting, trapping of Sun Bears or selling of their parts, and three separate accounts of hunting and trading other wildlife in Brunei Darussalam. This may indicate that indeed such behaviours are rare, or that they do occur but that people are unwilling to admit to knowing about them. There is limited data on local threats to Sun Bears.

From our encounters and interview surveys in the rural areas, there is a considerable shift in their way of life as the older generation has stopped hunting due to age and the newer generation is not interested in carrying on old traditions. In some cultures, Sun Bears have been associated with fear and danger stemming from folklore, which has led to indigenous tribes avoiding Sun Bears.

“Assessing road kill statistics can help identify where roads are built on animal pathways.”



→ In Brunei Darussalam, wire snare traps are still commonly used to capture animals such as pigs. (© Alexwilko, Shutterstock)

Interestingly, a few tribe groups believe that the Sun Bears are protected by deities or have a story passed down through generations as to why they do not consume or hunt Sun Bears, and those who do will be cursed. The tribespeople usually set free any Sun Bears accidentally captured in snares meant for other animals, such as pigs. These beliefs and cultural attitudes can significantly impact Sun Bear conservation, as they often result in harmful interactions between local communities and Sun Bears, such as hunting or intentional killing.

Additionally, these cultural attitudes can also impact the willingness of local communities to support conservation efforts. Conservationists need to understand and acknowledge these cultural beliefs and attitudes by working with local communities to promote understanding and appreciation of Sun Bears and develop culturally-sensitive conservation approaches. Through education and awareness-raising initiatives, it is possible to shift cultural attitudes and promote coexistence between Sun Bears and local communities, which can lead to more effective and sustainable conservation outcomes.



“The tribespeople usually set free any Sun Bears accidentally captured in snares meant for other animals, such as (Bornean Bearded) Pigs.”



→ A Sun Bear in Bornean Sun Bear Conservation
Centre, Sepilok, Sabah, Malaysian Borneo.
(© BorneoRimbawan, Shutterstock)

Conservation Priority Mapping

We created a **Priority Map** to pinpoint areas that need immediate intervention for the effective conservation of the species in the country.

This considers the average Sun Bear home range estimates of 7km² to 27km² (Wong et al. 2004, Fredriksson 2012, Cheah 2013) in relation to remaining forest patch size, and uses proximity to roads (Figure 8 and 9) as a key risk factor because of associated collision and population fragmentation risks. Due to the lack of information on the minimum size of fragments needed to sustain a Sun Bear

population, we have conservatively considered 1km² of forest fragment as unviable to support a Sun Bear's population in the long term, although such forest fragments could serve as dispersal stepping-stones between larger forested areas (Guharajan et al., 2022). The Priority Map (Figure 9) will indicate where actions should be prioritized to protect and conserve Sun Bear populations in Brunei Darussalam.

Table 3 Criteria for qualifying habitat patches as low, medium or high risk and action priority.

Measure	Risk		
	High	Medium	Low
Size of forest patch	< 2,500 Ha	2,500 - 10,000 Ha	> 10,000 Ha
Proximity to roads	< 1 km	1-5 km	> 5 km

