UNIVERSITI PUTRA MALAYSIA

MEGACHIROPTERAN DIVERSITY PATTERNS AND PROCESSES IN OIL PALM PRODUCTION LANDSCAPE

MUHAMAD SYAFIQ BIN CHE SHAFFINE

FH 2017 10

MEGACHIROPTERAN DIVERSITY PATTERNS AND PROCESSES IN OIL PALM PRODUCTION LANDSCAPE

By

MUHAMAD SYAFIQ BIN CHE SHAFFINE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

May 2017

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

MEGACHIROPTERAN DIVERSITY PATTERNS AND PROCESSES IN OIL PALM PRODUCTION LANDSCAPE

By

MUHAMAD SYAFIQ BIN CHE SHAFFINE

May 2017

Chairman: Badrul Azhar Md. Sharif, PhD
Faculty: Forestry

Oil palm industry is one of the main economic drivers in Southeast Asia. It has caused tropical deforestation on a massive scale in producing countries. Forest conversion to commercial oil palm agriculture has decimated habitats of countless native flora and fauna species. Large-scale plantations and smallholdings are two distinctive oil palm production systems. Smallholdings would host a greater biodiversity than large-scale plantations. Habitat complexity in smallholdings is influenced by multiple farming practices (i.e. polyculture and monoculture). However, little is known on the effects of such farming practices in oil palm smallholdings on mammal biodiversity, particularly megachiropteran bats. This study aimed to find the best farming practice to reconcile oil palm production and biodiversity conservation. Mist-nets were used to trap frugivorous bats at 120 smallholdings in Peninsular Malaysia. The species richness and abundance of frugivorous bats between monoculture and polyculture smallholdings were compared and their relationships with vegetation structure characteristics were investigated. The results revealed that species richness (total megachiropteran bat species) and abundance (total individual from each species of megachiropteran bat) were significantly greater in polyculture smallholdings than monoculture smallholdings. The result also found that 28.21% of the model variations in species richness were explained by the habitat characteristics measured including the number of dead standing oil palms and immature oil palms, non-grass cover, height of non-grass cover, and farming practice. This shows greater habitat complexity is required for the maintenance of frugivorous bats. Therefore, in order to conserve farmland biodiversity in oil palm production landscapes, either smallholding or plantation, commercial growers should implement polyculture rather than monoculture farming.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

PROSES DAN CORAK KEPELBAGAIAN MEGACHIROPTERA DI DALAM LANDSKAP PENGELUARAN HASIL KEBUN KECIL KELAPA SAWIT

Oleh

MUHAMAD SYAFIQ BIN CHE SHAFFINE

Mei 2017

Pengerusi: Badrul Azhar Md. Sharif, PhD
Fakulti: Perhutanan

Industri kelapa sawit merupakan salah satu daripada pemacu utama ekonomi di Asia Tenggara. Industri ini telah menyumbang kepada kemerosotan hutan tropika secara drastik dalam negara pengeluar kelapa sawit. Penukaran tanah hutan kepada kawasan pertanian kelapa sawit telah menyebabkan kemusnahan habitat flora dan fauna. Ladang kelapa sawit berskala besar dan kebun kecil merupakan dua sistem pengamalan penanaman kelapa sawit yang berbeza. Kebun-kebun kecil kelapa sawit dapat menampung kepelbagaian biodiversiti yang lebih tinggi berbanding ladang-ladang kelapa sawit yang berskala besar. Amalan pertanian yang pelbagai seperti monokultur dan polikultur yang diamalkan di dalam kawasan kebun kecil menyumbang kepada kewujudan habitat yang lebih kompleks di dalam kawasan ini. Walaubagaimanapun, tidak banyak maklumat yang dapat dikenalpasti daripada kesan amalan pertanian yang pelbagai di dalam kawasan kebun kecil ini terhadap biodiversiti mamalia terutamanya kelawar pemakan buah. Kajian ini bertujuan untuk mengenalpasti amalan pertanian yang terbaik yang dapat memaksimakan pengeluaran kelapa sawit dan dalam masa yang sama membantu dalam pemuliharaan biodiversiti. Jaring kabut digunakan untuk menangkap kelawar pemakan buah di dalam 120 kawasan pekebun kecil kelapa sawit di Semenanjung Malaysia. Kekayaan spesis dan kelimpahan kelawar pemakan buah di antara kebun kecil monokultur dan polikultur dibandingkan dan perkaitan antara kekayaan spesies dan kelimpahan kelawar pemakan buah ini dengan ciri-ciri vegetasi dikaji. Keputusan menunjukan bahawa kekayaan spesies (bilangan spesies kelawar pemakan buah) dan kelimpahan kelawar pemakan buah (bilangan individu dari setiap spesies kelawar pemakan buah) adalah jauh lebih tinggi dalam kebun kecil polikultur berbanding kebun kecil monokultur. Kajian ini juga mendapati bahawa 28.21% daripada variasi model dalam kekayaan spesis

adalah dipengaruhi oleh factor-faktor keadaan vegetasi iaitu bilangan pokok kelapa sawit yang mati berdiri dan bilangan kelapa sawit belum matang, peratus rumpai penutup bumi bukan rumput, ketinggian rumpai penutup bumi bukan rumput, dan amalan pertanian. Ini menunjukkan habitat yang lebih kompleks diperlukan untuk menarik perhatian kelawar pemakan buah. Oleh itu, bagi memulihara biodiversiti dalam landskap pengeluaran kelapa sawit, sama ada kebun kecil atau ladang, penanam komersial lebih digalakkan untuk melaksanakan kaedah polikultur bukannya pertanian monokultur.

