Life from Headwaters to the Coast

SAMUNSAM

Wilderness Rediscovered

Edited by

Jayasilan Mohd-Azlan,
Abang Arabi Abang Aimran and Indraneil Das

UNIMAS
UNIVERSITI MALAYSIA SARAWAK
PUBLISHER

SARAWAK
FORESTRY
CORPORATION
PARKS & WILD LIFE

Natural History
Publications (Borneo)

2022

Published by

UNIMAS Publisher
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia.

in cooperation with

Sarawak Forestry Corporation
Lot 218, KCLD, Jalan Tapang
Kota Sentosa
93250 Kuching
Sarawak, Malaysia.

and

Natural History Publications (Borneo) Sdn. Bhd. (216807-X)
A913, 9th Floor, Wisma Merdeka Phase 1
P.O. Box 15566, 88864 Kota Kinabalu
Sabah, Malaysia.

Samunsam: Wilderness Rediscovered
Mohd-Azlan Jayasilan, Abang Arabi Abang Aimran and Indraneil Das
ISBN 978-967-2298-81-6
First published 2022.

Front cover: Proboscis Monkey. Photo: Chien C. Lee.
Half-title page: Examples of lowland rainforest trees. Photo: Jayasilan Mohd-Azlan.
Frontispiece: Representations of canopy and emergent trees at Samunsam. Photo: Jayasilan Mohd-Azlan.

Printed in Taiwan

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Life from Headwaters to the Coast Samunsam : SAMUNSAM : Wilderness Rediscovered / Edited by Jayasilan Mohd-Azlan, Abang Arabi Abang Aimran and Indraneil Das
ISBN 978-967-2298-81-6

1. Wildlife refuges—Malaysia—Sarawak. 2. Biodiversity—Malaysia-Sarawak. 3. Wildlife management areas—Malaysia—Sarawak. 4. Government Publication—Malaysia. I. Jayasilan Mohd-Azlan. II. Abang Arabi Abang Aimran. III. Indraneil Das. IV. Title.

639.90959522

CONTENTS

FOREWORD

Malaysia's largest State, Sarawak, on the island of Borneo, is home to some of the world's richest biodiversity, including endemics, economically valuable species, as well as species of conservation importance. Some of the best examples of such plants and animals can be found in Sarawak's extensive network of protected areas. Many of us here in Universiti Malaysia Sarawak continue to explore Sarawak's biodiversity, with the hopes of generating critical knowledge at these sites. This book represents but a subset of work done by our academics in the realm of biodiversity research. I would like to commend the efforts by Sarawak Forestry Corporation Sdn. Bhd. who supported us in this task, by providing a research grant. The work is expected to be important for local communities, to aid them better understand, appreciate and perhaps use their resources sustainably, such as an interpretation tool to guide ecotourists and naturalists in Samunsam.

As will be evident to the readership, a variety of approaches have been taken by the authors of this volume. J. Mohd-Azlan, Lisa Lok and Indraneil Das provide the backdrop to the project, including introductory information on Samunsam. Siali and Tisen from SFC provides a brief account of the development of the site as a Wildlife Sanctuary. Subsequent chapters deal with the zoological components of the Sanctuary's biodiversity, including crabs (Jongkar Grinang), termites (Wan Nurainie Wan Ismail and colleagues), dragonflies and damselflies (Rory Dow), fishes (Fazimah Aziz and colleagues), amphibians and reptiles (Indraneil Das and his team), a separate chapter on the Painted Terrapin (James Bali), investigations on the bird diversity (Mohamad Fizl Sidq Ramji and colleagues); small mammal community (Faisal Ali and colleagues); a separate chapter focussed on the Proboscis Monkey (Ahmad Fitri Aziz and colleagues) and the larger mammals (Mohd-Azlan Jayasilan and his team). The book wraps up with chapters on related social elements, such as use of natural resources (Mohamad Suhaidi and his team), and finally, the ecotourism and entrepreneurial potential of Samunsam (Dayang Affizah).

It is my hope that this book will contribute in at least a small way of encouraging more people to work in the field, publish more articles of this

kind and new sponsors would emerge to provide support. I anticipate that this volume will be useful to stakeholders to whom we remain connected through our common views on biodiversity conservation for future generations.

Prof. Datuk Dr. Mohamad Kadim Suaidi
Vice Chancellor
Universiti Malaysia Sarawak

MESSAGE

The State of Sarawak boasts one of the most extensive networks of protected areas in Malaysia. The western tip of Sarawak is an important area for biodiversity conservation where iconic protected areas, such as Tanjung Datu National Park and Samunsam Wildlife Sanctuary are located.

Biodiversity is one of the top State agendas, whereby the State of Sarawak, with the establishment of Sarawak Forestry Corporation (Park and Wildlife) is determined to conserve and protect its wildlife and natural landscapes. This project sits in line with the University's niche area of biodiversity and environmental conservation and sustainable community transformation. This book, based on research collections by the staff of our two institutes, brings together information on species, their habitats and other aspects of natural history, and the perceptions of the human community on conservation and sustainable use.

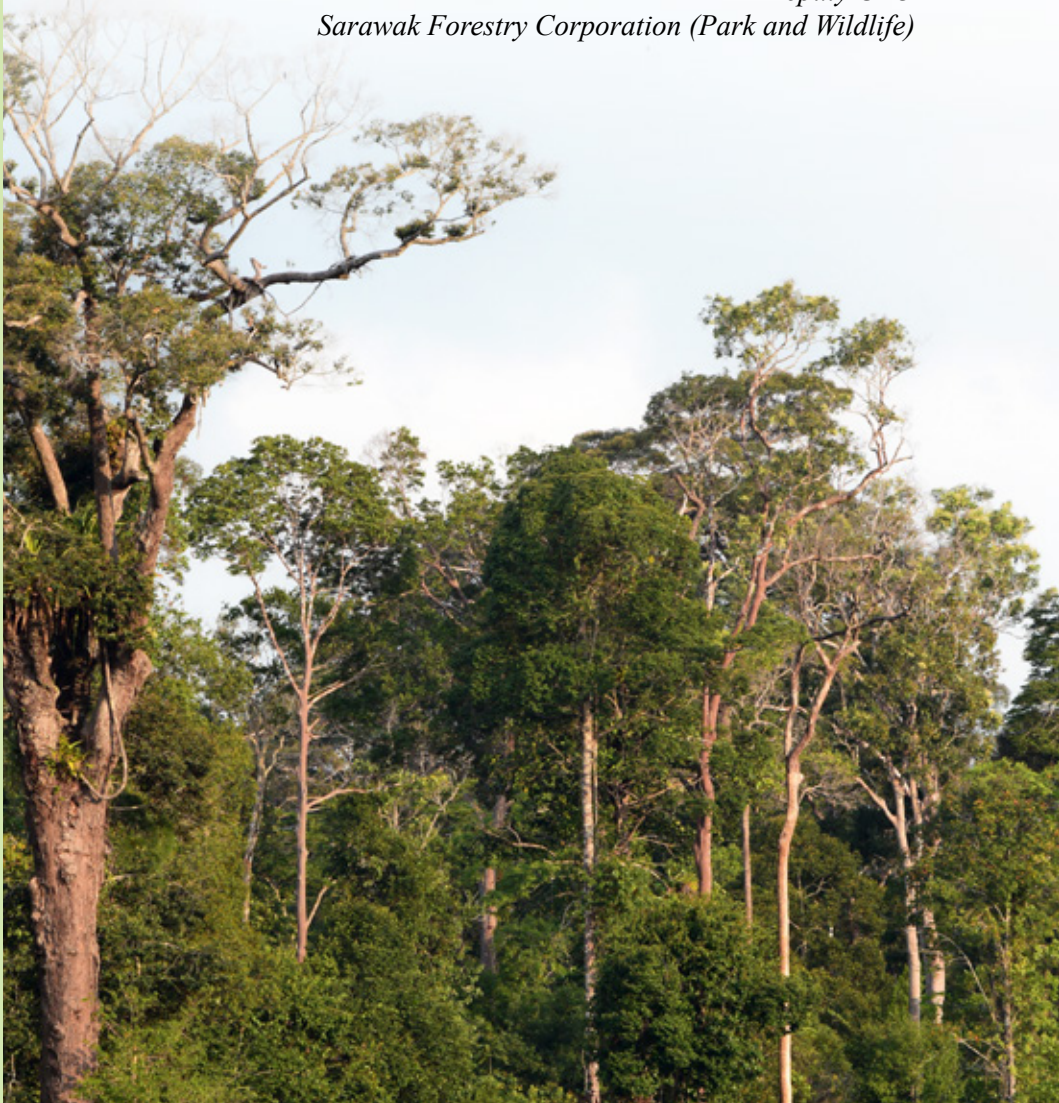
Identifying the distribution, densities and habitat use of animals in tropical rainforest are essential for understanding their ecology, and in facilitating management of our biodiversity-rich protected areas. This book attempts to enumerate these species, many of which remain undetected in the dense tropical rainforest. The faunal studies include inventories of crabs, termites, dragonflies and damselflies, fishes, frogs, reptiles, birds and mammals of the area, a critical first step towards understanding our natural heritage. The work also highlights how the local communities interact with biodiversity, and their deep dependence with such natural resources in Samunsam.