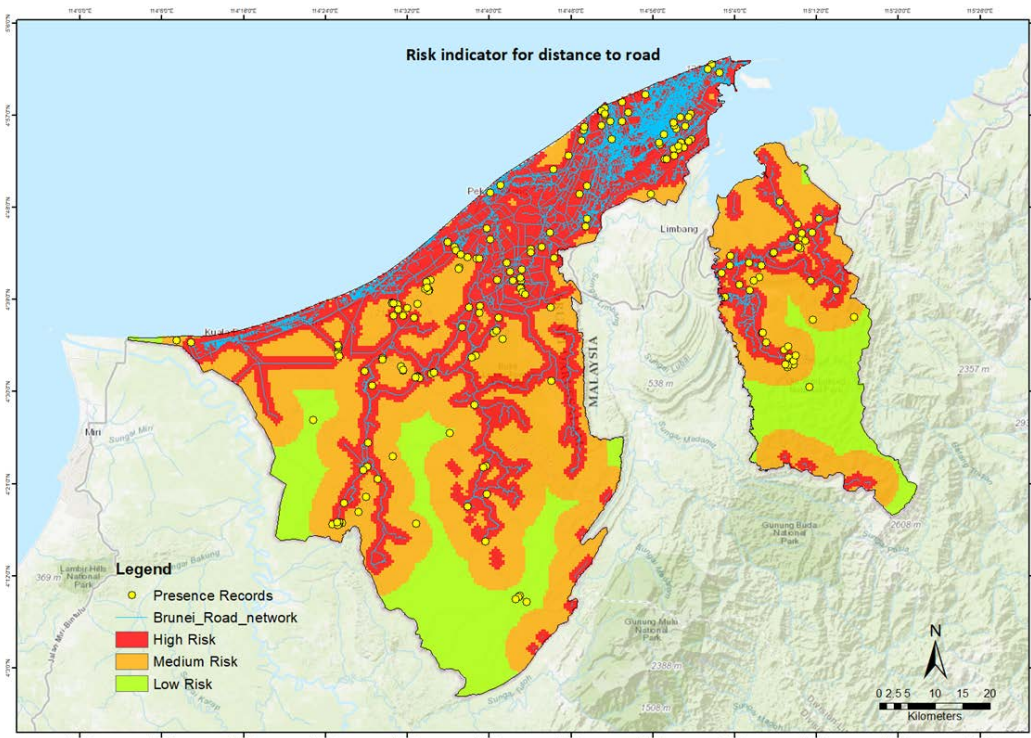


Figure 8 Distance to roads as risk indicator to Sun Bear populations.

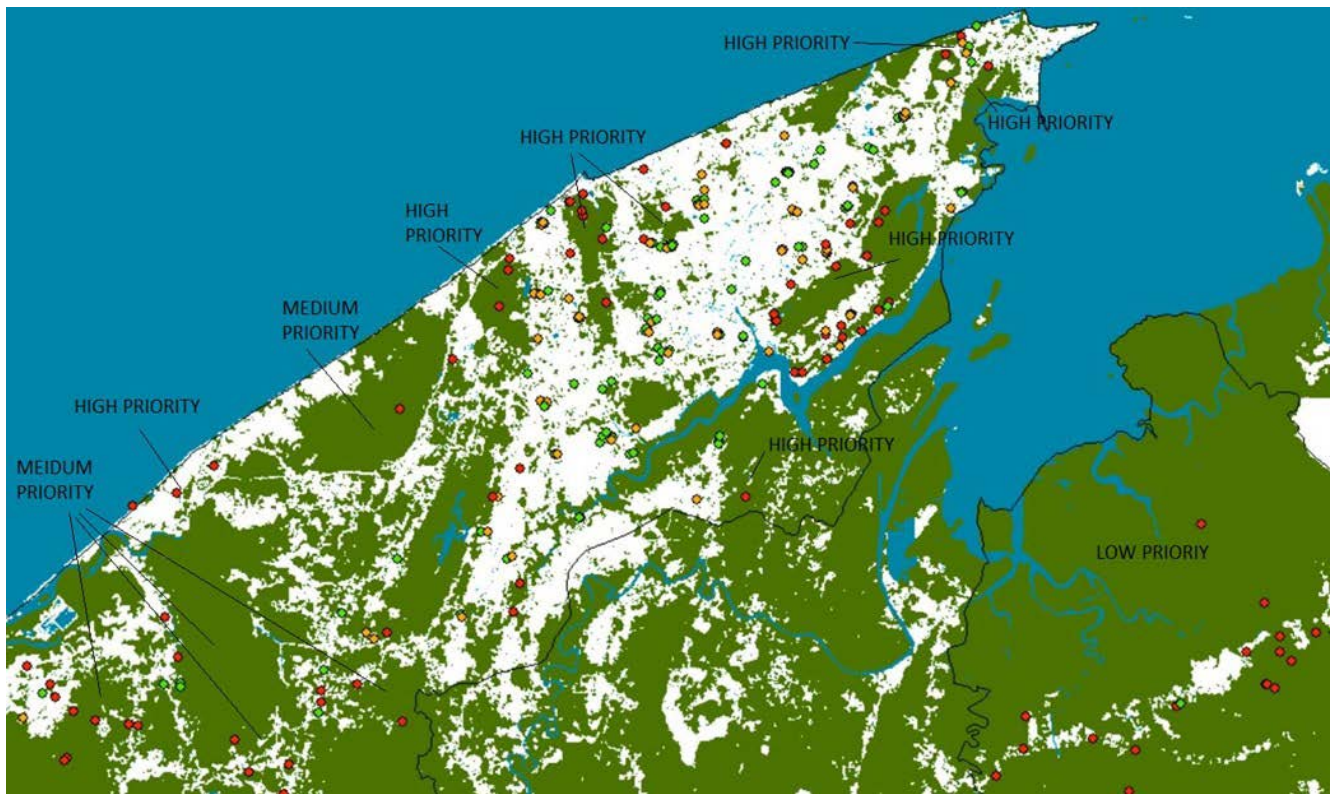


Figure 9 Priority map for Sun Bears in Brunei Darussalam's coastal area based on habitat suitability mapping and local threat levels, such as forest fragmentation at risk of deforestation and potential for traffic collisions.