ACKNOWLEDGEMENTS

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

In the name of Allah, the most Gracious and the Most Merciful. Alhamdulillah, all praises to Allah, the creator of all creating. Alhamdulillah, I have been given strength during the period of completing this study.

First, special gratitude goes to my supervisor, Doctor Badrul Azhar Md Sharif, for his support and knowledge regarding this topic. I would like to record my sincerest grateful to my supervisor, Dr. Badrul Azhar Md Sharif and Dr. Puan Chong Leong for their kindness, unfailing help and guidance throughout the course of undertaking this project. Their assistance and encouragement have been a tremendous boost to my effort in trying to give my best in this project. My deepest gratitude also to my fellow friends helping me in writing, for their willingness to help me with the data collected and in moral support ensuring the success of this project.

Finally, it is my greatest with special dedication to my beloved parent and my siblings cause of their appreciation and gratitude always giving me the motivation and support throughout this project. I would like to thank to all parties and individuals who had rendered their help directly and indirectly on my preparing this study. Hopefully these studies give some beneficial effects for us.

I certify that a Thesis Examination Committee has met on 4 May 2017 to conduct the final examination of Muhamad Syafiq bin Che Shaffine on his thesis entitled "Megachiropteran Diversity Patterns and Processes in Oil Palm Production Landscape" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Mohamad Azani bin Alias, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Mohamed Zakaria bin Husin, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Zubaid Akbar bin Mukhtar Ahmad, PhD
Professor
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)

NOR AINI AB. SHUKOR, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 8 August 2017

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Badrul Azhar Md Sharif, PhD
Senior Lecturer
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Puan Chong Leong, PhD
Senior Lecturer
Faculty of Forestry
Universiti Putra Malaysia
(Member)

_____

ROBIAH BINTI YUNUS, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby declare that:

- the thesis is based on my original work;
- quotations, illustration and citations have been duly referenced;
- this thesis has not been previously or concurrently submitted for any other degree at any other institutions;
- intellectual property from the thesis and copyright of the thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained by supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscript, poster, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/ fabrication in the thesis, and scholarly integrity is upheld as accordance to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Univeriti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Muhamad Syafiq Bin Che Shaffine (GS37406)

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of
Chairman of
Supervisory
Committee: Badrul Azhar bin Md Shariff, PhD

Signature: _____
Name of
Member of
Supervisory
Committee: Puan Chong Leong, PhD

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percent
-	Negative
+	Plus minus
o C	Degree Celsius
m	Meter
X	Multiplied
=	Equal
|r|	No element of set r
AIC	Akaike‘s Information Criterion
AICc	Akaike‘s Information Criterion Correction
ANOSIM	Analysis of Similarity
ANOVA	Analysis of Variance
F	F- statistic
GLM	Generalized Linear Modals
I	Delta I
MPOB	Malaysia Palm Oil Board
MPOC	*Malaysian Palm Oil Council*
p	p- value
R^2	R squared
S.E.	Standard Error
SIMPER	Similarity Percentage
Sp.	Species (singular)
Spp.	Species (plural)

CHAPTER 1

INTRODUCTION

1.1 General Review

Oil palm is a very important and efficient crop with the minimal production value (Carter *et al.,* 2007). It contributes almost 30% of the global's edible vegetable oil (Carter *et al.,* 2007) and biofuel product where it generates income to many producing countries in the tropics (Sargeant, 2001; Basiron, 2007). The production of palm oil has always been linked with tropical deforestation, water pollution, biodiversity loss, and manipulation of customary land right (Koh & Wilcove, 2008). In the past, Malaysia was among 14 countries with annual deforestation rates in excess of 250 000 ha per year (Wood, 1990). Even though all the damaging impacts from the uncontrolled oil palm expansion on biodiversity, (Fitzherbert *et al*., 2008; Koh & Wilcove, 2008), the industry is still growing all over many parts of the world. To date, only a small fraction of the published research focused on the impacts of oil palm cultivation on biodiversity and the environment (Fitzherbert *et al.,* 2008). Such information is still not sufficient to reflect the serious threat of this impact and there is an urgent need to mitigate the impact of oil palm plantation had on biodiversity.

Malaysia is the world's second largest oil palm production country in the world after Indonesia based on the data on year 2012 (Pakiam, 2013) that covered 5,642,943 hectares of land (MPOB, 2015) and produced 19,667,016 tonnes of crude palm oil (MPOB, 2015). Even though Indonesia is the world largest oil palm producing country, Malaysia became the world's largest palm oil exporter with the 18 million tonnes of exported palm oil products throughout the world in 2011 (May, 2012) with India, China, Netherlands, Pakistan and U.S.A. were the primary importers of Malaysian palm oil products (MPOC, 2016).

Palm oil industry sectors in Malaysia is dominated by several stakeholders such as FELDA (Federal Land Development Authority), FELCRA (Federal Land Consolidation and Rehabilitation Authority), RISDA (Rubber Industry Smallholders Development Authority), State Schemes, Smallholders, and Private Estates (Figure 1.1). Malaysia continues to increase planters' productivity and competitiveness through a state replacement of unproductive palms with high-yielding hybrids. This implementation includes cultivation on lands owned by independent smallholders who contribute 16% of the planted area under oil palm in Malaysia (MPOB, 2015).