This book is written for local stakeholders, management authorities, naturalists, researchers and for the general public. An understanding of our biodiversity may influence the support of the complex needs of conservation in this ever-challenging environment. It is hoped that nature enthusiasts and those who are interested in tropical biodiversity will find this book beneficial.

Acknowledgement is here made to the authors who have gathered these data, substantially increasing our knowledge and awareness of an important part of our national heritage.

Prof. Dr. Wan Hashim Wan Ibrahim
Deputy Vice Chancellor (Research & Innovation)
Universiti Malaysia Sarawak

Mr. Oswald Braken Tisen
Deputy CEO
Sarawak Forestry Corporation (Park and Wildlife)



PREFACE

The Expedition to Samunsam Wildlife Sanctuary, located near the western tip of Sarawak State, approximately 100 km from Kuching city, was held over the years 2019–2020. It was undertaken by the staff and students of Universiti Malaysia Sarawak, in collaboration with the Sarawak Forestry Corporation, the latter agency providing funding and on-the-ground support, besides joining forces in some of the field data collection.

The diversity of forest types (necessitating different sampling protocols) and eventually, the arrival of the Covid-19 pandemic, were major challenges on the ground, leading to reduced resources available for sampling. Despite these shortcomings, the multidisciplinary team from our two agencies could satisfactorily conduct what is essentially a rapid biodiversity survey, and bring the results out for our stakeholders in time.

Promotion of protected areas as tourist attraction and for research activities has been high on the State's agenda, being seen as an important driver of socioeconomic growth. It can also help governmental agencies such as ours remain engaged with the public for conservation, network with researchers locally and globally and incorporate new knowledge into conservation management plans.

The project was funded by Sarawak Forestry Corporation (GL/F07/SAMUNSAM/2019). We are especially thankful to Paschal Dagang and Taha Wahap for their assistance in the project. We also extend our gratitude to the staff of Samunsam Wildlife Sanctuary, namely, Mohamad Khalid B. Mohamad Zakeria, Mr. Japri and Mr. Shukor for their help. We would also like to thank Research, Innovation and Enterprise Centre, the Faculty of Social Sciences, the Faculty of Economics and Business, the Institute of Biodiversity and Environmental Conservation and the Faculty of Resource Science and Technology, UNIMAS for logistical and administrative support.

The following colleagues helped with reviews of manuscripts: Aaron M. Bauer, Henry Bernard, Kelvin Egay, Melvin Gumal, Jason Hon, David T. Jones, Kelvin K.P. Lim, Lo May Chiun, Suhaili bin Mokhtar, Peter K.L. Ng, Andrew Alek Tuen, Chan Kin Onn, Albert Orr, Pang Sing Tyan, Mustapha Abdul Rahman, Tan Heok Hui and Darren Yeo. We owe a special debt of gratitude to our friends and colleagues, Chien C. Lee, Research Associates of the Institute of Biodiversity and Environmental Conservation, UNIMAS, for providing images of species that we have used in this work.

Finally, we thank Chan Hin Ching for designing the page layout and Datuk Chan Chew Lun, Natural History Publications (Borneo) Sdn Bhd, and Sarawak Forestry Corporation and UNIMAS Publisher for arranging its publication.

If this guide contributes to the enhancement of knowledge and compel readers to think anew about conservation of this important protected area, and inspire local stakeholders to take pride in their biodiversity, we would consider the project a success.

Jayasilan Mohd-Azlan
Abang Arabi Abang Aimran
Indraneil Das

INTRODUCTION

Jayasilan Mohd-Azlan, Lisa Lok Choy Hong* and *Indraneil Das

The State of Sarawak has one of the most established networks of protected areas within Malaysia, covering some of the most megadiverse rainforests of the world. Among the protected areas are a total of five wildlife sanctuaries that have been established since 1979, totalling 225.791.4 ha, or 1.8% of land area of the State. Wildlife Sanctuaries in Sarawak have been mainly gazetted to protect Endangered, Rare or Threatened Species (ERTs). Samunsam Wildlife Sanctuary (Fig. 1), located near the western tip of Sarawak, was established to conserve the populations of the Proboscis Monkey (*Nasalis larvatus*). Gazetted in 1979, Samunsam Wildlife Sanctuary covers an area of 61 km^2 and is located in Sematan District, approximately 100 km from Kuching city.

Unlike National Parks, Wildlife Sanctuaries in Sarawak are entirely off-limits to the public and entrance is only permitted by the Chief Wildlife Warden. Such measures are to reduce anthropogenic activities that have potential for adverse ecological effects, while enhancing protection to species of conservation importance.

Despite the sizeable coverage of this protected area, Samunsam faces fragmentation and isolation due to road construction, which may affect the persistence of species, especially those that are not tolerant to edge effects and other disturbance. Thus, understanding how species occur and where they are distributed within the protected area is essential for thwarting potential threats and specify conservation strategies that will assist in decision making process for the management of Samunsam.

Samunsam Wildlife Sanctuary boasts a variety of forest types- mangroves, nipah, kerangas, riverine and mixed dipterocarp forests (Fig. 2). The mangrove forests line the lower reaches of the Samunsam River, where it forms a broad band near the mouth of the river, and gradually tapers out upstream, terminates around six kilometres upriver. Mangrove plant species, such as *Avicennia* and *Sonneratia* are located near the river mouth, while *Rhizophora* extend 1–3 km from the river mouth, and *Bruguiera* spp and Nipah palms (*Nypa fructicans*) form strands further upriver. The Nipah forest extends at about 4–6 km from the river mouth. Along the upper and middle reaches of the Samunsam River and its tributaries, belts of riverine forest are formed, averaging under 1 km wide. The riverine forest is dominated by trees of the genera *Hopea, Knemam,*

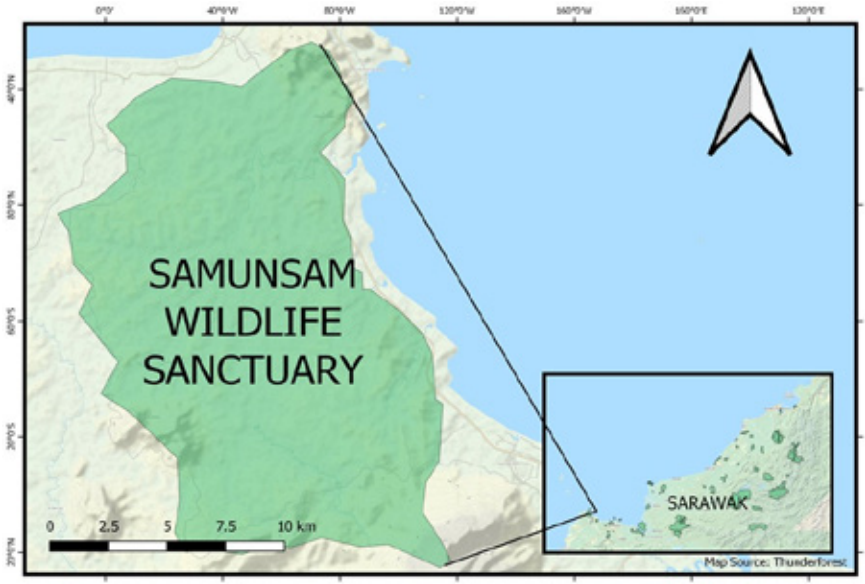


Fig. 1. Map of Samunsam Wildlife Sanctuary. Inset, map of Sarawak, showing location of Samunsam.

