PROCEEDINGS OF SABAH'S RAMSAR CONFERENCE 2015

Book · June 2016

CITATIONS
0

READS
1,429

4 authors:

Arthur Y.C. Chung
Sabah Forestry Department
297 PUBLICATIONS **2,600** CITATIONS
SEE PROFILE

Andi Maryani A Mustapeng
Forest Research Centre
149 PUBLICATIONS **114** CITATIONS
SEE PROFILE

Nurul Aqidah
18 PUBLICATIONS **5** CITATIONS
SEE PROFILE

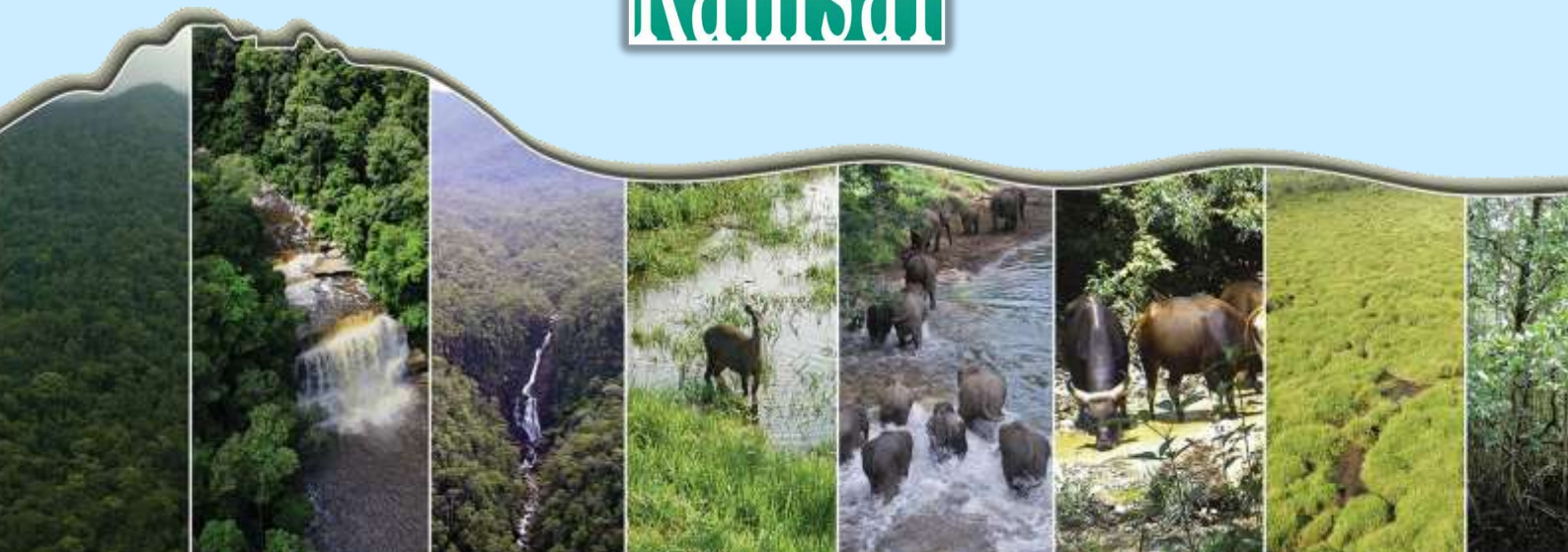
Noor Azmizah A.
3 PUBLICATIONS **0** CITATIONS
SEE PROFILE

PROCEEDINGS

of

Sabah's Ramsar Conference 2015

12th November 2015
Magellan Sutera Harbour Resort,
Kota Kinabalu, Sabah



PROCEEDINGS

of

Sabah's Ramsar Conference 2015

Published 2016

Locked Bag No. 68,
90009 Sandakan,
Sabah, Malaysia

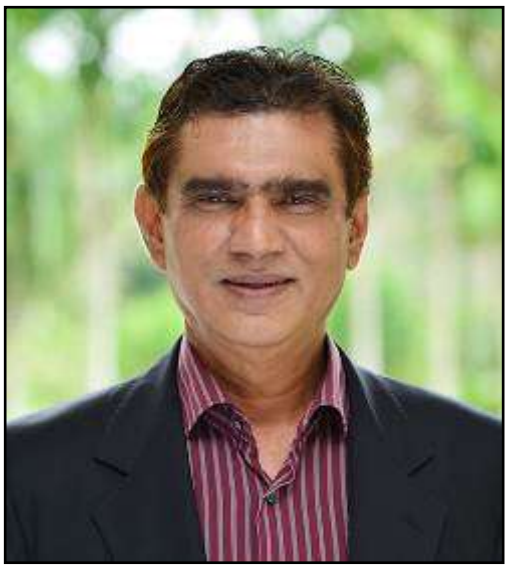
http://www.forest.sabah.gov.my/

PROCEEDINGS OF SABAH'S RAMSAR CONFERENCE 2015
12th November 2015, Kota Kinabalu, Sabah

ISBN: 978-967-0180-16-8

Printed in Malaysia

FOREWORD



Under the 10th Malaysia Plan, both the federal and state governments have put much effort in the conservation of the natural ecosystems and their biodiversity. This is reflected in the government's commitment and contribution to conservation endeavours, such as the designation and management of the Lower Kinabatangan-Segama Wetlands (LKSW) as a Ramsar site. Prudent management of biodiversity is a delicate balancing act which takes into account, the country's aspiration to become a developed nation and at the same time observing the need to conserve biodiversity.

Among the key contributions towards the success of Sabah's efforts in conservation, are the implementation of the Heart of Borneo Initiative, and more recently the designation of LKSW in Sabah as a Ramsar site, which is the largest in Malaysia, encompassing an area of 78,803 hectares and covering three forest reserves. Under the 10th Malaysia Plan, the Sabah Forestry Department has set up the Kulamba Field Centre in Tundon Bohangin for research and other activities in this Ramsar site.

This conference which was held back-to-back with the International Heart of Borneo (HoB) Conference has provided an opportunity for the experts, stakeholders and participants to discuss as well as to gain a better understanding on enhancing biodiversity conservation of the Ramsar site. A total of 14 oral papers and 10 research posters were presented, mainly based on the findings from two scientific expeditions conducted by the Sabah Forestry Department in 2014 and 2015 respectively. There were also some general posters to promote environmental awareness on the importance of wetlands.

My sincere appreciation to the Deputy Director (Forest Sector Planning), Mr Frederick Kugan and the Organizing Committee (as listed on page 4 to 7) for excellent team work in the planning and execution of the conference. I also thank the Deputy Director (Research), Dr Lee Ying Fah and the rapporteuring team (Dr Joan Pereira, Lee Kah Han and Julsun Sikui) as well as Dr Arthur Y.C. Chung, Andi Maryani Andi Mustapeng, Nurul Aqidah Ibrahim and Noor Azmizah Andaman for publication of the proceedings.

Thank you.

Datuk Sam Mannan
Director
Sabah Forestry Department

TABLE OF CONTENTS

1.0 CONFERENCE PROGRAMME

Sabah's Ramsar Conference was held back-to-back with the Heart of Borneo (HoB) Conference. The paper presentations for the Ramsar Conference were held on 12th November 2015, concurrently with other HoB Conference sessions.

11 November 2015	
	OPENING CEREMONY
Time	
7.00 am	Registration of Participants
8.30 am	Arrival of VVIPs and Invited Guests
8.50 am	Arrival of the Right Honourable Datuk Seri Panglima Musa Hj Aman, Chief Minister of Sabah
9.00 am	• Welcoming Performance • Heart of Borneo Malaysia Video and Song • Video Presentation • Welcoming Address by YBhg Datuk Sam Mannan, Director of Sabah Forestry Department • Address by the Right Honourable Datuk Seri Panglima Musa Hj Aman, Chief Minister of Sabah • Launching of the Conference by the Right Honourable Datuk Seri Panglima Musa Hj Aman, Chief Minister of Sabah • Signing of Memoranda of Understanding • Presentation of Mock Cheque from the Director of Sabah Forestry Department to the Right Honourable Chief Minister of Sabah • Presentation of Land Titles for Conservation from Mr. Liew Pin Cheong of Lebihasil Sdn Bhd, to the Right Honourable Chief Minister of Sabah • Presentation of Souvenir
9.45 am	Tour of the Exhibition
10.00 am	Refreshments / Press Conference

12 November 2015	
Sabah's Ramsar Conference **Chairperson: Dr Chan Hung Tuck** **International Society for Mangrove Ecosystems (ISME)** **Venue: Ballroom 1**	
Time	**Oral Paper**
9.00 am	Tn Hj Hussin Tukiman Sabah Forestry Department Title: Overview of LKSW Ramsar Project in Sabah
9:20 am	Dr Reuben Nilus Sabah Forestry Department Title: Forest Ecosystems of Sabah's Ramsar Site
9:35 am	Mr John B Sugau Sabah Forestry Department Title: Plant Diversity Study in Ramsar Site in Sabah, Malaysia
9:50 am	Ms Nadirah Abdul Manaf Universiti Malaysia Sabah

	Title: Sugar Production and Reproductive Phenology of *Nypa fruticans* in Labuk Bay, Sandakan, Sabah
10:05 am	Mr Hubert Petol Sabah Forestry Department Title: Preliminary Checklist of Mammals and Birds of Kulamba Field Centre and Nearby Forests in the LKSW
10.20 am	Q&A
10.30 am	Tea Break
10.50 am	Ms Sarifah Rejab (Presented by Ms Syamimi Md. Khalid) SIRIM Berhad Title: Aphrodisiac Potential & Preclinical Evaluation on the Extract of Mangrove Plants in Coastal Area of Sabah
11:05 am	Prof Dr Shin Watanabe Ryukyus University, Japan Title: Preliminary Survey to Set Up a Long-Term Mangrove Monitoring Site and to Establish a Transcriptome Database for Primary Mangrove Species in Sabah
11:20 am	Prof Dr Abd Hamid Ahmad Universiti Malaysia Sabah Title: Wild Cattle in the Wetlands – is the Bornean Banteng a Distinct Species?
11:35 am	Dr B. Mabel Manjaji Matsumoto Universiti Malaysia Sabah Title: Taxonomic Notes on Fishes of the Lower Kinabatangan-Segama Wetlands, Ramsar Site
11:50 am	Dr Tohru Naruse Ryukyus University, Japan Title: Decapod Crustaceans in the Mangrove Ecosystems Around Sandakan and LKSW, Sabah
12:05 pm	Dr Arthur Chung Sabah Forestry Department Title: Insect Diversity of Tundon Bohangin, Sabah
12.20 pm	Q&A
12.30 pm	Lunch
1.30 pm	Ms Guslia Lahasing Sabah Wetlands Conservation Society Title: KK Wetlands Towards its Ramsar Status
1.50 pm	Ms Irmadiana Ardi Forest Department Sarawak Title: Sharing of Experience, Management and Conservation of Kuching Wetlands National Park – Ramsar Site
2.10 pm	Professor Dr Fadzilah Majid Cooke Universiti Malaysia Sabah Title: Where are the People in the Ramsar Wetlands of the Lower Kinabatangan and Segama Rivers of Sabah?
2.30 pm	Q&A

CLOSING CEREMONY	
Time	
3.30 pm	Arrival of The Honourable Dato Sri Dr Hj Wan Junaidi Bin Tuanku Jaafar, Minister of Natural Resources and Environment, Malaysia
3.40 pm	Report by Session Chairpersons • SEARRP Supported Science (Impacts of Forest Fragmentation & the Importance of Connectivity) • SEARRP Supported Science (Sustainability & Development in Oil Palm Landscapes) • Ridge to Reef Initiatives (Forever Sabah) • Ridge to Reef Initiatives (Sabah 100% CSPO) • Sabah's Ramsar Conference
4.10 am	• Closing Speech by the Honourable Minister of Natural Resources and Environment • Presentation of Souvenir • Tour of the Exhibition / Refreshments / Press Conference
5.00 pm	Tea Break
5.30 pm	End of Conference

2.0 ORGANIZING COMMITTEE

The Organizing Committee for the Sabah Forestry Department's HoB International Conference and Sabah's Ramsar Conference 2015.

MAIN COMMITTEE

Front from left: Harith Ali, Samit Abd. Sani , John Angelo, Dr. Lee Ying Fah, **Datuk Sam Mannan (Chair)**, **Frederick Kugan (Secretary General)**, Chak Chee Ving, Mashor Hj. Mohd. Jaini, Wilfred Jilimin

Back from left: Heidi Henry William, Siti Zubaidah S. Abdullah, Michelle Yap Sue Sem, Yong Szu Cherng, Magdelina Maikas

Not in the picture: Fidelis Bajau, Rahim Sulaiman, Albert Radin, Masniah Hj. Othman, Kinus Mais, Noorhaneem Shahrain, Ahmad Saibi Hj. Zulkepli, Hj. Mohd Salleh Hj. Abbas, Mohd. Amzari Mohd Yusof

SECRETARIAT

Front from left: Siti Zubaidah S. Abdullah, Heidi Henry William, Michelle Yap Sue Sem, Hj. Mohd Salleh Hj. Abbas, **Frederick Kugan (Head),** Ahmad Saibi Hj. Zulkepli, Osman Bangkong, Yong Szu Cherng, Amelia Cynthia Bosi

Middle from left: Hjh. Mariam Hj. Dino, Malina Kulenting, Cecilia Garcia, Potia Ebin, Sitiana Kunching, Nurul Aqidah I., Andi Maryani A. M.

Back from left: Danil Samir, Aliff Sumino, Shani Hj. Yusof, Ereanah Tuarah, Monica Chang, Dg Nurzaza Hj. Ag. Hamzah, Angeline Karolus, Norlisah Saiman, Noor Azmizah Andaman

Not in the picture: Christopher A. Matunjau, Zuridah Jeragan, Mohd Amzari M. Yusof, Mohd Azman Othman, Mohd Nasrul Omar, Hon Wai Kong, Shim Yee Fong, Nurzaili Ali, Rita Garcia, Fatimah Johan@Jesudass, Samanja Salasim, Hamjah Sumo, Mohd Asma, Sudiknoh Maksut

EXHIBITION

Front from left: John B. Sugau, Dr. Arthur Y. C. Chung, Chak Chee Ving, **Albert Radin (Head)**, Pilis Malim, Ricky A. Martin, Eyen Khoo
Middle from left: Andi Maryani Andi Mustapeng, Yong Szu Cherng, Dr. Joan T. Pereira, Noor Azmizah Andaman, Fong Pek Yee, Elne Bethrece Johnlee, Sitti Khadizah Abdul Kadir, Suzana Sabran
Back from left: Mohamad Jumri, Mohd Azman Othman, Ahmad Harun, Hj. Hussin Tukiman, Kelvin Pang, Nigel Edward, Shim Yee Fong, Dr. Reuben Nilus, Ezli Kuang Yu Hj. Tujoh
Not in the picture: Afendi Suraip, Musa Salleh, Alexander Hastie, George Hubert Petol, Peter Lagan, Maria Ajik, Esther Dyi Ka Mei, Richard Majapun, Michelle Yap Sue Sem, Shafie Abu, Mohd Amzari Mohd Yusof, Hj. Abdul Samah

RAPPORTEURING, PROGRAMME BOOK & COMPILATION

Front from left: Maria Ajik, Dr. Joan T. Pereira, Dr. Arthur Y. C. Chung, **Dr. Lee Ying Fah (Head)**, Rosila Anthony, Andurus Abi, Musa Salleh
Back from left: Heidi Henry William, Siti Zubaidah S. Abdullah, Andi Maryani Andi Mustapeng, Lee Ka Han, Noor Azmizah Andaman, Kelvin Pang, Monica Chang, Kuina Kimjus, Elne Betrece Johnlee, Nurul Aqidah Ibrahim, Suzana Sabran
Not in the picture: Dr. Chey Vun Khen, Dr. Robert Ong, Dr. Reuben Nilus, Alexander Hastie, Eyen Khoo, Julsun @ Joseph Bin Sikui, Siti Masturah Norbeh

EVENT & PUBLICITY

Front from left: Salbiah Mohammad, Roslan Lalete, **Masniah Hj. Othman (Head)**, Magdelina Maikas, Azizah Landa
Back from left: Harith Ali, Dzulkifli Hj. Sanip, Nigel Edward Datu Balanjiu, Roddin Dilim, Rizuan Ngan Bun Kun, Ezli Kuang Yu Hj. Tujoh
Not in the picture: Marianah Othman, Noorsiah Hj. Ali, Osman Saibul, M Nasir Muin, Liaw Khin Hiung

POST CONFERENCE TOUR

Front from left: Cecilia Gawid, Daphne Robert, Awangku Effendy Pg. Mahmud, **Mashor Mohd. Jaini (Head)**, Nelly Undih, Sitti Khadizah Abd Kadir
Not in the picture: Roslan Abdillah, Azman Said, Salleh Intang, Shafie Abu, Hamidah Bujang, Nor Sabariah Jamalludin, Jannet Hilarius, , Ag. Junidih Ag. Ali

SAFETY & SECURITY

Werfred Jilimin (Head), Isgau Abdullah, Gerry Husrin, Jefry Lundu, Suhaidi Karim, Georgy Marcus, Abdullah Arshad

LOGISTICS

Front from left: Zubaidah Kaffle, Jumaiyah Abdullah, Easter HF Jubilee, Idris Md Jair, Bernard Valentine, **Kinus Mais (Head)**, Mazlan Dullah, Maidin Haris, Bilma Ismail, Awang Yusof, Awang Jaya Jabail, Mohd Fitrinizam Ezanee

Not in the picture: Sulaiman Asmat, Ismail Usin, Mohd Norzam Mohd Zaital, Osman Amat, Julkipli Nor Hussin, Ag. Yussop Ag Ahmad, Mohd Jepry Mohd Nuruddin, Abu Bakar Madali, Muhd Taupek Abdurahman, Amran Asli, Hassin Pupong, Mustapa Awang, Mohd Nazri Abd Rahman, Ibrahim Hassan, Michael Garcia, Masrum Sahdan, Armizi, Azrin, Surijansa Idris, Asnan, Rosman Duraman

USHERETTES & PROTOCOL

Front from left: Florence A Paulus, Nanidah Raman, Salbiah Mohammad, Shauna J. Silveo, Simah Amat

Back from left: Mary Kulenting, Noraini Kassim, Harbayah Mohammad, Norfaizah Amir, Jinah Ginoh, Aileen Nichol

Not in the picture: Masniah Hj. Othman (Head), Jennifer Amora, Nor Salbiah Sahat, Roslinde Jampan

LANDSCAPING & BEAUTIFICATION

Front from left: Kardi Nuin, Masrin Nasib, Ajahari Sampara, Kuil Sinti

Back from left: Asan Asin, Terney Duncan Kinajil, **Norsidi Mohd Kamdi (Head)**

Not in the picture: Yusop Baharun, Sawal Kontrik, Labily, Rizal, Ali Abdul Rahman, Rami Ahad

3.1 WELCOMING ADDRESS BY THE DIRECTOR OF SABAH FORESTRY DEPARTMENT, YBHG DATUK SAM MANNAN

Deanna, (5) beautiful dancing girls, ushering me, bidding at my feet?

All, at my will, call and fancy?

That is the life! Some people have all the luck!

Bismillahirrahman Nirahim.

Thank you Madam MC, the lovely Deanna, I will concede that.

The Right Honorable Chief Minister, Datuk Seri Panglima Musa Haji Aman, it is always a pleasure, Sir, to have you at our function, that re-enforces support at the highest level, to make things happen, here, in Sabah. You are on the right side of history, the world will acknowledge that.

Ladies and Gentlemen, if the momentum for progress in conservation and sustainable development is perceived by many, as progressive here in Sabah, the reason is leadership – leadership at the highest level. Pure and simple!

For that, we have to thank the Chief Minister.

The 5th Prime Minister of Malaysia, YABhg Tun Abdullah Haji Ahmad Badawi, Advisor to Tropical Rainforest Conservation and Research Bhd, YABhg Tun Jeanne Abdullah, Chairman, Tropical Rainforest Conservation and Research Bhd, Honorable Speaker of the State Assembly, Honorable Deputy Chief Minister, Honorable Ministers of the Federal and State Cabinets, the Honorable State Secretary, His Excellency, the Ambassador of Norway, Deputy Ministers, Deputies to the State Secretary, Under Secretary of the Ministry of Natural Resources and Environment, Speakers and experts, invited guests, Tan Sri – Tan Sri, Datuk – Datuk, the timber and tourism industry, NGOs, participants, the media, ladies and gentlemen.

Welcome to the HoB Conference of the 7th series and our inaugural Conference on the Ramsar Wetlands of the Lower Kinabatangan and Segama.

The two conferences have brought together a record number of participants, specialists and speakers from all over the world this time, including the USA, Austria, Japan, India, South Africa, Australia, the United Kingdom, New Zealand (by the way, the Kiwis beat the Aussies by a margin of 100% - in World Cup Rugby, truly whacked, well done.), friends from Canada, France, the Netherlands, the Philippines, Malaysia and even Robert Mugabe's Zimbabwe – African Voices! It seems the HoB has now spread to Africa.

We also have representatives from foreign governments, including, the Ministry of Primary Industries of NZ and the Rajaratnam School of International Studies, Singapore, and of course, His Excellency, the Norwegian Ambassador – he is bringing money to Sabah. Thank you all, for taking time to listen to stories about Sabah, and how we can learn from the world to move forward.

Ladies and gentlemen, this concept of the HoB, for my money, is the most important idea, that has emerged, to ensure the survival of arguably, the world's most important, old world tropics forests, on the island of Borneo. 1% of the world but 6% of its bio-diversity. We must keep them alive.

The forests on this island are under great threat of disappearing. In terms of peril, South East Asia, including the 3 countries that cover Borneo, has the highest capacity to kill and destroy: not Africa, not South America, but this place, we call home.

It is therefore, only appropriate that we acknowledge the role of WWF, that first thought of this concept, the HoB, whispered it softly into the ears of people who can make a difference, and Lo and Behold, the signing of the HoB agreement in 2007, in Bali.

Clever people of the WWF create an idea, make the listeners feel it is theirs, and then support the new owners. This is called influence, or the work of sorcerers, magicians and witches! Burn them on the stake!

But are we worthy of this ownership?

This is the 7th Conference. Is the HoB working? Or Is this just a gallery for me to amuse myself? Be an actor!

Ladies and gentlemen, if the Forestry Department of Sabah, defines itself by what it is and not by what it does, (Learned that from batman), my head would have been chopped off long ago, for good measure, by the Chief Minister himself.

So Mr Mannan, what has Sabah been able to do, piggy riding on the HoB?

The answer is exhaustive and so please, just let me highlight some of the achievements.

I. The totally protected areas of Sabah (the TPAs) were 864,182 ha (11% of Sabah) in 2007 when the HoB was launched and it is 1.56 million ha today or double, (21% of Sabah), rising further to 1.78 million ha (24%) before the year end, with the creation of some 220,000 ha of newly protected forests, largely in the lowlands. The final journey is 30% of Sabah or 2.2 million ha which I believe is achievable. There is no HoB without legally protected forests. The IUCN guideline is 10% - we intend to exceed that by 200%.

II. 75% of Sabah's Orang-utan population of 11,000 or so, are protected in FSC certified forests or totally protected areas – no worries there! They are not burnt to death.

III. Short term licenses that do great harm, have been phased out to a trickle. Soon, the 3-4 remaining, not exceeding 5000 ha in forest reserves will be extinct. Critically endangered species – let them die.

IV. Forest restoration and tree planting has exceeded 550,000 ha. and plantation timber production is about to exceed natural forest production for the first time.

V. Not less than 30,000 ha. of natural forests are treated/restored/tended each year.

VI. Corridors and connectivity have been addressed with the most vital forests (Danum. Imbak and Maliau), connected through a 500,000 ha ecological corridor – biggest eco-zone in one contiguous area in Malaysia.

Anyway, to add icing to the cake, today, we have 2 important events to celebrate, in the interest of conservation. i.e. the industry responds to conservation.

I. Firstly, Mr Liew Pin Cheong, the owner of a highly valuable piece of forested land, is donating about 460 ha (over 1110 acres) to connect Tabin with Kulamba Wildlife Forest Reserves. This land is worth RM20 million in the market – USD$4.8m today, and maybe USD$6m tomorrow.

II. And secondly, TSH Resources Bhd is carving out 28,375 ha of largely virgin forests from their FMU concession to be re-classified as a totally protected forest – Class One. They have taken the cue from the Sabah Foundation and Sapulot Forest Development, 2 licensees, who earlier on led the way.

Ladies and gentlemen, these are historical decisions and this can only happen if the donor trusts the intentions of the proponent – in this case, the Government of Sabah, and ultimately the Chief Minister. Mr Liew Pin Cheong and Datuk Kelvin Tan, don't worry, your endowments are in good hands. Congratulations for choosing the public good.

And complete trust can only come about with reputation – which has to be earned, not demanded, and must be protected at all costs.

I believe all these generous and enlightened donors deserve applause.

Chief Minister, ladies and gentlemen, with the presence of many rich countries that are here today, let me remind them that conservation comes with sacrifices at a great cost – for e.g., the cost of this thing, called "political expediency", the opportunity cost of not liquidating a ready-made resource, (so easy), the re-structuring of industries, losses and gains in employment, reduced revenue, cost of forest restoration, making unpopular decisions, etc., etc.

Assistance must therefore, promote good behavior and not to reward juvenile delinquents. Billions of AL CAPONE type reward schemes have recently gone up in smoke, literally! Unfortunately, some people give money on the basis of one's threat, one's intimidation and blackmail points: Al Capone – Life Bonus Points! For Blackmail! No time limit!

Sabah finds difficulty in getting funding because we are perceived as trying to be "Goody Goody", Miss Molly! I can guarantee you fresh oxygen – 24/7, not just for 9 months. So, where is the reward? I want it now! Or we can easily become Super Rogues by midnight today. Punish bad behavior – you must. Otherwise, you are sending confusing signals.

But Love and platitudes alone for Conservation, Ladies and gentlemen, is not enough. Not good even if it feels good! It must be *Love for Sale!* There must be a change in the attitude of countries that finance conservation. Otherwise, Fools Win!! And you will also look like Fools. Bodoh! Bodoh!

Nevertheless, in addressing the global concern on tropical forest security, we continue to engage with the world and attempt to learn from countries that are successful – whether they give us money or not!!

The department's recent trips to NZ, the land of the Hobbits and Singapore for e.g., opened up our minds even more. Such small countries truly punch above their weights with their trademark of innovation, creativity, resilience, steely determination, intelligence, and serious attention to implement: get the job done and now! No time to waste. Just do it!

So, we shall emulate them and try to move faster. Crack the whip! Knowledge not translated into actions is after all, no knowledge at all. Inflict pain if need be. Remember, what does not kill you will make you stronger. And If you make mistakes, so what? Try again or else, ask for forgiveness later! Beg for mercy.

Ladies and gentlemen, on the Ramsar Project, I shall not elaborate as the speakers will do that. Needless to say, we have the biggest wetlands in this country, with over 340,000 ha of mangroves alone, used in a conservative manner, largely protected and preserved. We now have to move to the next level and tap into their environmental services potential, translated into dollars and cents and the Reminbi.

On the subject of water, its importance and capacity, as a vital life support system will remain, so long as the HoB concept does not fail in Sabah. I believe, despite the threats of climate change, El-NINOs etc., we will be able to mitigate against the worst effects of threats, against our watersheds and wetlands, if we continue with our present trajectory. Failure is not an option.

On the outlook for conservation and forest management in Sabah, ladies and gentlemen, mark my words, I promise you this, today, 11.11.2015, at 9.30 am, I predict that in 10 years' time, Sabah will not only be rich in the green capital stored in protected forests, but also the cash flow from a timber industry and the value of environmental services to be generated in the future and translated into real money in a sustainable manner.

This is because, one gets rich not by earning more and more, but by saving more and more. Warren Buffet whispered that to me. So, save, save and save! But at the same time, remember that, conservation is like war and in war, a few must die for the many to live: you cannot save all but you cannot use all either! There has to be a balance.

And why are we doing all these? James Bond was once asked whether it was for England that he did what he did? He answered, it was for himself, not England. In our case, it is for Sabah, but not for England.

And before I end my speech, there is this other thing, I learned overseas, recently, called "the motherhood statement" and in the case of Sabah, our motherhood statement is: *The Greatest Good For The Greatest Number In The Long Run"*.

And what are we trying to protect? (Video clip).

With that, the Right Honorable Chief Minister, the Architect of Conservation In Sabah, Datuk Seri Panglima Musa Haji Aman, who came, in the nick of time, to introduce reforms, once again, thank you very much Sir, for gracing this occasion. And the vital support you have rendered us.

To the organizing committee, headed by Deputy Director, Dr. Frederick Kugan, Master of the HoB, 'Lei Hei Tok Kalu', well done, it means, for again, planning and executing a great event. You will be rewarded and paid your weight in Gold – I promise – the Pirates of the Caribbean have promised. Part of their CSR!

Ladies and gentlemen, thank you very much for listening to me and I hope you enjoy the conferences. Good morning!

3.2 ADDRESS BY THE CHIEF MINISTER OF SABAH, YAB DATUK SERI PANGLIMA MUSA HAJI AMAN

I am honoured to join you here this morning at the opening of the International Conference on Bridging Heart of Borneo (HoB) Landscapes and Beyond through Healthy Watershed Corridors. As we know, Malaysia is one of the world's few mega-biodiversity hotspots. In Sabah, our tropical rainforests are of immense value, extraordinary beauty, and are havens for a great number of plants and animals.

The abundance of species is a natural capital that sustains our environment and the life-support systems that provide us food, water and economic benefits. We depend on well function systems for our very existence and to meet our goals for sustainable economic development. Hence, it is of utmost importance that our natural resources and biodiversity are safe guarded as natural capital for the benefit of current and future generations.

Malaysia's main approach to conserving its natural ecosystems is through protected areas. For the terrestrial ecosystems in Sabah, I am pleased to note that to date, over 21% of the state's land are gazetted as Totally Protected Areas (TPAs), arguably the largest in Malaysia. This percentage exceeds the International Union for Conservation of Nature target of 10% and even the Convention on Biological Diversity target of 17% of various types of ecosystems. We are on track to expand the size of our TPAs to 30 % of Sabah's land mass within a decade.

Both the federal and state governments are placing effort in the conservation of natural ecosystems and biodiversity. This is reflected in the government's commitment to various initiatives such as the Heart of Borneo and the Ramsar Convention on Wetlands. Malaysia's commitment on biodiversity management is strengthened through our involvement in various multilateral environmental agreements and regional conservation initiatives.

The Sabah State Government through the Sabah Forestry Department has always been committed to the Heart of Borneo initiative and has in fact designated about four million hectares of the state's landmass, mainly comprising important inland and highland forest ecosystems, as part of this programme. The initiative is very much in line with the mission of the Sabah Forestry Department to effectively plan and implement the management of the state's forest resources in accordance with the principles of sustainable forest management, incorporating biodiversity conservation.

HoB member countries recognize the interconnection of forests, wetlands and coral reefs, and the necessity to maintain ecological corridors between terrestrial and marine biodiversity. The health of watershed corridors between the HoB landscapes and reefs are vital to ensure that clean water reaches the people, and also to wetlands and marine ecosystems where wildlife is abundant. Likewise, lakes, rivers, streams and wetlands within HoB landscapes and beyond are indispensable for supporting life, and must be conserved and restored. The earthquake in June this year has not only affected livelihoods of those living within and adjacent to the highlands of Mount Kinabalu, but has also severely affected rivers and water sources. While this was a natural disaster, we should learn that poor management of resources could adversely affect our environment.

Another contribution towards the success of Sabah's efforts in conservation is the commitment to the Ramsar Convention on Wetlands. There are six Ramsar sites in Malaysia and the Lower

Kinabatangan-Segama Wetlands in Sabah is the largest, covering three forest reserves. A 10-year management plan has been jointly formulated by the State Government through the Sabah Biodiversity Centre, Natural Resources Office and Forestry Department in collaboration with Japan International Cooperation Agency (JICA) to manage this site.

This conference aims to look into bridging HoB landscapes and beyond through healthy watershed corridors. You are here to deliberate, demonstrate and to identify synergies on existing initiatives related to watershed conservation within ecological corridors from HoB landscapes to the sea, that bring beneficial outcomes for the well-being of the people in Sabah and those within this region. I am pleased to learn that the conference will cover the South East Asia Rainforest Research Partnership (SEARRP) initiated by The Royal Society, the work of Forever Sabah under the Ridge to Reef approach, and the introduction of the Certified Sustainable Palm Oil (CSPO) jurisdictional approach in addressing sustainable practices in the palm oil palm sector.

I wish to take this opportunity to reiterate Sabah's commitment on sustainable development. We took a bold step by approving the CSPO jurisdictional approach for Sabah at the Cabinet meeting last month, as announced recently. Although a significant contributor to the economy, palm oil has a large footprint and is commonly linked with habitat loss and wildlife conflicts. As a responsible government, we need to strategize and build resilience to ensure our main industry remains relevant and highly competitive in future. We believe this can be achieved through jurisdictional certification and we are prepared to work with stakeholders, such as the Roundtable on Sustainable Palm Oil (RSPO) to explore ways in ensuring that palm oil produced and processed in Sabah is in full compliance with certification standards. This, however, must be done in a pragmatic, practical and implementable manner as to provide our growers, especially smallholders, credibility and assurance in global markets. Sabah must be rewarded for doing good and I hope we will receive support for this very important commitment.

Although much has been achieved, we will not be complacent. Sabah will continue to adopt best practices in natural ecosystem management and biodiversity conservation. We also value the need to have wide stakeholder participation, and for this reason we adopt partnerships at the local and international levels as part of our efforts to institutionalize the conservation and management of natural ecosystems. The MoUs that are about to be entered with various organisations this morning, is a testament for such engagements.

In conclusion, I take this opportunity to congratulate the Sabah Forestry Department under the leadership of Datuk Sam Mannan and his capable team for staging this important conference to deliberate on the Heart of Borneo and Ramsar in Sabah, bringing together various parties and individuals.

I hereby declare this 2-in-1 conference open and I wish you all a fruitful and meaningful conference.

Thank you.

ORAL PAPERS

ORAL PAPER 1

AN OVERVIEW OF LOWER KINABATANGAN-SEGAMA WETLANDS (LKSW) RAMSAR PROJECT IN SABAH

Haji Hussin Tukiman, Mohd Amzari Yusof & Haji Abdul Samah Sapni
Sabah Forestry Department

Tuan Hj. Hussin Tukiman has been the District Forestry Officer (DFO) of Kinabatangan since 2005. Started his career with Sabah Forestry Department as Research Assistant from 1982-1984, he was later appointed as a lecturer at the Sabah Forestry Training Institute from 1988-1993, and was transferred to Kota Kinabalu as Assistant DFO from 1993-1997. He moved to SFD Headquarters, where he was appointed as a Planning Officer in 1998 (for 2 years). From 1999-2002, he was transferred to Tongod (for 2 years) and Kota Marudu (for a year) to head the forestry districts. He holds a B.Sc. and M.Sc. from UPM, Serdang, on Forest Management.

Abstract

This paper provides an overview of the Lower Kinabatangan-Segama Wetlands (LKSW) Ramsar Project in Sabah. The site was officially designated as Sabah's first and Malaysia's largest Ramsar Site at the 10th Conference of the Contracting Parties of the Ramsar Convention on Wetlands (Ramsar COP10) in Korea in October 2008. Extending over 78,803 hectares of mangrove forests and peat swamps located on the east coast of Sabah, the site comprises three forest reserves: Trusan Kinabatangan Forest Reserve (40,471 ha), Kulamba Wildlife Reserve (20,682 ha), and Kuala Maruap-Kuala Segama Forest Reserve (17,650 ha). The development of a management plan for the Lower Kinabatangan-Segama Wetlands was initiated in November 2008 under the Phase II of the Bornean Biodiversity & Ecosystems Conservation (BBEC) Programme, which was a joint effort by the State Government of Sabah, Federal Government of Malaysia and Japan International Cooperation Agency (JICA). The plan was designed for the period of 10 years, from 2011 to 2020.

1. GENERAL INTRODUCTION

1.1 Introduction to the Site

The site lies along the east coast of the state of Sabah. It is mainly within the administrative district of Kinabatangan, with the northern tip under the administrative district of Sandakan. The nearest large town is Sandakan, which lies to the northwest of the site. The main access to the site is by boat. Alternatively, some parts of the site could be reached by oil palm estates road network.

Total area of LKSW Ramsar site is approximately 78,803 hectares (ha); comprising the three Forest Reserves: Trusan Kinabatangan Forest Reserve (40,471 ha), Kulamba Wildlife Reserve (20,682 ha), and Kuala Maruap and Kuala Segama Forest Reserve (17,650 ha). Thus, LKSW emerges as the largest Ramsar site in Malaysia.

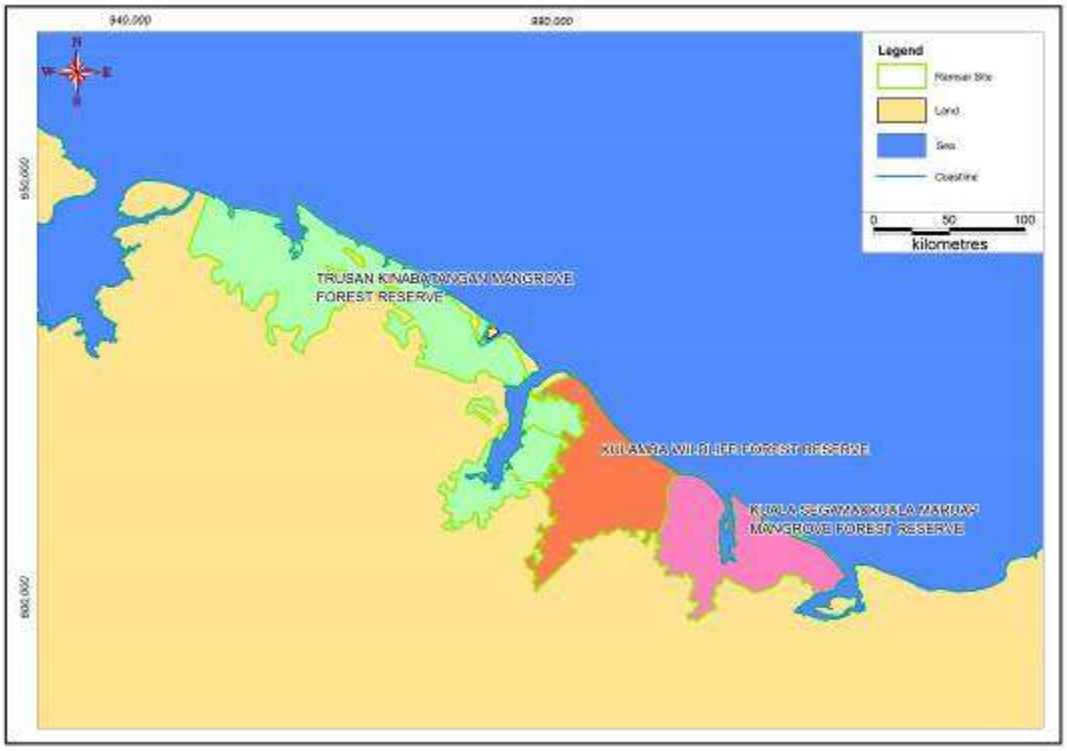


Figure 1: The three forest reserves of the LKSW Ramsar site.

1.2 Designation of LKSW as a Ramsar Site

Malaysia is a signatory to the Ramsar Convention. Upon joining the Ramsar Convention, each Contracting Party is obliged to designate at least one wetland site for inclusion in the List of Wetlands of International Importance (the so-called Ramsar List). In October 2008, the Lower Kinabatangan and Segama Wetlands, comprising three forest reserves as stated in 1.1, was designated as a Ramsar site at the 10th conference of parties (COP10) of the Ramsar Convention held in Changwon, South Korea.

The LKSW is Sabah's first Ramsar site, and sixth (see Table 1) and the largest in Malaysia. LKSW is the 1,849th Ramsar site in the world.

Table 1: List of Ramsar sites in Malaysia.

No	Ramsar Sites in Malaysia	State	Area (Ha)	Date of Designation
1	Tasek Bera	Pahang	6,150	10th November 1994
2	Pulau Kukup	Johor	647	31st January 2003
3	Tanjung Piai	Johor	526	31st January 2003
4	Sungai Pulai	Johor	9,126	31st January 2003
5	Kuching Wetland	Sarawak	6,610	8th November 2005
6	Lower Kinabatangan Segama Wetlands	Sabah	78,803	28th October 2008

The project to designate LKSW as Wetland of International Importance was the outcome of Bornean Biodiversity & Ecosystems Conservation Programme Phase II (BBEC II) in Sabah, Malaysia. BBEC Programme is a joint technical cooperation among the Sabah State Government, Malaysian Federal Government and Japan International Cooperation Agency (JICA) under Japan's Official Development Assistance (ODA). The BBEC Programme assisted the development of an integrated and durable system for biodiversity and ecosystem conservation in Sabah. This state-wide conservation system allowed a smooth operation of adaptive management based on the concept of ecosystem approach.

River basin management (Ramsar designation) was regarded as one of the pilot actions to strengthen the capacity of inter-agency cooperation of the Sabah State Government (Natural Resources Office and Sabah Biodiversity Centre). Both agencies coordinate all activities under a single framework, which strengthen the conservation governance of Sabah. A strategy to use international recognition as a common incentive appeared effective and productive where stakeholders agreed to work towards certification of a wetland ecosystem under the Ramsar Convention.

1.3 The LKSW Criteria for Designation

There are nine (9) criteria of which an area could be considered as wetland of international importance (**Annex 1**). The area should fulfill at least one criterion to qualify as a Ramsar Site. LKSW fulfills Ramsar criteria 1, 2, 3 and 8.

1.3.1 Criterion 1:

LKSW is a particularly good representative example of natural coastal mangrove, brackish and peat swamp forest systems, characteristic of the Indo-Malayan Realm. The peat swamp forest within the site is dominated by *Lophopetalum multinervium* (local name: *perupok*), a unique natural peat swamp forest association found only in the eastern part of Sabah. The site protects the largest remaining contiguous block of mangroves in Malaysia, and possibly in the southern Sulu Sea region.

1.3.2 Criterion 2:

LKSW supports 25 species of fauna and 9 species of flora which are listed in Appendices I or II of the Convention on International Trade in Endangered Species (CITES), and/or in the 2007 IUCN Red List of Threatened Species.

Mammals:

i. Sumatran Rhinoceros *Dicerorhinus sumatrensis harrisoni* (Bornean subspecies) – Appendix I; Critically Endangered.
ii. Proboscis Monkey *Nasalis larvatus* – Appendix I; Endangered.
iii. Tembadau (Banteng) *Bos javanicus* – Appendix I; Endangered.
iv. Borneo Pygmy Elephant *Elephas maximus borneensis* (Bornean sub-species) – the Asian Elephant *Elephas maximus*: Appendix I; Endangered.
v. Orang Utan *Pongo pygmaeus morio* (Northeast Bornean sub-species) - Appendix I; Endangered.
vi. Bornean Gibbon *Hylobates muelleri* - Near Threatened
vii. Long-tailed Macaque *Macaca fascicularis* - Near Threatened
viii. Pig-tailed Macaque *Macaca nemestrina* - Vulnerable
ix. Hose's Leaf Monkey *Presbytis hosei* – Data deficient
x. Red Leaf Monkey *Presbytis rubicunda* – Lower Risk
xi. Silvered Leaf Monkey *Trachypithecus cristatus* – Near Threatened
xii. Malayan Sun Bear *Helarctos malayanus euryspilus* (Bornean sub-species) - Data deficient
xiii. Marbled Cat *Pardofelis marmorata* (unconfirmed record) – Vulnerable
xiv. Bornean Clouded Leopard *Neofelis diardi* (Bornean endemic) – the Clouded Leopard *Neofelis nebulosa* Appendix I; Vulnerable.
xv. Hairy-nosed Otter *Lutra sumatrana* - Vulnerable
xvi. Smooth Otter *Lutra perspicillata* – Vulnerable
xvii. Binturong *Arctictis binturong* – Lower Risk

The Sumatran Rhinoceros *Dicerorhinus sumatrensis harrisoni* (Bornean subspecies) has been recorded several times in the Kulamba Wildlife Reserve, and once close to the Segama River. Believed to be fewer than 300 individuals left in the world due to poaching and habitat fragmentation, Sumatran rhinos are critically endangered. Previous estimates suggest that there were 30 to 50 rhinos on the island of Borneo, all in Sabah. Evidence of the Tembadau *Bos javanicus* has been recorded in all parts of the Kulamba Wildlife Reserve with a total population of about 70 animals. Though there is inadequate data at present to estimate the size of the population, it is estimated that the reserve supports the largest density of this specie in Sabah. The Borneo Pygmy Elephant *Elephas maximus borneensis* (Bornean sub-species) is the smallest known sub-species of elephant in the world. DNA analysis conducted in 2003 showed that Asian elephants in Borneo are genetically distinct and may have separated from those in mainland Asia about 300,000 years ago. Less than 1,500 Borneo Pygmy Elephants remain in the wild, mostly in the state of Sabah. This specie has been recorded from the dryland forest and hills in the central and southern parts of the Kulamba Wildlife Reserve, and occasionally in the lower Segama area.

The total estimated population of the Orang Utan *Pongo pymaeus morio* (Northeast Bornean sub-species) is 11,000. Tabin Wildlife Reserve (located to the south of the Ramsar Site), Kulamba Wildlife Reserve and the Lower Segama area are the last stronghold of the specie in eastern Sabah. Proboscis Monkey *Nasalis larvatus* populations have been recorded within the entire Ramsar site. A recent survey concluded that the lower Kinabatangan area, including the Lower Kinabatangan Wildlife Sanctuary and the Ramsar site are the stronghold of the *N. larvatus* population in Sabah, with an estimated population of more than 3,200 animals. This species breeds in the mangrove, riverine and peat swamp forests.

Birds:

i. Lesser Adjutant *Leptoptilos javanicus* - Vulnerable
ii. Oriental Darter *Anhinga melanogaster* - Near Threatened
iii. Chinese Egret *Egretta eulophotes* - Vulnerable
iv. Storm's Stork *Ciconia stormi* – Endangered
v. Rhinoceros Hornbill *Buceros rhinoceros* – Near Threatened
vi. Cinnamon-headed Green Pigeon *Treron fulvicollis* – Near Threatened

Reptiles and Amphibians:

i. Tomistoma (False Gharial) *Tomistoma schlegelii* – Appendix I; Endangered
ii. Estuarine Crocodile *Crocodylus porosus* - Least Concern

Plants (vernacular names in brackets):

i. (Keruing Kasugoi) *Dipterocarpus validus* – Critically Endangered
ii. (Selangan Daun Bulat) *Hopea wyatt-smithii* – Critically Endangered
iii. Light Red Meranti (Seraya tembaga) *Shorea leprosula* – Endangered
iv. (Kapur Merah) *Dryobalanops beccarii* - Endangered
v. (Katong-katong) *Cynometra inaequifolia* - Vulnerable
vi. Agarwood (Gaharu) *Aquilaria malaccensis* – CITES Appendix II; Vulnerable
vii. (Ipil Laut) *Intsia bijuga* - Vulnerable
viii. (Bangkita) *Rhizophora apiculata* – Lower Risk
ix. (Geronggang Biabas) *Cratoxylum formosum* – Lower Risk

1.3.3 Criterion 3:

LKSW is located within one of only two known sites in the world inhabited by ten species of primates: Orang utan *Pongo pymaeus morio*, Proboscis Monkey *Nasalis larvatus*, Slow Loris *Nycticebus coucang*, Western Tarsier *Tarsius bancanus*, Red Leaf Monkey *Presbytis rubicunda*, Long-Tailed Macaque *Macaca fascicularis*, Pig-Tailed Macaque *Macaca nemestrina*, Bornean Gibbon *Hylobates muelleri*, Silvered Leaf Monkey *Trachypithecus cristatus* and Hose's Leaf Monkey *Presbytis hosei*. Four of these are endemic to Borneo: Hose's Leaf Monkey, Red Leaf Monkey, Proboscis Monkey and Bornean Gibbon.

The Storm's Stork *Ciconia stormi* is the second most endangered stork in the world; the Kinabatangan area represents a stronghold in Malaysia. The Crested Toad *Bufo divergens* and Hose's Bush Frog *Philautus hosii* are endemic to Borneo. Of the fish species found in the area, *Labiobarbus sabanus* is known only from the

Kinabatangan and Segama river basins in Sabah; *Kryptopterus parvanalis* only from northeastern Borneo; and *Leptobarbus hosii* only from northern Borneo.

1.3.4 Criterion 8:

The two large rivers, the Kinabatangan and Segama, flow through the site and form important spawning and nursery grounds for fish and prawn species. The Marbled Sleeper Goby *Oxyeleotris marmorata* and the Giant Freshwater Prawn *Macrobrachium rosenbergii* are particularly important protein sources of the local inhabitants. *Macrobrachium rosenbergii* is a freshwater prawn species but requires brackish water for spawning, and the Ramsar site holds one of the largest spawning sites of the species in Sabah.

Among other fish that spawn in the site, species with a high commercially valuable as food source include *Anguilla malgumora*, *Clarias teysmanni*, *Mystus nemurus*, *Mystus sabanus*, *Oxyeleotris marmorata*, *Pangasius macronema*, *Pangasius nieuwenhuisii*, *Pangasius tubbi*, *Puntius bramoides*, *Puntius bulu* and *Puntius sealei*. For ornamental fish, important species are *Nematabramis everetti*, *Osphronemus goramy*, *Rasbora hubbsi*, *Rasbora myersi*, *Rasbora sumatrana* and *Trichogaster trichopterus*.

2. THE RESOURCES OF LKSW

2.1 Forest Resources

LKSW is formed by three different forest reserves from two different forest classification. Trusan Kinabatangan and Kuala Segama-Kuala Maruap Forest Reserves are classified under Class IV while Kulamba Forest Reserve under Class VI. Thus, there are different forest types lying within the site.

2.1.1 Mangrove Forest

This type of forest is the main vegetation within the LKSW Ramsar Site. It covers a total area of 32,274 ha or 40.8% of the site.

It is found throughout the Ramsar site, largely at the northwest and southeast part. This type of forest develops in silt-rich, saline (brackish water) habitats, generally near the coastal and river mouth that are affected by tidal movement of water. The mangrove provides coastal protection and prevents coastal erosion, acting as a natural barrier for storm surges.

Mangrove forest is characterized by low tree diversity, almost exclusively mangroves, with a low broken canopy. Salt tolerant plants, such as *Rhizophora* sp. (bakau), *Excoecaria agallocha* (buta-buta), *Avicennia* sp. (api-api) and *Ceriops tagal* (tengar) can be found in these areas. Of these species, *Rhizophora* sp. is the most dominant species of this forest type in the Ramsar site.

2.1.2 Nipah Forest

Nipah (*Nypah fruticans*) covered 25,486 ha or 32.2% of LKSW total area. This type of forest comprises pure nipah and associate plants which includes patches of mangrove plants, such as *Rhizophora* spp., *Avicennia marina* and *Bruguiera* spp.

This forest type is found in three main locations; on the northwest, southeast and on the centre of the Ramsar site. It mostly grows in soft mud in mangrove areas, usually where the water is calmer, but where there is a regular inflow of freshwater and nutritious silt, as Nipah is not as salt tolerant as *Rhizophora* sp. Associate species in nipah forest are *Bruguiera gymnorrhiza, Bruguiera parviflora, Rhizophora apiculata, Excoecaria agallocha* and *Lumnitzera littorea.* Dungun (*Heritiera littoralis*) is another species found growing together with nipah.

2.1.3 Beach Forest

Beach forest is distributed behind the beaches along the sandy coastlines of Trusan Kinabatangan, Kulamba and Kuala Segama-Kuala Maruap Forest Reserves. The forests are dominated by *Casuarina equisetifolia* and coarse grasses. Secondary species found in beach forest includes marine cycads and screw pines. The total areas of this classification are estimated to be 600 ha or 0.8% of the site.

2.1.4 Coastal Forest

This type of forest is found on the beach wall and it is on low (0.5 – 1 meter) ridges at the inland margin of the sand beach, and sandy ridges inland with a slight marine influence. Coastal forest can be found at the centre and northwest of Ramsar site which occupying about 1,210.66 ha or 1.53% of LKSW Ramsar site. Species that dominates this forest type are *Barringtonia* sp. with associate species, such like *Terminalia catappa* and *Calophyllum inophyllum.*

2.1.5 Peat Swamp Forest

The peat swamp forest is found mainly inside the Kulamba Wildlife Forest Reserve. This type of forest is estimated to be occupying 14,498 ha or 18.3% of the Ramsar site. In this forest type, the canopy can be uniform, but occasionally large gaps of various sizes can be found, and the ground cover is made up of dense sedge and marshy undergrowth. A number of species can be found, such as *Baccaurea* sp., *Campnosperma coriaceum*, *Syzygium* sp., and *Anisoptera costata.*

2.1.6 Freshwater Swamp Forest

Freshwater swamp forest occupies about 134 ha or 0.2% of Ramsar site. Species of trees that can be found in this forest are *Mallotus muticus*, *Alstonia spatulata*, *Excoecaria agallocha*, *Fragrea fragrans*, *Macaranga pruinosa* and *Campnosperma coriaceum*. This forest type can be found at the centre to the southeast part of the Ramsar site and also in small patches in Kulamba Wildlife Forest Reserve.

2.1.7 Lowland Forest

This type of forest can be found in the centre of the Kulamba Wildlife Forest Reserve and in the southeast part of the Ramsar site. It is classified as mixed dipterocarp forest of less than 500 m altitude. The dominant species that found in this area are from the dipterocarp family.

Lowland forest occupies a total of 3,517 ha or 4.5 % of the Ramsar site. Among the species that can be found in this type of natural vegetation are; *Dipterocarpus caudiferus*, *Dipterocarpus acutangulus*, *Shorea leprosula*, *Shorea johorensis*, *Dryobalanops lanceolata*, *Parashorea tomentella*, and *Hopea beccariana*.

2.2 Other Resources

2.2.1 Terrestrial Biodiversity

The variety of vegetation types within the LKSW Ramsar site ensures the suitability as habitats for a wide range of animal species. The vegetation types in the peat swamp have their own unique flora and fauna, including unique fish and bird species. Species from adjoining forests and oil palm estates may enter the dryland forests in the site.

Elephants, orang utans, saltwater crocodiles, bantengs (tembadau), proboscis monkeys, lesser adjutant storks are among the largest and most visible animal species in the site. These animals can all be seen during even a fairly casual visit to the site. The presence of all ten species of primate in LKSW Ramsar site has always been talked about. However, more detailed survey would be required for confirmation.

In 2010, the ngo 'Hutan' has conducted bird survey within the LKSW Ramsar site and identified 58 species; primarily of waterbird, mangrove and related species.

2.2.2 Aquatic Biodiversity

Covering 40.8% of the total area of LKSW Ramsar site, the mangrove ecosystem serves as nursery ground for valuable fisheries resources such as rays, snappers and shrimps.

Mangrove ecosystem is also an important habitat for mud crab. Unlike rays, snappers and shrimps which spawn into open waters, mud crab spent almost entirely their life cycle in the mangroves.

3. THE COMMUNITIES INSIDE AND AROUND LKSW

3.1 The Villagers

There are three (3) villages located within the LKSW Ramsar site namely Kg Mumiang, Kg Pitas and Kg Sri Ganda. Another five (5) villages lies adjacent to the site are Kg Boungon, Kg Abai, Kg Tundun Bohangin, Kg Dagat and Kg Parit.

Social Baseline Survey conducted by the Sabah Forestry Department indicated that majority of the villagers are fishermen. However, more information would be provided later by the consultant who conducted detailed Social Baseline Survey in these villages.

3.2 Tourism Operators

Tourism has developed rapidly within the Kinabatangan area over the last 20 years as high quality experiences with large and unique wildlife quickly attracted tourists.

The industry has gradually brought greater benefits for local communities through employment, training and development of community tourism. Kg Dagat and Kg Abai now have homestay programs that attracted a steady flow of tourists each year. Tourism will be potentially a significant source of income for local residents in terms of jobs, sale or products, and service provision. Kg Sri Ganda has also commenced community-based ecotourism business by adopting the success earned by KOPEL Bhd as an example.

There are also two privately owned resorts one operating within and another adjacent to the site. Kinabatangan Wetland Resort (KWR) is located inside the LKSW Ramsar site. The resort is owned by a family who runs an oil palm estate. Some portion of their revenue from the oil palm business was used to build the resort on their alienated land about two years ago.

Abai Jungle Lodge (wholly owned and managed by S.I. Tours Sdn. Bhd. has been operating tourism business almost two decades ago. The lodge has established a high reputation on tourism industry in Sabah. The resort is situated adjacent to LKSW Ramsar site in front of Kg Abai and separated by Kinabatangan River. The two neighbours are working closely in "Tree Planting Project and Lunch with the Villagers".

3.3 Workers of Oil Palm Plantations

Most of the adjoining land belongs to large oil palm plantations, such as IOI, Malbumi, Hap Seng, Bukit Kretam, Sime Darby and Avicess. The workers of these companies formed the majority of population around LKSW Ramsar site. Thus, these companies are the targets for awareness raising and partnership building in developing collaborative management under the management of the Buffer Area.

4. THREATS AND RISKS

A number of threats and risks were identified for LKSW Ramsar site. The threats and risks are discussed below:

4.1 Forest Fires

Threats of forest fires in the mangrove areas are less to be concerned due to the fact that the volume of litter on mangrove forest floor is lower and regularly inundated. However, fire remains a significant threat both to the dry (sandy soil) coastal and beach forest types, as well as the peat swamp forests that can experience deep burns during extended dry periods.

Kulamba Forest Reserve with beach/coastal forest, and peat swamp forest as major forest types face high risk of fires. The beach/coastal forest on sandy soil are regularly dry, and accumulating dry organic matter as forest floor litter. Regular landing by fishermen on the beaches and lit fires to keep warm, control mosquitoes and cook food has contributed to the potential of these fires to spread.

4.2 Illegal Debarking of Tengar

Some cases of illegal debarking of Tengar (*Ceriops tagal*) were detected in 2009, 2010, 2011 and 2012. A number of vessels were confiscated and the people involved were arrested by the personnel of Sabah Forestry Department with the help of the Malaysian Security Forces. Although there is no more detection of this illegal activity since 2013, the Sabah Forestry Department is beefing up patrolling the areas prone to encroachment.

4.3 Illegal Hunting and Trawling

Kulamba Forest Reserve is a habitat for some key species, such as Tembadaus, Orang Utans and other species. Although reports of hunting are low, there remains potential for ongoing hunting activities given that this is a large area that is difficult for authorities to access. Thus, it is likely that some small scale hunting occurs within or outside the reserve. Any hunting is likely to be damaging to the overall population.

Occasionally, trawling activity occurs within the Ramsar site river system. This fishing activity is a direct threat to fish, marine mammals, and turtles that may utilize the Ramsar site and surrounding waters. The damage of river floor caused by trawling may cause the loss of breeding adults. Overfishing of juveniles will cause changes in the population dynamics of some target species of both finfish and crustaceans. This is a direct threat both the ecology of the Ramsar site, and the economy of the fisheries industry.

Nearshore and offshore water are also utilized by some estuarine and freshwater species for feeding and breeding. Thus, offshore trawling is a direct threat for freshwater sharks, freshwater sawfish, Irrawaddy dolphins and other fishes.

4.4 Global Warming

Increasing sea levels suspiciously as a result of global would have the largest impacts by forcing a retreat of the shoreline. This would result in the loss of large areas of forest, and a reduction in size of the Ramsar site. The increased salinity of the rivers would have an impact on both flora and fauna and require a landward migration of most species. Parts of the Ramsar site are surrounded by private land. Thus, there will be limited opportunity for habitats and species to move with the conditions of the river, resulting in a loss of some species and habitats.

4.5 Competition for Land

The threat of demand for agricultural land leading to calls for conversion of forests within the Ramsar site is considered to be low. This is due to the saline condition of most of the soils, the deep peat soils in Kulamba, and the regular flooding by both salt and freshwater throughout the area.

Although there still application of pocket lands for agriculture in the fringes of the Site, Sabah Forestry Department is working closely with the Land and Survey Department to ensure that the land would not be alienated.

5. THE LKSW RAMSAR SITE MANAGEMENT PLAN

5.1 Management Objectives

The goal of LKSW Ramsar Site Management Plan is to maintain biodiversity and ecological functions, including hydrological regimes, while promoting wise use of the Ramsar wetland.

Below this goal, three Management objectives have been defined as follows:

- To protect, restore and enhance key ecosystem services and environmental values of the Ramsar site; particularly those of regional and global significance
- To develop appropriate and wise use of the wetlands for the betterment of local communities and Sabah
- To strengthen linkages between government agencies, the community and industry in achieving environmental conservation, connectivity, and protection in the Kinabatangan and Segama river basins

5.2 Management Structure for LKSW Ramsar Site

The management plan for LKSW Ramsar site was developed in two volumes; Volume 1 is the Management Plan and Volume 2 the Ramsar CEPA Kit.

The Management Plan includes management objectives and activities not only for the Ramsar site itself but also for the river basins of the two rivers (Kinabatangan and Segama) which flow into the Ramsar site. In the Management Plan, the Ramsar site itself which is composed of the three forest reserves is defined as Core Area, while the river basins upstream together with the sea area surrounding the Core Area is defined as Buffer Area.

5.3 Implementation of the Management Plan

Sabah Forestry Department is obliged to execute the management prescriptions for the Core Area stipulated in the Management Plan. Under the Sabah Development Corridor, the department received a total allocation of RM 2 million for the Research and Development of Lower Kinabatangan-Segama Wetlands. Ministry of Natural Resources and Environment Malaysia has approved RM 2.5 million under Rolling Plan 4 of Malaysian Development Plan 10. The allocations were spent to implement the project as follows:

5.3.1 Infrastructure Development

A field centre which consists of the main building, platform, staff quarters and watch tower equipped with electricity generator set was completely erected and upgraded in 2015. These blocks are connected to each other by boardwalks. The facilities serve as a centre for research, education, monitoring and management. The site at Kg Tundun Bohangin was selected in consideration of the presence of human settlement and General Force of Malaysian Royal Police nearby.

One substation was also built at Kg Sri Ganda. This facility is utilized by field staff of the Sabah Forestry Department for patrolling parts of the Core Area which are accessible by vehicles.

5.3.2 Procurement of High-Powered Boats

Two units of boats equipped with double 2HP engines were purchased specifically for the project. The boats are utilized for long distance travelling through the river system of the Ramsar site and through coastal rough water. LKSW Ramsar site is such a huge area and the service of these boats is of paramount importance.

5.3.3 Demographic Data Collection

The surveys were conducted at the villages located within and around the LKSW Ramsar site. The main purpose was to collect the demographic information of the villages as well as to identify the significant impact to the livelihood of the local communities as a result of the designation of LKSW as a Ramsar site.

Six villages were assessed in 2014 and another three villages in 2015. Final result of the surveys will be presented at the end of the year. The findings from the surveys will be used to enhance the Ramsar Site Management Plan.

5.3.4 Scientific Expeditions

Two scientific expeditions were conducted in 2014 and 2015. The team was led by senior researchers from Sepilok Forest Research Centre. Apart from Sabah Forestry Department experts, the expedition were joined by scientists from University Malaysia Sabah, WWF and Sabah Parks. Scientists from Japan and Australia have also joined the expedition conducted in 2014.

The findings from the two expeditions will be published after the second scientific expedition.

5.3.5 Communication, Education and Public Awareness (CEPA)

CEPA has been one of the main activities conducted primarily to disseminate the objectives and functions of the Ramsar site. Japanese International Cooperation Agency (JICA), Sabah Biodiversity Centre, Rainforest Discovery Centre (RDC), HUTAN, Sabah Wildlife Department, Department of Environment Malaysia, Department of Environment Protection, Department of Education and Kinabatangan District Forestry Office have been instrumental in conducting CEPA activities. The team has conducted numerous talks, workshops and dialogues in the villages and primary schools.

Leaders of villages, school children as well as the members of the security forces based within the Ramsar site were the target groups for the programme.

5.3.6 Safeguarding the Ecological Resources of the Ramsar Site

This programme comprises three activities conducted on daily basis all year round, as follows:

- river patrolling to ensure Core Area is free from encroachment, such as *Ceriop tagal* tree debarking activities.
- coastal and 'hotspots area' patrolling to ensure that there is no illegal hunting activity in the Core Area.
- monitoring activity along the beaches to detect the potential of fire.

5.3.7 Managing the boundaries of the Ramsar Site

Legal boundaries of the Core Area have yet to be demarcated. Therefore, assistance from the land owners has always been sought to determine the boundaries with reference to their surveyed boundaries. Signboards and small plates were installed along the boundaries to deter encroachment.

6. LESSONS LEARNED

6.1 Collaborative Enthusiasm

LKSW was successfully designated as a Ramsar site through participatory and consultative processes and mechanism in numerous committees. It was learned that sharing of information and making collective decisions were effective to strengthen conservation governance. The innovation to use international initiative proved useful in stimulating interests and enthusiasm among the stakeholders to achieve a common target.

The participation of different government agencies equipped with different laws and legislations in managing the LKSW Ramsar site is vital to strengthen governance.

6.2 Management Challenges

Government sector should play important role in the quest for conservation. However, public sector, civil society and others, such as the business sector should also be involved which requires empowerment as a whole. While LKSW Ramsar site is managed under a committee led by Sabah Forestry Department and supported by Core Area Advisory Team, the operational capacity of the committee including technical skills and financial strength is still limited and remains an issue and challenge. Financial as well as technical capacity of the committee should be further strengthened. This is important to ensure the effective implementation of existing Ramsar Site Management Plan.

7. CONCLUSIONS

Designating LKSW as a Ramsar site was once suggested in the past, but it was not materialized at that point of time. Collaborative enthusiasm among the agencies proved to be the key factor in attaining the international recognition.

The size of LKSW Ramsar site (78,803 ha) far exceeded the total size of all existing Ramsar sites in Malaysia (55,355 ha). It was not expected to be an easy task to manage such a large area for a single agency (Sabah Forestry Department). Thus, collaboration among agencies concerned is vital. Opportunity for cooperation towards the common interest as management of such an area would require active joint activities should be created and coordinated. This would contribute to the development of the state conservation governance.

Annex 1: Criteria for identifying Wetlands of International Importance

Under the Ramsar Criteria, wetlands should be selected for the Ramsar List on account of their international significance in terms of the biodiversity and uniqueness of their ecology, botany, zoology, limnology or hydrology. In addition, the Criteria indicates that in the first instance, wetlands of international importance to waterbirds at any season should be included on the Ramsar List.

The Criteria for Identifying Wetlands of International Importance were adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties, superseding earlier Criteria adopted by the 4th and 6th Meetings of the COP (1990 and 1996), to guide implementation of Article 2.1 on designation of Ramsar wetlands. The Criteria set out below, are for identifying wetlands of international importance.

Guidance on the application of the Criteria for identifying Wetlands of International Importance is provide under the Ramsar Convention's Strategic Framework for the List of Wetlands of International Importance, edition 2009.

Group A of the Criteria. Sites containing representative, rare or unique wetland types

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

Group B of the Criteria. Sites of international importance for conserving biological diversity

Criteria based on species and ecological communities

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Specific criteria based on waterbirds

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Specific criteria based on fish

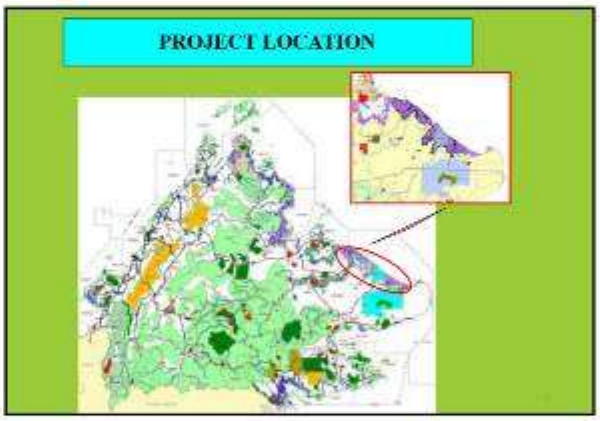
Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

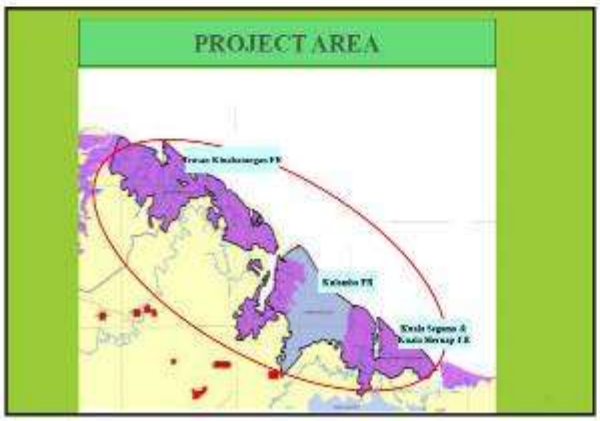
Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Specific criteria based on other taxa

Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Slide Presentation





Name of Reserve	Classification	Forest Type	Area (Ha)
Trusan Kinabatangan FR	Class V	Mangrove Forest	40,471
Kuala Segama & Kuala Merunip FR	Class V	Mangrove Forest	17,650
Kulamba FR	Class VII	Wildlife Reserve	20,682
Total Area			78,803

Designation as Ramsar Site

- An outcome of Bornean Biodiversity & Ecosystems Conservation Programme Phase II (BBEC II) in Sabah
- BBEC: Joint technical cooperation among the Sabah State Government, Malaysian Federal Government and Japan International Cooperation Agency (JICA) under Japan's Official Development Assistance (ODA)

Ramsar Criteria for Designation

- Nine criteria on account of international importance in terms of the biodiversity and uniqueness of their ecology, botany, zoology, limnology or hydrology.
- Divided into 2 groups
- Group A: Sites containing representative, rare or unique wetland types (1)
- Group B: Sites of international importance for conserving biological diversity
  - Criteria based on species and ecological communities (3)
  - Specific criteria based on waterbirds (2)
  - Specific criteria based on fish (2)
  - Specific criteria based on other taxa (1)

LKSW Ramsar Criteria (4)

Criterion 1
Sites containing representative, rare or unique wetland types

LKSW is a particularly good representative example of natural coastal mangrove, brackish and peat swamp forest systems

Criterion 2
A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

LKSW supports 25 species of fauna and 9 species of flora which are listed in Appendices I or II of the Convention on International Trade in Endangered Species (CITES), and/or in the 2007 IUCN Red List of Threatened Species.

Criterion 3
A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

The peat swamps forests (PSF) found in the site are unique in the east coast of Sabah, representing a true natural PSF type which is dominated by *Lophopetalum multinervium* (known locally as perapoh).

The Storm's Stork *Ciconia stormi* is the second most endangered stork in the world; the Kinabatangan area represents a stronghold in Malaysia.

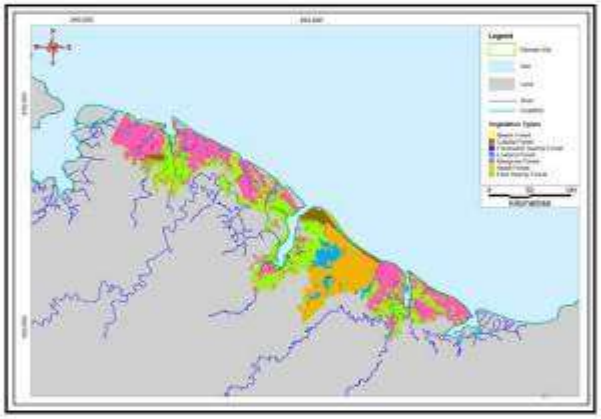
Criterion 8
A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

The two large rivers, the Kinabatangan and Segama, flow through the site and form important spawning and nursery grounds for fish and prawn species

2.0 RESOURCES OF LKSW

2.1 Forest Resources

- Mangrove Forest
- Beach Forest
- Coastal Forest
- Nipah Forest
- Peat Swamp Forest
- Freshwater Swamp Forest
- Lowland Forest



2.2 Other Resources

2.2.1 Terrestrial Biodiversity

- Variety of forest types ensure suitability of wide range of animal species
- Elephants, orang utans, saltwater crocodiles, bantengs (tembadau), proboscis monkeys, lesser adjutant are the largest and most visible animal species in the Site.
- The presence of all ten species of primate in LKSW require more detailed survey for confirmation
- 58 species; primarily waterbirds, mangrove and related species identified by HUTAN in 2010.

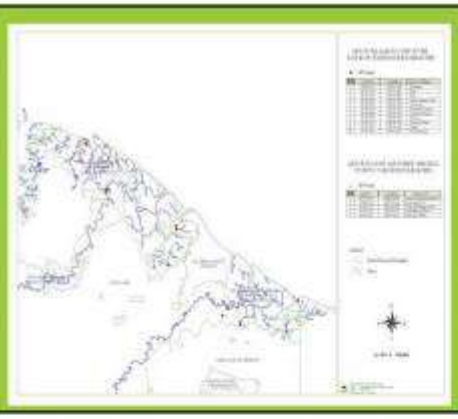
2.2.1 Aquatic Species

- Mangroves covered 40.8% of LKSW Ramsar Site
- The ecosystem serves as nursery ground for valuable fisheries resources such as rays, snappers and shrimps
- an important habitat for mud crabs which spent their entire life cycle in the mangroves.

3.0 THE COMMUNITIES INSIDE AND AROUND LKSW RAMSAR SITE

3.1 The Villages

- 3 villages within the LKSW Ramsar Site, namely Kg Mumung, Kg Pitas and Kg Sri Gasda
- Another five (5) villages adjacent to the Site [Kg Bonggon, Kg Abai, Kg Tandisi Bohangin, Kg Dagat and Kg Parit]
- Villagers are mostly fishermen
- Social Baseline Survey in these villages



3.2 Tourism Industry

- Rapid development of Tourism in Kinabatangan area over the last 20 years.
- brought greater benefits for local communities: employment, training and development of community tourism.
- homestay programmes in Kg Dagat and Kg Abai
- Kg Sri Ganda now follows suit.
- two (2) privately owned resorts - one operating within and one adjacent to the Site.

3.3 Surrounding Plantation

- Most adjoining land belongs to large oil palm plantations such as IOI, Malbumi, Hap Seng, Bukit Kretam, Sime Darby and Avicess.
- Workers of these companies form the majority of population around LKSW Ramsar Site.

4.0 THREAT AND RISKS

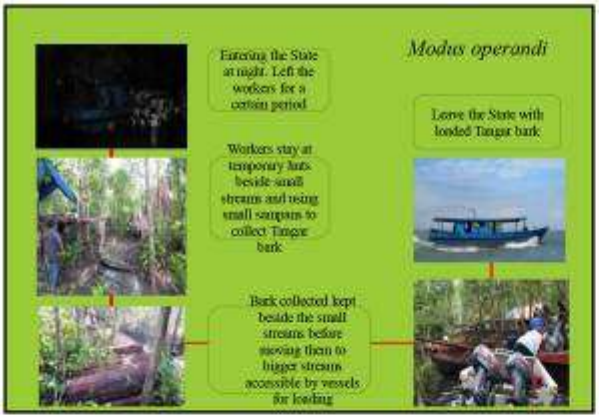
4.1 Forest Fires

- fire remains a significant threat both to the dry (sandy soil) coastal and beach forest types, as well as the peat swamp forests that can experience deep burns during extended dry periods.
- Kulamba Forest Reserve with Beach/Coastal Forest, and Peat Swamp Forest as major forest types face high risk of fires.
- Threats of forest fires in the mangrove areas are of minor concern.

The Beach/Coastal Forest on sandy soil are regularly dry, and accumulating dry organic matter as forest floor litter. Regular landing by fishermen on the beaches and lit fires to keep warm, control mosquitoes and cook food has contributed to the potential of these fires to spread.

4.2 Illegal Debarking of Tangar

- Some cases of illegal debarking of Tangar (*Ceriops tagal*) were detected in 2009, 2010, 2011 and 2012
- Commited by citizens of neighbouring country
- No more detection of this illegal activity since 2013
- The Sabah Forestry Department is beefing up patrolling at the potential areas to be encroached



4.3 Illegal Hunting & Trawling

- habitat for some key species, such as Tembadaus, Orang Utans and other species.
- large area potential for hunting activities
- small scale hunting likely occurs within or outside the reserve.

- Occasionally, trawling activity occurs within the Ramsar Site river system.
- This fishing activity is a direct threat to fish, marine mammals, and turtles that may utilize the Ramsar Site and surrounding waters.
- direct threat for freshwater sharks, freshwater sawfish, Irrawaddy dolphins, etc.

4.4 Global Warming?

- Increasing sea level as a result of global warming
- the largest impact by forcing a retreat of the shoreline.
- resulting in the loss of large areas of forest,
- a reduction in size of the Ramsar Site

4.5 Competition for Land

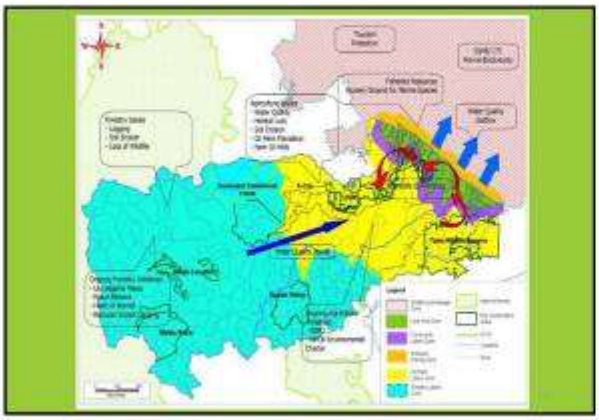
- threat of demand for agricultural land leading to calls for conversion of forests within the Ramsar Site is considered to be low.
- saline conditions of most of the soils
- there is still application of pocket lands for agriculture in the fringes of the Site,

4.6 River Pollution

- Water quality considered as a primary issue

5.0 LKSW RAMSAR SITE MANAGEMENT PLAN

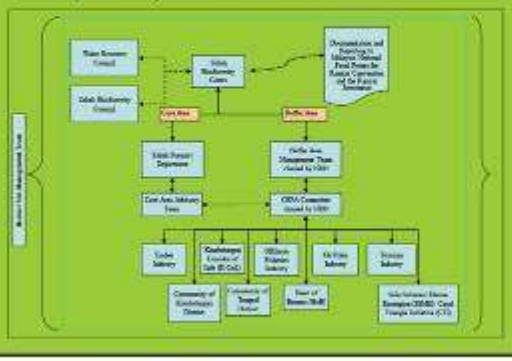
- Management Goal:
  - to maintain biodiversity and ecological functions, including hydrological regimes, while promoting wise use of the Ramsar wetland.
- three Management objectives:
  - To protect, restore and enhance key ecosystem services and environmental values of the Ramsar Site; particularly those of regional and global significance
  - To develop appropriate and wise use of the wetlands for the betterment of local communities and Sabah
  - To strengthen linkages between government agencies, the community and industry in achieving environmental conservation, connectivity, and protection in the Kinabatangan and Segama river basins



RAMSAR SITE MANAGEMENT APPROACH

CORE AREA	BUFFER AREA
3 Forest Reserves (78,803 ha) • Tuaran Kinabatangan Mangrove Forest Reserve, • Kulambu Wildlife Forest Reserve, and • Kuala Maruap and Kuala Segama Mangrove Forest Reserve. Leading Agency: SFD Supported by Core Area Advisory Team	Areas surrounding the Core Area • Upstream Buffer Area (Community Liaison Zone, Oil Palm Liaison Zone, Forestry Liaison Zone) • Downstream Buffer Area (Artisanal Fishing Zone, Sulu-Sulawesi Marine Ecoregion/Coral Triangle Zone). Buffer Area Management Team chaired by NRO supported by CEPA Committee chaired by NRO

Management Organisation chart for the LKSW Ramsar Site



Implementation of Management Plan

- Infrastructure Development

Kulambu Field Centre

Substation at Kg Sri Gunda

Logistic

Demographic Data Collection

- to identify the significant impact to the livelihood of the local communities as a result of the designation of LKSW as a Ramsar Site.
- six villages were assessed in 2014 and another two villages in 2015.