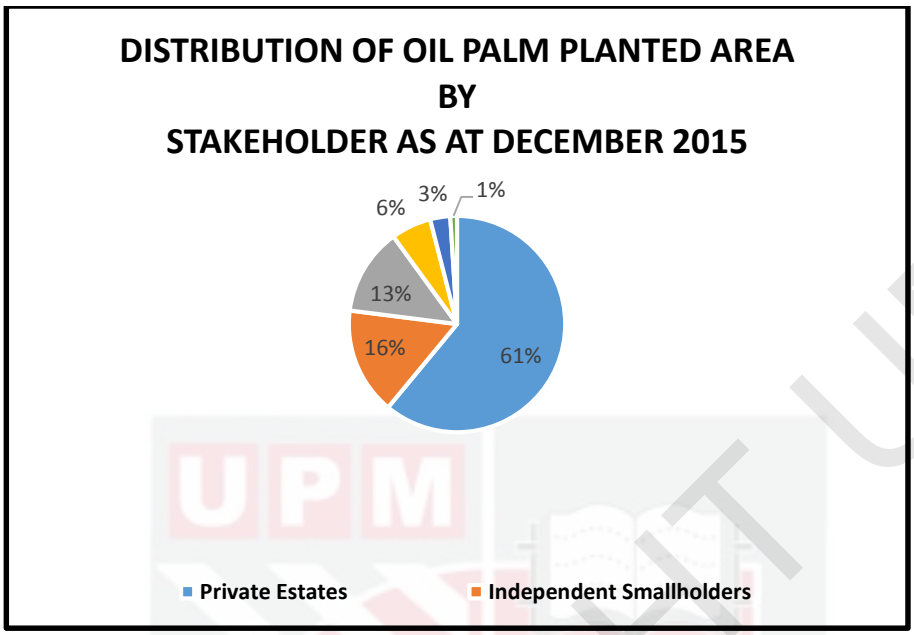

Figure 1.1: Distribution of oil palm planted area by stakeholder as at December 2015 with the total area 5,642,943 hectares.
(Source: MPOB, 2015)

Most commercial palm oil planters in Malaysia are using monoculture approach in planting palm oil tree except for independent smallholders (Basiron, 2007). In contrast to the motonous practice of commercial palm oil planters, independent smallholders practice either monoculture or polyculture approach. There has been much debate throughout the world discussing about the effect of this planting technique had on environment and biodiversity. Smallholdings are defined as semi-traditional farming areas covering less than 50 ha each that were owned by individuals and do not belong to any plantation companies or non-governmental business entity (RSPO, 2009). Smallholdings normally consist of various-age stands (polyculture) of palm oil tree, which are intercropped with other profitable plants (e.g. banana, coconut, coffee, pineapple, tapioca etc.) and some of smallholdings are monoculture which mean only planting with single species of palm oil tree (Amoah *et al.,* 1995; Azhar *et al.,* 2014a).

Despite oil palm production system is becoming quite common in the leading oil palm producing countries such as Indonesia and Malaysia (Murphy, 2007), there are relatively insufficient number of fauna studies in the smallholdings (Azhar *et al*., 2011, 2014a, b). Motivated by stable income opportunities and encouraging government policies, it is predicted that more small-scale farmers will be involved in self-managed and self-funded oil palm economy in the major oil-palm producing countries (Koczberski & Curry, 2005; Cramb & Curry, 2012) like Malaysia.

Understanding the ecological processes that affects the conservation of biodiversity in oil palm landscapes is critically appropriate for organisation practices (Tscharntke *et al.,* 2005). Biodiversity patterns in conventional plantations, ranging from invertebrates to vertebrate fauna estates, have been studied (Fayle *et al.,* 2010; Na´jera & Simonetti, 2010; Azhar *et al.,* 2013; Gillespie *et al.,* 2012). Most of the studies have concluded that oil palm plantations are unable to match natural forests in terms of biodiversity maintenance. On the contrary, oil palm smallholdings have not been studied thoroughly by conservation scientists in terms of their impact on biodiversity.

Effect of different oil palm smallholdings farming practices may vary on certain wildlife species. It is important to investigate the effect of these different farming practices because it may increase the survival of some wild life taxa. Megachiropteran bats (fruit eating bats) are the most common taxa that forage and inhabit these oil palm plantation area (Nur Juliani *et al.,* 2011). To maintaining their population, it is important to study and understanding the effect of different farming practices on Megachiropteran bats. This may provide better knowledge about the ecology aspect needed on these taxa to ensure the continuation of these species life on earth. Knowledge on habitat ecology characteristic can provide a method of conservation planning of endangered wild life species.

1.2 Problem Statement

Biodiversity assessments in oil palm smallholdings may provide valuable information into biodiversity-friendly practices that can be applied throughout oil palm agriculture (Foster *et al.,* 2011). In the tropics, nearly 70 % of agriculture land is used as a combination of managed landscapes (McNeely & Scherr, 2003). In agroecosystems, studies have shown that changes in habitat organization because of different agricultural practices (Pogue & Schnell, 2001) may lead to variations in animal assemblages. This has been confirmed in studies of small mammals (Sullivan *et al.,* 1998; Michel *et al.,* 2007; Moro & Gadal, 2007; Mendenhall *et al.*, 2014; Azhar *et al.,* 2014a), fruit bats (Azhar *et al.,* 2015b), birds (Fischer *et al.,* 2011; Azhar *et al.,* 2013, 2014b, 2015b), and invertebrates (Wilson *et al.,* 1999; Ghazali *et al.,* 2016; Asmah *et al.,* 2016). In addition, changes in habitat structure leading to increased habitat complexity have been confirmed to be positively related with animal assemblage diversity by providing nest sites and shelters from predators (Tscharntke *et al.,* 2005; Lambert *et al.,* 2008).