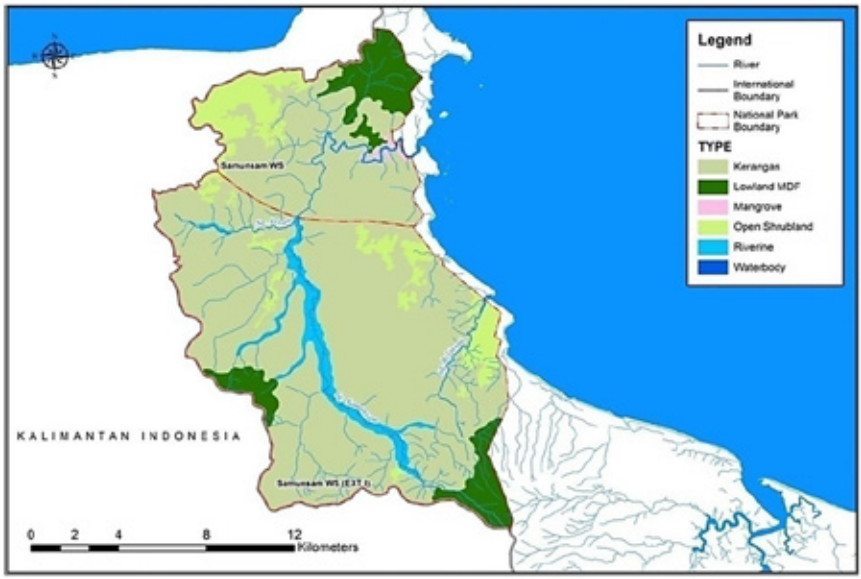


Fig. 2. Map showing the five major vegetation types recorded in SWS (source: Aziz, 2019).

Fig. 3. (a) Aerial view of Sungei Samunsam, showing pristine mangrove habitats; (b) Some of the best examples of Bornean tree flora can be found in protected areas of Sarawak, such as the mangroves of Samunsam.

Fig. 4. (a) Mangrove habitats in Samunsam offer breeding habitats for many species; (b) Recent road access has the potential to improve socioeconomic growth, as well as promote ecotourism.

Sterculia, Shorea and *Syzygium.* The forest features a dense undergrowth and abundant with rattans. The Kerangas forest is the most common forest type in Samunsam and is dominated by genera such as *Gymnostoma, Whiteodendron, Tristaniopis, Vatica* and *Shorea.* Rattan and a dense undergrowth are also common in this forest type, while pitcher plants can be observed in the more open areas. Mixed dipterocarp forests are largely confined to the hills in the north-eastern part of the Sanctuary and on patches of elevated, well-drained terrain elsewhere. Mixed dipterocarp forests have rich flora with tall trees, such as members from *Dipterocarpus, Shorea, Alstonia, Artocarpus, Gluta* and *Xanthophyllum*. The understory has climbing and non-climbing palm genera such as *Licuala, Caryota* and *Calamus* (Hazebroek and Abang, 2000).

Promoting protected areas as tourist attraction can improve socioeconomic growth as well as engage the public for conservation and maintenance. Local communities can play an essential role in assisting the authorities in detecting changes in the environment and managing the natural resources through traditional ecological knowledge. Therefore the synergy between empirical research and traditional knowledge should be regarded as a cornerstone for biodiversity conservation in the Samunsam area. This modest compilation provides new information on wildlife and species of conservation importance, evidence of ecotourism potential and the response of local communities for future management decisions in the Samunsam area.

References

Aziz, A.F. 2019. Population estimation of proboscis monkey (*Nasalis larvatus*) in Sarawak, Malaysia. Masters dissertation, Universiti Malaysia Sarawak, Kota Samarahan. 103 pp.

Hazebroek, H.P. & A. bin Kashim. 2000. National Parks of Sarawak. Natural History Publications (Borneo) Sdn Bhd, Kota Kinabalu. xii + 503 pp.

HISTORY

Siali Aban* and *Oswald Braken Tisen

Samunsam (Fig. 1) was gazetted as a Wildlife Sanctuary on 1 July 1978. Initially, the Sanctuary comprised the northernmost regions of the Gunung Pueh Forest Reserve, and cover an area ca. 6,092 hectares on both sides of Sungei Samunsam, the western boundary meeting the international border with Kalimantan, Indonesia and extended eastward towards around two kilometres from the sea coast. Over two decades later, on 29 May 2000, the Sanctuary was officially extended as Samunsam Wild Life Sanctuary Extension I, with an additional area of around 16,706 hectares. This covers the entire watershed of the Gunung Pueh Forest Reserve that adjoins Gunung Pueh National Park, and was gazetted on 15 January 2015, covering a total of 5,831 hectares. With a total area of 22,798 hectares and inclusive of Gunung Pueh National Park, the Protected Area is currently about 23,629 hectares, following the Pueh Range, to ensures the effective conservation of the watershed of Sungei Samunsam. This initiative is to support the survival of the Proboscis monkeys (*Nasalis larvatus*) in the State, the primary reason for the establishment of Samunsam. Other totally protected species that have benefitted include the Black banded langur (*Presbytis melalophos chrysomelas*), Silvered langur (*Presbytis cristata*) and the Bornean gibbon (*Hylobates abbotti*). The area also provides an excellent habitat for many of Borneo's hornbill species, including the Rhinoceros hornbill (*Buceros rhinoceros*), Sarawak's state bird, and other avian species, such as the Black-napped tern (*Sterna sumatrana*), the White-bellied sea eagle (*Haliacetus leucogaster*) and the Argus pheasant (*Argusianus argus*).

The coastal area of Samunsam is a favoured landing zone for the Painted terrapin (*Batagur borneoensis*) and Hawksbill turtle (*Eretmochelys imbricata*), and Sungei Samunsam provides habitat for the Saltwater crocodile (*Crocodylus porosus*).

The extended area of Samunsam has undergone several commercial logging activities that have led to the development of secondary forest gaps. These are recovering slowly after being gazetted as a protected area, and are now attracting species such as the Bearded Pig (*Sus barbatus*) and Barking deer (*Muntiacus* spp.).

Originally, the forest immediately adjacent to the coast, the upper region of Samunsam River, its tributaries and water catchment area were not included in