Scientific Expeditions

Communication, Education and Public Awareness (CEPA)

- JICA, SaBC, RDC, HUTAN, SWD, DoE, JPAS, Department of Education and Kinabatangan District Forestry Office have been instrumental in conducting CEPA activities.

Safeguarding the Ecological Resources of the Ramsar Site

Regular Patrolling

Managing the boundaries of the Ramsar Site

6.0 LESSONS LEARNED

6.1 Collaborative Enthusiasm

- sharing of information and making collective decisions effective to strengthen conservation governance
- innovation to use international initiative proved useful in stimulating interests and enthusiasm among the stakeholders to achieve a common target

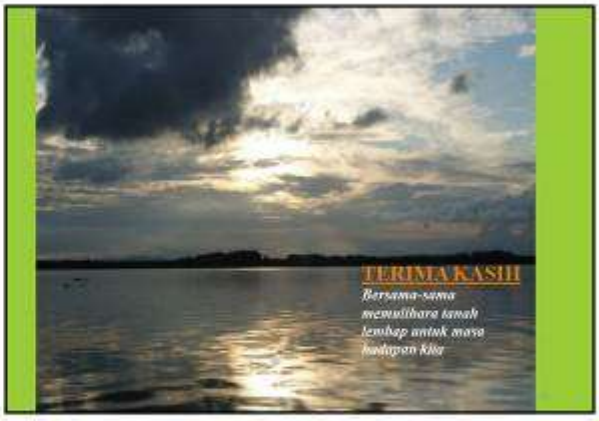
6.2 Management Challenged

- LKSW Ramsar Site is managed under a committee led by Sabah Forestry Department and supported by Core Area Advisory Team
- Operational capacity of the committee, including technical skills and financial strength is still limited
- Financial as well as technical capacity of the committee should be further strengthened

7.0 Conclusions

- LKSW Ramsar Site (78,803 ha) is a huge area
- Not easy task to manage such a large area for a single agency
- collaboration among agencies concerned is vital
- Opportunity for cooperation towards the common interest as management of such an area would require active joint activities should be created and coordinated

  - **contribute to the development of the state conservation governance.**



ORAL PAPER 2

FOREST ECOSYSTEMS OF SABAH'S RAMSAR SITE

Reuben Nilus, John B. Sugau, Joan T. Pereira, Suzana Sabran & Rosila Anthony
Sabah Forestry Department

Dr Reuben Nilus holds a D.Phil. from Aberdeen University on Tropical Plant Ecology. He has been active as a researcher, conducting ecological research mainly in forest conservation, biodiversity monitoring and rehabilitation of degraded high conservation value forests since 1995 in the Forest Research Centre of the Sabah Forestry Department. Besides being authors and co-authours in research papers, articles and reports, he has also contributed to numerous applied forestry activities in a number of forest management units in Sabah.

Abstract

Lower Kinabatangan-Segama Wetland (LKSW), a RAMSAR site No. 1849, is a natural coastal and contiguous wetland consists of mangrove, peatswamp, freshwater swamp and dryland forest ecosystems. Fed by two major rivers, i.e. Kinabatangan and Segama rivers, the 78,803 ha conservation area comprises one of the largest intact mangroves in southern Sulu Sea. The largest ecosystem in these wetlands is mangrove that occupies 71% of the total area; and followed by peatswamp (15%), coastal beach (6%), seasonal freshwater swamp (3%), freshwater swamp (3%) and coastal mixed dipterocarp forests (2%). With various ecosystems set up, the site harbours diverse terrestrial and aquatic wildlife, which some are listed as high conservation value species. The ecosystem health of the site is also vital for the continuous supply of resources for the local community livelihood and sustainable fishery activities surrounding the wetlands.

INTRODUCTION

Lower Kinabatangan-Segama Wetland (LKSW) contains true coastal mangrove, floodplains and dryland ecosystems. With international recognition of this wetland ecosystem, the reserve is one of the three-combined forest reserves that is recognized as the sixth RAMSAR site No. 1849 in Malaysia on 18 November 2008. The RAMSAR site consists of Trusan Kinabatangan FR, Kuala Meruap-Kuala Segama FR and Kulamba FR, covering an area of 78,803 hectares.

The mangrove zonation information was derived from the previous survey under the 9th Malaysian Plan development project in September 2008 for Trusan Kinabatangan FR and Dec 2009 for Kuala Segama and Kuala Meruap. The peatswamp and dryland ecosystem sampling was carried out in Kulamba FR under the Ramsar 2nd Scientific Expedition on the 5th till 10th August 2015. These rapid surveys were conducted to obtain the forest composition of the various ecosystems in the site.

SITE DESCRIPTION

Location and access

Lower Kinabatangan-Segama Wetland is located about 27−100 km (nearest to the furthest) southeast of Sandakan or 53 km northeast of Lahad Datu, on coastal zone from latitude N 5°25'0"–5°50'21" and longitude E 118°13'22"–118°56'05" (Figure 1). Consist of three forest reserve, i.e. Trusan Kinabatangan, Kulamba and Kuala Segama-Meruap, the Ramsar site with an area of 78,803 ha is one of the largest deltaic coastal zone and also other wetlands types in Sabah. The delta is mostly tidal swamps that thrive on sediments brought down by the Kinabatangan and Segama rivers with a catchment size of 16,868 km^2 and 5296 km^2, respectively. This reserve is only accessible by boat and is currently under the management purview of the Kinabatangan Forestry Office.

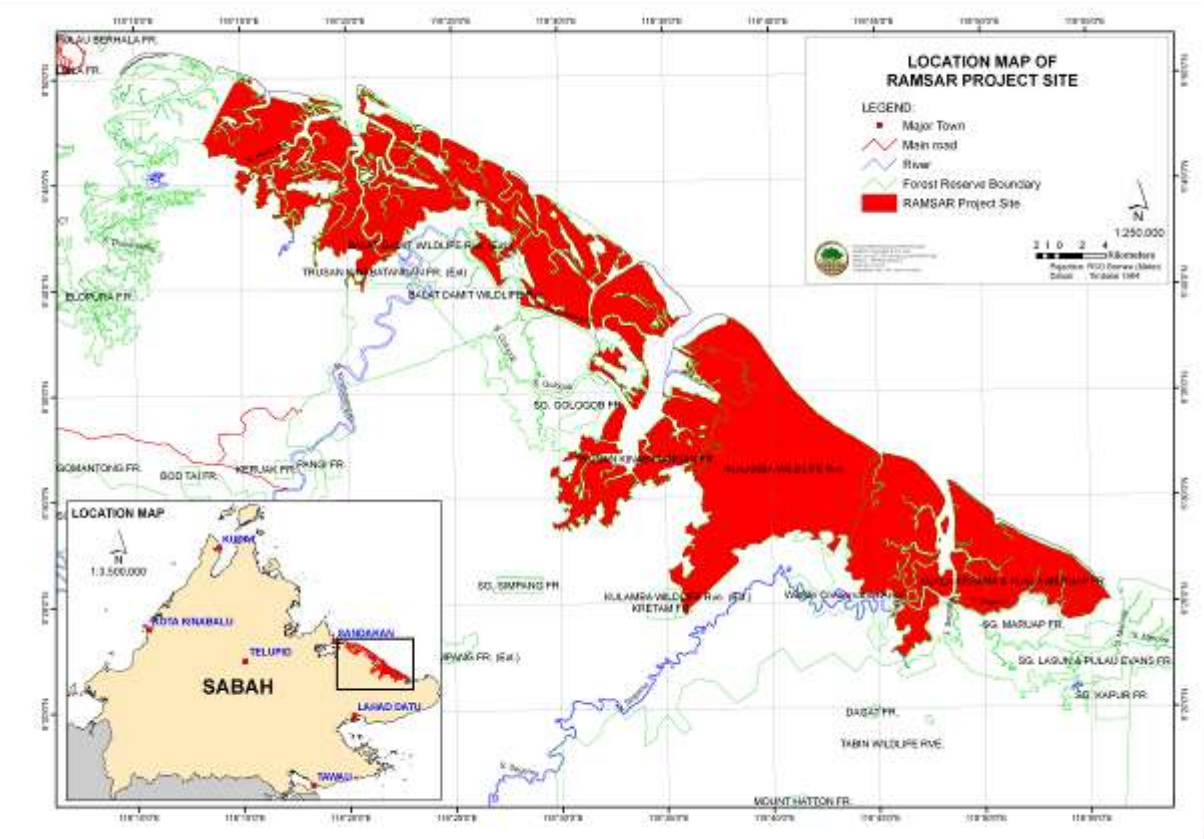


Figure 1. Lower Kinabatangan-Segama Wetland is situated in the east coast of Sabah.

Climate

The nearest climate station is at Sandakan Airport (5° 54' N, 117° 22' E; 15 m a.s.l.). It is operated by the Malaysian Meteorological Services and located approximately 40 km from the study site. In the period 1976–1995, Sandakan Airport recorded a mean (± one SEM) annual rainfall of 2929 ± 134 mm and mean annual temperature in the range of 26.7–27.7°C (source from DID). The rainfall is generally influenced by the northeast monsoon, which normally occurs between November and February in the region, and April is the driest month (mean 92 ± 20 mm).

METHODS

Survey planning

The recent updated mangrove stratum map that was based on 1971 aerial photo interpretation was acquired from the Forest Resource Management Division, Sabah Forestry Department. The area of forest ecosystems interest are those areas that are easily accessible by boat and vehicles, including various forest habitat according to mangrove zonation, peatswamp and dryland forest were sampled, such as, along large rivers and their tributaries, and also oil palm estates road. Beach and coastal areas were not surveyed due to national security reason.

RESULTS AND DISCUSSION

Forest Ecosystems

The largest ecosystem in the wetlands is mangrove that occupies 71 % of the total area; and followed by peatswamp (15%), coastal beach (6 %), seasonal freshwater swamp (3%), freshwater swamp (3%) and coastal mixed dipterocarp forests (2%) (Table 1 & Figure 2).

Table 1. The total area and percentages of various forest ecosystems in Lower Kinabatangan-Segama Wetland (Source: Forest Resource Management Division, Sabah Forestry Department).

Soil Water	Localities	Soils	Forest Ecosystem	Area (ha)	Percentage (%)
Dryland	Coastal	Beach sand	Beach vegetation	5091	6
	Inland	Zonal	Lowland Mixed Dipterocarp Forest	1372	2
		Podzolic	Lowland Kerangas Forest	46	0
High water table	Tidal-Salt Water	Alluvial	Mangrove Forest	56113	71
	Floodplain-Fresh water	Oligotrophic Peat	Lowland Peat Swamp Forest	11654	15
	Floodplain-Fresh water	Eutrophic soils	Lowland Freshwater Swamp Forest	2015	3
	Floodplain-Fresh water	Eutrophic soils	Lowland Seasonal Freshwater Swamp Forest	2511	3
			Grand Total	**78803**	**100**

A. Mangroves

Mangroves are represented by specialized plants that established in the most inhospitable zone between sea and land, thus the diversity in this forest is low. It is continually exposed to adverse environmental condition—a long-term impact in climatic change such as cycles of droughts and seasonal heavy rainfall; and short term impact on alternate conditions of saltwater inundation and drying out, including highly variable water salinities and aeration of the soils (Masteller, 1997). In respond to these adverse environmental conditions, mangroves have developed a number of special anatomical, metabolic and reproductive features that is distinctly different than plants growing in dryland.

The mangroves expand to about 56,113 ha or 71% of the total Ramsar site. The formation of mangrove zonation could be comprehended based on concepts derived from population dynamics, ecophysiology, and geomorphology (*sensu* Snedaker, 1982). These include variation in physical sorting of floating propagules by tidal movement and where they are stranded. Subsequently, a selection might take place after settlement according to the gradient of tidal inundation and salinity. Finally, the effect of interaction among mangrove communities and associates correspond to a succession of species over spatial and time.

There are three distinct mangrove zonation occurring in this site, i.e. seaward or riverine margins, main mangrove and back mangrove zones, conforming to Fox's 1972 classification (Table 2).

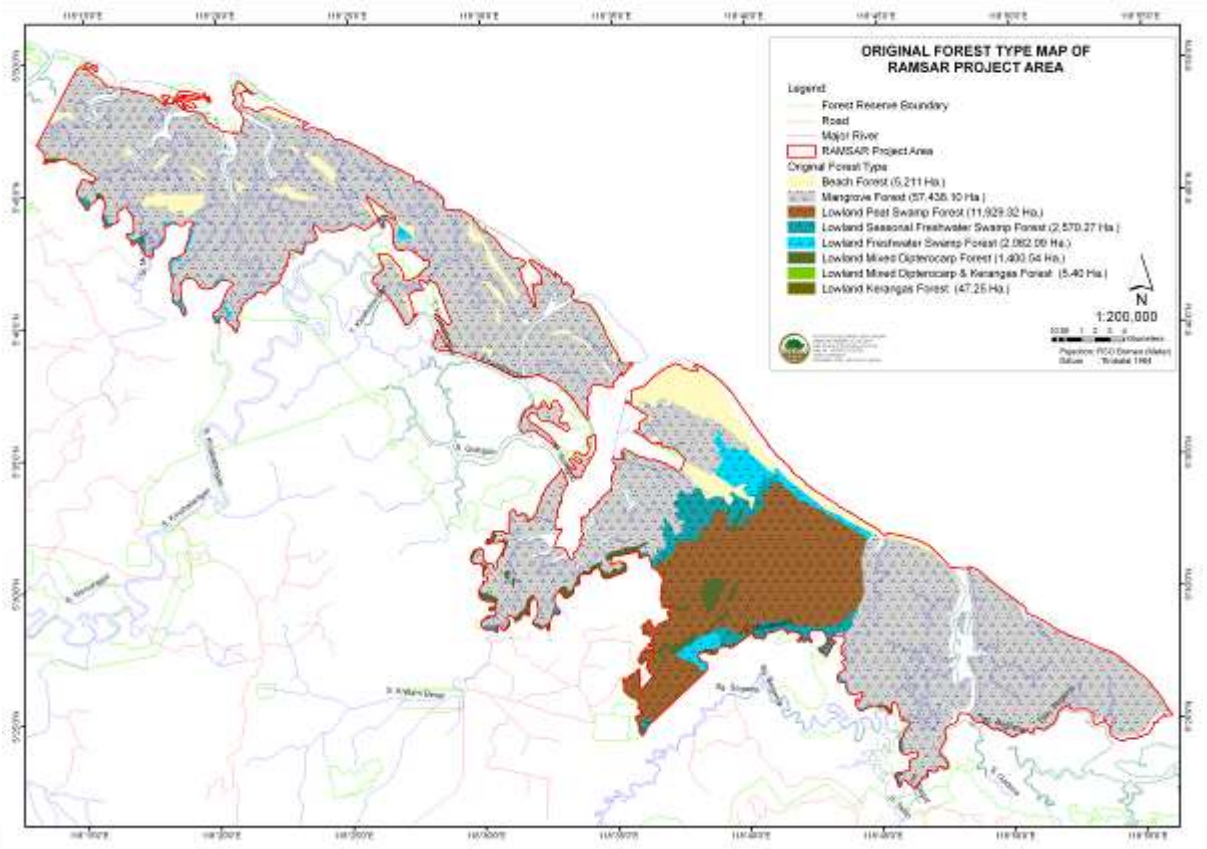


Figure 2. The distribution of the various forest ecosystems found within the Lower Kinabatangan-Segama Wetland, the first Ramsar Site of Sabah, Malaysia.

Table 2. The total area and percentages of various mangrove zones in Lower Kinabatangan-Segama Wetland, a Sabah's Ramsar Site (Source: Forest Resource Management Division, Sabah Forestry Department).

Mangrove zonation	Stratum	Area (Ha)	(%)
Seaward or riverine margins	T6	1162	2
Main Mangrove	T2, T3, T4, T5, T8 & T0	15279	27
Back Mangrove	T1 & T7	37408	67
No Data		2263	4
Total		**56112**	

Seaward or riverine margins of mangrove zone

This habitat is categorized as the pioneer zone where sediments from the upper-stream settled and formed new lands that progress seaward. Being the forefront in the mangrove zonation, this habitat is exposed to higher physical impacts, mainly tidal currents and wind, in comparison to the other mangrove zones. In this Ramsar site, approximately 2% of the total mangrove vegetation is occupied by this habitat and thus, found on seaward and narrow riverine fringes (Table 2). The forest is usually low in stature (<10 m tall and with small trunk diameter). A few sturdy mangrove species such as *Avicennia alba* and *Sonneratia alba* are commonly found predominating at the seaward fringes. In some areas, *Rhizophora mucronata* and *Rhizophora apiculata*, with an occasional mixture of *Excoecaria agallocha*, are found in gregarious stands that form a narrow riverine margin at the outer parts of deltas.

Main mangrove zone

This habitat usually occupies the central parts of the mangrove forest, which is less affected by tidal current and wind. In the reserve, this habitat covers about 27% of the total area (Table 2). It possesses higher structure (<15 m tall and various medium trunk diameter size) and a diverse complexity of mangrove communities and associates. In this habitat, *Rhizophora apiculata* and *Rhizophora mucronata* are the major mangrove species, forming almost uniform stands that line tidal riverbanks and estuarine delta areas. In some areas, clumping of single species of *Ceriops tagal*, *Bruguiera gymnorrhiza* and *Bruguiera parviflora*, forming almost pure stand are also found. Other major mangrove communities that are commonly found distributed randomly in this habitat are *Xylocarpus granatum*, *Lumnitzera littorea*, *Lumnitzera racemosa*, *Aegiceras corniculatum*, *Ceriops decandra*, *Excoecaria agallocha* and *Osbornia octodonta.* In most areas in the habitat, sporadic occurrence of *nipah* palm (*Nypa fruticans*) is found as understorey vegetation. In some of the opened areas that are devoid of trees, *paku piai* (*Acrostichum aureum*) established gregariously and form impenetrable thickets.

Back mangrove zones

The back mangrove zones occupy about 67 % of the total area and are often found behind the main zone, where the duration of tidal influence is low (Table 2). Three sub-zones can be differentiated and they are as follows:

i. ***Nipah* swamp**: The *nipah* palm establishes gregariously and forms pure stands in delta areas, and it also lines the banks of major rivers to the limit of tidal influence. Occasionally, other associate mangrove communities, such as *Heritiera littoralis*, *Bruguiera gymnorrhiza*,

Bruguiera parviflora, *Rhizophora apiculata*, *Excoecaria agallocha* and *Lumnitzera littorea*, are found distributed sporadically in the *nipah* swamp-dominated habitat. The presence of *Nipah* palm is also known to improve mound development.

ii. ***Brugueira* stand**: Dense pure stands of *Bruguiera gymnorrhiza* are often found behind the main zone where the duration of tidal influence is fairly minimal. *Heritiera littoralis* is an associate at the limits of inundation with *Lumnitzera littoralis*, *Brugueira sexangula* and *Osbornia octodonta*, forming local patches behind the main zone. The mangrove rattan (*Calamus erinaceous*) and the fern, *paku piai*, occur in open spaces on mounds.

iii. ***Nibung* stand:** *Nibung* (*Oncosperma trigillaria*) stands occur where the transition from tidal influence area to dryland is relatively abrupt. The stands are usually smaller in extent and generally develop on sandy mud heaps that are associated with crabs at the back of the woody mangroves.

B. Lowland Peatswamp Forest

This forest ecosystem develops on oligotrophic peat soils. Originally, this ecosystem occupied about 11654 ha or 15 % of the Ramsar site (Table 1). The original forests have been reduced to various regenerative secondary vegetation due to timber extraction activities and wildfire in the past.

The sampling of peatswamp forest is limited to the western part of Kulamba FR that has been exposed to severe logging intensity. A large extend of the once mixed peatswamp forest is largely dominated by low regenerating vegetation that includes herbaceous vines and sedges. Regenerating forest with presence of relics are found to be in patches and scattered in the matrix of low regenerating peatswamp vegetation. This forest is mainly dominated by trees both from the family Anacardiaceae and Rubiaceae that represent about 16–22 % and 36–43 % for the former, and 18–28 % and 8–18 % for the latter of the total tree density and basal area, respectively. Other important trees that contribute to the structure of the forest is represented by the family Hypericaceae. The main canopy consists of mature trees with diameter more than 30 cm and can attain a height to about 15–20 m tall. The main canopy is dominated by *Campnosperma campanulatum* (Anacardiaceae), *Jackiopsis ornata* (Rubiaceae)*, Aglaia silvestris* (Meliaceae), *Shorea leprosula* (Dipterocarpaceae), *Macaranga gigantean* (Euphorbiaceae), *Horsfieldia* sp. (Myristicaceae), *Cratoxlum arborescen* (Hypericaceae), and *Litsea* sp. (Lauraceae).

The middlestorey canopy layer of this forest is represented by most of the trees found in the main canopy layers, alongside medium-sized trees with diameter between 20–30 cm. Common trees in this middlestorey canopy and other regenerating main canopy trees are as mentioned above.

The understorey canopy layer of this forest is represented by most of the trees found in the main canopy and also middle storey layers, alongside treelet species with diameter less than 20 cm. Common trees in this understorey canopy and other regenerating main and middlestorey canopy trees are *Syzygium leucoxylon*, *Syzygium chloranthum* and *Syzygium pustalatum* from the tree family Myrtaceae; and *Cryptocarya densiflora* (Lauraceae).

C. Lowland Mixed Dipterocarp Forest

This forest ecosystem develops on zonal soils and distributed below 500–600 m a.s.l.. Originally, this ecosystem occupied about 1372 ha or 2 % of the Ramsar site (Table 1). The original forests have

been reduced to various regenerative secondary vegetation due to timber extraction activities in the past.

This forest is mainly dominated by trees from the family Dipterocarpaceae that represents about 14–23 % and 34–44 % of the total tree density and basal area, respectively. Other important trees that contribute to the structure of the forest are Euphorbiaceae and Malvaceae. The main canopy consists of mature trees with diameter more than 40 cm and can attain a height of about 30–40 m tall. The main canopy is dominated by *Dipterocarpus caudiferus, Dipterocarpus confertus, Parashorea malaanonan*, *Shorea foxworthii*, *Shorea gibbosa* and *Shorea symingtonii* (Dipterocarpaceae), *Heritiera elata* and *Scaphium macropodum* (Malvaceae), *Eusideroxylon zwageri* (Lauraceae), *Dillenia excelsa* (Dilleniaceae), *Mangifera foetida* (Anacardiaceae), *Lithocarpus meijeri* (Fagaceae), *Garcinia* sp. (Clusiaceae) and *Sympetalandra unijuga* (Leguminosae).

The middlestorey canopy layer of this forest is represented by most of the trees found in the main canopy layers, alongside medium-sized trees with diameter between 20–40 cm. Common trees in this middlestorey canopy and other regenerating main canopy trees are *Shorea almon*, *Shorea superba*, *Parashorea tomentella* and *Vatica* sp. (Dipterocarpaceae), *Lithocarpus beccarianus* and *Lithocarpus leptogyne* (Fagaceae), *Garcinia venulosa* (Clusiaceae), and *Barringtonia lanceolate* (Lecythidaceae).

The understorey canopy layer of this forest is represented by most of the trees found in the main canopy land also middle storey layers, alongside treelet species with diameter less than 20 cm. Common trees in this understorey canopy and other regenerating main and middlestorey canopy trees are *Dimorphocalyx murinus*, *Dimorphocalyx* sp., *Mallotus khortalsii* and *Mallotus penagensis* (Euphorbiaceae), *Shorea atrinervosa*, *Shorea ovalis* and *Vatica umbonata* (Dipterocarpaceae), and *Baccaurea tetandra* and *Aporosa frutescens* (Phyllanthaceae).

D. Freshwater swamp Forest

Both seasonal freshwater and freshwater swamp forests cover about 3% of the Ramsar site. The detail of forest stand and condition of these forests are unattainable due to the remoteness of the areas.

E. Beach vegetation

Beach vegetation covers about 5 % of the project area. The detail of forest stand and condition of these forests are unattainable due to the remoteness of the areas and also security reasons.

F. Other miscellaneous forests

Other miscellaneous forests that were encountered during the survey are the transitional and disturbed dryland forests. The transitional forest is found between the transitional forms of mangroves and dryland forest, such as in most cases they are heavily disturbed lowland forests. This habitat is similar in forest structure and floristic to freshwater swamp habitat, and the extension varies between areas and is often restricted to freshwater stream or low-lying areas, but not tidal flats. The tree species found in this habitat are highly mixed freshwater swamp and dryland communities and none of them display dominant characteristics.

In areas where beach forests border mangrove zones, some beach communities are found associated with the mangrove communities. The beach species that are commonly found in this

narrow zone are *Casuarina equisetifolia*, *Hibiscus tiliaceus*, *Pongamia pinnata*, *Pouteria obovata*, *Terminalia catappa*, and *Thespesia populnea*.

Forest Ecosystem Conservation and Regenerative Status

The large landscape of the Ramsar area contains many viable populations of plant species, especially within the intact coastal marine, floodplains and dryland ecosystems. These areas are important source of plant genetic materials and are also important habitat for wildlife. Furthermore, the existence of large intact coastal mangroves provide significantly important hatchery habitats for many marine wildlife that consequently supports the livelihood of the community living at the lower Kinabatangan area and also the fishery industries of Sandakan and Lahad Datu districts. Besides, a number of significant wildlife species, including, the proboscis monkey, orang utan and elephant, key conservation wildlife species of Sabah, takes residence in this vast mangrove ecosystem.

Most of the mangroves forest in this area have been harvested to support the wood chip industry in Sandakan in the 1970s. Fortunately, after the extraction ceased in 1986, the previously disturbed mangrove areas are found to be regenerating gregariously and may revert into their original forest structure and diversity over time.

THREATS

Forest fire

In Southeast Asian tropical rain forests, long drought events are associated with the atmospheric and oceanic anomaly known as the El Niño-Southern Oscillation (ENSO) phenomenon (Walsh, 1996). Frequent occurrences of these severe drought events have increased the susceptibility of vegetation to wildfire. Over the period 1957–1998, Sabah experienced at least eight significant drought events, and those in 1983, 1986–87, 1992 and 1998 were identified as the most extreme (Walsh, 1996; Walsh & Newbery, 1999). During these climatic extremes, drought-induced fire burnt large areas of forest in Borneo (Beaman *et al.*, 1985; Leighton & Wirawan, 1986, Woods, 1989, Sabah Forestry Department Annual Reports). For example, the ENSO-associated drought induced-fires event in 1982–83 had damaged 5×10^6 ha in Borneo (Goldammer *et al.* 1996).

A large northern portion of Kulamba peatswamp forest adjacent to coastal beach area was burnt during the ENSO-drought event in 1998. The peripheral of the reserve is mainly disturbed and covered with secondary growth vegetation. It is known that secondary vegetation or disturbed forest is more susceptible to fire in comparison to pristine forest (Woods, 1989). Therefore, fire is considered as a major threat to natural forest conservation and management, especially in areas surrounded by developed land for urban/rural or agricultural activities.

Water pollution

There is an environmental risk of this deltaic ecosystem to be polluted by upper-stream landuse activities. Large portion of Kinabatangan and Segama catchments has been converted into agricultural landuse. In this agro-based activities, chemical application is widely used for the management of the estates. Concurrently, the waste produced by the mills that operate within the vicinity of rivers, poses potential threat to the river if no environmental impact monitoring and measures are taken.

Siltation

The upper half of the catchment is within the forest reserve and is predominated by hilly and mountainous terrain. This is where logging is the main landuse activity especially the Kinabatangan catchments. The large areas along the river are statelands and these are usually converted to agricultural-based landuse activities. If high soil movement occurs in consequences from these activities, sedimentation and siltation rates will likely increase in the Kinabatangan and Segama rivers.

RECOMMENDATIONS

Monitoring extent of various Ramsar's ecosystems

The management of the reserve should be based on an ecosystem approach that essentially requires inventory and monitoring of large areas of natural landscapes at fine scales. Increasingly, remote sensing and GIS are used as a management tool to examine spatio-temporal processes, such as old, advance or second growth vegetations. Ultimately, this tool is anticipated to produce a stand-based mapping of vegetation types as the baseline for monitoring purposes in the management of this conservation area.

Monitor forest health and functionality

To monitor forest health and overall functionality of the existing forested area, establishment of long-term ecological research plots or permanent sample plots (PSPs) is a scientific approach for documenting detailed changes in forest structure and composition. The output of the plot could provide baseline information on distributions of species and habitats of a particular site. The long-term monitoring activities, such as assessment of the standing trees of these plots would provide valuable information on the changes in plant diversity and richness, growth, mortality, regeneration and dynamics of the sampled forest. This information on forest changes is an indicator of forest health and functionality.

Environmental monitoring on river pollution

Environmental impact measures should be taken abreast to prevent water pollution by agriculture-based activities. Similarly, mitigation measures on soil erosion by uncontrolled landuse activities, especially logging in the hilly and mountainous areas in the upper stream should also be taken into account. In order to monitor river quality, an integrated environmental monitoring system is required to be set up in the Kinabatangan and Segama rivers and major tributaries.

CONCLUSION

Lower Kinabatangan-Segama Wetland contains an important representation of a true coastal mangrove ecosystem, and other floodplains and dryland forest ecosystems. The significance of this wetland ecosystem made it internationally recognized as the sixth RAMSAR site in Malaysia. A continuous management and monitoring of forest ecosystem in this project area is prerequisite in maintaining the integrity of this wetland ecosystem.

REFERENCES

Acres, B.D. & Folland, C.J. (1975). *The soil of Sabah.* Volume 2: Sandakan and Kinabatangan Districts. Land Resource Study 20. Land Resource Division, Ministry of Overseas Development, Tolworth Tower, Surbiton, Surrey, England.

Beaman, R.S., Beaman, J.H., Marsh, C. & Woods, P. (1985). Drought and forest fires in Sabah in 1983. *Sabah Society Journal* 8: 10–30.

Fox, J.E.D. (1972). *The natural vegetation of Sabah and the natural regeneration of the dipterocarp forests.* PhD thesis, University College of North Wales, Bangor.

Goldammer, J.G., Seibert, B. & Schindele, W. (1996). Fire in dipterocarp forests. (In) Schulte, A. & Schöne, D. (eds.), *Dipterocarp forest ecosystems: towards sustainable management*. World Scientific Publication, Singapore-New Jersey-London-Hong Kong. Pp 155–185.

Leighton, M. & Wirawan, N. (1986). Catastrophic drought and fire in Borneo tropical rain forest associated with the 1982–1983 El Niño Southern Oscillation event. (In) Prance, G.T. (ed.), *Tropical rain forests and the world atmosphere.* Westview Press, Boulder, CO. Pp 75–102.

Mastaller, M. (1997). *Mangroves: The forgotten forest between land and sea*. Tropical Press Sdn. Bhd. Kuala Lumpur, Malaysia.

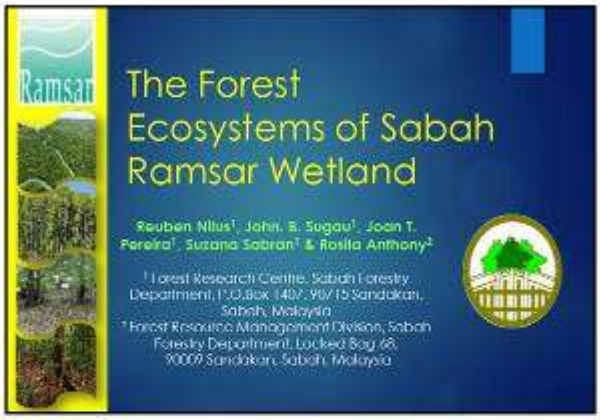
Snedaker, S.C. (1982). Mangrove species zonation: why? (In) Sen, D.N. & Rajpurohit, K.S. (eds.), *Contributions to the study of halophytes*. Tasks for Vegetation Science vol. 2. W. Junk, The Hague. Pp. 111–125.

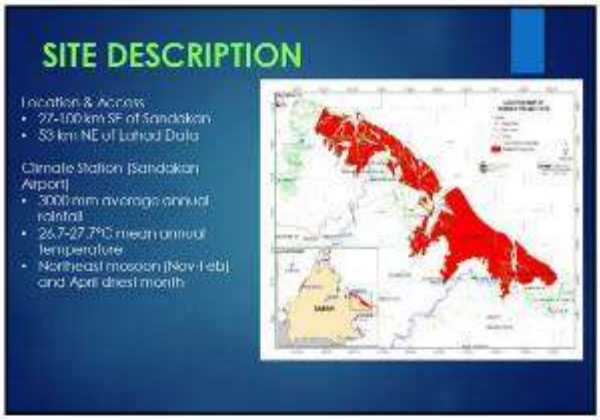
Walsh, R.P.D. & Newbery, D.M. (1999). The ecoclimatology of Danum, Sabah, in the context of the world's rainforest regions, with particular reference to dry periods and their impact. *Philosophical Transactions of the Royal Society of London Series* B 354: 1869–1883.

Walsh, R.P.D. (1996). Drought frequency changes in Sabah and adjacent parts of northern Borneo since the late nineteenth century and possible implications for tropical rain forest dynamics. *Journal of Tropical Ecology* 12: 385–407.

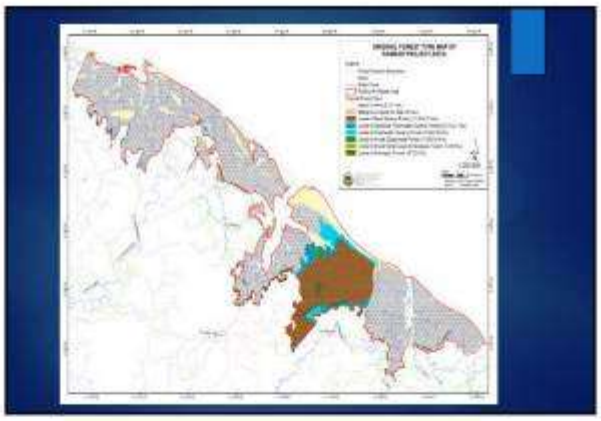
Woods, P. (1989). Effect of logging, drought, and fire on structure and composition of tropical rain forest in Sabah, Malaysia. *Biotropica* 21: 290–298.

Slide Presentation





Soil Water	Localities	Soils	Forest Ecosystem/ Vegetation Formation	Area (ha)	Percentage (%)
Dryland	Coastal	Beach sand	Beach vegetation	5091	6
	Inland	Zonal	Lowland Mixed Dipterocarp Forest	1372	2
		Podzolic	Lowland Kerangas Forest	46	< 0
High water table	Tidal-Salt Water	Alluvial	Mangrove vegetation	56133	71
	Floodplain-Fresh water	Oligotrophic Peat	Lowland Peat Swamp Forest	11654	15
	Floodplain-Fresh water	Eutrophic soils	Lowland Freshwater Swamp Forest	2615	3
	Floodplain-Fresh water	Eutrophic soils	Lowland Seasonal Freshwater Swamp Forest	2611	3
			Grand Total	78803	100



A. Mangrove vegetation:

- 3 mangrove zonations

Mangrove zonation	Stratum	Area (Ha)	(%)
Seaward or riverine margins	T6	1167	2
Main Mangrove	T2, T3, T4, T5, T8 & T9	15279	27
Back Mangrove	T1 & T7	37408	67
No Data		2263	4
Total		56112	

Mangrove Zonation: Seaward or riverine margins

- exposed to higher physical impacts, mainly tidal currents and wind
- approximately 2% of the total mangrove vegetation
- low in stature (<10 m tall and with small trunk diameter)
- A few sturdy mangrove species such as *Avicennia alba* and *Sonneratia alba*

Avicennia alba

Sonneratia alba

Mangrove Zonation: Main mangrove

- habitat covers about 27% of the total area
- possesses higher structure (>15 m tall and various medium trunk diameter dbh) and a diverse complexity of mangrove communities and associates.
- *Rhizophora apiculata* and *Rhizophora mucronata* are the major mangrove species, forming almost uniform stands that line tidal riverbanks and estuarine delta areas.
- clumping of single species of *Ceriops tagal*, *Bruguiera gymnorrhiza* and *Bruguiera parviflora*, forming almost pure stand are also found.
- Other major mangrove communities: *Xylocarpus granatum*, *Lumnitzera littorea*, *Lumnitzera racemosa*, *Aegiceras corniculatum*, *Ceriops decandra*, *Excoecaria agallocha* and *Osbornia octodonta*.

Mangrove Zonation: Main mangrove

Rhizophora apiculata

Bruguiera parviflora

Mangrove Zonation: Main mangrove

Mixed mangrove species

Mixed mangrove species

Mangrove Zonation: Back mangrove

- about 67 % of the total mangrove area
- behind the main zone, where the duration of tidal influence is low
- Three sub-zones can be differentiated and they are as follows:
  - **Nipah swamp:**
    - the limit of tidal influence
    - The presence of Nipah palm is also known to improve mound development
  - **Bruguiera stand:**
    - Dense pure stands of *Bruguiera gymnorhiza*
  - **Nibung stand:**
    - Nibung (*Oncosperma tigillaria*) stands occur where the transition from tidal influence area to dry land is relatively abrupt.

Mangrove Zonation: Back mangrove

Top: Nipah swamp
Top right: Nibung swamp
Right: Bruguiera parviflo

B. Peatswamp Forest

- occupied about 11654 ha or 15 % of the Ramsar site
- The original forests have been reduced to various regenerative secondary vegetation due to timber extraction activities and wildfire in the past
- mainly dominated by trees both from the family Anacardiaceae and Rubiaceae
- Other important trees: Hypericaceae.

B. Peatswamp Forest

C. Lowland Mixed Dipterocarp Forest

- occupied about 1372 ha or 2 % of the Ramsar site
- The original forests have been reduced to various regenerative secondary vegetation due to timber extraction activities in the pass.
- the family Dipterocarpaceae represents about 14–23 % and 36–44 % of the total tree density and basal area, respectively
- Other important trees: Euphorbiaceae and Malvaceae.

C. Lowland Mixed Dipterocarp Forest

D. Freshwater swamp Forest

- cover about 3 % of the Ramsar site
- Remote area, unattainable

E. Beach Forest

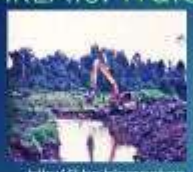
- cover about 5 % of the Ramsar site
- Restricted area due to security reasons

Forest Ecosystem Conservation and Regenerative Status

- large landscape of Ramsar area contains many viable populations of plant species
- important source of plant genetic materials
- important habitat for wildlife
- supporting the livelihood of the community living at the lower Kinabatangan area and also the fishery industries of Sandakan and Lahad Datu districts
- previously disturbed mangrove areas are regenerating gregariously

THREATS: Forest Fire

THREATS: Water Pollution



http://3.bp.blogspot.com/

Recommendations: Monitoring extent of various Ramsar's ecosystems

- based on an ecosystem approach requires inventory and monitoring of large areas of natural landscapes at fine scales
- produce a stand-based mapping of vegetation types as the baseline for monitoring purposes

Recommendations: Environmental monitoring on river pollution

- prevent water pollution by agriculture-based and other landuse activities
- an integrated environmental monitoring system is required to be set up in the Kinabatangan River

CONCLUSIONS

- The significance of this wetland ecosystem made it internationally recognized as the sixth RAMSAR site in Malaysia.
- A continuous management and monitoring of forest ecosystem in this project area is prerequisite in maintaining the integrity of this wetland ecosystem.

ACKNOWLEDGEMENT

Ministry of Natural Resource & Environment
Sabah State Government
Royal Police of Malaysia

THANK YOU

ORAL PAPER 3

PLANT DIVERSITY STUDY IN THE RAMSAR SITE IN SABAH, MALAYSIA

John B. Sugau, Joan T. Pereira, Suzana Sabran & Andi Maryani A. Mustapeng
Sabah Forestry Department

Mr John B. Sugau is a Senior Researcher at the Forest Research Centre of the Sabah Forestry Department (SFD), based in Sepilok, Sandakan. He holds a M.Sc. from Universiti Malaysia Sabah and B.Sc. from Universiti Kebangsaan Malaysia. He has been working with SFD for more than 20 years, and is currently the curator of the Sandakan Herbarium and head of the Plant Diversity Programme of the Forest Research Centre. He is also involved in the plant diversity documentation and conservation of plants in Sabah. He has co-authored the book entitled `Mangroves of Sabah - an introduction to the flora and fauna' and produced several research publications and reports on flora and botanical assessments of many mangrove areas in Sabah.

Abstract

A plant diversity study was conducted in the Ramsar site in Sabah. The study aimed to document plant diversity and to identify interesting, endemic, rare and threatened plant species which are considered high conservation value species. These high conservation value species are key conservation targets for any forested areas such as the Ramsar site. Adequate knowledge of plant diversity in the area is vital for the formulation of a Ramsar site management plan in Sabah.

INTRODUCTION

The Lower Kinabatangan Segama Wetlands (LKSW) in Sabah was officially designated as Sabah's first and Malaysia's largest Ramsar site at the 10th Conference of the Contracting Parties of the Ramsar Convention on Wetlands (Ramsar COP10) in Korea in October 2008. This is the 6th Ramsar site in Malaysia, extending over 78,803 hectares of mangrove and peat swamp forests located on the east cost of Sabah (N 5º25'0"–N 5º50'0"/ E 118º15'0"–E 118º55'0") (Figure 1). It is mainly within the administrative district of Kinabatangan, with the northern tip under the administrative district of Sandakan. The nearest large town is Sandakan, which lies to the northwest of the site. The main access to the site is by boat. The LKSW comprises three forest reserves: Trusan Kinabatangan Forest Reserve (40,471 ha), Kulamba Wildlife Reserve (20,682 ha), and Kuala Meruap & Kuala Segama Forest Reserve (17,650 ha). This area is even larger than the total area of previously designated five Ramsar sites in Malaysia (55,355 hectares). The site is recognized as an internationally important wetland for its undisturbed ecosystem such as the mangrove forest, rare peat swamp forest, etc. (Figure 2).

In terms of flora, there has been no comprehensive study on plant diversity in the Ramsar site. The earliest records of plant collecting in the area were that by Meijer in 1960 and 1967 in Kuala Segama, where he collected 15 species; Kuala Meruap by Lee & Aban in 1984 (27 species) and in Kulamba WR by Diwol in 1984 (5 species). Vegetation assessment and classification for Lower Kinabatangan was done by WWF in 2007 and about 85 species were recorded from the Ramsar site (SaBC, 2010). The Sabah Forestry Department staff carried out mangrove surveys in Trusan Kinabatangan (2008) and in Kuala Segama & Kuala Meruap FR (2008–2009).

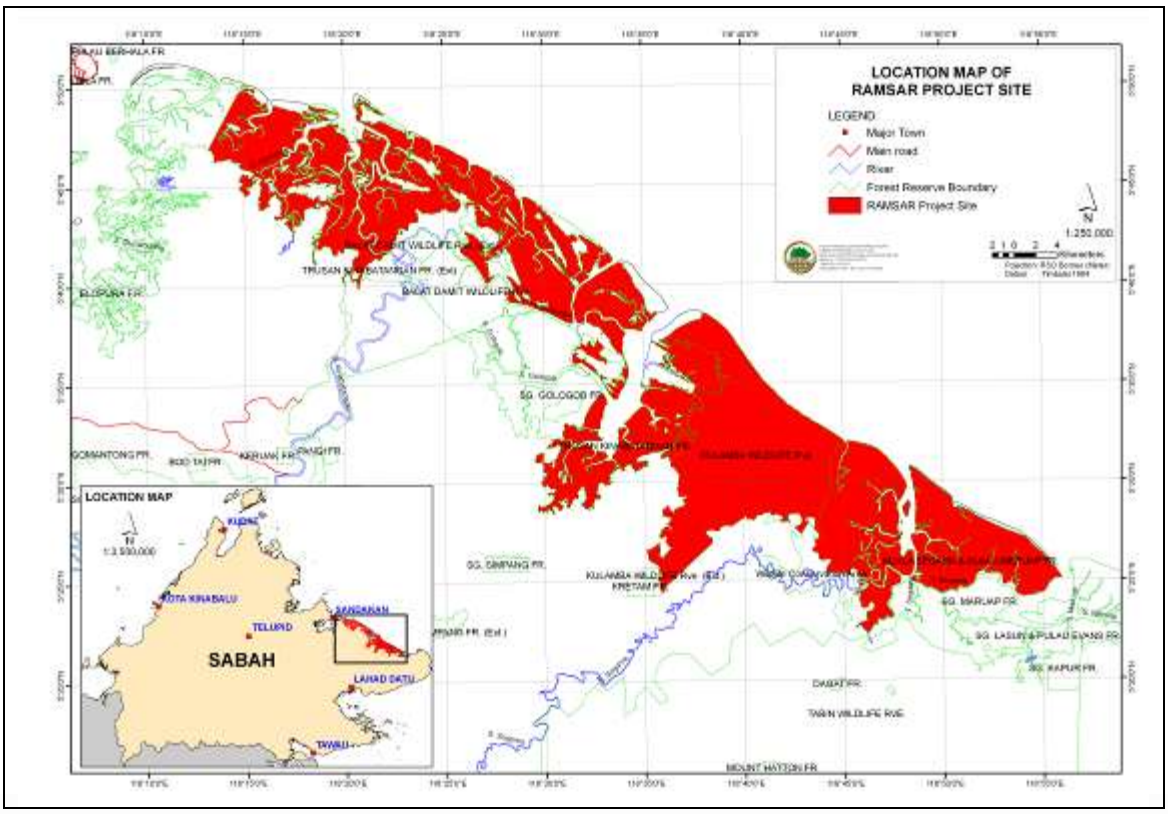


Figure 1. Location of Ramsar site in Sabah.

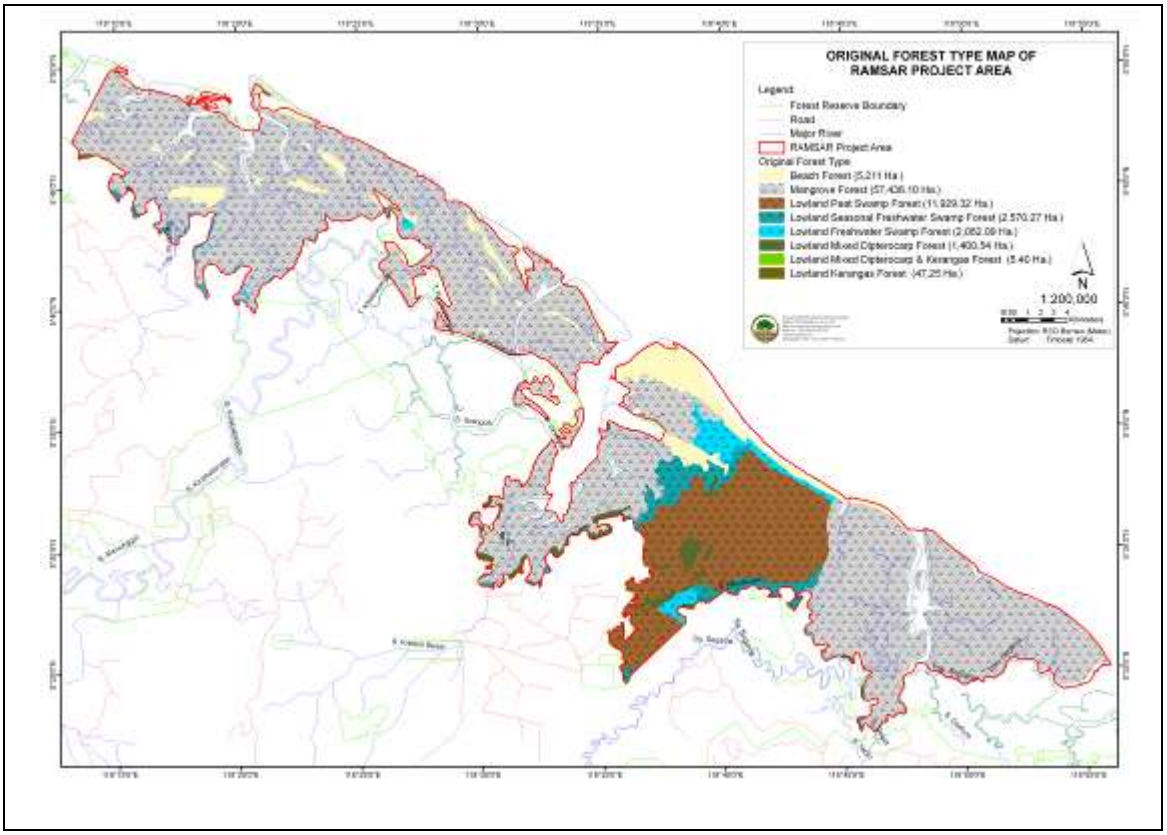


Figure 2. Original forest types in the Ramsar site, Sabah.

OBJECTIVES

The objectives of the study were as follows:
1. To document the flora of Ramsar site in Sabah.
2. To identify the key conservation targets, the issues and threats to plant species.
3. To provide recommendations for the conservation and wise use of wetlands and their resources.

METHODS

Data were gathered from the Sandakan Herbarium plant database (general plant collections from the area in the past), mangrove surveys and two scientific expeditions. The general plant collecting were made from Kulamba Wildlife Reserve by the staff of Forestry Department in 1960, 1967 and 1984. Mangrove surveys were conducted by the staff of the Sabah Forestry Department in Trusan Kinabatangan, Kuala Segama & Kuala Meruap FR in 2008 to 2009. The first Ramsar scientific expedition around Kulamba Field Centre in Kulamba WR was carried out in 2014 while the second expedition that focused on the in-land forests of Kulamba WR was in August 2015.

During the second scientific expedition, all plant species and trees ≥10 cm diameter at breast height (dbh) were recorded from 8 of 0.1 ha circular plots which were established on pristine and disturbed old growth forest (see table 1). Plant specimens with reproductive parts were collected (including voucher specimens) and deposited at the Sandakan Herbarium (SAN). Collecting and preserving plant specimens follow Bridson and Forman, 1992. The common plant species were identified directly to species level in the field by means of their distinctive field characteristics. For those that could not be readily identified, voucher specimens were collected for subsequent determination at

SAN. The voucher specimen collections were oven-dried at 45–55° C for several days before determining their identities. All specimens were sorted according to morphospecies and attempted for identification to species level by cross-referencing with the existing specimens in the herbarium and related flora references (e.g., Soepadmo and Wong, 1995; Soepadmo & Saw, 2000; Soepadmo *et al.*, 1996, 2002, 2004, 2007, and 2011). Plant classification of the Angiosperm group is based on Stevens, P.F. (2001 onwards), and for ferns and lycophytes groups are based on Smith *et al.*, 2006; Christenhusz *et al.*, 2011; Christenhusz and Chase, 2014. Relevant literature materials were also consulted to determine the conservation status of the plants listed. The accepted name of species were also cross references with digital resource at www.catalogueoflife.org/col (Roskov *et al.*, 2015).

Table 1. Location of plots in Lower Kinabatangan Segama Wetlands during the second scientific expedition.

Plot No	Lat	Long	Alt. (m)	Forest type
1	05° 27.764'	118° 36.271'	31	Lowland mixed dipterocarp
2	05° 27.618'	118° 36.414'	42	Lowland mixed dipterocarp
3	05° 24.452'	118° 34.558'	87	Lowland mixed dipterocarp
4	05° 24.565'	118° 34.551'	98	Lowland mixed dipterocarp
5	05° 28.721'	118° 36.999'	26	Peat swamp
6	05° 28.713'	118° 37.040'	36	Peat swamp
7	05° 36.346'	118° 29.087'	41	Lowland mixed dipterocarp
8	05° 36.391'	118° 29.063'	52	Lowland mixed dipterocarp

RESULTS AND DISCUSSION

Plant diversity

A total of 498 taxa (identified to specific and infra-specific levels and a few to "cf.") were recorded from Sabah's Ramsar site (Appendix 1). This is represented by one lycophyte family, 7 Fern families, 1 Gymnosperm, 13 Angiosperms (Monocotyledon) and 80 Angiosperms (Dicotyledon) (Table 2).

Table 2. Number of plant taxa according to plant groups from Ramsar site, Sabah, Malaysia.

Plant group	No. of families	No. of taxa
Lycopyhte	1	1
Ferns	7	22
Gymnosperm	1	2
Angiosperm:		
Monocotyledon	13	52
Dicotyledon	80	421
Total	**102**	**498**

The ten most speciose families are Dipterocarpaceae with 32 taxa, Rubiaceae 29, Fabaceae 29, Annonaceae 19, Malvaceae 17, Euphorbiaceae 15, Phyllanthaceae 14, Myrtaceae 13, Moraceae 12 and Rhizophoraceae 11 (Figure 3).

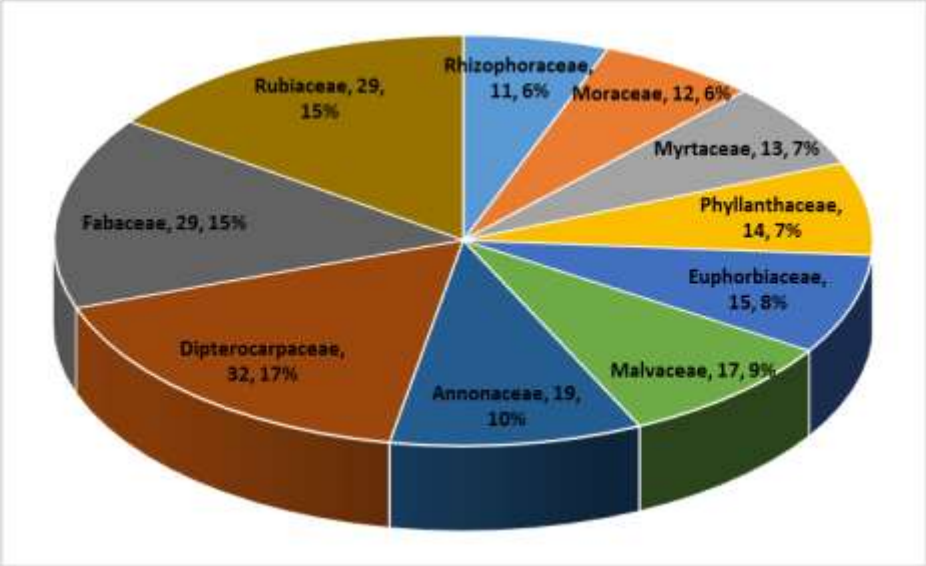


Figure 3. The ten most speciose families in Sabah's Ramsar site.

Trees

Trees are woody plants that have single stem. A total of 334 tree species from 70 families were recorded from the Ramsar site in Sabah. The trees category forms the main contributing group towards the total families recorded for the Ramsar site in Sabah.

Shrubs

Shrubs are woody plants that have multiple stems that arise from the base of the plant. There are 25 shrubs species recorded from the Ramsar site in Sabah.

Herbaceous Plants

Herbs are plants that have succulent leaves and without persistent woody stems above the ground. There are 15 herbacous species recorded from Sabah's Ramsar site.

Climbers

Climbers are long and weak stemmed plants that grow upwards by attaching themselves on other plants or objects by structures or features such as hooks and tendrils that are used as support for their vertical growth. There are 78 climber species in Sabah's Ramsar site.

Ferns and Lycophyte

Ferns and lycophytes are green plants that lack flowers. They reproduce by microscopic spores, rather than by seeds as in flowering plants. Ferns can be distinguished from lycophytes by having highly divided fronds with branching veins and spore-bearing structures on the margins or undersides. While in lycophytes their sporangia are on the upper surface of small leaves with unbranched veins. One species of lycophyte and 22 ferns were recorded from the Ramsar site in Sabah.

Plant Conservation

Endemism

From the 498 plant taxa, 78 plant species are endemic to Borneo, including 7 to Sabah but none is endemic to the Ramsar site. It is observed that 47 tree species are recognized as endemics to Borneo and four (4) species are endemic to Sabah, i.e., *Brownlowia stipulata* (Malvaceae), *Madhuca elmeri* (Sapotaceae), *Nephelium aculeatum* (Sapindaceae) and *Shorea symingtonii* (Dipterocarpaceae). Of the four Sabah endemic tree species, only one is currently protected under Schedule 1 of the Forest Rules 1969, which is *Nephelium aculeatum* (Sapindaceae). Three shrub species are identified as Bornean endemics, including one Sabah endemic (*Ptyssiglottis decurrens* of the Acanthaceae family). A total of 15 species of climbers are listed as Bornean endemics, and two (2) Sabah endemics (e.g. *Hoya nabawanensis* and *Dinochloa obclavata*). Two herbaceous species (*Alocasia scabriuscula* and *Alpinia ligulata*) are listed as Bornean endemics but none is endemic to Sabah or the Ramsar site. One of the Bornean endemic herbs (*Alpinia ligulata*) is formally protected under Sabah Wildlife Conservation Enactment and is also listed in the CITES Appendix. Only one species of the fern (*Pyrrosia christii*) is endemic to Borneo but none from the lycophyte group.

Though none of the plants recorded from the study is endemic to the area, many of the species are confined to wetlands, such as mangrove and swampy areas. For example, most of the mangrove species are only found in the mangrove area. Hence, conservation of the wetlands is crucial for the survival of such habitat specific species.

The IUCN Red List

The IUCN Red List Categories and Criteria were designed for global taxon assessments. There are 8 plant species that are listed as Vulnerable (VU), 3 Endangered (EN) and 8 Critically Endangered (CR) from the Ramsar site in Sabah (Table 3).

Table 3. List of threatened plant species in the Ramsar site in Sabah according to The IUCN Red List of Threatened Species. Version 2015-4.

Species	Family	End	IUCN
Anisoptera costata	Dipterocarpaceae	Not	EN (VU)*
Aquilaria beccariana	Thymelaeaceae	Not	VU
Aquilaria malaccensis	Thymelaeaceae	Not	VU
Cynometra inaequifolia	Fabaceae	Not	VU
Dipterocarpus lowii	Dipterocarpaceae	Not	CR (NT)*
Dipterocarpus validus	Dipterocarpaceae	Not	CR
Dryobalanops beccarii	Dipterocarpaceae	Not	EN (LC)*
Dryobalanops lanceolata	Dipterocarpaceae	Borneo	EN
Durio grandiflorus	Malvaceae	Borneo	VU
Eusiderxylon zwageri	Lauraceae	Not	VU
Gonystylus keithii	Thymelaeaceae	Borneo	VU
Heritiera globosa	Malvaceae	Borneo	EN
Hopea beccariana	Dipterocarpaceae	Not	CR (LC)*
Hopea ferruginea	Dipterocarpaceae	Not	CR (LC)*

Hopea wyatt-smithii	Dipterocarpaceae	Borneo	CR
Intsia bijuga	Fabaceae	Not	VU
Parashorea malaanonan	Dipterocarpaceae	Not	CR
Shorea agamii	Dipterocarpaceae	Borneo	EN
Shorea almon	Dipterocarpaceae	Not	CR
Shorea foxworthyii	Dipterocarpaceae	Not	CR (NT)*
Shorea gibbosa	Dipterocarpaceae	Not	CR (LC)*
Shorea guiso	Dipterocarpaceae	Not	CR
Shorea johorensis	Dipterocarpaceae	Not	CR (NT)*
Shorea leprosula	Dipterocarpaceae	Not	EN (LC)*
Shorea smithiana	Dipterocarpaceae	Borneo	CR
Shorea superba	Dipterocarpaceae	Borneo	CR
Shorea symingtonii	Dipterocarpaceae	Sabah	CR (NT)*
Vatica sarawakensis	Dipterocarpaceae	Borneo	CR

Notes: * the conservation status of the species in brackets is based on the Malaysian Red List. Even though there are species that have been assessed in the global IUCN assessment, the National Red List will have to take precedence for such species.

Wildlife Conservation Enactment 1997

Sabah Wildlife Conservation Enactment 1997 (SWD, 1997), under Ppart VI (Protection of Plants) listed plants that may not be harvested without a license. There is one taxon, namely *Tetrastigma papillosum* that falls under Schedule 1, Part II, Totally Protected Plant Species. There are 4 plant taxa, i.e., 2 taxa of gingers (*Alpinia aquatica* and *A. ligulata*) and 2 species of pitcher plants (*Nepenthes ampullaria* and *N. mirabilis*) that fall under Schedule 2, Part II, Protected Plant Species.

Threats

Forest fire is still the major threat to the forest. Hence, plants growing in the Ramsar site are vulnerable to this threat, especially during dry seasons. The fire may start from the surrounding plantation by small holders or seafarers. Illegal harvesting of mangrove species, especially the tengar species (*Ceriops tagal*) for its bark was also encountered in the area.

RECOMMENDATIONS

As the forests in the study area have already been legally gazetted as a Ramsar site which is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources, the essential step is to formulate a forest management plan for the area. Forest management plan is essential as a guideline to manage any forested area in order to conserve and wisely use the wetlands and their resources, including protection or conservation of plant species of high conservation value. Plant species of high conservation value may include species that are, e.g. endemic to a locality and also important as food source for wildlife. This high conservation value plants or plant conservation targets must be identified and monitored, including conducting population studies. The data obtained can be used to further determine appropriate steps to ensure their survival. Two species were identified as high conservation value plants species, i.e., *Heritiera globosa* (Photo Gallery, Plate 5) and *Arenga retroflorescens* (Photo Gallery, Plate 6), both are endemic to Borneo and confined to

wetland habitats. *Heritiera globosa* is also listed as an endangered species in the IUCN Red List. Another high conservation value plant is *Shorea symingtonii* (Photo Gallery, Plate 4), one of Sabah's endemic dipterocarps which has been assessed as Near Threatened (NT) under the Sabah Red List assessment. Protection of forest reserves, including from forest fires and illegal encroachment or felling must also be emphasized in the forest management plan.

CONCLUSION

A total of 498 taxa have been recorded from Ramsar site in Sabah. Though none of the plant recorded from the study is endemic to the area but there are species that endemic to Sabah and Borneo. There are also plants of threatened species. The area is important and crucial for the survival of many plant species that only thrive in such wetland habitats. Therefore, a forest management plan of the area is very crucial to be formulated as a guide to wisely manage the area.

ACKNOWLEDGEMENTS

The study is part of the Ramsar activities to procure data for the revision of Sabah's Ramsar Site management plan with funding from the 10th Malaysia Plan through the Ministry of Natural Resources & Environment (NRE). We thank the Deputy Director (Forest Sector Planning) and his staff from the Sabah Forestry Department who managed the programme for their support and assistance, Dr. Arthur Chung and his team for organizing the scientific expedition. We also thank the the Deputy Director (R&D), Dr. Lee Ying Fah for his support, Kinabatangan DFO for providing logistic support, En. Jumri Abd. Hamid for providing maps, and the staff of the Systematic Botany section for their excellent cooperation and hard work in the field.

REFERENCES

Bollendorff, S.M., Van Welzen, P.C. & Slik, J.W.F. (2000). A taxonomic revision of *Mallotus* section *Polyadeni* (Euphorbiaceae). *Blumea* 45: 319–340.

Bridson, D. & Forman, L. (1992). *The Herbarium Handbook*. Revised Edition. Royal Botanic Gardens, Kew. 303 pp.

Christenhusz, M.J.M., Zhang, Xian-Chun & Schneider, H. (2011). A linear sequence of extant families and genera of Lycophytes and ferns. *Phytotaxa* 19: 7–54.

Christenhusz, M.J.M. & Chase, M.W. (2014) Trends and concepts in fern classification. *Annals of Botany* 0: 1–24.

Dransfield, J. (1984). *The Rattans of Sabah.* Sabah Forest Record No.13. Sabah Forestry Department, Sandakan. 182 pp.

Haegens, R. (2000). Taxonomy, Phylogeny and Biogeography of *Baccaurea*, *Distichirhops*, and *Nothobaccaurea* (Euphorbiaceae). *Blumea*, supplement 12. 218 pp.

IUCN (2015). The IUCN Red List of Threatened Species. Version 2015-4. www.iucnredlist.org.

Kern, J.H. & Nooteboom, H.P. (1974). Cyperaceae. *Flora Malesiana* Series I, Vol. 9: 107–187.

Mabberley, D.J., Pannell, C.M. & Sing, A.M. (1995). Meliaceae. *Flora Malesiana.* Series I. Vol. 12 (1). 407 pp.

Roskov, Y., Abucay, L., Orrell, T., Nicolson, D., Kunze, T., Culham, A., Bailly, N., Kirk, P., Bourgoin, T., DeWalt, R.E., Decock, W. & De Wever, A., (eds.) (2015). Species 2000 & ITIS Catalogue of Life, 15th February 2015. Species 2000: Naturalis, Leiden, the Netherlands. Digital resource at www.catalogueoflife.org/col

SaBC (2010). Lower Kinabatangan Segama Wetlands Ramsar Site Management Plan 2011-2020. Sabah State Government, Kota Kinabalu, Sabah.

SFD (2015). *Fact sheets of Forest Reserves in Sabah*. Sabah Forestry Department. 37 pp.

Smith, A.R., Pryer, K.M., Schuettpelz, E., Korall, P., Schneider, H. & Wolf, P.G. (2006). A classification for extant ferns. *Taxon* 55 (3): 705–731.

Soepadmo E. & Wong, K.M. (eds.) (1995) *Tree Flora of Sabah and Sarawak.* Vol. 1. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E., Wong, K.M. & Saw, L.G. (eds.) (1996) *Tree Flora of Sabah and Sarawak.* Vol. 2. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E. & Saw, L.G. (eds.) (2000) *Tree Flora of Sabah and Sarawak.* Vol. 3. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E., Saw, L.G. & Chung, R.C.K. (eds.) (2002) *Tree Flora of Sabah and Sarawak.* Vol. 4. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E., Saw, L.G. & Chung, R.C.K. (eds.) (2004) *Tree Flora of Sabah and Sarawak.* Vol. 5. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E., Saw, L.G., Chung, R.C.K. & Kiew, R. (eds.) (2007) *Tree Flora of Sabah and Sarawak.* Vol. 6. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Soepadmo, E., Saw, L.G., Chung, R.C.K. & Kiew, R. (eds.) (2011) *Tree Flora of Sabah and Sarawak.* Vol. 7. Sabah Forestry Department, Sandakan; Forest Research Institute Malaysia and Sarawak Forestry Department.

Stevens, P.F. (2001 onwards). Angiosperm Phylogeny Website. Version 12, July 2012 [and more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb/

SWD (1997). *Sabah Wildlife Conservation Enactment*. Sabah Wildlife Department. 79 pp.

PHOTO GALLERY

Plate 1. Ferns and lycophytes in the Ramsar site, Sabah. **A.** *Pyrrosia christii* (Polypodiaceae); **B**. *Taenitis blechnoides* (Pteridaceae); **C**. *Lygodium circinnatum* (Schizaeaceae); **D**. *Stenochlaena palustris* (Aspleniaceae-Blechnoideae); **E.** *Lycopodiella cernua* (Lycopodiaceae). All photos were taken by J.B. Sugau except for A by Markus G.

Plate 2. The Monocotyledon group in the Ramsar site, Sabah. **A.** *Alpinia ligulata* (Zingiberaceae); **B**. *Alocasia scabriuscula* (Araceae); **C.** *Dinochloa obclavata* (Poaceae); **D**. *Arenga retroflorescens* (Arecaceae); **E.** *Benstonia rupestris* (Pandanaceae). **F**. *Scrotochloa urceolata* (Poaceae); **G.** *Nypha fruticans* (Arecaceae); **H.** *Scleria sumatrensis* (Cyperaceae); **I**. *Korthalsia fortudona* (Arecaceae). All photos were taken by J.B. Sugau, except A and B by Ubaldus M.

Plate 3. The dicotyledon group in Ramsar site in Sabah. **A.** *Aeaschynanthus tricolor* (Gesneriaceae); **B**. *Dacryodes rugosa* (Burseraceae); **C.** *Combretum sundaicum* (Combretaceae); **D**. *Syzygium creaghii* (Myrtaceae); **E.** *Dillenia suffruticosa* (Dilleniaceae); **F**. *Aporosa acuminatissima* (Euphorbiaceae); **G.** *Nepenthes ampullaria* (Nepenthaceae). All photos were taken by Ubaldus M.

Plate 4. *Shorea symingtonii* (Dipterocarpaceae). **A.** Habit; **B**. Inflorescence; **C.** Bark slash and leaves.

Plate 5. *Heritiera globosa* (Malvaceae).
A. Habit; **B.** Inflorescence; **C.** The fruits.

Plate 6. *Arenga retroflorescens* (Arecaceae).
A. Habit; **B.** The leaf

Appendix 1: List of plant species recorded from Ramsar site in Sabah.