1.3 Justification

This research may provide a clarification for decision-makers on biodiversity degradation due to growing of agriculture landscapes in oil palm producing countries. Loss of biodiversity component from tropical forest conversion are difficult to mitigate (Daily, 2001; Lindenmayer & Hobbs, 2004; Brook *et al.,* 2006). This is due to high profitability, high demand and revenue this industry can generate (Smith *et al.,* 2003; Sodhi & Brook, 2006; Koh & Wilcove, 2007).

Therefore, this Megachiropteran bat study was conducted as an initiative to preserve and enhance the biodiversity in the oil palm plantation as there is no scientific study focusing on the interaction of Megachiropteran bats with different farming practices and habitat quality in oil palm production landscape.

This study was conducted in habitats that have been converted into oil palm smallholdings (e.g. monocultures and polyculture farming practice), with the aim to compare Megachiropteran bats diversity in different farming practices. Polyculture smallholdings were expected to support higher level of Megachiropteran bat richness and more diverse species assemblages than monoculture smallholdings. This was related to greater structural complexity and floristic richness in polyculture smallholdings. The second objective was to study the relationships between Megachiropteran bats species richness and local-scale habitat quality characteristics (i.e. vegetation structure). This study predicted that key structural characteristics typically associated with agricultural practices play a significant role in influencing Megachiropteran bat species richness and composition. Certainly, this study helps ecologists to understand biodiversity patterns in modern human-modified landscapes and at the same time provide recommendations to support the biodiversity especially Megachiropteran bats in oil palm smallholdings.

1.4 Objective

There is an urgent need to inform stakeholders of the value of different oil palm farming practices to improve biodiversity conservation in existing production landscapes. The research aimed to investigate the effects of two common oil palm farming practices (i.e. monoculture and polyculture) on the diversity and abundance of Megachiropteran bat species. Specifically, Megachiropteran bat species richness, abundance and composition in monoculture and polyculture farming practices in oil palm smallholdings were determined. The study also attempted to quantify species diversity between this two farming practices and examine the relations between species occurrence and the habitat quality. In this study, two types of smallholdings, monoculture and polyculture where only integrated plantation of oil palm with banana tree were selected. Within the chosen smallholdings, Megachiropteran bats were sampled and correlated with farming practices and habitat quality inside the sampling area.

The specific objectives were:

i. To compare the effects of two different oil palm smallholding farming practices (monoculture and polyculture) on the abundance and species richness of Megachiropteran bats.
ii. To determine the key habitat quality variables that influence Megachiropteran bats abundance and species richness in oil palm smallholdings.

1.5 Research Hypothesis

i. Polyculture farming could support greater species richness, composition, and abundance compare to monoculture farming, due to the availability of multiple niches and resources.

ii. Habitat quality characteristic will influence Megachiropteran bat species richness in oil palm smallholdings due to sensitiveness of certain species to the changes in habitat quality.

REFERENCES

Abdullah, M.T., Siswanto, H., Widiyanto, A., Setiabudi, & Firmansyah. 1997. Abundance, diversity and distributional records of bats in disturbed habitats in Kalimantan Barat, Indonesia. *Sarawak Museum Journal*, 11: 75-84.

Adams, R.A., & Hayes, M.A. 2008. Water availability and successful lactation by bats as related to climate change in arid regions of western North America. *Journal of Animal Ecology,* 77: 1115-1121.

Ahlen, I., & Baagoe, H. 1999. Use of ultrasound detectors for bat studies in Europe: experiences from field identification, surveys, and monitoring. *Acta Chiropterologica,* 1(2): 137-150.

Amoah, F.M., Nuertey, B.N., Baidoo-Addo, K., Oppong, F.K., Osei-Bonsu, K., & Asamoah, T.E.O. 1995. Underplanting oil palm with cocoa in Ghana. *Agroforestry Systems,* 30: 289–299.

Aratrakorn, S., Thunhikorn, S., & Donald, P.F. 2006. Changes in bird communities following conversion of lowland forest to oil palm and rubber plantations in Southern Thailand. *Bird Conservation International*, 16: 71–82.

Arnett, E.B. 2003. Advancing science and partnerships for the conservation of bats and their habitats. *Wildlife Society Bulletin,* 31: 2-5.

Asmah, S., Ghazali, A., Syafiq, M., Yahya, M.S., Peng, T.L., Norhisham A.R., Puan, C.L., Azhar, B., & Lindenmayer, D.B. 2016. Effect of polyculture and monoculture farming in oil palm smallholdings on tropical fruit-feeding butterfly diversity. *Agricultural and Forest Entomology,* 2017: 70–80.

Azhar, B., Lindenmayer, D.B., Wood, J., Fischer, J., Manning, A., McElhinny, C., & Zakaria, M. 2011. The conservation value of oil palm estates, smallholdings and logged peat swamp forest for birds. *Forest Ecology and Management*, 262: 2306-2315.

Azhar, B., Lindenmayer, D.B., Wood, J., Fischer, J., Manning, A.D., McElhinny, C., & Zakaria, M. 2013. The influence of agricultural system, stand structural complexity and landscape context on foraging birds in oil palm landscapes. *Ibis,* 155: 297–312.