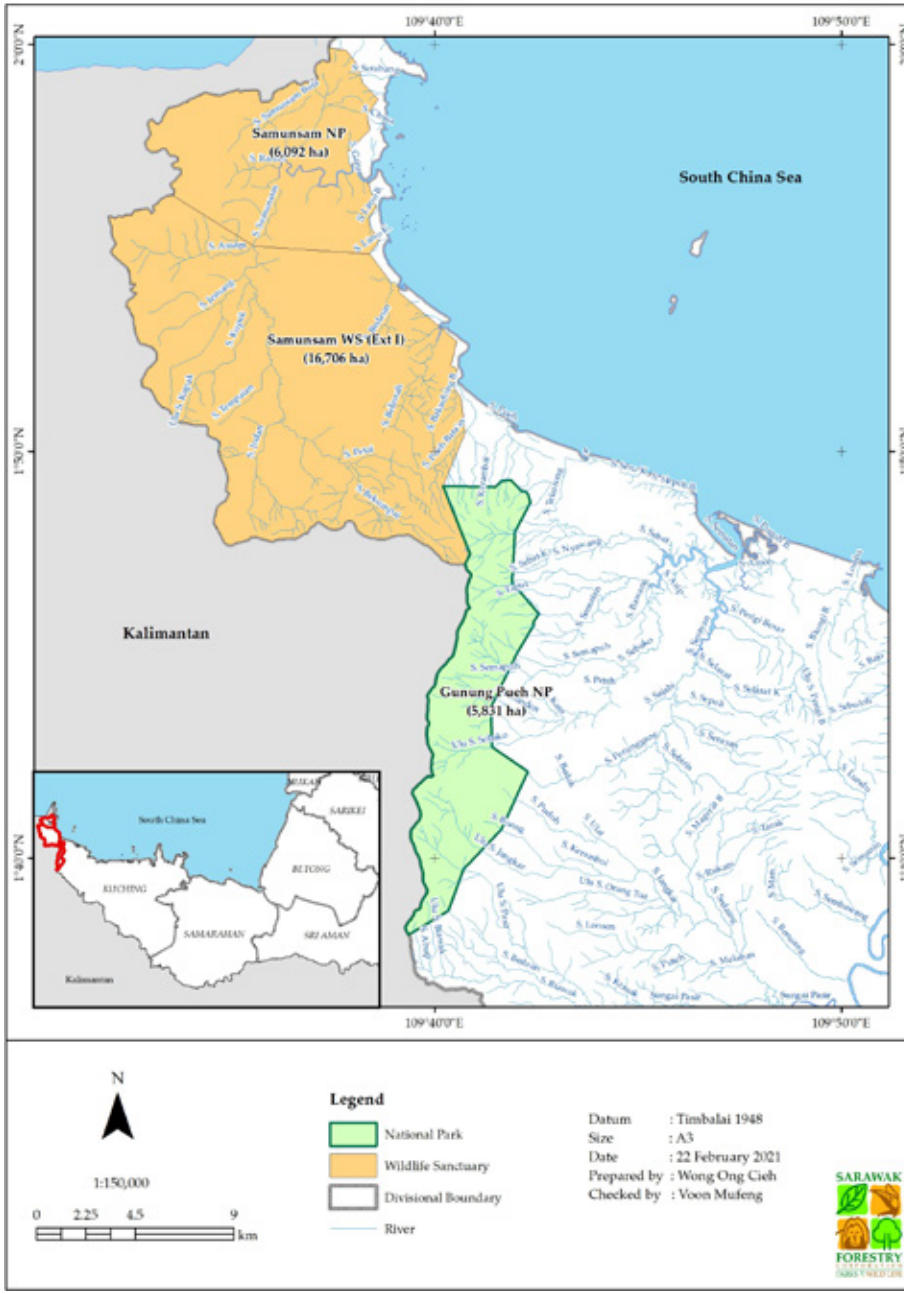


Fig. 1. Locality map of Samunsam and Extension I, with Gunung Pueh.

the Sanctuary. Comprehensive protection of these areas and their biodiversity is incomplete unless the entire watershed, including the rest of Gunung Pueh Forest Reserve, is protected. The logged-over extension area protects the watershed and reduces pollution and siltation, which would otherwise threaten the rest of the area downstream and the surrounding beaches of Tanjung Datu, Telok Melano, Telok Serabang, as far as the town of Sematan. It is also vital to the future of Samunsam as a Wildlife Sanctuary that fulfils a fundamental role of sustaining the protection of the biodiversity as a whole. Part of the extended area serves as a buffer to regulate and administer the rights and privileges of local communities to collect minor forest produce within prescribed areas at Telok Melano, Telok Serabang, Kampung Pueh and Kampung Bedaun. These people are currently given such rights and the entry of others and generally all other rights would be prohibited in the buffer zone.

Current demands under rural development initiatives, in connecting the coastal villages with road network throughout the State, resulted in Samunsam Wild Life Sanctuary being fragmented by the construction of the new Pan-Borneo Highway at the coastal part, ending up at Kampung Telok Melano, being the last fishing village situated at the western-tip of Sarawak. The Highway was officially opened to the public on 26 January 2019.

This new rural development project has triggered a new approach to manage the Sanctuary, so as to balance efforts in protecting and conserving the habitats in tandem with the fast growing rural transformation needs by initiating and promoting local communities engagement. The setting of this Sanctuary, with the tranquillity of sea beaches and majestic mountains and forests offers a tourism attraction like few others. Samunsam, being sandwiched by two national parks, Tanjung Datu and Gunung Pueh, is now ready to support the tourism industry of the State. It is being proposed that parts of the Sanctuary be converted into a National Park, so as to provide opportunities that can be tapped by tourism players in creating spin-off economic and tourism industry welfare and bring benefit to the local communities living within the Lundu and Sematan districts.

Mangrove vegetation at Samunsam intergrading with Nipah forests.
Photo: Jayasilan Mohd-Azlan.

BIRDS

Mohamad Fizl Sidq Ramji, Ng Wen Teng, Hilda Jelembai Neilson Ilan, Standley Bawin Bunsi, Isa Sait, Rahah Mohamad Yakup* and *Nur Nadhirah Izzaty Selamat

Birds are useful bioindicators for monitoring ecological change. They form an interactive community within the ecosystem and are integral for pollination and seed dispersal for many native plants (Gatesire *et al.*, 2014; Stratford *et al.*, 2015). Nonetheless, the destruction of avian habitats, such as lowland forests for timber, human settlements and coastal development in recent decades have resulted in the decline of many avian species (Kihia, 2014; Barlow *et al.*, 2016). Little work has been done on the mangroves and coastal birds in Sarawak, despite increasing threats towards such ecosystems (Wilson, 2002).

Samunsam Wildlife Sanctuary (SWS) is situated adjacent to the Tanjung Datu National Park, and is one of Sarawak's smallest national parks, located in

Fig. 1. Location of Samunsam Wildlife Sanctuary, close to Tanjung Datu National Park at the south-western tip of Sarawak (modified using QGIS).

the far west of Kuching Division (Fig. 1). SWS comprises lowland vegetation including mangroves, alluvial, heath and mixed dipterocarp forest, with extensive nipa palm (*Nypa fruiticans*) strands from the mangroves of Sungei Samunsam (Dow, 2016; Khan *et al.*, 2017) and large patches of beach forest extend from the coastal area around the boundary of the Sanctuary. The aim of this study was to document the bird diversity within the vicinity of the sanctuary and along coastal mangroves of SWS. Both active (boat cruise and line transect) and passive (mist-netting) sampling methods were utilised in this survey.

Fig. 2. A mangrove forest stretch along Sungei Samunsam.

A total of 20 mist-nets were set within the heath and mangrove forests (Fig. 2). Sampling areas were marked with a hand-held Global Positioning System (GPS) unit. Nets were deployed for 12 hours, from 0600 to 1800 hours and checked at every two hour intervals daily to minimize mortality. Total mist-netting effort throughout the sampling was 4,560 hours. Observation and call records were obtained during the boat survey along Sg. Samunsam and adjacent trails in the early mornings and late afternoons (Fig. 3).

A total of 119 species from 44 families were recorded over the five sampling occasions (Table 1). Of this, 49 and 96 species were recorded from mist-netting and boat surveys, respectively. Our assessment of species richness and abundance within the area reveals contrasting figures from the methods used, which highlights the importance of conducting intensive surveys at both temporal and spatial scales. Bird trapping using mist nets explains the moderate species diversity, but show an abundance of forest floor dwellers and

Checklist of Birds

Table 1: Checklist of bird species recorded in Samunsam Wildlife Sanctuary. Abbreviations: SWLPO 1998 = Sarawak Wild Life Protection Ordinance 1998; TP = Totally Protected; P = Protected; NP = Not Protected; IUCN = IUCN Red List (2020–1); LC = Least Concern; NT = Near Threatened; VU = Vulnerable; No. = number of individuals captured; Mn = Mist Netting; BS = Boat Survey; LT = Line Transect; Dist. = Distributional Status; CR = Common Resident; SR = Scarce Resident; CNR = Common Nomadic Resident; CWV = Common Winter Visitor; LR = Lowland Resident; R = Resident; N = Native; M = Migrant; E = Endemic; * = mangrove species; ** = endemic species.