Idlocation/Plot number	Species	Family	Group	H	End	IUCN	SFDpro	SWCE	CITES
TK; KSM	*Acanthus ebracteatus*	Acanthaceae	Ad	s	Not	LC	No	No	No
TK; KSM	*Acanthus ilicifolius*	Acanthaceae	Ad	s	Not	LC	No	No	No
SAN 157830; TK, KSM	*Avicennia marina*	Acanthaceae	Ad	t	Not	LC	No	No	No
KSM	*Avicennia officinalis*	Acanthaceae	Ad	t	Not	LC	No	No	No
SAN 157840	*Physiglottis decurrens*	Acanthaceae	Ad	s	Sabah	NE	No	No	No
KL1; KL2; GOL1	*Hydnocarpus borneensis*	Achariaceae	Ad	t	Borneo	NE	No	No	No
TK	*Crinum asiaticum*	Amaryllidaceae	Ad	h	Not	NE	No	No	No
GOL1; 1; TBFC 5; SGO 10; Kul 11; TK	*Buchanania arborescens*	Anacardiaceae	Ad	t	Not	NE	No	No	No
	Campanosperma auriculatum	Anacardiaceae	Ad	t	Not	NE	No	No	No
Kul	*Campnosperma coriaceum*	Anacardiaceae	Ad	t	Not	NE	No	No	No
KL1/T27	*Dimycarpus lucidus*	Anacardiaceae	Ad	t	Not	NE	No	No	No
KL2/T44	*Gluta cf. oba*	Anacardiaceae	Ad	t			No	No	No
KL2/8;KL2/48;GOL1;GOL2; SGO 57	*Gluta oba*	Anacardiaceae	Ad	t	Borneo	NE	No	No	No
KL1; KL2; KL3/18	*Mangifera foetida*	Anacardiaceae	Ad	t	Not	LC	Yes	No	No
KRTM2;KL1/2	*Melanochyla auriculata*	Anacardiaceae	Ad	t	Not	NE	No	No	No
KL1/T19	*Melanochyla caesia*	Anacardiaceae	Ad	t	Not	NE	No	No	No
KL1/26;KL1/73; KL2/64	*Melanochyla castenifolia*	Anacardiaceae	Ad	t	Borneo	NE	No	No	No
KL1/34;KL1/57;KL2/17;KL2/17	*Melanochyla elmeri*	Anacardiaceae	Ad	t	Borneo	NE	No	No	No
KL1/32	*Artabotrys cf. suaveolens*	Annonaceae	Ad	c			No	No	No
KL2; KRTM1; TBFC 4	*Artabotrys costatus*	Annonaceae	Ad	c	Not	NE	No	No	No
Kul 6	*Artabotrys roseus*	Annonaceae	Ad	c	Borneo	NE	No	No	No
KL3; KL4; GOL2; SAN 157816; SAN 157858; Kul 36	*Artabotrys suaveolens*	Annonaceae	Ad	c	Not	NE	No	No	No
KL3/32	*Fissistigma fulgens*	Annonaceae	Ad	c	Not	NE	No	No	No
KL1/70; KL1/30; KL4/16; LL2/10; KR1/51;KR2/29	*Friesodielsia glauca*	Annonaceae	Ad	c	Not	NE	No	No	No
KR1/27; KL1/48	*Friesodielsia grandifolia*	Annonaceae	Ad	c	Borneo	NE	No	No	No
KR1/7; KR2/53; KL1/1;KL2/41; SAN 157835	*Goniothalamus woodii*	Annonaceae	Ad	t	Borneo	NE	No	No	No
KL5/T41	*Mezzetia parviflora*	Annonaceae	Ad	t	Not	NE	No	No	No
KSM	*Necuvaria acuminatissima*	Annonaceae	Ad	c	Not	NE	No	No	No
TK	*Polyalthia cauyeta*	Annonaceae	Ad	t		NE	No	No	No
LL1/5;LL1/16;LL2/5;KL1/3;KL2/30;KR1/32;KR2/58	*Polyalthia ignifiora*	Annonaceae	Ad	t	Borneo	NE	No	No	No
KL2/T26; 3	*Polyalthia rumphii*	Annonaceae	Ad	t	Not	NE	No	No	No
KL1/28; KL2/31	*Polyalthia saprosma*	Annonaceae	Ad	t	Borneo	NE	No	No	No
KRTM2; GOL1;KL2/34	*Sageraea lanceolata*	Annonaceae	Ad	t	Not	NE	No	No	No
TBFC 37	*Uvaria cf. monticola*	Annonaceae	Ad	c			No	No	No
KL1/40; KL1/75	*Uvaria cf. sarawakensis*	Annonaceae	Ad	c			No	No	No
SGO 33; TBFC 43	*Uvaria littoralis*	Annonaceae	Ad	c	Not	NE	No	No	No
LL1/37; KL2/50;KR2/2	*Uvaria littoralis*	Annonaceae	Ad	c	Not	NE	No	No	No
Kul	*Alstonia spatulata*	Apocynaceae	Ad	t	Not	LC	No	No	No
Kul 24	*Alyxia reinwardtii*	Apocynaceae	Ad	c	Not	NE	No	No	No
KSM	*Asclepias curassavica*	Apocynaceae	Ad	s	Not	NE	No	No	No
Kul	*Cerbera manghas*	Apocynaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Cerbera odollam*	Apocynaceae	Ad	t	Not	NE	No	No	No
SAN 157818	*Hoya cf. revoluta*	Apocynaceae	Ad	c			No	No	No
Kul 19	*Hoya nabawanensis*	Apocynaceae	Ad	c	Sabah	NE	No	No	No
KL2/53	*Kopsia pauciflora*	Apocynaceae	Ad	t	Not	NE	No	No	No
TK	*Tylophora flexuosa*	Apocynaceae	Ad	c	?	NE	No	No	No
KL2/24	*Urceola brachysepala*	Apocynaceae	Ad	t	Not	NE	No	No	No
LL2/21; TBFC 21	*Willughbeia angustifolia*	Apocynaceae	Ad	c	Not	NE	No	No	No
KL1/20;KL4/14;KR2/38;KR1/23	*Willughbeia coriacea*	Apocynaceae	Ad	c	Not	NE	No	No	No
KL3; KL4; SAN 157003; TBFC 32; TK	*Ilex cymosa*	Aquifoliaceae	Ad	t	Not	NE	No	No	No
KR1/78;KL1/84; KL2/5	*Alocasia scabriuscula*	Araceae	Am	h	Borneo	NE	No	No	No
TK	*Cryptocoryne ciliata*	Araceae	Am	h	Not	LC	No	No	No
KL80	*Cyprenmum pinnatum*	Araceae	Am	h	Not	NE	No	No	No
TK	*Laska spinosa*	Araceae	Am	h	Not	LC	No	No	No
Kul	*Pistia stratiotes*	Araceae	Am	h	Not	LC	No	No	No
KL1/82	*Pothos borneensis*	Araceae	Am	h	Not	NE	No	No	No
KL3/6	*Rhaphidophora latevaginata*	Araceae	Am	h	Not	NE	No	No	No
KL 79; KL1/86;KL3/7	*Scindapsus pictus*	Araceae	Am	h	Not	NE	No	No	No
KL2/6	*Scindapsus rupestris*	Araceae	Am	h	Not	NE	No	No	No
Kul 32	*Dendropanax borneensis*	Araliaceae	Ad	s	Not	NE	No	No	No
KL4/20	*Schefflera obovatilimba*	Araliaceae	Ad	c		NE	No	No	No
TK	*Areca catechu*	Arecaceae	Am	pt	Introduced	NE	No	No	No
KL1/87; TBFC 24	*Arenga retroflorescens*	Arecaceae	Am	pt	Borneo	NE	No	No	No
KL2/7	*Calamus convallium*	Arecaceae	Am	c	Borneo	NE	No	No	No
SAN 156851; TK	*Calamus erinaceus*	Arecaceae	Am	c	Not	NE	No	No	No
TBFC 49; SGO 36	*Calamus gonospermus*	Arecaceae	Am	c	Borneo	NE	No	No	No
KSM	*Daemonorops fissa*	Arecaceae	Am	c	Borneo	NE	No	No	No
KL1/77	*Korthalsia echinometra*	Arecaceae	Am	c	Not	NE	No	No	No
KL1/89	*Korthalsia furtadoana*	Arecaceae	Am	c	Borneo	NE	No	No	No
KL1/90	*Licuala valida*	Arecaceae	Am	pl	Borneo	NE	No	No	No
TK; KSM	*Nypa fruticans*	Arecaceae	Am	pt	Not	LC	No	No	No
TK; KSM	*Oncosperma tigillarium*	Arecaceae	Am	pt	Not	NE	No	No	No
KRTM1;KL3;KL4; SAN157810; KSM	*Asplenium nidus*	Aspleniaceae	F	f	Not	NE	No	No	No
KL 3/1	*Asplenium pellucidum*	Aspleniaceae	F	f	Not	NE	No	No	No
KSM	*Blumea balsamifera*	Asteraceae	Ad	s	Not	NE	No	No	No
Kul 14	*Chromolaena odorata*	Asteraceae	Ad	s	?	NE	No	No	No
KL1	*Vernonia arborea*	Asteraceae	Ad	t	Not	NE	No	No	No
KL2	*Diplazium riparium*	Athyriaceae	F	f	Not	NE	No	No	No
TK; KSM	*Dolichandrone spathacea*	Bignoniaceae	Ad	t	Not	LC	No	No	No
KL1; KL3;KL4; SAN 157036; Kul 29; TBFC 52, TK	*Stenochlaena palustris*	Blechnaceae	F	f	Not	NE	No	No	No
KL1/T6	*Canarium cf. megalanthum*	Burseraceae	Ad	t			No	No	No
KL1;KRTM1;KRTM2;GOL2;	*Canarium denticulatum*	Burseraceae	Ad	t	Not	NE	No	No	No
KL1/19,KR1/70; KL2/36	*Dacryodes cf. rugosa*	Burseraceae	Ad	t			Yes	No	No
KL2/117	*Dacryodes incurvata*	Burseraceae	Ad	t	Not	NE	Yes	No	No
KL2,KRTM1	*Dacryodes rostrata*	Burseraceae	Ad	t	Not	LC	Yes	No	No
KL1;KL2;KRTM2; SAN 157832; SAN 157846	*Dacryodes rugosa*	Burseraceae	Ad	t	Not	NE	Yes	No	No
KL3/15,KL4/6,KL5/T44	*Santiria laevigata*	Burseraceae	Ad	t	Not	LC	Yes	No	No
KL1/13;KL2/11	*Calophyllum cf. blancoi*	Calophyllaceae	Ad	t			No	No	No
KSM	*Calophyllum inophyllum*	Calophyllaceae	Ad	t	Not	LC	No	No	No
SAN 157040	*Trema tomentosa*	Cannabaceae	Ad	t	Not	NE	No	No	No
Kul 7; TK; KSM	*Casuarina equisetifolia*	Casuarinaceae	Ad	t	Not	NE	No	No	No
TK	*Cassine viburnifolia*	Celastraceae	Ad	t	Not	LC	No	No	No

KSM	*Euonymus costanelfolius*	Celastraceae	Ad	t	Not	NE	No	No	No
KL1/59	*Kokoona cf. littoralis*	Celastraceae	Ad	t			No	No	No
KL4	*Lophopetalum multinervium*	Celastraceae	Ad	t	Not	NE	No	No	No
KSM	*Atuna racemosa subsp. Excelsa*	Chrysobalanaceae	Ad	t	Not	NE	No	No	No
KL1;KL2	*Maranthes corymbosa*	Chrysobalanaceae	Ad	t	Not	LC	No	No	No
KL4;6	*Parastemon urophyllus*	Chrysobalanaceae	Ad	t	Not	NE	No	No	No
TBFC 2	*Garcinia beccarii*	Clusiaceae	Ad	t	Borneo	NE	Yes	No	No
KL2/13;LL1/9	*Garcinia cf. gaudichaudi*	Clusiaceae	Ad	t			Yes	No	No
KL2/57	*Garcinia cf. venulosa*	Clusiaceae	Ad	t			Yes	No	No
KR1/15; KR2/19;KL1/18; SGO 5	*Garcinia farbesii*	Clusiaceae	Ad	t	Not	NE	Yes	No	No
KL4; TK; KSM	*Garcinia parvifolia*	Clusiaceae	Ad	t	Not	NE	Yes	No	No
KL1/T17;KL2/T43	*Garcinia venulosa*	Clusiaceae	Ad	t	Not	NE	Yes	No	No
KR1/21; KL1/37; SAN 157848	*Combretum sundaicum*	Combretaceae	Ad	c	Not	NE	No	No	No
SAN 157827; SAN 157009; TK	*Lumnitzera littorea*	Combretaceae	Ad	t	Not	LC	No	No	No
TK; KSM	*Lumnitzera racemosa*	Combretaceae	Ad	t		LC	No	No	No
TK; KSM	*Terminalia catappa*	Combretaceae	Ad	t		NE	No	No	No
KSM	*Terminalia copelandii*	Combretaceae	Ad	t	Not	NE	No	No	No
KL1/13	*Terminalia foetidissima*	Combretaceae	Ad	t	Not	NE	No	No	No
KRTM2; GOL2;KL1/55	*Agelaea trinervis*	Connaraceae	Ad	c	Not	NE	No	No	No
KL2/56, KR1/36	*Connarus odoratus*	Connaraceae	Ad	c	Not	NE	No	No	No
KL/45	*Connarus villosus*	Connaraceae	Ad	c	Not	NE	No	No	No
KL1;GOL1;GOL2	*Rourea mimosoides*	Connaraceae	Ad	c	Not	NE	No	No	No
1	*Alangium griffithii*	Cornaceae	Ad	t	Not	LC	No	No	No
TBFC 53	*Momordica denticulata*	Cucurbitaceae	Ad	c	Not	NE	No	No	No
TBFC 17	*Carex filicina*	Cyperaceae	Am	sd	Not	LC	No	No	No
KSM	*Cyperus javanicus*	Cyperaceae	Am	sd	Not	NE	No	No	No
KL2/4	*Cyperus luzulae*	Cyperaceae	Am	sd	Not	NE	No	No	No
Kul	*Hypolytrum nemorum*	Cyperaceae	Am	sd	Not	NE	No	No	No
Kul 41	*Kyllinga brevifolia*	Cyperaceae	Am	sd	Not	NE	No	No	No
SAN 157803; SAN 157019	*Mapania cuspidata*	Cyperaceae	Am	sd	Not	NE	No	No	No
Kul 39	*Scleria levis*	Cyperaceae	Am	sd	Not	NE	No	No	No
SAN 157823	*Scleria sumatrensis*	Cyperaceae	Am	sd	Not	NE	No	No	No
Kul	*Thoracostachyum bancanum*	Cyperaceae	Am	sd	Not	NE	No	No	No
TK; KSM	*Cyathea contaminans*	Cythaceae	F	f	Not	NE	No	No	No
TBFC 38	*Dillenia beccariana*	Dilleniaceae	Ad	t	Borneo	NE	No	No	No
KL1;KL2;KRTM1;KRTM2	*Dillenia excelsa*	Dilleniaceae	Ad	t	Not	NE	No	No	No
SAN 157801; SAN 157002, TK	*Dillenia suffruticosa*	Dilleniaceae	Ad	t	Not	NE	No	No	No
KSM	*Tetracera akara*	Dilleniaceae	Ad	c	Not	NE	No	No	No
KL1/44; KL2/60	*Tetracera cf. akara*	Dilleniaceae	Ad	c			No	No	No
KSM	*Tetracera karthalsii*	Dilleniaceae	Ad	c	Not	NE	No	No	No
LL1/40; LL1/24; SAN 157819; SAN 157038; Kul 26	*Tetracera scandens*	Dilleniaceae	Ad	c	Not	NE	No	No	No
Kul	*Anisoptera costata*	Dipterocarpaceae	Ad	t	Not	EN (VU)	No	No	No
Kul	*Dipterocarpus acutangulus*	Dipterocarpaceae	Ad	t	Not	NE (LC)	No	No	No
Kul	*Dipterocarpus caudiferus*	Dipterocarpaceae	Ad	t	Borneo	NE	No	No	No
KL2;1	*Dipterocarpus confertus*	Dipterocarpaceae	Ad	t	Borneo	NE	No	No	No
Kul	*Dipterocarpus humeratus*	Dipterocarpaceae	Ad	t	Not	NE	No	No	No
Kul	*Dipterocarpus lowii*	Dipterocarpaceae	Ad	t	Not	CR(NT)	No	No	No
Kul; KSM	*Dipterocarpus validus*	Dipterocarpaceae	Ad	t	Not	CR	No	No	No
KSM	*Dryobalanops beccarii*	Dipterocarpaceae	Ad	t	Not	EN (LC)	No	No	No
Kul	*Dryobalanops lanceolata*	Dipterocarpaceae	Ad	t	Borneo	EN	No	No	No
Kul	*Hopea beccariana*	Dipterocarpaceae	Ad	t	Not	CR (LC)	No	No	No
Kul	*Hopea dyeri*	Dipterocarpaceae	Ad	t	Not	NE	No	No	No
KL2/35	*Hopea ferruginea*	Dipterocarpaceae	Ad	t	Not	CR (LC)	No	No	No
KSM	*Hopea wyatt-smithii*	Dipterocarpaceae	Ad	t	Borneo	CR	No	No	No
2;4	*Parashorea tomentella*	Dipterocarpaceae	Ad	t	Borneo	NE	No	No	No
KL1;2	*Parashorea malaanonan*	Dipterocarpaceae	Ad	t	Not	CR	No	No	No
Kul	*Shorea agamii*	Dipterocarpaceae	Ad	t	Borneo	EN	No	No	No
2	*Shorea almon*	Dipterocarpaceae	Ad	t	Not	CR	No	No	No
KL1;KL2	*Shorea atrinervata*	Dipterocarpaceae	Ad	t	Not	NE (LC)	No	No	No
KL1/T42	*Shorea foxworthyi*	Dipterocarpaceae	Ad	t	Not	CR (NT)	No	No	No
2	*Shorea gibbosa*	Dipterocarpaceae	Ad	t	Not	CR (LC)	No	No	No
TBFC 25	*Shorea guiso*	Dipterocarpaceae	Ad	t	Not	CR	No	No	No
Kul	*Shorea johorensis*	Dipterocarpaceae	Ad	t	Not	CR (NT)	No	No	No
5	*Shorea leprosula*	Dipterocarpaceae	Ad	t	Not	EN (LC)	No	No	No
KL1;KRTM2,2	*Shorea ovalis*	Dipterocarpaceae	Ad	t	Not	NE	No	No	No
Kul & Kretam	*Shorea parvifolia*	Dipterocarpaceae	Ad	t	Not	NE	No	No	No
Kul & Kretam	*Shorea smithiana*	Dipterocarpaceae	Ad	t	Borneo	CR	No	No	No
1	*Shorea superba*	Dipterocarpaceae	Ad	t	Borneo	CR	No	No	No
KL1	*Shorea symingtonii*	Dipterocarpaceae	Ad	t	Sabah	CR (NT)	No	No	No
Kul	*Vatica oblongifolia*	Dipterocarpaceae	Ad	t	Borneo	NE	No	No	No
LL1/52; KL2/66,KL1/T41; SGO 39	*Vatica oblongifolia var. multinervata*	Dipterocarpaceae	Ad	t	Borneo	NE	No	No	No
KL2	*Vatica sarawakensis*	Dipterocarpaceae	Ad	t	Borneo	CR	No	No	No
KL1;KL2;KRTM1;KRTM2;KL4;GOL1	*Vatica umbonata*	Dipterocarpaceae	Ad	t	Not	LC	No	No	No
KL3/34,GOL1;4; TBFC 19	*Diospyros diepenhorstii*	Ebenaceae	Ad	t	Not	NE	No	No	No
KRTM1;KL3;KL4;GOL1,GOL2; 1; SAN 157022; TBFC 14	*Diospyros elliptifolia*	Ebenaceae	Ad	t	Not	NE	No	No	No
KL1;KL2;KRTM1;KRTM2	*Diospyros euphlebia*	Ebenaceae	Ad	t	Borneo	NE	No	No	No
LL1/18; LL2/26/KL1/43;KL2/28	*Diospyros frutescens*	Ebenaceae	Ad	t	Not	NE	No	No	No
KL1/46	*Diospyros halleri*	Ebenaceae	Ad	t	Borneo	NE	No	No	No
KL1/6; KL2/18	*Diospyros mindanaensis*	Ebenaceae	Ad	t	Not	NE	No	No	No
KRTM1;KL2/54;KL1/71	*Diospyros subrhombiodea*	Ebenaceae	Ad	t	Not	NE	No	No	No
TBFC 10	*Elaeocarpus clementis*	Elaeocarpaceae	Ad	t	Borneo	NE	No	No	No
Kul 23	*Elaeocarpus cuneurus*	Elaeocarpaceae	Ad	t	Borneo	NE	No	No	No
KL4/21;KL3/39	*Elaeocarpus griffithii*	Elaeocarpaceae	Ad	t	Not	NE	No	No	No
SAN 157815	*Elaeocarpus nitidus*	Elaeocarpaceae	Ad	t	Not	NE	No	No	No
GL7/T64; /T6;6	*Elaeocarpus pedunculatus*	Elaeocarpaceae	Ad	t	Not	NE	No	No	No
KL3	*Elaeocarpus stipularis*	Elaeocarpaceae	Ad	t	Not	NE	No	No	No
SGO 22; KSM	*Erythroxylum cuneatum*	Erythroxylaceae	Ad	t	Not	NE	No	No	No
Kul	*Polyosma mytabilis*	Escalloniaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Croton heterocarpus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
KL1/TS1;KL2/T27; KL1/66	*Dimorphocalyx muricus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
Kul 35; TK; KSM	*Excoecaria agallocha*	Euphorbiaceae	Ad	t	Not	LC	No	No	No
Kul	*Homalanthus populneus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
SAN 157816	*Macaranga conifera*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
5;6; TBFC 40	*Macaranga gigantea*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
TBFC 15	*Macaranga pruinosa*	Euphorbiaceae	Ad	t	Not	NE	No	No	No

KL3/31; KL1/65; SAN 157812	*Macaranga triloba*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
KL1;KL2;KL2/39	*Mallotus karthaisi*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
KL1;KL2;KRTM1;KRTM2; SAN 157834	*Mallotus miquelianus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
Kul	*Mallotus muticus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
KL1;KL2; SAN 157814; SAN 157834	*Mallotus penangensis*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
SAN 157811	*Paracroton pendulus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Shirakiopsis indica*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
KL1/12; KL2/16; KL2/63	*Trigonostemon polyanthus*	Euphorbiaceae	Ad	t	Not	NE	No	No	No
TK	*Aganope heptaphylla*	Fabaceae	Ad	c	Not	NE	No	No	No
KL1/29	*Albizia cf. scandens*	Fabaceae	Ad	t			No	No	No
KL5/TS4; SAN 157825; SAN 157860	*Archidendron clypearia*	Fabaceae	Ad	t	Not	NE	No	No	No
KL3/25;KL3/36	*Archidendron microcarpum*	Fabaceae	Ad	t	Not	NE	No	No	No
KL2/47; KR2/48; KL/77; KRTM1	*Bauhinia diptera*	Fabaceae	Ad	c	Borneo	NE	No	No	No
KSM	*Caesalpinia bonduc*	Fabaceae	Ad	c	Not	NE	No	No	No
TK; KSM	*Caesalpinia crista*	Fabaceae	Ad	c	not	NE	No	No	No
KSM	*Centrosema pubescens*	Fabaceae	Ad	c	Not	NE	No	No	No
KSM	*Crotalaria pallida*	Fabaceae	Ad	s	Not	NE	No	No	No
Kul	*Cynometra inaequifolia*	Fabaceae	Ad	t	Not	VU	No	No	No
TK	*Dalbergia candenatensis*	Fabaceae	Ad	c	Not	NE	No	No	No
Kul 3; Kul 15	*Dalbergia junghuhnii*	Fabaceae	Ad	c	not	NE	No	No	No
TBFC 44	*Dalbergia rimosa*	Fabaceae	Ad	c	Not	LC	No	No	No
TK; KSM	*Dendrolobium umbellatum*	Fabaceae	Ad	t	Not	NE	No	No	No
KSM	*Derris elegans*	Fabaceae	Ad	c	Not	NE	No	No	No
Kul 27; TK; KSM	*Derris trifoliata*	Fabaceae	Ad	t	Not	NE	No	No	No
KL1; TBFC 11	*Fordia splendidissima*	Fabaceae	Ad	t	Not	NE	No	No	No
TK	*Inocarpus fagifer*	Fabaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Intsia bijuga*	Fabaceae	Ad	t	Not	VUL	Yes	No	No
KSM	*Peltophorum pterocarpum*	Fabaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Pongamia pinnata*	Fabaceae	Ad	t	Not	LC	No	No	No
KL2;4	*Saraca declinata*	Fabaceae	Ad	t	Not	NE	No	No	No
KSM	*Senna tora*	Fabaceae	Ad	t	Not	NE	No	No	No
SAN 157804	*Sindora cf. irpicina*	Fabaceae	Ad	t			No	No	No
KL1/39;LL1/30; SGO 13	*Sindora irpicina*	Fabaceae	Ad	t	Borneo	NE	No	No	No
TBFC 26	*Spathalobus ferrugineus*	Fabaceae	Ad	c	Not	NE	No	No	No
KL1/38	*Spathalobus persicinus*	Fabaceae	Ad	c	Not	NE	No	No	No
LL1/23; LL2/7; KR2/59;KL1/25;KL2/42;KL2/47;KR1/40	*Spathalobus sanguineus*	Fabaceae	Ad	c	Not	NE	No	No	No
KL2;KRTM1;KRTM2; 1	*Sympetalandra unijuga*	Fabaceae	Ad	t	Not	NE	No	No	No
KL1/T30	*Lithocarpus beccarianus*	Fagaceae	Ad	t	Borneo	NE	No	No	No
KL1/T7; KL4/17;2	*Lithocarpus leptogyne*	Fagaceae	Ad	t	Not	NE	No	No	No
KL2/T61	*Lithocarpus meijeri*	Fagaceae	Ad	t	Not	NE	No	No	No
KL1/41	*Lithocarpus urceolaris*	Fagaceae	Ad	t	Not	NE	No	No	No
KL1/81; KL2/3; KL1/5; GOL1;GOL2; SGO 34; TBFC 22; KSM	*Flagellaria indica*	Flagellariaceae	Am	c	Not	NE	No	No	No
Kul	*Fagraea fragrans*	Gentianaceae	Ad	t	Not	NE	No	No	No
KSM	*Fagraea splendens*	Gentianaceae	Ad	t	Not	NE	No	No	No
SAN 157006	*Utania cuspidata*	Gentianaceae	Ad	t	Not	NE	No	No	No
KL2; SAN 157809; TBFC 35	*Utania spicata*	Gentianaceae	Ad	t	Not	NE	No	No	No
KL3; KL4; SAN 157865	*Aeschynanthus tricolor*	Gesneriaceae	Ad	c	Borneo	NE	No	No	No
Kul 38	*Dicranopteris linearis*	Gleicheniaceae	F	f	Not	NE	No	No	No
KL3; KL4	*Gnetum cuspidatum*	Gnetaceae	G	c	Not	LC	No	No	No
KL1/27,KL3/17,GOL1	*Gnetum diminutum*	Gnetaceae	G	c	Borneo	NT	No	No	No
KSM	*Scaevola taccada*	Goodeniaceae	Ad	t	Not	NE	No	No	No
KL4/26	*Hanguana malayana*	Hanguanaceae	Am	s	Not	NE	No	No	No
Kul 5	*Cratoxylum arborescens*	Hypericaceae	Ad	t	Not	LC	No	No	No
Kul 25	*Cratoxylum formosum*	Hypericaceae	Ad	t	Not	LC	No	No	No
KL1	*Curculigo latifolia*	Hypoxidaceae	Am	s	Not	NE	No	No	No
Kul	*Irvingia malayana*	Irvingiaceae	Ad	t	Not	LC	No	No	No
Kul 28	*Ixonanthes reticulata*	Ixonanthaceae	Ad	t	Not	NE	No	No	No
KSM	*Gmelina elliptica*	Lamiaceae	Ad	t	Not	NE	No	No	No
Kul 40	*Hyptis capitata*	Lamiaceae	Ad	h	Introduced	NE	No	No	No
TK	*Teijsmanniodendron unifoliolatum*	Lamiaceae	Ad	t	Not	NE	No	No	No
SAN 157821; SAN 157879; Kul 20; TK; KSM	*Vitex pinnata*	Lamiaceae	Ad	t	Not	NE	No	No	No
TBFC 31	*Vitex quinata*	Lamiaceae	Ad	t	Not	NE	No	No	No
TK	*Vitex trifolia*	Lamiaceae	Ad	t	Not	NE	No	No	No
KL4; LL1/14; **SGO 35; TBC 41**	*Actinodaphne glabra*	Lauraceae	Ad	t	Not	NE	No	No	No
KL2/15	*Beilschmiedia lucidula*	Lauraceae	Ad	t	Not	NE	No	No	No
TK	*Cassytha filiformis*	Lauraceae	Ad	t	Not	NE	No	No	No
KL/35; KR1/60	*Cinnamomum affine*	Lauraceae	Ad	t	Not	NE	No	No	No
KL3; KL4;KL2/31	*Cryptocarya densiflora*	Lauraceae	Ad	t	Not	NE	No	No	No
KL1;KRTM1;KRTM2;2	*Eusideroxylon zwageri*	Lauraceae	Ad	t	Not	VU	No	No	No
GL8/T12; KL4/1; KL3/27;GOL1;GOL2; SGO 8	*Litsea cylindrocarpa*	Lauraceae	Ad	t	Not	NE	No	No	No
KL2/45	*Litsea tomentosa*	Lauraceae	Ad	t	Not	NE	No	No	No
KSM	*Barringtonia asiatica*	Lecythidaceae	Ad	t	Not	LC	No	No	No
KL1;KL2	*Barringtonia lanceolata*	Lecythidaceae	Ad	t	Borneo	NE	No	No	No
KSM	*Barringtonia pterita*	Lecythidaceae	Ad	t	Not	NE	No	No	No
TK	*Barringtonia racemosa*	Lecythidaceae	Ad	t	Not	NE	No	No	No
Kul	*Planchonia valida*	Lecythidaceae	Ad	t	Not	NE	No	No	No
KL3;KL4;GOL1;GOL2	*Indorouvera griffithiana*	Linaceae	Ad	c	Not	NE	No	No	No
LL2/19; KL2/62;KL1/80;KL2/33; SGO 65	*Strychnos polytrichantha*	Loganiaceae	Ad	c	Borneo	NE	No	No	No
Kul 8	*Dendrophthoe curvata*	Loranthaceae	Ad	ep	Not	NE	No	No	No
Kul 16	*Macrosolen acunae*	Loranthaceae	Ad	ep	Not	NE	No	No	No
KSM	*Scurrula ferruginea*	Loranthaceae	Ad	ep	Not	NE	No	No	No
Kul 22	*Lycopodiella cernua*	Lycopodiaceae	L	l		NE	No	No	No
KL1;KL2;KRTM1;KRTM2;GOL1;GOL2; SGO 68	*Lygodium circinatum*	Lygodiaceae	F	f	Not	NE	No	No	No
SAN 157035; Kul 37; TK	*Lygodium microphyllum*	Lygodiaceae	F	f	Not		No	No	No
TBFC 34	*Lagerstroemia speciosa*	Lythraceae	Ad	t	Introduced	NE	No	No	No
SAN 157828; TK	*Sonneratia alba*	Lythraceae	Ad	t	Not	LC	No	No	No
TK; KSM	*Sonneratia caseolaris*	Lythraceae	Ad	t	Not	LC	No	No	No
KSM	*Magnolia gigantifolia*	Magnoliaceae	Ad	t	Not	NE	No	No	No
KL1/4; TK	*Brownlowia argentata*	Malvaceae	Ad	t	Not	NE	No	No	No
KL1;KRTM1,KRTM2	*Brownlowia stipulata*	Malvaceae	Ad	t	Sabah	NE	No	No	No
TK	*Brownlowia tersa*	Malvaceae	Ad	t	Not	NT	No	No	No
KL1/14;KRTM2; SAN 157845	*Byttneria reinwardtii*	Malvaceae	Ad	t	Not	NE	No	No	No
TK	*Colona serratifolia*	Malvaceae	Ad	t	Not	NE	No	No	No
KL1	*Durio grandiflorus*	Malvaceae	Ad	t	Borneo	VU	Yes	No	No
KL1;KL2;KRTM1;KRTM2	*Heritiera elata*	Malvaceae	Ad	t	Not	NE	No	No	No

TK; KSM	*Heritiera globosa*	Malvaceae	Ad	t	Borneo	EN	No	No	No
TK; KSM	*Heritiera littoralis*	Malvaceae	Ad	t	Not	LC	No	No	No
SAN 157820; TK; KSM	*Hibiscus tiliaceaus*	Malvaceae	Ad	t	Not	NE	No	No	No
KR1/74	*Leptonychia caudata*	Malvaceae	Ad	t	Not	NE	No	No	No
KL1/29;KR2/17	*Microcos membranifolia*	Malvaceae	Ad	t	Borneo	NE	No	No	No
KL2/40	*Neesia strigosa*	Malvaceae	Ad	t	Not	NE	No	No	No
2	*Pentace adenophora*	Malvaceae	Ad	t	Not	NE	No	No	No
KL2; 1	*Pentace laxiflora*	Malvaceae	Ad	t	Borneo	NE	No	No	No
KL1/T35; KRTM1; KL2/10	*Scaphium macropodum*	Malvaceae	Ad	t	Not	LC	No	No	No
TK; KSM	*Thespesia populnea*	Malvaceae	Ad	t	Not	NE	No	No	No
TBFC 51	*Donax canniformis*	Maranthaceae	Am	s	Not	NE	No	No	No
KL3;KL4	*Clidemia hirta*	Melastomataceae	Ad	s	Not	NE	No	No	No
KL1/52	*Kibbesia galeata*	Melastomataceae	Ad	t	Borneo	NE	No	No	No
KL3/8; KL4/9; SAN 157864	*Medinilla alternifolia*	Melastomataceae	Ad	s	Not	NE	No	No	No
KL3/20	*Medinilla cf. quadrifolia*	Melastomataceae	Ad	s			No	No	No
KL4; KSM	*Melastoma malabathricum*	Melastomataceae	Ad	t	Not	NE	No	No	No
Kul	*Memecylon laevigatum*	Melastomataceae	Ad	t	Not	NE	No	No	No
KRTM2;GOL2; 1; TBFC 47	*Memecylon paniculatum*	Melastomataceae	Ad	t	Not	NE	No	No	No
TBFC 39	*Pternandra azurea*	Melastomataceae	Ad	t	Not	NE	No	No	No
SAN 157806; SAN 157004	*Pternandra coerulescens*	Melastomataceae	Ad	t	Not	NE	No	No	No
KL2/23	*Aglaia cf. oligophylla*	Meliaceae	Ad	t			No	No	No
KL2/9	*Aglaia cf. rufinervis*	Meliaceae	Ad	t			No	No	No
TK; KSM	*Aglaia cucullata*	Meliaceae	Ad	t	Not	DD	No	No	No
KL2;KRTM1; SAN 157894	*Aglaia meliasmoides*	Meliaceae	Ad	t	Not	NE	No	No	No
KL3;KL4	*Aglaia silvestris*	Meliaceae	Ad	t	Not	NT	No	No	No
KL2/T12	*Dysoxylum cf. densiflorum*	Meliaceae	Ad	t			No	No	No
KSM	*Heynea trijuga*	Meliaceae	Ad	t	Not	NE	No	No	No
KL1	*Reinwardtiodendron humile*	Meliaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Xylocarpus granatum*	Meliaceae	Ad	t	Not	LC	No	No	No
TK; KSM	*Xylocarpus moluccensis*	Meliaceae	Ad	t	Not	LC	No	No	No
U1/31; KL1/33; KL2/70; LL1/45	*Albertisia cf. fulva*	Menispermaceae	Ad	c			No	No	No
LL2/39; KL3/16;KL4/19	*Fibraurea chloroleuca*	Menispermaceae	Ad	c	Not	NE	No	No	No
KL1/60	*Artocarpus kemando*	Moraceae	Ad	t	Not	NE	Yes	No	No
KL1; 2	*Artocarpus nitidus*	Moraceae	Ad	t	Not	NE	Yes	No	No
KL2/T13	*Artocarpus peltatus*	Moraceae	Ad	t	Not	NE	Yes	No	No
KSM	*Ficus benjamina*	Moraceae	Ad	t	Not	NE	No	No	No
2	*Ficus glandulifera*	Moraceae	Ad	t	Not	NE	No	No	No
KSM	*Ficus globosa*	Moraceae	Ad	t	Not	NE	No	No	No
TBFC 30	*Ficus inaequipetiolata*	Moraceae	Ad	t	Borneo	NE	No	No	No
3; TK	*Ficus microcarpa*	Moraceae	Ad	t	Not	NE	No	No	No
KL3/35	*Ficus pellucido-punctata*	Moraceae	Ad	t	Not	NE	No	No	No
TBFC 54	*Ficus punctata*	Moraceae	Ad	t	Not	NE	No	No	No
SAN 157826; TBFC 16	*Ficus sundaica var. beccariana*	Moraceae	Ad	t	Not	NE	No	No	No
1	*Ficus variegata*	Moraceae	Ad	t	Not	NE	No	No	No
GL7/T3;KL5/T55	*Horsfieldia crassifolia*	Myristicaceae	Ad	t	Not	NT	No	No	No
KL1	*Knema furfuracea*	Myristicaceae	Ad	t	Not	NE	No	No	No
KL1;KL2;KRTM1;KRTM2;GOL1;GOL2; SGO 38	*Knema laurina*	Myristicaceae	Ad	t	Not	NE	No	No	No
KL1/68	*Myristica villosa*	Myristicaceae	Ad	t	Borneo	NE	No	No	No
TK	*Osbornia octodonta*	Myrtaceae	Ad	t	Not	LC	No	No	No
KL1/54	*Syzygium brachypodum*	Myrtaceae	Ad	t	Borneo	NE	No	No	No
KL3;KL4;GOL1;GOL2	*Syzygium caudatilimbum*	Myrtaceae	Ad	t	Not	NE	No	No	No
SAN 157807	*Syzygium cf. tawahense*	Myrtaceae	Ad	t			No	No	No
KL5/T7; KL4/13; KL3/14;5;6	*Syzygium chloranthum*	Myrtaceae	Ad	t	Not	NE	No	No	No
KL2;KL4;GOL1; SAN 157888	*Syzygium creaghi*	Myrtaceae	Ad	t	Borneo	NE	No	No	No
TBFC 3; TBFC 13	*Syzygium ellipitilimbum*	Myrtaceae	Ad	t	Borneo	NE	No	No	No
KL1/23	*Syzygium kingii*	Myrtaceae	Ad	t	Not	NE	No	No	No
KR2/47	*Syzygium leptostemon*	Myrtaceae	Ad	t	Not	NE	No	No	No
KR1/41	*Syzygium leucocladum*	Myrtaceae	Ad	t	Borneo	NE	No	No	No
KL5/T4; KL3/29;KL4/5;6; Kul1; Kul 33; SGO 45	*Syzygium leucoxylon*	Myrtaceae	Ad	t	Not	NE	No	No	No
KL5/T21; KL1/26; KL2/27;KL2/44	*Syzygium pustulatum*	Myrtaceae	Ad	t	Not	NE	No	No	No
KL2/20; KR2/49; KL2/51	*Syzygium scortechinii*	Myrtaceae	Ad	t	Not	NE	No	No	No
KL3;KL4; SAN 157863	*Nepenthes ampullaria*	Nepenthaceae	Ad	s	Not	NE	No	Yes	Yes
KL3;KL4, SAN 157862	*Nepenthes mirabilis*	Nepenthaceae	Ad	s	Not	NE	No	Yes	Yes
TBFC 55	*Nephrolepis acutifolia*	Nephrolepidaceae	F	f	Not	NE	No	No	No
TK	*Nephrolepis biserrata*	Nephrolepidaceae	F	f	Not	NE	No	No	No
KL1;KL2;GOL1;GOL2; SGO 14	*Gomphia serrata*	Ochnaceae	Ad	s	Not	LC	No	No	No
KR1/43;LL1/11; KR2/14; KL2/58; SAN 157847	*Anacolosa frutescens*	Olacaceae	Ad	t	Not	NE	No	No	No
SAN 157839	*Strombosia ceylonica*	Olacaceae	Ad	t	Not	NE	No	No	No
KL1/10	*Jasminum pellucidum*	Oleaceae	Ad	c	Borneo	NE	No	No	No
KR1/1	*Myxopyrum nervosum*	Oleaceae	Ad	t	Not	NE	No	No	No
TBFC 50	*Helminthostachys zeylanica*	Ophioglossaceae	F	f	Not	NE	No	No	No
KL3/3	*Ophioglossum pendulum*	Ophioglossaceae	F	f	Not	NE	No	No	No
KL2/72	*Champereia manillana*	Opiliaceae	Ad	t	Not	NE	No	No	No
SAN 156951	*Neuwiedia zollingeri var. javanicum*	Orchidaceae	Am	h	Not	NE	No	No	No
KL2/46	*Sarcotheca diversifolia*	Oxalidaceae	Ad	t	Not	NE	No	No	No
KL1/57;GOL1	*Galearia fulva*	Pandaceae	Ad	t	Not	NE	No	No	No
KR1/81;KL 91; KL2/1;LL2/1; LL1/2	*Benstonia gibbsiana*	Pandanaceae	Am	s	Borneo	NE	No	No	No
KL1/88; KL4/28; SAN 157833	*Benstonia rupestris*	Pandanaceae	Am	s	Borneo	NE	No	No	No
KL3/5	*Freycinetia palawanensis*	Pandanaceae	Am	s	Not	NE	No	No	No
TBFC 57	*Pandanus basiloculoris*	Pandanaceae	Am	s	Not	NE	No	No	No
TK; KSM	*Pandanus odorifer*	Pandanaceae	Am	s	Not	NE	No	No	No
KR2/64; KL1/83; KL2/2	*Adenia cordifolia*	Passifloraceae	Am	t	Not	NE	No	No	No
KL2/59	*Ternstroemia aneura*	Pentaphylacaceae	Ad	t	Not	NE	No	No	No
KL2/27;KL1/21	*Antidesma fructiferum*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
SAN 157841	*Antidesma hosei*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL1/76;KL2/22	*Antidesma montanum*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL1;KRTM1;KRTM2	*Antidesma neurocarpum*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL2/T14; LL2/11;LL2/13; KL2/43; KR3/T32; SGO 19, SGO	*Aporosa frutescens*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KR1/49; KL1/50; KL2/12; SAN 157850	*Aporosa grandistipula*	Phyllanthaceae	Ad	t	Borneo	NE	No	No	No
GOL1;GOL2; SAN 157813; TBFC 46	*Aporosa lucida*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL1/17; KL1/61	*Aporosa nigricans*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL3;KL4; KL5/T26; 6	*Baccaurea bracteata*	Phyllanthaceae	Ad	t	Not	NE	Yes	No	No
KL1;KL2;KRTM2	*Baccaurea tetrandra*	Phyllanthaceae	Ad	t	Not	NE	Yes	No	No
KL1/49;KL1;2	*Cleistanthus myrianthus*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
KL2	*Cleistanthus pani*	Phyllanthaceae	Ad	t	Borneo	NE	No	No	No

SAN 157855	*Glochidion cf. microbotrys*	Phyllanthaceae	Ad	t			No	No	No
SAN 157011; TK	*Glochidion littorale*	Phyllanthaceae	Ad	t	Not	NE	No	No	No
TBFC 20	*Piper blumei*	Piperaceae	Ad	c		NE	No	No	No
KL1/11	*Piper cf. caninum*	Piperaceae	Ad	c			No	No	No
KL3/9; KL4/4	*Piper macropiper*	Piperaceae	Ad	c	Not	NE	No	No	No
TK	*Bambusa vulgaris*	Poaceae	Am	g	Introduced	NE	No	No	No
KL1;KL2	*Centotheca lappacea*	Poaceae	Am	g	Not	NE	No	No	No
KL2/3	*Dinochloa obclavata*	Poaceae	Am	c	Sabah	NE	No	No	No
SGO 78; TBFC 18	*Dinochloa scabrida*	Poaceae	Am	c	Borneo	NE	No	No	No
KL1/78	*Dinochloa trichogona*	Poaceae	Am	c	Borneo	NE	No	No	No
Kul 42	*Eragrotis atrovirens*	Poaceae	Am	g	Not	NE	No	No	No
Kul 43	*Ischaemum barbatum*	Poaceae	Am	g	Not	NE	No	No	No
SAN 157831	*Ischaemum muticum*	Poaceae	Am	g	Not	LC	No	No	No
KL1/79	*Scratochloa urceolata*	Poaceae	Am	g	Not	NE	No	No	No
KL2;KRTM1;KRTM2	*Xanthophyllum adenotus*	Polygalaceae	Ad	t	Not	NE	No	No	No
SAN 157890	*Xanthophyllum cf. elliticum*	Polygalaceae	Ad	t			No	No	No
KL2/14; KR1/62; KR2/44	*Xanthophyllum neglectum*	Polygalaceae	Ad	t	Borneo	NE	No	No	No
KRTM2; SGO 76; TK	*Drynaria sparsisora*	Polypodiaceae	F	f	Not	NE	No	No	No
KL4/24	*Pyrrosia christii*	Polypodiaceae	F	f	Borneo	NE	No	No	No
Kul	*Eichhornia crassipes*	Pontederiaceae	Am	h	Not	NE	No	No	No
TK	*Aegiceras corniculatum*	Primulaceae	Ad	t	Not	LC	No	No	No
KSM	*Ardisia macrocalyx*	Primulaceae	Ad	t	Borneo	NE	No	No	No
KSM	*Ardisia macrophylla*	Primulaceae	Ad	t	Not	NE	No	No	No
KL1/22; KR1/55	*Ardisia serrata*	Primulaceae	Ad	t	Not	NE	No	No	No
Kul 30	*Myrsine fluviatilis*	Primulaceae	Ad	t	Not	NE	No	No	No
TK	*Rapanea cf. avenis*	Primulaceae	Ad	t			No	No	No
TK; KSM	*Acrostichum aureum*	Pteridaceae	F	f	Not	LC	No	No	No
KL1	*Antrophyum callifolium*	Pteridaceae	F	f	Not	NE	No	No	No
TK	*Ceratopteris thalictroides*	Pteridaceae	F	f	Not	LC	No	No	No
KL1; GOL1; GOL2; SGO 63; TBFC 56	*Taenitis blechnoides*	Pteridaceae	F	f	Not	NE	No	No	No
KL3/4	*Vittaria elongata*	Pteridaceae	F	f	Not	NE	No	No	No
KL4/25; KL4/25; KL3/2; KL4/29	*Vittaria ensiformis*	Pteridaceae	F	f	Not	NE	No	No	No
KR1/8; KL1/9; KR2/40	*Drypetes longifolia*	Putranjivaceae	Ad	t	Not	NE	No	No	No
KL2/21; KL1/63	*Ventilago dichotoma*	Rhamnaceae	Ad	c	Not	NE	No	No	No
KL1/31	*Ziziphus angustifolius*	Rhamnaceae	Ad	t	Not	NE	No	No	No
KL1/62; KR2/23	*Ziziphus cumingiana*	Rhamnaceae	Ad	c	Not	NE	No	No	No
KR2/26; KL2/26	*Zizíphus havilandii*	Rhamnaceae	Ad	c	Borneo	NE	No	No	No
TK	*Bruguiera cylindrica*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Bruguiera gymnorhiza*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Bruguiera parviflora*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Bruguiera sexangula*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
Kul 21	*Carallia barneensis*	Rhizophoraceae	Ad	t	Not	NE	No	No	No
1;7;8	*Carallia brachiata*	Rhizophoraceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Ceriops decandra*	Rhizophoraceae	Ad	t	Not	NT	Yes	No	No
TK; KSM	*Ceriops tagal*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Kandelia candel*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Rhizophora apiculata*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
TK; KSM	*Rhizophora mucronata*	Rhizophoraceae	Ad	t	Not	LC	Yes	No	No
KR1/31; KL2/49	*Prunus cf. turfosa*	Rosaceae	Ad	t			No	No	No
KL1;KL2	*"Rothmannia pseudoternifolia"*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1/51; SGO 23; SGO 60	*Canthium confertum*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL2-65	*Chassalia curviflora*	Rubiaceae	Ad	t	Not	NE	No	No	No
TK	*Gardenia elata*	Rubiaceae	Ad	t	Not	NE	No	No	No
KSM	*Guettarda speciosa*	Rubiaceae	Ad	t	Not	NE	No	No	No
KSM	*Hedyotis cf. pulchella*	Rubiaceae	Ad	s			No	No	No
TK; KSM	*Hydnophytum formicarium*	Rubiaceae	Ad	ep	Not	NE	No	No	No
KL3/21	*Ixora blumei*	Rubiaceae	Ad	t	Not	NE	No	No	No
2	*Ixora elliptifolia*	Rubiaceae	Ad	t		NE	No	No	No
KL3;KL4; 5; 6	*Jackiopsis ornata*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1; KL1/64; KL2/61	*Lasianthus barneensis*	Rubiaceae	Ad	t	Borneo	NE	No	No	No
TK; KSM	*Morinda citrifolia*	Rubiaceae	Ad	t	Not	NE	No	No	No
TBFC 36	*Naucléa officinalis*	Rubiaceae	Ad	t	Not	NE	No	No	No
KSM	*Naucléa subdita*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1; SAN 157837	*Pleiocarpidia sandahanica*	Rubiaceae	Ad	t	Borneo	NE	No	No	No
KL2/55, KL1/42; KR2/30	*Prismatomeris malaccensis*	Rubiaceae	Ad	t	Borneo	NE	No	No	No
TBFC 28	*Psychotria agamae*	Rubiaceae	Ad	t	Borneo	NE	No	No	No
GOL1;KL4/8; SAN 157817; SAN 157014	*Psychotria sarmentosa*	Rubiaceae	Ad	c	Not	NE	No	No	No
KL3/24; LL2/9	*Psychotria viridiflora*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL2;KRTM1;KRTM2	*Saprosma arborea*	Rubiaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Scyphiphora hydrophylacea*	Rubiaceae	Ad	t	Not	LC	No	No	No
TK	*Tarenna bartlettii*	Rubiaceae	Ad	t	Borneo	NE	No	No	No
KL4; KL3/10; LL1/22; SAN 157861; SGO 43	*Timonius flavescens*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1; 2	*Timonius pakawanensis*	Rubiaceae	Ad	t	Not	NE	No	No	No
TBFC 48	*Uncaria acida*	Rubiaceae	Ad	c	Not	NE	No	No	No
KL3/12; KL4/15	*Uncaria lanosa f. glabrata*	Rubiaceae	Ad	c	Not	NE	No	No	No
Kul 12	*Uncaria nervosa*	Rubiaceae	Ad	c	Not	NE	No	No	No
KR2/33; KL1/78	*Urophyllum glabrum*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1	*Urophyllum griffithianum*	Rubiaceae	Ad	t	Not	NE	No	No	No
KL1;KL2;KRTM1;KRTM2; Kul 4	*Clausena excavata*	Rutaceae	Ad	t	Not	NE	No	No	No
KL2/69	*Luvunga sarmentosa*	Rutaceae	Ad	t	Not	NE	No	No	No
Kul 18	*Melicope hookeri*	Rutaceae	Ad	t	Not	NE	No	No	No
KL3/28; KL4/7	*Melicope latifolia*	Rutaceae	Ad	t	Not	NE	No	No	No
TK; KSM	*Merope angulata*	Rutaceae	Ad	t	Not	NE	No	No	No
LL3/17; SAN 157875; TBFC 8	*Xylosma luzonense*	Salicaceae	Ad	t	Not	NE	No	No	No
Kul	*Salvinia molesta*	Salviniaceae	F	f	Not	NE	No	No	No
TK; KSM	*Allophylus cobbe*	Sapindaceae	Ad	t	Not	NE	No	No	No
KL1/7;4	*Dimocarpus longan*	Sapindaceae	Ad	t	Not	NT	Yes	No	No
TK	*Dodonaea viscosa*	Sapindaceae	Ad	t	Not	NE	No	No	No
LL1/33; LL2/24; KL4/2	*Guioa pleuropteris*	Sapindaceae	Ad	t	Not	NE	No	No	No
KL2/38; KL1/67; KL2/25	*Lepisanthes fruticosa*	Sapindaceae	Ad	t	Not	NE	No	No	No
KL1	*Lepisanthes multijuga*	Sapindaceae	Ad	t	Borneo	NE	No	No	No
TBFC 9	*Mischocarpus sundaicus*	Sapindaceae	Ad	t	Not	NE	No	No	No
LL2/31	*Nephelium ovaleatum*	Sapindaceae	Ad	t	Sabah	NE	Yes	No	No
KRTM2;1; SGO 7	*Nephelium lappaceum*	Sapindaceae	Ad	t	Not	LC	Yes	No	No
2	*Pometia pinnata*	Sapindaceae	Ad	t	Not	NE	No	No	No

KL2/T32	*Madhuca elmeri*	Sapotaceae	Ad	t	Sabah	NE	No	No	No
GOL1; SAN 157027; Kul 17; TK; KSM	*Planchonella obovata*	Sapotaceae	Ad	t	Not	NE	No	No	No
SAN 157020	*Schizaea dichotoma*	Schizaeaceae	F	f	Not	NE	No	No	No
KL2;GOL1;GOL2; SGO 30; TBFC 12	*Eurycoma longifolia*	Simaroubaceae	Ad	t	Not	NE	No	No	No
KL1;KL3;KL4; TK	*Quassia indica*	Simaroubaceae	Ad	t	Not	NE	No	No	No
KL1/58	*Stemonurus scorpioides*	Stemonuraceae	Ad	t	Not	NE	No	No	No
SAN 157824; SAN 157010; TK	*Symplocos celastrifolia*	Symplocaceae	Ad	t	Not	NE	No	No	No
2	*Camellia lanceolata*	Theaceae	Ad	t	Not	NE	No	No	No
KRTM1;GOL1; 1;6	*Aquilaria beccariana*	Thymelaeaceae	Ad	t	Not	VU	Yes	No	Yes
KL1;1;6; SGO 26, TBFC 6	*Aquilaria malaccensis*	Thymelaeaceae	Ad	t	Not	VU	Yes	No	Yes
KR3/T4; KR2/22; KR2/41; KL2/52	*Gonystylus keithii*	Thymelaeaceae	Ad	t	Borneo	VU	Yes	No	Yes
Kul 2	*Wikstroemia tenuiramis*	Thymelaeaceae	Ad	t	Not	NE	No	No	No
KL1	*Dendrocnide oblanceolata*	Urticaceae	Ad	t	Borneo	NE	No	No	No
TBFC 1	*Poikilospermum cordifolium*	Urticaceae	Ad	c	Not	NE	No	No	No
KSM	*Poikilospermum suaveolens*	Urticaceae	Ad	c	Not	NE	No	No	No
KSM	*Lantana camara*	Verbenaceae	Ad	s	Not	NE	No	No	No
KSM	*Stachytarpheata jamaicensis*	Verbenaceae	Ad	s	Not	NE	No	No	No
Kul 13	*Cayratia japonia*	Vitaceae	Ad	c	Not	NE	No	No	No
TK	*Cayratia trifolia*	Vitaceae	Ad	c	Not	NE	No	No	No
KR1/28; KL1/53	*Cissus repens*	Vitaceae	Ad	c	Not	NE	No	No	No
KRTM1; SAN 157867; TBFC 33	*Leea indica*	Vitaceae	Ad	t	Not	NE	No	No	No
KL4/12; KL3/22	*Pterisanthes cissoides*	Vitaceae	Ad	c	Not	NE	No	No	No
TBFC 23	*Pterisanthes polita*	Vitaceae	Ad	c	Not	NE	No	No	No
KL3/23; KL4/18	*Tetrastigma papillosum*	Vitaceae	Ad	c	Not	NE	No	Yes	No
SAN 157802	*Alpinia aquatica*	Zingiberaceae	Am	h	Not	NE	No	Yes	Yes
SAN 157808	*Alpinia ligulata*	Zingiberaceae	Am	h	Borneo	NE	No	Yes	Yes

Notes:

Idlocation: KL=Kul=Kulamba WR; LL=SGO=GOL=Sungai Gologob FR; KR=KRTM=Kretam FR; TK=Trusan Kinabatangam FR; KSM=Kuala Segama & Meruap FR; SAN=Sandakan Herbarium series

IUCN Red List: CR=Critically endangered; EN=Endangered; VU=Vulnerable; NT=Near threatened; LC=Least concern; NE=Not Evaluated.

SFDpro=Sabah Forestry Department protected species; SWCE=Sabah Wildlife Conservation Enactment, CITES=Convention of International Trade of Endangered Species

Group: Ad=Angiosperm Dicotyledon; Am=Angiosperm Monocotyledon; G=Gymnosperm; F=Fern; L=Lycophyte

H=habit; c=climber; ep=epiphyte; f=fern; g=grass; h=herb; l=lycophytes; pt=palm tree; s=shrub; sd=sedge; t=tree.

Slide Presentation

Plant Diversity Study in RAMSAR Site in Sabah, Malaysia

John B. Sugau, Jom T. Pereira, Suzana Saban and Anik Maryam M.

Forest Research Centre,
Sabah Forestry Department,
Sepilok, 90715 Sandakan,
Sabah, Malaysia

Contents

- Introduction
- Objectives
- Methods
- Results and discussion
- Recommendation
- Conclusion
- Acknowledgments

Introduction

- In terms of flora, there has been no comprehensive study on plant diversity in Sabah's Ramsar site.
- The earlier records of plant collecting in the area:
  -Meijer (1960 and 1967) in Kuala Segama-15 species;
  -Lee & Aban (1984) in Kuala Meruap- 27 species;
  -Diwol (1984) in Kulamba FR- 5 species.
- Vegetation assessment and classification for Lower Kinabatangan was done by WWF in 2007 and recorded about 85 species from Ramsar site (SaBC, 2010).
- FRC staff carried out Mangrove surveys in Trusan Kinabatangan in 2008 and in Kuala Segama & Kuala Meruap FR in 2008 -2009.

Objectives

- To document the flora of Ramsar site in Sabah.
- To identify key conservation target plant species.
- To identify issues and threats to plant species.
- To provide recommendations for the conservation and wise use of wetlands and their resources.

Methods

-Data were retrieved from database:

- --Plant collection in the past.
- --Mangrove survey were done in Trusan Kinabatangan FR and Kuala Segama & Kuala Segama FR
- --The first expedition around Kulamba Field Centre in Kulamba FR

-The second expedition focused on the in-land forests of Kulamba FR :

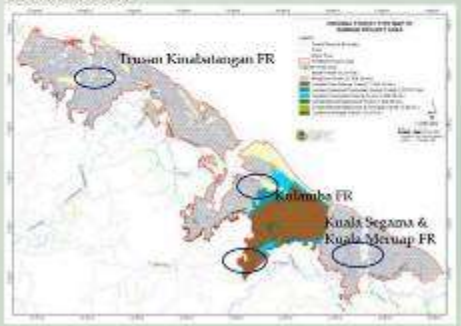
- --Plant/specimen collection: sterile and fertile.
- --All specimens were oven dried and identified

-Data compilation.

-Only species that identified to specific, infra-specific and cf. level were used in this paper.

Methods cont.

Collection sites



Results and Discussion

Plant Diversity

Number of plant taxa according to plant groups from RAMSAR site, Sabah, Malaysia.

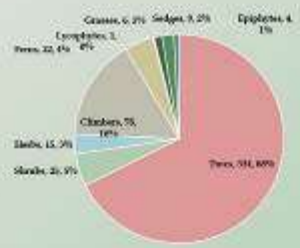
Plant group	No. of families	No. of taxa
Lycopyhtes	1	1
Ferns	12	22
Gymnosperms	1	2
Angiosperms:		
Monocotyledon	13	52
Dicotyledon	80	421
Total	107	498

Results and Discussion cont..

The ten most specious plant families in Sabah's Ramsar site.

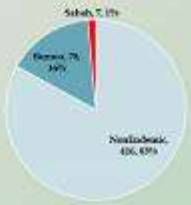
Results and Discussion cont..

Diversity of plant life form in Sabah's Ramsar site



Results and Discussion cont...

Plant endemism in Sabah's Ramsar site



Results and Discussion cont...

Endemism

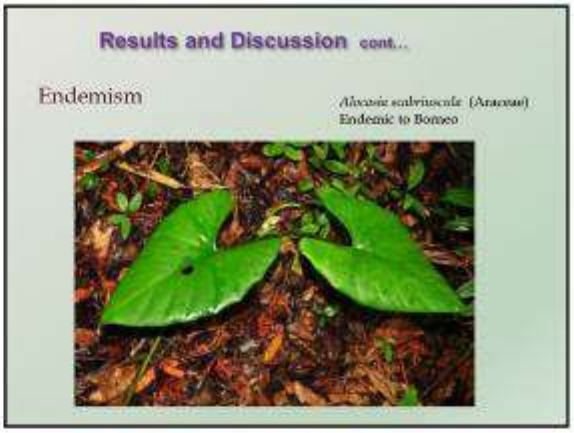
Shorea symingtonii (Dipterocarpaceae)
Endemic to Sabah

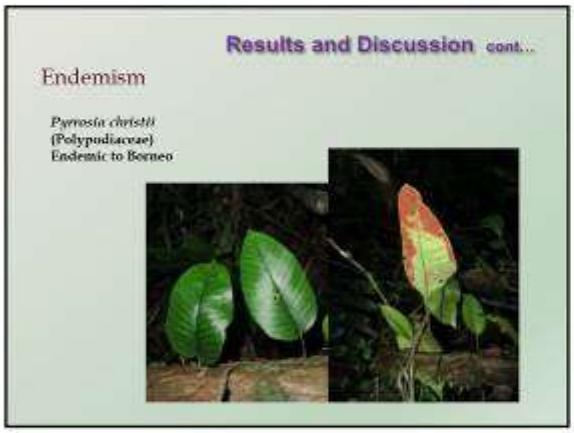
Results and Discussion cont...

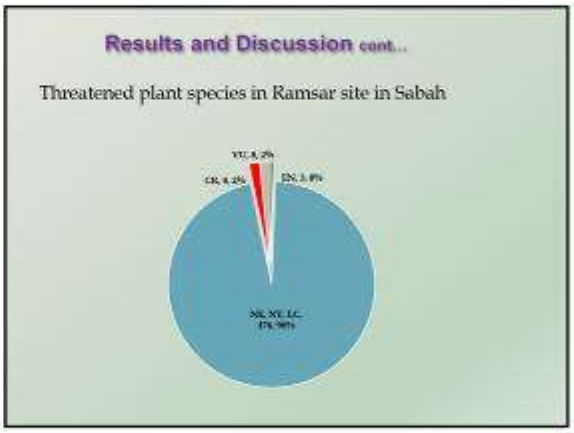
Endemism

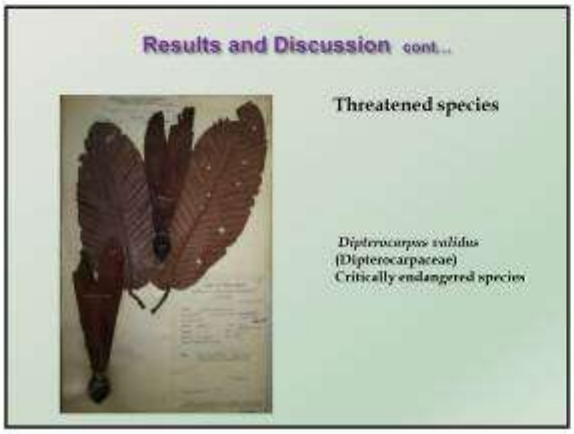
Dinochloa oliveriana (Poaceae)
Endemic to Sabah

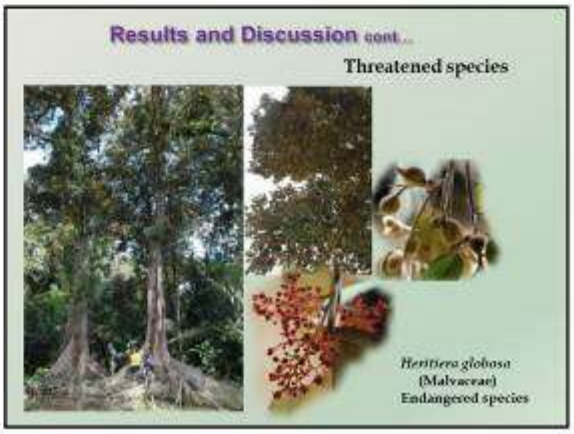

Results and Discussion cont...
Endemism
Syzygium craighii (Myrtaceae)
Endemic to Borneo


Results and Discussion cont...
Endemism
Alocasia scalprinoscala (Araceae)
Endemic to Borneo


Results and Discussion cont...
Endemism
Pyrrosia christii
(Polypodiaceae)
Endemic to Borneo


Results and Discussion cont...
Threatened plant species in Ramsar site in Sabah


Results and Discussion cont...
Threatened species
Dipterocarpus validus
(Dipterocarpaceae)
Critically endangered species


Results and Discussion cont...
Threatened species
Heritiera globosa
(Malvaceae)
Endangered species

Results and Discussion cont...

Threatened species

Fosilerocylon zuvageri
(Lauraceae)
Vulnerable species

Issues and Threats

- Forest Fire
- Illegal harvesting of plant (tengar)

Recommendations

Management plan:

-Population study of high conservation value plant species.

-Forest fire Control.

-Enforcement to curb illegal encroachment or felling of trees.

Recommendations cont...

Population study of high conservation value plant species:

-*Arenga retroflorescens* (Arecaceae)

-*Heritiera globosa* (Malvaceae)

-*Shorea symingtonii* (Dipterocarpaceae)

Recommendation cont...

- High conservation value plant to monitor

Arenga retroflorescens
(Arecaceae)
Endemic to Borneo

Recommendation cont...

- High conservation value plant to monitor

Heritiera globosa
(Malvaceae)
Endemic to Borneo

Recommendation cont...

- High conservation value plant to monitor

Shorea symingtonii
(Dipterocarpaceae)
Endemic to Sabah

Conclusion

- A total of 498 taxa have been recorded from Ramsar site in Sabah.
- The area contains high conservation value plant species:
  - Endemic to Sabah (7) and Borneo (78).
  - Threatened plant species (19).
- The area is important and crucial for the survival of the high conservation value plant species and species that confine to wetland habitats, such as mangrove species, nypha, etc. Therefore management plan of the area is very important to be formulated as a guide to wisely manage the area.

Acknowledgements

- Ministry of Natural Resources & Environment (NRE) - funding.
- Director of Forestry, Deputy Director (Forest Sector Planning) and Deputy Director (R&D) for their constant support.
- Kinabatangan DFO and RAMSAR scientific expedition secretariat for providing logistic support.
- PGA for security.
- En. Jumri Abd. Hamid provided maps.
- The staff of the Systematic Botany section for their hard work in the field.

ORAL PAPER 4

SUGAR PRODUCTION AND REPRODUCTIVE PHENOLOGY OF *Nypa fruticans* (Palmae) IN LABUK BAY, SABAH

Nadirah Abd Manaf, Colin R. Maycock & Berhaman Ahmad
Universiti Malaysia Sabah

Ms Nadirah Abdul Manaf is a M.Sc. (Forestry) student from Universiti Malaysia Sabah (UMS). She obtained her degree in B.Sc. in Biological Science from Universiti Brunei Darussalam in which the topic of her project was about roost selection of Small Woolly Bat, *Kerivoula intermedia* in Brunei Darussalam. Her recent research in UMS focuses on reproductive phenology, distribution and sugar production of nipah palm, *Nypa fruticans*, in Labuk Bay, Sabah.

Abstract

Nipa (*Nypa fruticans*) has been traditionally used for multiple purposes from roofing material to foods. The palm produced sugar sap (nira) which is produced by traditional method of massaging. The study was conducted to explore new method to produce nira using heat. In addition, we also observed the reproductive phenology of nipa palms from July 2014 to July 2015 to determine the best period for tapping. The palm was suitable for tapping in June until December where dry season begins until the start of rainy season. The period of massaging the fruit stalk to obtain high volume of nira (sap) is within 137 days (SD=27.3, n=18) when the endosperms are soft and jelly-like. Traditional method produced better sap yield compared to heated method. However, heated method generated higher sugar content of nira.

INTRODUCTION

Nipa palm (*Nypa fruticans* Wurmb) is a mangrove tree that can be found growing in brackish water in estuaries, coastal zones, small channels of river, tidal flats and creeks, as long as tide exist (Fong 1982, Rozainah & Aslezaeim 2010). Nipa palm has been used for generations by locals in Southeast Asia for various purposes from thatching for roof to cigarettes, vinegar, sugar, alcohol and as traditional medicine (Paivoke, 1996). Currently, interest on this species is back in the focus of the world due to its potential as a source of bioethanol (Tsuji *et al*. 2011, Tamunaidu *et al.* 2011, Tamunaidu *et al.* 2013 & Matsui *et al*. 2014). Previous work in Thailand has shown that nipa can produce between 4,550 to 9,100 litres of ethanol per hectare per year (Tamunaidu *et al.* 2013). This suggests that nipa may have the potential to replace fossil fuels. The process of tapping nira does not involve cutting down the palm tree (Tsuji *et al.* 2011). Given that Sabah has an estimated massive stand of 331,620.12 hectares of undisturbed mangrove forest reserves, this could be profitable to the state (Annual Report 2013). However, to realize this potential, an understanding of the reproductive phenology of nipa is needed.

Thus, information about reproductive phenology of nipa palm is crucial to plan the tapping regime for nira production. Therefore the objective of this study is to investigate time and duration in which the palm can produce maximum volume of nira. We had also tested the palms with traditional and a new method of heated water to produce nira.

METHODOLOGY

Study site - The study was conducted in nipa stand surrounding Nipah Lodge and Platform C of the Labuk Bay Proboscis Monkey Sanctuary (LBPMS) (N 05° 55.014', E 117° 47.904', and N 05° 56.158' E 117° 47.552', respectively), in Mile 19, Sandakan, Sabah, Malaysia. These naturally occurring nipa stands are part of a large 263 hectares of mangrove forest, which is surrounded by an oil-palm plantation. The palms in both areas are frequently flooded at a certain time daily depending on the tide. From July 2014 until July 2015, the area had received 168 rainy days (Figure 1) with 2.47 meter of rain in total. Heavy rain occurred particularly on the 13th January, 2015 (164.6mm). Mean daily temperature ranged from 24.9°C to 30°C, with the highest mean daily temperature occurring in May, 2015.

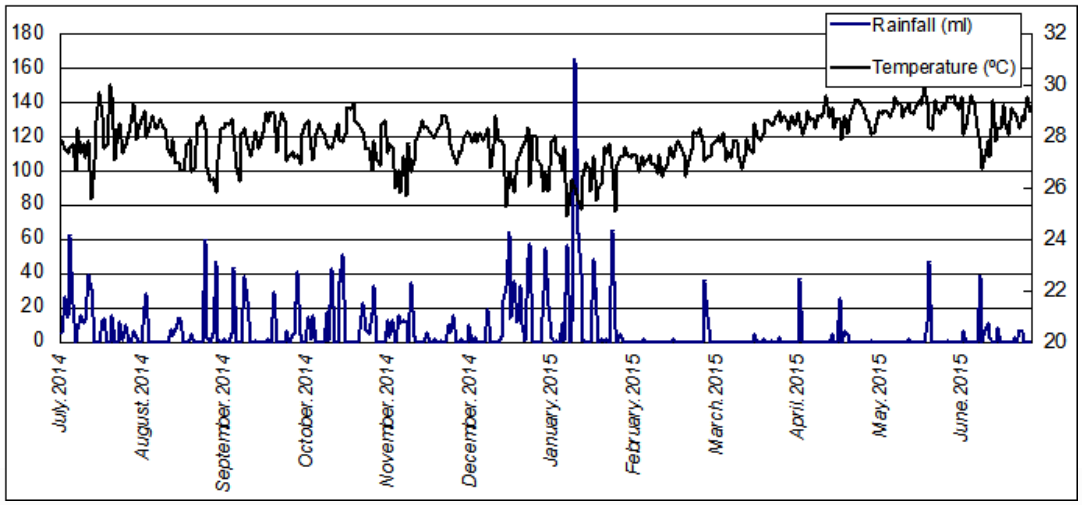


Figure 1. Monthly temperature (black) and rainfall (blue) in Labuk Bay, Sandakan, Sabah.

Reproductive phenology – To identify the most suitable tapping period, we recorded the reproductive phases of 54 palms for a 12 month period from July 2014 until July 2015. Time taken

(days) and number of individuals involved for each phase to occur were recorded. We classified the reproductive phases into different stages based on a modified method of Rozainah & Aslezaeim (2010). We recorded the phases for each of the 54 individual palms for the presence and absence of 1) unopened flower bud, 2) the pistil head of female flowers, 3) spikes of male flowers, 4) infructescences brown (immature) consisted of jelly-like endosperm, 5) infructescences brown (mature) consisted of hardened endosperm, and 6) no reproductive phenomenon occurred. Due to frugivores that consumed some of the enlarged flower bud, newly emerged pistil head and individual infructescence, the palms involved that did not survive will be noted in Phase 6 until such occurrence of another flower bud begins. The individuals had either experienced the breaking of infructescence which released the viviparous fruits or any of its phase disturbed by frugivores and ended until the next cycle begins. An individual palm can possess more than one phase at the same time. This is due to some individuals possessing more than one inflorescence/infructescence at the same time.

Sugar/sap production - To determine sugar/sap yield production we selected six adult palms for traditional method namely Tree 29, 73, 56, 58, 66, and 70. We also selected five palms for heated water method, namely Tree 77, A1, A7, A8 and A9. As it is difficult to determine the exact age of the palms, we selected our palms based on modification of the criteria outlined in methods outline by Rozainah & Aslezaeim (2010). Adult nipa palms were selected if 1) they possessed seven or more fronds, 2) thicker and longer infructescence stalk, 3) infructescences in perfect condition, without disturbance by any animals. All palms are situated in the surrounding area of Platform C, LBPMS. To prepare the palm infructescence stalk for sugar production, we followed the method of Päivöke (1985), where six palms undergo standardized pre-treatment of massaging and bending of the stalk for 3-5 times a week for 4-12 weeks. Apart from traditional method of getting nira, we applied heated water (80-90^{o}C) to the stalk of the infructescences of five palms. The process is repeated daily for a month. Sugar (brix) measurement was done in the field using portable digital refractometer HI 96801 (Hanna Inst., USA) every morning (8:00-9:00 am). To investigate the peak of production of nira, we also measured sugar and sap production of the palms every four hours for three days to determine the peak production of sugar and sap.

RESULTS

Reproductive phenology

The reproductive phenology of nipa palm occurred throughout the year (Table 1 & Figure 2). However, there was an average of 243.3 days (n=40, SD=53.6) gap in a year where there was no reproductive phenology occurred (Phase 6). Phase 6 occurred all year and peaked in June and July during the dry season.

The peak of flower buds emergence (Phase 1) occurred in July with an average of 43.9 days (n = 12, SD = 27.68). There were 13.5 individuals (SD = 4.9) budding at the same time. 18 individuals did not show any flower bud emergence throughout the year. Pistillate phase and staminate phase occurred a day apart. The yellow pistil head of female flower emerged for average 5.5 days (n=10, SD=1.08) before pollination occurred. Spikes of staminate flowers bloomed for 9 days (n = 11, SD = 4.69) before wilted. Flowering peaked on July but it also occurred in August, October, January and May. Apart from the peak months, only surviving flowers were recorded.

Immature infructescence phase which was suitable for tapping transpires in June until December. Duration of Phase 4 was approximately 137 days (n=18, SD=27.3). However, a total of 13% immature infructescences were eaten by frugivores among the individuals observed (n=54). Tapping possibility

diminished in January due to heavy rainfall that caused flooding. Mature infructescences took in average approximately 85.2 days (n=41, SD=47) before individual fruits started to drop. The phase took place throughout the year but peaked in July and August. October and November showed the lowest amount of mature infructescences seen.

Table 1. Average duration of time (day) and standard deviation for each phases observed.

Phase	Days (Average)	SD	No. of Individuals
1	43.9	27.68	12
2	5.5	1.08	10
3	9	4.69	11
4	137	27.3	18
5	85.2	47	41
6	243.3	53.6	40

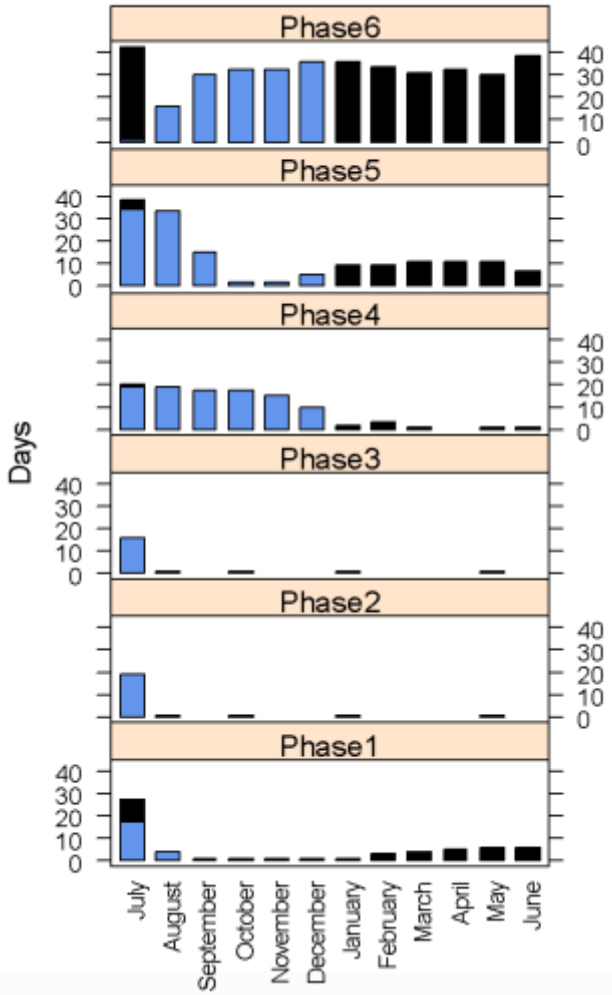


Figure 2. Phases of reproductive phenology from July 2014 (blue) until July 2015 (black).

Sugar/sap production

Although treated with the same method of pre-treatment, the palms chosen for nira tapping had variation in sap production. The palms had 9 to 13 fronds in range. On average, the palms produced sap from 450.6 mL to 774.1mL daily with average brix concentration ranging from 17.8% to 19.2% daily (Table 2). Tree 58 had the highest brix reading at 19.2%. Five of the trees produced nira for more than 1L sap daily (Table 2). On average, the palms were able to produce ≥1L nira for 30 days (n=5, SD=12.9). We found a significant negative correlation between the number of fronds and the concentration of brix (Spearman, r=-0.83, p-value=0.02).

Table 2. Six palms treated with traditional method. Only one tree did not produce nira for more than 1L in a day.

Tree	No. of Fronds	Total Day of Sap Produced (days)	Average Sap Daily (mL/d)	Total Sap (L)	Average Brix Concentration (%)	Days Sap Produced ≥1L (days)
29	10	138	774.1	106.8	19.0	52
56	9	66	761.3	50.3	18.2	20
58	9	113	652.3	73.7	19.2	26
66	13	80	753.4	60.3	17.8	30
70	13	84	450.6	37.9	17.8	-
73	10	65	636.2	41.4	18.7	22

Sap production fluctuated greatly with the amount of rainfall daily (Figure 3). Amount of sap increased daily when amount of rainfall decreased. Great fluctuation could be seen on day 77-78 when total rainfall of 164.6 and 64.4mm had caused the nira to decrease to 320 and 90 mL respectively.

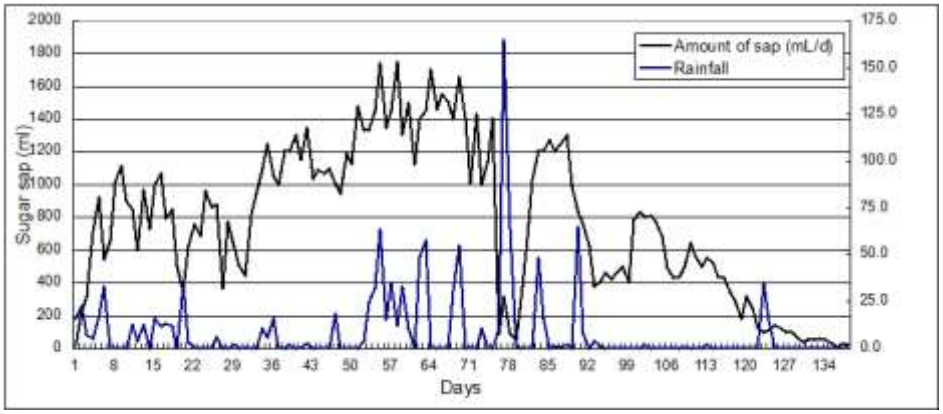


Figure 3. The graph showed one of the trees tapped (Tree 29), amount of sap daily against rainfall data. The tapping started in 24th October 2014 until 19th March 2015.

Sugar concentration (brix) was the highest at 10:00 a.m daily (Figure 4). All 6 individuals peaked at 10:00 am with mean amount ranging from 17.4% to 20.47%. Meanwhile, mean sap yield showed the highest at 6:00 am (n=2) and 10:00 am (n=4) (Figure 5). Mean sap yield ranged from 105 to 600 mL. The lowest sap value recorded was at 2:00 pm (n=4) and 6:00 pm where sap produced ranged from 75mL to 162.5mL.

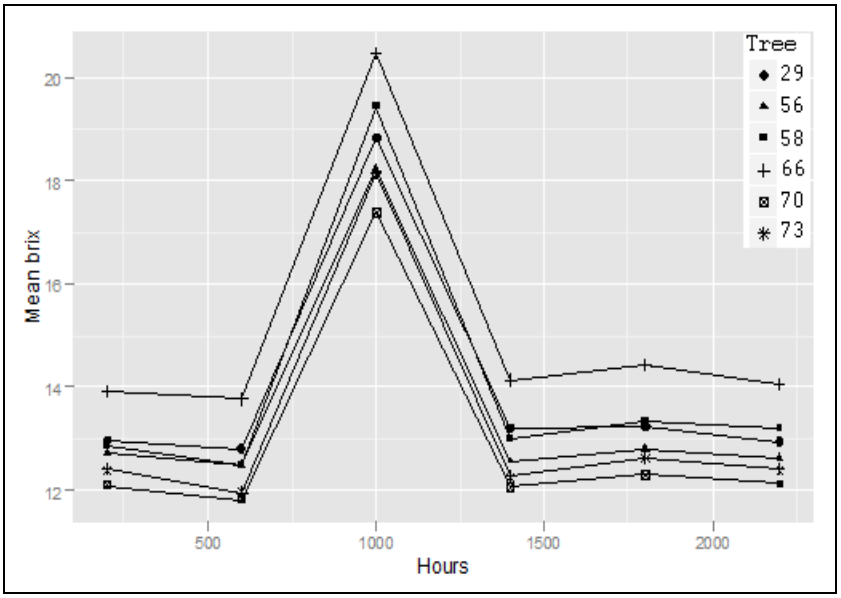


Figure 4. Average concentration (%) of sugar (brix) for six palms every 4 hours. The palms produced the highest sugar concentration at 10:00 a.m.

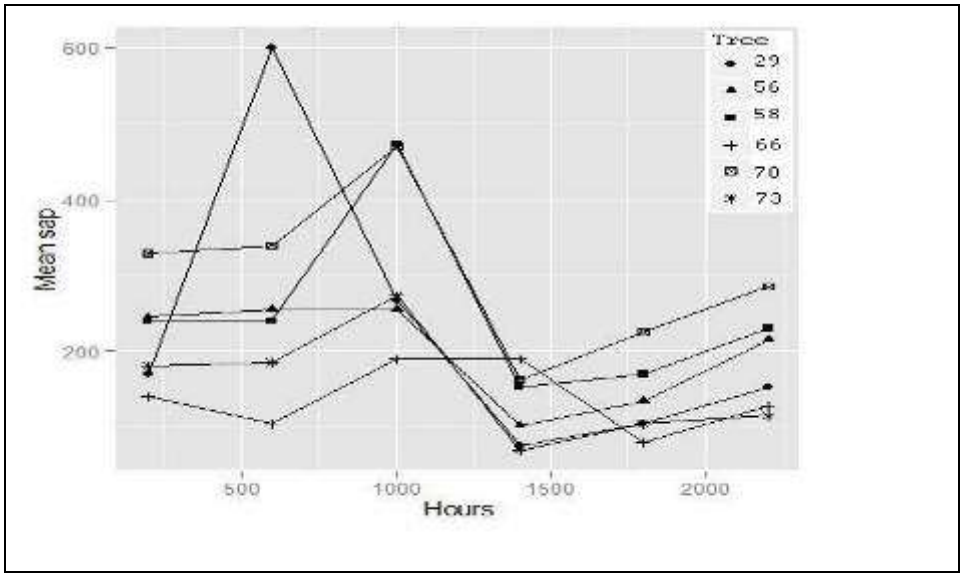


Figure 5. Average sap (nira) produced for every four hours.

The amount of sap produced was the highest at 6:00 am for one individual and 10:00 am for 5 individuals. Tree 66 still produced high sap at 2:00 pm although the rest of the trees had the lowest production at that time. Five individuals that were applied with heated water showed lower value than tapping using traditional method (Table 3). The average sap producing days was 55 days and ranged from 20 to 71 days. Average brix concentration was 20.26%, slightly higher than traditional method (18.45%). There is no significant difference in sugar concentration (brix %) between traditional method and heated water method (Welch T-Test, p-value = 0.7871). However there is a significant difference between their average sugar production (Welch T-Test, p-value= 2.2x10^-16).

Table 3. Five individual palms applied with heated water.

Tree	Total Day of Sap Produced (days)	Average Sap Daily (mL/d)	Total Sap (L)	Average Brix Concentration (%)
77	42	71.1	2.9	18.78
A1	71	209.71	14.47	19.68
A7	59	540.85	31.91	19.8
A8	59	140.45	7.87	20.26
A9	20	79.5	1.59	19

DISCUSSION

Phenology

Seasonal fruiting pattern in palms has been recorded before in numerous study (Galetti *et al.* 1999, Silva & Scariot 2013, Genini *et al.* 1999, Kubickova 1990, Marten *et al.* 1999). A number of palms have fruiting peak whether during dry season or wet season (Galetti *et al.* 1999 & Silva & Scariot 2013). Census done on *Astrocaryum standleyanum* and *Attalea butyracea* in Panama showed fruiting peaks in rainy season and the last month of drier season (Adler & Lambert 2008). Fruiting ability of palms had so far been influenced by weather. However, palms produced ripe fruits all over the year (De Steven *et al.* 1987).

We found that all of the phases of flowering and fruiting from Phase 1 until 6 of nipa peaked in dry season. The phases occurred throughout the year, and began in July. Approximately 41.2% occurrence began in July. It was difficult to determine what caused high occurrence in dry season. Flowering peaks could be due to higher insect activity during the time (Smythe 1982 & Wolda 1978). It also pointed out to possible photosensitivity cue (De Steven *et al.* 1987). However, these remain speculative without further work.

Slight decrease in fruiting activity of palms usually occurred during the wet-dry season transition (De Steven *et al.* 1987). This can be seen in October, the inter-monsoon period where only three individuals bore mature infructescences which dropped by the end of November. We found that 13% of the young infructescences eaten by animals. Immature infructescences of Phase 4 must be protected and secured due to disturbance by frugivores. The pre-treatment of tapping nira should begin when the infructescences start to bear jelly-like endosperm which attracts frugivores. Phase 4 which peaked in July-December where rain was scarce. In addition, the probability of frugivore predation was higher due to lack of rain causing them to find alternatives to look for water. Among the predators were squirrels, mice, monkeys, macaques, orang utans, ants and bees. Disturbance by these animals was less during rainy season.