Azhar, B., Lindenmayer, D.B., Wood, J., Fischer, J., & Zakaria, M. 2014a. Ecological impacts of oil palm agriculture on forest mammals in plantation estates and smallholdings. *Biodiversity & Conservation,* 23: 1175–1191.

Azhar, B., Puan, C.L., Zakaria, M., Hassan, N., & Arif, M. 2014b. Effect of monoculture and polyculture practices in oil palm smallholdings on tropical farmland birds. *Basic and Applied Ecology,* 15: 336-346.

Azhar, B., Saadun, N., Puan, C.L., Kamarudin, N., Aziz, N., Nurhidayu, S., & Fischer, J. 2015a. Promoting landscape heterogeneity to improve the biodiversity benefits of certified palm oil production: evidence from Peninsular Malaysia. *Global Ecology and Conservation*, 3: 553-561.

Azhar, B., Puan, C.L., Aziz, N., Sainuddin, M., Adila, N., Samsuddin, S., Asmah, S., Syafiq, M., Razak, S.A., Hafizuddin, A., Hawa, A., & Jamian, S. 2015b. Effects of in situ habitat quality and landscape characteristics in the oil palm agricultural matrix on tropical understory birds, fruit bats and butterflies. *Biodiversity and Conservation,* 24: 3125-3144.

Bala, G., Caldeira, K., Wickett, M., Phillips, T.J., Lobell, D.B., Delire, C., & Mirin, A. 2007. Combined climate and carbon-cycle effects of large-scale deforestation. *Proceedings of the National Academy of Sciences USA,* 104: 6550-6555.

Barbaro, L., Dulaurent, A.M., Payet, K., Blache, S., Ventillara, F., & Battisti, A. 2013. Winter bird numerical responses to a key defoliator in mountain pine forest. *Forest Ecology and Management,* 296: 90-97.

Barlow, C., & Jayasuriya, S.K. 1984. Problems of investment for technological advance: The case of Indonesian rubber smallholders. *Journal of Agricultural Economics*, 35(1): 85-95.

Basiron, Y. 2007. Palm oil production through sustainable plantations. *European Journal of Lipid Science and Technology,* 109: 289-295.

Basiron, Y., & Chan, K.W. 2004. The oil palm and its sustainability. *Journal of Oil Palm Research,* 16: 1-10.

Basiron, Y., Jalani, B.S., & Chan, K.W. 2000. *Advances in Oil Palm Research*. MPOB, Bangi, 1 & 2: 1-782, 783-1526.

Belcher, B., Rujehan, B.M., Imang N., & Achdiawan, R. 2004. Rattan, rubber, or oil palm: cultural and financial considerations for farmers in Kalimantan. *Economic Botany*, 58: 77–87.

Bonaccorso, F.J. 1979. Foraging and reproductive ecology in a Panamanian bat community. *Biological Sciences Bulletin*, 24: 359-408.

Brooks, T.M., Mittermeier, R.A., Mittermeier, C.G, da Fonseca, G.A.B., Rylands, A.B., Konstant, W.R., Flick, P., Pilgrim, J., Oldfield, J., Magin, G., & Hilton-Taylor, C. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology*, 16(4): 909-923.

Brook, B.W., Bradshaw, C.J., Koh, L.P., & Sodhi, N.S. 2006. Momentum Drives the Crash: Mass Extinction in the Tropics. *Biotropica,* 38: 302-305.

Budiman, A.F.S. 1996. *The Future Development of Rubber Production and Marketing in Indonesia.* International Rubber Marketing Conference, Phuket, Thailand, April 11-13.

Bumrungsri, S., Harbit, A., Benzie, C., Carmouche, K., Sridith, K., & Racey, P.A. 2008. The pollination ecology of two species of Parkia (Mimosaceae) in southern Thailand. *Journal of Tropical Ecology,* 24: 467-475.

Bumrungsri, S., Sripaoraya, E., Chongsiri, T., Sridith, K., & Racey, P.A. 2009. The pollination ecology of durian (*Durio zibethinus*, Bombacaceae) in southern Thailand. *Journal of Tropical Ecology*, 25: 85-92.

Campbell, P., Reid, N.M., Zubaid, A., Adnan, A.M., & Kunz, T.H. 2006. Comparative roosting ecology of *Cynopterus* (Chiroptera: Pteropodidae) fruit bats in Peninsular Malaysia. *Biotropica*, 38: 725-734.

Carter, C., Finley, W., Fry, J., Jackson, D., & Willis, L. 2007. Palm oil markets and future supply. *European Journal of Lipid Science and Technology,* 109: 307-314.

Clarke, K.R., & Gorley, R.N. 2006. *User manual /tutorial.* PRIMER-E Ltd., Plymouth.

Clarke, K.R., & Warwick, R.M. 2001. *Change in marine communities: an approach to statistical analysis and interpretation*. Plymouth: PRIMER-E, 2.

Colchester, M. 2010. *Land acquisition, human rights violations and indigenous peoples on the palm oil frontier.* Forest Peoples Programme and International Land Coalition. Moreton-in Mash UK.

Colchester, M., Jiwan, N., Andiko, M.S., Sirait, M., Firdaus, A.Y., Surambo, A., & Pane, H. 2006. *Promised Land. Palm oil and land acquisition in Indonesia: implications for local communities and indigenous peoples.* Forest Peoples Programme/Perkumpulan Sawit Watch, Jakarta.

Constantine, D.G. 1958. An automatic bat-collecting device. *Journal of Wildlife Management*, 22: 17-22.