The maps indicate that smaller areas with smaller populations of Sun Bears are at a higher risk of extinction due to deforestation and road collisions compared to larger populations inhabiting larger areas and further away from traffic.



→ Lush rainforest in Batang Duri, Brunei Darussalam with a river flowing in the middle.
(© MEMBERHS, Shutterstock)

Recommendations

Based on the countrywide interview surveys and consideration of threats, species ecology, conservation needs and locally determined risk to populations (Figure 9) we identified several **recommendations**.

These recommendations incorporates experts' comments and elements from international best practices and other established species conservation action plans (Crudge et al. 2019, Gaffi et al. 2020, Scotson et al. 2017).

DEFINITION OF THE PRIORITY ACTIONS

High-Priority Recommendations:

High-priority recommendations are those that are critical for the survival and well-being of Sun Bear populations. These recommendations may directly address the most pressing threats. These recommendations may be time-sensitive and require immediate attention to mitigate significant threats.

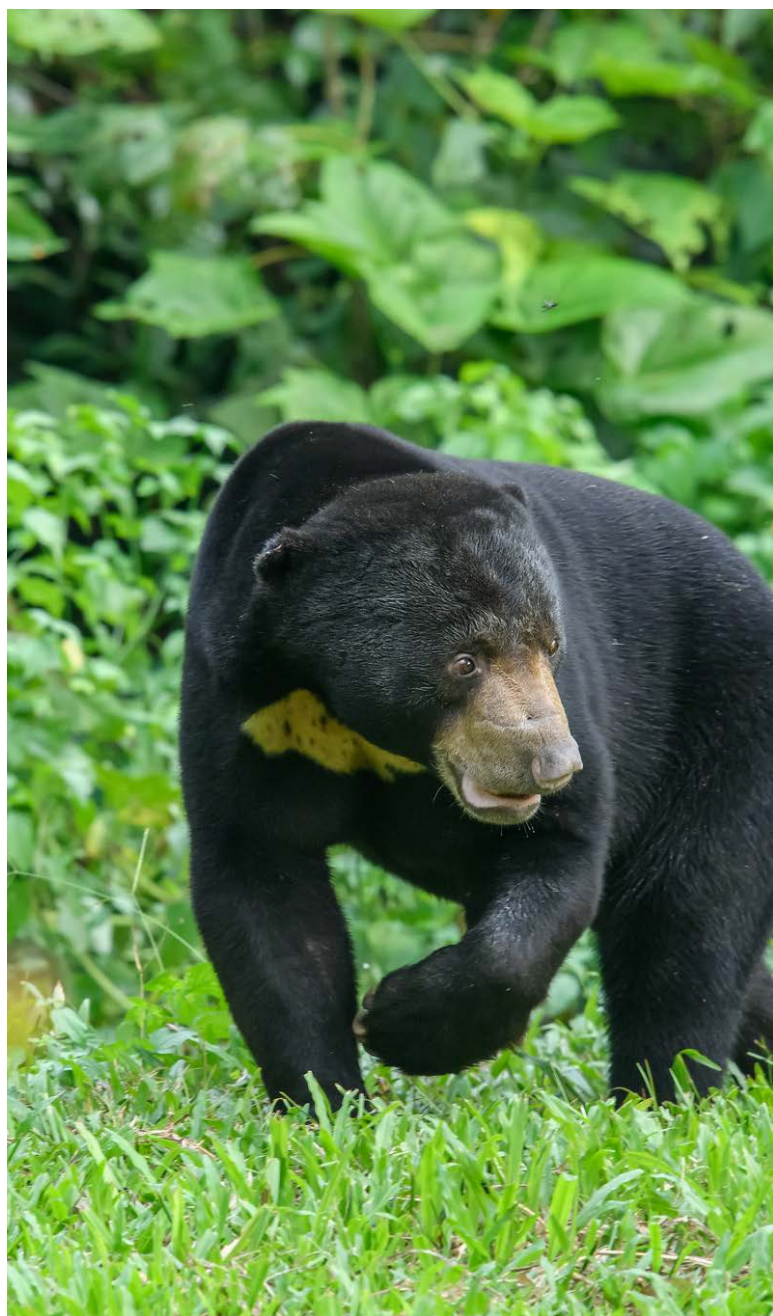
Other Recommendations:

Other recommendations contribute to the conservation effort but may not be as urgent or directly impactful as high-priority recommendations. These recommendations may have importance but can be implemented over a longer time frame.