Sugar and sap production

Our results showed that sugar content of nipa sap was 18.45%. Thailand showed a brix concentration of 18.1% and Papua New Guinea, 16.4% (Paivoke 1983, Matsui *et al*. 2014). Small data sampled in this study could hardly show significant result. In addition, according to Matsui *et al*. (2014), for every 1 litre of sap produced, sugar content (brix) decreased by 4%. Higher amount of sap showed less sugar content (e.g. Tree 29; 21.8% brix, 50 ml sap on day 132 compared to 16.7% sugar to 1.27L sap on day 85). However, nipa palm in Labuk Bay showed longer sap producing days (ranged from 51 to 138 days) compared to Thailand (ranged from 20 to 56 days). It is unknown what factor that could influence the production of sap, the sugar content and the longevity of palm to produce sap continuously. Age of the palm is probable cause. However, it is difficult to determine the age of monocots. We know from Rozainah & Aslezaeim (2010) that the age can be determined by the number of fronds produced. There is a positive correlation between number of fronds that a palm possessed and concentration of sugar produced (p-value=0.02). However, Tree 29 and Tree 73 that are supposed to be in the same age did not produce similar amount of sap and concentration of sugar. The same goes to Tree 56 and 58, and Tree 66 and 70. Like Matsui *et al.* (2014), we hereby conclude that it is unlikely for age to influence sap production in nipa palm. According to Matsui *et al*. (2014), temperature, soil, and water condition are the most probable factor that could influence sugar content. This was supported by high variation in sap yield from two different nipa palms (Matsui *et al.* 2014).

Heavy rain for two days in January (164.6 mL/d and 64.4mL/d) brought along flood which made tapping nira impossible, as the stalk was in the water. Water inundation proved to be a problem because stalks that have not been tapped will decrease the amount of sap the next day. Disruption by macaques (*Macaca fascicularis*) left the end of the infructescence stalk exposed, thus reducing the amount of sap as well. Prevention could be taken to avoid this disruption. However, it is inevitable that immature infructescenses and flower buds would be eaten.

More experiments need to be conducted to determine factors that influence differences between the amount of sap/sugar in every 4 hours; on why the sugar and sap amount the highest in the morning at 6:00 and 10:00 am. The factor could be caused by photosynthesis process. The intensity of photosynthetic rate under the sun starts to increase during sunrise, reaching maximum rate at mid-morning and then decreases during mid-day (Koyama & Takemoto 2014). However, without further information and experiments conducted, these factors cannot be determined.

Sap and sugar production in Labuk Bay, Sabah differed from other places. One of the main reasons for this is skill and expertise of people that did the tapping. Other reasons are environmental factors caused by temperature, soils, rainfall and water condition.

More samples for sugar/sap production are needed in order to have better analysis. Lack of samples for nira tapping was due to inexperience skill. Without doubt, the process of nira tapping requires skill that can only be garnered by years of experience. Improvised methods of heat treatment hopefully could generate better production of sap in the future. Experiments need to be conducted to determine the temperature of heated water needed for optimal sap production. Furthermore, other methods apart from heated water must be explored. Thus, disadvantages of high demand for manual labour in nira tapping as mentioned by Paivoke (1996) could be reduced and the use of heavy machinery could be avoided.

Acknowledgement

We thank Dr. Lee Ying Fah of Forest Research Centre (FRC), Sabah Forestry Department for continuous advice and support on this study; Mr. Michael Lee for permission to work in Labuk Bay Proboscis Monkey Sanctuary. We thank the staff of FRC for help in the field especially Mr. Selamat Mail, Mr. Ridhwan Malijau and Mr. Salamat Ali. We are grateful to the small grant provided by FRC for this project.

References

Adler, G. H., & Lambert, T. D. (2008). Spatial and temporal variation in the fruiting phenology of palms in isolated stands. *Plant Species Biology* 23: 9-17.

Annual Report (2013). *Sabah Forestry Department Annual Report 2012.* Sabah Forestry Department, Sandakan.

De Steven, D., Windsor, D. M., Putz, F. E., & Leon, B. d. (1987*).* Vegetative and reproductive phenologies of a palm assemblage in Panama. *Biotropica* 19(4): 342-356.

Fong, F.W. (1982). *Nypa swamps in Peninsular Malaysia.* Proceedings of the First International Wetlands Conference. Wetlands: Ecol. Manage. Pp. 31-38.

Galetti, M., Zipparro, V. B., & Morellato, P. C. (1999). Fruiting phenology and frugivory on the palm Euterpe Edulis in a lowland Atlantic forest of Brazil*. Ecotropica* 5: 115-122.

Genini, J., Galetti, M., &Morellato, P. C. (2009). Fruiting phenology of palms and trees in an Atlantic rainforest land-bridge island*. Flora* 204: 131-145.

Koyama, K., & Takemoto, S. (2014). Morning reduction of photosynthetic capacity before midday depression. Scientific Report 4: 4389.

Marten, S., & Quesada, M. (2001). Phenology, sexual expression and reproductive success of the rare neotropical palm Geonomaepetiolata. *Biotropica* 33(4): 596-605.

Matsui, N., Okimori, Y., Takahashi, F., Matsumura, K., and Bamroongrugsa, N. (2014). Nipa (*Nypa fruticans* Wurmb) sap collection in Southern Thailand I. Sap production and farm management. *Environment and Natural Resources Research* 4 (4): 75-88.

Päivöke, A. E. A. (1985). Tapping practices and sap yields of the nipa palm (*Nypa fruticans*) in Papua New Guinea. *Agriculture, Ecosystems and Environment* 13: 59-72.

Rozainah, M. Z., & Aslezaeim, N. (2010). A demographic study of a mangrove palm, *Nypa fruticans*. *Scientific Research and Essays* 5 (24): 3896-3902.

Silva, P. A. D. & Scariot, A. (2013*).* Phenology, biometric parameters and productivity of fruits of the palm *Butia capitata* (Mart.) Beccari in the Brazillian cerrado in the north of the state of Minas Gerais. *Acta Botanica Brasilica* 27(3): 580-589.

Smythe, N. (1982). The seasonal abundance of night-flying insects in a neotropical forest. In E. G. Leigh, A. S. Rand, and D.M. Windsor (Eds.). *The ecology of a tropical forest*. Pp. 309-318. Smithsonian Inst.Press,Washington, D.C.

Tamunaidu, P. & Saka, S., (2011). Chemical characterization of various parts of nipa palm (*Nypa fruticans*). *Industrial Crops and Products* 34: 1423-1428.

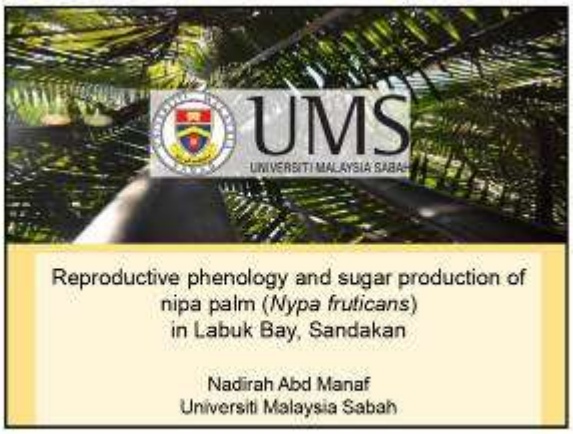
Tamunaidu, P., Matsui, N., Okimori, Y., & Saka, S. (2013). Nipa (*Nypa fruticans*) sap as a potential feedstock for ethanol production. *Biomass and Bioenergy* 52: 96-102.

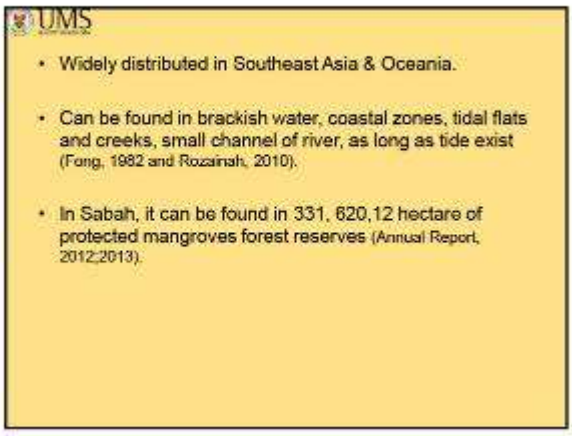
Tsuji, K., Ghazalli, M. N. F., Zulhairil Ariffin, Nordin, M. S., Khaidizar, M. I., Dulloo, M. E., & Sebastian, L. S. (2011). Biological and Ethnobotanical Characteristics of Nipa Palm (*Nypa fructicans* Wurmb.): A Review. *SainsMalaysiana* 40(12): 1407-1412.

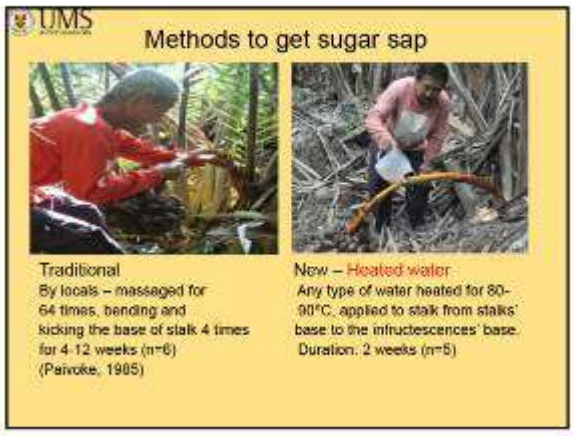
Uhl, N. W. (1972*).* Inflorescence and flower structure in *Nypa fruticans* (Palmae). *American Journal of Botany* 59(7): 729-743.

Wolda, H. (1978). Seasonal fluctuations in rainfall, food, and abundance of tropical insects. *J. Anim. Ecol*. 47: 369-381.

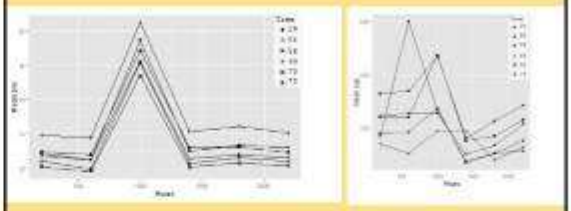
Slide Presentation







Nira collection



Observation on amount of nira every 4 hours in 3 days (n=6).

- Average sap (right) peaks at 6:00 and 10:00 am daily.
- Sugar concentration (left) peaks at 10:00 am.

Tree	Total Day of Sap Produced (days)	Average Sap Daily (mL/d)	Total Sap (L)	Average Brix Concentration (%)	Days Sap Produced ≥1L (days)
39	138	774.1	106.8	19.0	52
56	66	661.5	50.3	18.2	20
58	113	652.5	73.7	19.2	28
66	80	753.4	60.3	17.8	30
70	84	450.6	37.9	17.8	
73	65	636.2	41.4	18.7	22

- Average sap ranges from 636.2 mL to 753.4mL daily
- Average brix concentration ranging from 17.8% to 20.2% daily
- In average, the palms are able to produce ≥1L nira for 30 days (n=5, SD=12.9).
- Average sap producing days ranges from 51 to 138 days.

Tree	Total Day of Sap Produced (days)	Average Sap Daily (mL/d)	Total Sap (L)	Average Brix Concentration (%)
77	42	71.1	2.9	18.78
A1	71	208.71	14.47	19.68
A7	59	540.85	31.91	19.8
A8	59	140.45	7.87	20.26
A9	20	79.5	1.59	19

- Average sap from 71.1 mL to 540.85 mL daily
- Average brix concentration ranging from 18.78% to 20.26% daily
- In average, the palms are able to produce ≥1L nira for 30 days (n=5, SD=12.9).
- Average sap producing days is 55 days (ranges from 20 to 92 days).

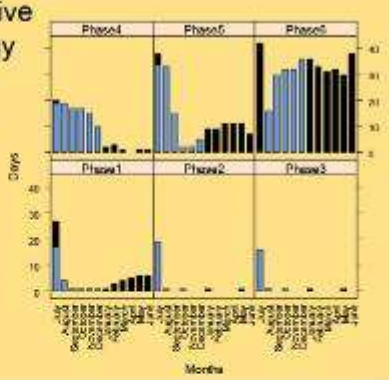
- Traditional method – produced higher amount of sap but heated method produced higher sugar content.
- Soil is the factor that influence the production of sap (Matsui, 2014)
- Further study need to be done on ideal temperature for heated method.
- More samples for sugar/sap production are needed in order to get comprehensible analysis. Lack of samples for nira tapping is due to inexperience and skills. Other reasons are environmental factors caused by temperature, soils, rainfall and water conditions.

- Furthermore, other methods apart from heated water must be explore. Thus disadvantages of high demand for manual labor in nira tapping as mentioned by Paivoke (1996) could be reduce and the use of heavy machinery could be avoided
- High sap & sugar amount in the morning - The factor could be caused by photosynthesis process. The intensity of photosynthetic rate under the sun starts to increase during sunrise, reached maximum rate at mid-morning and then showed depression during mid-day (Koyama & Takemoto, 2014).
- However, without further information and experiments done the factors can't be determine.

UMS

Reproductive phenology

- 54 nipa palms observed for a year
- Phases of reproductive phenology divided into 6



UMS

Reproductive phenology

Phase 1 – occurrence of flower bud.
Duration: Average 43.9 days
(n=12, sd= 27.68)

Peaks in July.

UMS

Phase 2– emergence of female flower

Pistillate phase and staminate phase occurred a day apart.

The yellow pistil head of female flower emerged for average 5.5 days (n=10, SD=1.08) before pollination occurred.

UMS

Phase 3 – emergence of male flowers

Spikes of staminate flowers blooms for 9 days (n=11, SD=4.69) before wilted.

Peaks in July.

UMS

Phase 4 – immature infructescence

Edible jelly-like endosperm.
Suitable for tapping nira.
Occurred from July – December.
Peaked on July-August.

Duration :
137 days (n=18, SD=27.3).

UMS

Phase 5 – mature infructescence

Hardened endosperm.
Nira tapping is not possible.
Peaked on July – August.

Duration :
85.2 days (n=41,SD=47)

UMS

Phase 6 – no reproductive process occurred.

A gap in a year where no reproductive cycle occurred. Vegetative process still occurred during this time.
Can be seen throughout the year.

Duration :
243.3 days (n=40, SD 53.6)

UMS

- Seasonal fruiting pattern in palms has been recorded before in numerous study
- Fruiting and flowering ability of palms had so far been influenced by weather.(Galetti et al., 1999; Silva et al., 2013; Genini et al., 1999; Kubickova 1990; Marten et al., 1999).
- July- August is the start of Phase 1-5, which is the beginning of rainy season in 2014.
- Slight decreased in fruiting activity of palms usually occurred during the wet-dry season transition (De Steven, 1987). This can be seen in October and November where only three individuals bear mature infructescences which dropped by the end of November.

- July is the beginning of rainy season in 2014.
- Sugar sap production diminished due to heavy rain and floods.

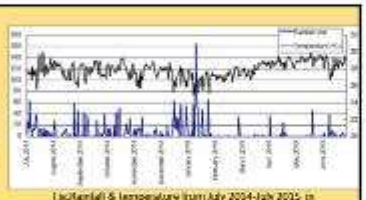


Fig.Rainfall & temperature from July 2014-July 2015 in Lubuk Buaj, Sandakan, Sabah.

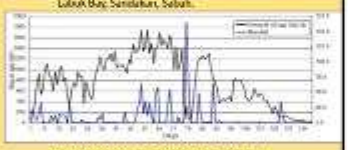


Fig.Sugar sap production versus rainfall data

UMS

Conclusion, Challenges & Future study

Conclusion:. Suitable tapping months starts from July – August. Amount of sugar sap using traditional method of tapping still surpassed the method of heated water. Phase1-5 (flowering &fruiting) begins in July-August.

Challenges

- Disturbance by animals; *Macaca nemestriana & Macaca fascicularis*, ants, bees, orangutan, squirrels, mice etc. exposed the stalk to dried up & the next day reading to differed.
- Environment; high tides, heavy rain, floods.

UMS

Future recommendation : Improvised methods of heat treatment hopefully could generate a better production of sap in the future.

Furthermore, other methods apart from heated water must be explored. Thus disadvantages of high demand for manual labor in nira tapping as mentioned by Paivoke (1996) could be reduce and the use of heavy machinery (if there's any) could be avoided.

Production of nira will certainly bring profits to the local people and the government through production of various products.

Acknowledgement

Sabah Forestry Department
Forest Research Centre
Dr. Lee Ying Fah of Forest Research Centre(FRC), Sabah Forestry Department
Dr. Berhaman Ahmad of Universiti Malaysia Sabah
Mr. Michael Lee of Labuk Bay Proboscis Monkey Sanctuary(LBPMS)
Staff of FRC,Mr. Selamat Mail, Mr. Salamat Ali, Mr. Marcus Gubill
Mr. Rizwan Malijau Abdullah, Ms. Nurul Shabariah Abu Bakar
Staff of LBPMS

Thank you

ORAL PAPER 5

PRELIMINARY CHECKLIST OF MAMMALS AND BIRDS OF KULAMBA FIELD CENTRE AND NEARBY FORESTS IN THE LOWER KINABATANGAN-SEGAMA WETLANDS

Rayner Bili, Vivian Rudolf, Lawrence Tingkui & George Hubert Petol
Sabah Forestry Department

(Presented by George Hubert Petol)

Mr George Hubert Petol, joined Sabah Forestry Department since May 1995 as a research officer on a research project in Danum Valley. He has been based at the Forest Research Centre, Sepilok since 1997 and became involved with environmental education at the (then) newly set up Rainforest Interpretation Centre, RIC. He reignited interest in birding in 2008 as the RDC became a focal point for birders with the regular sightings of the Bornean Bristlehead. He is also a co-author of a book entitled "A photographic guide to the lowland birds of Sepilok" which was published to encourage birding among the younger generation.

Abstract

This presentation provides a preliminary list of mammal and bird species at and nearby Kulamba Field Centre. These species were observed during the "Ramsar Site: Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition" which was held on the 16th-26th June 2014. The five-day observation period for birds yielded 70 species from 35 families (including 1 unresolved family). Only 3 species are endemic to Borneo; however, these endemics—the White-crowned shama, Bornean Brown Barbet and Dusky Munia are common in Sabah. It is found that the species observed were mainly of wetlands, open spaces and secondary forest species. There was a noticeable lack of lowland forest bird species. The common bird species seen flying constantly at KFC were the Silver-rumped Spinetail, Mossy-nest Swiftlet and Pacific Swallow. Brahminy Kites and other birds-of-prey can be seen soaring high above Sg. Kulamba and Sg. Kretam. To local birders or bird enthusiasts, the avifauna of the KFC and its nearby areas is not remarkably interesting due to the fact that the bird species recorded could be easily and commonly seen in most open areas and forest edges near coasts and large rivers. The five-day observation period for wildlife yielded 22 species of terrestrial mammals from 15 families. Of these, 14 species were documented through confirmed sightings, animal tracks, droppings, nests and vocalisations, while 8 species were included after personal communications with locals and those familiar with the area. Interesting Bornean fauna includes the Bornean orangutan, proboscis monkey, Müller's Bornean gibbon, Sunda clouded leopard, oriental small-clawed otter and the Bornean sun bear.

Oral Paper 5.1

REPORT ON WILDLIFE SURVEY (MAMMALS AND BIRDS) IN TUNDON BOHANGIN, RAMSAR PROJECT SITE

Rayner Bili, Yoktan Julbit & Lawrence B. Tingkoi
Sabah Forestry Department

Abstract

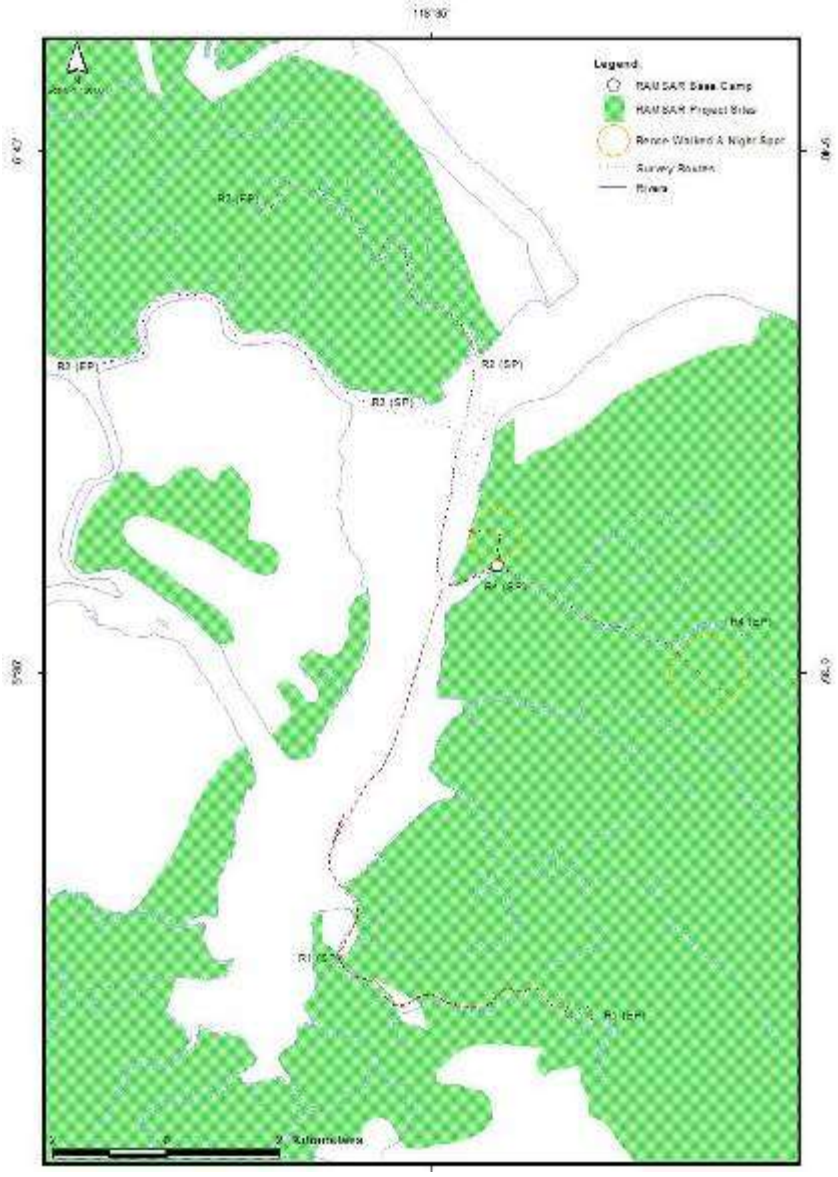
At least 14 species of terrestrial mammals with 11 different families were detected and recorded during the expedition, 4 species were classified in schedule I (totally protected), 7 species in schedule II (protected species-limited hunting with license) and 3 species in schedule III (protected species-hunting with license) under the Wildlife Conservation Enactment 1997. From this information, 57.14% of species detected (n=8) are classified as threatened species, 28.57% as least concern (n=4), 7.14% (n=1) as near threatened and 7.14% (n=1) classified as data deficient in IUCN red list. In general, 5 primate species were recorded which all of them are diurnal species and 3 species, namely Proboscis Monkey, Bornean Gibbon and Orang-utan are classified as threatened species in IUCN red list, 4 species of Carnivora were recorded, in which 2 species (Clouded Leopard and Oriental Small-clawed Otter) are threatened in IUCN red list. Besides, more than 50 species of birds from 36 families were sighted and recorded throughout the survey which only 5.08% (n=3) species are classified as threatened and 13.56% (n=8) species are classified as near threatened in IUCN red list Others recorded are mainly classified as least concern.

1.0 INTRODUCTION

General wildlife survey for mammals and birds was conducted from 22nd to 26th June 2014. The survey was carried out to procure information of mammals and birds within the Ramsar project area.

1.1 Study Area

Map 1.1: Wildlife observation within Ramsar project site.



1.2 Objectives

The main objectives of wildlife survey are as follows:

i. To accumulate and document information in relation to the existing terrestrial mammals and birds within to the selected areas in Ramsar project site.

ii. To gather general information in relation to the major threats of wildlife diversity status in the Ramsar project site.

2.0 METHODOLOGY

Direct and indirect sightings through recce, night walk and river survey, opportunistic sightings and direct interviews with rangers working in the Ramsar project site. All methods were based on the comprehensive field manual of monitoring large terrestrial mammals in Sabah by Ancrenaz (2013).

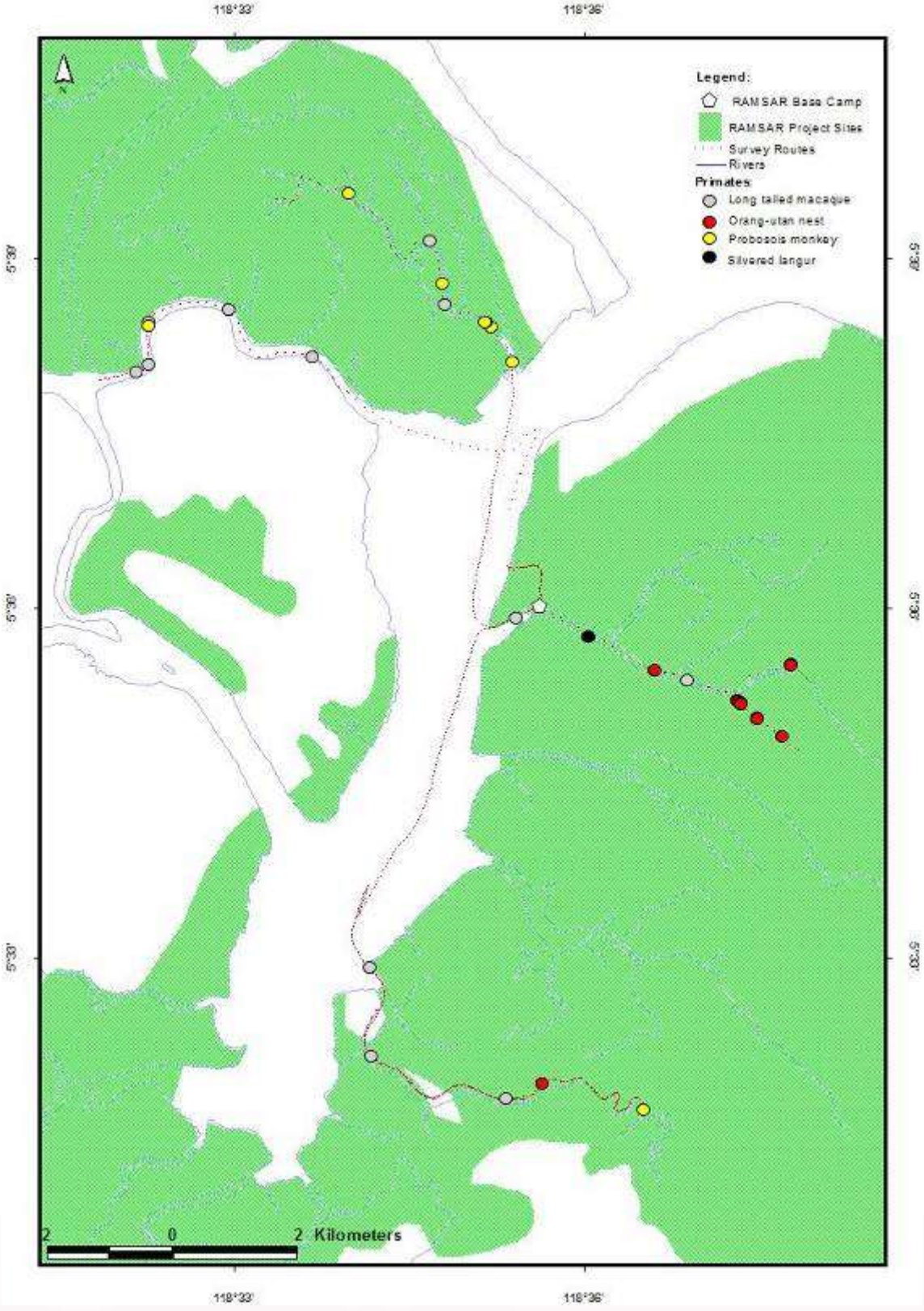
The team walked through the forest by foot (during daytime and night time) along the existing trails and ex-logging road. Two survey routes were established: (i) nearby Ramsar base camp and (ii) Kulamba (ex-logging road). The transect length was 1300 m. Observation was conducted without predetermined direction, to gather information on wildlife presence within the new areas being explored. Three people were involved and walked slowly through the transect, and any wildlife signs detected along the survey (both diurnal and nocturnal) were recorded to determine the species. For every wildlife spotted, the team stopped for species identification and collected additional information (number of animals, behaviour upon detection and distance). All wildlife signs detected were analysed by using linear kilometric index (number of sightings/km). Besides, human activities within the Ramsar project site were also noted to formulate better wildlife management plan in future.

2.1 Field Equipment

Map, GPS, compass, head lamp, torch light, datasheet form, knife, measuring tape, binocular, digital camera, handy radio, raincoat, waterproof notebook, field manual (monitoring large terrestrial mammals in Sabah, mammals and birds of Borneo) and proper personal gear.

3.0 RESULTS

Map 3.1: Distribution of some primate species detected during wildlife survey.



3.1 Mammals

Generally, at least 14 wildlife terrestrial mammal species with 11 different families were detected during the rapid survey and assessment in Ramsar project site. There are 4 large terrestrial wildlife species namely Clouded Leopard, Orang-utan, Proboscis Monkey and Banteng were detected and recorded along the survey, all these species known and classified as schedule I (totally protected) under Wildlife Conservation Enactment 1997, at least 7 wildlife species, namely Long-tailed Macaque (Crab-eating Macaque), Silvered Langur (Silvered leaf monkey), Bornean Gibbon (Müller's Bornean Gibbon), Oriental Small-clawed Otter (Asian Small-clawed Otter), Plantain Squirrel, Common Palm Civet and Malay Civet are in schedule II (protected species-limited hunting with license). There are 3 species, namely Sambar Deer, Wild Pig and Mouse Deer are in schedule III (protected species-hunting with license). Based on percentage, we noticed that 57.14% of wildlife species detected along the survey were classified as threatened species, 28.57% known as least concern, 7.14% near threatened and 7.14% classified as data deficient in IUCN red list. Besides that, we also noticed that the presence (based on footprints) of game species such as Wild Pig, Sambar Deer and Mouse Deer were found in all over the project site.

At least 5 species of primates were sighted and recorded during the wildlife survey and all of them are diurnal species, 3 species of primates detected, namely Proboscis Monkey, Bornean Gibbon and Orang-utan are classified as threatened in IUCN red list. Current survey showed that Long-tailed Macaque (crab-eating macaque) is a common species and was quite often observed along the river in all Ramsar project sites. Proboscis Monkey was also sighted in almost all project sites but it was often spotted in *Sg. Kuburan R2* **(see map 1.1 and 3.1)**.

Table 3.1: Numbers of large terrestrial mammal species detected through wildlife survey (recce) within Ramsar project site.

Common name	Scientific Name	Family	WCE [SWD]	IUCN red list
Banteng	*Bos javanicus*	**Bovidae**	I	Endangered
Wild pig	*Sus barbatus*	**Suidae**	III	Vulnerable
Bornean gibbon	*Hylobates muelleri*	**Hylobatidae**	II	Endangered
Clouded leopard	*Neofelis nebolusa*	**Felidae**	I	Vulnerable
Common palm civet	*Paradoxurus hermaphroditus*	**Viverridae**	II	Least concern
Lesser mouse deer	*Tragalus javanicus*	**Tragulidae**	III	Data Deficient
Long-tailed macaque	*Macaca fascicularis*	**Cercopithecidae**	II	Least concern
Malay civet	*Viverra tangalunga*	**Viverridae**	II	Least concern
Orang-utan	*Pongo pygmaeus*	**Pongidae**	I	Endangered
Oriental small clawed otter	*Aonyx cinerea*	**Mustelidae**	II	Vulnerable
Plantain squirrel	*Callosciurus notatus*	**Sciuridae**	II	Least concern
Proboscis monkey	*Nasalis larvatus*	**Cercopithecidae**	I	Endangered
Sambar deer	*Rusa unicolor*	**Cervidae**	III	Vulnerable
Silvered langur	*Trachypithecus cristatus*	**Cercopithecidae**	II	Near Threatened

Note (WCE. 1997):
Schedule I - totally protected, Schedule II - species protected - license limited, Schedule III - hunt with license

Some information from direct interview with senior rangers and foresters were recorded. Any data gathered from previous studies (carried out by WWF-Malaysia and BORA) were also noted and compiled. According to information obtained, a total of 22 species from 15 families of terrestrial mammals were identified from the project sites **(see Table 3.2)**. Approximately 54.55% (n=12) were classified as threatened species in IUCN red list **(see Figure 3.1)**. The information shows imperative figures that Ramsar project site as having interesting species diversity, and significantfor conservation.

Table 3.2: A list of terrestrial mammals in Ramsar project site (information gathered based on current survey and previous observation by WWF-Malaysia & BORA as well as interviews from senior rangers and foresters).

Common name	Scientific Name	Family	WCE [SWD]	IUCN red list	Note
Banded palm civet	*Hemigalus derbyanus*	**Viverridae**	II	V	Interview, June 2014
Banteng	*Bos javanicus*	**Bovidae**	I	E	SFD, survey June 2014 (dung and prints)
Bearded pig	*Sus barbatus*	**Suidae**	III	V	SFD, June 2014 survey, common
Binturong/Bearcat	*Arctictis binturong*	**Viverridae**	II	V	Interview, June 2014
Bornean gibbon	*Hylobates muelleri*	**Hylobatidae**	II	E	SFD, survey June 2014 (vocalizing)
Clouded leopard	*Neofelis nebolusa*	**Felidae**	I	V	SFD, survey June 2014 (prints)
Common palm civet	*Paradoxurus hermaphroditus*	**Viverridae**	II	LC	SFD, survey June 2014
Giant squirrel	*Ratufa affinis*	**Sciuridae**	II	NT	Interview, June 2014
Large flying fox	*Pteropus vampyrus*	**Pteropodidae**	III	NT	Interview, June 2014
Leopard cat	*Prionailurus bengalensis*	**Felidae**	II	LC	Interview, June 2014
Lesser mouse deer	*Tragalus javanicus*	**Tragulidae**	III	DD	SFD, survey June 2014 (prints)
Long-tailed macaque	*Macaca fascicularis*	**Cercopithecidae**	II	LC	SFD, survey June 2014 (sighting)
Malay badger	*Mydaus javanensis*	**Mephitidae**	II	LC	Interview, June 2014
Malay civet	*Viverra tangalunga*	**Viverridae**	II	LC	SFD, survey June 2014 (sighting)
Orang utan	*Pongo pygmaeus*	**Pongidae**	I	E	SFD, survey June 2014 (nest)
Oriental small clawed otter	*Aonyx cinerea*	**Mustelidae**	II	V	SFD, survey June 2014 (sighting)
Plantain squirrel	*Callosciurus notatus*	**Sciuridae**	II	LC	SFD, survey June 2014 (sighting)
Proboscis monkey	*Nasalis larvatus*	**Cercopithecidae**	I	E	SFD, survey June 2014 (sighting)
Sambar deer	*Rusa unicolor*	**Cervidae**	III	V	SFD, survey June 2014 (prints)
Silvered langur	*Trachypithecus cristatus*	**Cercopithecidae**	II	NT	SFD, survey June 2014 (sighting)
Sumatran Rhinoceros	*Dicerorhinus sumatrensis*	**Rhinocerotidae**	I	CR	Interview, June 2014
Sun bear	*Helarctos malayanus*	**Ursidae**	I	V	Interview, June 2014

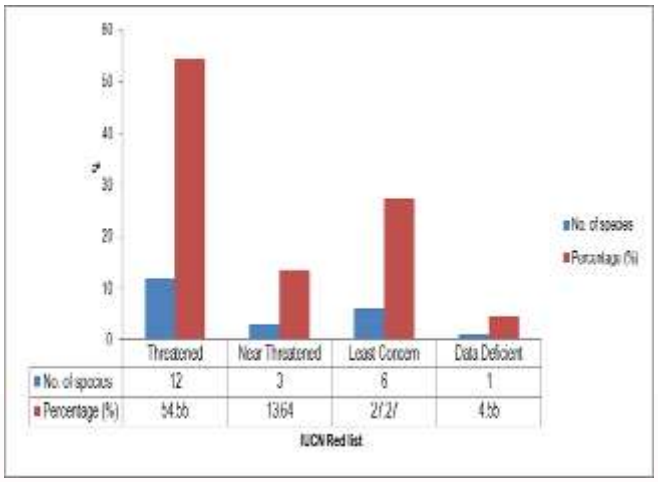


Figure 3.1: Status of significant terrestrial mammals (based on current and previous studies as well as from interviews) in Ramsar project area based on IUCN red list categories.

3.1.1 River Surveys

Table 3.3 and Figure 3.2 show the number of primate species detected per kilometre in four different rivers within Ramsar project area, [no. of species (group)/km], total distance covered Sg. Merah: (R1) = 5.9km, Sg. Kuburan (R2) = 6.5, Sg. Terusan Kecil (R3) = 6.2km & Sg. Kulamba (R4) = 5.1km.

Table 3.3: Number of primate species detected (by group) per kilometre during the river surveys conducted within Ramsar project site, [no. of species detected / kilometre], ∑distance covered each studies sites (average) = 5.925 km.

Common Name	*Scientific Name*	R1 (Sg. Merah)	R2 (Sg. Kuburan)	R3 (Sg. Terusan Kecil)	R4 (Sg. Kulamba)
Long-tailed macaque (Crab-eating macaque)	*Macaca fascicularis*	3	2	5	2
Proboscis monkey	*Nasalis larvatus*	1	6	1	0
Silvered langur (Silvered leaf monkey)	*Trachypithecus cristatus*	0	0	0	1
Orang utan	*Pongo pygmaeus*	1	0	0	3

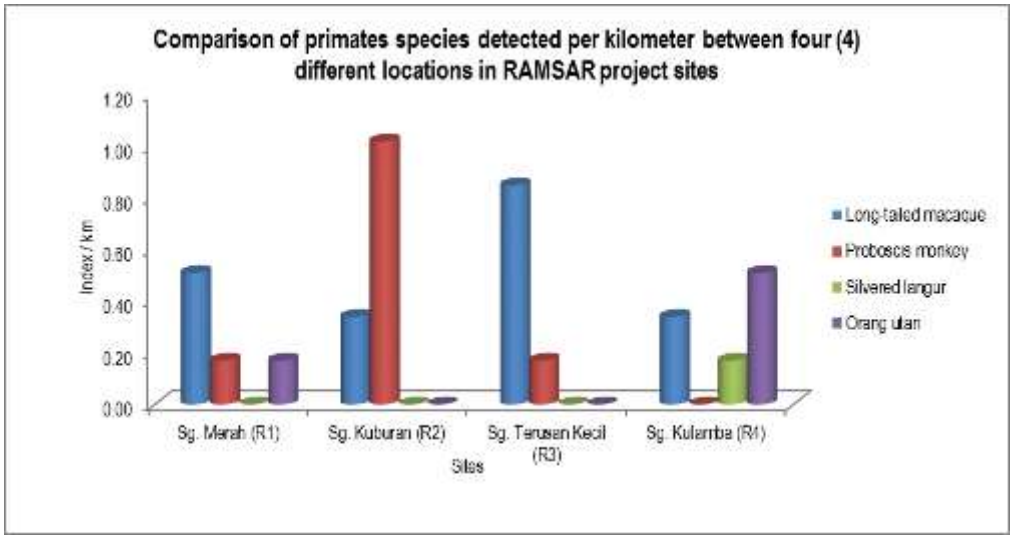


Figure 3.2: Primate species (by group) detected per kilometer during river surveys in Ramsar project area.

In term of species detection per km, we noticed that Long-tailed Macaque showed the highest species detection (2.03 group/km) and followed by Proboscis Monkey (1.36 group/km). Long-tailed Macaque can be found in all study sites, while for Proboscis Monkey, it was found only in several sites, such Sg. Merah, Sg. Kuburan and Sg. Terusan. For the period of river survey, the highest detection for Proboscis monkey was in Sg. Kuburan (1.02 group/km) and followed by Sg. Merah and Sg. Terusan (0.17 group/km). Silvered Langur was sighted only in Sg. Kulamba, while some Orang-utan nests were recorded in Sg. Merah and Sg. Kulamba.

3.1.2 Recce Walks

Recce walks are significant during rapid wildlife inventories to adapt with new areas and provide information about wildlife species (presence/absence) and human activities. However, the sample not representative to the whole study area and sometimes we missed to detect some animal signs. However, since no proper line transect was established in project sites, we have selected randomly some locations (travel recces) that could be reached by foot and followed the easy paths with clear forest cover and dried area. All wildlife signs detected every 50 meters have been recorded and pooled as a single detection. The recce findings are shown in Tables 3.4 & 3.5 and Figures 3.3 & 3.4.

Table 3.4: Number and percentage of some terrestrial mammals detected through wildlife survey (recce walks) within Ramsar project site.

Common name	Scientific Name	Family	No. of Objects/signs	%
Orang utan (nests)	*Pongo pygmaeus*	**Pongidae**	9	27.27
Sambar deer (prints)	*Rusa unicolor*	**Cervidae**	6	18.18
Wild pig (prints)	*Sus barbatus*	**Suidae**	6	18.18
Lesser mouse deer (prints)	*Tragalus javanicus*	**Tragulidae**	5	15.15
Banteng (dung/prints)	*Bos javanicus*	**Bovidae**	3	9.09
Clouded leopard (prints)	*Neofelis nebolusa*	**Felidae**	2	6.06
Oriental small-clawed otter (sightings)	*Aonyx cinerea*	**Mustelidae**	2	6.06

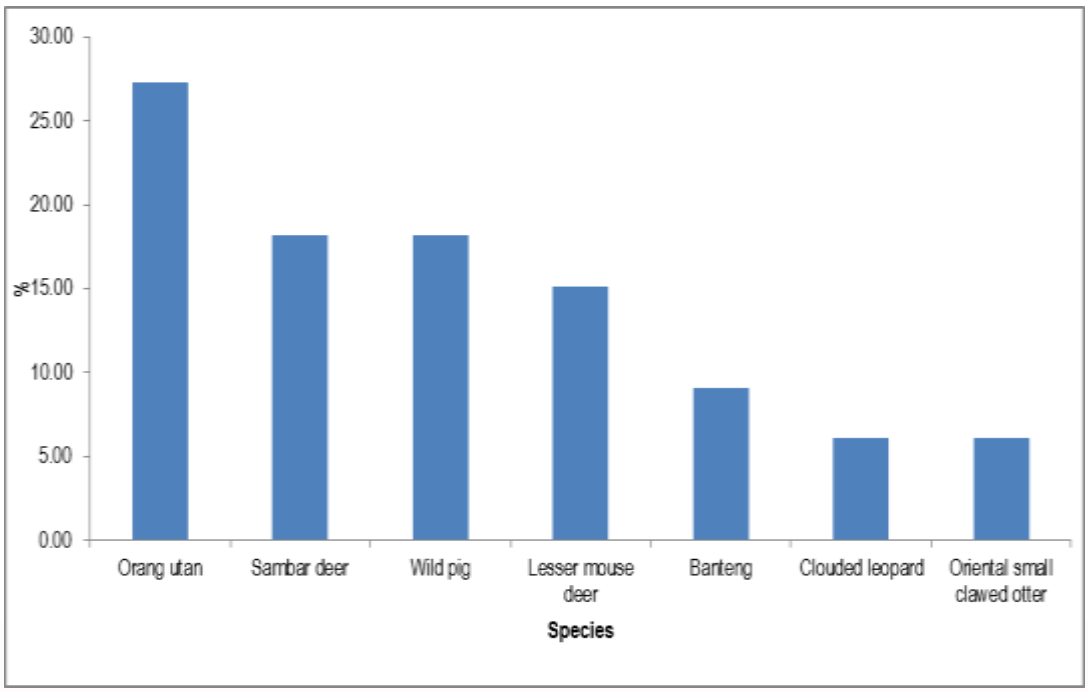


Figure 3.3: Percentage (%) of large terrestrial mammals detected based on direct and indirect sightings through recce walk within Ramsar project site.

Table 3.5: Relative indices of large mammals based on direct and indirect signs detected per kilometre for the period of recce walked within Ramsar project site, (no. of species signs/km), ∑distance covered = 2.6km.

Common name	Scientific Name	Family	No. of Objects	Index / km
Orang utan (nests)	*Pongo pygmaeus*	**Pongidae**	**9**	**3.46**
Sambar deer (prints)	*Rusa unicolor*	**Cervidae**	**6**	**2.31**
Wild pig (prints)	*Sus barbatus*	**Suidae**	**6**	**2.31**
Lesser mouse deer (prints)	*Tragalus javanicus*	**Tragulidae**	**5**	**1.92**
Banteng (prints)	*Bos javanicus*	**Bovidae**	**3**	**1.15**
Clouded leopard (prints)	*Neofelis nebolusa*	**Felidae**	**2**	**0.77**
Oriental small clawed otter (sighting)	*Aonyx cinerea*	**Mustelidae**	**2**	**0.77**

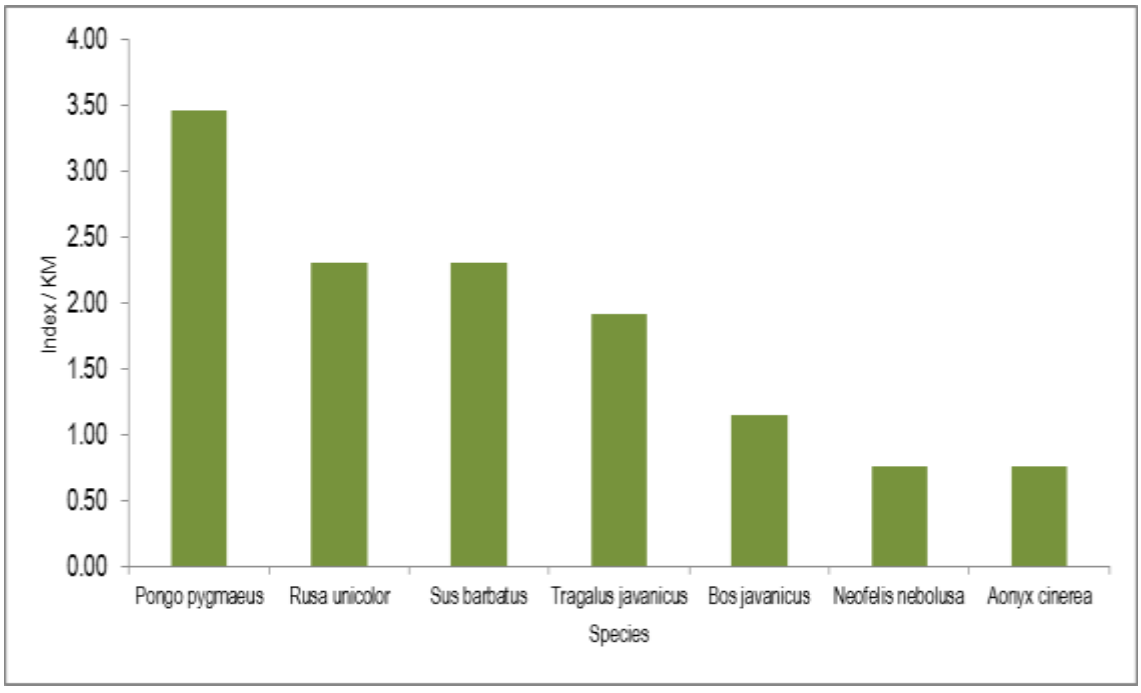


Figure 3.4: Species diversity index of large terrestrial mammal detection per kilometre within Ramsar project site.

3.1.3 Night Spot (by foot)

The activity was conducted only once and covered at least 2.6 kilometres. Limited main power, habitat type (area mostly swampy), and no proper routes established within the project site are the main reasons that some other areas could not be fully studied. The results are shown as Table 3.6.

Table 3.6: Indices of wildlife species detected during the night spot (by foot) conducted within Ramsar project area, (no. of species detected / km), ∑distance covered = 2.6 km.

Common name	Scientific Name	Family	No. of detection	Detection / km
Common palm civet	*Paradoxurus hermaphroditus*	**Viverridae**	3	**1.15**
Bonaparte's nightjar (Sunda nightjar)	*Caprimulgus concretus*	**Caprimulgidae**	1	**0.38**

3.2 Birds

The observation areas were selected randomly during rapid wildlife (mammals) assessment in the Ramsar project site. Direct and indirect sightings through vocalizing or sound are the foremost method that were used to record presence of bird species. All bird species that been listed and compiled in Table 3.7.

Table 3.7: List of bird species detected and recorded during the wildlife survey in the Ramsar project area, [Identified by Mr. Yoktan Julbit and Mr. Lawrence Tingkoi, compiled and sorted by Rayner Bili].

No	Common Name	Scientific Name	Family	Comment / Status	IUCN Red List
1	Ashy tailorbird (Red headed tailorbird)	*Orthotomus ruficeps*	**Sylviidae**	Common resident	LC
2	Asian glossy starling	*Aplonis panayensis*	**Sturnidae**	Abundant resident	LC
3	Asian paradise lycatcher	*Terpsiphone paradisi*	**Monarchidae**	Common resident	LC
4	Black and red broadbill	*Cymbirhynchus macrorhynchos*	**Eurylaimidae**	Common resident	LC
5	Black magpie	*Platysmurus leucopterus*	**Corvidae**		NT
6	Black naped monarch	*Hypothymis azurea*	**Monarchidae**	Common resident	LC
7	Blue crowned hanging parrot	*Loriculus galgulus*	**Psittacidae**	Common resident	LC
8	Blue eared barbet	*Megalaima australis*	**Ramphastidae**	Common resident	LC
9	Blue eared kingfisher	*Alcedo meninting*	**Alcedinidae**	Common resident	LC
10	Blue throated bee-eater	*Merops viridis*	**Meropidae**	Common nomadic resident	LC
11	Bonaparte's nightjar (Sunda nightjar)	*Caprimulgus concretus*	**Caprimulgidae**	Rare resident	VU
12	Brahminy kite	*Haliastur Indus*	**Accipitridae**	Common resident	LC
13	Brown throated sunbird (Plain throated sunbird)	*Anthreptes malacensis*	**Nectariniidae**	Common resident	LC
14	Buffy fish owl	*Ketupa ketupu*	**Strigidae**	Common resident	LC
15	Chestnut breasted malkoha	*Phaenicophaeus curvirostris*	**Cuculidae**	Common resident	LC
16	Chestnut necklaced partridge (Scaly-breasted Partridge)	*Arborophila charltonii*	**Phasianidae**	Common resident	NT
17	Common Iora	*Aegithina tiphia*	**Aegithinidae**	Common resident	LC
18	Common redshank	*Tringa totanus*	**Scolopacidae**	Common winter visitor	LC
19	Diard's trogon	*Harpactes diardii*	**Trogonidae**	Lowland resident	NT

20	Dollarbird (Asian dollarbird / Eastern broad billed roller)	*Eurystomus Orientalis*	**Coraciidae**	Common resident & winter visitor	LC
21	Dusky munia	*Lonchura fuscans*	**Estrildidae**	Common endemic	LC
22	Emerald dove	*Chalcophaps indica*	**Columbidae**	Common nomadic resident	LC
23	Eurasian tree sparrow	*Passer montanus*	**Passeridae**	Common resident	LC
24	Great egret	*Casmerodius albus*	**Ardeidae**	Common migrant & local resident	LC
25	Greater coucal	*Centropus sinensis*	**Cuculidae**	Common resident	LC
26	Greater crested tern	*Sterna bergii*	**Laridae**	Common visitor	LC
27	Greater racquet tailed drongo	*Dicrurus paradiseus*	**Dicruridae**	Common resident	LC
28	Grey imperial pigeon	*Ducula pickeringii*	**Columbidae**	Rare island resident	VU
29	Grey-headed fish eagle	*Ichthyophaga ichthyaetus*	**Accipitridae**	Scarce resident	NT
30	Hooded pitta	*Pitta sordida*	**Pittidae**	Common nomadic resident	LC
31	Intermediate egret (Plumed egret)	*Mesophoyx intermedia*	**Ardeidae**	Common migrant & local resident	LC
32	Large green pigeon	*Treron capellei*	**Columbidae**	Scarce resident	VU
33	Little green pigeon	*Treron olax*	**Columbidae**	Common nomadic resident	LC
34	Little spiderhunter	*Arachnothera longirostra*	**Nectarinidae**	Common resident	LC
35	Long tailed parakeet (native parrots)	*Psittacula longicauda*	**Psittacidae**	Local resident	NT
36	Malaysian eared nightjar	*Eurostopodus temminckii*	**Caprimulgidae**	Local resident	LC
37	Malaysian plover	*Charadrius peronii*	**Charadriidae**	Local resident	NT
38	Mangrove blue flycatcher	*Cyornis rufigastra*	**Muscicapidae**	Common resident	LC
39	Olive backed sunbird	*Nectarinia Jugularis*	**Nectariniidae**	Common resident	LC
40	Orange bellied flowerpecker	*Dicaeum trigonostigma*	**Dicaeidae**	Common resident	LC
41	Oriental darter	*Anhinga melanogaster*	**Pelecanidae**	Local resident	NT
42	Oriental magpie robin	*Copsychus saularis*	**Turdidae**	Common resident	LC
43	Oriental pied hornbill	*Anthracoceros albirostris*	**Bucerotidae**	Common resident	LC
44	Osprey	*Pandion haliaetus*	**Accipitridae**	Migrant	LC
45	Pacific swallow	*Hirundo tahitica*	**Artamidae**	Common resident	LC
46	Pied fantail	*Rhipidura javanica*	**Monarchidae**	Local resident	LC
47	Pink necked green pigeon	*Treron vernans*	**Columbidae**	Common resident	LC
48	Raffles's malkoha	*Phaenicophaeus chlorophaeus*	**Cuculidae**	Common resident	LC
49	Red legged crake	*Rallina fasciata*	**Rallidae**	Scarce resident and nomad	LC
50	Slender billed crow	*Corvus enca*	**Corvidae**	Local resident	LC
51	Spectacled bulbul	*Pycnonotus erythrophthalmos*	**Pycnonotidae**	Common resident	LC
52	Stork billed kingfisher	*Pelargopsis capensis*	**Alcedinidae**	Common resident	LC
53	Striped wren babbler	*Kenopia striata*	**Timaliidae**	Scarce resident	NT
54	Violet cuckoo	*Chrysococcyx xanthorhynchus*	**Cuculidae**	Common resident	LC
55	White bellied sea eagle	*Haliaeetus leucogaster*	**Accipitridae**	Common resident	LC
56	White breasted waterhen	*Amaurornis phoenicurus*	**Rallidae**	Common resident	LC
57	White collared kingfisher (Collared kingfisher)	*Todiramphus chloris*	**Alcedinidae**	Common resident	LC
58	White crowned shama	*Copsychus stricklandii*	**Turdidae**	Common endamic	unknown status

59	Yellow vented bulbul	*Pycnonotus goiavier*	**Pycnonotidae**	Common resident	LC

Overall, at least 59 species of birds from 35 families **(see Table 3.7)** were identified and recorded during the rapid wildlife survey in the Ramsar project site. From that, 79.66% (n=47) of the bird species recorded were classified as least concern, 13.56% (n=8) species classified as near threatened, while 5.08% (n=3) categorized as vulnerable and 1.69% (n=1) not evaluated in IUCN red list.

3.3 Reptiles

Reptiles spotted during the scientific expedition within the Ramsar site are listed in Table 3.8.

Table 3.8: Reptiles sighted within the Ramsar site during the survey.

Reptiles					
No	**Common Name**	***Scientific Name***	**Family**	**Comment / Status**	**IUCN Red List**
1	Sumatran Pit-viper	*Trimeresurus sumatranus*	**Viperidae**	Common, David and Vogel (1996), wide distribution	Status: LC Pop. Trend: unknown
2	Dog faced water snake	*Cerberus rynchops*	**Homalopsidae**	Nocturnal snake/ active at night	Status: LC ver. 3.1, Pop trend: unknown
3	Estuarine crocodile	*Crocodylus porosus*	**Crocodylidae**		Status: Lower risk/least concern ver. 2.3

4.0 DISCUSSION

There are only 14 species of terrestrial mammals detected and recorded during the rapid survey in Ramsar project sites. The results cannot simply indicate that project area was low in species diversity because some other factors might have affected the detection (for example, inadequate survey period, main power, skill, weather, presence of food source, cryptic behaviour of some species and disturbance from human activities). The nocturnal wildlife species, especially large terrestrial mammals almost contributed to the non-sighting (only one sighting which was the common palm civet). Human disturbance within the project site could be the main reason for the low wildlife presence.

5.0 RECOMMENDATIONS

- Using camera trap devices could be the best practice to continue wildlife survey and monitoring within the project site, especially for threatened species.

- Strict enforcement "anti-poaching" to minimize illegal activities, especially hunting in and adjacent to the project site. Promote education and awareness programmes for local communities and enhance cooperation among local communities through the Honorary Forest Ranger.

- For long-term programmes, the significant wildlife species within Ramsar project site should be monitored continuously and project manager needs to improve more systematic surveys throughout the project area. Wildlife protection can be enhanced through educating local

communities to be more responsible and by soliciting their cooperation in maintaining the game species and other important species for future generation and for tourism activities.

- Hunting activities are strictly prohibited within Ramsar project site, hence, significant signboards, such as SFD warning signages indicating boundary areas of forest reserve with heavy fines and penalties for hunting should be placed in strategic locations.

- Awareness programmes should be consistently conducted, targeting all settlements in and adjacent to the forest reserve. The programmes should be focused to inform the local communities and the plantation workers about the rules and regulation pertaining to forest offense and illegal hunting activities.

REFERENCES

CITES species database. http://www.cites.org/eng/resources/species.html. Retrieved 16 June 2014.

Convention on International Trade in Endangered Species of Wild Fauna and Flora. *The CITES Appendices*. http://www.cites.org/eng/app/index.php. Retrieved 16 June 2014.

Mammals of Borneo. http://en.wikipedia.org/wiki/Mammals_of_Borneo. Retrieved 16 June 2014.

IUCN (2013). IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Retrieved 16 June 2014.

Mackinnon, J. & Phillipps, K. (2008). *A field guide to the birds of Borneo, Sumatra, Java and Bali*. Oxford University Press, New York.

Phillipps, Q. & Phillipps, K. (2011). *Phillipps' field guide to the birds of Borneo.* Second edition, fully revised. Beaufoy publishing Ltd, Oxford, UK.

Payne, J., Francis, C.M. & K. Phillipps. (2005). *A field guide to the mammals of Borneo.* The Sabah Society, Kota Kinabalu, Sabah.

Stuebing, R.B. & Inger, R.F. (1999). *A field guide to the snakes of Borneo.* Natural History Publication (Borneo), Kota Kinabalu, Sabah.

Oral Paper 5.2

PRELIMINARY CHECKLIST OF THE AVIFAUNA OF KULAMBA FIELD CENTRE AND NEARBY FORESTS IN THE LOWER KINABATANGAN-SEGAMA WETLANDS

Vivian Rudolf & George Hubert Petol
Sabah Forestry Department

Abstract

This paper provides a preliminary list of bird species at and nearby Kulamba Field Centre (KFC). These species were observed during the first phase of the "Ramsar Site: Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition" which was held on the 16th-26th June 2014. The five-day observation period for birds yielded 70 species from 35 families (including 1 unresolved family). Only 3 species were endemic to Borneo; however, these endemics—the White-crowned Shama, Bornean Brown Barbet and Dusky Munia—are common in Sabah. It is found that the species observed were mainly of wetlands, open spaces and secondary forests species. There was a noticeable lack of lowland forest bird species. The common bird species seen flying constantly at KFC were the Silver-rumped Spinetail, Mossy-nest Swiftlet and Pacific Swallow. Brahminy Kites and other birds-of-prey can be seen soaring high above Sg. Kulamba and Sg. Kretam. To local birders or bird enthusiasts, the avifauna of the KFC and its nearby areas is not remarkably interesting due to the fact that the bird species recorded could be easily and commonly seen in most open areas and forest edges near coasts and large rivers. Recommendations for further research were also made.

INTRODUCTION

This paper provides a preliminary list of bird species at and nearby Kulamba Field Centre (KFC). These species were observed during the *Ramsar Site: Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition* held from 16th-26th June 2014. The expedition was organized by the Forest Research Centre with assistance from the Kinabatangan District Forestry Office, both of which are of the Sabah Forestry Department. The expedition base camp was at the department's then-newly completed Kulamba Field Centre. This brief study, conducted during the first phase of the expedition (16th-21st June), was also conducted with the hope of identifying iconic bird species that can attract birders to visit the area with the field centre as their base.

Survey sites: Kulamba Field Centre (KFC) and its surroundings

The Kulamba Field Centre (KFC) is managed by the Kinabatangan District Forestry Office. It is located within the Lower Kinabatangan-Segama Wetlands (LKSW), normally referred to as the Ramsar centre, in the east coast of Sabah. It was built on the riverbank of Sg. Kulamba, thus the name of the centre. The river is a tributary of the larger Sg. Kretam that flows into Dewhurst Bay. KFC is about 2.5 hours by speedboat from Sandakan town through the Sg. Kinabatangan estuary waterway route. The sea route cuts the time by 30 minutes, provided the sea is calm. Just about 500 m away at the river mouth of Sg. Kulamba is the fishing village of Tundon Bohangin.

Although the main vegetation of the area was primarily of nipah palms and mangrove trees, the KFC was surrounded by degraded secondary peat swamp forest. The canopy was open and broken with trees with an average height of about 6 m in height. There were, however, quite a number of tall

trees (mainly simpoh, *Dillenia suffruticosa*) further inland. Further up Sg. Kulamba, the peat swamp forest was also degraded and was similar in structure to the forest near KFC. According to the supplied vegetation map, the primary peat swamp forest was located further east towards Kulamba Wildlife Reserve (Class 7). However, no attempt was made to survey the forest by the expedition teams as the access was difficult due to the thick understorey and wet, peaty condition of the ground.

METHODS

The purpose of this study is to produce a preliminary list of bird species with the hope of identifying iconic species that can be used to promote this area as a birding site. No attempt was made to quantify bird species richness, distribution and abundances. This was due several considerations, mainly:

i) Unfamiliarity of the area by the observers,
ii) To avoid false conclusions from possible unrepresentative sites,
iii) Detectability of birds was very variable in the peat swamps with varying levels of degradation,
iv) To maximize fuel efficiency during the expedition, the survey sites chosen were dependent on the other research teams.

Direct visual observations were made although some species were identified by their calls, for e.g. the Collared Kingfisher, Buffy Fish-owl, Hooded Pitta and Bold Striped Tit-babbler. The main reference book used was the 3rd edition of the *Phillips' Field Guide to the Birds of Borneo* by Quentin Phillips and Karen Phillips, and the common English and species names used here were based on the book.

Bird surveys were conducted between 6 am to 6 pm with short breaks during mid-days. These were mainly conducted at KFC due to the ease of birding and its excellent view of the surroundings, especially from the elevated watch tower. The two surveys at Sg. Pelanduk and along Sg. Kulamba (from Sg. Pelanduk to KFC) were conducted only in the mornings due to rain and transportation problems respectively. The bird surveys continued later at KFC from 2 pm to 6 pm for both days.

Table 1. Time table of bird surveys at Kulamba Field Centre.

Date	Survey site	Observation times	Notes
16th June	KFC complex	3 pm–6 pm	Arrival day.
17th June	KFC complex	6 am–6 pm	
18th June	KFC trails	6 am– 9 am, 2 pm–5 pm	
19th June	Sg. Pelanduk	7 am–11 pm, 3 pm–6 pm (KFC)	Intermittent rain from 10 am to 2 pm.
20th June	Along Sg. Kretam heading towards Kg. Sri Ganda	7 am–12 pm, 3 pm–6 pm (KFC)	Boat cruise from KFC to Kg. Sri Ganda.

From personal communications with the Assistant District Forestry Officer, Hj. Abdul Samah bin Sapni and who is very familiar with the larger birds of the LKSW, two additional species were included in the list although they were not observed during the surveys. These species, frequently observed by Hj. Abdul Samah soaring high above KFC, were the Lesser Adjutant and Storm's Stork.

RESULTS

The five-day observation period yielded 70 species from 35 families (including 1 unresolved family of the tailorbirds) were recorded in the study sites, including the 2 species that were mentioned by Hj. Abdul Samah. *[See Appendix B for the complete list of bird species arranged by families.]* Out of the 70 species, only 3 were endemic to Borneo; however, these endemics—the White-crowned Shama, Bornean Brown Barbet and Dusky Munia—are common in Sabah. It is found that the most of the bird species observed were mainly birds of wetlands (e.g. kingfishers, egrets, terns, darters, storks), open spaces (e.g. sunbirds, bulbuls, pigeons, munias, tailorbirds and Blue-crowned Hanging Parrots) and secondary forests (e.g. certain babblers and tailorbirds). There was a noticeable lack of lowland forest bird species; only a few species such as the Racquet-tailed Drongo, Velvet-fronted Nuthatch, Dark-necked Tailorbird and the Hooded Pitta were observed.

Hornbills and both the Grey and Green Imperial Pigeons were commonly seen flying in a north-south direction, most likely between food sources located towards the north and south of KFC. These birds were also observed feeding on a large fig tree (unknown species), about 200 m south of the KFC when view from the watch tower. Brahminy Kites and other birds-of-prey can be seen soaring high above Sg. Kulamba and Sg. Kretam, normally flying singly although 4 individuals of Brahminy Kites were seen above KFC during the early morning (at about 7 am) of the 19th June. The common bird species seen flying constantly at KFC were the Silver-rumped Spinetail, Mossy-nest Swiftlet and Pacific Swallow. The Collared Kingfisher can be seen perched on bare twigs of trees at the forest edge of the centre. Other easily seen birds at KFC are the Rhinoceros Hornbill, the pigeons, Collared Kingfisher, the babblers, all 3 species of tailorbirds, the egrets, terns, Braminy Kite, White-bellied Sea Eagle, Pacific Swallow, Darter and the Silver-rumped Spinetail.

CONCLUSIONS

To local birders or bird enthusiasts, the avifauna of the KFC and its nearby areas is not remarkably interesting due to the fact that the bird species recorded could be easily and commonly seen in most open areas and forest edges near coasts and large rivers. The 3 Bornean endemics (White-crowned shama, Dusky Munia and Bornean Brown Barbet) might appeal to beginner birders but most would certainly have seen them elsewhere and in places more accessible than KFC in the Lower Kinabatangan-Segama Wetlands. There is a pronounced lack of endemic 'trophy' species, such as the Bornean Bristlehead (also reported to be found in primary peatswamp forests) or the Blue-headed Pitta, to attract local birders.

Foreign birders though may be lured to this remote part of east Sabah for a chance of spotting the rare and endangered Storm's Stork soaring high above the wetlands. The easily-sighted hornbills, kingfishers (*N.B.* Europe has only 1 species of kingfisher), the 3 endemics and the other colourful species might add value to the area as a birding stopover. However, common birding trips/packages normally follow the tried and tested routes of KK-Kinabalu Park-Kinabatangan-Sepilok and KK-Kinabalu Park-Danum Valley-Tabin-Kinabatangan-Sepilok (and variations thereof). Unfortunately, the KFC is situated far from these established routes which are easily accessed by tour vans and/or 4WD vehicles. One might argue that the boat ride takes only 2.5 hours by a 300 hp speedboat from Sandakan town. However, the other sites still offer more species count, especially for the Bornean endemics. There is also the current issue of coastal security at the KFC and its surrounding areas. However, it is in the authors' opinion that the KFC's most important role may be as an education centre specializing in wetland ecology and communities. At present, the centre has excellent facilities to accommodate a group of 30 school children and about 5 teachers. Birding can be an

interesting activity to introduce the importance of birds in the wetland ecosystems. In this way, the bird species in this area becomes an invaluable educational tool.

Recommendations

As a wetland education centre

The KFC has great potential in a wetland education centre. The riverine and marine life offer a diverse range of educational topics. Birding can be a major activity for such groups as wetland birds can be easily seen at KFC. For normal safety reasons, school groups that are likely to visit the area will mainly be made up of upper secondary school students. Thus, SFD or the Kinabatangan District Forest Office should promote KFC mainly to secondary schools in the Sandakan, Kinabatangan and Lahad Datu districts. This can be done through the District Education Offices (Pejabat Pendidikan Daerah, PPD). However, the cost of transportation—especially the fuel for outboard engines—to the area will be a major hindrance for school groups. The SFD should subsidise these groups to enable them to visit KFC.

As a wetland ecology research site

Very little research studies have been conducted in the area; thus, it has a high potential for growth as a research site, either as the main site or as a site for comparative studies. The riverine and marine life offer many opportunities for research. SFD should promote KFC to higher institutions, such as Universiti Malaysia Sabah and the newly-formed University College Sabah Foundation, to conduct undergraduate or post-graduate research there. However, as mentioned earlier, SFD may need to provide boats with outboard motors for researchers to conduct field work as boats are the only means of transportation in the area. Another factor that needs to be noted is the issue of safety, especially for foreign researchers. The presence of the field force personnel at Kg. Tundon Bohangin should provide some form of security at KFC.

Setting up of a short-term avifauna research and monitoring programme

A simple and short-term (of about 3-4 years) avifauna research programme could be set up for the KFC and its areas to monitor spatial and temporal variation in species' abundances. Based on the current proficiency level of SFD, the rapid but reliable MacKinnon list technique could be used (MacKinnon and Phillips, 1993). This technique is typically used to estimate species richness but is also used to generate abundance indices that are consistent between observers of markedly different experience (MacLeod *et al*. 2011). The data accumulated from such a programme could form the basis of future ornithological studies in the area and in the LKSW in general.

References

Phillips, Q. & Phillips, K. (2014). *Phillips' field guide to the birds of Borneo.* 3rd Edition. John Beaufoy Publishing.

MacKinnon, J. & Phillips, K. (1993). *A field guide to the birds of Borneo, Sumatra, Java and Bali, the Greater Sunda Islands.* Oxford University Press, Oxford.

MacLeod, R., Herzog, S.K., Maccormick, A., Ewing, S.R., Bryce, R. & Evans, K.L. (2011). Rapid monitoring of species abundance for biodiversity conservation: consistency and reliability of the MacKinnon lists technique. *Biological Conservation*. 144: 1374-1381.

Appendix A: Field notes during the expedition

Day	Birds	Notes
Arrival Day (16th June)	- Great Egret. - Brahminy Kite. - Collared Kingfisher. - Brown-throated Sunbird. - Stork-billed Kingfisher. - Grey Imperial Pigeon. - Rhinoceros Hornbill. - Pied Hornbill. - Red-bearded Bee-eater. - Oriental Darter. - Grey-headed Fish Eagle. - Intermediate Egret. - Velvet-fronted Nuthatch. - Blue-crowned Hanging Parrot.	Location: Along river about 30 mins to Kulamba Field Centre (KFC) and at KFC after arrival. Weather: Clear sky all day.
Day 2 (17th June)	- Hooded Pitta (call). - White-crowned Shama. - Bold-striped Tit-babbler. - Rufous-tailed Tailorbird. - Dusky Munia. - White-chested Babbler. - Red-eyed Bulbul. - Chestnut-winged Babbler. - Eurasian Tree Sparrow. - Pied Fantail. - Dark-necked Tailorbird. - Yellow-vented Bulbul. - Rufous-tailed Shama. - Scarlet Minivet. - Slender-billed Crow. - Pink-necked Green Pigeon. - Plaintive Cuckoo. - Silver-rumped Spinetail. - Ashy Tailorbird. - Long-tailed Parakeet. - Black-and-red Broadbill. - Buff-necked Woodpecker. - Red-throated Barbet. - Yellow-bellied Prinia. - Malaysian Blue Flycatcher. - Cream-Vented Bulbul. - Bornean Brown Barbet. - Common Kingfisher. - Crimson Sunbird. - Green Imperial Pigeon. - Olive-winged bulbul. - Oriental Pied Hornbill (call). - Asian Glossy Starling. - White-bellied Sea Eagle. - Oriental darter. - Blue-eared Kingfisher. - Black-naped tern.	Location: KFC building and grounds. Weather: Rained last night and an overcast day.
Day 3 (18th June)	- Common Iora. - Plain Sunbird. - Chestnut-breasted malkoha. - Blue-throated Bee-eater. - White-crowned Shama. - Little Egret. - Magpie Robin. - Black-and-white Bulbul (?).	Location: KFC trails Weather: Overcast day (4 Braminy Kites overhead in the early morning)

Day 4 **19th June**	- Brown-throated Sunbird. - Pied Fantail. - Plaintive Cuckoo. - Dusky Munia. - Long-tailed Parakeet. - Imperial Green Pigeon. - Yellow-vented Bulbul. - Bold-striped Tit-babler - Red-eyed Bulbul. - Blue-crowned Hanging Parrot. - Common Iora. - Horsfield's Babbler. - Greater Racquet-tailed Drongo. - Ashy Tailorbird. - Pacific Swallow. - Blue-throated Bee-eater. - Stork-billed Kingfisher. - Pink-necked Green Pigeon. - Mossy-nest Swiftlet. - Chestnut-necklaced Hill Partridge (call). - Buff-rumped Woodpecker. - Chestnut Munia. - White-crowned Shama. - Crimson Sunbird. - Hooded Pitta (call). - Collared Kingfisher.	Location: Secondary forest near Sg. Pelanduk. Weather: Overcast (morning) and rain (late morning to afternoon)
Day 5 **(20th June)**	- Malaysian Eared Nightjar - Red Junglefowl. - Streaked Bulbul.	Location: Along river to Kg. Tundon Bohagin and Kg. Seriganda
Other possible species	- Black-backed Kingfisher - Lesser Adjutant	Haji Abdul Samah bin Sapri *(pers. comm.)*

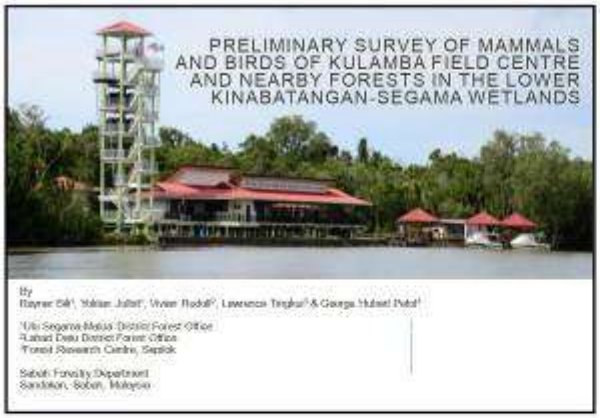
Appendix B: List of bird families and species recorded during the **Ramsar Site: Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition** held from 16th-26th June 2014.

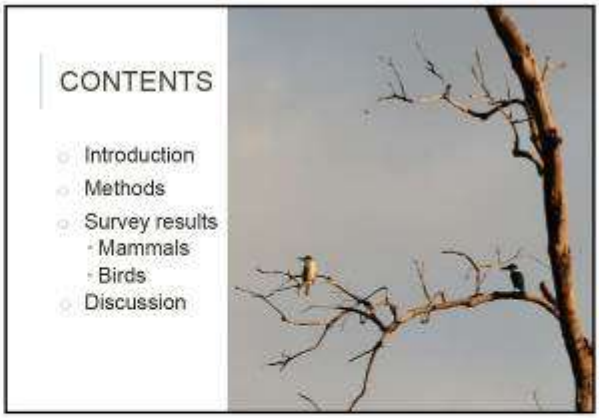
No. of family	Family	Common Name	Scientific Name
1	Accipitridae	White-bellied Sea Eagle	*Haliaeetus leucogaster*
		Brahminy Kite	*Haliastur indus*
		Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*
2	Aegithinidae	Common Iora	*Aegithina tiphia*
3	Alcedinidae	Blue-eared Kingfisher	*Alcedo meninting*
		Common Kingfisher	*Alcedo atthis*
		Rufous-backed Kingfisher	*Ceyx rudiforsa motleyi*
		Stork-billed Kingfisher	*Pelargopsis capensis*
		Collared Kingfisher	*Todiramphus chloris*
4	Anhingidae	Darter	*Anhinga melanogaster*
5	Apodidae	Silver-rumped Spinetail	*Rhaphidura leucopygialis*
		Mossy-nest Swiftlet	*Aerodramus salanganus*
6	Ardeidae	Great Egret	*Ardea alba*
		Little Egret	*Egretta garzetta*
		Intermediate Egret	*Egretta intermedia*
		Black-crowned Night Heron	*Nycticorax nycticorax*
7	Bucerotidae	Oriental Pied Hornbill	*Anthracoceros albirostris*
		Rhinoceros Hornbill	*Buceros rhinoceros*
8	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus*
9	Caprimulgidae	Malaysian Eared Nightjar	*Eurostopodus temminckii*
10	Cisticolidae	Yellow-bellied Prinia	*Prinia flaviventris*
11	Ciconiidae	Storm's Stork	*Ciconia stormii*
		Lesser Adjutant	*Leptotilos javanicus*
13	Columbidae	Green Imperial Pigeon	*Ducula aenea*
		Grey Imperial Pigeon	*Ducula pickeringii*
		Pink-necked Green Pigeon	*Treron vernans*
14	Corvidae	Slender-billed Crow	*Corvus enca*
15	Cuculidae	Plaintive Cuckoo	*Cacomantis merulinus*
		Chestnut-breasted Malkoha	*Phaenicophaeus curvirostris*
16	Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus*
17	Estrildidae	Dusky Munia	*Lonchura fuscans*
		Chestnut Munia	*Lonchura atricapilla*
18	Eurylaimidae	Black-and-red Broadbill	*Cymbirhynchus macrorhynchos*
19	Hirundindae	Pacific Swallow	*Hirundo tahitica*
20	Meropidae	Blue-throated Bee-eater	*Merops viridis*
		Red-bearded Bee-eater	*Nyctyornis amictus*
21	Muscicapidae	Pied Fantail	*Rhipidura javanica*
		Malaysian Blue Flycatcher	*Cyornis turcosus*
22	Nectariniidae	Eastern Crimson Sunbird	*Aethopyga siparaja*

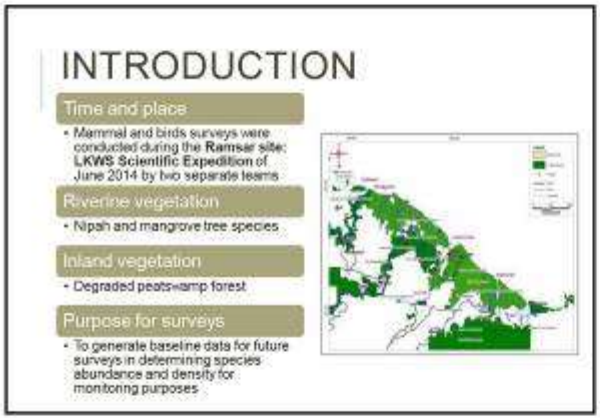
		Brown-throated Sunbird	*Anthreptes malacensis*
		Plain Sunbird	*Anthreptes simplex*
23	Passeridae	Eurasian Tree Sparrow	*Passer montanus*
24	Phasianidae	Chestnut-necklaced Hill Partridge	*Arborophilla charltoni*
		Red Junglefowl	*Gallus gallus*
25	Picidae	Buff-rumped Woodpecker	*Meiglyptes tristis*
		Buff-necked Woodpecker	*Meiglyptes tukki*
26	Pittidae	Hooded Pitta	*Pitta sordida*
27	Psittacidae	Blue-crowned Hanging Parrot	*Loriculus galgulus*
		Long-tailed Parakeet	*Psittacula longicauda*
28	Pycnonotidae	Streaked Bulbul	*Ixos malaccensis*
		Red-eyed Bulbul	*Pycnonotus brunneus*
		Yellow-vented Bulbul	*Pycnonotus goiavier*
		Olive-winged Bulbul	*Pycnonotus plumosus*
		Cream-vented Bulbul	*Pycnonotus simplex*
		Black-and white Bulbul	*Pycnonotus melanoleucos*
29	Ramphastidae	Bornean Brown Barbet	*Calorhamphus fuliginosus*
		Red-throated Barbet	*Megalaima mystacophanos*
30	Sittidae	Velvet-fronted Nuthatch	*Sitta frontalis*
31	Sternidae	Black-naped Tern	*Sterna sumatrana*
32	Sturnidae	Asian Glossy Starling	*Aplonis panayensis*
33	Timaliidae	Bold-striped Tit-Babbler	*Macronous bornensis montanus*
		Chestnut-winged Babbler	*Stachyris erythroptera*
		White-chested Babbler	*Trichastoma rostratum*
		Horsfield's Babbler	*Trichastoma sepiarium*
34	Turdidae	White-crowned Shama	*Copsychus stricklandii*
		Rufous-tailed Shama	*Trichixos pyrropygus*
		Oriental Magpie Robin	*Copsychus saularis adamsi*
35	Unresolved family	Dark-necked Tailorbird	*Orthotomus atrogularis*
		Red-headed Tailorbird	*Orthotomus ruficeps*
		Rufous-tailed Tailorbird	*Orthotomus sericeus*

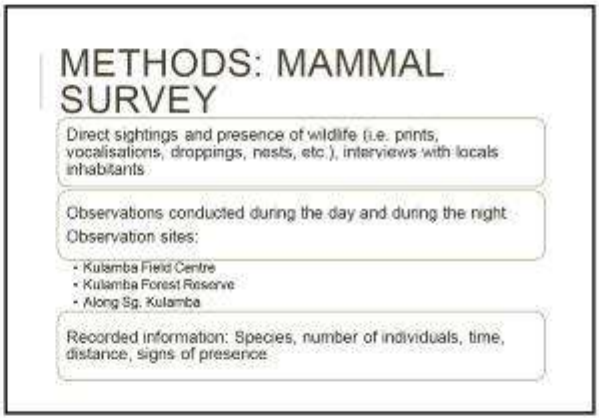
*Bornean endemic species in red.