Corley, R.H.V. & Tinker, P.B. 2003. *The Oil Palm*, Blackwell Science.

Courts, S.E. 1998. Dietary strategies of Old World fruit bats (Megachiroptera, Pteropodidae): how do they obtain sufficient protein? *Mammal Review,* 28: 185-194.

Cox, M.P., Dickman, C.R., & Hunter, J. 2003. Effects of rainforest fragmentation on nonflying mammals of the Eastern Dorrigo Plateau, Australia. *Biological Conservation,* 115: 175-189.

Cramb, R., & Curry, G.N. 2012. Oil palm and rural livelihoods in the Asia-Pacific region: an overview. *Asia Pacific Viewpoint,* 53: 223–239.

Daily, G.C. 2001. Ecological forecasts. *Nature,* 411: 245-245.

Danielsen, F., Beukema, H., Burgess, N.D., Parish, F., Brühl, C.A., Donald, P.F., Murdiyarso, D., Phalan, B., Reijnders, L., Struebig, M., & Fitzherbert, E.B. 2009. Biofuel plantations on forested lands: double jeopardy for biodiversity and climate. *Conservation Biology,* 23: 348-358.

Danielsen, F., & Heegaard, M. 1995. Impact of logging and plantation development on species diversity: A case study from Sumatra. In Sandbukt O (ed.). *Management of tropical forests: Towards an integrated perspective.* Oslo: Centre for Development and the Environment, University of Oslo, 73–92.

De Koninck, R. 1979. Comment capturer le potentiel productif des petits paysans. *Anthropologie et Sociétés,* 3(3): 87-107.

Dinerstein, E. 1986. Reproductive ecology of fruit bats and the seasonality of fruit production in a Costa Rican cloud forest. *Biotropica,* 18: 307-318.

Donald, P.F. 2004. Biodiversity impacts of some agricultural commodity production systems. Conservation Biology, 18: 17–37.

Edwards, D.P., Hodgson, J.A., Hamer, K.C., Mitchell, S.L., Ahmad, A.H., Cornell, S.J., & Wilcove, D.S. 2010. Wildlife friendly oil palm plantations fail to protect biodiversity effectively. *Conservation Letters,* 3: 236–242.

Estrada, A., Coates-Estrada, R., & Meritt, D. 1993. Bat species richness and abundance in tropical rain forest fragments and in agricultural habitats at Los Tuxtlas, Mexico. *Ecography*, 16: 309-318.

FAO. 2002. *Small-Scale Palm oil processing in Africa*. FAO Agricultural Services Bulletin 148 ISSN 1010-1365. Rome, Italy.

FAO. 2007. FAOSTAT *Online Statistical Service*. Retrieved on 25 December 2016 from: http://faostat.fao.org.

FAO. 2009. FAOSTAT *Online Statistical Service.* Food and Agriculture Organization of the United Nations, Rome, Italy. Retrieved on 25 December 2016 from http://faostat.fao.org/.

Fayle, T.M., Turner, E.C., Snaddon, J.L., Chey, V.K., Chung, A.Y., Eggleton, P., & Foster, W.A. 2010. Oil palm expansion into rain forest greatly reduces ant biodiversity in canopy, epiphytes and leaf-litter. *Basic and Applied Ecology,* 11: 337–345.

Fenton, M.B. 1992. *Bats. Facts on file*. New York.

Fenton, M.B. 1997. Science and the conservation of bats. *Journal of Mammalogy,* 78: 1-14.

Francis, C.M. 1989. A comparison of mist nets and two designs of harp traps for capturing bats. *Journal of Mammalogy*, 70: 865-870.

Findley, J.S. 1993. *Bats: a Community Perspective*. Cambridge University Press, Cambridge.

Fisher, A. 1966. *South-east Asia: A Social, Economic and Political Geography*. 2nd edition. London, Methuen.

Fischer, C., Flohre, A., Clement, L.W., Bata´ry, P., Weisser, W.W., Tscharntke, T., & Thies, C. 2011. Mixed effects of landscape structure and farming practice on bird diversity. Agriculture, Ecosystems and Environment, 141: 119–125.

Fitzherbert, E.B., Struebig, M.J., Morel, A., Danielsen, F., Bruhl, C.A., Donald, P.F., & Phalan, B. 2008. How will oil palm expansion affect biodiversity?. *Trends in Ecology and Evolution*, 23: 538-545.

Foster, W.A., Snaddon, J.L., Turner, E.C., Fayle, T.M., Cockerill, T.D., Ellwood, M.F., Broad, G.R., Chung, A.Y.C., Eggleton, P., Khen, C.V., & Yusah, K.M. 2011. Establishing the evidence base for maintaining biodiversity and ecosystem function in the oil palm landscapes of South East Asia. *Philosophical Transactions of the Royal Society B Biological Sciences,* 366: 3277-3291.

Fox, J., & Castella, J.C. 2013. Expansion of rubber (*Hevea brasiliensis*) in Mainland Southeast Asia: what are the prospects for smallholders?. *The Journal of Peasant Studies*, 40(1): 155-170.

Francis, C.M. 1994. Vertical stratification of fruit bats (Pteropodidae) in lowland dipterocarp rainforest in Malaysia. *Journal of Tropical Ecology,* 10: 523-530.

Francis, C.M. 2008. *A Guide to the Mammals of Southeast Asia.* New Holland Publishers United Ltd, UK, pp. 328-345.

Fujita, M.S., & Tuttle, M.D. 1991. Flying foxes (Chiroptera: Pteropodidae): threatened animals of key ecological and economic importance. *Conservation Biology*, 5: 454-463.