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
Accipitridae	Brahminy Kite	*Haliastur indus*	P	LC	-	-	+	R
	Crested Goshawk	*Accipiter trivirgatus*	P	LC	2	-	-	CR
	Crested Serpent-eagle	*Spilornis cheela*	NP	LC	-	+	-	R
	Lesser Fish-Eagle	*Icthyophaga humilis*	NP	NT	-	+	-	R
	White-bellied Sea Eagle	*Haliaeetus leucogaster*	TP	LC	-	+	-	R
Aegithinidae	Common Iora*	*Aegithina tiphia*	NP	LC	2	+	+	R
Alcedinidae	Blue-eared Kingfisher*	*Alcedo meninting*	P	LC	4	-	-	R
	Ruddy Kingfisher	*Halcyon coromanda*	P	LC	-	-	+	R
	Rufous-backed Kingfisher	*Ceyx rufidorsa*	P	LC	11	-	-	CR
	Stork-billed Kingfisher*	*Pelargopsis capensis*	P	LC	-	-	+	R
	White-collared Kingfisher	*Todiramphus chloris*	P	LC	-	+	-	R
Apodidae	Black-nest Swiftlet	*Aerodramus maximus*	P	LC	-	+	-	R
	Glossy Swiftlet	*Collocalia esculenta*	P	LC	-	+	+	R
	White-nest Swiftlet	*Aerodramus fuciphagus*	P	LC	2	+	-	R

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
Ardeidae	Great Egret	*Ardea alba*	P	LC	-	-	+	M
	Little Heron	*Butorides striata*	P	LC	-	+	-	R
	Purple Heron	*Ardea purpurea*	P	LC	-	+	-	M
Bucerotidae	Black Hornbill	*Anthracoceros malayanus*	TP	VU	-	+	+	R
	Bushy-crested Hornbill	*Anorrhinus galeritus*	TP	NT	-	-	+	R
	Rhinoceros Hornbill	*Buceros rhinoceros*	TP	VU	-	-	+	R
	Wrinkled Hornbill	*Rhabdotorrhinus corrugatus*	TP	EN	-	+	-	R
Campephagidae	Pied Triller	*Lalage nigra*	NP	LC	-	+	+	R
Caprimulgidae	Malaysian Eared-nightjar	*Lyncornis temminckii*	NP	LC	-	-	+	R
Charadriidae	Lesser Sandplover	*Charadrius mongolus*	P	LC	-	+	+	R
	Little Ringed Plover	*Charadrius dubius curonicus*	P	LC	-	+	-	M
	Plover	*Charadrius* sp.	P	-	-	-	+	-
	Stint	*Calidris* sp.	P	-	-	+	-	-
Chloropseidae	Lesser Green Leafbird	*Chloropsis cyanopogon*	NP	NT	1	-	+	R
Cisticolidae	Ashy Tailorbird	*Orthotomus ruficeps*	NP	LC	1	+	+	R
	Rufous-tailed Tailorbird	*Orthotomus sericeus*	NP	LC	4	+	-	R
	Yellow-bellied Prinia	*Prinia flaviventris*	NP	LC	1	-	-	R
Columbidae	Emerald Dove	*Chalcophaps indica*	NP	LC	8	+	-	CNR
	Little Green-pigeon	*Treron olax*	NP	LC	-	+	-	CR
	Green Imperial-pigeon	*Ducula aenea*	TP	LC	-	+	-	R

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
	Pied Imperial-pigeon	*Ducula bicolor*	TP	LC	-	+	+	R
	Pink-necked Green-pigeon	*Treron vernans*	NP	LC	-	-	+	R
	Spotted Dove	*Streptopelia chinensis*	NP	LC	-	+	-	R
Cuculidae	Black-bellied Malkoha	*Phaenicophaeus diardi*	NP	NT	-	+	-	R
	Plaintive Cuckoo	*Cacomantis merulinus*	NP	LC	2	-	+	R
Dicaeidae	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	NP	LC	2	+	-	R
	Scarlet-breasted Flowerpecker	*Prionochilus thoracicus*	NP	NT	3	-	-	R
	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	NP	LC	3	-	+	R
	Yellow-rumped Flowerpecker**	*Prionochilus xanthopygius*	NP	LC	3	-	-	E
	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	NP	LC	-	-	+	N
Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus*	NP	LC	-	+	+	R
Estrildidae	Chestnut Munia	*Lonchura atricapilla*	NP	LC	-	-	+	R
	Dusky Munia**	*Lonchura fuscans*	NP	LC	-	-	+	E
Eurylaimidae	Black-and-red Broadbill	*Cymbirhynchus macrorhynchos*	NP	LC	2	-	-	R
	Black-and-yellow Broadbill	*Eurylaimus ochromalus*	NP	NT	-	+	+	R
	Long-tailed Broadbill	*Psarisomus dalhousiae*	TP	LC	-	-	+	R
Hemiprocnidae	Whiskered Treeswift	*Hemiprocne comata*	NP	LC	-	+	-	R
Hirundinidae	Barn Swallow	*Hirundo rustica*	NP	LC	2	-	-	M
	House Swallow	*Hirundo javanica*	NP	LC	1	+	+	R

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
	Pacific Swallow	*Hirundo tahitica*	NP	LC	-	+	-	R
Indicatoridae	Malay Honeyguide	*Indicator archipelagicus*	NP	NT	1	-	-	R
Laridae	Black-naped Tern	*Sterna sumatrana*	TP	LC	-	+	+	R
Megalaimidae	Blue-eared Barbet	*Psilopogon cyanotis*	NP	LC	-	+	-	R
	Gold-Whiskered Barbet**	*Psilopogon chrysopogon*	NP	LC	-	+	+	E
	Red-crowned Barbet	*Psilopogon rafflesii*	NP	NT	-	+	+	R
	Red-throated Barbet	*Psilopogon mystacophanos*	NP	NT	-	-	+	R
Meropidae	Blue-throated Bee-eater	*Merops viridis*	NP	LC	-	-	+	R
Monarchidae	Asian Paradise-flycatcher	*Terpsiphone affinis*	NP	LC	-	+	+	CR
	Black-naped Monarch	*Hypothymis azurea*	NP	LC	-	-	+	CR
Muscicapidae	Bornean Blue-flycatcher**	*Cyornis superbus*	TP	LC	-	-	+	E
	Mangrove Blue-flycatcher*	*Cyornis rufigastra*	NP	LC	4	-	+	R
	Rufous-chested Flycatcher	*Ficedula dumetoria*	NP	LC	-	-	+	R
	White-rumped Shama	*Copsychus malabaricus*	P	LC	-	-	+	R
Nectariniidae	Brown-throated Sunbird	*Anthreptes malacensis*	NP	LC	4	+	+	CR
	Copper-throated Sunbird	*Leptocoma calcostetha*	NP	LC	1	-	+	R
	Grey-breasted Spiderhunter	*Arachnothera modesta*	NP	LC	1	-	-	R
	Little Spiderhunter	*Arachnothera longirostra*	NP	LC	39	-	+	R
	Long-billed Spiderhunter	*Arachnothera robusta*	NP	LC	-	-	+	R
	Olive-backed Sunbird	*Cinnyris jugularis*	NP	LC	-	+	+	CR

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
	Purple-naped Sunbird	*Hypogramma hypogrammicum*	NP	LC	18	-	+	R
Pachycephalidae	Mangrove Whistler*	*Pachycephala cinerea*	NP	LC	-	+	-	CR
Passeridae	Eurasian Tree Sparrow	*Passer montanus*	NP	LC	-	-	+	R
Pellorneidae	Black-capped Babbler	*Pellorneum nigrocapitatum*	NP	LC	7	-	-	R
	Ferruginous Babbler	*Trichastoma bicolor*	NP	LC	1	-	-	R
	Grey-breasted Babbler	*Malacopteron albogulare*	NP	NT	1	-	-	R
	Scaly-crowned Babbler	*Malacopteron cinereum*	NP	LC	2	-	-	R
	Short-tailed Babbler	*Trichastoma malaccense*	NP	NT	3	+	-	R
	White-chested Babbler	*Trichastoma rostratum*	NP	NT	4	-	-	R
Phasianidae	Great Argus	*Argusianus argus*	TP	NT	-	+	+	R
Phylloscopidae	Arctic Warbler	*Phylloscopus borealis*	NP	LC	2	-	-	CWV
Picidae	Banded Woodpecker	*Chrysophlegma mineaceus*	P	LC	-	+	+	CR
	Buff-necked Woodpecker	*Meiglyptes tukki*	P	NT	2	-	-	R
	Crimson-winged Woodpecker	*Picus puniceus*	P	LC	-	+	-	R
	Great Slaty Woodpecker	*Mulleripicus pulverulentus*	P	VU	-	+	-	R
	Rufous Piculet	*Sasia abnormis*	P	LC	—	+	-	R
	White-bellied Woodpecker	*Dryocopus javensis*	P	LC	-	+	-	R
Pittidae	Garnet Pitta	*Pitta granatina*	TP	NT	—	+	-	R
Pityriaseidae	Bornean Bristlehead**	*Pityriasis gymnocephala*	TP	NT	—	+	-	E
Psittacidae	Blue-crowned Hanging-parrot	*Loriculus galgulus*	P	LC	-	+	-	R