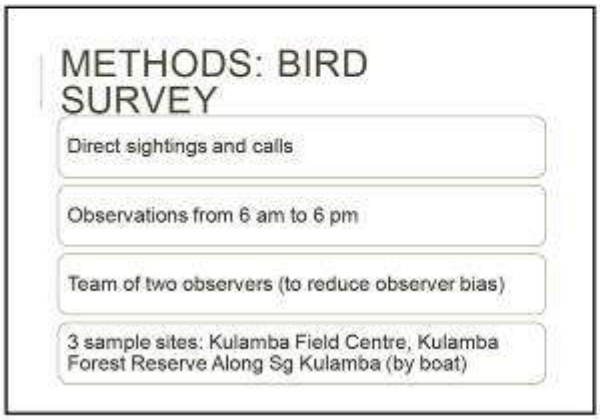
Slide Presentation

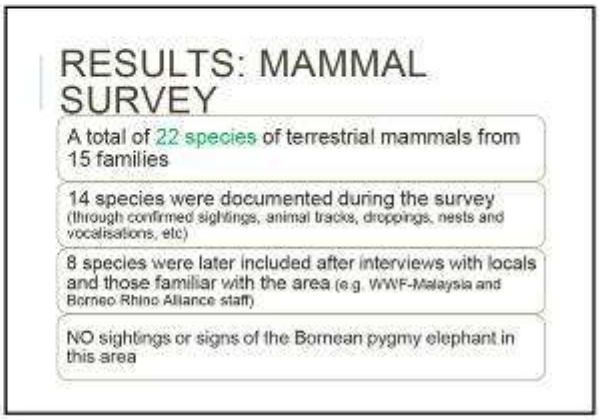












RESULTS: MAMMAL SURVEY

Interesting Bornean fauna includes

- Bornean orangutan
- Proboscis monkey
- Müller's Bornean gibbon
- Sunda clouded leopard
- Oriental small-clawed otter
- Bornean sun bear

TABLE 1: LIST OF MAMMALS SIGHTED AND RECORDED FROM LKWS

Common name	Scientific Name	Family	IWCP (2007)	IUCN red list
kijang	Muntiacus	Cervidae	I	Endangered
bornean bearded pig	Sus barbatus	Suidae	III	Vulnerable
Müller's Bornean gibbon	Hylobates muelleri	Hylobatidae	II	Endangered
sunda clouded leopard	Neofelis diardi	Felidae	I	Vulnerable
Asian palm civet	Paradoxurus hermaphroditus	Viverridae	II	Least concern
Lesser mouse-deer	Tragulus kanchil	Tragulidae	III	Data Deficient
Long-tailed macaque	Macaca fascicularis	Cercopithecidae	II	Least concern
Malay civet	Viverra tangalunga	Viverridae	II	Least concern
Bornean orangutan	Pongo pygmaeus pygmaeus	Pongidae	I	Endangered
oriental small-clawed otter	Amblonyx cinerea	Mustelidae	II	Vulnerable
Plantain squirrel	Callosciurus notatus	Sciuridae	II	Least concern
Proboscis monkey	Nasalis larvatus	Cercopithecidae	I	Endangered
sambar deer	Rusa unicolor	Cervidae	III	Vulnerable
Silvery lutung	Trachypithecus	Cercopithecidae	II	Near Threatened

TABLE 2: LIST OF ALL MAMMALS RECORDED FROM LKWS (INCL. DATA FROM WWF-MALAYSIA AND BORA)

Common name	Scientific Name	Family	IWCP (2007)	IUCN red list
Banded palm civet	Hemigalus derbyanus	Viverridae	II	V
Hanging	Rat penomys	Hanidae	I	I
Bornean bearded pig	Sus barbatus	Suidae	III	V
Flat-headed/Rajah cat	Prionailurus planiceps	Felidae	II	V
Müller's Bornean gibbon	Hylobates muelleri	Hylobatidae	II	I
Sunda clouded leopard	Neofelis diardi	Felidae	I	V
Asian palm civet	Paradoxurus hermaphroditus	Viverridae	II	LC
Cream-colored giant squirrel	Ratufa affinis	Sciuridae	II	NT
Large flying fox	Pteropus vampyrus	Pteropodidae	III	NT
Leopard cat	Prionailurus bengalensis	Felidae	II	LC
Lesser mouse deer	Tragulus kanchil	Tragulidae	III	DD
Long tailed macaque	Macaca fascicularis	Cercopithecidae	II	LC
Malay badger	Mydaus javanensis	Mephitidae	II	LC
Malay civet	Viverra tangalunga	Viverridae	II	LC
Bornean orangutan	Pongo pygmaeus	Pongidae	I	E
Oriental small-clawed otter	Aonyx cinereus	Mustelidae	II	V
Plantain squirrel	Callosciurus notatus	Sciuridae	II	LC
Proboscis monkey	Nasalis larvatus	Cercopithecidae	I	E
Sambar deer	Rusa unicolor	Cervidae	III	V
Silvery lutung	Trachypithecus	Cercopithecidae	II	NT
Sumatran Rhinoceros	Dicerorhinus sumatrensis	Rhinocerotidae	I	CR
Bornean sun bear	Helarctos malayanus	Ursidae	I	V

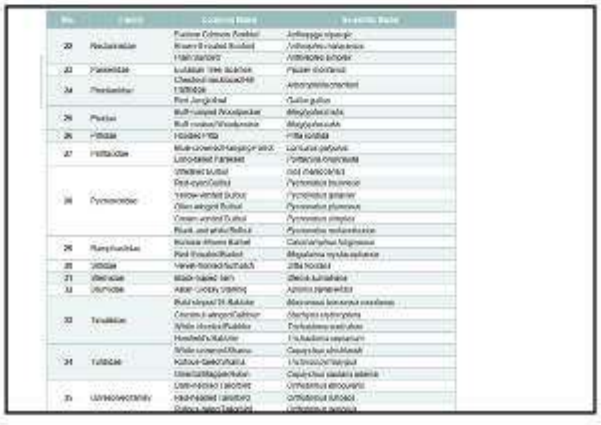
RESULTS: BIRD SURVEY

70 species from 35 families, including one unresolved family

Only 3 endemics were recorded: White-crowned shama, Bornean brown barbet and Dusky Munia

Mainly birds of wetlands, open spaces and secondary forests

Noticeable lack of lowland forest species

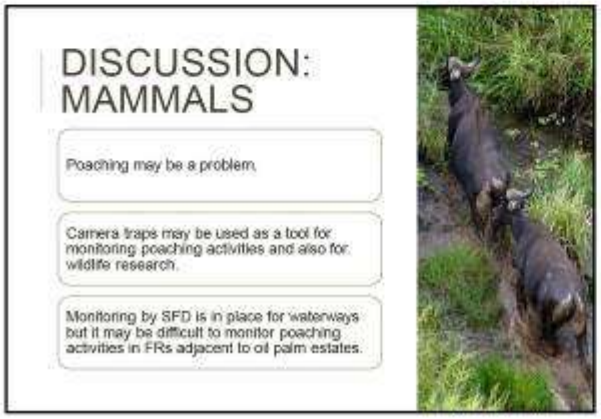


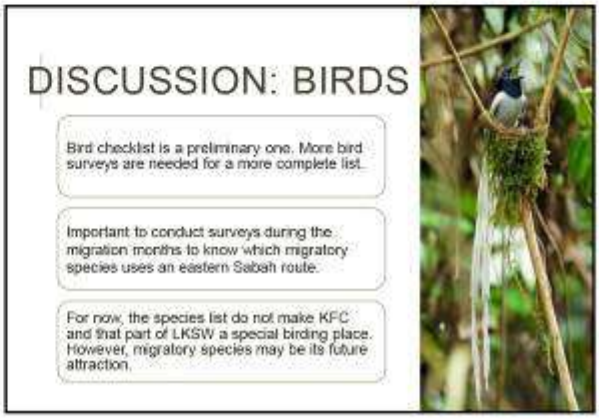

SOME WETLAND BIRDS AT LKSW
Stork-billed kingfisher
Great egret
Storm's stork
Oriental darter
White-bellied sea-eagle
Lesser adjutant


BIRDS OF OPEN SPACES AT LKSW
Dusky munia
Rufous-tailed tailorbird
Blue-crowned hanging parrot
Pacific swallow
Green imperial pigeon
Bold-striped tit-babbler


BIRDS OF OPEN SPACES AT LKSW
Plaintive cuckoo
Yellow-bellied prinia
Eastern crimson sunbird
Eurasian tree sparrow
Yellow-vented bulbul
Oriental magpie robin


FOREST BIRDS AT LKSW
Greater racquet-tailed drongo
Red-bearded bee-eater
Blue-throated bee-eater
Green imperial pigeon
Common iora
Scarlet minivet


DISCUSSION: MAMMALS
Poaching may be a problem.
Camera traps may be used as a tool for monitoring poaching activities and also for wildlife research.
Monitoring by SFD is in place for waterways but it may be difficult to monitor poaching activities in FRs adjacent to oil palm estates.


DISCUSSION: BIRDS
Bird checklist is a preliminary one. More bird surveys are needed for a more complete list.
Important to conduct surveys during the migration months to know which migratory species uses an eastern Sabah route.
For now, the species list do not make KFC and that part of LKSW a special birding place. However, migratory species may be its future attraction.

ORAL PAPER 6

APHRODISIAC POTENTIAL AND PRECLINICAL EVALUATION ON THE EXTRACT OF MANGROVE PLANTS IN COASTAL AREA OF SABAH

Sarifah Rejab[1], Syamimi Khalid[1], Ahmad Hazri Ab. Rashid[1], Noor Rabihah Aid[1], Aidawati Mohd. Shabery[1], Thavamanithevi a/p Subramaniam[1], Mohd Helme Mohd Helan[1], Ana Sharmila Shafie[1], Zuleen Delina Fasya Abd. Ghani[1], Nurul Husna Abdullah[1], Lim Chuan Gee[1], Puziah Hashim[2], John Sugau[3] & Joseph Tangah[3]

[1]Industrial Biotechnology Center, SIRIM Berhad, Shah Alam, Malaysia
[2]Halal Products Research Institute, Universiti Putra Malaysia, Serdang, Malaysia
[3]Sabah Forestry Department

(Presented by Ms Syamimi Md. Khalid)

Ms. Syamimi Md Khalid obtained her M.Sc. from Faculty of Medical and Health Science, UPM on Animal Physiology. She is a Researcher and Toxicology Analyst of Bioprocess Department at Industrial Biotechnology Research Centre, SIRIM Berhad and has been working at the department for 5 years. She has also obtained Professional qualifications as Named Animal Care and Welfare Officer (NACWO) from Institute of Animal Technology (Scotland) and Biological Safety Specialist from NAMSA, USA

Abstract

In this study, *M. muticus and R. mucronata* were chosen for preliminary investigation on aphrodisiac potential using animal model. In materials and methods, The 50% ethanol extract of powder leaf were subjected to chemical profiling, phytochemical analysis, testosterone screening and preclinical evaluation. Preclinical study to access the safety of plant extracts was performed. *In vivo* investigation of aphrodisiac potentials on the crude extracts was determined by assessing the libido and sexual potency enhancement. From the findings, phytochemical screenings showed the presence of saponins and steroids compound believed to be responsible for aphrodisiac properties. NRU toxicity results were used to estimate the starting dose for acute oral study as well as *in vivo* efficacy. Under the conditions of this study, the acute oral toxicity of extracts was classified as Category 5 according to the Globally Harmonised System for the classification of chemicals. The LD_{50} is greater than 2000 mg/kg body weight. The *in vivo* study has shown that the extract studied significantly increased the serum testosterone level in sexually experienced rats. Sexual desire (libido) and motivation are improved as evidenced by the reduction in mount latency, while sexual performance is enhanced by the reduction of intromission latency.

INTRODUCTION

Aphrodisiac is a substance that stimulates/increases sexual desire (libido), motivation and performance. It also used to modify the impaired sexual functions of human beings. There is a large number of synthetic drugs available to improve sexual function, such as sildenafil (sold as Viagra) and tadalafil (sold as Cialis). However, these substances can produce negative side effect, such as headache, muscle pain, and blurred vision, and may have dangerous interactions with other medications. Therefore, the demand for natural aphrodisiac remedy has increased as evidence of its booming business on the internet.

The research was initiated based on the observation of proboscis monkey seem to have active sexual activity and high sex ratio towards the female (sex ratio 1:8.4). Their diet consuming local plants believed to contribute to the high sexual activities. Based on the active sexual behaviour and higher sex ration of adult male proboscis monkeys that fed the mangrove young leaves, no evaluation on mangrove leaves for their pharmacological properties as aphrodisiac has been carried out.

In this preliminary study, the potential aphrodisiac activity of mangrove plants extracts (aqueous and organics) has been evaluated for their aphrodisiac property using animal model. Six mangrove plants in the coastal area of Sabah, namely *M. muticus, R. mucronata, R. apiculata, A. aureum, D. trifoliata* and *B. parviflora* were chosen for preliminary investigation on aphrodisiac potential.

Investigation of aphrodisiac potentials on the crude extract was determined by assessing the libido and sexual potency enhancement. Assessment was done on the sexual desire (mounting behavior test), sexual motivational (partner preference test) and sexual performance test.

MATERIALS AND METHODS

i) Plant authentication and preparation of extracts

Samples of mangrove plants were identified, collected and authenticated along Sabah coastal area by experts from Sabah Forestry Department and send to SIRIM Berhad for analysis. The voucher specimen for each plant is kept at Sabah Forestry Department and Forest Research Institute of Malaysia (FRIM).
The authenticated dried young leaves of mangrove plants were oven dried at 40^{o}C and finely powdered and extracted using 50:50 EtOH:water. The extract was evaporated under vacuum followed by freeze drying to dryness.

ii) Animals and reagents

Healthy, male albino Sprague Dawley (SD) rats weighing 150 - 300 gram, aged 8-12 weeks were kept in well-ventilated house condition (temperature 26–30^{o}C) with free access to rat pellets and tap water. Estradiol benzoate, progesterone and L-Dopa were purchased from Sigma Aldrich, USA. *Eurycoma longifolia* extract was obtained from research collaborator, Malaysian Institute of Pharmaceutical and Nutraceutical (IPHARM). The serum testosterone assay kit was purchased from Cayman Chemical Company, USA.

iii) BALB/C 3T3 Neutral Red Uptake cytotoxicity study

The NRU cytotoxicity assay is a cell survival/viability chemosensitivity assay based on the ability of viable cells to incorporate and bind neutral red (NR), a supravital dye, in two cultured cell systems

[mouse fibroblast (BALB/c) 3T3 and normal human keratinocytes (NHK)]. This study was performed to estimate the starting dose for the *in vivo* study (i.e: oral acute toxicity test; behavioural study, etc.), thus reducing and refining the use of animals in the toxicological assessment of plant extract studied. This study will generate information on the No-Obrserved-Adverse-Effect level (NOAEL), Low-Obrserved-Adverse-Effect level (LOAEL), Adverse-Observed-Effect level (AOEL) based on the Inhibition Concentration (IC) obtained.

iv) Acute oral toxicity

An acute oral toxicity study was conducted on rats to determine the toxicity potential of mangrove extracts from a single dose via oral route according to Organization of Economic Cooperation and Development (OECD) guidelines No: 425. The acute oral toxicity up-and-down procedure (UDP) – Limit Test is a sequential test which uses a maximum of five animals. Animals are dosed in sequential manner with the next animal receiving the same dose only if the first animal survives the limit dose. A starting dose of 2000 mg/kg was selected based on recommendation from BALB/c 3T3 NRU cytotoxicity study.

v) Evaluation of male sexual behavior

The aphrodisiac potential was evaluated through mounting behaviour study for libido effect, partner preference study for sexual motivational (Agmo *et al*. 2004 & Zanoli *et al*. 2009) and assessment of mating performance for potency effect (Agmo 1997).

vi) Testosterone assay

The treated group was administered orally at various doses based on body weight with 300, 400 and 500 mg/kg of the crude mangrove extracts (obtained from BALB/c 3T3 NRU cytotoxicity study). Animals were sacrificed 24 h after the last dose on the 6 days. Trunk blood was collected into centrifuge tubes. The tubes were centrifuged (3000 rpm, 20 min and 4^{o}C) to give serum and stored frozen until analysis time. The serum testosterone concentration was quantitatively determined using Testosterone EIA kit.

v) Statistical analysis

The statistical comparison between control, standard and treated groups was done using the analysis of variance method (ANOVA) with confidence level of 95 % ($P < 0.05$) compared to negative control (water). Data were presented as mean ± SEM (n=6).

RESULTS

Phytochemical screenings

Phytochemical screening showed the presence of saponins, flavonoids, tannins & polyphenolic compounds, triterpenes and steroids in the crude extracts studied (Table 1). The presence of steroidal compounds in the extract is also as an indicator that the plants might have bioactive compound associate with sex hormones (Egwaikhide 2008).

Table 1. Phytochemical components of crude mangrove extracts.

Crude extract	Alkaloids	Saponins	Flavonoids	Tannins & Polyphenolic compounds	Triterpenes/ Steroids
R. apiculata	-	-	++	++	+
R. mucronata	-	++	+	++	++
B. parviflora	-	++	++	++	+
A. aureum	-	+	+++	++	++
D. trifoliata	+	+	+++	++	+++
M. muticus	-	++	+++	+++	+++

Neutral Red Uptake Cytotoxicity of the extracts

This study will generate information on the No-Obrserved-Adverse-Effect level **(**NOAEL) , Low-Obrserved-Adverse-Effect level **(**LOAEL), Adverse-Observed-Effect level **(**AOEL) based on the Inhibition Concentration (IC) obtained. Hence, NOAEL value (IC_5) had been selected as a dosage to be used for animal behaviour studies of the crude extracts.

Table 2. Results for Neutral Red Uptake of the extracts studied.

No	Plant extracts	Estimated doses (mg/kg)/body weight		
		LD_5	**LD_{20}**	**LD_{50}**
1	*Rhizophora apiculata*	580	680	800
2	*Rhizophora mucronata*	460	560	670
3	*Acrostichum aureum*	580	700	850
4	*Mallotus muticus*	400	450	500
5	*Bruguiera parviflora*	320	570	780
6	*Derris trifoliata*	-	-	2 636

Acute Oral Toxicity

All animals were observed individually for mortality, signs of gross toxicity and behavioural changes once during the first 30 minutes after dosing. No mortality was observed within the 14 days procedure. All animals gained body weight, appeared normal and did not demonstrate any abnormal behaviour during the observation period. Under the condition of this study, the acute oral toxicity of all mangrove extracts studied were classified as Category 5 which is non-toxic according to the Globally Harmonised System for the classification of chemicals (LD_{50} is greater than 2000 mg/kg body weight).

Evaluation of male sexual behaviour

Assessment of aphrodisiac potential was done on the sexual desire (mounting behaviour study), sexual motivational (partner preference study) and sexual performance study.

a) Mounting behaviour study
   The results showed that SD rats treated with extracts of *M. muticus* and *R. mucronata* increase in number of mounts throughout the observation compared to the negative control (Figure 1).

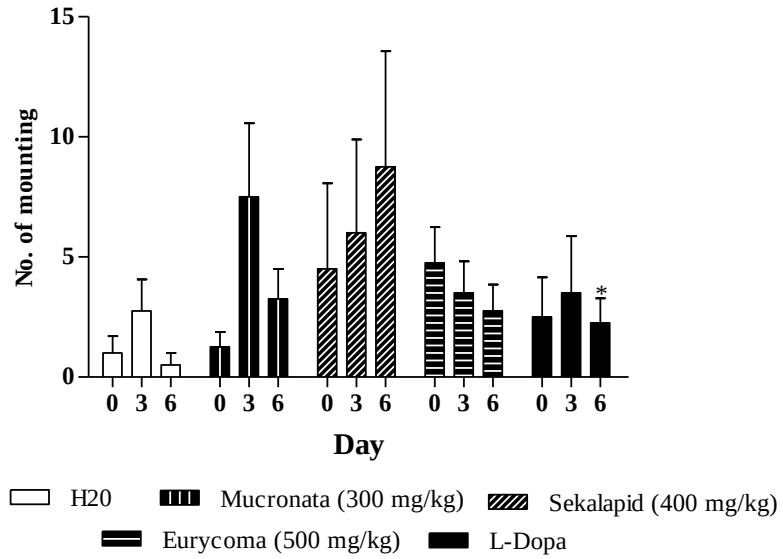


Figure 1. Effect of subacute treatment on number of mounting in rats treated with *R. mucronata* and *M. muticus* (Sekalapid). Data obtained from groups of 6 animals.

b) Mating performance study

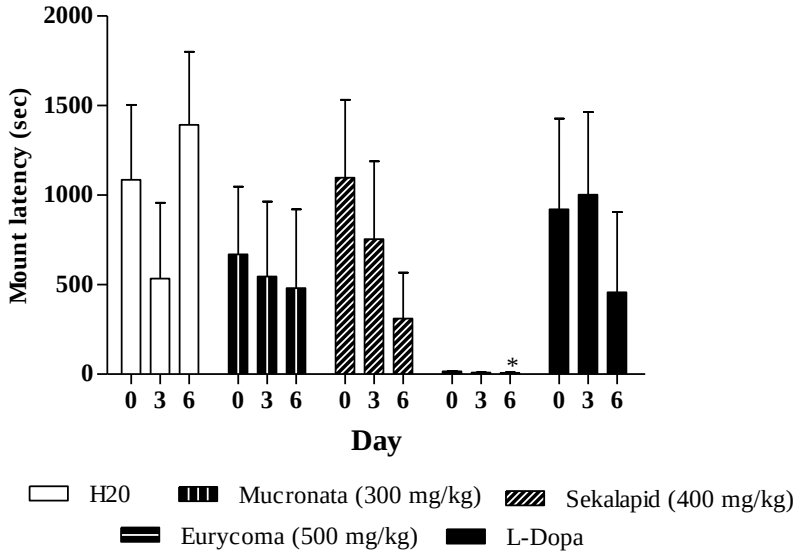


Figure 2. Effect of subacute treatment on mount latency in rats treated with *R. mucronata* and *M. muticus* (Sekalapid). Data obtained from groups of 6 animals.

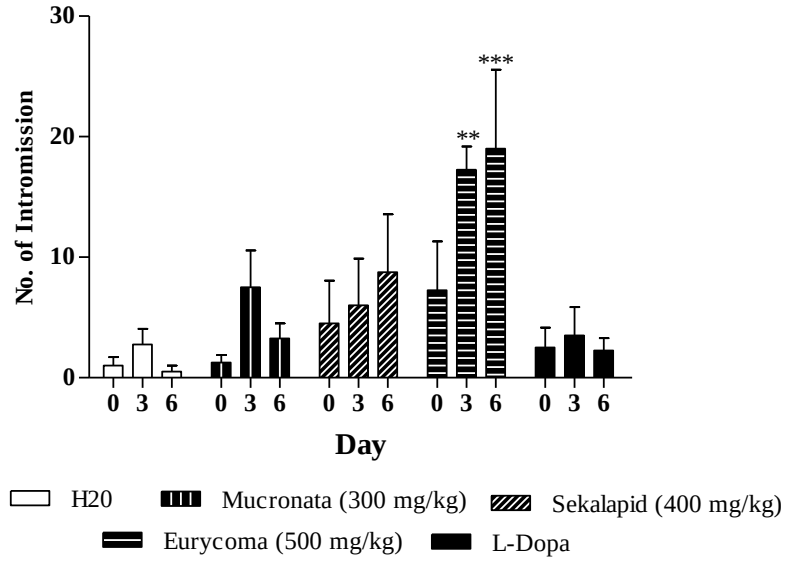


Figure 3. Effect of subacute treatment on number of intromission in rats treated with *R. mucronata* and *M. muticus* (Sekalapid). Data obtained from groups of 6 animals.

Partner preference study

Table 3. Effect of extracts on partner preference study (sexual motivation).

Sample name	Receptive Female		Non Receptive Female	
	Cumulative Time Spent (s)	Percentage (%)	Cumulative Time Spent (s)	Percentage (%)
Water	296.67	40.21	118.5	14.83
L- Dopa	498	55.33	287.17	31.91
E. longifolia	36.17	8.56	377.83	33.89
M. muticus	546.5	60.72	330.5	36.72
R. mucronata	414.83	46.09	202.5	22.5

Results expressed as mean ± SEM, each group= 6 animals

The results showed that the male rats treated with crude extracts *(M. muticus and R. mucronata)* increased in preference for the sexually receptive female rats when compared to the negative control (water). Therefore, sexual motivation was altered (preference for receptive female) or observed to increase in rats treated with both *M. muticus* and *R. mucronata* extracts when subjected to partner preference study.

Effect of subacute treatment on testosterone level in sexually experienced rats treated with *R. mucronata* and *M. muticus*

At the last day of sexual behavioral studies, serum testosterone level was determined for all groups (Figure 4). Groups receiving crude extracts of *R. mucronata* and *M. muticus* produced significant increase of testosterone concentration compared with the negative control groups ($p<0.001$). A significant increase ($p < 0.001$) in serum testosterone level confirmed that the crude extract studied was able to improve sexual function (Fahim *et al.* 1982, Gauthman *et al*. 2002 & Zanoli *et al*. 2003).

Table 4. Effect of subacute treatment on testosterone level in sexually experience rats treated with *R. mucronata* and *M. muticus*. Each column represents the mean ± S.E.M for 6 animals; *p<0.05 significantly different from control, **p<0.01 significantly different from control, ***p<0.001 significantly different from control.

Sample	**Mean Testosterone Conc. (pg/ml)**		
	300 mg/kg	**400 mg/kg**	**500 mg/kg**
Water (H_2O)	9974.88 ± 548.41		
R.mucronata	19583.87 ± 2014.65***	-	-
M. muticus	-	19738.23 ± 1050.24***	
E. longifolia	-	-	9551.36 ± 1005.19
L-Dopa	9286.72 ± 886.73		

CONCLUSIONS

The in vivo study has shown that the extracts significantly increased the serum testosterone level in sexually experienced rats. This finding suggests that phytochemical compound present in the extract might have assisted in stimulating testosterone production in the body.

Sexual desire (libido) and motivation have improved as evidenced by the reduction in mount latency and increase in number of mounting (Eckstein 1960). Whereas, sexual performance is enhanced by the reduction in intromission latency.

The mangrove extracts studied offer as one of the candidates for natural products with the aphrodisiac properties capable of increasing testosterone level in rat blood serum. Work is in progress on the isolation and characterization of the bioactive compound responsible for aphrodisiac observed.

REFERENCES

Agmo, A. (1997). Male rat sexual behavior. *Brain Research Protocols.* 1: 203-209.

Agmo, A.L., Turi, E., Ellingsen & H. Kaspersen (2004). Preclinical models of sexual desire: conceptual and behavioral analyses. *Pharmacology Biochemistry and Behavior.* 78: 379 – 404.

Eckstein P. & Zukerman S. (1960). *Marshall's physiology of reproduction*. In: Parker A.S., Vol. 1, pp. 127-9.

Egwaikhide P.A., Okeniyi, S.O., Akporhonor, E.E. & Emua, S.O. (2008). Studies on bioactive metabolites constituents and antimicrobial evaluation of leaf extracts of *Eucalyptus globulus*. *Agricultural Journal.* 3: 42-45.

Fahim, M.S., Fahim, Z., Harman, J.M., Clevenger, T.E., Mullins, W. & Hafez, E.S.E. (1982). Effect of Panax Ginseng on testosterone level and prostrate in male rats. *Archives of Andrology.* 8: 261-263.

Gauthaman K., Adaikan P.G. & Prasad R.N. (2002). Aphrodisiac properties of *Tribulus terrestris* extract (Protodioscin) in normal and castrated rats. *Life Sci* 71: 1385-1396.

OECD (2001). Guidance for testing of chemicals, Acute Oral Toxicity Up Down Procedure Method. 17: 425.

OECD (2010). Guidance document on using cytotoxicity tests to estimate starting doses for acute oral systemic toxicity tests. Environmental Health and Safety Monograph Series on Testing and Assessment No 129 (Neutral Red Uptake study).

Zanoli, P., Benelli, A., Rivasi, M., Baraldi, C., Vezzalini, F. & Baraldi, M. (2003). Opposite effect of acute and subchronic treatments with Ferula hemonis on copulatory behavior of male rats. *International Journal of Impotence Research*. 15: 450 – 455.

Zanoli, P., Zavatti, M., Montanari, C. & Baraldi, M. (2009). Influence of *Eurycoma longifolia* on the copulatory activity of sexually sluggish and impotent male rats. *Journal of Ethnopharmacology*. 126: 308-313.

Slide Presentation

Aphrodisiac Potential and Preclinical Evaluation on the Extract of Mangrove Plants in Costal Area of Sabah

Project Leader: Sarifah Bt. Rejab

Project Members: Syamima Md Khalid, Ahmad Hazri Ab. Rashid, Thavamanithevi a/p Subramaniam, Mohd Helme Mohd Helan, Noor Rabihah Ad, Ana Sharmila Shafie, Auliawati Mohd Shabery, Zuleea Delina Fasya Abd. Ghani, Nurul Husna Abdullah, Lim Chuan Gee, Puzish Hashim, John Sugau, Joseph Tangsh

BACKGROUND

- The research was initiated based on the observation of group of animals seem to have active sexual activity and high sex ratio towards the female (sex ratio 1:8.4)
- Their diet consuming local plant believed to contribute to the high sexual activities
- Thus, the project was given to SIRIM as a top-down project under R & D Initiatives, funded by MOSTI

OBJECTIVE

- To investigate the aphrodisiac potentials of the local plant extract using animal models (*in vivo* method)
- To establish chemical profiling of the bioactive extracts.
- To access the safety and efficacy of local plant extract as aphrodisiac potential

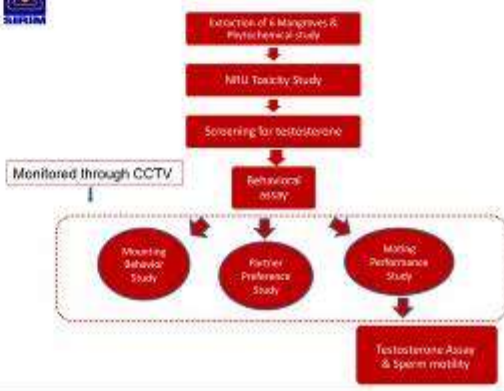
Six (6) mangrove plants chosen for screening:-

- *Rhizophora apiculate* (bakau minyak)
- *Rhizophora mucronata* (bakau kurap)
- *Bruguiera parviflora* (langadai)
- *Acrostichum aureum* (fern) or piai
- *Derris trifoliata* (tuba)
- *Mallotus muticus* (sekalapid)

Voucher Specimens:-

*The plants are identified by Sabah Forestry Botanist and the voucher specimens are deposited at Sabah Herbarium, Sandakan (SAN Herbarium) and FRIM.

RESEARCH FLOW CHART



Phytochemical screenings

Crude extract	Alkaloids	Saponins	Flavonoids	Tannins & Polyphenolic compounds	Triterpenes/ Steroids
Plant A	-	++	+	++	++

Phytochemical screening showed the presence of saponins, flavonoids, tannins & polyphenolic compounds, triterpenes and steroids in the crude extracts studied.

All extracts demonstrated higher level of saponins, tannins & polyphenolic compounds, triterpenes and steroids compounds.

PHYTOCHEMICAL ANALYSIS

Crude extract	Alkaloids	Saponins	Flavonoids	Tannins & Polyphenolic compounds	Triterpenes/ Steroids
Rhizophora apiculata (bakau minyak)	-	-	2+	2+	1+
Rhizophora mucronata (bakau kurap)	-	2+	1+	2+	1+
Bruguiera Parviflora (lenggadai)	-	2+	1+	2+	1+
Acrostichum aureum (piai)	-	1+	3+	2+	1+/2+
Derris trifoliata (tuba)	1+	1+	3+	2+	3+
Malotus muticus (sekalapid)	-	2+	3+	3+	3+

I Preclinical Evaluation

a *In vitro* / Cytotoxicity Study

The Neutral Red Uptake (NRU) Cytotoxicity Assay

b *In vivo* / Animal Study

Acute Oral Toxicity Study

CYTOTOXICITY STUDY OF THE PLANT EXTRACT

The Neutral Red Uptake (NRU) Cytotoxicity Assay

The NRU cytotoxicity assay is a cell survival/viability chemosensitivity assay based on the ability of viable cells to incorporate and bind neutral red (NR), a supravital dye, in two cultured cell systems [mouse fibroblast (BALB/c) 3T3 and normal human keratinocytes (NHK)].

Objective of this study

To estimate the starting dose for the *in vivo* study (i.e: oral acute toxicity test; behavioural study etc) thus reducing and refining the use of animals in the toxicological assessment of plant extract studied

In Vitro Cytotoxicity Determination of LD50 for The Extracts (NRU Toxicity Study)

No	Plant extracts	Estimated Doses (mg/kg)		
		LD5	LD20	LD50
1	*Rhizophora apiculata* (bakau minyak)	680	680	800
2	*Rhizophora mucronata* (bakau kurap)	460	560	670
3	*Acrostichum aureum* (piai)	580	700	850
4	*Malotus muticus* (sekalapid)	400	480	600
5	*Bruguiera parviflora* (lenggadai)	320	570	780
6	*Derris trifoliata* (tuba)	-	-	2830

The results obtained from this test is to be used as a guide for oral doses in animal studies.
The proposed estimation of NOAEL (No-Observed-Adverse-Effect level), LOAEL (Low-Observed-Adverse-Effect level) and LD_{50} (the highest dose level) are as tabulated below.

b Preclinical Evaluation *In vivo* / Animal Study

I Safety Dose Assessment

Objective of this study

An acute oral toxicity study is conducted on rats to determine the toxicity potential of plant extracts from a single dose via oral route.

References

OECD (2008), Acute Oral Toxicity – Up-and-Down Procedure (UDP), OECD Guidelines for Testing of Chemicals No. 425, OECD, Paris.

ANIMAL STUDY OF THE PLANT EXTRACT

Result for the Acute Oral Toxicity Up-And-Down Procedure (UDP) – Limit Test

No mortality was observed within the 14 days procedure. All animals gained body weight, appeared normal and did not demonstrate any abnormal behaviour during the observation period

Under the conditions of this study, the acute oral toxicity of plant extracts studied were classified as **Category 5 according to the Globally Harmonised System** for the classification of chemicals. The LD_{50} is greater than 2000 mg/kg body weight

II Assessment of Aphrodisiac Potential

Definition

Substance stimulate / increase sexual desire, performance and pleasure.

(S.Ramachandran et. Al 2004)

Animal Sexual Behavior Studies – Evaluation of Aphrodisiac Potentials

Mounting Behaviour Study	Partner Preference Study	Mating Performance Study
Sexual desire	Sexual motivational	Sexual potency

Animal

Ethics

The use and care of the animal was in accordance to the Animal Welfare Guideline established at R&D SIRIM Berhad center level.

Test System

Male & Female Sprague Dowley Rat

- 8 – 13 weeks old
- Acclimatized for 3 weeks under reversed light cycle

Test Samples

For each study, rats were administered of following based on body weight:-

- 300 mg/kg of plant extract A
- 500 mg/kg of *positive control* (Natural Extract)
- 100 mg/kg of positive control (Synthetic)
- 10oml/ kg of negative control

II Assessment of Aphrodisiac Potential

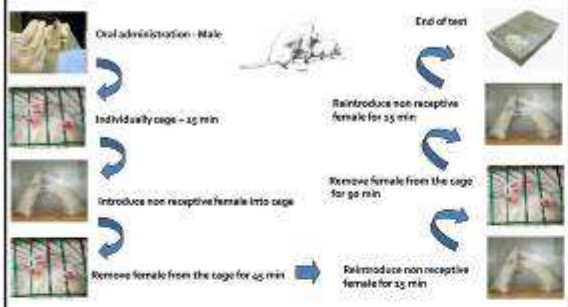
a Mounting Behavior Study – Sexual Desire Assessment

Mount is operationally defined as the male assuming the copulatory position but failing to achieve intromission

Movement of animals was recorded throughout the period studied using video camera

Parameters monitored :
Orientation activities of male rat toward female rat, toward the environment and toward self

Mounting Behavior Study (Sexual Desire) *(A. Zamble et. al.2008)*



Mounting Behavior Study (Sexual Desire)

Picture captured above showed male SD rat in a mounting position

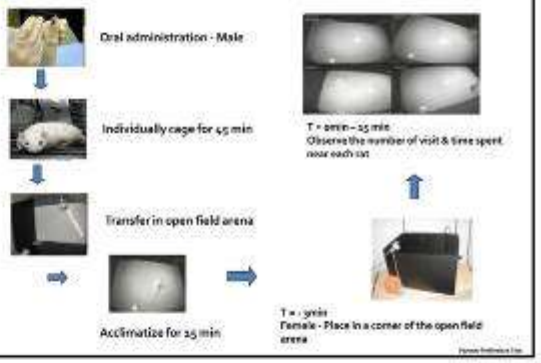
Assessment of Aphrodisiac Potential

b **Partner Preference Study – Sexual Motivational Assessment**

1 male SD rat in one cage vs 1 female SD receptive rat in one cage
Monitoring time: 30 min

Parameter monitored:
The number of visit male rat to receptive female rat vs male rat (sexual visit vs social visit)

Partner Preference Study Method (P. Zanoli et. al 2009)



Effect of Extracts on partner preference study (sexual motivational)

Sample name	Receptive Female		Non Receptive Female	
	Cumulative Time Spent (s)	Percentage (%)	Cumulative Time Spent (s)	Percentage (%)
Water (10ml/kg)	296.67	40.21	118.5	14.83
L-Dopa 100 mg/kg	498	55.33	287.17	31.91
E. longifolia 500 mg/kg	36.17	8.56	377.83	89.89
Plant A 400 mg/kg	546.5	60.72	330.5	36.72
Plant B 300 mg/kg	414.83	46.09	202.5	22.5

Assessment of Aphrodisiac Potential

c **Mating Performance Study– Sexual Performance Assessment**

Sexually experience male SD rat + Receptive Female SD rats
Dosages only on male SD rat : Repeated dose
Treatment period : 6 days

Parameters monitored
Number of mounting, Mounting latency,
Number of intromission, Intromission latency,
Number of Ejaculation, Ejaculation Latency

Mating Performance Study (Agmo et al 2008)

Mating Performance Study

Research Findings

Assessment of Aphrodisiac Potential

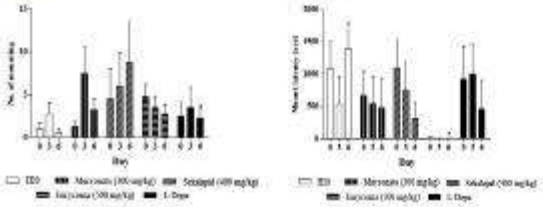
Mounting Behavior Study	Mating Performance Study	Partner Preference Study
Sexual Desire	Sexual Performance	Sexual Motivational

Sexual Desire and Motivation is improved as evidenced by the reduction in mount latency

Sexual Performance is enhanced by the reduction of intromission latency

Mounting Behavior Study

Sexual Desire



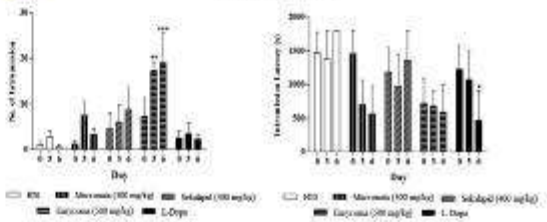
Effect of subacute treatment on number of mounting in rats treated with *R. mucronata* and *M.muticus* (Sekalapid). Data are obtained from groups of 6 animals.

Effect of subacute treatment on mount latency in rats treated with *R. mucronata* and *M.muticus* (Sekalapid). Data are obtained from groups of 6 animals.

Prior art studies ..cont

Mating Performance Study

Sexual Potency



Effect of subacute treatment on number of intromission in rats treated with *R. mucronata* and *M.muticus* (Sekalapid). Data are obtained from groups of 6 animals.

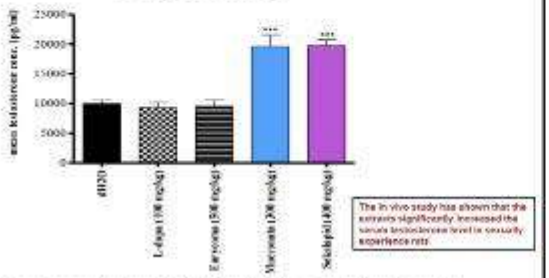
Effect of subacute treatment on intromission latency in rats treated with *R. mucronata* and *M.muticus* (Sekalapid). Data are obtained from groups of 6 animals.

*Number of intromission , between 5 -10 shows the ease of ejaculatory reflexes are activated (Anders Agmo, 1997).

Hormone (Testosterone assay)

indicates the amount of male sex hormone being synthesized based on crude extracts administered on the treated animal

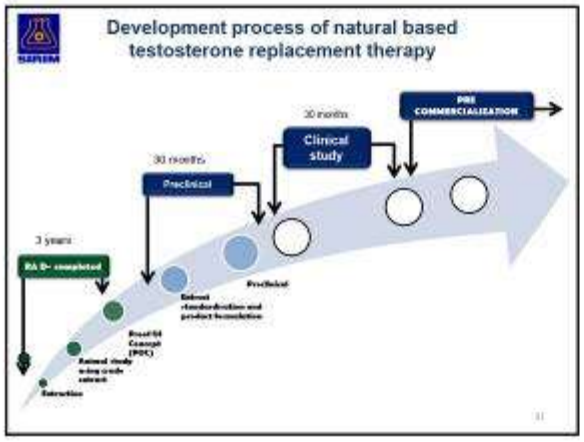
MPT (Testesterone)



The in vivo study has shown that the extracts significantly increased the serum testosterone level in sexually experience rats

Each column represents the mean ± S.E.M for 6 animals. *p<0.05 significantly different from control, **p<0.01 significantly different from control, ***p<0.001 significantly different from control.

PROJECT CONCLUSIONS


Development process of natural based testosterone replacement therapy
PRE COMMERCIALISATION
Clinical study
Preclinical
3 years


Thank You
Email : sarifah@sirim.my
syamimr@sirim.my
Tel : 03-5544 6952/5792
Fax : 03-5544 6988

ORAL PAPER 7

PRELIMINARY SURVEY TO SET UP LONG-TERM MANGROVE MONITORING SITE AND TO ESTABLISH A TRANSCRIPTOME DATABASE FOR PRIMARY MANGROVE SPECIES IN SABAH

Shin Watanabe[1] & Joseph Tangah[2]
[1]Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus
[2]Sabah Forestry Department

Associate Professor Dr Shin Watanabe holds a D.Phil. and M.Sc. from the University of Tokyo, and B.Sc. from Miyazaki University, on Agriculture Forestry. He is currently a Director for the Field of Mangrove Research, Iriomote Station, at the Tropical Biosphere Research Center, University of the Ryukyus; he has been working at the University for 8 years. Previously he was a Post-Doc Researcher for Molecular Breeding at Tsukuba University from 2003 until 2007.

Abstract

Mangroves are distributed in intertidal environments and major contributors to maintain stable coastal and marine environment. Their root systems protect the reefs from terrestrial sediments and other forms of pollution, and provide attachment surfaces for various marine organisms. In spite of the fact of their ecological importance, human activities have strongly affected mangrove distributions, resulting in decline of worldwide mangrove ecosystem. Although every endeavor to rehabilitate mangrove forests has been made in many countries, there is still room for increasing success rate of reforestation by improving the silvicultural method, especially by matching suitable mangrove species with degraded area. In order to make a decision of which mangrove species should be planted in a target place, it is necessary to know which environmental factor affects the niche of each mangrove species. In other words, it is important to comprehend the tolerant mechanism in each mangrove species against various environmental stresses, such as flooding, salinity or shading. Therefore, we set the purpose of our research to elucidate the mechanism of how the ecological niche of each mangrove species is decided. Fortunately, we could start this research project at a rehabilitated site in suburban Sandakan in June of 2014 in collaboration with Sabah Forestry Department and International Society for Mangrove Ecosystems. To achieve this research purpose, three goals are set, as described below. 1) to find a suitable afforestation method by monitoring the growth of replanted mangrove trees by using the following equipment or an application, such as a laser compass, an unmanned aerial vehicle (UAV), an algorithm of structure from motion (SfM). 2) to understand the function of each mangrove species genetically, a transcriptome database will be established by using next generation sequencer (NGS). 3) to clarify change of the biodiversity as a result of mangrove rehabilitation, regular monitoring will be conducted. In this presentation, some research results obtained from a rehabilitated mangrove forest in Malaysian state of Sabah and natural mangrove forests in Micronesia and Japan will be featured.

Slide Presentation

Preliminary survey to set up
long-term mangrove monitoring site and
to establish a transcriptome database
for primary mangrove species

Shin Watanabe[1] & Joseph Tangah[2]
[1]Iriomote Station
Tropical Biosphere Research Center
University of the Ryukyus
[2]Sabah Forestry Department

Establishing International transcriptome database of Mangrove

&

Estimating Biomass of Regenerated Forest by ISME & SFD
(substitution)

Research Interest

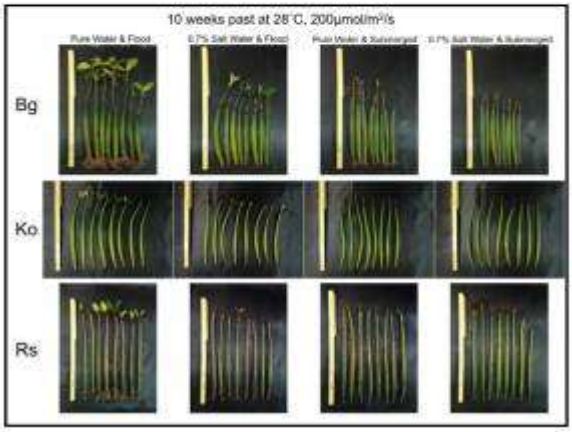
It is significant to select suitable tree species for reforestation of mangrove after deforestation by natural disaster or artificial factors.

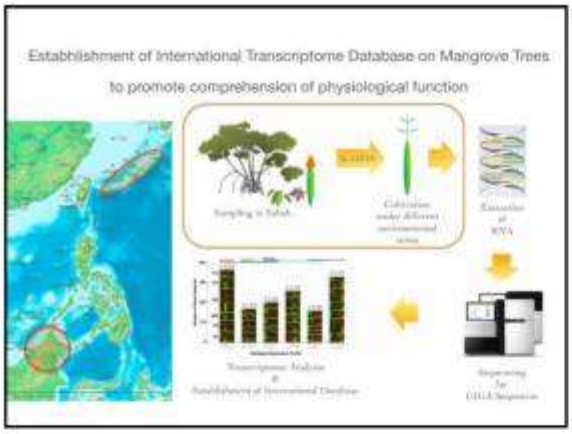
Focus Point
→ How the ecological niche is decided in each mangrove species
(Matching environmental stress & phsiological tolerance of plant)

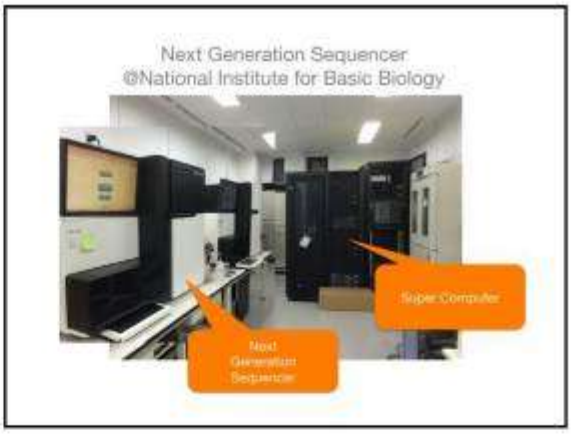
Points to be checked
-Flooding tolerance = Tide level+Ground level
-Salinity tolerance = Salinity of water or soil
-Shade tolerance = Competition by plant growth

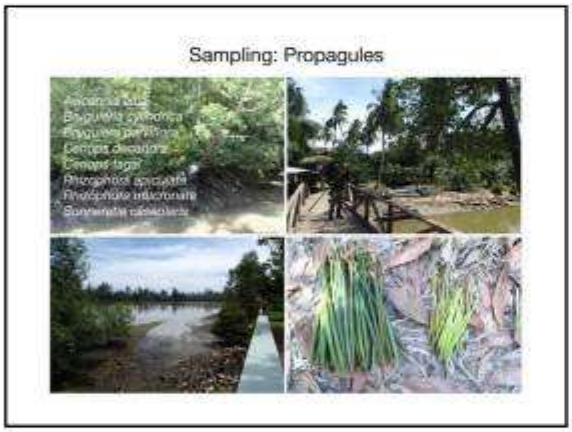
Mangrove Research in Sabah

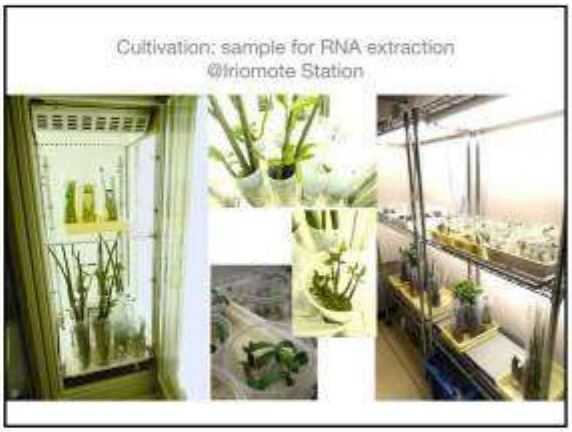
- Lab: Next Generation Sequence
- Field: Biomass Monitoring

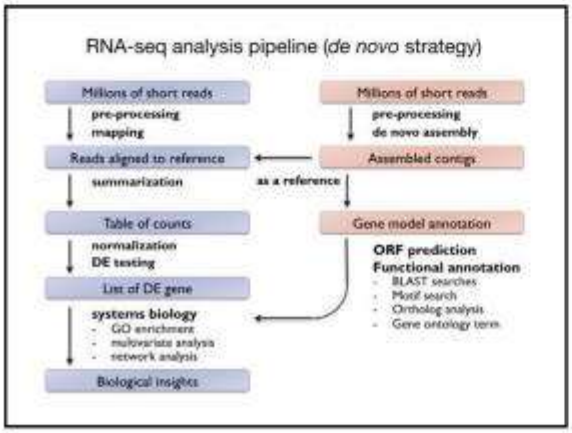



Establishment of International Transcriptome Database on Mangrove Trees
to promote comprehension of physiological function


Next Generation Sequencer
@National Institute for Basic Biology
Super Computer
Next Generation Sequencer


Sampling: Propagules


Cultivation: sample for RNA extraction
@Iriomote Station


RNA-seq analysis pipeline (de novo strategy)
Millions of short reads
pre-processing
mapping
Reads aligned to reference
summarization
Table of counts
normalization
DE testing
List of DE gene
systems biology
- GO enrichment
- multivariate analysis
- network analysis
Biological insights
Millions of short reads
pre-processing
de novo assembly
Assembled contigs
as a reference
Gene model annotation
ORF prediction
Functional annotation
- BLAST searches
- Motif search
- Ortholog analysis
- Gene ontology term

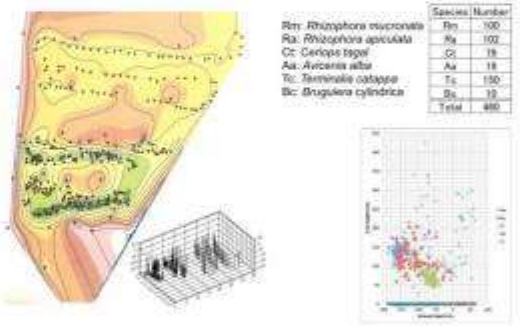

RNA extraction, Quality Check & Prep Treatment
@Iriomote Station

Mangrove Research in Sabah

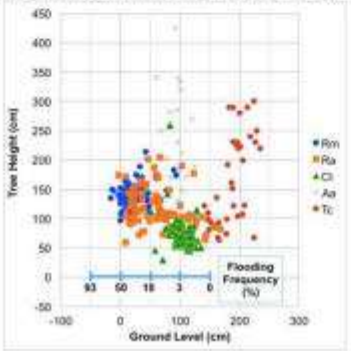
- Lab: Next Generation Sequence
- Field: Biomass Monitoring

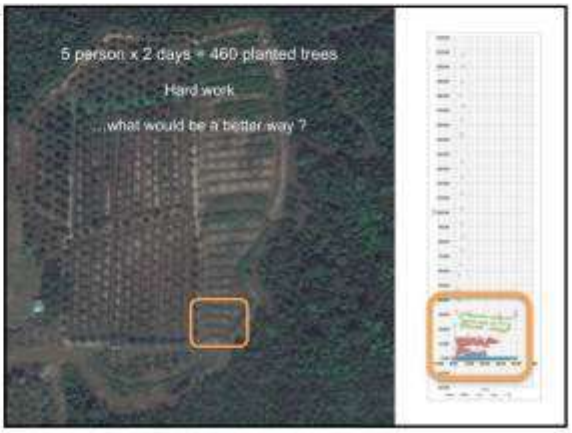
How to measure
Ground level of individual trees / Cordinate

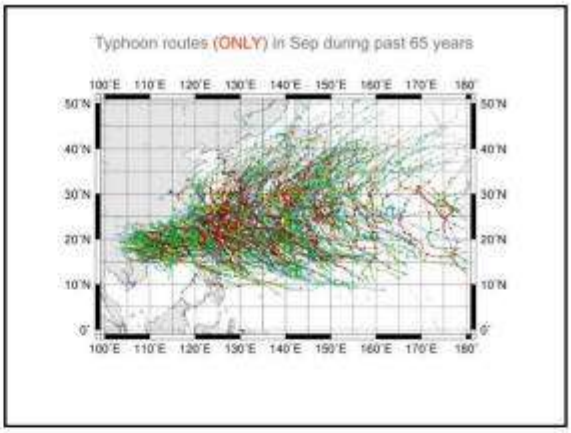
Coordinate with geographical information
Correlation between Tree Growth & Ground Level



Correlation between Tree Height & Ground Level







Collaborate Research with FD

- Researching the extent of the damage of the mangrove forest
- Monitoring recovery condition of damaged mangrove forest

Broad Area · · ·

· · · UAV (Drone)

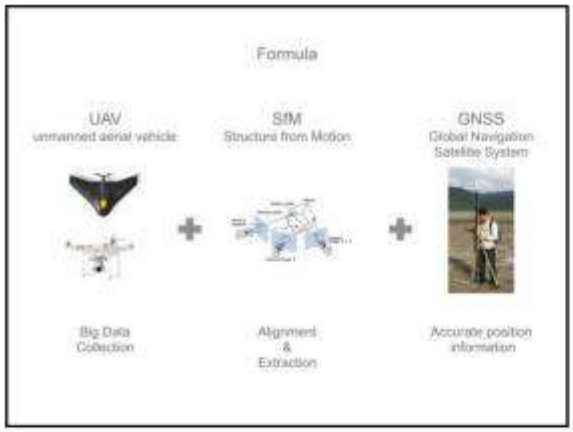
New Challenge 1
Applying UAV(Drone) to SFD's work

From Bird's-Eye View

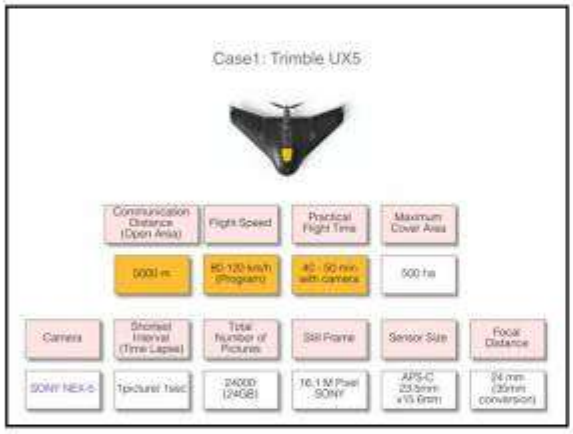
Researching or monitoring
Forests, Field, Coastline
Animals, Insects, Plants

Measurement
Forest biomass, Biodiversity

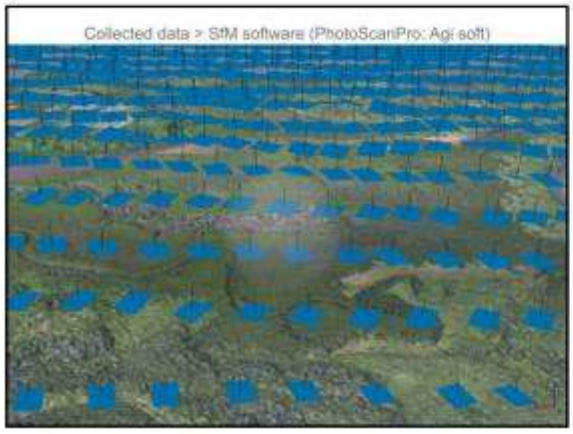
Patrolling border area

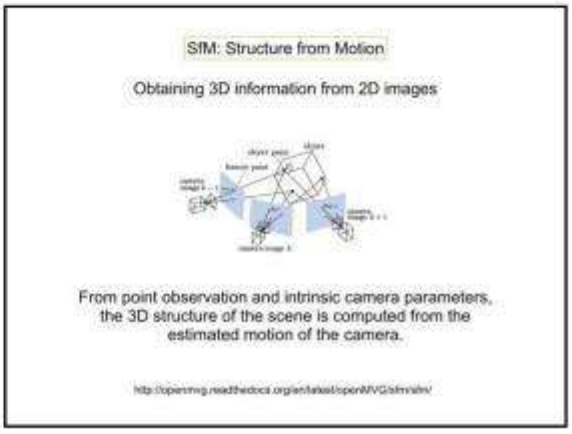

Formula
UAV
unmanned aerial vehicle
SfM
Structure from Motion
GNSS
Global Navigation Satellite System
Big Data Collection
Alignment & Extraction
Accurate position information


Test Flight in Iriomote

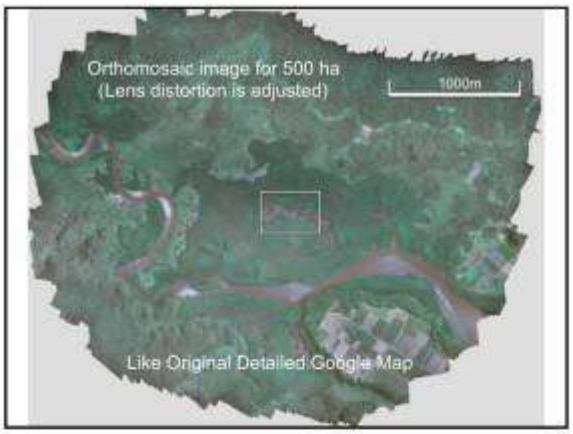

Case1 : Trimble UX5
Communication Distance (Open Area)
Flight Speed
Practical Flight Time
Maximum Cover Area
5000 m
80-120 km/h (Program)
40 - 50 min with camera
500 ha
Camera
Shortest Interval (Time Lapse)
Total Number of Pictures
Still Frame
Sensor Size
Focal Distance
SONY NEX-5
1pc/unit 1sec
24000 (24GB)
16.1 M Pixel SONY
APS-C 23.5mm x15.6mm
24 mm (35mm conversion)

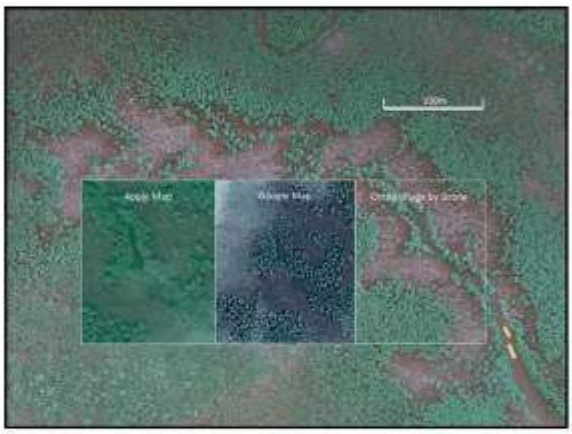

Waypoint
80

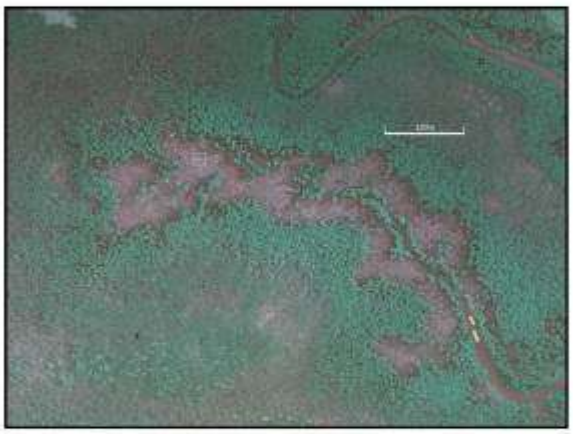

Collected data > SfM software (PhotoScanPro: Agi soft)

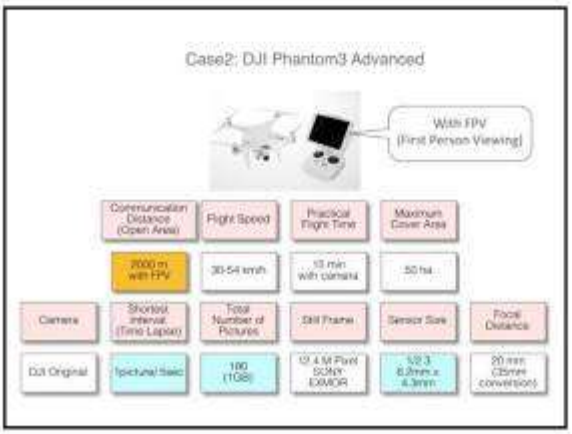

SfM: Structure from Motion
Obtaining 3D information from 2D images
From point observation and intrinsic camera parameters, the 3D structure of the scene is computed from the estimated motion of the camera.

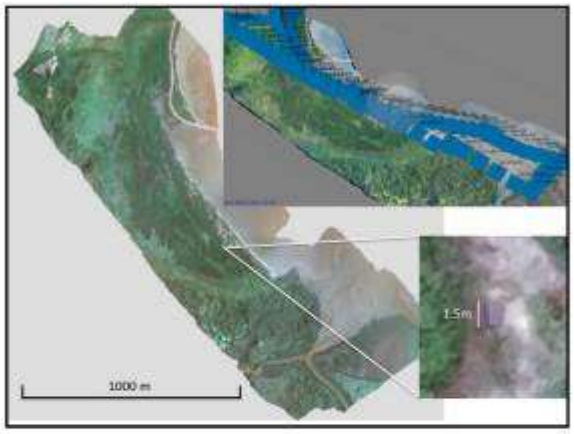

Measuring accurate position by GNSS

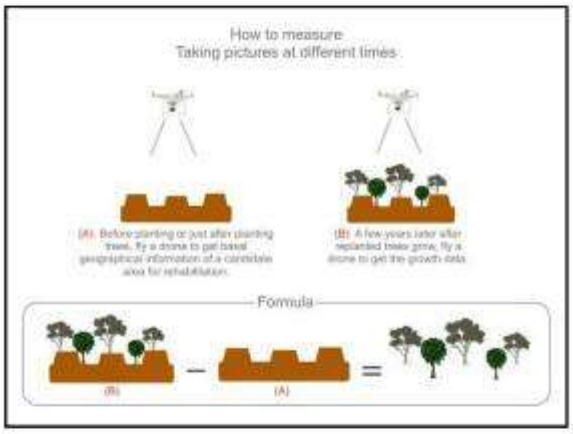

Orthomosaic image for 500 ha
(Lens distortion is adjusted)
1000m
Like Original Detailed Google Map

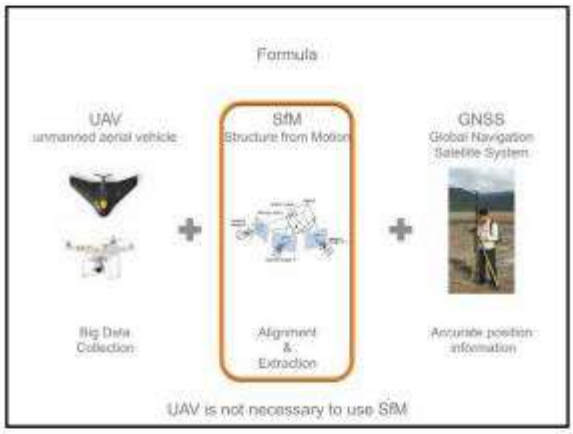


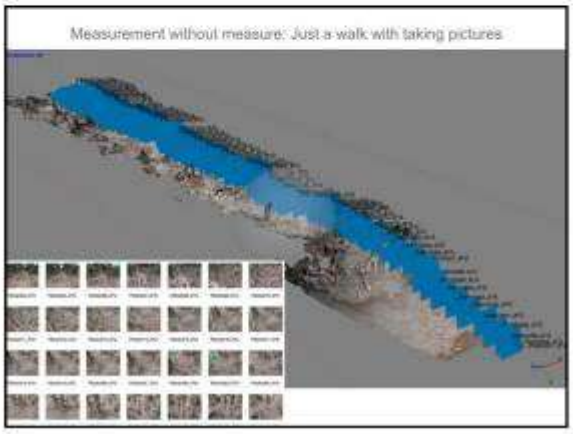


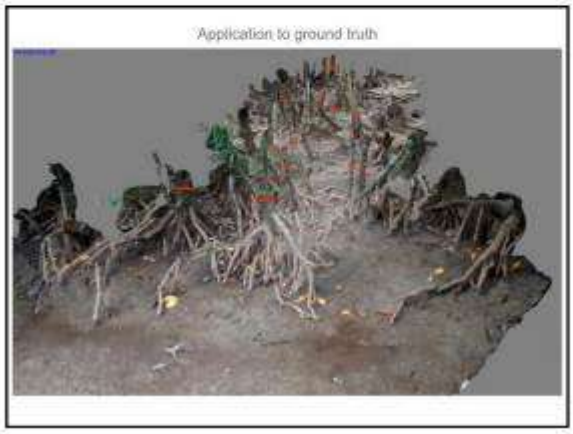

Case2: DJI Phantom3 Advanced
With FPV
(First Person Viewing)
Communication Distance (Open Area)
Flight Speed
Practical Flight Time
Maximum Cover Area
2000 m with FPV
30-54 km/h
10 min with camera
50 ha
Camera
Shortest Interval (Time Lapse)
Total Number of Pictures
Still Frame
Sensor Size
Focal Distance
DJI Original
1pic/sec/1sec
100 (1GB)
12.4 M Pixel SONY EXMOR
1/2.3 6.2mm x 4.3mm
20 mm (35mm conversion)

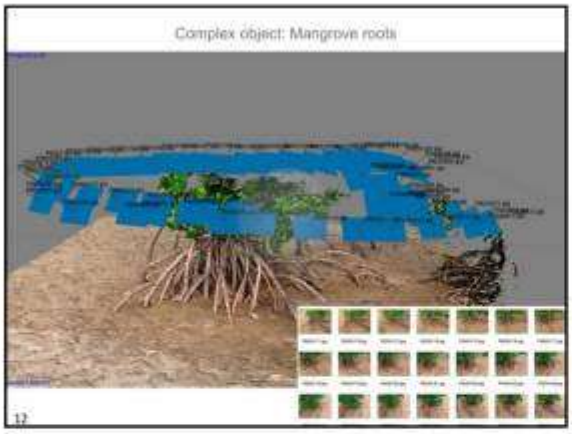

1.5m
1000 m

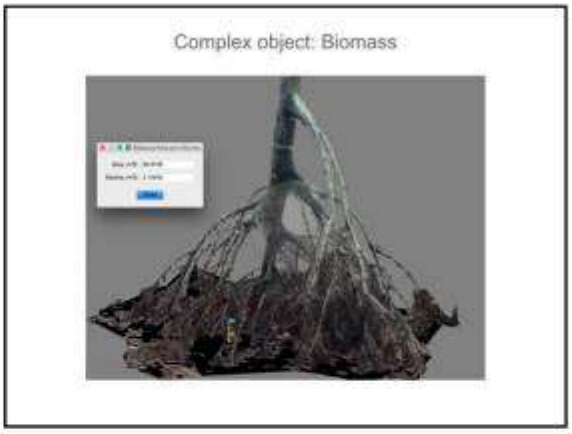

How to measure
Taking pictures at different times
Formula

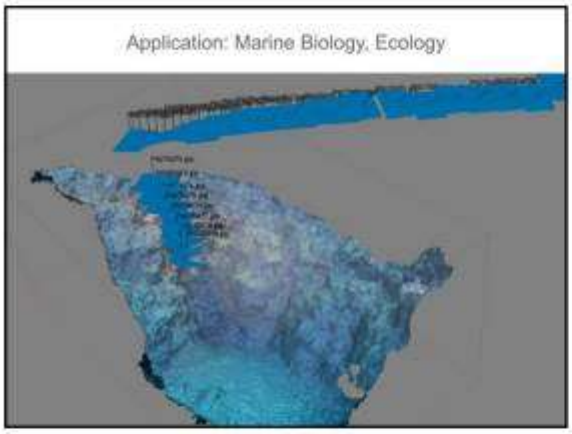

Formula
UAV
unmanned aerial vehicle
SfM
Structure from Motion
GNSS
Global Navigation Satellite System
Big Data Collection
Alignment & Extraction
Accurate position information
UAV is not necessary to use SfM

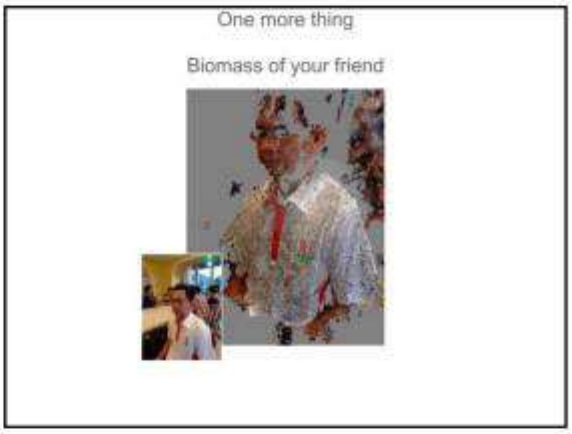

Measurement without measure: Just a walk with taking pictures


Application to ground truth

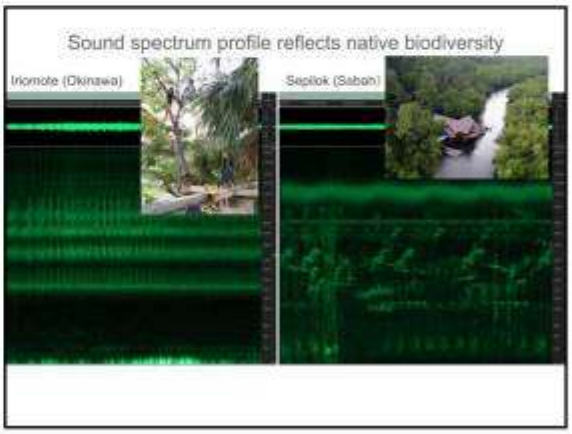

Complex object: Mangrove roots
12


Complex object: Biomass

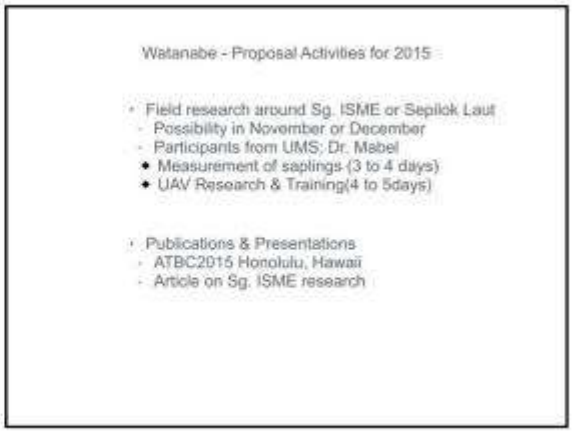

Application: Marine Biology, Ecology


One more thing
Biomass of your friend


New Challenge 2
Monitoring Biodiversity by Sound Spectrum
Sounds contains incredible amounts of information
(Bernie Krause: The voice of the natural world (TED))
Animal orchestra, that instantaneous and organized expression of insects,
reptiles, amphibians, birds and mammals.


Sound spectrum profile reflects native biodiversity
Iriomote (Okinawa)
Sepilok (Sabah)


Acknowledgement
SABAH FORESTRY DEPARTMENT
NIED
防災科学技術研究所
東北学院大学


Watanabe - Proposal Activities for 2015
Field research around Sg. ISME or Sepilok Laut
Possibility in November or December
Participants from UMS; Dr. Mabel
Measurement of saplings (3 to 4 days)
UAV Research & Training(4 to 5days)
Publications & Presentations
ATBC2015 Honolulu, Hawaii
Article on Sg. ISME research

ORAL PAPER 8

WILD CATTLE IN THE WETLANDS – IS THE BORNEAN BANTENG A DISTINCT SPECIES?

Abdul Hamid Ahmad[1] & Hisashi Matsubayashi[2]
[1]Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah
[2]Faculty of Agriculture, Tokyo University of Agriculture, Japan.

Professor Dr Abdul Hamid Ahmad holds a B.Sc. in Biology. Upon obtaining his first degree, he continued as postgraduate student in zoology and began working as an academician, teaching biology at Universiti Kebangsaan Malaysia Sabah and later, joined Universiti Malaysia Sabah in 1995. He completed his PhD in the University of Queensland in 2001. At present, Dr Abdul Hamid Ahmad is an Associate Professor and is currently based in Universiti Malaysia Sabah. He and his research group began studying the Bornean banteng in the field from 2006 and published the first research paper on the genetics of the Bornean banteng.

Abstract

The banteng (*Bos javanicus*) is the only wild cattle species in Borneo. The Lower Kinabatangan-Segama Ramsar site is known to harbor the largest herds of the Bornean banteng in Sabah. Smaller populations are scattered in forest reserves throughout Sabah and the populations in the Southwest are already disconnected with other populations in the eastern parts of the State. Until today, the Bornean banteng is categorised as a sub-specific member for *Bos javanicus*, which is confined to Borneo and is the least studied amongst all three subspecies. Fecal samples from the Bornean banteng have been collected since 2006 and subjected to partial mtDNA analysis, which show that the Bornean banteng does not form a sister group with the other two banteng subspecies. A transpatry speciation was similarly proposed for the Bornean banteng. Later, a banteng tooth was extracted from a skull of a poached bull and dried blood tissue within the pulp cavity was then used to totally sequence the mtDNA of the Bornean banteng. It confirmed earlier results. Efforts must be taken to begin conservation breeding of the Bornean banteng as an intervention to increase its population size.

Slide Presentation

Wild Cattle in the Wetlands - Is the Bornean Banteng a Distinct Species?

Abdul Hamid Ahmad
Universiti Malaysia Sabah

Hisashi Matsubayashi
Tokyo University of Agriculture

Bos javanicus D'Alton 1823

Three subspecies:
Java banteng : *B. j. javanicus*

Mainland banteng : *B. j. birmanicus*

Borneo Banteng: *B. j. lowi*

Banteng in Sabah

- Historically abundant – amazing anecdotes during timber extraction time (e.g. 1970s)
- Still exists in major forest reserves, although in small and scattered populations.
- Banteng could benefit a lot from forest connectivity (Ulu Padas FR)
- Kulamba Wetlands has the largest herds

Borneo Banteng: Paitan FR

Hybridisation

- Many cattle species from the genus *Bos* are able to produce hybrids (with various degrees of interfertility)
- Hybrids are still produced for various purposes e.g. The Gayal in India (Gaur x cattle)
- If Bornean banteng readily breeds with domestic cattle, it could pose a hybridiation threat!

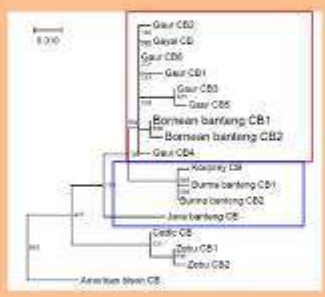
IUCN-SSC Asian Wild Cattle Specialist Group

- Hybridisation with domestic cattle is one of the biggest threat to the Bornean banteng
- Field studies began in 2006 (UMS) and TUA joined in 2012.
- We wanted confirm genetic introgression by the domestic cattle onto banteng genetics

Is it threatened by hybridization?