High Priority Recommendations

In the High Priority Areas identified in Figure 9 we recommend the following actions:

- Conduct camera-trapping or other surveys in isolated forest patches in Muara and Bandar to determine the population size and viability of these populations in human-dominated landscapes.
- Identify where habitat corridors exist or are needed to connect small, isolated Sun Bear populations.
- Examine Sun Bear use of already existing/potential corridors or degraded habitats between forest patches and PAs.



→ An adult Sun Bear at the Kaeng Krachan National Park, Thailand. (© Rushen, Thai National Parks)

Other Recommendations

- Continue to monitor landcover changes over time and hotspots of deforestation.
- Identify and map ecosystem services beneficial to people derived from the conservation of Sun Bear habitat, including opportunities for carbon credit system.
- Support initiatives to link community forest management with micro business opportunities in order to provide economic benefits on the short and long term to communities who commit to environment conservation
- Form collaboration with international researchers especially from the neighboring countries to coordinate conservation efforts, share information and collectively address transboundary challenges.
- Gather existing relevant information from published and unpublished sources regarding Sun Bear's use of various natural and altered habitats.
- Conduct research to fill gaps in information about assessing the quality of Sun Bear habitat and defining highest quality Sun Bear habitats.
- Explore other cost-effective options for data collection; i.e., citizen science
- Monitor signs of bear trade on online platforms.
- Implement a Sun Bear monitoring programme through camera trap and sign surveys.
- Collect camera trap by-catch data on Sun Bear throughout the country in order to identify the presence of isolated Sun Bear populations.
- Analyse data collected in the field to produce potential distribution maps and models for the identification of population trend
- Collect roadkill data from the relevant authorities.
- Map out roadkill data to identify with a high number of roadkill incidents or areas where roadkill incidents occur repeatedly.
- Share knowledge, data and best practices between all stakeholders involved in Sun Bear conservation, organize periodical thematic meetings among Government Agencies, NGOs and research institutes.
- Create a data sharing platform to be used as a repository of all information regarding Sun Bear (and possibly other species) deriving from research and monitoring.
- Organize awareness-raising campaigns (including but not limited to education programmes in schools) communicating to local communities the role of the Sun Bear within the whole forest ecosystem, and its importance in the conservation of local forests and the wellbeing of village communities, promoting a positive image of the Sun Bear in terms of territorial identity.
- Engage with social influencers and stakeholders to ensure the use of Sun Bears, their parts and products is no longer considered socially, personally, or culturally acceptable.



→ **A Sun Bear in its natural forest habitat.** (S. Khalid and U. Grafe, IBER & FOS, UBD)



→ A Sun Bear at the Oregon Zoo, Portland, Oregon, United States. (© Stuart Seeger, Wikimedia Commons)

The value of Sun Bears for ecotourism in Brunei Darussalam

People like bears. Our idealized image of a cartoon bear, aloof and full of honey, makes us eager to see the real deal. What do they look like? Where do they live? Do they wear funny little t-shirts and share their thoughts with a piglet?

Unsurprisingly, bear tourism is a growing economic opportunity in many parts of the world. A study in British Columbia's Great Bear Rainforest showed that bear tourism generated an annual revenue of US\$15.1 – twelve times more per year than commercial bear hunting (Honey et al. 2016). The global ecotourism industry is booming. With an estimate of growth rates three times that of conventional tourism (Das and Chatterjee 2015). Ecotourism brings more than eight million visitors to the world's protected areas each year, generating approximately US\$600 billion in direct in-country expenditure (Balmford et al. 2015).

This study shows that Brunei Darussalam is a Sun Bear hotspot. Sun Bears inhabit many parts of the country, including rainforest peripheries, such as Tasek Lama, which border towns and cities. While one might assume that bear sightings in these areas are common, the Sun Bear's shy and elusive behavior makes human encounters a rarity.

This is where technology can help us to observe bears, thereby providing researchers with essential information on their movements and population trends. Programs such as BearCam and BearID have been set up in the USA to monitor bear movement and identify individual bears (Clapham et al. 2020). A similar program in Brunei Darussalam could help to monitor populations and identify sites that bears frequently use. This may open avenues to develop safe and sustainable ecotourism, where skilled guides take small groups of visitors to quietly view Brunei Darussalam's incredible wildlife, including Sun Bears.

Viewing wild Sun Bears by tourists is currently not feasible anywhere. The only place to see them is in zoos and rehabilitation centers. The unique proximity of Brunei Darussalam's Sun Bear populations to human settlements presents an opportunity to explore professionally guided wild bear tours. Investing in sustainable ecotourism would not only reap economic benefits for Brunei Darussalam but could allow for the improved management and monitoring of local Sun Bear populations.



→ A young Sun Bear resting on a tree.
(© Pavel Tvrđy, Shutterstock)

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