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
Pycnonotidae	Black-headed Bulbul	*Pycnonotus atriceps*	NP	LC	1	-	+	R
	Cream-vented Bulbul	*Pycnonotus simplex*	NP	LC	16	-	+	R
	Hairy-backed Bulbul	*Tricholestes criniger*	NP	LC	2	-	-	R
	Olive-winged Bulbul	*Pycnonotus plumosus*	NP	LC	22	-	+	CR
	Puff-backed Bulbul	*Pycnonotus eutilotus*	NP	NT	1	-	+	R
	Red-eyed Bulbul	*Pycnonotus brunneus*	NP	LC	-	+	+	CR
	Spectacled Bulbul	*Pycnonotus erythrophthalmos*	NP	LC	1	-	-	R
	Yellow-bellied Bulbul	*Alophoixus phaeocephalus*	NP	LC	14	-	+	R
	Yellow-vented Bulbul	*Pycnonotus goiavier*	NP	LC	1	+	-	R
Rhipiduridae	Pied Fantail	*Rhipidura javanica*	NP	LC	8	+	+	R
Scolopacidae	Common Sandpiper	*Actitis hypoleucos*	P	LC	-	+	+	R
	Whimbrel	*Numenius phaeopus*	P	LC	-	+	+	CWV
	Wood Sandpiper	*Tringa glareola*	P	LC	-	-	+	CR
	Terek Sandpiper	*Xenus cinereus*	P	LC	-	+	+	CR
Strigidae	Brown Hawk Owl	*Ninox scutulata*	P	LC	-	+	+	R
Sturnidae	Asian Glossy Starling	*Aplonis panayensis*	NP	LC	-	+	+	R
	Hill Myna	*Gracula religiosa*	P	LC	-	+	+	CR
Timaliidae	Black-throated Babbler	*Stachyris nigricollis*	NP	NT	3	-	+	R
	Bold-striped Tit-babbler	*Mixornis bornensis*	NP	LC	4	-	-	R
	Chestnut-rumped Babbler	*Stachyris maculata*	NP	NT	7	-	-	R

Family	Common Name	Species name	SWPO 1998	IUCN	Mn	BS	LT	Dist.
	Chestnut-winged Babbler	*Stachyris erythroptera*	NP	LC	13	+	+	R
	Fluffy-backed Tit-babbler	*Macronus ptilosus*	NP	NT	6	-	+	R
Turdidae	Oriental Magpie-robin	*Copsychus saularis*	NP	LC	-	+	+	R
Vangidae	Philentoma	*Philentoma* sp.	NP	-	-	-	+	-
	Rufous-winged Philentoma	*Philentoma pyrhoptera*	NP	LC	2	-	-	LR
Vireonidae	White-bellied Erpornis	*Erpornis zantholeuca*	NP	LC	2	-	-	R
Total number of species					**50**	**97**		**(120)**
Number of netted individuals					**247**			

Fig. 3. Two observers conducting visual survey of birds from boat covering river mouth to the upstream of Sungei Samunsam.

understorey birds. Additional sightings via visual and aural detection provide important records of species that were not recorded using the aforementioned methods. Such survey was rapid and expansive to maximise species detection, including middle-high canopy fliers, migratory shorebirds and seabirds.

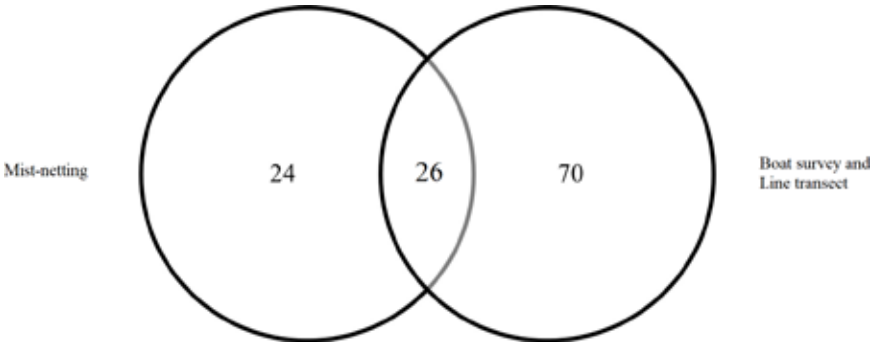


Fig. 4. Venn diagram showing number of shared bird species and numbers of species recorded at Samunsam.

Fig. 4 shows shared species (n = 26) recorded using active and passive methods. These include Common Iora (*Aegithina tiphia*), White-nest Swiftlet (*Aerodramus fuciphagus*), Lesser Green Leafbird (*Chloropsis cyanopogon*), Ashy Tailorbird (*Orthotomus ruficeps*), Rufous-tailed Tailorbird (*Orthotomus*

sericeus), Emerald Dove (*Chalcophaps indica*), Plaintive Cuckoo (*Cacomantis merulinus*), Orange-bellied Flowerpecker (*Dicaeum trigonostigma*), Yellow-breasted Flowerpecker (*Prionochilus maculatus*), House Swallow (*Hirundo javanica*), Mangrove Blue-flycatcher (*Cyornis rufigastra*), Brown-throated Sunbird (*Anthreptes malacensis*), Copper-throated Sunbird (*Leptocoma calcostetha*), Little Spiderhunter (*Arachnothera longirostra*), Purple-naped Sunbird (*Hypogramma hypogrammicum*), Short-tailed Babbler (*Trichastoma malaccense*), Black-headed Bulbul (*Pycnonotus atriceps*), Cream-vented Bulbul (*Pycnonotus simplex*), Olive-winged Bulbul (*Pycnonotus plumosus*), Puff-backed Bulbul (*Pycnonotus eutilotus*), Yellow-bellied Bulbul (*Alophoixus phaeocephalus*), Yellow-vented Bulbul (*Pycnonotus goiavier*), Pied Fantail (*Rhipidura javanica*), Black-throated Babbler (*Stachyris nigricollis*), Chestnut-winged Babbler (*Stachyris erythroptera*), and Fluffy-backed Tit-babbler (*Macronus ptilosus*).

Of the 49 species recorded from mist-netting, 247 individuals from 22 families were banded. The Little Spiderhunter (*Arachnothera longirostra*) was the most abundant species, with 39 individuals caught, followed by Olive-winged Bulbul (*Pycnonotus plumosus*) (22), Purple-naped Sunbird (*Hypogramma hypogrammicum*) (18), Cream-vented Bulbul (*Pycnonotus simplex*) (16), Yellow-bellied Bulbul (*Alophoixus phaeocephalus*) (14), Chestnut-winged Babbler (*Stachyris erythroptera*) (13), and Rufous-backed Kingfisher (*Ceyx rufidorsa*) (11). Fig. 5 depicts the species relative abundance plot.

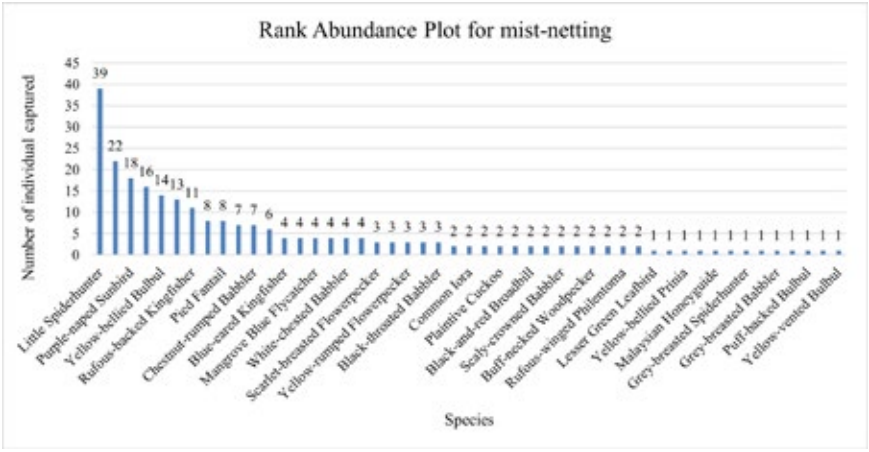


Fig. 5. Number of individuals of birds caught and species recorded from mist-netting at Samunsam.