- Domestic cattle?
- Fecal samples: Deramakot FR, Malua FR, Maliau FR, Kulamba WR

Published 2014 – results of partial mtDNA analyses



The Bornean banteng…

- Is free from genetic introgression by domestic cattle
- Hybridization threat is not demonstrated in wild Bornean banteng
- Does not form sister group with the other two subspecies, but closer to the gaur (*Bos gaurus*)

Complete mtDNA seq

Was earlier not possible – difficulty in getting blood samples.

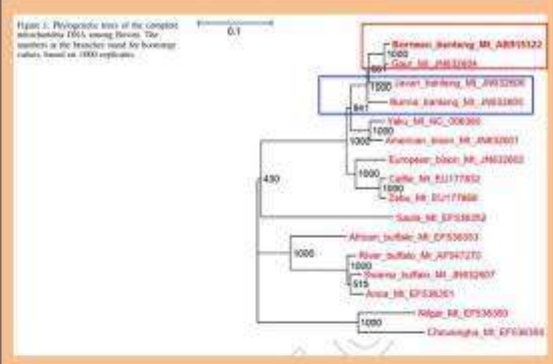
- 2010, Malua FR – dried skull
- Pulp from a tooth of a poached bull
- Sequenced for complete mtDNA
- Published in 2015 (Mitochondrial DNA)
- Similar results

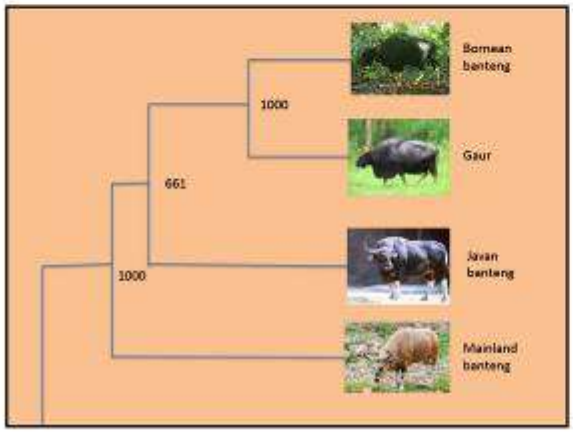
Complete mitochondrial genomes of the tooth of a poached Bornean banteng (Bos javanicus lowi; Cetartiodactyla, Bovidae).

6/15/2015

Mitochondrial DNA
PubMedID: 26075477

Ishige T, Gakuhari T, Hanzawa K, Kosai T, Suzuyoki J, Suhor JR, Ahmad AH, Matsushayashi H. Complete mitochondrial genomes of the tooth of a poached Bornean banteng (Bos javanicus lowi; Cetartiodactyla, Bovidae). Mitochondrial DNA. 2015;1-2.





Distinct species (?)

- Improves the profile for the Borneo banteng
- Very small and scattered populations
- Kryotyping
- Boundary of new genetic profile is unknown
- In need of conservation
- Conservation breeding

ORAL PAPER 9

TAXONOMIC NOTES ON FISHES OF THE LOWER KINABATANGAN–SEGAMA WETLANDS, RAMSAR SITE

B. Mabel Manjaji-Matsumoto
Borneo Marine Research Institute, Universiti Malaysia Sabah

Dr B. Mabel Manjaji Matsumoto is the Head of the Endangered Marine Species Research Unit (UEMS), which was recently established (6 July 2015) under the Borneo Marine Research Institute, Universiti Malaysia Sabah. The primary function of UEMS is to conduct strategic research that will help these rare species within the marine ecosystem. Mabel holds a PhD in Zoology (University of Tasmania), and BSc (Hons.) in Marine Science (Universiti Kebangsaan Malaysia), and has 20 years of working experience in the field of elasmobranch (sharks and rays) biodiversity. Her range of research interests includes ichthyology (fish studies), marine conservation and sustainable fisheries.

Abstract

A survey of coastal marine and estuarine fishes and their abundance was carried out during the Lower Kinabatangan – Segama Wetlands (LKSW) Scientific Expedition in June 2014. The survey concentrated in the Kulamba Bay area, a coastal lagoon in the southern part of the Kinabatangan River catchment. Fishes were collected from six localities using various fishing gears, namely gillnet, cast net, longline and hand line. Water depth and hydrological parameters (pH, DO, salinity, TDS, current speed, water temperature) were recorded for each locality and are presented herein. A total of 56 species comprising 45 genera, 28 families in 9 orders were recorded. Almost all the coastal marine and estuarine fish species recorded from Kulamba Bay occur elsewhere within the State of Sabah. The most abundant (Category 5 of the $\log_3$ abundance category) fish families are Ariidae and Plotosidae (catfishes/*ikan duri*), Engraulidae (thryssa/*kasai*), Gobiidae (gobies/*belodok*), Mugilidae (mullets/*belanak*) and Sciaenidae (croakers/*gelama*), whereas a few other families are represented by just a single specimen (Category 1, $\log_3$ abundance).

INTRODUCTION

The Lower Kinabatangan – Segama Wetlands (LKSW) which is Sabah's first Ramsar Site, covers 78,803 hectares of peat swamp and mangrove forests (SFD, 2008). The Site lies within the Sulu-Sulawesi marine seascape, and the Coral Triangle (ADB, 2014; MyNODC, 2015). As well as being a global marine biodiversity hotspot, the LKSW is part of a designated wildlife sanctuary within the Sabah Biodiversity Conservation Zone, and is home to a number of endangered aquatic and terrestrial species (SFD, 2008; SaBC, 2010). This drainage basin is fed by two large rivers, the Kinabatangan River (560 km long), and Segama River (350 km long), and numerous small tributaries, such as Kretam Besar River (50 km long), and Kulamba River (6 km long) (SFD, 2008).

In 1950, American researchers carried out the Borneo Zoological Expedition at Bukit Kretam Camp – an area described as a lowland rain forest near the southeast end of Dewhurst Bay (Inger, 1955). [Note: Dewhurst Bay is presently known as Kulamba Bay]. The two-month expedition yielded 71 fish species collected from the mouth of Kretam Kecil River to its sources at the watershed. This comprised 27 fresh water, and 44 marine species, including one new pufferfish species *Dichotomyctere kretamensis* (Inger, 1953, 1955; Kottelat, 2013).

Two additional new fish species were described decades later, based on Inger's voucher specimens collected during the 1950 expedition and deposited at The Field Museum, Chicago (FMNH; formerly the Field Museum of Natural History; https://www.fieldmuseum.org/). These two new species are a freshwater pufferfish *Dichotomyctere sabahensis* nsp. (Dekkers, 1975), and a halfbeak *Dermogenys bispina* nsp. (Meisner & Collette, 1998), which were purportedly identified as *Tetraodon fluviatilis* and *Dermogenys pusillus*, respectively, by Inger (1953, 1955) and Inger & Chin (1962). In the first case, Dekker (1975) described *D. sabahensis* based entirely on Inger's 1950 specimens, in which he designated a holotype and several paratypes. Whereas, in the second case, Meisner & Collette (1998) partially based their description of *D. bispina* on Inger's specimens, in which they designated part of these as paratypes in the paratype series of the new species they described.

Other major works on ichthyofaunal diversity in the LKSW include Martin-Smith and Tan (1998), and Ng (1999), which focused on freshwater teleosts, and Fowler et al. (1999) and Manjaji (2002) on freshwater elasmobranchs. This present study was part of a multi-discipline LKWS Ramsar Site Scientific Expedition carried out in June 2014 (SFD, 2014). The main objective of this study is to obtain a baseline data of the ichthyofaunal species composition, abundance, and distribution.

MATERIALS AND METHODS

Study area

Sampling concentrated in the Kulamba Bay, including the tidal reaches of the Kretam Kecil and Kulamba rivers (Figure 1). The area was accessed by speed boat from Sandakan city – the nearest and most accessible route to the study area – where participants of the expedition were based at Tundon Buhangin Field Centre (TBFC). [Note: TBFC is presently known as KFC (Kulamba Field Centre); pers. comm. Tn. Hj. Abdul Samah Sapni, Kinabatangan ADFO-SFD, Nov 2015]. According to the Sabah Biodiversity Council report on the LKSW Management Plan (SaBC, 2010), the Kinabatangan-Segama floodplains is subject to regular flooding and water logging throughout the year.

Figure 1. Map of the sampling area and sampling stations (red dots). The coordinates of sampling stations were recorded using a global positioning device (Garmin GPSMAP 62sc). (Google Earth Pro map template)

Sampling period

The field survey was conducted from 16-21 June 2014, with actual sampling conducted from 17-20 June 2014, as the first and last day were reserved for travelling to and from the study area by speed boat. The sampling period was at the beginning of the Southwest Monsoon, which is the drier season. At the time of this study, the Lower Kinabatangan floodplain was still flooded (pers. observation, Jun 2014). It is further noted that the tidal influence is strong at the Field Centre, with a gradual but obvious change from ebb to flood tide (pers. observation, Jun 2014; Figure 2).

Figure 2. The Field Centre at low (left) and high tide.

Hydrological parameters

Hydrological parameters (pH, dissolved oxygen, salinity, total dissolved solids and water temperature) were measured *in situ* at three depth levels, i.e. surface, middle and bottom using a multiparameter meter (HI 9828 Multiparameter Portable Meter). Water depths were measured using a depth sounder (Hondex PS-7 handheld depth sounder; 0.6-80 m depth range).

Sampling efforts

For fish sampling, the objective was to collect as many specimens as possible of all species. Thus, apart from setting fishing gears, fish specimens were also acquired from fishermen fishing in the area. Specimens caught by the fisherfolks largely comprise food fishes. During meetings with the locals, i.e. village heads, artisanal fishers, they were also asked questions about their capture and encounters with aquatic "flagship species", i.e. riverine sharks and rays, and sawfishes.

For setting fishing gears, i.e. fishing efforts, the diverse fish ecology and feeding behaviour warrants the use of more than one type of fishing gear. Therefore, various types of fishing equipment were deployed to catch fishes; these include gill net (*pukat*) (2 inch/ 5 cm mesh size), cast net (*rambat*) (1.5 inch/3.8 cm mesh size), trammel net (*pukat karan*), long line (*rawai*), rod and reel (*joran*), and handline with spool (*pancing*). The nets (gill and trammel) and longlines were set both perpendicular and parallel to the shoreline/riverbanks.

Additional fish specimens, specifically the diminutive gobies, were acquired from Dr. Tohru Naruse, a member of the expedition studying decapod crustaceans. Dr. Naruse caught the gobies while crab-fishing in the main rivers and in shallow canals and ditches, using a yabby pump (core with suction pump; pers. comm. Dr. Tohru Naruse; Naruse et al., 2015).

Species abundance

Species abundance was estimated semi-quantitatively, as sampling at each site was not replicated, and not structured, i.e. sampling were conducted at either ebb or flood tide. The abundance of each species was estimated cumulatively on a log 3 abundance scale from 1 to 7 (Russ, 1984). Using this scale, there are seven abundance categories, each indicating the number of individuals per species, i.e. Abundance Category 1 indicates 1 individual, Category 2 with 2-3 individuals, Category 3 with 4-9 individuals, Category 4 with 10-27 individuals, Category 5 with 28-81 individuals, Category 6 with 82-243 individuals, and Category 7 with 244-729 individuals. All specimens identifiable to genus level were censused; in a few cases this includes microscopic fishes of less than 1 centimetre total length.

Specimen handling, measurements and counts, and species identification

Fishes in unpreserved condition were digitally photographed, then fixed in 10% formalin, before being preserved in 70% ethanol. Voucher specimens are deposited in the Marine Reference Collection, Borneo Marine Research Institute, Universiti Malaysia Sabah, and registered with the acronym "IPMB-I" and serial numbers "IPMB-I 08.00028-110". Individual specimens are tagged with a unique number; however, specimens less than 10 cm total length are usually not individually tagged, and one registration number may be assigned to more than one of the smaller specimen of the same species. Measurements and counts generally follow Carpenter (1999). Direct, point to point measurements of the specimen in normal resting position were taken using a digital vernier calliper (Mitutoyo waterproof and solar powered digital calliper) to the nearest 0.01 mm. Fish

identification generally follow Kottelat et al. (1993), Lourie et al. (2004), Matsunuma et al. (2011), Kimura et al. (2009, 2015), and White et al. (2013). The validity and status of species followed Eschemeyer and Fricke (2016), while the systematic arrangement of families largely follows Nelson (2006). Species under each family are listed alphabetically, the common name in English and Malay is provided, with a diagnostic character, and specimen registration code and specimen size in total length (TL) and standard length (SL) – unless as stated – are provided.

RESULTS AND DISCUSSION

Hydrological parameters

Readings of the hydrological parameters in the sampling localities where fishing gears were set are shown in Table 1. The ph, DO and temperature readings are within the normal range, except for salinity. The lowest salinity was off Kampung Tundon Buhangin, a site near the mouth of the Kulamba River, with just 7.6 ppt, whereas another site just further north, recorded a salinity of 24.5 ppt. These two sites, although not far off from each other, showed a significant difference in the water current speed, which is 13.3 ms/cm in the low salinity, and 39.2 ms/cm in the higher salinity.

According to Bruijnzeel (1990), large changes in hydrological regime are normal for Borneo's streams and rivers. As such, others (e.g. Martin-Smith & Tan, 1998) have suggested that the fish fauna may have evolved to withstand the highly fluctuating physico-chemical conditions.

In the open ocean, the range of the seawater salinity is 30 and 35 ppt (parts per thousand). The salinity of a column of water through a river mouth can range from 18 ppt at the surface to 27 ppt at the bottom. Thus fish species preferring freshwater would tend to be found nearer the top and marine species nearer to the bottom.

Table 1. Sampling localities and hydrological parameter values in Kulamba Bay (17-20 June 2014).

	Site (GPS)	Depth (m)	pH	DO (ppm)	DO (%)	Salinity (ppt)	Total Dissolved Solids (TDS)	Current Speed (ms/cm)	Tempera-ture (°C)
1	Kg. Tundon Buhangin (N 5° 35.761'; E 118° 35.278')	4.5	7.7	4.8	65.0	14.1	12.5	24.5	29.2
2	Off Kg. Tundon Buhangin (N 5° 36.095'; E 118° 35.080')	7.2	8.1	5.2	69.2	7.6	6.7	13.3	28.8
3	Off Kg. Tundon Buhangin (N 5° 36.419'; E 118° 34.486')	7.7	8.3	4.7	69.2	24.5	19.5	39.2	29.9
4	mouth of Dewhurst Bay (N 5° 38.415'; E 118° 36.439')	11.1	8.2	5.1	78.4	28.3	28.1	40.2	29.7
5	Base camp (Kulamba Field Centre) (N 5° 36.024'; E 118° 35.614')	3.4	7.5	4.2	60.6	18.7	15.1	30.3	29.4
6	Base camp (Kulamba Field Centre) (N 5° 36.017'; E 118° 35.614')	0.6	7.6	4.0	55.8	15.1	12.5	24.9	29.2
7	Kg. Tundon Buhangin (N 5° 35.082'; E 118° 35.079')	2.9	7.4	3.9	52.6	14.7	46.6	24.1	28.6

	Site (GPS)	Depth (m)	pH	DO (ppm)	DO (%)	Salinity (ppt)	Total Dissolved Solids (TDS)	Current Speed (ms/cm)	Tempera-ture (°C)
8	Kg. Sri Ganda, Sg. Kretam Kecil (N 5° 30.486'; E 118° 33.559')	3.9	6.8	2.7	36.0	16.2	13.3	26.7	28.2
9	Hulu Kulamba (new rubber plantation, former logging area; narrow man-made water way) (N 5° 35.226'; E 118° 37.253')	3.0	7.1	3.4	48.7	17.2	14.0	28.1	30.1

Artisanal fisheries

Three main types of fishing gears are used by the local fishers in the Kulamba area. These are fish and prawn traps (*bubu ikan* and *bubu udang*), nets (*pukat, rambat*) and fishing line (*pancing*). These traditional gears are constructed by the fishers themselves using natural raw materials (rattan, bamboo, and other unidentified hard wood) from their surroundings, except for the monofilament used for the fish nets.

In each village, there is apparently at least one person (who is a member of the community) acting as a middleman to market the high value species caught by the artisanal fishers in the Kulamba area, to wholesale buyer(s) in Sandakan. The high value species, namely prawns, groupers and snappers are mainly marketed as food fish (live or chilled), with the live juvenile fishes sold as seeds to grow-out cage operators in Sandakan. The middlemen in the respective villages will transport the fishery commodities to Sandakan once or twice a week, depending on the supply volume.

Fish species biodiversity and species abundance

In preparing the species list, the taxonomic problems in some groups became apparent, and over the duration of the preparation of this report manuscript, many of the scientific names have changed under the rules of zoological nomenclature. For example, a few species of Hemiramphidae (*see* Nelson, 2006) is currently placed under Zenarchopteridae (*see* Eschmeyer & Fricke, 2016). A few species of Apogonidae and Callionymidae have also been reassigned a new genus after recent revisions (see Eschmeyer & Fricke, 2016, version 1 March 2016).

A total of 54 coastal marine and estuarine fish species comprising 45 genera, 28 families, 9 orders were recorded on the basis of approximately 120 specimens obtained during the sampling. These fishes were found to inhabit estuarine and coastal habitats, including the intertidal zone. In addition, two amphidromous species, not recorded during this study, but based on literature review are present in the area, are added to the list, resulting in a total of 56 valid species. These amphidromous species i.e. halfbeaks, gobies and pufferfish are observed to swim just below the water surface in the estuary, as they are able to tolerate very low salinities. The fish faunal elements are of interest in that it contained a high proportion of juveniles, and with one species (Giant Mudskipper) confined to a small home range.

The fish species list excludes elasmobranchs (sharks and rays), as the fishermen interviewed mentioned that sharks and rays they caught were caught in the open sea adjacent the Kulamba Bay, and not within the Bay itself. As for the conservation status of the fish species recorded, a majority

have the status of "Not Evaluated" under the 2015-4 IUCN Red List of Threatened Species (IUCN, 2015).

For species abundance, species are grouped under the same family, and the data presented as family abundance. A few of the fish families are represented by just a single specimen. The most abundant (Category 5, $\log_3$ abundance) fish families are from Ariidae and Plotosidae (catfishes/*ikan duri*), Engraulidae (thryssa/*kasai*), Gobiidae (gobies/*belodok*), Mugilidae (mullets/*belanak*) and Sciaenidae (croakers/*gelama*).

Systematic list and taxonomic notes of Lower Kinabatangan teleosts

ANGUILLIFORMES

OPHICHTHIDAE

Category 1, $\log_3$ abundance.

Pisodonophis cancrivorus (Richardson, 1848)
English common name: Longfin Snake-eel; Malay common name: Belin Sirip Panjang
Dorsal-fin origin above middle of pectorals; teeth granular.
IPMB-I 08.00082, 850.0 mm TL.
One specimen was taken near the mouth of Kulamba Bay on rod and reel. Fresh prawn was used as bait.

CLUPEIFORMES

PRISTIGASTERIDAE

Category 4, $\log_3$ abundance.

Ilisha elongata (Anonymous [Bennett], 1830)
English common name: Elongate Ilisha; Malay common name: Puput
Body compressed and slender; mouth directed obliquely upward; 32-42 abdominal scutes.
IPMB-I 08.00039, 185.0 mm TL; 150.0 mm SL; IPMB-I 08.00058, 150.0 mm TL; 120.0 mm SL; IPMB-I 08.00059, 155.0 mm TL; 135.0 mm SL; IPMB-I 08.00107, 323.0 mm TL; 277.0 mm SL; IPMB-I 08.00108, 350.0 mm TL; 300.0 mm SL.

Pellona ditchela Valenciennes, 1847
English common name: Indian Pellona; Malay common name: Beliak Mata
Dorsal-fin origin near midpoint of body.
IPMB-I 08.00052, 107.0 mm TL; 90.0 mm SL; IPMB-I 08.00053, 187.0 mm TL; 154.0 mm SL.

ENGRAULIDAE

Category 5, $\log_3$ abundance.

Coilia neglecta Whitehead, 1968
English common name: Neglected Grenadier Anchovy; Malay common name: Bulu Ayam Carik
Dorsal fin short, far forward of body, beginning in first third of body length; pectoral fins with upper six rays free, unbranched, long and filamentous, reaching posteriorly to a vertical through anal-fin origin.
IPMB-I 08.00057 (10 specimens), 89.0-114.0 mm TL; 81.0-102.0 mm SL.

Setipinna melanochir (Bleeker, 1849)
English common name: Dusky-hairfin Anchovy; Malay common name: Empirang Sirip Gelap
Mouth oblique, large; maxilla reaching far beyond posterior edge of eye. Anal-fin origin in front of dorsal-fin origin.
IPMB-I 08.00074, 214.5 mm TL; 170.0 mm SL.

Setipinna taty (Valenciennes, 1848)
English common name: Scaly-hairfin Anchovy; Malay common name: Empirang Kasai
Mouth nearly horizontal; first supramaxilla absent. Dorsal-fin origin distinctly anterior to body midpoint, its origin slightly in advance of vertical through anal-fin origin.
IPMB-I 08.00055, 192.0 mm TL; 158.0 mm SL;

Stolephorus indicus (van Hasselt, 1823)
English common name: Indian Anchovy; Malay common name: Bilis Bunga Air
Posterior tip of maxilla pointed, extending to anterior border of preopercle. Anal fin short, its origin situated at vertical through middorsal-fin base.
IPMB-I 08.00046, 110.0 mm TL; 85.0 mm SL;

Thryssa setirostris (Broussonet, 1782)
English common name: Longjaw Thryssa; Malay common name: Kasai Rahang Panjang
Maxilla very long, posterior tip tapering to tip of pectoral fins, usually to pelvic-fin base.
IPMB-I 08.00054, 165.0 mm TL; 145.0 mm SL.

CLUPEIDAE

Category 4, $\log_3$ abundance.

Anodontostoma chacunda (Hamilton, 1822)
English common name: Chacunda Gizzard Shad; Malay common name: Kebasi Kuasi
Posterior edge of scales toothed, the teeth thinner than the gaps between them.
IPMB-I 08.00051, 115.0 mm TL; 100.0 mm SL; IPMB-I 08.00073, 125.0 mm TL; 110.0 mm SL.

Anodontostoma selangkat (Bleeker, 1852)
English common name: Indonesian Gizzard Shad; Malay common name: Kuasi
Posterior edge of scales toothed, the teeth wider than the gaps between them.
IPMB-I 08.00036, 88.0 mm TL; 69.0 mm SL; IPMB-I 08.00037, 94.0 mm TL; 73.0 mm SL; IPMB-I 08.00050, 121.0 mm TL; 95.0 mm SL; IPMB-I 08.00097, 81.0 mm TL; 60.0 mm SL.

SILURIFORMES

PLOTOSIDAE

Category 5, $\log_3$ abundance.

Plotosus canius Hamilton, 1822
English common name: Gray Eel Catfish; Malay common name: Semilang
Dorsal and anal fins continuous with caudal fin. Nasal and maxillary barbels long, reaching to pectoral-fin base.
IPMB-I 08.00056, 444.0 mm TL; 414.0 mm SL; IPMB-I 08.00104, 450.0 mm TL; 433.0 mm SL.

ARIIDAE

Category 5, $\log_3$ abundance.

Arius oetik Bleeker, 1846
English common name: Catfish; Malay common name: Duri Utik
Palatine teeth villiform, in a single, roughly triangular patch on each side, with the base directed anteriorly.
IPMB-I 08.00040, 220.0 mm TL; 190.0 mm SL.

Cephalocassis borneensis (Bleeker, 1851)
English common name: Borneo Catfish; Malay common name: Duri Borneo
Head about as deep as wide; snout rounded; premaxilla narrow, almost as long as wide; accessory tooth plates absent.
IPMB-I 08.00043, 364.0 mm TL; 275.0 mm SL.

Plicofollis argyropleuron (Valenciennes, 1840)
English common name: Longsnouted Catfish; Malay common name: Duri Muncung Panjang
Head depressed and elongate; exposed head shield very striate; supraoccipital process always keeled.
IPMB-I 08.00042, 245.0 mm TL; 215.0 mm SL.

MUGILIFORMES

MUGILIDAE
Category 5, $\log_3$ abundance.

Liza subviridis (Valenciennes, 1836)
English common name: Greenback Mullet; Malay common name: Belanak Anding
Head flat dorsally, width subequal to depth.
IPMB-I 08.00033, 76.0 mm TL; 63.0 mm SL; IPMB-I 08.00034, 214.0 mm TL; 104.0 mm SL; IPMB-I 08.00035, 96.0 mm TL; 74.0 mm SL; IPMB-I 08.00094, 125.0 mm TL; 100.0 mm SL.

Moolgarda perusii (Valenciennes, 1836)
English common name: Longfinned Mullet; Malay common name: Kembura
Head flat dorsally, width narrower than depth.
IPMB-I 08.00096, 114.0 mm TL; 90.0 mm SL.

Moolgarda seheli (Forsskål, 1775)
English common name: Bluespot Mullet; Malay common name: Kedera Tanda Biru
Origin of second dorsal fin above anal-fin origin.
IPMB-I 08.00095, 133.0 mm TL; 104.0 mm SL; IPMB-I 08.00109, 139.0 mm TL; 111.2 mm SL; IPMB-I 08.00110, 146.0 mm TL; 114.0 mm SL.

BELONIFORMES

ZENARCHOPTERIDAE
Category 4, $\log_3$ abundance.

Dermogenys bispina Meisner & Collette, 1998
English common name: Bispinous Halfbeak; Malay common name: Jolong Dwispina

Mature males with thick, unsegmented, dorsally curved spicules, and a second set of smaller spines on distal tip of spicules; females with pigmentation around urogenital papilla.
No specimens obtained. After Meisner & Collette (1998).
Amphidromous.

Zenarchopterus dunckeri Mohr, 1926
English common name: Duncker's River Garfish; Malay common name: Jolong Ambon
Sixth anal fin ray thickened and greatly elongate, reaching posteriorly past the base of the caudal fin.
IPMB-I 08.00080, 195.0 mm TL; 172.0 mm SL (female); IPMB-I 08.00090, 189.0 mm TL; 167.0 mm SL (female); IPMB-I 08.00064, 148.0 mm TL; 130.0 mm SL (male).
Amphidromous.

SYNGNATHIFORMES

SYNGNATHIDAE
Category 1, $\log_3$ abundance.

Hippocampus kuda Bleeker, 1852
English common name: Spotted Seahorse; Malay common name: Kuda Laut Rintik
Body and head deep; coronet low to medium height, rounded, overhanging at the back.
IPMB-I 08.00087, 14.9 mm snout length; 29.5 mm head length.
One specimen was taken near the Base Camp on cast net.

PERCIFORMES

AMBASSIDAE
Category 4, $\log_3$ abundance.

Ambassis nalua (Hamilton, 1822)
English common name: Scalloped Perchlet; Malay common name: Seriding Kipas
Supraorbital ridge smooth, terminating in a posteriorly directed spine. No nasal spine.
IPMB-I 08.00067, 74.0 mm TL; 56.0 mm SL.

SERRANIDAE
Category 3, $\log_3$ abundance.

Epinephelus erythrurus (Valenciennes, 1828)
English common name: Cloudy Grouper; Malay common name: Kerapu Tompok Awan
Body olive to reddish brown, with irregular pale spots and blotches; 3 dark streaks across opercle; fins mottled.
IPMB-I 08.00075, 155.0 mm TL; 144.0 mm SL.

APOGONIDAE
Category 4, $\log_3$ abundance.

Fibramia amboinensis (Bleeker, 1853)
English common name: Amboina Cardinalfish; Malay common name: Sebekah Ambon
Dark stripe from snout to blotch to caudal-fin base.
IPMB-I 08.00061, 71.0 mm TL; 59.0 mm SL.

Yarica hyalosoma (Bleeker, 1852)
English common name: Humpbacked Cardinalfish; Malay common name: Sebekah Bonggol
Dorsal profile of head distinctly concave, forming a hump-back appearance.
IPMB-I 08.00060, 98.0 mm TL; 81.0 mm SL.

CARANGIDAE
Category 3, $\log_3$ abundance.

Carangoides malabaricus (Bloch & Schneider, 1801)
English common name: Malabar Trevally; Malay common name: Demudok Cermin
Dorsal profile of head strongly elevated to nape.
IPMB-I 08.00092, 70.0 mm TL; 55.0 mm SL.

Scomberoides commersonianus Lacepède, 1801
English common name: Talang Queenfish; Malay common name: Talang Lima Jari
Flanks with 5-8 blotches above or touching lateral line.
IPMB-I 08.00041, 330.0 mm TL; 260.0 mm SL.

Scomberoides tala (Cuvier, 1832)
English common name: Barred Queenfish; Malay common name: Talang Padi
Flanks with 4-8 vertically elongate blotches, most of which intersect lateral line.
IPMB-I 08.00098, 290.0 mm TL; 238.0 mm SL.

LEIOGNATHIDAE
Category 4, $\log_3$ abundance.

Leiognathus equula (Forsskål, 1775)
English common name: Common Ponyfish; Malay common name: Kekek Gedabang
Dorsal flank with many light but relatively broad vertical lines descending to about midline of flank.
IPMB-I 08.00063, 113.0 mm TL; 87.0 mm SL.

LUTJANIDAE
Category 4, $\log_3$ abundance.

Lutjanus argentimaculatus (Forsskål, 1775)
English common name: Mangrove Red Snapper; Malay common name: Kakap Merah
In estuarine/ freshwater – body greenish gray; juveniles with a series of 8 whitish bars crossing sides and 1 or 2 blue lines across cheek.
IPMB-I 08.00038, 215.0 mm TL; 185.0 mm SL.

Lutjanus russellii (Bleeker, 1849)
English common name: Russell's Snapper; Malay common name: Merah Tanda
A large blackish spot below anterior portion of soft dorsal fin, with more than half of the spot above lateral line; juveniles (up to 7 cm SL) with 4 wide blackish-red stripes on sides and an oval black spot on back, black spot with pearly white border.
IPMB-I 08.00069, 74.0 mm TL; 61.0 mm SL;

GERREIDAE
Category 4, $\log_3$ abundance.

Gerres limbatus Cuvier, 1830
English common name: Saddleback Silver-biddy; Malay common name: Kapas Pelana
Premaxillary groove without scales. Diffused dark saddle patches along the back of live specimens.
IPMB-I 08.00068, 90.0 mm TL; 76.0 mm SL.

Gerres macracanthus Bleeker, 1854
English common name: Longspine Silverbiddy; Malay common name: Kapas Duri Panjang
Second dorsal-fin spine elongate, filamentous, may reach to level of first anal-fin spine. Body silver, with 6-7 indistinct vertical dark bands on body.
IPMB-I 08.00093, 78.0 mm TL; 59.0 mm SL.

HAEMULIDAE
Category 3, $\log_3$ abundance.

Pomadasys kaakan (Cuvier, 1830)
English common name: Javelin Grunter; Malay common name: Gerut-gerut Ompakan
Dorsal fin spotted with black-brown spots on proximal half of spinous rays, spotted in 3 rows on soft rays.
IPMB-I 08.00078, 252.0 mm TL; 217.0 mm SL.

SCIAENIDAE
Category 5, $\log_3$ abundance.

Johnius dussumieri (Cuvier, 1830)
English common name: Sin Croaker; Malay common name: Gelama Keeling
Swimbladder hammer-shaped. Body dark pigmented, pigments randomly concentrated into short, dark bars along back; spinous part of dorsal fin black.
IPMB-I 08.00077, 146.0 mm TL; 125.0 mm SL; IPMB-I 08.00049, 150.0 mm TL; 135.0 mm SL.

Otolithes ruber (Bloch & Schneider, 1801)
English common name: Tigertooth Croaker; Malay common name: Tengkerong Panjang
Swimbladder carrot-shaped. Body silvery with a golden sheen on flanks and belly; dark oblique streaks dorsally; pectoral, pelvic and anal fins reddish or light brown.
IPMB-I 08.00045, 169.0 mm TL; 151.0 mm SL.

Panna microdon (Bleeker, 1849)
English common name: Panna Croaker; Malay common name: Gelama-panjang Pisang
Swimbladder carrot-shaped, with a pair of simple appendages arising from the anterior end.
IPMB-I 08.00076, 196.0 mm TL; 159.0 mm SL.

Protonibea diacanthus (Lacepède, 1802)
English common name: Blackspotted Croaker; Malay common name: Gelama Eron
Swimbladder carrot-shaped, with 16-20 pairs of arborescent appendages along its sides. 3-5 dark bars along back and many small black spots on body.
IPMB-I 08.00083, 131.0 mm TL; 126.0 mm SL.

TOXOTIDAE
Category 3, $\log_3$ abundance.

Toxotes chatareus (Hamilton, 1822)

English common name: Spotted Archerfish; Malay common name: Sumpit Tanda
Body silvery white, 6-7 large and small black spots on head and back.
IPMB-I 08.00072, 113.0 mm TL; 96.0 mm SL.

Toxotes jaculatrix (Pallas, 1767)
English common name: Banded Archerfish; Malay common name: Sumpit Belang
Body silvery white, 4-5 black saddles on head and back.
IPMB-I 08.00071, 145.0 mm TL; 120.0 mm SL; IPMB-I 08.00081, 177.0 mm TL; 144.0 mm SL.

CALLIONYMIDAE

Category 1, $\log_3$ abundance.

Repomucenus schaapii (Bleeker, 1852)
English common name: Short-snout sand-dragonet; Malay common name: Bebaji Pasir
Head depressed; distal tip of preopercular spine inwardly curved.
IPMB-I 08.00085, 23.0 mm TL; 19.0 mm SL.
One specimen was taken from sandy area at the Base Camp on cast net.

ELEOTRIDAE

Category 3, $\log_3$ abundance.

Butis butis (Hamilton, 1822)
English common name: Duckbill Sleeper; Malay common name: Ubi Muncung Itik
A row of bony interorbital ridges. Two orangish-red patches anterior pelvic-fin base.
IPMB-I 08.00062, 91.0 mm TL; 73.0 mm SL.

Oxyeleotris urophthalmus (Bleeker, 1851)
English common name: Sleeper; Malay common name: Ubi Muncung
IPMB-I 08.00031, 52.0 mm TL; 45.0 mm SL; IPMB-I 08.00079, 25.0 mm TL; 21.0 mm SL.

GOBIIDAE

Category 5, $\log_3$ abundance.

Brachygobius kabiliensis Inger, 1958
English common name: Kabili Bumblebee Goby; Malay common name: Belodok Kabili
Bright yellow with four black bands; first band begins behind gill opening, never reaches the opercle, and lacks a mid-ventral extension; second black band reaches the anal-fin base.
IPMB-I 08.00028, 15.0 mm TL; 12.0 mm SL.
One specimen was taken from muddy area of upper Kulamba River using yabby pump.

Mugilogobius tigrinus Larson, 2001
English common name: TigerGoby; Malay common name: Belodok Rimau
Body slender, with four complete black bands, two half bands and one elongate black spot on caudal base.
IPMB-I 08.00029, 25.0 mm TL; 21.0 mm SL.
One specimen was taken from muddy area of upper Kulamba River using yabby pump.

Periophthalmodon schlosseri (Pallas, 1770)
English common name: Giant Mudskipper; Malay common name: Belacak Lumpur
Isthmus lacking scales; pelvics completely united into a disc.

IPMB-I 08.00099-103, 161.0-199.0 mm TL; 138.0-172.0 mm SL.
Five specimens were taken from Kg. Kulamba near mouth of Kulamba River on hook and line. Fresh shrimp was used as bait.

Periophthalmus argentilineatus Valenciennes, 1837
English common name: Barred Mudskipper; Malay common name: Belacak Belang
Frenum absent; first dorsal fin pointed, no black spots, with prominent black inframarginal stripe.
IPMB-I 08.00044, 63.4 mm TL; 52.8 mm SL; IPMB-I 08.00086, 16.2 mm TL; 14.0 mm SL.

Stigmatogobius pleurostigma (Bleeker, 1849)
English common name: Spotted Goby; Malay common name: Belodok Bintik
Mid-lateral row of black spots and distinct black blotch on ventral base of caudal fin.
IPMB-I 08.00030, 31.0 mm TL; 22.0 mm SL.

SCATOPHAGIDAE
Category 3, $\log_3$ abundance.

Scatophagus argus (Linnaeus, 1766)
English common name: Spotted Scat; Malay common name: Kitang
Body quadrangular, strongly compressed; dorsal head profile deep; mouth small.
IPMB-I 08.00066, 66.0 mm TL; 55.0 mm SL.

SIGANIDAE
Category 3, $\log_3$ abundance.

Siganus guttatus (Bloch, 1787)
English common name: Orangespotted Spinefoot; Malay common name: Dengkis Tompok Oren
Large roundish bronze-gold spots on sides; a bright yellow blotch about size of orbit on sides at base of last few rays of dorsal fin.
IPMB-I 08.00084, 194.0 mm TL; 160.0 mm SL; IPMB-I 08.00105, 116.0 mm TL; 93.0 mm SL; IPMB-I 08.00106, 169.0 mm TL; 137.0 mm SL.

Siganus vermiculatus (Valenciennes, 1835)
English common name: Vermiculated Spinefoot; Malay common name: Dengkis Batik
Body brownish or golden yellow with irregular blue lines.
IPMB-I 08.00089, 290.0 mm TL; 225.0 mm SL.

STROMATEIDAE
Category 2, $\log_3$ abundance.

Pampus argenteus (Euphrasen, 1788)
English common name: Silver Pomfret; Malay common name: Bawal Putih
Body grey dorsally, shading to silvery white ventrally.
IPMB-I 08.00088, 174.0 mm TL; 125.0 mm SL.

PLEURONECTIFORMES

PARALICHTHYIDAE
Category 2, $\log_3$ abundance.

Pseudorhombus dupliciocellatus Regan, 1905
English common name: Ocellated Flounder; Malay common name: Sebelah Tiga-tanda Kembar
Dorsal-fin origin on blind side in front of upper eye and posterior nostril; 1-3 pairs of ocelli above and below lateral line; many darker rings and spots scattered on body and median fins
IPMB-I 08.00065, 71.0 mm TL; 59.0 mm SL; IPMB-I 08.00091, 129.0 mm TL; 109.0 mm SL.

TETRAODONTIFORMES

TRIACANTHIDAE
Category 2, $\log_3$ abundance.

Tripodichthys angustifrons (Hollard, 1854)
English common name: Black-flag Tripodfish; Malay common name: Lembu Panji
First dorsal-fin spine greatly enlarged; pectoral, anal and caudal fins yellow.
IPMB-I 08.00047, 147.0 mm TL; 121.0 mm SL.

TETRAODONTIDAE
Category 4, $\log_3$ abundance.

Dichotomyctere kretamensis (Inger, 1953)
English common name: Kretam Pufferfish; Malay common name: Buntal-gigi Kretam
Inner surface of nasal flaps smooth. Caudal fin without bars.
No specimens obtained. After Inger (1953).

Dichotomyctere nigroviridis (Marion de Procé, 1822)
English common name: Spotted Green Pufferfish; Malay common name: Buntal-gigi Kupang
Back and sides with spots, never forming transverse bars on back.
IPMB-I 08.00032, 22.0 mm TL; 16.0 mm SL; IPMB-I 08.00070, 50.0 mm TL; 38.0 mm SL.

Lagocephalus gloveri Abe & Tabeta, 1983
English common name: Dark-back Golden Puffer; Malay common name: Buntal-pisang Perang
A patch of spinules on back between snout and halfway to dorsal-fin origin; belly covered with spinules; lateral silver band without spines.
IPMB-I 08.00048, 120.0 mm TL; 98.0 mm SL.

CONCLUSION

Almost all the coastal marine and estuarine fish species recorded from Kulamba Bay occur elsewhere within the State of Sabah (e.g. see Manjaji-Matsumoto, 2007, 2012). Two amphidromous species – *Dermogenys bispina* and *Dichotomyctere kretamensis* – are considered endemic to Sabah, although both were not recorded during this study, and have not been recorded from the west coast of Sabah. One species (Giant Mudskipper; F. Gobiidae) was recorded from a relatively small and restricted distribution range, where food is apparently in abundance.

The relatively low biodiversity of the fish fauna recorded in this study is not indicative of the macrofaunal productivity, since there is a high presence of juvenile fishes in the fish communities. The latter is an indicator of high food availability, and hence a positive ecosystem health, and ecological function of the area as fish nursery and critical habitat for estuarine and diadromous fishes. Inger (1955) in his study, demonstrated that the brackish water fish fauna in Kulamba depends primarily on crustaceans (prawns) for food. Thus, increasing the sampling size (number of sites) and sampling strategy especially for benthic and burrowing species may increase the number of fish species recorded.

Fisheries are an important economic activity, encompassing artisanal, commercial and recreational fishing; most of the species are considered as food fishes, entering the market both direct and indirectly. Thus, research efforts should be expanded to study the economic value of the commercial and recreational estuarine fisheries. There should also be more efforts to gather basic information on fish fauna diversity covering the wider Ramsar Site.

ACKNOWLEDGEMENTS

This work has been made possible with the support and assistance of many individuals. First of all, my sincere gratitude to Datuk Sam Mannan, Director, Sabah Forestry Department (SFD) for extending an invitation to participate in this expedition. Thanks also to Prof. Dr. Saleem Mustafa, the immediate past Director, and to Prof. Dr. Rossita Shapawi, present Director, Borneo Marine Research Institute – UMS for their encouragement and support in this study. The provision of financial support from BMRI enabled one field assistant, Mr. Mail Kahar, to join me in the field. In the field, we received further support and assistance from staff of SFD and other members of the expedition, namely Dr. Arthur Chung, Ms. Andi Maryani A. Mustapeng, Tn. Hj. Abdul Samah Sapni, Dr. Joan Pereira, Mr. Mohd. Jeprey bin Mohd. Nuruddin and Mr. Garry Husin, Dr. Tohru Naruse, and personnel from Pasukan Gerakan Am Polis Di Raja Malaysia. Several fish species specialists assisted with the identification of some of the 'difficult' species, namely Prof. Dr. Hiroyuki Motomura & team (Kagoshima University Museum), Prof. Dr. Seishi Kimura (Mie University) and Dr. Koichi Shibukawa (Nagao Foundation). Last but not the least, thanks to Ms. Flora Asalin, Curator, BMRI-UMS, for assistance with the curation of the fish voucher specimens collected during this work.

REFERENCES

ADB (Asian Development Bank). (2014). State of the Coral Triangle: Malaysia. Mandaluyong City, Philippines. 109 pp.

Bruijnzeel, L.A. (1990). Hydrology of moist tropical forests and effects of conversion: a state of knowledge review. UNESCO International Hydrological Programme. A publication of the Humid Tropics Programme. International Institute for Aerospace Survey and Earth Survey. 224 pp.

Carpenter, K.E. (1999). Bony fishes: technical terms and measurements. The Living Marine Resources of the Western Central Pacific. Volume 3. Batoid fishes, chimaeras and bony fishes Part 1 (Elopidae to Linophtynidae). In: K.E. Carpenter and V.H. Niem (eds). Rome, FAO. pp. 1397-2068. ISBN 92-5-104302-7

Dekkers, W.J. (1975). Review of the Asiatic freshwater puffers of the genus *Tetraodon* Linnaeus, 1758 (Pisces, Tetraodontiformes, Tetraodontidae). *Bijdragen tot de Dierkunde* 45: 87-142.

Eschmeyer, W.N., & Fricke, R. (eds.) (2016). Catalog of Fishes: genera, species, references. http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). Electronic version accessed 01 March 2016.

Fowler, S.L., Manjaji, B.M., Cavanagh, R.D., Compagno, L.J.V., Last, P.R., & Mycock, S.G. (1999). Elasmobranch biodiversity, conservation and management in Sabah (Malaysia). *Proceedings of the 5th Indo-Pacific Fish Conference, Nouméa (3-8 November 1997)*: 257-269.

Inger, R.F. (1953). A new fish from North Borneo. Genus *Tetraodon*. *Fieldiana: Zoology* 34(11): 149-152.

Inger, R.F. (1955). Ecological notes on the fish fauna of a coastal drainage of North Borneo. *Fieldiana: Zoology* 37: 47-90.

Inger, R.F. & Chin, P.K. (1962). The fresh-water fishes of North Borneo. *Fieldiana: Zoology 45*: 3-268.
IUCN (International Union for Conservation of Nature). 2015. The IUCN Red List of Threatened Species. Version 2015-4. http://www.iucnredlist.org. Accessed on 19 November 2015.

Kimura, S., Arshad, A., Imamura, H., & Ghaffar, M.A. (eds.) (2015). Fishes of the northwestern Johor Strait, Peninsular Malaysia. Universiti Putra Malaysia Press, Serdang and Mie University, Tsu. viii + 108 pp.

Kimura, S., Satapoomin, U., & Matsuura, K. (eds.) (2009). Fishes of Andaman Sea, west coast of southern Thailand. National Muesum of Nature and Science, Tokyo, vi+346 pp.

Kottelat, M. (2013). The fishes of the inland waters of Southeast Asia: a catalogue and core bibliography of the fishes known to occur in freshwaters, mangroves and estuaries. *The Raffles Bulletin of Zoology Supplement* 27: 1-663.

Kottelat, M., Whitten, A.J., Kartikasari, S.N., & Wirjoatmodjo, S. (1993). Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions (HK) Limited. xxxviii+221 pp+84 plates.

Lourie, S.A., Foster, S.J., Cooper, E.W.T., & Vincent, A.C.J. (2004). *A Guide to the Identification of Seahorses*. Project Seahorse and TRAFFIC North America. Washington D.C.: University of British Columbia and World Wildlife Fund. 114 pp.

Manjaji, B.M. (2002). Elasmobranchs recorded from rivers and estuaries in Sabah. *Elasmobranch Biodiversity, Conservation and Management.* In: S.L. Fowler, T.M. Reed and F.A. Dipper (eds). *Occasional Paper of the IUCN Species Survival Commission* No. 25: 194-198. ISBN 2 8317 065 5

Manjaji-Matsumoto, B.M. (2007). Fish and Fisheries Resources, pp. 95-133. *In*: S. Mustafa, and E. Saleh (eds). Coastal Environmental Profile of Brunei Bay, Sabah. Kota Kinabalu: Universiti Malaysia Sabah. 190 pp. ISBN 978 83 641 22 3

Manjaji-Matsumoto, B.M. (2012). Fish and Fisheries, pp. 93-102. *In*: Environment Protection Department, Ministry of Tourism, Culture and Environment Sabah, Malaysia (ed.). Coastal Environmental Profile of Sulaman Bay and Adjacent Coastal Area, Tuaran, Sabah. Kota Kinabalu: Environment Protection Department. ISBN 978 983 41174 4 3

Martin-Smith, K.M., & Tan, H.H. (1998). Diversity of freshwater fishes from eastern Sabah: annotated checklist for Danum Valley and a consideration of inter- and intra-catchment variability. *The Raffles Bulletin of Zoology* 46(2): 573-604.

Matsunuma M., Motomura, H., Matsuura, K., Shazili, N.A.M., & Ambak, M.A. (eds.) (2011). Fishes of Terengganu – east coast of Malay Peninsula, Malaysia. National Museum of Nature and Science, Universiti Malaysia Terengganu and Kagoshima University Museum, ix + 251 pp.

Meisner, A.D., & B.B. Collette. (1998). A new species of viviparous halfbeak, *Dermogenys bispina* (Teleostei: Hemiramphidae) from Sabah (North Borneo). *The Raffles Bulletin of Zoology* 46(2): 373-380.

MyNODC (Malaysian National Oceanography Data Centre). (2015). Official Portal of the Malaysia National Oceanography Data Centre. http://www.mynodc.gov.my/index.php?q=#

Naruse, T., Chung, A.Y.C., & Tangah, J. (2015). Description of a new genus and a new species of the family Camptandriidae Stimpson, 1858 (Crustacea: Decapoda: Brachyura) from Lower Kinabatangan – Segama Wetlands, Sabah, Malaysia. *The Raffles Bulletin of Zoology* 63: 327-333.

Nelson, J.S. (2006). Fishes of the World. Fourth Edition. John Wiley & Sons, New Jersey.

Ng, H.H. (1999). Two new species of catfishes of the genus *Clarias* from Borneo (Teleostei: Clariidae). *The Raffles Bulletin of Zoology* 47(1): 17-32.

Russ, G. (1984). Distribution and abundance of herbivorous grazing fishes in the central Great Barrier Reef. I. Levels of variability across the entire continental shelf. *Marine Ecology Progress Series* 20: 23-34.

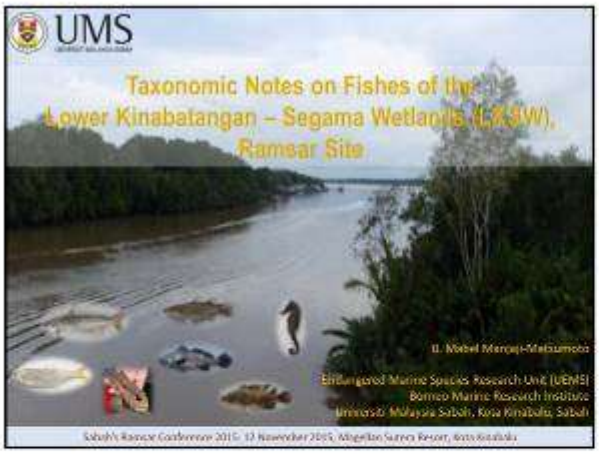
SaBC (Sabah Biodiversity Council). (2010). Lower Kinabatangan Segama Wetlands Ramsar Site Management Plan 2011-2020. Sabah State Government, Kota Kinabalu, Sabah.

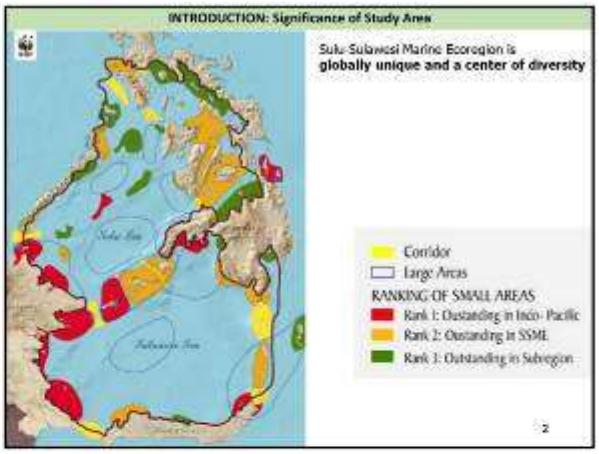
SFD (Sabah Forestry Department). (2008). Information Sheet on Ramsar Wetlands (RIS) – 2006-2008 version. Available for download from http://www.ramsar.org/ris/key_ris_index.htm.

SFD (Sabah Forestry Department). (2014). Ramsar Site: Lower Kinabatangan Segama Wetlands (LKSW) Scientific Expedition 2014. Tentative programme. Sabah Forestry Department. 8 pp.

White, W.T., Last P.R., Dharmadi, Faizah, R., Chodrijah U., Prisantoso, B.I., Pogonoski J.J., Puckridge, M., & Blaber, S.J.M. (2013). Market fishes of Indonesia (Jenis-jenis ikan di Indonesia). ACIAR Monograph No. 155. Australian Centre for International Agricultural Research: Canberra. 438 pp.

Slide Presentation



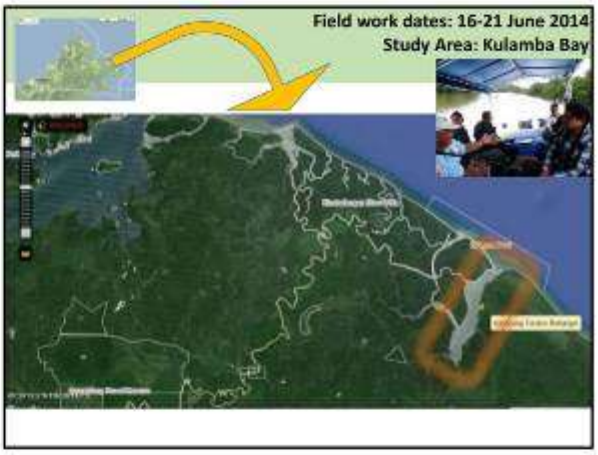


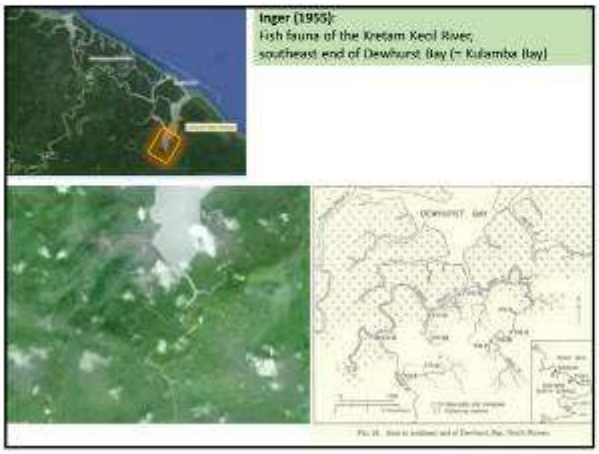
Aim

To elucidate the biodiversity of the fish fauna of the Lower Kinabatangan – Segama Wetlands

Objectives

a. To obtain a baseline data on fish species composition, and abundance;
b. To identify the occurrence endangered fish species, specifically riverine sharks and rays;
c. To obtain data on the fisheries activities in the area.





Tundon Buhangin Field Centre: at low tide (left); and high tide (right); soft substrate habitat

- The depth and hydrological parameters (pH, DO, salinity, TDS, and temperature) were recorded for each locality.
- The depth was measured with a depth sounder, and hydrological parameters using a YSI portable multiparameter probe.

Data analysis:

Fish density at each site were recorded in a semi-quantitative form using $\log_3$ abundance estimate scale/ class, i.e.

Class 1 indicates 1 individual,
Class 2 indicates 2-3 individuals,
Class 3 indicates 4-9 individuals,
Class 4 indicates 10-27 individuals,
Class 5 indicates 28-81 individuals, etc. .

Results & Discussion

- **7.5 m**: average depth of the Bay, and along the middle of the two main tributaries (Kulamba and Kretam Kecil).
- **11.1 m**: deepest at the mouth of Kulamba Bay.

- pH 6.8-8.3
- Dissolved Oxygen (ppm) 2.02-5.60
- Salinity (ppt) 7.63-28.31
- Total Dissolved Solids 6.66-76.82
- Temperature (°C) 27.9-30.1

- 54 species
  - 45 genera, 28 families in 9 orders recorded on the basis of 120 voucher specimens collected during the study period.
  - No sharks and rays recorded during this study.
  - The Conservation Status of the majority of the fish species is unknown due to the species being Not Evaluated for the IUCN Red List.

- Most of the species obtained are considered as food fishes.
- The fish faunal elements are of interest in that it contained juvenile specimens, with one species in a small distribution range.
- The most abundant (Class 5, $\log_3$ abundance class, 28-81 individuals) fish families are:
  - Ariidae (catfishes/ *ikan duri*),
  - Engraulidae (thryssa/ *kasai*),
  - Gobiidae (gobies/ *belodok*),
  - Mugilidae (mullets/ *belanak*) and
  - Sciaenidae (croakers/ *gelama*).
- Fish families inhabiting estuarine and coastal habitats, including the intertidal zone.
- A few other families are represented by just a single specimen (Class 1, $\log_3$ abundance).

Ariidae (catfishes/ *ikan duri*): 4/ 16 recorded species

- A main reason for its dominance might be the availability of their food plants.

Description

1. D I, 7; A 19–23; P_2 I, 9-10; P_2 6; GR 5–7 + 11-14; V 41–44.
2. body elongate, compressed
3. head depressed; snout rounded,
4. maxillary **barbels** reaching pectoral fins; mandibular barbels to posterior margin of operculum
5. **head bony shield** and supraoccipital process;

Max. size : 80.0 cm TL.
Habitat : Inshore waters and estuaries.

Engraulidae (thryssa/ *kasai*) 5/ 8 recorded species

Description
1. A 48–57; LL 40-48; GR 17-21.
2. body strongly compressed; caudal forked;
3. mouth nearly horizontal; first supramaxilla absent; small, even tooth in jaws; gill rakers fairly stout, serrae of lower gill rakers distinctly clumped
4. dorsal-fin origin distinctly anterior to body midpoint, its origin slightly in advance of vertical through anal-fin origin; pectoral fins with first fin ray produced as a long filament, reaching to base of posterior half of anal-fin base
5. dorsal and anal fins scaly; a spine-like scute just anterior to dorsal-fin origin; **abdomen with complete series of keeled scutes** from isthmus to anus; 20-29 prepelvic, and 9-14 postpelvic scutes
6. body brown or blue dorsally, flanks silvery

Max. size : 32.1 cm SL.
Habitat : Coastal waters and estuaries.

Gobiidae (gobies/ *belodok*): 6/ 22 recorded species

Description	
1	D IV + I, I 9-12; A I, I 9-11; P; 15-16; LR 24-108; PSS 27-42
2	body elongate, compressed; caudal fin rounded
4	head subcylindrical, slightly depressed, eyes protruding well above dorsal profile of head; a dermal ray attached to ventral half of eye; a single row of teeth in jaws; teeth in upper jaw bifid
5	first dorsal fin pointed, origin just behind pectoral-fin base; dorsal-fin spines thin, flexible; pelvic fins partially joined, frenum absent
6	six sensory canals and pores on head
9	head and body light brown dorsally, whitish ventrally; distinctive silvery-white vertical lines along sides; head with small, pale spots on lower half; dorsal fins with white-edged, sub-marginal black stripe
Max. size	: 0.3 cm - 15.8 cm TL
Habitat	: A resident intertidal species with homing behaviour in brackish mud flats in mangrove and nipa palm areas.
Conservation status	: IUCN Red List: Not Evaluated.

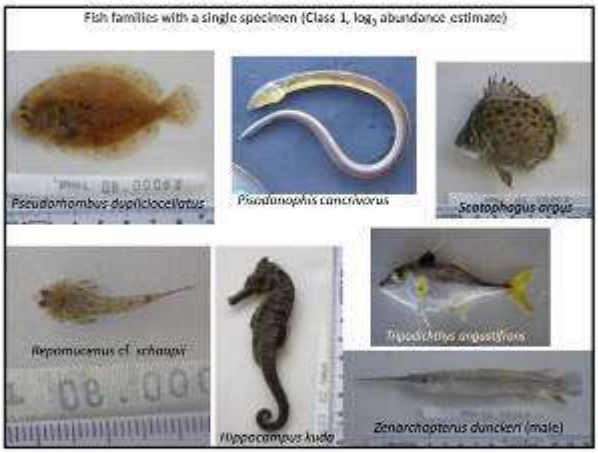
Mugilidae (mullets/ *belanak*): 3/ 4 recorded species

Description	
1	D IV + 8-10; A III, 9; P, 15-17; LR 31-34.
2	body moderately robust, compressed posteriorly, caudal fin emarginate
3	head flat dorsally, width narrower than depth
4	**adipose eyelid developed**, extending to iris
5	posterior tip of maxilla concealed when mouth closed
6	**body silvery**, greenish dorsally; a small gold spot on operclar; pectoral fin origin with a dark spot; caudal fin with dusky narrow margin
Max. size	: 25.0 - 40.0 cm TL.
Habitat	: Inhabits coastal waters and estuaries.

Sciaenidae (croakers/ *gelama*): 4/ 12 recorded species

Description	
1	D X + I, 26-30; A II, 7-8; LSR 8-11.
2	**body slender, cylindrical; caudal fin rhomboidal**
3	snout not swollen or projecting; mouth oblique; no barbel on chin
4	second anal-fin spine short, slender, its length 10-23% HL
5	swimbladder carrot-shaped, with 30-36 pairs of fan-like appendages along its sides, the first pair not entering head
6	body brownish dorsally, silvery with a golden sheen on flanks and belly; dark oblique streaks dorsally; pectoral, pelvic and anal fins reddish or light brown
Max. size	: 50.0 - 90.0 cm TL
Habitat	: Inhabits shallow coastal waters to 40 m depth.

Fish families with a single specimen (Class 1, $\log_2$ abundance estimate)



Conclusions

- The biodiversity of the fish fauna recorded in this study is relatively low; However, with increased efforts, this is expected to increase to at least twice the number of current species list.
- No sharks and rays recorded; the presence of endemic and near threatened species was not detected; although one species (Giant Mudskipper; F. Gobiidae) was only recorded from a relatively restricted distribution range, where food is apparently in abundance.
- Aspects of the species distribution and abundance data is useful to fill the current gap knowledge for IUCN Red List species assessment.
- A high presence of juvenile fishes in the fish communities; this is a positive indicator of the ecosystem health, and ecological function of the area as fish nursery and critical habitat for estuarine and diadromous fishes.
- Fisheries is an important economic activity, encompassing artisanal, commercial and recreational fishing; most of the species are considered as food fishes, entering the market both direct and indirectly.
- Research efforts to gather basic information on fish fauna diversity should be expanded to cover the wider Ramsar Site, continued for future effective management programs; this will ensure aquatic food security.

Acknowledgements

- Sabah Forestry Department
- Pasukan Gerakan Am Polis Di Raja Malaysia
- Prof. Dr. Saleem Mustafa, Borneo Marine Research Institute – UMS
- Associate Prof. Dr. Tohru Naruse (University of the Ryukyus)
- Prof. Dr. Hiro Motomura & team (Kagoshima University Museum)
- Prof. Dr. Soishi Kimura (Mie University)
- Dr. Koichi Shibukawa (Nagao Foundation)

Terima kasih

ORAL PAPER 10

DECAPOD CRUSTACEANS IN THE MANGROVE ECOSYSTEMS AROUND SANDAKAN AND LOWER KINABATANGAN-SEGAMA WETLANDS, SABAH

Tohru Naruse[1], Arthur Y. C. Chung[2] & Joseph Tangah[2]
[1] Tropical Biosphere Research Center, Iriomote Station, University of the Ryukyus, Okinawa, Japan
[2]Sabah Forestry Department

Dr Tohru Naruse holds a B.Sc., M.Sc., and PhD from the University of the Ryukyus, Nishihara, Okinawa, Japan on Biology. He is an Associate Professor at the Tropical Biosphere Research Center, Iriomote Station, University of the Ryukyus, and has been working at the University for 6 Years. His major area for specialization is taxonomy of decapod crustaceans.

Abstract

Invertebrates, such as decapod crustaceans receive relatively little publicity and conservation attention, in spite of their key role in the mangrove ecosystem functioning. Decapod crustaceans play important roles in the mangrove ecosystems, but even the other macro-fauna within the mangrove ecosystem is not well documented in Sabah. We conducted faunal surveys of decapod crustaceans within the mangrove areas of Sepilok Laut and Lower Kinabatangan-Segama Wetlands. Although the periods of the surveys were limited, several interesting crustaceans, including undescribed crab genus and species, were collected. The Sepilok Laut and Lower Kinabatangan-Segama Wetlands are known for their high diversity and probably harbour many other interesting taxa of decapod crustaceans awaiting to be described.

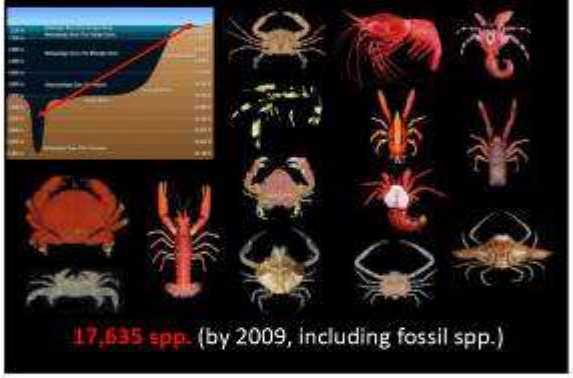
Slide Presentation

Decapod crustaceans in the mangrove ecosystems around Sandakan and Lower Kinabatangan-Segama Wetlands, Sabah

Tohru Naruse
Tropical Biosphere Research Center
University of the Ryukyus
Arthur Y. C. Chung & Joseph Tangah
Forest Research Centre
Sabah Forestry Department

Crustacea: Decapoda

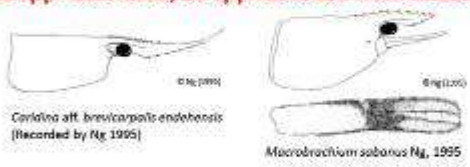
Crustacea: Decapoda



Crustacean decapoda from Sabah

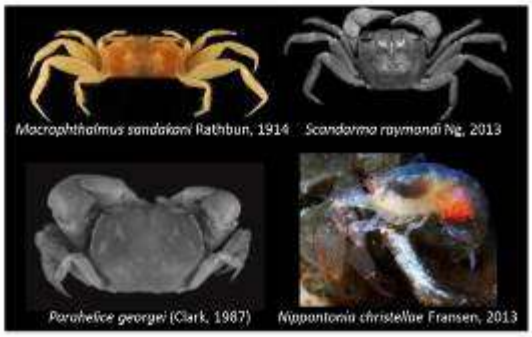
Freshwater & terrestrial species

18 spp. described, 29 spp recorded from Sabah



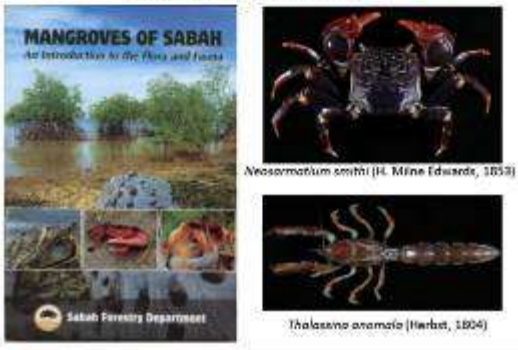
Crustacean decapoda from Sabah

Intertidal & sublittoral species



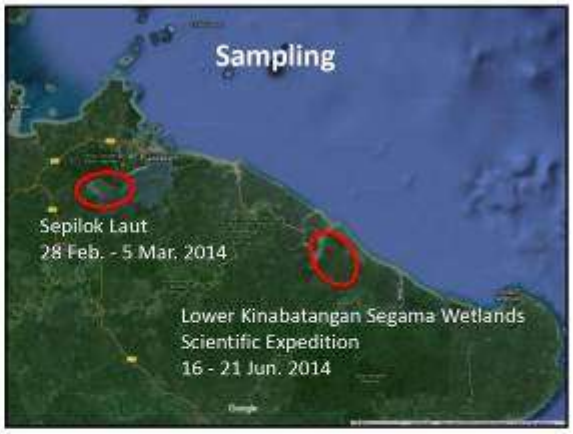
Crustacean decapoda from Sabah

Intertidal & sublittoral species



SFD-ISME-TBRC collaboration

Sampling



Collecting methods

Hand picking & hand net collecting
- Not always effective
- Many crustaceans are nocturnal

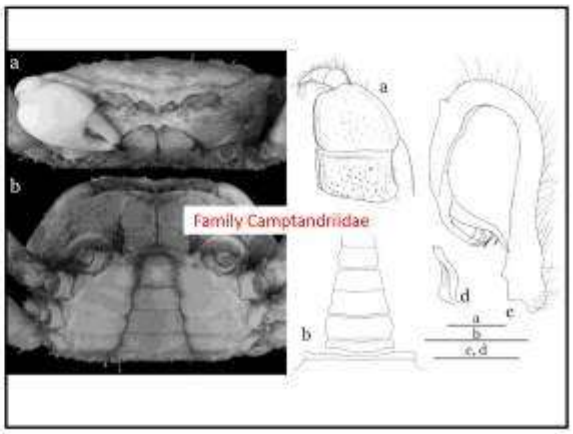
Collecting methods

Collecting methods

- Yabbie pump
- Very effective for burrow dwelling animals
- Effective with subtidal animals too

Collecting methods

Collected animals



Summary

- Decapod fauna of Sabah is not well-studied
  - especially marine species
- Lack of information even for common species
- A lot of topics to work on

Acknowledgements

Sabah Forestry Department
- Director **Datuk Sam Mannan**
- Deputy Director **Fidelis Edwin Bajau**

International Society of Mangrove Ecosystem
- Prof. **Shigeyuki Baba**

Tropical Biosphere Research Center, University of the Ryukyus
- Prof. **Hirosuke Oku**
- Prof. **Kazuhiko Sakai**

And for all who kindly assisted our research

ORAL PAPER 11

INSECT DIVERSITY OF TUNDON BOHANGIN, SABAH

Arthur Y. C. Chung, Richard Majapun , John L.Y. , Roslee M., Nurul Aqidah I. & Siti Zubaidah S.A.
Sabah Forestry Department

Dr Arthur Y. C. Chung holds a B.Sc. and M.Sc. from Universiti Kebangsaan Malaysia, Bangi and a D.Phil. from Oxford University, UK, on Tropical Forest Entomology. He is a Senior Researcher at the Forest Research Centre, Sepilok of the Sabah Forestry Department, and has been working at the Centre for 22 years. He has written numerous research papers, authored two books on insects and co-authored a few others.

Abstract

An insect diversity survey was carried out in June, 2014 in Tundon Bohangin within the Lower Kinabatangan-Segama Wetlands (LKSW) Ramsar Site in eastern Sabah. Unlike marine life, insects are not particularly diverse in this area which is dominated by nipah palms and other mangrove vegetation. This is due to the low plant diversity and harsh environment of which only certain insect species could adapt. As there was no insect survey in the past in Tundon Bohangin, this pioneer study will provide baseline information for other research work in future. Insect data recorded during the survey provide information to enhance the biodiversity conservation of this Ramsar site. Despite the relatively low species richness and abundance in Tundon Bohangin, insects are ecologically important in the mangrove ecosystem as pollinators, defoliators, borers, decomposers as well as source of food for other animals. Monitoring, as well as enforcement according to the management plan in this area on a regular basis is important in ensuring that this wetland is protected and conserved according to its status as a Ramsar site.

1. INTRODUCTION & STUDY AREA

A Ramsar site is an internationally recognized wetland for its significance on conservation and wise use of its resources. It is named after the city of Ramsar in Iran where the wetland convention was first signed in 1971. There are six Ramsar sites in Malaysia, and LKSW in Sabah is the largest, encompassing an area of about 80,000 hectares, covering three forest reserves. A management plan (2011-2020) has been jointly formulated by the State Government through the Sabah Biodiversity Centre, Natural Resources Office and Forestry Department in collaboration with Japan International Cooperation Agency (JICA) to manage this site (SaBC 2010).

Tundon Bohangin is centrally located within the Lower Kinabatangan-Segama Wetlands (LKSW) Ramsar site in eastern Sabah. Situated at the confluence of Sg. Kretam and Sg. Kulamba which flows into the Dewhurst Bay of the Sulu Sea, Kampung Tundon Bohangin is one of the few villages established within this area. The villagers are sea-faring people, relying on marine resources for their livelihood.

Scientifically, not much is known about Tundon Bohangin. Hence, the Sabah Forestry Department organized a scientific expedition from 16th to 26th of June 2014, based at the newly completed Kulamba Field Centre to explore this rather unknown part of the Ramsar site, with funding from the Federal Ministry of Natural Resources and Environment. The centre is managed by the District Forestry Officer of Kinabatangan. Some 60 participants took part in this exploration, with researchers from the Sabah Forestry Department, with participation from Universiti Malaysia Sabah and University of Ryukyus, Okinawa, Japan. As this area falls under the Eastern Sabah Security Zone (ESSZone), the General Task Force or Pasukan Gerakan Am (PGA) also provided security assistance throughout the expedition.

2. MATERIALS & METHODS

The insect survey was carried out during the first week of the expedition, from 16th to 21st of June, 2014. Light trap was used to sample nocturnal insects while sweep nets and forceps were used to sample diurnal insects.

2.1 Light trap

The trap consists of a vertical white sheet (2 X 2 m) illuminated by a 250W mercury-lithium bulb. It was powered by a generator at the field centre.

The trap was set up at the field centre facing the forested area, from 7:00 to 9:00 p.m. Due to security and safety reasons, we were advised not to travel outside of the field centre after 6:00 pm. A GPS (Model: Garmin GPSMAP 60CSx) was used to determine the coordinates of each sampling site. Temperature and humidity were taken with a digital hygrometer from Extech Instruments (model no. 445702).

To evaluate diversity of the sampling area, insect species and individuals (≥ 5 mm) within the 1 X 1 m square of the white cloth were enumerated from 8:30 to 9:00 pm. This is a rapid biodiversity assessment method because by the end of the sampling time, species and individual numbers can be obtained, and the data can be used to calculate diversity indices, i.e. Shannon Wiener, Simpson and Fisher Alpha, using the Species Diversity & Richness version IV (SDR 2006). This method is simple, fast and can be carried out by non-insect specialist. To avoid compounding human error, the same

staff was assigned to count the species and individual numbers throughout the sampling period, and also for other sampling sites. Light-trapping sites are shown in Table 1.

Table 1: Light-trapping at different locations within the Kulamba Field Centre.

Sampling site	Coordinates	Temp. (°C)	Humidity (%)	Sampling date	Remarks
TB1	N05°36'24.5" E118°35'27.5"	26.0	78	18 June	Calm weather without moon light.
TB2	N05°36'05.2" E118°35'25.6"	26.0	87	19 June	Calm weather after rain. No moon light.
TB3	N05°36'05.2" E118°35'25.6"	25.0	90	20 June	Calm weather with stars. No moon light.

2.2 Sweep net and manual collection

Sweep nets were used to collect flying insects while other insects were sampled using fine forceps. Butterflies were put in triangle papers while other specimens were put in vials with 75% ethanol solution. Sampling was conducted by boat and trekking along the trails adjacent to the Kulamba Field Centre. Details of the daytime sampling sites are listed in Table 2.

Table 2: Daytime sampling sites in Tundon Bohangin.

Sampling site	Starting point coordinates	Elevation (m)
1 (Sg Kulamba)	N05°35'03.1" E118°37'23.8"	2-20 m
2 (Behind Kulamba Field Centre)	N05°36'15.6" E118°35'28.5"	20-25 m
3 (Bukit Lawa Lawa in Sg. Gelogop FR)	N05°36'27.9" E118°28'55.6"	12-64 m

2.3 Insect specimens and identification

In this survey, focus was given to certain insect groups, i.e., butterflies, moths, beetles, dragonflies and damselflies. Only interesting and potential indicator insect species were sampled, as to minimize the workload at the laboratory in preparing the specimens for identification. Photographs were taken with DSLR Nikon D800E and Coolpix S8100 cameras to facilitate identification. Common insects were not sampled but photographs were taken for record purposes.

Selected specimens were dry-mounted and sorted to family and some to the genus and species level. Many of the identifications are still tentative while some will be identified later. The specimens sampled from this study are deposited at the Forest Research Centre, Sepilok, Sabah. Dry-mounted specimens were identified based on the FRC Entomology Collection and various reference materials, e.g. Otsuka (1988 & 2001) for butterflies; Holloway (1983, 1985, 1986, 1988, 1989, 1993, 1996a, 1997, 1998a & b, 1999, 2001, 2003, 2005, 2008, 2009 & 2011) and Robinson *et al.* (1994) for moths; Fujita (2010), Makihara (1999) and Tung (1983) for beetles; Orr (2003) and Tang *et al*. (2010) for dragonflies and damselflies. Some other insects were identified based on Hill and Abang (2005). Dr Steven Bosuang assisted in the identification of a few beetle species.

3. RESULTS & DISCUSSION

3.1 Overall insect diversity

The nocturnal insect species richness and abundance were low, as shown in Table 3. On average, only 44 species and 57 individuals were recorded within a one-square-metre. The mean Shannon Index was 3.63 while Simpson Index was 69.10 and Fisher Alpha Index was 89.49. During light-trapping, the temperature was between 25^{0}C and 26^{0}C with humidity between 78 and 90% (Table 1). The distribution of insect species from the light-trapping sites is reflected in the species-rank abundance curves in Figure 1. Overall, the distribution of species was quite even throughout the sampling although the number of species was low. This is reflected in the Shannon Index, with value more than 3.0 in all sampling sites. The species with the highest individuals was only 6, as recorded in TB2 and TB3.

Table 3: Insect diversity within a one-square-metre, as sampled through light-trapping in Tundon Bohangin.

No.	Sampling site	Species	Ind.	Shannon	Simpson	Fisher Alpha
1.	TB1	34	43	3.41	60.20	75.12
2.	TB2	56	76	3.90	86.36	96.13
3.	TB3	41	51	3.58	60.71	97.22
	Mean	44±11	57±17	3.63±0.25	69.10±15	89.49±12

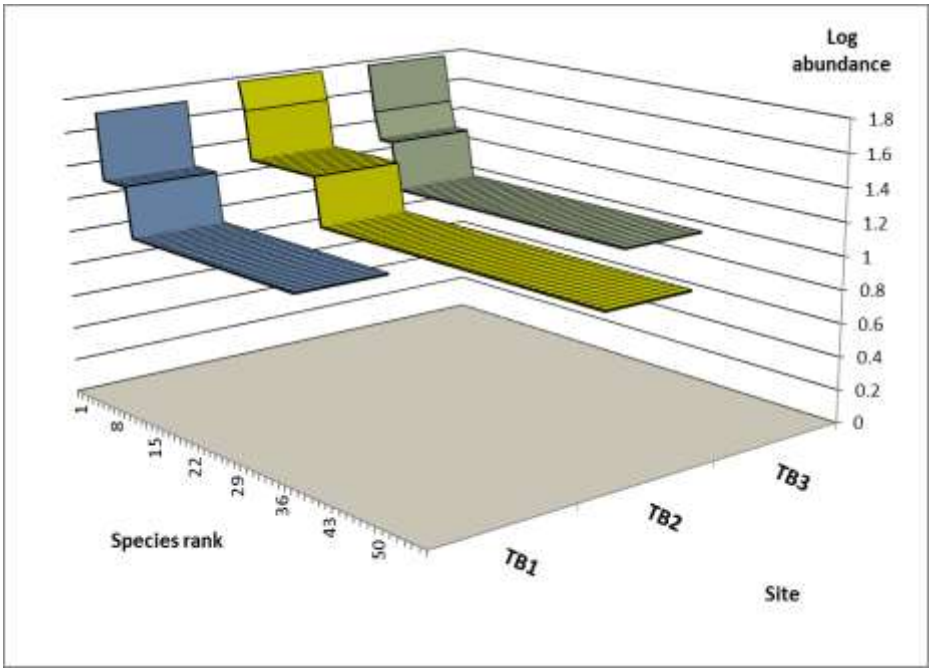


Figure 1: Species-rank abundance curves of the light-trapping sites in Tundon Bohangin.

When the nocturnal insect species richness is compared with other forest reserves, Tundon Bohangin appeared to be very low, as shown in Figure 2a. This is not surprising because Tundon Bohangin is located within the nipah and mangrove vegetation which is low in plant diversity, unlike the mixed dipterocarp forest. In addition, some parts of the adjacent lowland forest were quite

degraded. Similarly, Sg. Kapur F.R. (that was surveyed earlier) also showed low insect species richness because it is also located near to the mangrove and nipah vegetation. Sg. Kapur F.R. is situated adjacent to the Lower Segama area in eastern Sabah. In terms of nocturnal insect diversity in Tundon Bohangin, it is moderate due to the evenness of distribution between species and individuals (Figure 2b).