Fukuda, D., Tisen, O.B., Momose, K., & Sakai, S. 2009. Bat diversity in the vegetation mosaic around a lowland dipterocarp forest of Borneo. *Raffles Bulletin Zoology,* 57: 213-221.

Gaiser, N. 2009. *Oil palm in Kalimantan: the meaning of oil palm expansion on local farmers' lives—two case studies of villages in Sanggau district, West Kalimantan*. Bachelor of ethnology thesis. Albert-Ludwigs University, Freiburg, Germany.

Galindo-Gonza'lez, J., & Sosa, V.J. 2003. Frugivorous bats in isolated trees and riparian vegetation associated with human-made pastures in a fragmented tropical landscape. *The Southwestern Naturalist,* 48: 579-589.

Ghazali, A., Asmah, S., Syafiq, M., Yahya, M.S., Aziz, N., Tan, L.P., Norhisham, A.R., Puan, C.L., Turner, E.C., & Azhar, B. 2016. Effects of monoculture and polyculture farming in oil palm smallholdings on terrestrial arthropod diversity. *Journal of Asia Pacific Entomology*, 19(2): 415-421.

Gillespie, G.R., Ahmad, E., Elahan, B., Evans, A., Ancrenaz, M., Goossens, B., & Scroggie, M.P. 2012. Conservation of amphibians in Borneo: relative value of secondary tropical forest and non-forest habitats. *Biological Conservation,* 152: 136–144.

Gillette, D.D., & Kimbrough, J.D. 1970. Chiropteran mortality. In: Slaughter, B.H., & Walton, D.W. (Eds.), *About Bats*. Southern Methodist University Press, Dallas, pp. 262-283.

Gorresen, P.M., & Willig, M.R. 2004. Landscape responses of bats to habitat fragmentation in Atlantic forest of Paraguay. *Journal of Mammalogy*, 85: 688-697.

Greenslade, P.J.M., & Greenslade, P. 1977. Some effects of vegetation cover and disturbance on a tropical ant fauna. *Insectes Sociaux*, 24: 163-182.

Gukasova A.S., & Vlaschenko A.S. 2010. Bat fauna primary inventory and monitoring using mist nets. In: Horáèek, I., Benda, P. (Eds) – *Abstracts of the 15th International Bat Research Conference*. Prague (Czech Republic), pp: 157.

Hall, L.S., Grigg, G.G., Moritz, C., Ketol, B., Sait, I., Marni, W., & Abdullah, M.T. 2004. Biogeography of fruit bats in Southeast Asia. *Sarawak Museum Journal,* 80: 191-284.

Hardter, R., Chow, W.Y., & Hock, O.S. 1997. Intensive plantation cropping, a source of sustainable food and energy production in the tropical rain forest areas in Southeast Asia. *Forest Ecology and Management*, 91: 93-102.

Harvey, C.A., Medina, A., Sanchez, D.M., Vilchez, S., Hernandez, B., Saenz, J.C., Maes, J.M., Casanoves, F., & Sinclair, F.L. 2006. Patterns of animal diversity in different forms of tree cover in agricultural landscapes. *Ecology Applications*, 16: 1986-1999.

Hayami, Y. 1996. The Peasant in Economic Modernization. *American Journal of Agricultural Economics,* 78:1157-67.

Hayami, Y. 2002. Family farms and plantations in tropical development. *Asian Development Review*, 19(2): 67-89.

Hazell, P., Poulton, C., Wiggins, S., & Dorward, A. 2010. The Future of Small Farms: Trajectories and Policy Priorities. *World Development*, 38(10): 1349-1361.

Heidemann, P.D., & Heaney, L.R. 1989. Population biology and estimates of abundance of fruit bats (Pteropodidae) in Phillippine submontane rainforest. *Journal of Zoology*, 218: 565-586.

Hill, J., & Smith, J. 1984. *Bats: A Natural History*. Austin: University of Texas Press.

Hodgkinson, R., Balding, S.T., Zubaid, A., & Kunz, T.H. 2003. Fruit bats (Chiroptera-Pteropodidae) as seed dispersers and pollinators in a lowland Malaysian rainforest. *Biotropica,* 35: 491-502.

Hodgkison, R., Balding, S.T., Zubaid, A., & Kunz, T.H. 2004a. Temporal variation in the relative abundance of fruit bats (Megachiroptera: Pteropodidae) in relation to the availability of food in a lowland Malaysian rain forest. *Biotropica,* 36: 522-533.

Hodgkison, R., Balding, S.T., Zubaid, A., & Kunz, T.H. 2004b. Habitat structure, wing morphology, and the vertical stratification of Malaysian fruit bats (Megachiroptera: Pteropodidae). *Journal of Tropical Ecology,* 20: 667-673.

Immerzeel, D.J., Verweij, P.A., Hilst, F.V.D., & Faaij, A.P.C. 2013. Biodiversity impacts of bioenergy crop production: a state-of-the-art review. *Global Change Biology Bioenergy*, 6: 183–209.

IPOC/WWF- Indonesia. 2004. *Impact Assessment on Oil Palm Development (Indonesia) by Dr Asril Darussamin.* IPOC / Mr Fitrian Ardiansyah, WWF-Indonesia.

Iremonger, S., Ravilious, C., & Quiton, T. 1997. *A global overview of forest conservation CD-ROM*. Center for International Forestry Research and World Conservation Monitoring Centre (CIFOR-WCMC), Cambridge.