Our mist netting effort yielded an abundance of understorey birds within mixed vegetation forests, comprising heath and mangroves. Members of the family Pycnonotidae (Bulbuls) were the most diverse bird group netted (eight species), followed by the babblers, which comprised two families, Pellorneidae (six species) and Timaliidae (six species). Both sunbirds and spiderhunters from the family Nectariniidae were netted frequently along the forest trails, with five species. These are predominantly nectarivores attracted to the abundance of food sources such as fruiting and flowering plants in the lowland mix dipterocarp forest (Symthies and Davidson, 1999; Sim and Kong, 2004). Mangroves in Samunsam, on the other hand, offer an ideal environment for insectivorous species. Aside from feeding, they use bushes and dead trees to feed and rest (Canales-Delgadillo *et al.*, 2019).

In contrast, a high number of bird species was recorded from visual observation via the boat survey and line transect method. Migrants such as the Great Egret (*Ardea alba*), Little Heron (*Butorides striata*), and Purple Heron (*Ardea purpurea)* were sighted during the boat survey. Additionally, shorebird species such as the Lesser Sand Plover (*Charadrius moongolus*) and Little Ringed Plover (*Charadrius dubius curonicus*), Common Sandpiper (*Actitis hypoleucos*), Whimbrel (*Numenius phaeopus*), Wood Sandpiper (*Tringa glareola*), Terek Sandpiper (*Xenus cinereus*), and Black-naped Tern (*Sterna sumatrana*) were also spotted flying across and / or lingering by the coastal shorelines. The presence of these globally threatened migratory species in Samunsam further underline the coastline habitat as an important stop-over site during their long migration.

Some notable species, such as the Black Hornbill (*Anthracoceros malayanus*), Bushy-crested Hornbill (*Anorrhinus galeritus*), Rhinoceros Hornbill (*Buceros rhinoceros*), Wrinkled Hornbill (*Rhabdotorrhinus corrugatus*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), Great Argus (*Argusianus argus*) and Garnet Pitta (*Pitta granatina*) were recorded during the survey. Wrinkled Hornbills were spotted flying in flock high above the mangrove forest canopy along Sungei Samunsam during several late afternoons. The distinctive calls of the Great Argus were also heard from further inside the forest along the main forest trail. According to the IUCN Red List of Threatened Species, the Wrinkled Hornbill is classified as 'Endangered' (EN), while the Black Hornbill, Rhinoceros Hornbill, and Great Slaty Woodpecker are classified as 'Vulnerable' (VU). The Bushy-crested Hornbill, Great Argus and Garnet Pitta are 'Near Threatened' (NT). Additionally, the Great Slaty Woodpecker is listed as a 'Protected' Species, whilst the Great Argus, Garnet Pitta, and all hornbills are listed as 'Totally Protected' Species under Sarawak Wild Life Protection Ordinance, 1998.

Four endemic species were recorded in SWS, including the Yellow-rumped Flowerpecker (*Prionochilus xanthopygius*), Dusky Munia (*Lonchura fuscans*), Bornean Blue-flycatcher (*Cyornis superbus*), and Bornean Bristlehead (*Pityriasis gymnocephala*). Of these, only the Bornean Bristlehead is classified as 'Near Threatened' (NT), while the rest are classified as 'Least Concern' (LC) according to the IUCN Red List of Threatened Species, 2021. The Bornean Bristlehead was identified by its loud and distinctive call from the forest interior. It has a wide range of distribution in Borneo (Phillipps and Phillipps, 2014), and is known as a scarce native resident of lowland and hill primary forest, but can be found mostly in peat swamp forests. Another uncommon native resident from understorey primary forests that was sighted along the line transect was the Bornean Blue-flycatcher. This species prefers to occupy the hill forest (Phillipps and Phillipps, 2014). Both are listed as 'Totally Protected' Species under the Sarawak Wild Life Protection Ordinance, 1998.

Sampling saturation was not achieved during this study, suggesting that the Sanctuary has potentially higher bird species richness. This indicates that the number of species recorded is likely to increase if sampling days or occasions are extended (Fig. 6).

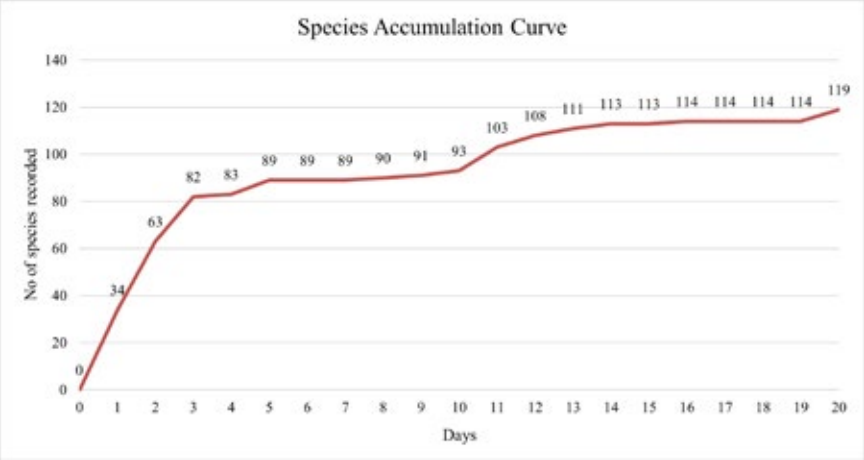


Fig. 6. Avian species accumulation curve, though not reaching asymptote, is nearing a plateau on the last sampling occasion at Samunsam.

Figure 7 shows the species richness estimator curves and estimate accumulation number of bird species from mist-netting effort throughout the entire sampling period. Chao1 estimates 58 species of birds, while ACE estimated 62 bird species can be found in SWS. The curves on the last few

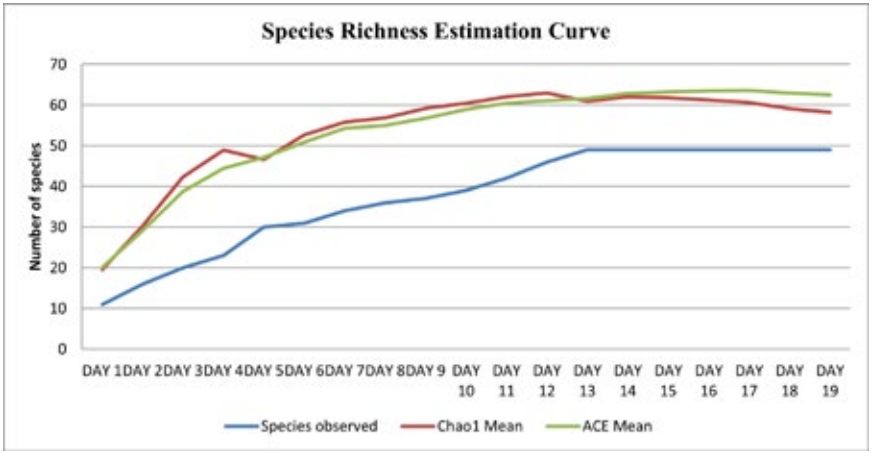


Fig. 7. Comparison between observed bird species and estimated species richness (by Chao 1 and ACE mean) using mist-netting data at Samunsam.

sampling days shows plateau, indicating that the bird species recorded from the current list in SWS is nearing asymptote.

The completion of the Telok Melano-Sematan road of Pan Borneo Highway has brought a seismic impact on the survival and wellbeing of the wildlife community in SWS (Fig. 8). The ongoing construction and expansion of the Pan Borneo Highway to other road networks could lead to an increasingly challenging task of tackling human-wildlife conflicts within the existing fragmented wildlife populations (Cannon, 2019). Noise and vibrations from vehicles may further hinder wildlife from passing through, confining them into a restricted habitat. This could increase the chances of poaching and roadkill incidents by forcing terrestrial wildlife to come into contact with human residents or traverse the highway. Such consequences of the altercation are naturally disastrous for both wildlife and humans (Alamgir *et al*., 2017). Hence, mitigation measures are crucial, in order to formulate a short-term and long-term management strategy for the protected area. This

Fig. 8. A high rise slope of the Pan Borneo Highway, as viewed from the edge of the forest trail (estimated distance 50 m), connecting Samunsam Wildlife Sanctuary Headquarters.