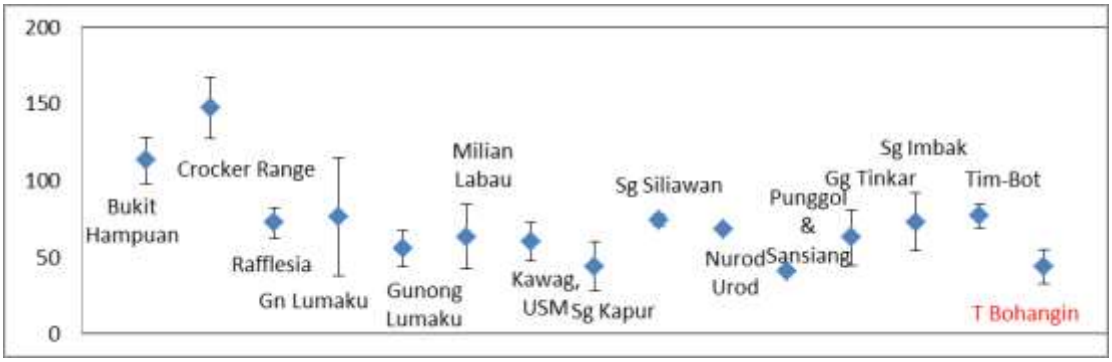


Figure 2a: Species number (±standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah.

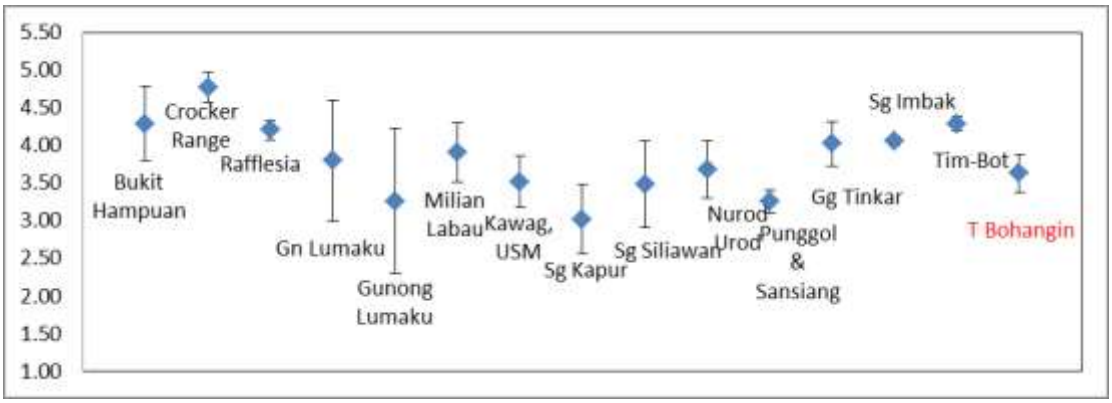


Figure 2b: Shannon Index (±standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah.

During this survey, no Bornean endemic insect species was recorded. Unlike marine fauna, the insect fauna in Tundon Bohangin is not particularly interesting. Only common insect species were recorded. Some of the large and interesting species are highlighted in this report. As there was no insect study conducted previously in Tundon Bohangin, the insect data procured from this survey serves as baseline information for this area. Studies in the past were only conducted in adjacent areas in Lower Segama, e.g. in Kampung Tidong on butterflies (Nakanishi *et al*. 2006) and saproxylic beetles (Dawood 2006).

3.1.1 Butterfly (Lepidoptera)

At least 23 butterfly species were sampled during the survey. Large and interesting species were the Mangrove Nymph, *Idea leuconoe* and the much larger Tree Nymph, *Idea hypermnestra*. They flew gracefully at the fringe of the forest and were easily recognized through their polka dot wings. Both species were recorded in Sg. Gelogop F.R. *I. leuconoe* was spotted perching on the leaf of the nipah palm while *I. hypermnestra* was seen fluttering on the flowers of *Nephelium* sp. The former is one of the few butterflies which seem to be confined to mangrove swamps.

3.1.2 Moth (Lepidoptera)

Some 37 moth species were recorded from this study. The common uraniid moth, *Lyssa menoetius* and sphingid moths, namely *Acosmeryx anceus*, *Enpinanga borneensis* and *Theretra latreillei* were among the large moths documented from this survey.

3.1.3 Beetle (Coleoptera)

Some 15 species of macro-beetles were recorded. *Cyclommatus insignis* and *Odontolabis gazella* are among the interesting Stag Beetles documented in this brief survey. Both were attracted to the light trap.

3.1.4 Dragonfly & Damselfly (Odonata)

A total of 11 Odonata species were recorded during the survey. *Gynacantha dohrni* is a large dragonfly, with a hindwing length of 40 mm. It was attracted to the light at night. The bee-like dragonfly, *Rhyothemis phyllis* was commonly seen hovering over the open grassy area at the back of the field centre. *Neurothemis fluctuans* and *N. terminata* were also encountered in the open area.

3.2 Insect diversity and ecology in Tundon Bohangin

Insects are not particularly diverse in mangrove and nipah vegetation compared to lowland mixed dipterocarp forest (Field 1995). This concurs with the findings from the insect survey in Tundon Bohangin, with low species richness as well as abundance. However, mangrove is home to certain interesting insect species, such as the Mangrove Tree Nymph and fireflies. Some are ecologically important to the mangrove trees. Certain hawk moth species are pollinators while some other moth caterpillars are defoliators (Nilus *et al*. 2010). Towards to the inner part of the mangroves, termites were seen causing damage to some of the trees. In this study, a few termite species were recorded. Wood-boring insects, such as pin-hole borers from the beetle subfamilies Scolytinae also cause damage to mangrove trees and seedlings (Chung *et al*. 2008). Mangroves have an unenviable reputation for breeding and harbouring large numbers of biting insects, such as mosquitoes and midges (Field 1995). Hence, mangrove forests are often considered as harsh environment by humans.

As mangrove forest is transitional between land and sea, insects that are found in this ecosystem are those that can adapt in this transitional coastal environment. Besides the low plant diversity, insects living within this habitat should be able to adapt to drastic changes in microclimate, such as strong wind and waves, high salinity, as well as intense sunlight. Hence, this could also be the reason for the rather low insect species richness in such environment, as shown in this Tundon Bohangin survey. Nevertheless, insects are still important in the food chain and energy flow in the mangrove ecosystem. For example, mosquitoes and midges are source of food for the carnivorous dragonflies which in turn may be eaten by insectivorous birds.

4. CONCLUSION

From this study, insects are not particularly diverse in mangrove and nipah vegetation compared to lowland mixed dipterocarp forest due to the low plant diversity and harsh environment which only certain insect species could adapt in such habitat.

As there was no insect survey in the past in Tundon Bohangin, this pioneer data will serve as baseline information for other research work in future. Insect data recorded during the survey provides

salient information to enhance the biodiversity conservation of this area within the Lower Kinabatangan-Segama Wetlands Ramsar Site.

Despite the low species richness and abundance in Tundon Bohangin, insects are ecologically significant in the mangrove ecosystem as pollinators, defoliators, borers, decomposers as well as source of food for other animals.

It is important that the forests within this Ramsar site continue to be managed according to the forest management plan. Regular monitoring and enforcement should be carried out to prevent encroachment in this protected area.

ACKNOWLEDGEMENTS

This is part of the Ramsar programme with funding from the 10th Malaysia Plan through the Ministry of Natural Resources & Environment (NRE). Within the Sabah Forestry Department, this programme is managed under the Deputy Director (Forest Sector Planning), Frederick Kugan. We thank the DFO of Kinabatangan (Tn. Hj. Hussin Tukiman) and his staff (particularly Tn. Hj. Abdul Samah Sapni), and Head, General Service Division (Kinus Mais) for logistics and field support. The Deputy Director (R&D), Dr Lee Ying Fah and Head of FRC Insect Diversity Programme, Dr Chey Vun Khen are also acknowledged for their support. Dr Steven Bosuang (Kipandi Park) has kindly identified a few of the beetle species from this survey.

REFERENCES

Chung, A.Y.C., Hulcr, J., Hastie, A. & Chong Y.F. (2008) Occurrence of scolytine beetles on some forest plants in Sabah, Malaysia. Poster presented at the 7th International Conference on Plant Protection, Kuala Lumpur. 27-29 August, 2008.

Dawood, M. M. (2006). Brief account of saproxylic beetles of Lower Segama. In M. Mohamed, H. Benard, S. Abu Bakar & R. Matsunaga (Eds.), *Lower Segama scientific expedition*. Universiti Malaysia Sabah, Kota Kinabalu. Pp. 5-10.

Field, C. (1995). *Journey amongst mangroves*. International Society of Mangrove Ecosystems, Okinawa, Japan. 140 pp.

Fujita, H. (2010). *The lucanid beetles of the world*. Mushi-Sha's Iconographic Series of Insects 6. Tokyo, Japan.

Hill, D. & Abang, F. (2005). *The insects of Borneo (including South-east and East Asia)*. Universiti Malaysia Sarawak. 435 pp.

Holloway, J.D. (1983). Moths of Borneo (part 4): family Notodontidae *Malayan Nature Journal* 37: 1-107.

Holloway, J.D. (1985). Moths of Borneo (part 14): Family Noctuidae: subfamilies Euteliinae, Stictopterinae, Plusiinae, Pantheinae *Malayan Nature Journal* 38: 157-317.

Holloway, J.D. (1986). Moths of Borneo (part 1): key to families: families Cossidae, Metarbelidae, Ratardidae, Dudgeoneidae, Epipyropidae and Limacodidae. *Malayan Nature Journal* 40: 1-166.

Holloway, J.D. (1988). *The moths of Borneo (part 6): family Arctiidae, subfamilies Syntominae, Euchromiinae, Arctiinae; Noctuidae misplaced in Arctiidae (*Camptoloma*, Aganainae).* Southdene Sdn. Bhd., Kuala Lumpur. 101 pp.

Holloway, J.D. (1989). *The moths of Borneo (part 12): family Noctuidae, trifine subfamilies: Noctuinae, Heliothinae, Hadeninae, Acronictinae, Amphipyrinae, Agaristinae*. Southdene Sdn. Bhd., Kuala Lumpur. 226 pp.

Holloway, J.D. (1993). *The moths of Borneo (part 11): family Geometridae, subfamily Ennominae*. Southdene Sdn. Bhd., Kuala Lumpur. 309 pp.

Holloway, J.D. (1996). The moths of Borneo (part 9): family Geometridae, subfamilies Oenochrominae, Desmobathrinae and Geometrinae. *Malayan Nature Journal* 49: 147-326.

Holloway, J.D. (1997). The moths of Borneo (part 10): family Geometridae, subfamilies Sterrhinae & Larentiinae. *Malayan Nature Journal* 51: 1-242.

Holloway, J.D. (1998a). The moths of Borneo (part 8): families Castniidae, Callidulidae, Drepanidae & Uraniidae. *Malayan Nature Journal* 52: 1-155.

Holloway, J.D. (1998b). *The moths of Borneo (part 3): superfamily Bombycoidea: families Lasiocampidae, Eupterotidae, Bombycidae, Brahmaeidae, Saturniidae, Sphingidae*. Southdene Sdn. Bhd., Kuala Lumpur. 199 pp.

Holloway, J.D. (1999). The moths of Borneo (part 5): family Lymantriidae. *Malayan Nature Journal* 53: 1-188.

Holloway, J.D. (2001). *The moths of Borneo (part 7): family Arctiidae, subfamily Lithosiinae.* Southdene Sdn. Bhd., Kuala Lumpur. 486 pp.

Holloway, J.D. (2003). *The moths of Borneo (part 18): family Nolidae.* Southdene Sdn. Bhd., Kuala Lumpur. 279 pp.

Holloway, J.D. (2005). The moths of Borneo: family Noctuidae, subfamily Catocalinae. *Malayan Nature Journal* 58(1-4): 1-529.

Holloway, J.D. (2008). The moths of Borneo: family Noctuidae, subfamilies Rivulinae, Phytometrinae, Herminiinae, Hypeninae and Hypenodinae. *Malayan Nature Journal* 60(1-4): 1-268.

Holloway, J.D. (2009). The moths of Borneo (part 13): family Noctuidae, subfamily Pantheinae (part), Bagisarinae, Acontiinae, Aediinae, Eustrotiinae, Bryophilinae, Araeopteroninae, Aventiinae, Eublemminae and further miscellaneous genera. *Malayan Nature Journal* 62(1&2): 1-240.

Holloway, J.D. (2011). The moths of Borneo: families Phaudidae, Himantopteridae and Zygaenidae; revised and annotated checklist. *Malayan Nature Journal* 63(1-2): 1-548.

Makihara, H. (1999). Atlas of longicorn beetles in Bukit Soeharto Education Forest, Mulawarman University, East Kalimantan, Indonesia. *PUSREHUT Special Publication No. 7.* Mulawarman University & JICA. 140 pp.

Nakanishi, A., Yago, M. & Mohamed, M. (2006). List of butterflies collected in Lower Segama region. In M. Mohamed, H. Benard, S. Abu Bakar & R. Matsunaga (Eds.), *Lower Segama scientific expedition*. Universiti Malaysia Sabah, Kota Kinabalu. Pp. 5-10.

Nilus, R., Chung, A.Y.C., Pereira, J., Sugau, J., Tangah, J., Sabran, S. & Chong, R.F.Y. (2010). *Mangroves of Sabah – an introduction to the flora and fauna*. Sabah Forestry Department. 150 pp.

Orr, A.G. (2003). *A guide to the dragonflies of Borneo: their identification and biology*. Natural History Publications (Borneo), Kota Kinabalu. 195 pp.

Otsuka, K. (1988). *Butterflies of Borneo.* Vol. I. Tobishima Corporation, Tokyo, Japan. 61 pp.

Otsuka, K. (2001). *A field guide to the butterflies of Borneo and South East Asia*. Hornbill Books. 224 pp.

Robinson, G.S., Tuck, K.R. & Shaffer, M. (1994). *A field guide to smaller moths of South-east Asia.* The Natural History Museum, London & Malaysian Nature Society. 309 pp.

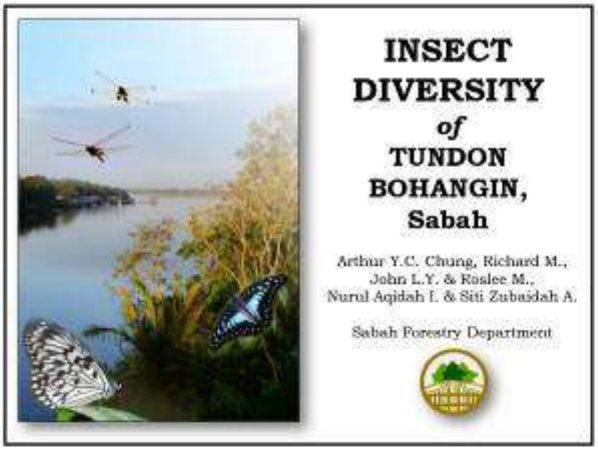
SaBC (2010). *Lower Kinabatangan Segama Wetlands Ramsar Site Management Plan 2011-2020*. Sabah State Government, Kota Kinabalu, Sabah.

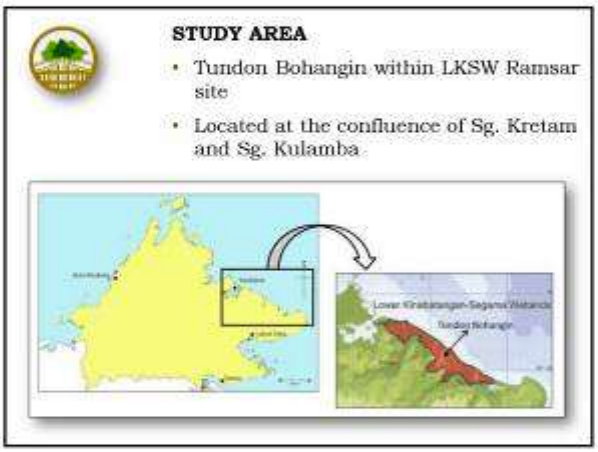
SDR (2006). Species Diversity & Richness version IV. Pisces Conservation Ltd., Lymington, UK.

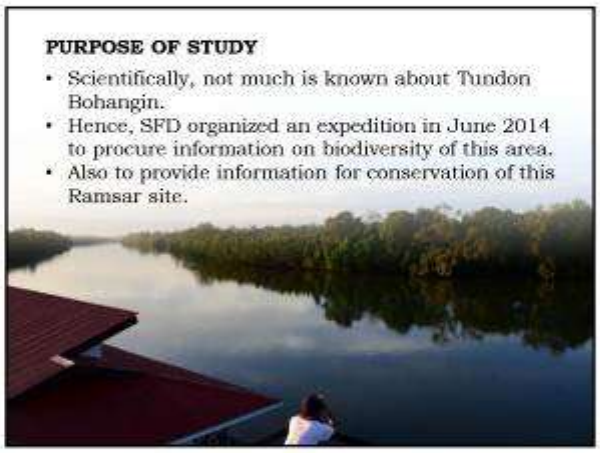
Tang, H.B., Wang, L.K. & Hamalainen, M. (2010). *A photographic guide to the dragonflies of Singapore*. The Raffles Museum of Biodiversity Research, Singapore. 222 pp.

Tung, V. W-Y. (1983). *Common Malaysian beetles*. Longman, Kuala Lumpur. 142 pp.

Slide Presentation





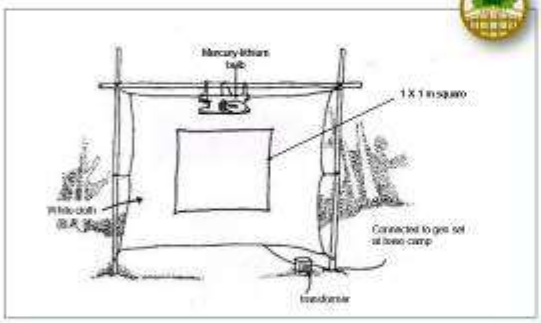


MEANS OF TRANSPORT IN TUNDON BOHANGIN

METHODS & MATERIALS FOR INSECT SAMPLING

- Survey was conducted from 16 to 21 of June, 2014.
- Insect groups – butterflies, moths, beetles & dragonflies
- Light trap powered by gen set to sample nocturnal insects
- sweep net and forceps to sample diurnal insects.

LIGHT TRAPPING COMPONENTS



LIGHT TRAPPING SITES (within Kulamba Field Centre)

Sampling site	Coordinates	Temp. (°C)	Humidity (%)	Sampling date	Weather condition
TB1	N05°36'24.5" E118°35'27.5"	26.0	78	18 June	Calm weather without moonlight.
TB2	N05°36'05.2" E118°35'25.6"	26.0	87	19 June	Calm weather after rain. No moonlight.
TB3	N05°36'03.5" E118°35'25.6"	25.0	90	20 June	Calm weather with stars. No moonlight.

STAFF ASSISTED IN SAMPLING

DAYTIME SAMPLING

Sampling site	Starting point coordinates	Elevation (m)
1 (Sg Kulamba)	N05°35'03.1" E118°37'23.8"	2-20 m
2 (Behind Kulamba Field Centre)	N05°36'15.6" E118°35'28.5"	2-25 m
3 (Bukit Lawa Lawa in Sg. Gologop FR)	N05°36'27.9" E118°28'55.6"	12-64 m

INSECT SPECIMENS & IDENTIFICATION

- Photographs of insects were taken for record purposes.
- Identification based on FRC collection and various reference materials.
- Assistance from other insect experts.

RESULTS & DISCUSSION

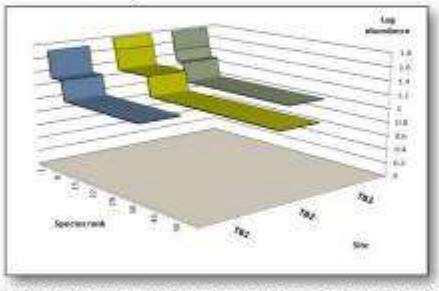
Insect diversity within a one-square-metre, as sampled through light-trapping in Tundon Bohangin

No.	Sampling site	Species	Ind.	Shannon	Simpson	Fisher Alpha
1.	TB1	34	43	3.41	80.20	25.12
2.	TB2	50	76	3.90	86.36	99.19
3.	TB3	41	51	3.68	90.71	97.22
	Mean	44±11	57±17	3.63±0.25	85.10±15	89.49±12

The nocturnal insect species richness and abundance were low. On average, only 44 species and 57 individuals were recorded within a one-square-metre. The mean Shannon Index was 3.63 while Simpson Index was 85.10 and Fisher Alpha Index was 89.49.

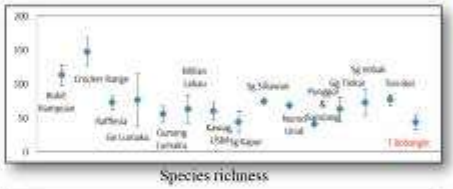
RESULTS & DISCUSSION

Species-rank abundance curves of the light-trapping sites in Tundon Bohangin

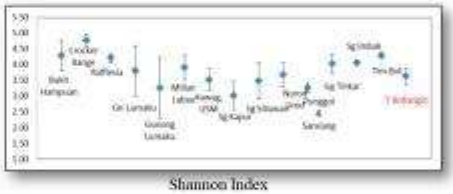


Overall, the distribution of species was quite even throughout the sampling although the number of species was low. This is reflected in the Shannon Index, with value more than 3.0 in all sampling sites. The species with the highest individuals was only 6, as recorded in TB2 and TB3.

RESULTS & DISCUSSION



Species richness



Shannon Index

RESULTS & DISCUSSION

- When the nocturnal insect species richness is compared with other forest reserves, Tundon Bohangin appeared to be very low. This is not surprising because Tundon Bohangin is located within the nipah and mangrove vegetation which is low in plant diversity, unlike the mixed dipterocarp forest.
- In terms of nocturnal insect diversity in Tundon Bohangin, it is moderate due to the evenness of distribution between species and individuals.
- During this survey, no Bornean endemic insect species was recorded. Unlike marine fauna, the insect fauna in Tundon Bohangin is not particularly interesting. Only common insect species were recorded.
- As there was no insect study conducted previously in Tundon Bohangin, the insect data procured from this survey serves as baseline information for this area.

RESULTS & DISCUSSION

Butterfly (Lepidoptera)

Idea leuconoe

Idea hypermnestra

At least 23 butterfly species recorded.

Graphium antipates tampusi

Pandita sinope sinope

Parantica vulgaris

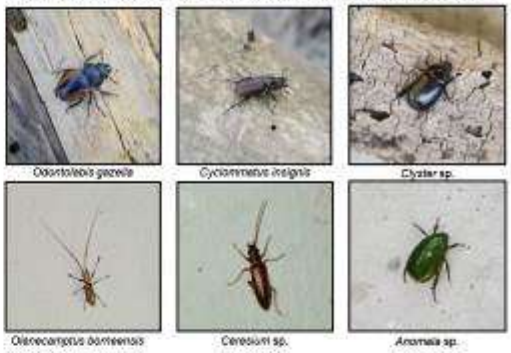
RESULTS & DISCUSSION

Moth (Lepidoptera)

Some 37 moth species were recorded.

RESULTS & DISCUSSION

Beetle (Coleoptera) Some 15 species of macro-beetles were recorded.



RESULTS & DISCUSSION

Dragonfly (Odonata) A total of 11 Odonata species were recorded during the survey.

RESULTS & DISCUSSION

Other insects

RESULTS & DISCUSSION

- Mangrove is home to certain interesting insect species, such as the Mangrove Tree Nymph and fireflies. Some are ecologically important to the mangrove trees. Certain hawk moth species are pollinators while some other moth caterpillars are defoliators.
- Mangroves have a reputation for breeding and harbouring large numbers of biting insects, such as mosquitoes and midges. Hence, mangrove forests are often considered as harsh environment by humans.

Dragonflies are known as mosquito hawks, preying on mosquitoes and midges which are common in wetlands.

RESULTS & DISCUSSION

- As mangrove forest is transitional between land and sea, insects that are found in this ecosystem are those that can adapt in this transitional coastal environment.
- Besides the low plant diversity, insects living within this habitat should be able to adapt to drastic changes in microclimate, such as strong wind and waves, high salinity, as well as intense sunlight. Hence, this could also be the reason for the rather low insect species richness in such environment, as shown in this Tundon Bohangin survey.
- Nevertheless, insects are still important in the food chain and energy flow in the mangrove ecosystem. For example, mosquitoes and midges are source of food for the carnivorous dragonflies which in turn may be eaten by insectivorous birds.

Insects are source of food for birds in Tundon Bohangin, such as the Sacred Kingfisher, *Todiramphus sanctus*.

CONCLUSION

- From this study, insects are not particularly diverse in mangrove and nipah vegetation compared to lowland mixed dipterocarp forest due to the low plant diversity and harsh environment which only certain insect species could adapt in such habitat.
- This pioneer data will serve as baseline information for other research work in future. Insect data recorded during the survey provides salient information to enhance the biodiversity conservation of this area within the Lower Kinabatangan-Segama Wetlands Ramsar Site.
- Despite the low species richness and abundance in Tundon Bohangin, insects are ecologically significant in the wetland ecosystem as pollinators, defoliators, borers, decomposers as well as source of food for other animals.
- It is important that the forests within this Ramsar site continue to be managed according to the management plan. Regular monitoring and enforcement should be carried out to prevent encroachment in this protected area.

ACKNOWLEDGEMENTS

This is part of the Ramsar programme with funding from the 10th Malaysia Plan through the **Ministry of Natural Resources & Environment** (NRE)

Within the **Sabah Forestry Department**.

- Director of Forestry, Datuk Sam Mannan
- Deputy Director (Forest Sector Planning), Frederick Kugan
- Deputy Director (R&D), Dr Lee Ying Fah
- DFO of Kinabatangan (Tn. Hj. Hussin Tukiman) and his staff (particularly Tn. Hj. Abdul Samah Sapri)
- Head, General Service Division (Kinus Mais) for logistics and field support
- Head of FRC Insect Diversity Programme, Dr Chey Vun Khen
- Dr Steven Bosuang (Kipandi Park)
- Dr Rory Dow

ORAL PAPER 12

KOTA KINABALU WETLANDS: TOWARDS ITS RAMSAR STATUS

Guslia Lahasing[1], Rita Ignatius[1] & Ann Anton[2]
[1]Sabah Wetlands Conservation Society, Kota Kinabalu, Sabah,
[2]Borneo Marine Research Institute, Universiti Malaysia Sabah

Ms Guslia Lahasing, has held the post as Conservation & Science Officer for Sabah Wetlands Conservation Society (SWCS) since 2014. Her core responsibility is to conduct all conservation and science activities in Kota Kinabalu Wetlands, especially in tree planting programme and research. She graduated with a Bachelor of Science (Hons) in Biology in 2013 from Universiti Putra Malaysia. Guslia worked as a Research Assistant with Tioman Development Authority on several projects on Waste Management System in 2012. She presented a paper with title "The importance of Wetlands for Sustainable Water Management" during Sabah State Level World Water Day Conference & Exhibition 2015.

Abstract

Kota Kinabalu Wetlands (KKW), a 24 hectare mangrove area located in the heart of Kota Kinabalu city, is managed by the Sabah Wetlands Conservation Society (SWCS), a Not-for Profit Organisation. KKW is governed by a Management Committee consisting of elected members and ex-officio from relevant government agencies and WWF-Malaysia. This unique collaborative partnership provides diverse expertise needed for achieving its aims. Since its official opening to the public in March 2000 until 2014, more than 150,000 local and international visitors have visited KKW, and more than 30,000 students have participated in its Environmental Education Programme. Acting as a biodiversity reservoir, KKW supports more than 92 species of resident and migratory birds, various reptilian species, 12 species of mangrove trees, and other marine life-forms. KKW was nominated as a Ramsar site in 2013, and is currently pursuing Ramsar status as Wetlands of International Importance. This paper describes the crucial timeline of Kota Kinabalu Wetlands, the introduction of SWCS Management, efforts for biodiversity conservation, environmental education activities as well as the achievements and challenges encountered over the past 15 years.

INTRODUCTION

Sabah Wetlands Conservation Society

Sabah Wetlands Conservation Society (SWCS) is a not-for-profit organization based in Kota Kinabalu City, which advocates environmental conservation and awareness of wetlands ecosystem found in Sabah. The vision of SWCS is "conservation and sustainable management of Sabah's wetlands". Derived from the vision, the mission of SWCS is "to ensure protection and wise use of all wetlands in Sabah, through education, research and advocacy".

Formed on 22nd August 2005, SWCS was entrusted by the Sabah Wildlife Department to manage KKW in 2006 with the aim to operate independently as a self-sustainable centre. SWCS has three objectives which are (i) to promote the conservation of wetlands in Sabah and the variety of plants, birds and other kinds of living organisms found in them; (ii) to raise public awareness and appreciation of the wetlands and public involvement in protecting wetlands; (iii) to manage Kota Kinabalu Wetlands as a model wetland centre for the purpose of conservation, education, recreation, tourism and research.

SWCS is managed by 20 management committee members from relevant government agencies viz. Ministry of Local Government & Housing, Kota Kinabalu City (DBKK), Sabah Wildlife Department, Environment Protection Department, Sabah Education Department, Department of Irrigation and Drainage and a local NGO (i.e. WWF- Malaysia).

KOTA KINABALU WETLANDS

Wetlands are often misunderstood and underappreciated as wastelands. This resulted in most of the wetlands being destroyed to make way for buildings or landfills. In the late 1980's, a group of environmentalist from WWF discovered a mangrove swamp in Likas and lobbied for the area to be converted for protection. This area is now known as the Kota Kinabalu Wetlands (KKW), a 24 hectares of mangrove swamp located in the heart of Kota Kinabalu City. It was designated as a bird sanctuary in September 1996 under the custody of Sabah Wildlife Department, and was declared a State Cultural Heritage Site in 1998 towards wetlands conservation in Sabah. It was previously known as Kota Kinabalu City Bird Sanctuary (KKCBS) and went through a name change to become the Kota Kinabalu Wetlands on 1st August 2006. This change was to reflect the overall values of the place and while placing greater emphasis on the conservation of wetlands.

KKW was managed by the Likas Wetlands Sanctuary Management Committee (LWSMC) before it was officially taken over by SWCS on July 1, 2006. KKW is managed by 6 full time staff, who are responsible for managing daily activities at the wetlands - they consist of the Manager, Conservation & Science Officer, Environmental Education Officer, Conservation & Education Assistant, Administrative & Account Assistant and Gardener. KKW is opened from 8.00 am to 6.00 pm from Tuesday until Saturday and is closed on Mondays, except for public holidays.

BIODIVERSITY CONSERVATION

Fauna Diversity

KKW supports an abundance of aquatic and other wildlife. More than 90 species of resident and migratory birds, 21 species of fish, 19 crustacean species, 13 mollusc species, 44 insect species and 6 reptile species, 2 chelicerate species and 1 species of cnidaria have been recorded in KKW. Egrets,

Kingfishers and little Herons are commonly seen throughout the day whilst the iconic Purple Heron and Rufus Night heron are known to make quite frequent appearances. KKW also serves as resting and feeding habitats for migratory birds, which are usually sighted from September to April. These wetlands have recorded 2 protected species of birds which are the Lesser Adjutant Stork (*Leptoptilos javanicus*) and the Chinese Egret (*Egretta eulophotes*). Both species are listed in the 2010 IUCN red list as Vulnerable.

Research and development (R&D) is part of the conservation efforts in KKW. Besides studies on the mangrove fauna and flora at KKW, a recent study on bees, wasps and hoverflies recorded an additional 44 new insect species (28 bees, 15 wasps and 1 hoverfly) from a total of 88 insect species identified (Dirk, 2014). Continuous water quality monitoring is conducted to ensure that the wetlands sustainably support the survival of aquatic species.

KKW has seen the disappearance of particular animal species due to the presence of illegal settlements within the mangrove swamp. For example, otters, long-tailed macaques (*Macaca fascicularis*), some birds, such as Black-shouldered Kite (*Elanus axillaris*) and Straw-headed Bulbul (*Pycnonotus zeylanicus*) which used to inhabit the mangrove swamp are no longer sighted since the development of a golf course in the vicinity of the wetlands (Lee 2011).

Flora Diversity

There are more than 12 species of mangrove trees out of a total of 32 mangrove species found in Sabah recorded in KKW, viz the genus *Rhizophora, Bruguiera, Avicennia* and *Sonneratia*. Of these, the most dominant species in KKW is *Rhizophora apiculata.* Since the early days of KKW, mangrove tree planting is the priority in order to restore the badly degraded area due to encroachment by illegal settlers in KKW. More than 10,000 seedlings have been planted in KKW since year 2000 until 2012 (Lee & Zainie 2012).

The total area of mangrove vegetation within forest reserves in Sabah is approximately 338,000 ha or 60% of the country's total (Tangah *et al.* 2015). Based on the latest assessment of forest cover of Sabah, about 3,300 ha of mangrove forest have been illegally encroached and exploited which led to ecological devastations, such as flash floods, waste disposal problem and low water quality. Therefore, in collaboration with Sabah Forestry Department in the year 2010, approximately 25,000 trees have been planted at Sulaman Lake Forest Reserve (SLFR) to conserve the degraded mangrove area.

SWCS in collaboration with Sabah Parks has embarked on efforts to conserve and protect an endangered mangrove species known as Berus Mata Buaya (*Bruguiera hainessii*). This species is listed as "critical endangered" by the IUCN. It has very low propagation and a slow growth rate (Yang *et al*. 2011) The propagules were obtained from the only 2 mature trees left in Pulau Manukan, Taman Tunku Abdul Rahman, Sabah. Currently, 56 propagules have been planted in KKW nursery, and studies are currently conducted to monitor their propagation and growth rate.

ENVIRONMENTAL EDUCATION PROGRAMME

Since its official launching to the public in March 2000 until 2014, more than 150,000 local and international visitors have visited KKW; of these, more than 30,000 students have participated in the Environmental Education Programme. A number of Environmental Education Programmes in line with SWCS objectives was developed, mainly to raise public awareness and appreciation of the importance of wetlands as well as to promote public involvement in protecting the wetlands. These

include international participation from Japan, Sweden, Singapore and many more through our existing Environmental Education Programme.

Among the programmes carried out in KKW are (i) Mangrove Experience Programme: main activity is to introduce wetlands through interpretative walks into the mangroves, where participants can appreciate the various types of flora and fauna. (ii) Mangrove Conservation Programme: where participants contribute back to the wetlands - after guided walks in the mangroves, they will experience the mangrove tree replanting activity. This has proven to be an excellent opportunity for those interested in getting closer to the mangroves. (iii) Mangrove Voluntary Work: this programme offers the community an opportunity to play a role in supporting the conservation of KKW in mangrove clean up or nursery work. (iv) Handcrafting from Mangrove Programme: this programme is in support of efforts to recycle, where participants learn how to recycle used paper and produce creative handmade products, i.e. photo frames, greeting cards and others.

KKW also has a programme with local schools and communities through the outreach programme; via this activity, KKW is able to spread public awareness and appreciation of the wetlands through talks and motivational camps. This is one of the programmes conducted by KKW to share the importance and crucial facts about wetlands to the public. On an annual basis, KKW celebrates World Wetlands Day, World Environment Day and Malaysia Environment Week, as part of our effort to increase awareness among the community.

ACHIEVEMENTS OF KOTA KINABALU WETLANDS

KKW is heading towards its goal as a model wetland centre involved in the conservation, education, tourism and research activities. Currently, it is considered as a well-managed wetland reserve that serves as a model for mangrove conservation in an urban environment.

From the environmental conservation perspective, KKW has achieved remarkable success in fulfilling its responsibilities. Among its achievements since it was established are:

- It is ranked by Sabah Wetlands inventory of 1986 as the top most important wetlands habitat in Sabah to "… water birds significant interest combined with accessibility making it ideal for educational tourist development".
- Received the Sabah Environmental Award 2009–2010 for Outstanding Non-Governmental Organization Award.
- Recognition by Sabah Government as *"Pejabat Tanpa Sampah"* in 2012 – 2013.
- Nomination as the second Ramsar site in Sabah in 2013.
- Successfully organized the 3-in-1 fundraising events; Fundraising Dinner, Fundraising Golf Tournament and International Symposium on Conservation and Management of Wetlands in 2014.

Nomination as Ramsar Site

Malaysia presently has 6 sites designated as Wetlands of International Importance, with a surface area of 134,158 hectares, in which 4 wetlands are in Peninsular Malaysia, 1 in Sarawak and 1 in Sabah. Of these, Sabah has the largest Ramsar site located in the Lower Segama-Kinabatangan Wetlands with the area coverage of 78,803 hectares.

Sabah Wetlands Conservation Society has initiated the proposal to attain Ramsar status for KKW. The Sabah Tourism, Culture and Environment Minister, Datuk Seri Panglima Haji Masidi Haji Manjun,

expressed his utmost support towards the proposal during World Wetlands Day celebration on 2009. This was then coordinated by SWCS in collaboration with the Sabah Biodiversity Centre (SaBC) and now Sabah Natural Resources Office (NRO) as the new focal point for Ramsar at the State level. The nomination has been facilitated by the Ministry of Natural Resources and Environment (NRE) as the administrative authority (National Focal Point) and communicates with the Ramsar Secretariat for any inquiries or requirement regarding the nomination.

Due to its importance as wetland ecosystem with significant conservation and socioeconomic value, the KKW was submitted for recognition as the second Ramsar site in Sabah as it fulfils 4 listed criteria out of the 9 criteria as stipulated under the Convention on Wetlands of International Importance, called the Ramsar Convention.

Criteria 1: Wetlands of international importance due to representative, rare or unique examples of a near-natural wetland type found within the appropriate biogeographic region.

KKW is a particularly good example of a natural coastal mangrove system, characteristic of the Borneo biogeographical region and critical in maintaining local biodiversity due to the extensive loss of mangrove forests that once existed in the coastal Kota Kinabalu.

Criteria 2: Wetlands of international importance supporting vulnerable, endangered, or critically endangered species or threatened ecological communities.

KKW recorded 2 protected species of birds:

i. Lesser Adjutant Stork (*Leptoptilos javanicus*), listed in the 2010 IUCH red List as "Vulnerable"
ii. Chinese Egret (*Egretta eulophotes*), listed in the 2010 IUCN Red List as "vulnerable" and Appendix 1 of the CMS.

Criteria 3: Wetlands of international importance supports populations of plant and/or animal species important the biological diversity of a particular biogeographic region.

KKW supports more than 12 species of mangroves plants and a large diversity of animals including more than 92 species of resident and migratory birds, various reptilian species like monitor lizards and mangrove skinks, piscine species, including mudskippers, archerfish, catfish and halfbeak, many crustacean species such as mud lobster and fiddler crab.

Criteria 8: Wetlands international importance due to its role of as a source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetlands or elsewhere, depend.

KKW is an important spawning and nursery ground for fish, prawn and crab. It is also an important feeding ground for water birds as well as canopy birds. Migratory birds, such as sandpipers, red shanks and snipes use the site as a rest place in their migration path.

THE CHALLENGES

Wetlands have been internationally recognised as a valuable ecosystem for wildlife and utilisation by human. It has become a major source of interest to the professional and the public, but at times has often been regarded as wastelands, with some of the biggest abuses put on it observed.

Over the years, it has been very challenging year for SWCS, particularly in the conservation efforts to restore the degraded mangroves areas or to raise awareness among the public. Other key challenges faced by SWCS are as follows;

1. Insufficient and inconsistent sources of funding required to manage these urban wetlands as well as to carryout research upon which conservation and protection strategies are based upon.
2. Manpower shortage is one of the most serious problems that tend to affect the daily operation adversely besides delaying even the disposal of urgent cases. What is also a matter of concern is that it seriously restricts the scope for taking up new activities, which is not only inevitable at times, but it could also be critical requirement to fulfil growing information needs. KKW is currently operating with a minimum of 6 staffs that required to do multi-tasks, such as publicity, technician, security guard, maintenance, account, daily cleaning, CSR and funding etc. It is, however, important to note that it is not just the mere manpower shortage that is responsible for inadequate output or inefficient service delivery process but the quality of personnel as well as the working environment is also important to improve the output.
3. KKW experiencing rapid growth and encroachment from land developers. Many of these communities are confronted with the tough issue of preserving the quality of the environment, while at the same time allowing development to occur. SWCS supports sustainable development with the intention to protect KKW from any form of activities/projects which are detrimental the wetland ecosystem and home to various species of mangrove trees, birds and aquatic organisms.
4. KKW is faced with a number of issues that threaten the mangrove ecosystem. One of the threats that is periodically faced is the illegal harvesting of resources within the wetlands. Poaching of aquatic resources activity by local villagers occurs which causes decimation of the aquatic resources which serves as food for the resident and migratory birds.

WAY FORWARD

Sabah Wetlands Conservation Society (SWCS) has been vigorously working through collaboration with Sabah Natural Resources Office (NRO) as the State focal point for Ramsar and Ministry of Natural Resources & Environment Malaysia towards achieving Ramsar recognition status for KKW as wetland of international importance. To support this process, the Sabah Biodiversity Centre (SaBC) commissioned the development and preparation of a management plan as a tool for the conservation and sustainable management of the KKW. In addition, SWCS is seeking for funds to conduct more research and development (R&D) at KKW in order to obtain new and fundamental knowledge towards the conservation of an urban wetland ecosystem, in line with SWCS's objective to manage KKW as a model wetland centre for the purpose of conservation, education, recreation, tourism and research.

REFERENCES

Guslia, L., Jane. J & Aan, A. (2015). The importance of wetlands in sustainable water management. Sabah Wetlands Conservation Society.

Dirk, D.S. (2014). *A preliminary study on bee-Hymenoptera;Apoidea, wasps-Hymenoptera; Vespoidea and hoverflies-Diptera; Syrphidae in the Kota Kinabalu Wetlands*. Hogent Nature En Techniek.

Jocelyn, M. (2007). Enviromental education for sustainable development-conservation of coastal

ecosystem for lives of local communities report. Sabah Wetlands Conservation Society.

Lee, K.H. (2011). Mangrove fauna and their adaptations in the Kota Kinabalu Wetlands. *Sabah Society Journal* Vol (28): 15-22.

Lee, K.H. & Zainie, A.A. (2012). Wetlands conservation through education and restoration in Sabah, Malaysia. Sabah Wetlands Conservation Society, Kota Kinabalu.

Ramsar World Wetlands Day 2015 Handouts. Retrieved on 10 March 2015 from: http://www.worldwetlandsday.org/documents/handout

Sabah Wetlands Conservation Society (2009). Kota Kinabalu Wetland Centre: checklist of Birds. Sabah Wetlands Conservation Society, Kota Kinabalu.

Tangah, J., Bajau, F.E., Jilimin, W., Baba, S., Chan, H.T. & Kezuka, M. (2015). *Rehabilitation of mangroves in Sabah − the SFD-ISME Collaboration (2011−2014).* Sabah Forestry Department, International Society for Mangrove Ecosystems and Tokio Marine & Nichido Fire Insurance Co., Ltd.

Yang, S., Rachel L.F., Lim., Sheue, C.R. & Jean, W.H. Yong (2011). *The current status of mangrove forests in Singapore.* Nature Society, Singapore's Conference on 'Nature Conservation for a Sustainable Singapore'. Pp. 99–120.

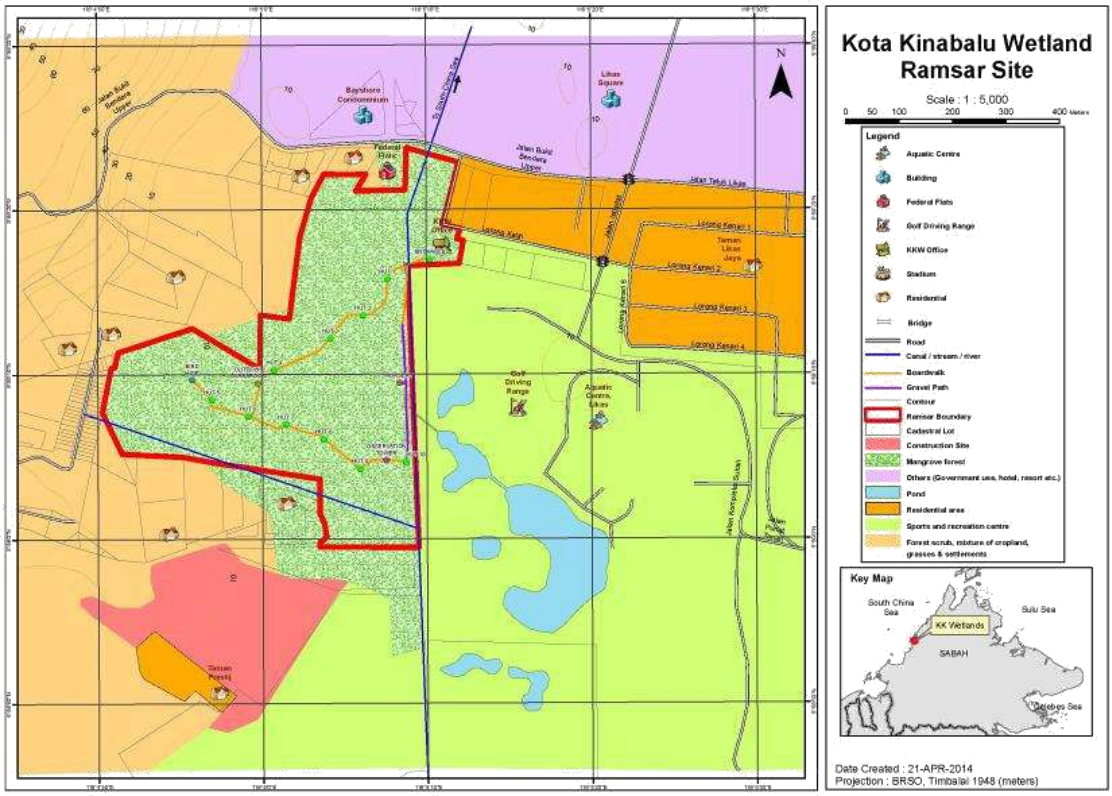
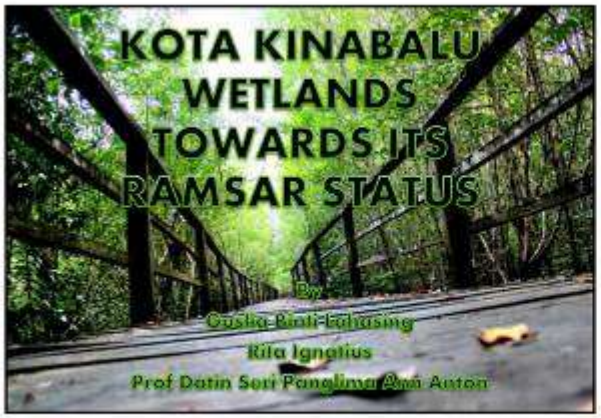
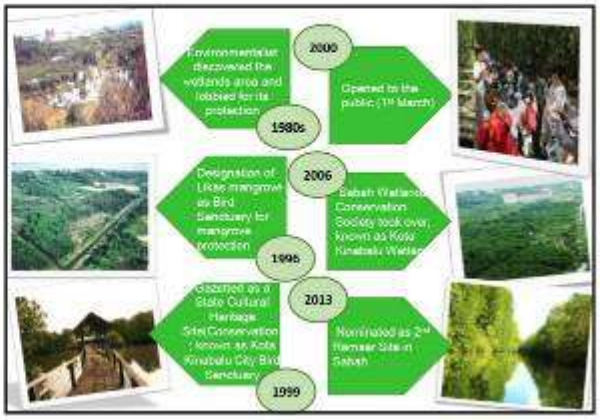
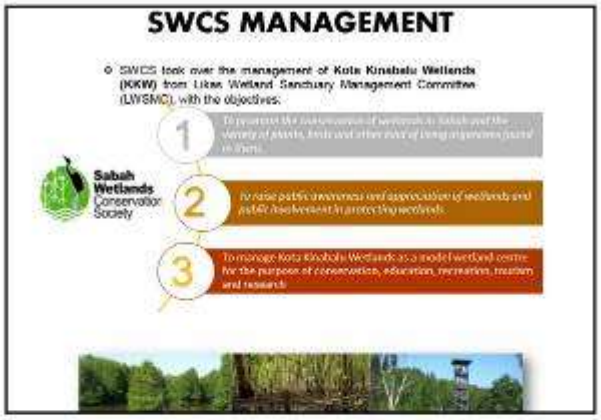


Figure 1. GIS map of Kota Kinabalu Wetlands.

Slide Presentation





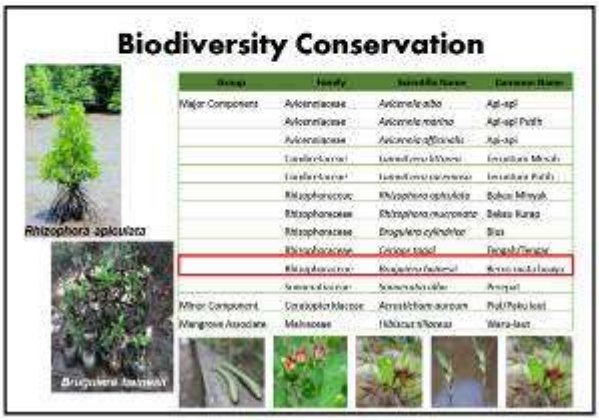

SWCS MANAGEMENT
SWCS took over the management of Kota Kinabalu Wetlands (KKW) from Likas Wetland Sanctuary Management Committee (LWSMC), with the objectives:
1
2
To raise public awareness and appreciation of wetlands and public involvement in protecting wetlands
3
To manage Kota Kinabalu Wetlands as a model wetland centre for the purpose of conservation, education, recreation, tourism and research
Sabah Wetlands Conservation Society


Sabah Wetlands Conservation Society
SWCS forms a Management Committee comprising of voluntary members and Ex-Officios :

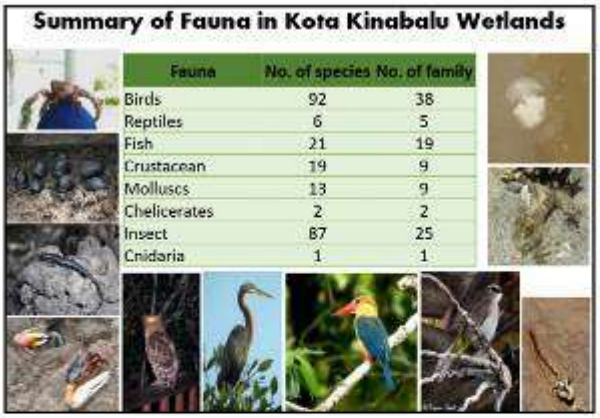

Ex-Officio Members
Director, Sabah Wildlife Department
Director, Environment Protection Department
Director, Sabah Education Department
Director, Department of Irrigation & Drainage
Mayor, Kota Kinabalu City
Permanent Secretary, Ministry of Local Government & Housing
CEO, WWF-Malaysia
Legal Advisor
Trustees
Auditor
Ms. Chou Soon Lan


ORGANIZATION CHART
Management Committee & Ex-Officio
Trustee
EXCO
Executive Secretary/Manager
Conservation & Science Officer
Environmental Education Officer
Conservation & Education Assistant
Admin & Accounts Clerk
Handyman
Indirect Advisor


SWCS is a Member of:
Sabah Environmental Education Network (SEEN)
Malaysian Environmental NGOs (MENGO)
International Society for Mangrove Ecosystems (ISME)
Malaysian Environmental NGOs
ISME

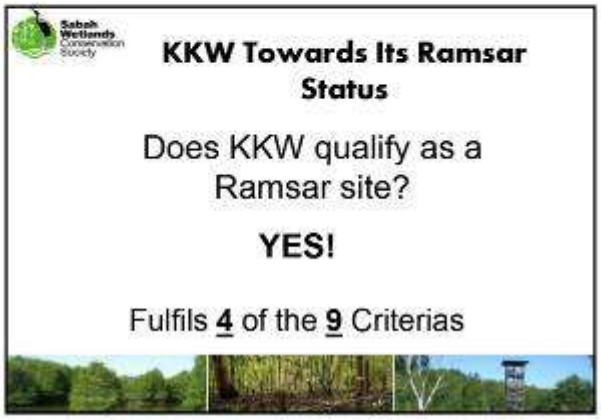

Biodiversity Conservation
Rhizophora apiculata

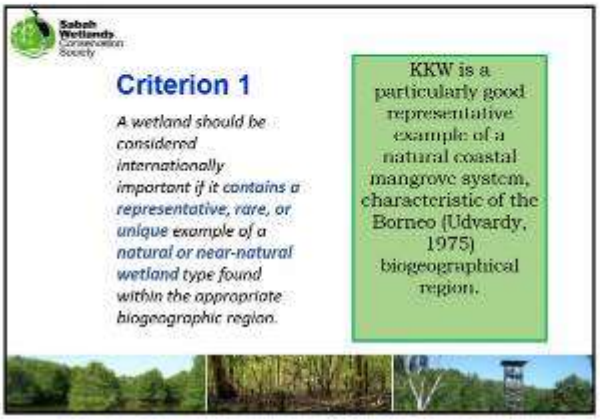

MANGROVE FLORA
Avicennia marina
Rhizophora apiculata ('Bangkita')


Summary of Fauna in Kota Kinabalu Wetlands
Fauna | No. of species | No. of family
Birds | 92 | 38
Reptiles | 6 | 5
Fish | 21 | 19
Crustacean | 19 | 9
Molluscs | 13 | 9
Chelicerates | 2 | 2
Insect | 87 | 25
Cnidaria | 1 | 1

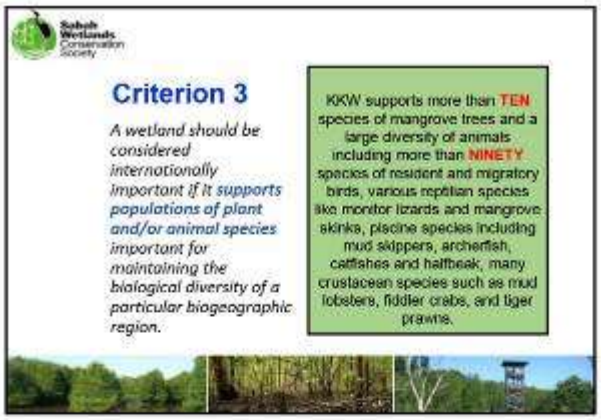

Mangrove conservation programme
Mangrove Experience Programme
Mangrove Voluntary Work
ENVIRONMENTAL EDUCATION PROGRAMME
Outreach Programme
Handcrafting Programme

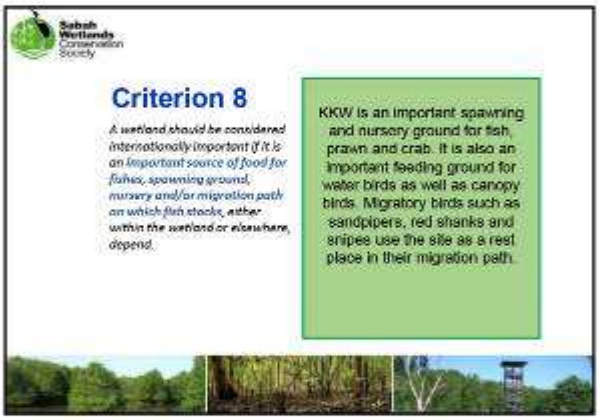

Mangrove Conservation Programme
Mangrove Voluntary Work
Handcrafting Programme
Outreach Programme


KKW Towards Its Ramsar Status
Does KKW qualify as a Ramsar site?
YES!
Fulfils 4 of the 9 Criterias


Criterion 1
A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
KKW is a particularly good representative example of a natural coastal mangrove system, characteristic of the Borneo (Udvardy, 1975) biogeographical region.


Sabah Wetlands Conservation Society
KKW supports
Lesser Adjutant Stork
Leptoptilos javanicus
Listed in the 2010 IUCN Red List as 'Vulnerable'
Chinese Egret
Egretta eulophotes
Listed in the 2010 IUCN Red List as 'Vulnerable' and Appendix I of the CMS


Sabah Wetlands Conservation Society
Criterion 3
A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
KKW supports more than TEN species of mangrove trees and a large diversity of animals including more than NINETY species of resident and migratory birds, various reptilian species like monitor lizards and mangrove skinks, piscine species including mud skippers, archerfish, catfishes and halfbeak, many crustacean species such as mud lobsters, fiddler crabs, and tiger prawns.


Sabah Wetlands Conservation Society
Criterion 8
A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
KKW is an important spawning and nursery ground for fish, prawn and crab. It is also an important feeding ground for water birds as well as canopy birds. Migratory birds such as sandpipers, red shanks and snipes use the site as a rest place in their migration path.


Sabah Wetlands Conservation Society


ACHIEVEMENTS
•It is ranked by Sabah Wetlands Inventory of 1986 as the top most important wetlands habitat in Sabah to "... water birds significant interest combined with accessibility making it ideal for educational tourist development"


Sabah Environmental Recognition Night 2011
SWCS' conservation effort was crowned with the "Most Outstanding Non-Governmental" Award handed out by YB Datuk Masidi Manjun, Minister of Tourism, Culture and Environment, Sabah. Among many aspects, SWCS is noted particularly for its environment education program as well as its mangrove restoration program that are actively being carried out.


Nominated as the second RAMSAR Site in Sabah on 2013
KK lucky to have a wetlands centre, says Mayor
Sabah wants Ramsar site No. 2


Successfully organized the 3-in-1 fundraising events; Fundraising Dinner, Fundraising Golf Tournament and International Symposium on Conservation and Management of Wetlands in 2014
No property developments near KK Wetlands – Masidi


Development Pressure
Financial
CHALLENGES
Encroachment & Poaching
Manpower


WAY FORWARD
Research & Development Project
10 Years Management Plan
KKW Gazette as RAMSAR site


THANK YOU FOR YOUR ATTENTION
Kota Kinabalu Wetlands
Off Jalan Bukit Bendera Upper,
88400 Likas, Kota Kinabalu,
Sabah, Malaysia.
Tel: +60-88-246955
Fax: +60-88-247955
E-mail: awcs@kkwetlands.org
Website: www.sabahwetlands.org

ORAL PAPER 13

SHARING OF EXPERIENCE, MANAGEMENT AND CONSERVATION OF KUCHING WETLANDS NATIONAL PARK – RAMSAR SITE

Irmadiana Ardi
Forest Department Sarawak, Kuching, Sarawak

Ms Irmadiana Ardi holds a B.Sc. from Universiti Malaysia Sabah, on Forestry, Nature Park and Recreation. She has been working as an Executive Forester in Forest Department Sarawak since 2013 and recently, appointed as Ramsar Sarawak Manager.

Abstract

Kuching Wetlands National Park was listed in the Ramsar wetlands list in 2005, the fifth in Malaysia and the first in Sarawak. This totally protected area (TPA) is managed under the jurisdiction of Forest Department Sarawak under the Ramsar Unit. Predominantly covered with mangrove forest, the site is an important habitat for primates and other wildlife, including the endangered Proboscis Monkey (*Nasalis larvatus*). The wetland is also known for its abundant avifauna. Several types of migratory birds, such as the rare Lesser Adjutant Stork, have been seen roaming in the National Park vicinity. Mangrove swamp serves as a breeding ground for numerous commercially important species of fishes, crabs and prawns. Nearby villagers have made fishing in the swamp as their way of life and source of income. Kuching Wetlands National Parks close proximity to the Kuching city has made it exposed to a number of threats and pollution over the years. However, since the Management Plan was formulated and implemented in 2010, illegal activities, i.e. hunting, encroachment, log harvesting have been under control by regulating enforcement and monitoring programmes. CEPA programmes are conducted regularly to create environmental awareness to the public and help rehabilitate degraded areas of the wetland. Due to the increasing number of visitors to KWNP, there is a strong need for infrastructure and presence of management authorities to enhance tourism at the site. Projects for building infrastructure in the National Park have been proposed and hoped to begin soonest.

1.0 Introduction

Kuching Wetlands National Park (KWNP) is located in Kuching Division about 15 km NW of Kuching. It was gazetted as Sarawak's 15th national Park under the National Park and Nature Reserve Ordinance 1990. The KWNP is located inside a much larger area known as Sarawak Mangrove Forest Reserve (SFMR). The SMFR was gazetted in 1924 to regulate the harvesting of mangroves and covers an area of 17,153 ha. After many excisions, 6610 ha of the SMFR was gazetted as a TPA in 2002. In 2005, KWNP was listed as a Ramsar wetland, the 5th in Malaysia and the first in Sarawak. Upon joining the Ramsar Convention, each Contracting Party is obliged under Article 2.4 to designate at least one wetland site for inclusion in the List of Wetlands of International Importance.

Currently Sarawak has 20 National Parks, 5 nature reserves and 4 wildlife sanctuary which are all categorized as TPA, giving a total TPA size of 687,230 ha. The total area of mangrove forests in Sarawak is approximately 127,736 ha, which is about 1% of the total area of Sarawak. Majority or about 80% of the mangrove forests are found in Kuching and Mukah Divisions.

As a TPA, the objectives of KWNP include the conservation of biodiversity and habitat, protection of environment and areas of natural beauty, provision of socio-economic benefits through sustainable utilization of renewable resources, recreation and tourism and provision of location for environmental education and scientific research.

2.0 Kuching Wetlands National Park-Ramsar site

KWNP is located in Kuching Division about 15 km NW of Kuching. It was gazetted as Sarawak's 15th national park under the National Park and Nature Reserve Ordinance 1990. The park is located between two main rivers; the Sg. Sibu to the west and Btg. Salak in the east. To the south, the boundary of the KWNP runs close and almost parallel to the Kuching-Matang-Lundu road. The stretches in between the southern boundary and the main road had mostly been taken up by settlement and other development.

The KWNP area is almost entirely made up of estuarine deltas, with well-developed dendritic deltaic channels and streams. The whole area is part of the coastal zone greatly affected by tidal. The predominant vegetative cover of the KWNP area consists of *nipah* (*Nypa fruticans)* and mangrove forests. Small portions to the south of the park and in the centre larger deltas are covered by lowland forest which has been previously cleared for agriculture purposes. Inhabiting the *nipah* and mangrove forests are several species of mammals, with monkeys and bats being particularly common.

Prior to 1986, the forest was subjected to exploitation by clear felling. However, such exploitation has ceased, the mangrove forest has undergone and will continue to undergo selective exploitation as long as the demand for housing materials, poles, charcoal and firewood remain.

The park provides protection to the coastline, villages, farms and some areas of Kuching from erosion, salt intrusion, storm damage, flooding and siltation. KWNP is an important fishing ground not only for the villages located in the immediate vicinity of the park but also those from the Kuching city. Of the 121 fish species recorded in KWNP, at least about 62% of these species are of commercial value.

2.1 KWNP-Ramsar key features and qualifiers

As a Ramsar site, a wetland of international importance, KWNP qualified the criterions as below;

Criterion 1: The site is a particularly good representative example of a natural coastal mangrove system, characteristic of the Borneo (Udvardy, 1975) biogeographical region.

Criterion 2: The site supports the Proboscis Monkey *Nasalis larvatus* listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) and 'Endangered' in the 2008 IUCN Red List, Lesser Adjutant *Leptoptilos javanicus (bangau botak)* - listed in the 2004 IUCN Red List as 'Vulnerable', and Griffith's Silver Leaf Monkey/Langur *Trachypithecus villosus* (listed as "Near Threatened" in the 2008 IUCN Red List).

Criterion 4: The site is of special value as a nursery area for the Estuarine Crocodile (*Crocodylus porosus*).

Criterion 8: The site is an important spawning and nursery ground for fish and prawn species.

2.2 Multi-disciplinary Assessment

The management of National Park requires a multi-disciplinary approach that integrates the technical, economic, environmental, social and legal considerations.

In order for the park to achieve the objectives a management plan is required, a comprehensive description of the area is needed. Such description is also required for updating the Ramsar Secretariat on status of the wetland site which is done every six years. Thus Multi-disciplinary Assessment (MDA) was done for the formulation of KWNP Management Plan. The MDA presented here was the result from the report of a joint collaboration project between Forest Department Sarawak and UNIMAS done in 2008 until 2009. On June 2010, the MDA was presented to the State Wetland Committee and the comments and recommendations arising from the consultations have been incorporated into the final document.

2.2.1 Geomorphology, land use and soil assessment

The Kuching Wetlands National Park has a delta-estuary landform that is much dependent on the tidal cycle. Much of the land mass is inundated at high tide, sustaining the mangrove ecosystem in narrow outer belt of the irregular shaped and variable-sized landmasses.The park is surrounded by traditional settlements, new housing development, and aquaculture.

2.2.2 Hydrology and water quality

Btg. Salak and Sg. Sibu drain the mountainous region at the upper reaches and the mangrove swamp within the delta at the estuary. However the freshwater discharges into the wetland area are small as compared to the tidal flooding of the wetland, which has kept the salinity of the region to more than 30%.

The pollution level at KWNP is minimal except for domestic wastewater discharges at the upper reaches of Batang Salak where villages and residential areas are located. Bacteriological contamination was recorded at Kpg. Semariang Batu.

2.2.3 Vegetation

A total of 64 species were recorded in the KWNP. Fourteen species are major mangroves, four species are minor mangroves and five species are mangrove associates.

There are three major forest types in KWNP, namely *Sonneratia alba* (perepat) forest, mixed-mangrove forests, and heath or *kerangas* forest. *Sonneratia alba* (perepat) dominated the sandy mud-flat however their occurrence is confined to areas along the coastlines and estuaries of Batang Salak opposite Pulau Salak. The vast majority of the mangroves is composed of *Rhizophora apiculata* (Bakau Minyak), *Rhizophora mucronata* (Bakau Kurap) and interspersed with *Xylocarpus granatum*, *Avicennia alba* and *Nypa fruticans*. Scattered throughout the interior of the park occurring on higher and drier ground are the heath forests. Heath forest generally are species-rich (41 species) compared to the adjacent mangrove forests. The southern region of the park contains secondary forest. Apparently this area was once cleared for agricultural activities and abandoned for years.

The mangrove forest played a major role in protecting the river banks against wave action, provides breeding ground for fish and their food source, as well as a source of food and refuge for wildlife. The endangered Proboscis Monkey in KWNP consumes almost exclusively on "perepat".

2.2.4 Fauna

KWNP has 104 species of birds with 42 considered high conservation value species and 8 species of mammals of which six are considered high conservation value species that include the endangered, endemic and totally protected Proboscis Monkey.

A number of herpetofauna species were recorded in KWNP, including the Mangrove Frog (*Fejervarya cancrivora*), Monitor Lizard (*Varanus salvator*), Crested Green Lizard (*Bronchocela cristatella*), Bornean Tree Skink (*Apterygodon vittatus*) and Estuarine Crocodile (*Crodylus porosus*). One hundred and five crocodiles were spotted during a four day survey in August 2009 where 25.71% were hatchlings, 39.05% yearlings, 4.76% sub-adult and 30.48% were adults. After applying a correction factor, the estimated population of estuarine crocodile in KWNP is 317. The highest concentration of individuals were found in and near confluence of upper Sg. Sibu and Lobak Matang, at Sg. Lemidin and Sg. Samariang , Lobak Kilong and Sg. Gelugor-Enggang suggesting that Estuarine Crocodile use these area as its breeding ground.

A total of 104 species of birds from 41 families have been recorded at KWNP from both observation and mist-netting method. The Lesser Adjutant Stork is listed as vulnerable by IUCN while five other species were listed as near-threatened. Seven species of birds are totally protected and 38 species are protected by Wildlife Protection Ordinance.

Three species of primates were recorded, Proboscis Monkey (*Nasalis larvatus*), Silvered Langur (*Presbytis cristata*) and Long-tailed Macaque (*Macaca facicularis*). Proboscis monkey is endemic to Borneo, listed as endangered by IUCN, listed under Appendix I and CITES and totally protected by Wildlife Protection Ordinance 1998. Other mammals recorded at KWNP include wild pigs, bats, plantain squirrel, common treeshrew, otters and Irrawaddy Dolphins.

The KWNP is one of the few remaining large and productive mangrove areas in Kuching that supports a substantial number of fish species as well as an important commercial and recreational fishing ground. KWNP supports at least 121 species of fishes from 44 families. The complexity of the mangrove habitat in the park has attracted many species of fishes to utilize the area as their breeding and nursery ground as well as to reduce the risk of them being preyed upon by predators.

2.2.5 Socio-economic

There are estimated a total of 6000 households resided in close proximity (within 3 kilometers) to the park. This includes households from suburban residential areas and rural areas. The rural population includes isolated villages on Pulau Salak, Kampung Mersan, Kampung Santin, Kampung Sibu Laut on the northern edge of the park, and Kampung Telaga Air, Kampung Sungai Aur, Kampung Selang, Kampung Temenggong and several smaller isolated communities as well as individual homesteads on the western and southwestern parts of the park. The local communities are majority Malays being more than 90% of them.

Household income average RM1145 per month. The local community viewed the rivers and waterways as very important for fishing, transportation and tourism activities. Although 43% of the households are engaged in fishing, collection of crabs, snails and prawn, only 17% do it for commercial purpose.

The major economic activities inside the park boundary as well as outside of the park boundary include fishing, aquaculture, quarrying as well as the harvesting of mangrove trees. Fishing and collecting other aquatic resources are carried out throughout the park, with Sg. Gelugor and Sg. Enggang being the more favourite sites. The communities that are mostly involved in this activity are Kpg. Salak (about 70% of the households) and Kpg. Sg. Aur (100% of the households).

The respondents strongly agree that the area is suitable for a park, and that the pristine environment and scenic river system are valuable assets for tourism development. Some 61% of the respondents are with the impression that the park will benefit their community.

3.0 Conservation management and park administration

The MDA has identified the resources and threats that have to be managed. So far, KWNP has been administered as a non-revenue generating national park with no administrative centre or clear presence of management authority. The purpose of the management plan is to ensure that the objectives of the park as a TPA and a Ramsar Site are met. More than 100 action plans are being proposed, including for the setting up of an administrative centre, management of the park territory and boundary (enforcing NPNRO and WPO 1998), engaging local community and other stakeholders, management of tourists and visitors, and continuing research and monitoring especially in view of potential threats to the parks.

The management of forest in Sarawak is governed by the following major legal instruments:

- The Forests Ordinance (1958) Cap. 126
- Forest Rules (1962)
- The National Parks and Nature Reserves Ordinance (1998)
- The National Parks and Nature Reserves Regulations (1998)
- The Wildlife Protection Ordinance (1998)

- The Wildlife Protection Rules (1998)
- The Wildlife (Edible Bird's Nests) Rules (1998)
- The Forests (Planted Forests) Rules (1997)

The implementation and enforcement of the aforementioned legal and regulatory provisions by FDS have accordingly been guided by the mission "*To sustainably manage and develop the forest resources and optimize their contributions to the socio-economic development of the nation*".

3.1 Enforcement and monitoring activities

For the purpose of enforcing the NPNRO and WPO, and managing the values of KWNP, it is necessary that the park boundary be clearly demarcated. Thus, demarcation of the KWNP boundary of 65km at the perimeter has been done. Marks and signage has been installed at the National Park boundary as a measure of facilitating enforcement as well as keeping neighbouring land users, and would-be intruders, aware of legitimate Park boundary (and legal actions that can be taken against them for encroachment).

Currently the Ramsar management unit of FDS is doing twice-a-month monitoring activity. Activities that requires close monitoring include settlement within park boundary, mangrove pole extraction, poaching or hunting of wildlife and overfishing (other than subsistence fishing by the locals). Other than the Ramsar management unit, the Preventive and Enforcement Division of FDS is constantly doing aerial surveillance using hyper-spectral technology for forest management and protection. The use of hyper-spectral technology has been very effective in identifying illegal operations from the air and was proven useful especially in harder-to reach areas in TPA's. Aerial surveillance is done by the Preventive and Enforcement Division four times a year, preferably every quarterly in all TPA's in Sarawak.

3.2 CEPA

Educating the public, especially the communities that are living in or near the park on the importance and significance of KWNP is necessary. Once the local communities realize the importance of this unique ecosystem to the global life, they will take every step to conserve and protect the mangrove forests. These environmentally friendly practices and attitudes will definitely preserve mangroves for future generations.

Since 2012, the Ramsar unit has been actively organising environmental awareness programmes to the public. The programmes include World Wetlands Day which is held on February every year and mangrove planting programmes with agencies and schools.

CEPA programmes are essential for the protection and rehabilitation of KWNP. Every year, FDS Ramsar unit invites local communities as well as other agencies to participate in either the World Wetlands Day or other mangrove planting programme. CEPA programmes in KWNP aim to educate and create awareness for the communities of the importance of taking care or protecting the mangrove forest. Other than that, mangrove planting programmes are also done at degraded areas (due to flood mitigation project) in KWNP. Apparently, the demand for mangrove planting programmes in KWNP has been increasing due to exposures from the media. As a result, more and more agencies are interested to collaborate with FDS to organize planting programmes in KWNP. Up to now, there are about 50 hectares of degraded land has already planted with mangroves.

3.3 Research

Continuous research and monitoring of the physical, human environment and biological environment and resources within and surrounding the KWNP are crucial for their protection, conservation and sustainability.

For the past few years, FDS has organized a few research programmes internally and also with local institutes, e.g. UNIMAS and Swinburne University. Most researches and surveys are done on the wildlife and hydrology.

Based on wildlife surveys, especially crocodiles and Proboscis Monkeys, KWNP still supports viable numbers of the animals. Hydrological surveys had shown that KWNP water quality is still in good condition with minimal pollution.

3.4 Management of visitors

KWNP is presently one of the parks in Sarawak that is yet to be designated for visitor use, and as such the park has not been equipped with much of visitor facilities. Apart from the local villagers who use the waterways surrounding KWNP on a daily basis for subsistence fishing, the Park is also visited on an irregular basis by tourists/visitors joining excursion trips managed by private tour operators for sighting of Proboscis Monkeys and Estuarine Crocodiles. There are occasional visits by researchers and fishing enthusiasts.

Access to KWNP is either by land through a small gravel road from Federal Access road in *Matang* or by water from the Kpg. Telaga Air jetty or Kpg. Samariang Batu jetty. Up to now, visitors (mainly for Awareness Programmes or Mangrove Planting Activities) can enter the KWNP by permission and logistics arrangement with FDS due to the lack of management authority and administration on site.

3.5 Management of threats and challenges

A number of activities and development are found within and on the immediate periphery of the National Park. To control its possible adverse impact on the environment and natural resources of the National Park, it is important to address the activities and development individually and to ascertain that the related laws are not infringed.

3.5.1 Flood mitigation project

In 2009, the state government proposed flood mitigation works for Kuching city to control flood issues by diverting flood water from Sg. Sarawak through Btg. Salak before discharging into the sea. Parallel to this project, the Btg. Salak was widened and huge amount of soil was dumped at the adjacent mangrove forests. The impact, mangrove ecosystem mainly at the Sg. Lemidin area was disturbed. That was how FDS came with the initiative to plan a mangrove planting program to rehabilitate the mangrove ecosystem.

The biggest threat to wildlife came from the construction of flood diversion channel which diverts flood waters form Sarawak River into Salak Bay through Sg. Lemidin. Associated with it is the dumping of soil from the channel into adjacent mangrove and secondary forest area south of KWNP. This mega project reduces wildlife habitat by one-quarter just from soil-dumping alone (EIA for the Proposed Flood Mitigation Works for Kuching City, 2009).

Large volume of freshwater discharged into the park area. This will dilute the brackish water and alter the fish fauna composition. The dredged materials that are deposited inside or in the immediate vicinity of the park area which are rich in sulphide could potentially develop acidic condition under oxidizing environment. When it rains, acidic runoff will flow into the park waters. The flood mitigation project has already presented a physical 'damage' to the park. The potential long run impacts on the ecological integrity of the park system are hard to predict.

Since 2012, FDS has organized numerous mangrove planting programmes with the locals, institutes, schools and various agencies. Up to now, the area planted with mangroves resulted from the planting programmes cover more than 50 ha. In this year alone, more than 5000 mangrove trees were planted in KWNP.

3.5.2 Clearing and harvesting

The mangrove forests in KWNP have been cleared to make way for agricultural land, human settlement, infrastructure and industrial areas. More recently, massive clearing activities for the proposed flood diversion channel and housing development have also taken place. Clearing activities are a major factor in mangrove loss in KWNP.

Mangrove trees are used for firewood, construction wood, wood chip and pulp production, charcoal production and animal fodder. KWNP mangrove forest has undergone and will continue to undergo exploitation as long as the demand for housing materials, poles charcoal and firewood remain. The mangroves directly provide the major source of subsistence, revenue and employment for all of the villagers in the area.

Efforts to protect mangrove forest in KWNP are vital. Educating the public, especially the communities in mangroves conservation is a big challenge. However, FDS always involve the communities in the World Wetlands Day or any awareness campaign to instil positive attitudes towards mangrove conservation.

3.5.3 Coastal development

Destruction of the KWNP mangrove forests and conversion of mangrove lands to domestic and industrial development in the surrounding areas is actually occurring. Physical development like housing estates (Kpg. Semariang Batu, Kpg. Sibu Laut, Kpg. Salak, Matang) prawn farming (Telaga Air and Semariang Batu), stone quarrying at Pulau Salak, coastal tourist facilities, road and bridge construction increasingly threaten the mangrove ecosystem.

These new development, however, may or may not pose significant threat to the park depending on how they are managed. The coastal road that runs along the southern parts of the park may increase human settlement and activities in the area.

Activities occurring outside the KWNP are very difficult for FDS to control. However, with a strong enforcement unit, increasing public awareness and media coverage, the communities surrounding KWNP will realize the importance of this ecosystem and will take every step to conserve and protect the mangrove forests.

4.0 Future projects

For the next 5 years, FDS will be managing the development of these projects:

4.1 Installation of infrastructural necessities

Upgrading of KWNP into a revenue-generating park and installation of visitors infrastructural necessities is possibly a viable option for becoming a top destination for those who have limited time to view wildlife, especially the Proboscis Monkey and Estuarine Crocodile.

The objectives of the visitor use management are;

- To offer Kuching community as well as local and foreign tourists an alternative and additional destination for wetland ecosystem and wildlife appreciation and other recreational activities.
- To provide easier, better organised and safer accessibility to KWNP features.
- To develop communication and interpretation services that enable visitor to use, enjoy and appreciate the park and its values.
- To monitor visitor use, and regulate sustainable use of the natural resources in the park.