Fig. 9. (a) Black Hornbill (*Anthracoceros malayanus*); (b) Whiskered Treeswift (*Hemiprocne comata*); (c) Great Egret (*Ardea alba*); (d) Brahminy Kite (*Haliastur indus*); (e) Stork-billed Kingfisher (*Pelargopsis capensis*); (f) Fluffy-backed Tit-Babbler (*Macronus ptilosus*).

Fig. 10. (a) Hairy-backed Bulbul (*Tricholestes criniger*); (b) Ashy Tailorbird (*Orthotomus ruficeps*); (c) Crested Serpent Eagle (*Spilornis cheela*). (d) Garnet Pitta (*Erythropitta granatina*); (e) Black-and-red Broadbill (*Cymbirhynchus macrorhynchos*); (f) Blue-eared Kingfisher (*Alcedo meninting*).

includes any effort to strengthen law enforcement and continuous monitoring of habitat degradation within the SWS.

A total of 119 bird species, representing 44 families were recorded from the site, based on multiple surveys. Of these, 13 species are listed as 'Totally Protected' and 32 are in the 'Protected' categories under Sarawak Wild Life Protection Ordinance 1998 (SWLPO, 1998). The high diversity can be attributed to the diverse lowland habitats represented, including mangroves, beach forests, riverine forests, heath forests, and mixed dipterocarp forests. Finally, we recommend regular rapid surveys to monitor species distribution and population dynamics of bird community within the Sanctuary, especially along the coastal mangrove fringes.

We are grateful to the Sarawak Forestry Corporation for funding this work through a research grant (GL/F07/SAMUNSAM/2019). We would also like to thank the Park Warden of SWS, Mohamad Khalid Mohamad Zakeria, Sarawak Forest Department, and colleagues at the Faculty of Resource Science and Technology, UNIMAS, Trevor Allen Anak Nyaseng, Nur Qamareena Karim, Dayang Hafizah Abang Iskandar and Syameera Jemat. Chien C. Lee provided the bird images reproduced in this chapter.

REFERENCES

Alamgir, M., M.J. Campbell, S. Sloan, M. Goosem, G.R. Clements, M.I. Mahmoud & W.F. Laurance. 2017. Economic, social-political and environmental risks of road development in the tropics. Current Biology 27:1130–1140.

Barlow, J., G.D. Lennox, J. Ferreira, E. Berenguer, A.C. Lees, R. MacNally, J.R. Thomson, S.F.B. Ferraz, J. Louzada, V.H.F. Oliveira, L. Perry, R.R.C. Solar, I.C.G. Vieira, L.E.O.C. Aragao, R.A. Begotti, R.F. Braga, T.M. Cardoso, R.C. Oliveira Jr., C.M. Souza Jr., N.G. Moura, S.S. Nunes, J.V. Siqueira, R. Pardini, J. Silveira, F.Z. Vaz-de-Mello, R.C.S. Veiga, A. Venturieri & T.A. Gardner. 2016. Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. Nature 35(7610):144–147.

Canales-Delgadillo, J.C., R. Perez-Ceballos, M.A. Zaldivar-Jimenez, M. Merino-Ibarra, G. Cardoza & J.G. Cardoso-Mohedano. 2019. The effect of mangrove restoration on avian assemblages of a coastal lagoon in southern Mexico. PeerJ 7:e7493 http://doi.org/10.7717/peerj.7493.

Cannon, J.C. 2019. Pan Borneo Highway development endangers the Heart of Borneo. Mongabay: News and Inspiration from Nature's Frontline. https://news.mongabay.com/2019/09/pan-borneo-highway-development-

Fig. 11. Banded Woodpecker (*Chrysophlegma miniaceum*).

threatens-to-carve-up-intact-forest/
Dow, R.A. 2016. Odonata collected at the Samunsam Wildlife Sanctuary, Kuching Division, Sarawak, Malaysia. Journal of the International Firefly Fund 14:1–3.
Gatesire, T., D. Nsabimana, A. Nyiramana, J.L. Seburange & M.O. Mirville. 2014. Bird diversity and distribution in relation to urban landscape types in northern Rwanda. The Scientific World Journal 14:1–12.
IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-1. https://www.iucnredlist.org. Downloaded on 17 April 2021.
Khan, F.A.A., N.A.A. Tahir, S.P.H. Rahman, J.W. Dee, M.A. Morni, Q.S. Rosli, R.C.T. Tingga, M.R. Rahman & I. Azhar. 2017. Small mammals from Samunsam Wildlife Sanctuary, Sarawak, Malaysian Borneo. Borneo Journal of Resource Science and Technology 7(2):98–106.
Kihia, C.M. 2014. Impact of human physical disturbance on mangrove forest structure at the Gazi Bay, Kenya. Egerton Journal of Science and Technology 14:31–47.
Phillipps, Q. & K. Phillipps. 2014. Phillipps's field guide to the birds of Borneo, Sabah,
Sim, L.K. & D. Kong. 2004. Avifauna. Sarawak Bau limestone biodiversity. The Sarawak Museum Journal 80(6):235–242.
Stratford, J.A., L.L. Powell & N.J. Cordeiro. 2015. Ecology and conservation of avian insectivores of the rainforest understory: a pantropical perspective. Biological Conservation 188:1–10.
Wilson, K.J. 2002. A survey of coastal and marine birds at Bako National Park and Samunsam Wildlife Sanctuary, Sarawak. Lincoln University, Canterbury, New Zealand.

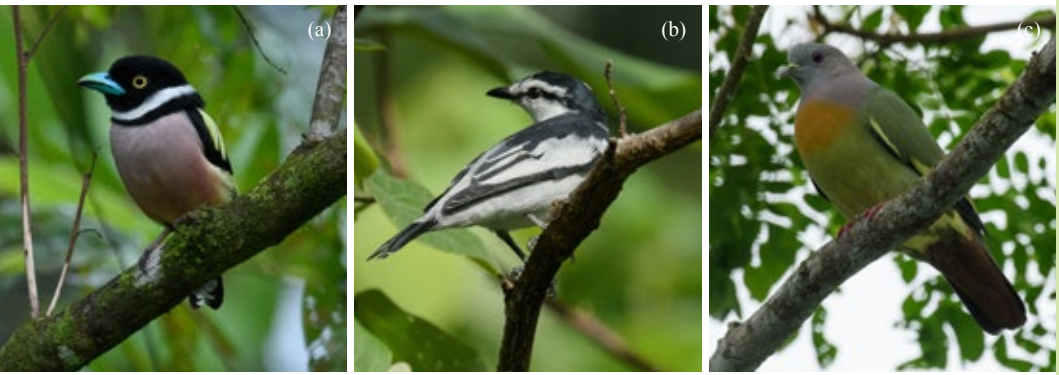


Fig. 12. (a) Black-and-yellow Broadbill (*Eurylaimus ochromalus*); (b) Pied Triller (*Lalage nigra*); (c) Pink-necked Green-Pigeon (*Treron vernans*).

Izneil Nashriq
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Ng Wen Teng
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Norsyarizan Jamil
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Wan Nurainie Wan Ismail
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Trevor Allen Nyaseng
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Mohd. Ridwan Abd. Rahman
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Sultana Parvin Habeebur Rahman
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Ratnawati Hazali
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Qhairil Shyamri Rosli
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Isa Sait
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Nur Nadhirah Izzaty Selamat
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Radin Azreena Radin Shahrom
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Tan Dick Shen
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Mohammad Fizl Sidq Ramji
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Mohamad Suhaidi Salleh
Faculty of Social Sciences and Humanities, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Nurfazlin Shahira binti Mohd Fauzi
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Siti Shamimi Abidin
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Mohd. Asaraf Sulaiman
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Nurul Farah Diyana Ahmad Tahir
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Roberta Chaya Tawie Tingga
Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Wong Jye Wen
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Rahah Mohamad binti Yakup
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

Farah Zaini
Faculty of Social Sciences and Humanities, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.