4.2 KWNP as a Crocodile Sanctuary Project

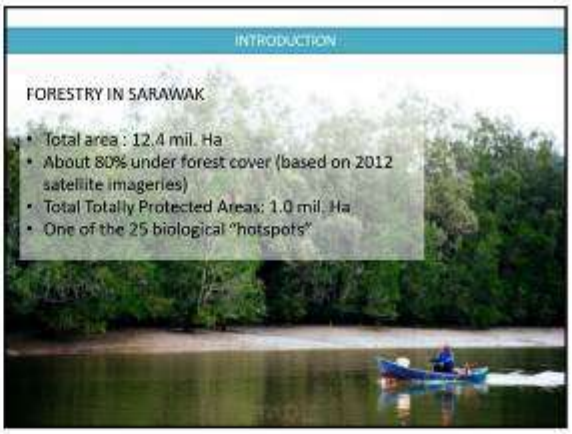
The State Government of Sarawak has agreed to a number of steps to control human-crocodile conflicts in the state. One of the steps is establishing Crocodile Free Zones in tourism and high human population areas. Statistics have shown that 3 out of 6 crocodile attack cases in 2014 caused death, 7 deaths out of 10 cases in 2013 and 4 deaths out of 9 cases in 2012. In Sarawak, crocodiles that are caught within the Crocodile Free Zones or potentially dangerous crocodiles are transferred to wildlife centres which usually have very limited spaces. That was why the Crocodile Sanctuary Project was proposed in the KWNP to support Crocodile Free Zones area and surplus crocodile population in wildlife centres as well as enhancing KWNP as an eco-tourism spot.

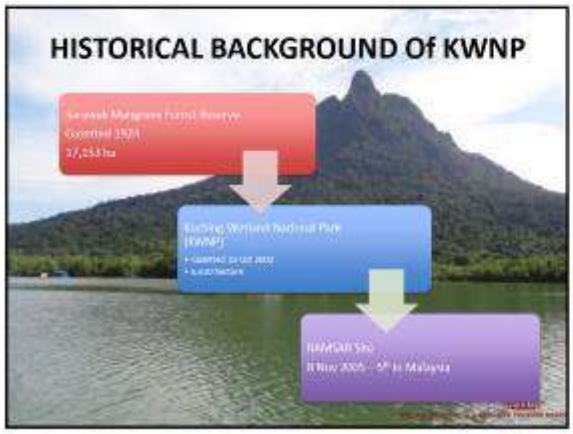
5.0 Conclusion

The park is threatened by conversion to agriculture, coastal industrialization and urbanization. Implementation of mangrove conservation strategies in KWNP should involve many agencies, including state government, research institutions, private sectors and other relevant stakeholders. Tourism potential for the area in general is considered good. Tourism development is one of the potential economic benefits that local communities can look forward to. With the growing population of Kuching city as well as the corresponding development and maturity of the ecotourism industry in western Sarawak, the KWNP is poised to become one of the outstanding natural attractions. Being a national park, it is likely that the restoration of degraded habitats will further enhance the quality of the natural environment, and thus will not only serve adventure tours but also scientific research as well as educational tourism.

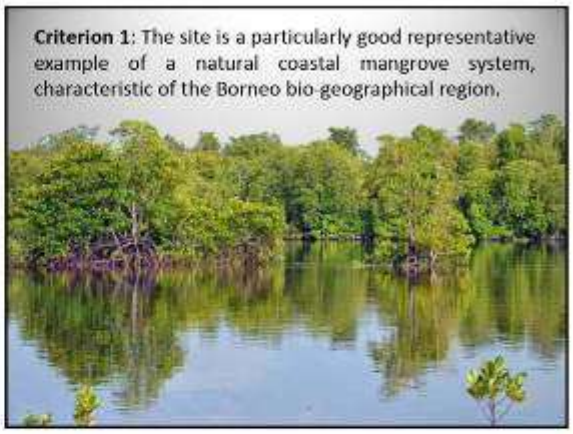
As a newly gazetted national park with no management authority present, it is the responsibility of FDS to ensure earliest possible management presence in the park to facilitate an effective and efficient enforcement of the relevant laws. Lack of knowledge by the public, especially the local communities could also endanger the mangrove ecosystem. There are needs for more recognition, promotion and research to protect KWNP mangrove ecosystem.

Slide Presentation





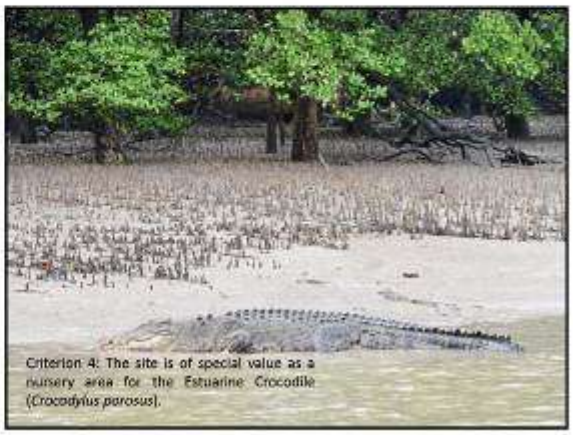

KWNP-RAMSAR KEY FEATURES/QUALIFIERS


Criterion 1: The site is a particularly good representative example of a natural coastal mangrove system, characteristic of the Borneo bio-geographical region.

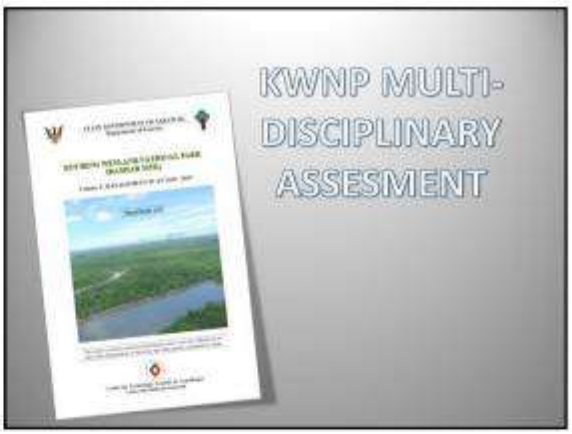

Criterion 2: The site is an important habitat for the Proboscis Monkey...


... the Griffith's Silver Leaf Monkey a.k.a Lutong...


... and the Lesser Adjutant Stork a.k.a Bangau Botak


Criterion 4: The site is of special value as a nursery area for the Estuarine Crocodile (Crocodylus porosus).

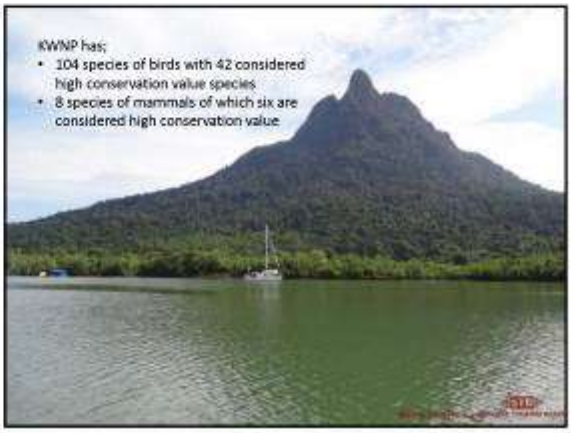

Criterion 8: The site is an important spawning and nursery ground for fish and prawn species.


KWNP MULTI-DISCIPLINARY ASSESMENT


Geomorphology, land use and soil assessment
Moderate fertile marine alluvium soil
Moderate cation exchange capacity – absorb / filter heavy metal


Hydrology and water quality
Minimal pollution level
A little bacterial contamination near settlements (Kpg. Semarang Batu) due to wastewater discharge

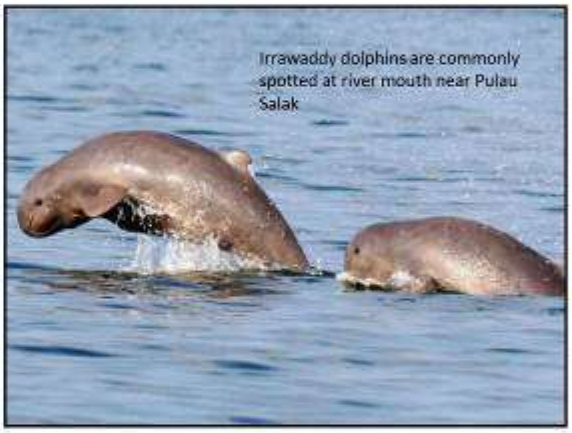

Vegetation
Mixed mangrove forest
3 types of forest in KWNP
Heath forest
Sonneratia alba forest

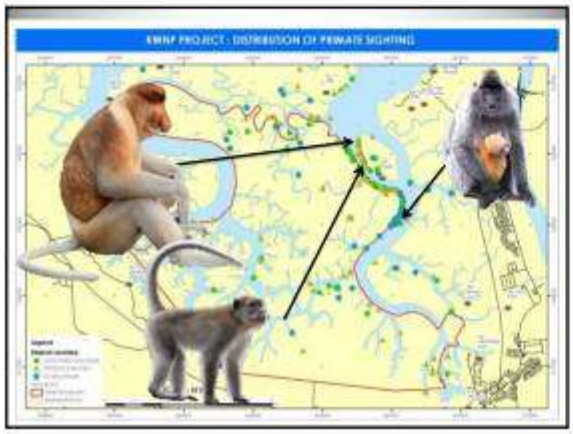

KWNP has;
• 104 species of birds with 42 considered high conservation value species
• 8 species of mammals of which six are considered high conservation value


Crocodiles (crocodylus porosus)
• Estimated population : 317 mature individuals
• Estimated density : 4.51 individuals/km
• Population is recovering well


KWNP - The Management Zones
KWNP MANAGEMENT ZONES
Lobak Belanga
Sg. Sibu
Pulau Lak/Pulau Buaya
Lobak Matang

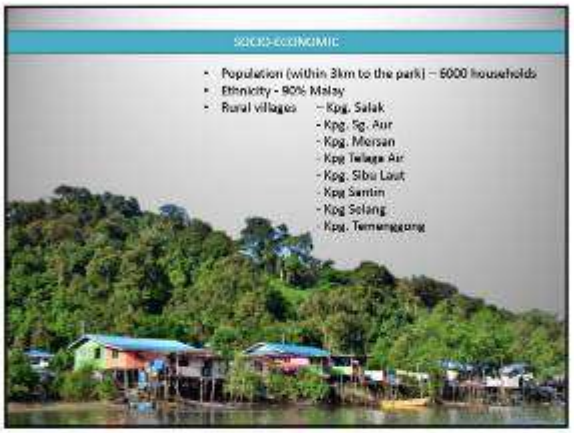

4 SPECIES OF DOLPHIN FOUND IN KWNP
Humpback Dolphin
Finless Porpoise
Bottlenose Dolphin
Irrawaddy Dolphin


Irrawaddy dolphins are commonly spotted at river mouth near Pulau Salak


KWNP PROJECT : DISTRIBUTION OF PRIMATE SIGHTING


• KWNP is one of a few remaining productive mangrove areas in Kuching
• Mangrove forests serve as a vital nursery and breeding ground for fishes and other benthic organism
KWNP IS AN IMPORTANT AREA FOR FISHING ACTIVITIES


SOCIO-ECONOMIC
Kampung Salak at Pulau Salak


SOCIO-ECONOMIC
Population (within 3km to the park) – 6000 households
Ethnicity - 90% Malay
Rural villages – Kpg. Salak
- Kpg. Sg. Aur
- Kpg. Mersan
- Kpg Telaga Air
- Kpg. Sibu Laut
- Kpg Santin
- Kpg Solong
- Kpg. Temenggong


43% of the household engage in subsistence fishing
Only 17% fish for commercial purposes
Local communities viewed the rivers and waterways as very important for fishing, transportation and tourism activities


CONSERVATION MANAGEMENT
AWAS DANGER


ENFORCEMENT OF RELEVANT LAWS
Monitoring activities done twice a month
Installation of fences
Installation of signage for awareness


AERIAL SURVEILLANCE
Preventive & Enforcement Division constantly conducting aerial surveillance for forest management and protection purposes
Operator Display & Controls
Mobile Navigation & Gimbal Payload

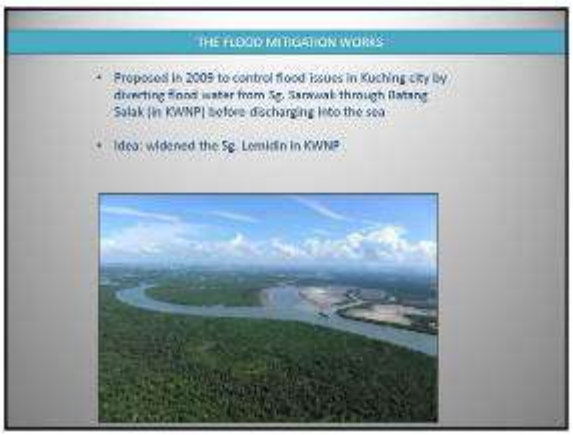

ENVIRONMENTAL AWARENESS PROGRAMS
Aim:
To educate the public especially local communities on the importance of mangrove ecosystem


Mangrove Planting Programs
Since 2012, the Ramsar Management Unit have been actively organizing planting programs .
World Wetland Day is done on February every year – involving local communities, schools and various agencies

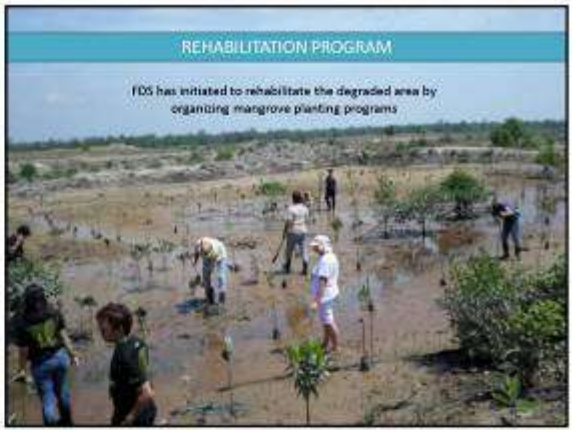

ACHIEVEMENT
Up to now:
More than 58 ha of land are planted with 57,600 mangrove trees
More media coverage, more interest
Objective achieved!


Management of Visitors
KWNP has not yet been equipped with much facilities or any administrative building
However the park is visited daily by tourists on an organized trip by private tour operators
Other than that, visitors can only enter KWNP with permission and logistic arrangements with FDS

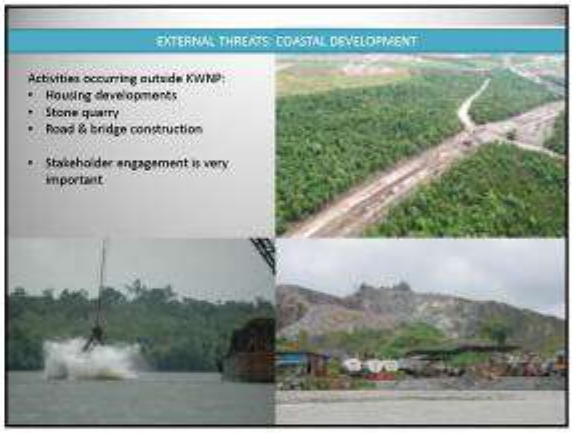

Management of Threats & Challenges
Kpg. Sungai Aur


THE FLOOD MITIGATION WORKS
Proposed in 2009 to control flood issues in Kuching city by diverting flood water from Sg. Sarawak through Batang Salak (in KWNP) before discharging into the sea
Idea: widened the Sg. Lemidin in KWNP


IMPACT
• Soil was dug and dumped on the adjacent mangrove and secondary forest
• Major destruction of mangrove and secondary forest


REHABILITATION PROGRAM
FDS has initiated to rehabilitate the degraded area by organizing mangrove planting programs


CLEARING & HARVESTING
• In the past, mangrove forest in KWNP have been cleared to make room for agricultural land, settlements and industrial areas
• Controlled by regular monitoring and enforcement activities


EXTERNAL THREATS: COASTAL DEVELOPMENT
Activities occurring outside KWNP:
• Housing developments
• Stone quarry
• Road & bridge construction
• Stakeholder engagement is very important


THE WAY FORWARD
Opportunities:
Tourism and research


Ya ajak...
THANK YOU

ORAL PAPER 14

WHERE ARE THE PEOPLE IN THE RAMSAR WETLANDS OF THE LOWER KINABATANGAN AND SEGAMA RIVERS OF SABAH?

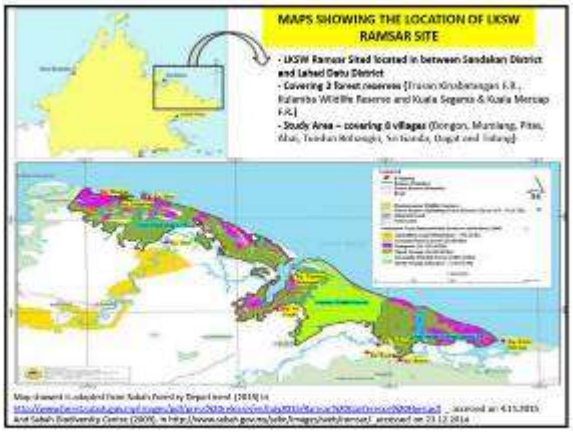
Fadzilah Majid Cooke
Universiti Malaysia Sabah

Professor Dr Fadzilah Majid Cooke is a Professor of Environmental Sociology at the Faculty of Humanities, Arts and Heritage (FKSW), Universiti Malaysia Sabah (UMS). For the past 17 years she has worked in the composite area of political ecology on the social context of natural resource management especially forests and land; water (marine protected areas, ecological aquaculture production), agricultural expansion especially oil palm, and the implications of all of the above for socio-ecological systems. Long engagement with rural communities in Sabah and Sarawak affected by oil palm expansion, and hydro power energy generation has helped her think through policy issues and approaches to natural resources that ought to be more inclusive and participatory. In recent years, the way some rural village communities deal with national and international conservation interests in their midst further show their understanding and putting into practice of strategies that try to balance local interests with external imperatives.

Abstract

The session has been especially designed to welcome representatives from selected villages of the Lower Kinabatangan and Segama Rivers, the RAMSAR conservation site in Sabah The villages of Abai, Bongon, Mumiang, Pitas, Sri Ganda and Dagat were participants of a baseline socio-economic study involving 8 villages. The study (in two volumes), funded by the Sabah Forestry Department were conducted by a team from the Research Unit for Ethnography and Development, Universiti Malaysia Sabah, headed by Prof. Dr Fadzilah Majid Cooke and Assoc. Prof. Dr Rosazman Hussin in 2014 and 2015. At the Heart of Borneo Conference in 2015, on the 12th of November, they kindly agreed to meet with donor and researchers at a special session to acknowledge their participation in the study and for their continued involvement in the RAMSAR process. They will be awarded special posters containing the studies' research findings pertaining to their respective villages.

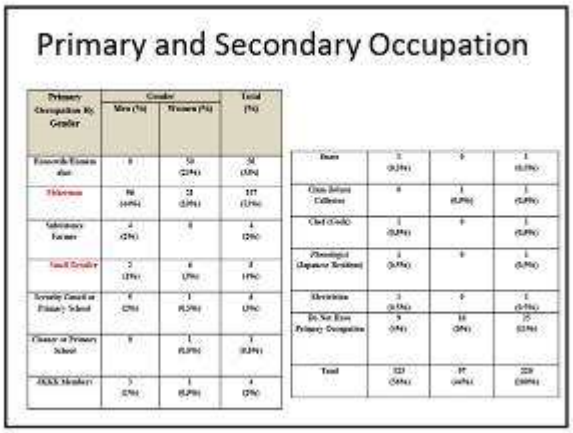
Slide Presentation

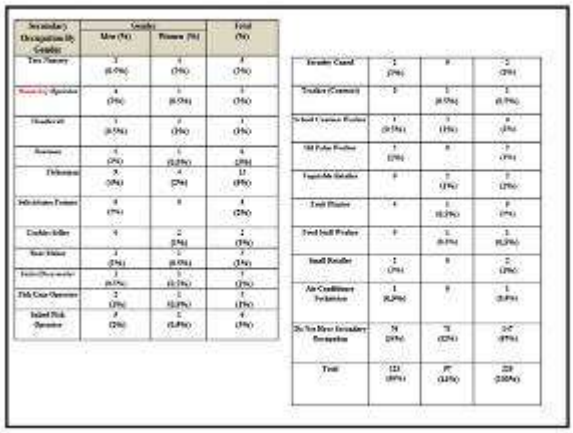


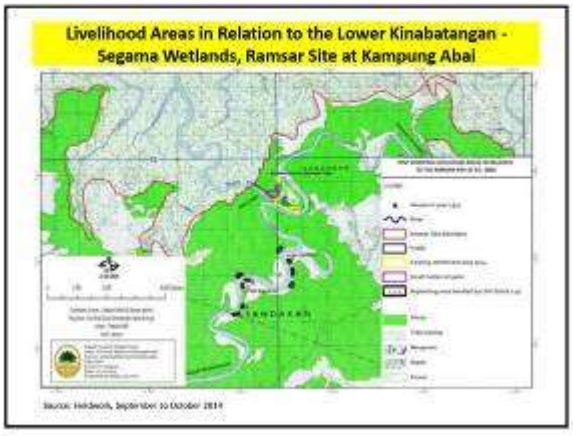
STATISTICAL PROFILE

- Overall population: 2014 /2015 close to 2000
- Ethnic groups: In the Lower Kinabatangan: Suluk , Sungei, Kadazan, Bugis, Kagayan, Javanese, Chinese, Indian.
- In Segama: Tidung.

Primary and Secondary Occupation







KAMPUNG ABAI

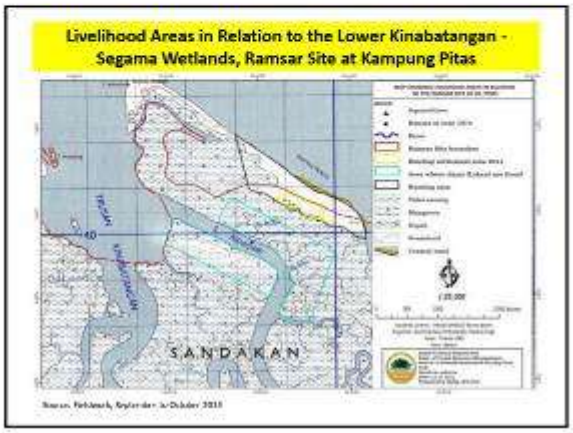
- Village site is away (approx. 1.5 km) from the Ramsar border, surrounded by alluvial forest, mangrove and nipah palm forests,
- Total population in 2014 = 234 , mostly Orang Sungei
- Fishing and prawning (*udang galah*) in the Kinabatangan river, small scale, and getting smaller – stock reducing
- regenerating forest plots for cash
- homestay

Bongon Besar, B. Kecil and B. Tengah

- Village boundary borders Ramsar on one side and *Laut Bongon (local parlance)* on the other,
- Popn. / Ethnic 200, Bajau, with a few Suluk
- Largely fishermen, access to 'river delta' (Terusan Kinabatangan and Sungei Bongon Besar).
- very small area cultivated to oil palm and vegetables (3 families)

Mumiang Perpaduan, Mumiang Kuala, M. Tengah, M. Kem

- Location: Mumiang Tengah and Mumiang Kem located insider Ramsar Border.
- Surrounding vegetation: mangrove swamps
- Population 443
- Ethnic Group: Suluk, Sungei
- Fishing, fish cage, lokan (clam)
- Dried fish (women); women also fishermen as primary occupation



Pitas

- Location: 2/3 of village area inside Ramsar border; surrounded by mangrove and tidal swamp;
- Population. 110
- Ethnic group: Suluk; Kagayan
- Fishing access to Terusan Kinabatangan, and Pantai Pukul (local name); also fish cage (ikan merah and kerapu)
- Large hunting ground – payau (deer), kancil (mousedeer)

Livelihood Areas in Relation to the Lower Kinabatangan - Segama Wetlands, Ramsar Site at Kampung Sri Ganda

Sri Ganda

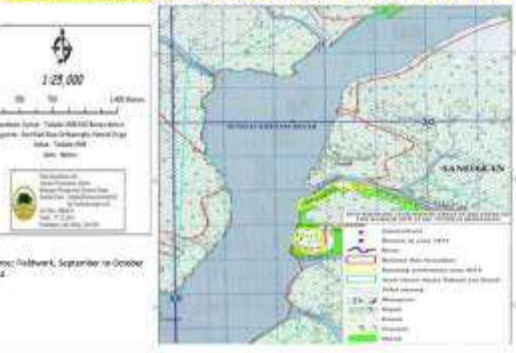
- Location: half of village area inside Ramsar
- Population: 422
- Ethnic group: Sungei, a few Bugis
- Economic: oil palm (not official) planted before Ramsar declared in 2008,
- fishermen (sungei Kertam Besar, Telok Dewhurst);
- Fish cage, homestay

Livelihood Areas in Relation to the Lower Kinabatangan - Segama Wetlands, Ramsar Site at Kampung Dagat

KAMPUNG DAGAT (DAGAT LAMA DAN BARU)- SUNGAI SEGAMA

- Location: Outside Ramsar but has community forest inside Ramsar
- Population: 112
- Ethnic group: Mostly Tidung
- Fisherman fishermen (Sungei Segama, Kuala Segama); homestay

Livelihood Areas in Relation to the Lower Kinabatangan - Segama Wetlands, Ramsar Site at Kampung Tundun Bohangin



Tundon Bohangin

- Location: dilemma, village outside Ramsar but surrounded by Ramsar border, front and back.
- Population. 217 (2014); mixed Sungei, Bajau, and others including Bugis and Javanese.
- Fish in the river (Sungei Kinabatangan)and have access to sea
- Life caged fish as additional activity

RAPPORTEUR'S NOTES

Concurrent Session Two (Sabah's Ramsar Conference) 12/11/2015, 9:00 am – 5:00 pm
Chairman: Dr. Chan Hung Tuck, International Society for Mangrove Ecosystems (ISME)
(Dr Lee Ying Fah of Sabah Forestry Department chaired the afternoon session)
Rapporteurs: Dr. Joan T. Pereira, Ms. Lee Ka Han and Mr. Julsun @ Joseph Sikui
Venue: Ballroom 1

Introduction

The Concurrent Session Two is a session aimed at giving the audience an understanding about the efforts of both Federal and State Governments in the conservation of natural ecosystem and biodiversity of the Ramsar site. There were fourteen presentations covering various topics on research findings and experiences in the natural ecosystem conservation efforts that have been done in Malaysia, specifically in Borneo.

An overview of each presentation is as follows:

Paper #1: An Overview of Lower Kinabatangan-Segama Wetlands (LKSW) Ramsar Project in Sabah by Tn. Hj. Hussin Tukiman

Tn Hj Hussin Tukiman presented an overview and management of LKWS Ramsar Project in Sabah. LKSW was designated as a RAMSAR site on 28th October 2008 during the Ramsar Convention on Wetlands (Ramsar COP10) in Korea. Covering an area of over 78,803 hectares of mangrove forests and peat swamps which is located on the east coast of Sabah, the site comprises three forest reserves: Trusan Kinabatangan Forest Reserve (40,471 ha), Kulamba Wildlife Reserve (20,682 ha), and Kuala Maruap-Kuala Segama Forest Reserve (17,650 ha). LKWS Ramsar focussed on 4 criteria under Ramsar Convention; Natural Coastal Mangrove and Peat Swamp, habitat for 9 species of flora and 25 species of fauna, Unique Peat Swamp forest ecosystems in the east coast of Sabah, Important habitat and ecosystem for fish and prawn species. There are 8 villages, 3 are within the Ramsar site area and 5 others are located adjacent to the LKWS. Most of the villagers are fishermen. Homestay programme in Kg. Dagat and Kuala Abai was initiated to help local communities in terms of income generations as part of the tourism activity within the LKWS. Forest fire, debarking of *Tangar*, global warming and river pollution are considered few threats and risks in the LKWS. The management plan of the LKWS was prepared prior to the designation of the area within Ramsar, which focussed on the management goal towards biodiversity and ecology enhancement. Current facilities in the LKWS were upgraded through funding from Federal Government. Some of the lesson learned from the project includes consultative process, collaboration among agencies and stakeholders on data sharing to strengthen conservation governance and to achieve target of the project. The role of the government sector towards conservation is equally important with other sectors. Public sector, civil society and other parties' involvement in supporting the conservation programme is highly required.

Paper #2: Forest Ecosystems of Sabah's Ramsar Site by Dr. Reuben Nilus

Dr. Reuben Nilus briefly explained that the LKWS encompasses a natural coastal and contiguous wetland: peatswamp forest, coastal beach forest, seasonal freshwater swamp and coastal mixed dipterocarp forest. Generally, LKWS receives 3000 ml of rainfall, 27◦C of temperature and the wet season is in the month of December to February where the driest month is in April. The largest

ecosystem is the mangrove vegetation (71%), which comprises of 3 zonations: seaward or riverine margins, main mangrove and back mangrove. The largest zone of the mangrove vegetation is the 'Back mangrove' representing 67% of the whole area. The most impacted area and the productive site for timber production in the past is the 'Main mangrove' representing about 27%. Peatswamp forest occupies 15% of the Ramsar site. The original forest has been reduced to secondary vegetation due to timber extraction in the past and about 30% of the area was burnt in 1997. The Coastal Lowland Mixed Dipterocarp Forest covers 2% of the total area. It is found that there are still regenerations of dipterocarp species within the LKWS, representing about 20-40% tree density. About 34%-40% of the basal area was found to belong to the dipterocarp family. The freshwater swamp forest represents about 3%. Due to limited access and the remoteness, the freshwater swamp and beach forests were not surveyed. Overall, the conservation value of the Ramsar site is viable for plant species population and also for plant genetic material. Besides that, it is an important habitat for wildlife and also important for local community living adjacent to the area. The fishery industry plays an important role for Sandakan and Lahad Datu. The threats in the area are forest fires and water pollution. Based on the survey, the recommendation is to monitor the extent of the ecosystems, e.g., remote sensing applications and more ground survey to monitor biodiversity habitat. River pollution monitoring system should be established within the buffer zone area of Ramsar Site.

Paper #3: Plant Diversity Study in the Ramsar Site in Sabah, Malaysia by Mr. John B. Sugau

Mr. John Sugau presented the findings of the plant diversity study that was carried out in the Ramsar Site. Prior to this, there was no comprehensive study done on plant diversity in the Ramsar Site. However, there were sporadic botanical collections made in the past, e.g. 1960 and 1967 with the total collection of 15 species. In 1984, 57 and 5 species were recorded by two collectors, respectively. In terms of vegetation assessment, a total of 85 species were recorded in 2007. During the recent expeditions in 2014 and 2015, a total of 107 families represented by 498 taxa were recorded. These included: 1 Lycophytes family (1 species), 12 Ferns families (22 Species), 1 Gymnosperm family (2 species), 13 Angiosperms (Monocotyledon - 52 species) and 80 Angiosperms (Dicotyledon - 451 species). The 10 most diverse plant species in the Ramsar site were: Dipterocarpaceae (32 taxa); Rubiaceae and Fabaceae (29 taxa); Annonaceae (19 taxa); Malvaceae (17 taxa); Euphorbiaceae (15 taxa); Phyllanthaceae (14 taxa); Myrtaceae (13 taxa); Moraceae (12 taxa) and Rhizophoraceae (11 taxa). In terms of life form, the trees make up the most diverse life form, representing 60% (334 species). About 78 plant species (60%) are endemic to Borneo and 7 species are endemic to Sabah. There are 19 plant species recorded as threatened (8 vulnerable; 3 endangered and 8 critically endangered). Forest fires and illegal harvesting of mangrove plant species such as *Ceriops tagal* (Tengar) are the main threats. The recommendations include formulating a forest management plan for the area to identify high conservation value plants, including plant conservation targets, and also to conduct plant species population study in the Ramsar Site. Proposed focus of species for population studies are *Arenga retroflorescens*, *Heritiera globosa* and *Shorea symingtonii*. In addition, protection of the forest reserve from threats needs to be emphasized.

Paper #4: Reproductive Phenology and Sugar Production of *Nypa fruticans* in Labuk Bay, Sandakan by Ms. Nadirah Abd. Manaf

Ms. Nadirah shared about her study conducted in Labuk Bay, Sandakan. Sugar sap of *Nypa fruticans* can be harvested by two methods: (1) Traditional method: massaging for 64 times, bending and

kicking were employed between 2 to 4 weeks – producing high amount of sugar sap but less sugar concentration; (2) Heated water method: water is heated about 80-90 degree Celsius and applied to the spout base for two weeks – producing less sugar sap but higher sugar concentration. It is observed that the peak of sugar concentration and sugar sap (nira) is in the morning around 6 a.m– 10 a.m., which is influenced by the photosynthesis process that occurs in that period of time. This is the most suitable time to harvest sugar sap from *Nypa* based on the observation of every 4 hours in 3 days. This is a preliminary study, and further studies have to be carried out to identify the optimal temperature that enhances the production of nira. In terms of reproductive phenology, there are 6 phases involved. Phase 1 (flower budding, peaks in July); Phase 2 (female flower, peaks in July); Phase 3 (male flower – lots of spikes, peaks in July); Phase 4 (immature infructescence, tapping of nira); Phase 5 (mature infructescence, no production of nira because of hardened endosperms); and Phase 6 (no reproduction process). Phases 1 – 5 which begin from July to August is the flowering period and the most suitable for sap tapping is in the month of July. Traditional method is still considered the best method. However, future studies need to be carried out to find the best method for nira production. Some of the challenges faced during the studies are animal disturbance and environmental challenges like high tides, heavy rain and floods. Flooding or heavy rain will decrease the amount of sap produced. Improvement and enhancement of the heated water method are needed in the future.

Paper #5: Preliminary Checklist of Mammals and Birds of Kulamba Field Centre and Nearby Forests in the Lower Kinabatangan Segama Wetlands by Mr. George Hubert Petol

Mr. George Petol presented his study which is based on the 1st Scientific Expedition, conducted in June 2014 in Kulamba Field Centre and along Sg. Kulamba. For mammals, there are 22 terrestrial species from 15 families that were observed. 14 species were documented during the survey and 8 species were from the third party source such as interview with the local people, staff and from reports (WWF, BORA). Banteng, Gibbon, Proboscis Monkey, Bornean Orang Utan are some of the endangered species sighted during the expedition. From the previous year expedition, about 70 species of birds from 35 families including 1 unresolved family have been recorded. There was an increase of 88 species during 2015 expedition. There are 3 endemic species recorded; White-crowned Sharma, Bornean brown Barbet and Dusky munia. Mainly, they were the birds of the mainland, wetlands, open spaces and secondary forest. Storm stork is one of the wetland birds that has been observed and it is the 2nd most threatened bird in the world. Birds of open spaces found are Dusky munia and Refous tailor bird. Camera trapping is recommended to monitor poaching activity and wildlife research is needed. The bird checklist needs to be updated since the current checklist is very preliminary. It is also important to conduct survey during migratory season (October to April). All those recommendations need to be considered in order to create a potential place for birding in the future.

Question & Answer:

Name	Omar Abdul Kadir
Agency	MENGO and Sabah Wetlands Conservation Society (SWCS)
Question/Comment	Any statistic on number of visitors to the Ramsar site? The reason I asked is due to the distance from the nearest Sandakan town, where logistic is a problem and costly. You may have a better figure for the cost so that we can organise a trip to the site.

Answer (Tuan Hj. Hussin Tukiman)	Ramsar site is far away from the facilities but we had numerous visits by NGOs and government agencies, where we arranged their trips. KK Wetlands is our partner, so just call/write to us and we will arrange the trip.

Name	Omar Abdul Kadir
Agency	MENGO and Sabah Wetlands Conservation Society (SWCS)
Question/Comment	Did you find the 2 critically endangered mangrove species, namely *Bruguiera hainesii* and *Sonneratia griffithii*? According to IUCN, there are only 250 mature stands of *B. hainesii* in the world. Forestry Department of Peninsular Malaysia and stakeholders found number of trees of *B. hainesii* in Merbok mangrove in Kedah. 2 matured stands of *B. hainesii* found in Manukan island and currently SWCS in collaboration with Sabah Parks to propagate in the KK Wetlands' nursery but it was not very successful.
Answer (Mr. John Sugau)	No, we did not encounter both species during the scientific expedition. The Sabah Parks earlier this year sent the specimen collected from Manukan island to SFD. This is first record for Sabah.

Name	Datuk Anthony Lamb
Agency	Forest Research Centre
Question/Comment	My experience from visiting isolated or fragmented small areas of heath forest here has been noted in peat swamp forest areas; these sites could yield some rare or endemic plants, especially epiphytes in the areas. It is quite interesting to get into the sites and check on that patch of forest.
Answer (Dr. Chan Hung Tuck)	The people who are working in mangrove should then proceed further inland into the transitional forests, somewhere between the peat and mangrove that could be the zone of highest biodiversity.

Name	Kan Yaw Chong
Agency	Daily Express
Question/Comment	What is the biggest source of threat?
Answer (Tuan Hj. Hussin Tukiman)	No study to rank the threats yet. This is an opportunity for us to do preliminary study.

(Mr. George Hubert Petol)	Personally, I think one of the threats will be the quality of water from the streams from nearby areas. This year we don't see much palm oil effluence at these areas because of dry season. But few villagers said during the raining season, when there is flood and ground water flow, this effluence that flows to the river create problem. The fishes in cages get killed and it effects the life in the rivers. Although the State has been doing a lot of mitigation in this area when heavy rains occur and the pond overflows into river. This is beyond our control and can be one of the main threats.

Name	Chai Chuan Jun
Agency	Universiti Malaysia Sabah
Question/Comment	Is there suggestion of any other potential Ramsar site in Sabah? If yes, why?
Answer (Mr. Omar Abdul Kadir)	There is a second Ramsar site that has already been nominated, and gone through the endorsement process from the State Cabinet and Federal Cabinet. The nomination paper is at the Ramsar Convention HQ since December 2013, but the process has been delayed due to the administration system changes in HQ. That is the Kota Kinabalu Wetlands, and if this is approved, we will have the largest, which is LKSW, and the smallest Ramsar site in Malaysia because KKW is only 24 ha.

Name	Chai Chuan Jun
Agency	Universiti Malaysia Sabah
Question/Comment	What are the feedbacks from the villagers in the Ramsar site? Are there any ways to sell souvenirs in the tourist spot that can raise the public awareness?
Answer (Ms. Bernadette Joeman)	I am involving in the public awareness in LKSW, you may talk to me during the tea break.

Name	Anonymous
Agency	N/A
Question/Comment	Is there any further research on the sugar content of nira from nipah?
Answer	There will be further study on nipah if fund is available.

Name	Anonymous
Agency	N/A
Question/Comment	There are some researches that were done by a private body on *Arenga pinnata* for the value of diabetes. In regard to the method of harvesting the *Arenga pinnata*, research in Indonesia and Balung, Tawau used wooden hammer to knock hard on a certain point of the plant in the early part of the day and towards evening more sap is produced. In comparison with Nadirah's study, maybe this can be a better method for the nipah study too.
Answer	We tried using wooden hammer but it did not work because the stalk breaks. The most suitable method for now is the massage and water heated method. The solar device maybe able to be used to generate power to heat the water in future study. It is hoped that this could manifest better production.

Paper #6: Aphrodisiac Potential and Preclinical Evaluation on the Extract of mangrove Plants in Coastal Area of Sabah by Ms. Syamimi Khalid (Representative speaker for Ms. Sarifah Rejab)

Ms. Syamimi reported about the findings of mangrove plants as an Aphrodisiac – a substance that stimulate or increase sexual desire or libido; motivation or sexual performance. This study was initiated due to the large number of synthetic drugs being used to improve sexual function but with side effects. Natural-based aphrodisiac is of high demand as it has low side effects. Six (6) mangrove plants were chosen for the screening study. Only 2 species were selected for the study, namely *Mallotus muticus* (Sakulapit) and *Rhizophora mucronata* (Bakau Kurap). All samples were collected in the coastal areas of Sabah. Phytochemical screenings on these two species showed the presence of saponin compound and steroid in the plants, indicating the existence of aphrodisiac potential. NRU toxicity results were used to estimate the starting dose. Acute oral toxicity study within 14 days showed all experimental rats gained weight and appeared to have normal behavior during the observation period. There are 3 categories involved to assess for aphrodisiac performance which were tested on male and female rats, i.e., sexual behavior through mounting behavior study, partner preference study and mating performance study. The two species of mangrove plants have been found to increase the mating behavior, performance, and the testosterone level. This study is ongoing for further preclinical test before proceeding for commercialization process.

Paper #7: Preliminary Survey to Set Up Long Term Mangrove Monitoring Site and to Establish a Tanscriptome Database for Primary Mangrove Species in Sabah by Assoc. Prof. Dr. Shin Watanabe

Dr Watanabe outlined the objectives of the study which are (1) to establish transcriptome database for mangrove; (2) to estimate biomass of regenerated forest by the International (ISME) and Sabah Forestry Department (SFD). In 2014, sampling was done in a rehabilitated site in suburban Sandakan, Sabah. The cultivation of propagules, extraction of RNA, sequencing and analyzing were done in Japan. Biomass measurement was conducted using laser range finder/laser compass to coordinate each of the mangrove tree including the elevation. About 460 mangrove trees (6 species) were

measured in a 3-day assessment. The output is the correlation between tree height and ground level information. Mangrove species planted better in the lower ground level than higher ground level. The results suggested that those primary mangrove species should be planted in the lower ground level. Alternatively, in order to view bigger mangrove area, drone (UAV) was used to collect geographical data. Structure generated from motion is used to extract 3D information from 2D image. Monitoring biodiversity content can be obtained through sound system application.

Paper #8: Wild Cattle in the Wetlands – Is the Bornean Banteng a Distict Species? by Assoc. Prof. Dr. Abdul Hamid Ahmad

Dr. Abdul Hamid shared about the study on the distribution of the Bornean Banteng or locally known as Tembadau which began in 2006. The present world distribution of Banteng covers Indo-China, Java and Borneo only. Each region has only 1 subspecies. It became extinct in Peninsular Malaysia back in 1950. Three sub-species are recognized within the species *Bos javanicus*, namely Norminal Javan Banteng, Mainland Banteng and Bornean Banteng. The Bornean Banteng is confined to Borneo and is least studied. Much research is needed on this subspecies in terms of ecology, behavior and conservation. Currently, Tembadau exists in small populations in almost all major forest reserves in Sabah. Focus will be given to Ulu Padas Forest Reserve to see if the species is effectively isolated from the rest of the population in Sabah. The largest herd was seen around Kulamba Wildlife Reserve – grazing in the swamp early in the morning through air observation. Hybridization among the cattle species from the genus *Bos* is quite common.

Feacal samples of the Bornean Banteng were collected from 4 forest reserves in Sabah, i.e., Deramakot FR, Malua FR, Maliau Basin Conservation Area and Kulamba Wildlife Reserve and subjected to partial mt DNA analysis. From this study, it is found that Bornean banteng does not form a sister group with the other two Javan and the Mainland Banteng subspecies. But it forms a sister group with another Asian Wild Cattle, which is closely related to the Goar. A dried skull of a bull was found and tooth was extracted to sequence the mtDNA. From this study it also confirmed that the Bornean Banteng is distinctly different from the two other subspecies. Whether or not the Bornean banteng is a new species is yet to be confirmed. Its population in Sabah is small and scattered and therefore, a conservation programme is much needed for this subspecies. Furthermore, a captive population is required to conduct conservation breeding as an intervention to increase its population size.

Paper #9: Taxonomic on Fishes of the Lower Kinabatangan-Segama Wetlands, Ramsar Site by Dr. Mabel Manjaji Matsumoto

Dr. Mabel shared her study on fishes that was carried out in the 1st Ramsar Scientific expedition in 2014. Ramsar site on the East of Sabah is a significant marine eco-region and recognized as globally unique and a center for diversity of marine species. The study area was in the southern part of Kinabatangan River, i.e., Kulamba Bay. The objectives of the study were (1) to obtain a baseline data on fish composition and abundance; (2) to identify the occurrence of endangered species,

particularly riverine shark and rays; and (3) to obtain data on fisheries activities in the area. Fish were captured using gill net, cast net, trammel net and long net. Communication with the locals was made to use their cages. From the study, 54 species from 45 genera and 28 families from 9 orders were recorded. 120 voucher specimens have been deposited at the Borneo Marine Research Institute, Universiti Malaysia Sabah (UMS). Most of the fish recorded were considered food fish and many were juveniles. The 5 most abundance species contain between 28 to 81 individuals. There are also few families with only one sample. Catfish is one of the most abundant with 4 records of species and 16 species are known from Sabah. Catfish generally can reach up to 80 cm of total length. The reason of the abundance of catfishes in this area is because of the rich availability of food (fig – mangrove plant). One of the anchovy families is recorded to have 5 of 8 species recorded from the area. The maximum size of this fish is about 20 cm. There are also Gobies, including mud-skipper with 6 out of 22 known species have been recorded. Ikan belanak (mullets) was also found with 4 records from Sabah and 3 species were recorded in this study. The 5th most abundant species is Ikan Gelama-*Oncorhynchus* with 4 out of 12 recorded species. Overall, the biodiversity of marine species in this area is relatively low, however, it is expected that with more effort, the current list of species recorded will increase twofold. No endemic or threatened species were recorded during the study. The high presence of juvenile fish observed may indicate that the fish still reproduce and it is a positive indicator of the ecosystem health. Hence, there should be more efforts to cover a wider area of Ramsar Site to ensure aquatic food security.

Paper #10: Decapod Crustaceans in the Mangrove Ecosystems around Sandakan and Lower Kinabatangan-Segama Wetlands, Sabah by Dr. Tohru Naruse

Dr. Tohru reported on his research findings on the Decopod crustaceans. In Sabah, this group is well studied for the freshwater crab species. There were two sampling done, i.e., one in Sepilok Laut (6 days) and the other one at LKWS in 2014 (11 days). Collecting was done by hand-picking and using hand net. These methods are not effective during the day as most decapods are nocturnals. From the survey, two species were found and they are the 2nd record in the world. A new genus and species from the Camtanvideae family was encountered, i.e. *Exagorium fidelise*. Overall, Decapod fauna in Sabah is not well studied, especially for marine species, so it is difficult to carry out ecological study for this species. It is hoped that there will be more efforts made to carry out research on this group.

Paper #11: Insect Diversity of Tundon Bohangin, Sabah by Dr. Arthur Y.C. Chung

Dr. Arthur started his presentation by highlighting the ecological importance of insect diversity in the tropics, especially in the tropical ecosystems. Borneo is one of the mega biodiversity hotspots in the world including insects. The sampling of insect diversity was carried out at Kulamba Field Centre (formerly Tundon Buangin), within LKWS during the 1st Ramsar expedition in June 2014. Some of the focus insect groups include butterfly, moth, beetle, and dragonfly. Light traps were used to sample nocturnal insects while sweep nets and forceps were used to sample diurnal insects. The results indicated that the nocturnal insect richness and abundance were low. On average 44 species and 57 individuals were recorded within the 1 m^2 plot. Overall, the species distribution was quite even throughout the sampling, eventhough the number of species was low. The species with the highest individual is only 6. In terms of species richness in Kulamba Field Centre is poor while the insect diversity is moderate in comparison to other studies from other forest reserves in Sabah. No Borneo endemic species was recorded. The insect fauna in Kulamba Field Centre is not particularly interesting as only common species were recorded. 23 species of butterfly were recorded including the mangrove tree nymph. Some 37 moth species and 15 species of micro beetles were recorded. On dragonfly, 11 Ordonata species were recorded. Other insect species were also recorded including termites, Diptera, ants, mantis, grasshopper, and crickets. In conclusion, insect species richness is low in Kulamba Field Centre due to the transition between land and sea and insects that are found in this area are those that can adapt to the harsh environment. Nevertheless, insects are still ecologically important in the food chain and energy flow in mangroves.

Question & Answer:

Name	Penny C. Gardner
Agency	Cardiff University
Question/Comment	Additional information to the morphological development of Banteng calves. My survey confirmed that the Banteng developed the white stockings in the first month of development. During that stage the male calf actually developed the buds/horns, but the female Banteng calf generally developed horn in a slower pace throughout couple of months.

Name	Anonymous
Agency	Tour Agency
Question/Comment	Did you do any studies on mosquitos in Kulamba and Lower Kinabatangan?
Answer (Dr. Arthur Chung)	I did sample and surveyed mosquitos and flies in general, but no intensive studies yet.

Name	Kan Yaw Chong
Agency	Daily Express
Question/Comment	Why is the species diversity of fish so low?
Answer (Dr. B. Mabel Manjaji-Matsumoto)	It is due to limited sampling time as we are not able to do sampling at night. Some sampling sites indeed have a low fish diversity because we think that the area has been disturbed (e.g.,where village exist). Juvenile fish is still high and it is an indicator that fish are breeding in the mangrove. The encounter of the giant mudskipper near the village is surprising. However, there are pressures from fishing activities.

Name	Kan Yaw Chong
Agency	Daily Express
Question/Comment	The diversity of insects is low, why is it so?
Answer (Dr. Arthur Chung)	The nocturnal insect diversity is low because we only sampled nocturnal insect diversity in the field centre. We could not go out to the proper forest for sampling due to security reasons. Also, I am not surprise that the insect diversity is low because the natural ecosystem is dominated by mangrove species and nipah, as compared to the diversity in mixed lowland dipterocarp. Although the overall diversity is low, other interesting fauna such as such fish and fireflies are important in the mangrove.

Paper #12: Kota Kinabalu Wetlands: Towards its Ramsar Status by Ms. Guslia Lahasing

Ms. Guslia shared an overview of the Kota Kinabalu Wetlands (KKW). It is about 24 hectares of mangrove area, located in the heart of Kota Kinabalu and managed by the Sabah Wetlands Conservation Society (SWCS). KKW is governed by a Management Committee comprising of elected members and ex-officio from relevant government agencies and WWF-Malaysia. KKW qualifies as a Ramsar status because it fulfills 4 out of 9 criteria. Criterion 1: KKW is a good example of natural coastal mangrove system; Criteria 2: KKW has recorded 2 protected species of birds – vulnerable species listed in the IUCN Red list; Criteria 3: KKW harbours abundance of aquatics and other wildlife which includes more than 10 species of mangrove trees and more than 90 species of birds; and Criteria 8: KKW is an important nursery ground for fish, prawn and crab. It is also an important feeding ground for birds. KKW acts as a reservoir of biodiversity. The most threatened mangrove species in the area is the *Rhizophora apiculata* – Bakau minyak. Conservation efforts also have been in place for endangered mangrove species such as *Burgueira hainesii* – Berus mata buaya. KKW also harbours abundance of aquatics and other wildlife such as more than 90 species of birds. Public awareness has also been implemented through the Environmental Education Programme (EEP).

Some of KKW's achievements include — it was ranked by Sabah Wetlands Inventory 1986 as the top most important wetland habitat in Sabah. SWCS received the Sabah Environmental Award for Outstanding NGO Award in 2011 and in 2014 and KKW was nominated as the 2nd Ramsar site in Sabah. Some of the challenges are the unstable financial status of SWCS and the rapid development surrounding KKW, giving pressure to the area. Encroachment and poaching are also other challenges. Limited manpower is also a problem in managing KKW. In conclusion, KKW is seeking funds for R&D projects. It is also at the final stage of preparing the 10-year management plan for the sustainable management of KKW. It is expected that KKW will be approved the full status as a Ramsar Site after finalizing the submission.

Paper #13: Sharing of Experience, Management and Conservation of Kuching Wetlands National Park – Ramsar Site by Ms. Irmadiana Ardi

Ms. Irmadiana shared about Kuching Wetlands National Park. Kuching Wetlands National Park (KWNP), was once part of the Sarawak Mangrove Forest Reserve and was gazetted in 1924 with the aim to protect the mangrove forest in the Northern part of Kuching. KWNP covers about 6,610 hectares and was gazetted in 2002 as a National Park i.e., Kuching Welands National Park. In 2005, KWNP was designated as one of the RAMSAR Sites in Malaysia. The KWNP qualified and fulfilled 4 criteria: 1: Natural Coastal Mangrove Systems; 2: Endemic and Endangered Species; 4: Special Value of the Area; and 8: Important Ponding and Nursery Ground for Aquatic (Fish and Prawn). In 2009, a multidisciplinary assessment was carried out by Forest Department Sarawak and UNIMAS for the management plan preparation. About 104 species of birds are found in the KWNP and 42 of them are listed as HCV (High Conservation Value) species. 6 out of 8 mammals species are considered as HCV, including crocodiles has been recorded. About 317 mature crocodiles can be found in the KWNP, with an estimate of 4 to 5 individual crocodiles per kilometer. There are 3 management zones in KWNP, namely restricted zones from entrance, Core Protection Zones 1 and 2 for crocodile nesting and breeding grounds. There are also records of four dolphins in KWNP, mostly at the river mouth towards the sea. In terms of socio-economy, there are estimated 6000 houses residing in close proximity, within 3 km from the park and 90% of them are Malays. In terms of the conservation management of KWNP, boundary monitoring was carried out twice a month. Aerial surveillance using the hyper-spectral technology for forest protection purposes was implemented which is considered effective in identifying and detecting illegal activities in TPA. Environmental awareness programme was also implemented to educate the public especially the local communities. Although KWNP has limited facilities, it is visited daily by tourists through organized trips by tour operators or by visitors that have been approved by the Director of Sarawak Forestry Department. Some of the achievements include the restoration of more than 50 hectares that have been planted with 57,600 mangrove tree species. On management threats and challenges, the flood mitigation project which aimed to control floods in Kuching city, was implemented in 2009 but it imposed major destruction to the mangroves. Sarawak Forestry Department rehabilitated the degraded area through a mangrove replanting programme conducted every month. It is seen that KWNP has big opportunities for tourism and research and it also provides engagement of stakeholders, e.g. local communities and developers.

Paper #14: Where are the People in the Ramsar Wetlands of the Lower-Kinabatangan and Segama Rivers of Sabah by Prof. Dr. Fadzilah Majid Cooke

Prof. Dr. Fadzilah had a very different approach in her presentation. She was accompanied by the representatives from each of the villages around the Ramsar Site of the Lower Kinabatangan and Segama Rivers, namely Kampung Bungon, Mumiang, Pitas, Abai, Tundon Bohangin, Dagat and Seri Ganda. All these representative of each of the villages have issues or comments about the Ramsar Site on how this project affects their lives. Representative from Kampung Abai asked the question about where they are going to go as their village is in the middle of LKSW surrounded by the wildlife sanctuary, forest reserve and the Ramsar Site. Representative from Kg. Sri Ganda reported that about 80% of the 423 people from the village live inside the Ramsar Site. They hope that they can continue to live there. Another issue was on timber usage whereby timber is used for everything including constructing houses as concrete houses are not affordable. This was highlighted by the representatives of 4 kampungs; Kg. Bungon, Kg. Mumiang, Kg. Pitas and Kg. Tundon Bohangin. They also are worried that they may not be able to use timber if the implementation will be strict with Ramsar. A representative from Dagat mentioned that they need land to grow vegetables and hope Ramsar will allow them to use the land for cultivating. They are also hoping that Ramsar will provide support in terms of allowing homestay programmes in their area. The Homestay Programme has started but is now languishing due to the security issue after the Lahad Datu intrusion.

Question and Answer:

Name	James Chu
Agency	Sabah Tourist Guide Association
Question/Comment	Is there a proper feasibility study done for the flood mitigation project?
Answer (Ms. Irmadiana Ardi)	Prior to the project, the EIA was done. So proper assessment was done before project took off. Even though freshwater is entering the site, mangrove planted at the degraded area has 80% survival rate. No detailed survey/research for prawns have been done. Hence, it is uncertain if the prawn population is decreasing or not.

Name	Dr. Lee Ying Fah
Agency	Forest Research Centre, SFD
Question/Comment	Does SFD have any feedback to the issues raised by the LKSW local communities?
Answer (Mr. Fred Kugan)	Ramsar is about wise-use, therefore the local communities' activities should not be restricted. All the issues raised by the communities will be taken into account. There is an existing management plan for LKSW and the plan will be assessed. Therefore, it is timely that we consider the local communities' views, and the issues raised will be taken into account during the assessment. It is important that capacity is built up in order for the community to be part

	of the Ramsar management. There will be some funding from the next Malaysia Plan-11 to be invested for CEPA to increase the capacity of the community to build entrepreneurship. This will help them establish their alternative livelihood such as tourism.

Name	Dr. Lee Ying Fah
Agency	Forest Research Centre, SFD
Question/Comment	Please share your vast experience or views on eco-tourism.
Answers (Mr. Albert Teoh)	It is always challenging when there is conservation in an area with local communities, but it can be overcome. It needs time to build capacity. In Australia, there is a model that allows the private sector investors to invest in the protected areas. The private sector takes all the risks, face the challenges, and work with the local communities that have no experience in tourism, hospitality, interpretation, skills, etc. They are part and parcel of the stakeholder in allowing the community to build up capacity. I am sure that many of us in the tourism industry is willing to take the challenge, but a mechanism needs to be set up by the government with the incentive from the income tax.
(Prof. Dr. Fadzilah Majid Cooke)	The idea of private investment is a good one. However, investment in protected area is heavily monitored by the civil society in Australia. Do we have that capacity here? The capacity needs to be built side by side when investment is going in. We need to build the capacity before the private investment goes in a big scale. If we are going to have private investment, then we need to have the capacity of the communities to decide and negotiate with the private sectors.
(Neville Yapp, LEAP)	It is important to look at the impact of the investment. The big tour operators in Sabah have created so much wealth already, so why not let the communities themselves manage and run it to receive direct benefits from it.

Name	Chai Chuan Jun
Agency	Universiti Malaysia Sabah
Question/Comment	Is there a necessity to do a frequent survey towards the local community and make a statistic to show to the public that the protected area does benefit the local?
Answer (Prof. Dr. Fadzilah Majid Cooke)	Citizen initiative to do the survey is a long term process. Learning by doing and continued commitment.

POSTER'S ABSTRACTS

DIPTEROCARP DIVERSITY WITHIN LOWER KINABATANGAN-SEGAMA WETLANDS RAMSAR SITE AND ADJACENT AREAS

Eyen Khoo, Richard Majapun, Jeisin Jumian, Awang Jasmin, Martin Tuyok & John B. Sugau
Sabah Forestry Department

Abstract. As Malaysia's Federal and State governments have made the commitment to take necessary steps to protect some of our country's wetlands, it is important that the biodiversity values within these areas are assessed and recognised to ensure the ecological character of the particular site is preserved. From the Ramsar expeditions conducted in 2014 and 2015, a total of 26 species of dipterocarps were recorded: one Sabah endemic, *Shorea symingtonii*; 11 Bornean endemics; and the rest are widely distributed within South East Asia. In terms of threat categories, there are at least 16 species that are listed under the International Union for Conservation on Nature and Natural Resource (IUCN) Red List threatened category. The record of the dipterocarp species reflects the LKSW and adjacent forest reserves' importance for conserving biological diversity. Together with other interesting flora and fauna findings, this would lead to greater understanding and efficient management for the area. This is to achieve the ultimate aim of protecting the ecological character and to lessen the impacts of urbanisation and development upon such sites.

A PRELIMINARY STUDY ON FLOWERING, FRUITING, TREE AND SEEDLING DENSITY OF *Xylocarpus granatum* ALONG THE KULAMBA RIVER, LOWER KINABATANGAN-SEGAMA WETLANDS, SABAH

Chong Fung Yun
Sabah Forestry Department

Abstract. A scientific expedition on biodiversity in the Lower Kinabatangan-Segama Wetlands (LKSW) was carried out in June, 2014. As part of the expedition, the tree and seedling density of *Xylocarpus granatum*, as well as flowering and fruiting trees were enumerated. Even though this species is widely distributed in the coastal regions, the ecology of this species at this Ramsar site is still lacking. Three study plots; each measuring 40×10 m, were established at upstream, mid-stream and downstream along the Kulamba river bank and all mature trees and seedlings were enumerated for average density. Besides that, seven trees were randomly selected from each plot for flowering and fruiting observation. The area had a low average tree density of 317 trees/per hectare although there was a high occurrence of seedlings (2058 seedlings/ha). It was also noted that heavy fruiting occurred in June, 2014. Further studies of *X. granatum* at LKSW are needed.

FERNS OF SUNGAI GOLOGOB FOREST RESERVE, ADJACENT TO THE RAMSAR SITE IN SABAH

Andi Maryani A. Mustapeng, John B. Sugau & Joan T. Pereira
Sabah Forestry Department

Abstract. A preliminary survey of ferns was conducted in Sungai Gologob Forest Reserve during the Ramsar Scientific Expedition 2014 and 2015. Sungai Gologob FR is located ($05^0$36'N $118^0$30'E) in the Kinabatangan district, an area adjacent to the existing Ramsar site. The reserve, with approximately 7,900 ha, was formerly a stateland, was gazetted as a Virgin Jungle Reserve (Class VI) since 18 May, 2010. Sungai Gologob FR is also one of the potential areas that will be included in the Ramsar site in

the future. The preliminary survey was aimed to collect, identify, and document the fern diversity in the reserve. From the short survey, nine (9) species of ferns were recorded, from nine (9) genera, and eight (8) families. Among the species, *Tectaria mesodon* (Copel.) M. Price (Tectariaceae) was discovered for the first time in Borneo, and at the same time, making it a new addition to Sabah's fern species. This finding is far from complete, but is presented as a baseline data for the reserve. Further studies on fern diversity should be conducted to provide a complete checklist of ferns from Sungai Gologob FR.

THE SECONDARY METABOLITES AND ANTIMICROBIAL ACTIVITIES OF THE CRUDE EXTRACTS OF *Alocasia scabriuscula* N.E. BR. (ARACEAE)

Kartini Saibeh, Salani Selveno & Charles S. Vairappan
Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah

Abstract. *Alocasia scabriuscula* N.E. Br. was found commonly growing in the Lower Kinabatangan-Segama Wetlands (LKSW). The secondary metabolites and antimicrobial activities of the crude extracts of *A. scabriuscula* were compared with *A. macrorrhiza* (L.) Schott and *A. cuprea* K. Koch.. The samples were soaked in 70% ethanol, extracted and produced crude extracts of leaves, petiole and tuber. The crude extracts were profiled via Thin Layer Chromatography (TLC) and reverse phase High Performance Liquid Chromatography (HPLC). The secondary metabolites were highest in *A. cuprea* (petiole with six spots) followed by *A. macrorrhiza* (leaves with four spots) and *A. scabriuscula* (leaves with three spots). The antimicrobial activities of all crude extracts, were tested using AA disc diffusion assay with eight human pathogenic bacteria strains [*Pseudomonas aurelis* (P1), *E. coli*[1] (P4), *Salmonella thypymurium* (P5), *E. coli*[2] (P6), *Vibrio cholerae* (P8), *Listeria monocytogenes* (P10), *Staphylococcus aureus* (P11) and *Salmonella* sp. (P12)]. The leaf crude extracts showed high antimicrobial activities compared to petiole and tuber extracts. The leaves of *A. macrorrhiza* (14.5 mm) in tested bacteria strains showed highest inhibition zone in *Salmonella thypymurium* (P5). *Alocasia scabriuscula* showed the least efficacy in antimicrobial activity as the chemical profiles have minimum compound detected in TLC and reverse phase HPLC.

WILDLIFE SURVEY FROM THE LOWER KINABATANGAN-SEGAMA WETLANDS (LKSW) SCIENTIFIC EXPEDITION

Elyrice Alim, Ronny Madius, Oswald Goniur & Rumiow Pulin
WWF-Malaysia, Sabah

Abstract. WWF-Malaysia participated in the Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition held from the 3rd to 8th August 2015. The survey team conducted a general wildlife survey to record the species richness of LKSW, in the Kulamba Wildlife Reserve (Kulamba WR), the adjacent Kretam Forest Reserve (Kretam FR) and Bukit Lawa-Lawa. Observations were recorded from a total of 8 km recce walks and 15 trap nights. Signs of banteng (6), wild pigs (6), giant squirrel (1), orang-utan (5), pig tailed-macaque (2), Malayan sun bear (3), sambar deer (4) and gibbon (3) were observed or heard. WWF-Malaysia's camera trap surveys in 2009-2010 recorded more wildlife presence, most probably due to more trap nights. The past surveys also showed the presence of proboscis monkey, Malay civet, Malay badger, greater mouse-deer, lesser mouse-deer, short-tailed mongoose, tufted-ground squirrel and thick-spined porcupine. Sumatran rhinoceros was last seen

and rescued in Kretam FR in 2009. The threat of poaching and unauthorised entry to the Forest Reserve and Wildlife Reserve is considered highly significant with the discovery of two sun bear carcasses in an adjacent oil palm plantation, about 100 metres from the Kulamba WR boundary and the discovery of bullet casings at the scene. Abandoned agarwood collector's camp, porcupine trap and old bullet casings were also observed during the survey. It is recommended that urgent measures are taken to combat illegal entry and poaching in the Wildlife Reserve and the Forest Reserve, preferably with a multi-stakeholders approach.

PRELIMINARY BIRD SURVEY IN THE LOWER KINABATANGAN-SEGAMA WETLANDS, SABAH

Alim Biun[1], Enroe Evertius Soudi[1], Lawrence Tingkui[2] & G. Hubert Petol[2]
[1]Sabah Parks
[2]Sabah Forestry Department

Abstract. A bird survey involving 4 observers was conducted for 4 consecutive days in four localities during the Lower Kinabatangan-Segama Wetlands (LKSW) Scientific Expedition within Sabah's Ramsar site on the 4th to 7th of August 2015. The survey method chosen was the MacKinnon Lists Method (with each list being 20 species in length), a popular rapid survey method, especially effective for unfamiliar sites and with limited survey duration. The method was also chosen as it is less susceptible to the varying abilities between the observers in both aural and visual bird identification. Eleven MacKinnon lists were successfully recorded during the survey. The cumulative total number of species from these lists was 88 in 35 families represented by five major groups of birds based on their feeding habits. The number of species of each group were as follows; Carnivorous, n=15 (17.05%); Omnivorous, n=15 (17.05%); Frugivorous, n=15 (17.05%); Insectivorous, n=37 (42.05%) and Nectarivorous, n=6 (7%). The species density of bird fauna in this area was estimated to be low. However, the results were preliminary at best as many other factors (i.e. migration season, fruiting season, duration of survey and habitat conditions) were not taken into account during the survey. Long-term research plan on the birds of the area is recommended to get a clearer picture of bird diversity, densities and abundances in the LKSW.

TABURAN DAN KOMPOSISI HERPETOFAUNA DI TAPAK RAMSAR (LOWER KINABATANGAN-SEGAMA WETLANDS)

Paul Y. Imbun, Benedict Butit & Johny Lapidin
Taman Kinabalu, Kota Kinabalu, Sabah

Abstrak. Tinjauan herpetofauna telah dijalankan di tapak Ramsar LKSW pada 3 – 8 Ogos 2015 untuk menentukan komposisi dan taburan spesies herpetofauna di kawasan tersebut. Tinjauan telah dibuat di empat transek hutan dan trail-trail hutan yang dapat diakses. Semua spesies amfibia dan reptilia direkodkan melalui pengutipan dan pemerhatian dari bunyinya dan individu yang dilihat secara langsung. Sejumlah 34 spesimen herpetofauna telah direkodkan dalam 10 famili yang terdiri daripada 11 spesies katak, enam spesies cicak, satu spesies buaya dan dua spesies ular. Spesies amfibia, *Fejervarya cancrivora* (Dicroglossidae) dan *Polypedates macrotis* (Rhacophoridae) menyumbangkan bilangan individu yang terbanyak dalam koleksi spesimen yang dikutip. Spesies *Fejervarya cancrivora* adalah spesies yang biasa dijumpai di habitat hutan paya bakau dan dapat

bertoleransi dengan air bersaliniti tinggi. Kebanyakan spesies herpetofauna yang direkodkan adalah spesies yang biasa dijumpai serta bertaburan luas di Borneo dan kawasan sekitarnya. Dua spesies amfibia endemik kepada Borneo direkodkan, iaitu *Philautus hosii* dan *Hylarana megalonesa*. Spesies yang mungkin terancam ialah *Philautus hosii* kerana taburannya yang terhad (jarang ditemui pada ketinggian lebih dari 350 m dari aras laut) dan dijangka tidak dapat hidup dalam hutan yang terganggu. Bagi spesies reptilia, kebanyakannya adalah spesies yang biasa dijumpai dan dapat menyesuaikan hidup di habitat yang terganggu.

WATER QUALITY PRELIMINARY DATA OF THE RAMSAR SITE: LOWER KINABATANGAN-SEGAMA WETLANDS (LKSW)

Sahana Harun
Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah

Abstract. A preliminary study on water quality was carried out at the Lower Kinabatangan-Segama Wetlands (LKSW), Sabah in August 2015. The objectives were to study the surface water quality of LKSW; and to characterise dissolved organic matter (DOM) in LKSW by using UV-visible spectroscopy. A total of 49 water samples were collected from six water bodies. Due to the nature of LKSW, which is an estuary area, the physico-chemical parameters varied and categorised within Class I to Class V in accordance to the Interim National Water Quality Standards (INWQS) for Malaysia. Statistical analyses ANOVA one-way and discriminant analysis have been carried out to the water quality data set. Discriminant analysis suggested that UV-visible absorption coefficients at 254 and 340 nm were the highest in samples from a swamp located within the Kretam Forest Reserve, which could be attributed by the accumulation of dissolved organic matter (DOM) within the water body.

A STUDY ON ECOTOURISM POTENTIAL IN THE RAMSAR SITE: LOWER KINABATANGAN-SEGAWA WETLANDS (LKSW), SABAH

Jarry K. Lajanga
Sabah Forestry Department

Abstract. This study attempted to determine new potential ecotourism areas in Sabah to be introduced as alternative attractions to the readily available tourism products. The objective was to investigate tourism potentials in LKSW. Surveys included the exploration of the potential attractions and also by interviewing the parties involved and local people.

RAMSAR CEPA PROGRAMME BY THE SABAH FORESTRY DEPARTMENT

Arni Natalia Arpa & Bernadette D. Joeman
Sabah Forestry Department

Abstract. Ramsar CEPA (Communication, Education, Participation and Awareness) is one of the platforms for Sabah Forestry Department (SFD) to convey knowledge and to create awareness on the importance of wetlands among the people of Sabah. This programme targets but not confined to, the community living adjacent to the Lower Kinabatangan-Segama Wetlands. This Ramsar site,

the first in Sabah, was designated in October 2008. It is also the biggest of the six Ramsar sites in Malaysia, with an area of 78,803 ha. Due to its proximity to various villages, the Sabah Forestry Department deemed that the community nearby need to be aware of, the existence of the Ramsar site and their roles in its wise use. It is important to work together with the community to promote the wise use of the Ramsar site in order to sustain its valuable ecological services and the wetland resources for the community. This poster aims to highlight some the CEPA activities which have been carried out by the department thus far. The SFD also works closely with the Sabah Environmental Education Network (SEEN) members and the Japan International Co-operation Agency (JICA), through the Sustainable Development for Biodiversity and Ecosystems Conservation (SDBEC) Project in this Ramsar CEPA programme.

CLOSING CEREMONY

& PHOTO GALLERY

6.0 CHAIRMAN'S REPORT
SABAH'S RAMSAR CONFERENCE 2015

The Sabah's Ramsar Conference, held on 12 November 2015, was the first to be organized by the Sabah Forestry Department (SFD). Hopefully, this Conference will become an annual event to be held concurrently with the Heart of Borneo (HoB) Conference from now on. It has been proposed that someone from the Ramsar Secretariat based at IUCN in Switzerland be invited for the next Conference. This is to keep the Ramsar Secretariat informed of the good work done by researchers at the Sabah Ramsar Site.

Designated in 2008, covering 78,803 ha and comprising three forest reserves, the Lower Kinabatangan-Segama Wetlands (LKSW) Ramsar Site is the first in Sabah and by far the largest in Malaysia. It is larger than all the other Ramsar Sites in the country put together and probably the most diverse biologically.

The Conference started with an overview of the LKSW. Most of the 14 presentations reported on the flora and fauna, with some studies and experiences elsewhere included. A new genus and species of crab (*Exagorium fidelisi*) was reported and 19 taxa of threatened plants have been documented in this site. It is encouraging to note that besides biology and ecology, a few of the wetland studies entailed other disciplines such as pharmacology, genomics, socio-economics and utilization have been initiated. Eleven posters were exhibited, covering broader disciplines of biodiversity, bioactivities, environmental ecology, ecotourism, nature education and socio-economics. Some studies were presented orally and exhibited as posters.

The Conference received overwhelming response with full audience in the Ballroom most of the day. Due to time constraint, one paper on the Ramsar Living Seascape had to be covered by another concurrent session. This one-day event had generated a wealth of exciting scientific information, which would be documented as Proceedings of the Sabah's Ramsar Conference 2015. Overall, the first Ramsar Conference had enough firepower to match the HoB Conference. The prospects of holding the next Ramsar Conference in November 2016 are promising.

Dr Chan Hung Tuck & Dr Lee Ying Fah

7.0 CLOSING SPEECH BY THE MINISTER OF NATURAL RESOURCES & ENVIRONMENT (NRE), MALAYSIA,
YB DATO SRI DR WAN JUNAIDI BIN TUANKU JAAFAR

Bismillahirrahmanirrahim.

Thank you, Ms Deanna.

Yang Berbahagia Datuk Sam Mannan
Director of Sabah Forestry Department,

Yang Amat Berbahagia Tun Jeanne Abdullah
Chairman Tropical Rainforest Conservation & Research Centre Berhad,

Yang Berhormat Tan Sri-Tan Sri, Datuk-Datuk, Datin-Datin,

Distinguished guests,

Members of the media,

Ladies and gentlemen.

Assalamualaikum warahmatullahi wabarakatuh.

A very good afternoon and Salam 1Malaysia.

First and foremost, I would like to express my appreciation to the Organizing Committee for this kind invitation for me to officiate the closing of two important back-to-back conferences, namely "The International Heart of Borneo (HoB) Conference on Bridging HoB Landscapes and Beyond through Healthy Watershed Corridors and Sabah's Ramsar Conference."

Malaysia recognises the significance of the HoB Initiative, which is in harmony with the existing policies, plans and programmes pertaining to sustainable development, land use and conservation, at both the state and national levels. The Ministry of Natural Resources and Environment Malaysia views that the HoB Initiative as an important initiative of national status that will directly contribute towards the betterment in forest management as well as forest. Malaysia reiterates the importance that this initiative be continued to be placed well within the government's sustainable development framework and policy.

Similarly, Ramsar is equally important and will be priority in the government's policy in sustainable development. Ramsar promotes the wise use of wetlands which can be achieved through the implementation of ecosystem approaches within the context of sustainable development. Of all the Ramsar sites in Malaysia, the Lower Kinabatangan-Segama Wetlands is the largest, covering an area of about 80,000 hectares. This site is ecologically important for its rich biodiversity, such as Tembadau, Bornean Pygmy Elephant, Proboscis Monkey and Storm's Stork, just to name a few. I was informed that the Ramsar expiditions, organized by the Sabah Forestry Department had harboured some interesting discoveries, including a new species of crab from Tundon Bohangin within the Ramsar site.

I am glad that Sabah Forestry Department has been pro-active, taking the lead role in the implementation of HoB and Ramsar activities with support from various government departments, the private sector, non-governmental organizations and also involving the local communities. The conservation of forests and wetlands is a matter of major local, national, regional and international concern for the diversity of their unique array of plant and animals, as well as landscapes.

Equally important, they are of critical value to the people of Borneo as a prized natural heritage and for the goods and services that they provide. Hence, the HoB and Ramsar areas must be effectively managed on the basis of sustainable land used planning and implementation with regard to the balance of ecosystem, socio-cultural, ecomonic and political aspects within the respective nations.

I am pleased to announce that HoB Initiative, entered by Malaysia, Indonesia and Brunei Darussalam in 2007, has demonstrated remarkable progress since its inception. This Initiative has been serving as an important vehicle to spearhead efforts to protect and conserve the rich biodiversity within the Borneo Island. Over the years, various projects and activities have been carried out. I was informed that the State of Sarawak with support from WWF-Malaysia had just conducted an International Workshop on the HoB Corridor Project Implementation last week. The workshop had received overwhelming response from local and international participant including invited speaker to share their views and experiences on Corridors Project Implementation across the three countries in Borneo Island.

The Federal Government is committed to the HoB Initiative and will continue to support Sabah and Sarawak in the implementation of various projects and activities under this initiative. The Federal Government has allocated about RM34.46 million under the 9th and 10th Malaysian Development Plan, and will continue to support the HoB programmes under the 11th Malaysia Development Plan. The successful implementation of all the activities under HoB also indicates the dedication and support of the both state government. I would like to take this opportunity to thank both state governments, Sabah and Sarawak.

Ladies & Gentlemen,

The theme of the HoB Conference this year, entitled "Bridging HoB Landscapes and Beyond through Healthy Watershed Corridors" is indeed timely and appropriate. We have to look beyond the HoB landscapes and link them with other areas of ecological importance, such as the wetlands. The 9th HoB Trilateral Meeting which was held in Sandakan, Sabah in August this year also highlighted the importance of bridging HoB landscapes and beyond.

The Ramsar Conference held today is actually a continuation of the conservation effort of various agencies from the highlands to the coastal areas in Sabah. Bridging or linking such initiatives is important for a thorough and coordinated effort in conservation throughout Sabah. I believe that this would bring better outcomes in sustainable management of various ecosystems in the state.

I was informed that the totally protected areas of Sabah were 864,182 hectares or 11% in 2007 when HoB Initiative was first launched and which has now risen to 1.56 million hectares or about 21% of the land area of Sabah. That is a significant achievement toward the conservation of biodiversity in HoB areas.

Ladies & Gentlemen,

I am happy to know that many participants of different backgrounds representing various agencies, both local and international, participated in the conferences. I am sure that all of you have benefitted and contributed significantly in both conferences. Besides presentation of papers and discussions, participants were also enlightened with information in the HoB and Ramsar exhibitions set up by the Sabah Forestry Department together with other agencies.

I am delighted that the Sabah Forestry Department, under Datuk Sam Mannan, has been taking the lead in organizing both events. This effort would undoubtedly contribute significantly to the State's sustainable forest and wetland management. The cooperation with other agencies, which includes the Ministry of Natural Resources and Environment in organizing the two back-to-back conferences signifies the smart partnership in working together for best practices in forest and wetland management in Sabah. I also wish to express my appreciation and gratitude to the speakers and all the participants for making both events a success.

With these remarks, ladies & gentlemen, I declare both the HoB and Ramsar Conferences, officially close. Congratulations.

Thank you very much!

Wabillahitaufik walhidayah assalamualaikum warahmatullahi wabarakatuh.

Ministry of Natural Resources and Environment, Malaysia
12 November 2015

8.0 PHOTO GALLERY

OPENING CEREMONY

EXHIBITION









CONFERENCE IN PROGRESS


SuteraHarbour


11 - 12 November 2015
The Magellan Sutera Harbour Resort,
Kota Kinabalu, Sabah


Sutera Harbour Resort,


November 2015
Sutera Harbour Resort,


The Magellan Sutera Harbour
Kota Kinabalu, Sabah
11 - 12 November 2015
The Magellan Sutera Harbour
Kota Kinabalu, Sabah
11 - 12 November 2015
The Magellan Sutera Harbour
Kota Kinabalu, Sabah
The Magellan Sutera Harbour
Kota Kinabalu, Sabah
The Magellan Sutera Harbour
Kota Kinabalu, Sabah
11 - 12 November 2015
The Magellan Sutera Harbour
Kota Kinabalu, Sabah
The Magellan Sutera Harbour
Kota Kinabalu, Sabah

CLOSING CEREMONY