Ismail, A., Simeh, M.A., & Noor, M.M. 2003. The production cost of oil palm fresh fruit bunches: the case of independent smallholders in Johor. *Oil Palm Industry Economic Journal*, 3(1): 1-7.

IUCN, 2016-1. *The IUCN Red List of Threatened Species*. Retrieve on 11 November 2016 from: http://www.iucnredlist.org/search.

Jenni, L., & Leuenberger, M. 1996. Capture efficiency of mist nets with comments on 58 their role in the assessment of passerine habitat use. *Journal of Field Ornithology*, 67: 263-274.

Jones, G., Jacobs, D.S., Kunz, T.H., Willig, M.R., & Racey, P.A. 2009. Carpe noctem: the importance of bats as bioindicators. *Endangered Species Research*, 8: 93-115.

Kingston, T., Lim, B.L., & Zubaid, A. 2006. *Bats of Krau Wildlife Reserve.* Penerbit Universiti Kebangsaan Malaysia, Selangor.

Kinjo, K., Nakamoto, A., Izawa, M., Baba, M., Doi, T., & Boeadi. 2003. Preliminary report on the bat fauna in an agricultural field in West Java, Indonesia. *Bulletin of the Kitakyushu Museum of Natural History and Human History,* 1: 51-55.

Kinnaird, M.F., Sanderson, E.W., O'brien, T.G., Wibisono, T.G., & Woolmer, G. 2003. Deforestation trends in a tropical landscape and implications for endangered large mammals. *Conservation Biology,* 17: 245-257.

Koczberski, G., & Curry, G.N. 2005. Making a living: land pressures and changing livelihood strategies among oil palm settlers in Papua New Guinea. *Agricultural Systems,* 85: 324–339.

Koh, L.P. 2007. Potential habitat and biodiversity losses from intensified biodiesel feedstock production. *Conservation Biology*, 21: 1373–1375.

Koh, L.P. 2008. Can oil palm plantations be made more hospitable for forest butterflies and birds?. *Journal of Applied Ecology*, 45:1002–1009.

Koh, L.P., & Ghazoul, J. 2008. Biofuels, biodiversity, and people: understanding the conflicts and finding opportunities. *Biological Conservation*, 141: 2450–2460.

Koh, L.P., & Wilcove D.S. 2007. Cashing in palm oil for conservation. *Nature*, 448: 993–994.

Koh, L.P., & Wilcove, D.S. 2008. Is oil palm agriculture really destroying tropical biodiversity?. *Conservation Letters,* 1: 60-64.

Koh, L.P. & Wilcove, D.S. 2009. Oil palm: disinformation enables deforestation. *Trends Ecology Evolution,* 24 :67–68.

Koh, L.P., Miettinen, J., Chin, L.S., & Ghazoul, J. 2011. Remotely sensed evidence of tropical peatland conversion to oil palm. *Proceedings of the National Academy of Sciences,* 108(12): 5127-5132.

Koopman, K.F. 1994. Chiroptera: Systematics. *Zoology,* 8(60): 12-18.

Kunz, T. 1990. *Ecological and Behavioral Methods for the Study of Bats*. Smithsonian; New edition. pp. 556.

Kunz, T.H., & Anthony, E.L.P. 1977. On the efficiency of the Tuttle bat trap. *Journal of Mammalogy,* 58: 309-315.

Kunz, T.H., Tidemann, C.R., & Richards, G.C. 1996. Small volant mammals. In: Wilson, D.E., Cole, F.R., Nichols, J.D., Rudran, R., & Foster, M.S. (Eds) - *Measuring and monitoring biological diversity: standard methods for mammals.* Smithsonian Institution Press, Washington, D.C., pp. 122-146.

Kunz, T.H., & Fenton, M.B. 2006. *Bat Ecology.* USA: University of Chicago Press.

Kunz, T.H., & Parsons, S. 2009. *Ecological and Behavioral Methods for the Study of Bats*. Johns Hopkins University Press, Baltimore, MD.

Kunz, T.H., Braun, de, Torrez, E., Bauer, D., Lobova, T., & Fleming, T.H. 2011. Ecosystem services provided by bats. *Annals of the New York Academy of Sciences*, 1223: 1-38.

Krzanowski, A. 1973. Numerical comparison of Vespertilionidae and Rhinolophidae (Chiroptera: Mammalia) in the owl pellets. *Acta Zoologica Cracovensia,* 18: 133-140.

Lapola, D.M., Schaldach, R., Alcamo, J., Bondeau, A., Koch, J., Koelking, C., & Priess J.A. 2010. Indirect land-use changes can overcome carbon savings from biofuels in Brazil. *Proceedings of the National Academy of Sciences,* 107(8): 3388-3393.

Lambert, M.S., Quy, R.J., Smith, R.H., & Cowan, D.P. 2008. The effect of habitat management on home-range size and survival of rural Norway rat populations. *Journal Applied Ecology,* 45: 1753–1761.

Lassau, S.A., & Hochuli, D.F. 2004. Effects of habitat complexity on ant assemblages. *Ecography,* 27: 157-164.

LaVal, R.K., & Fitch, H.S. 1977. Structure, movements and reproduction in three Costa Rican bat communities. *Occasional Papers of the Museum of Natural History*, University of Kansas, 69: 1-28.

Allen, & Unwin L.T.G. 1977. Peasants and their Agricultural Economy in Colonial Malaya, 1874-1941. In: Lewis, W.A. 1970 (Ed.) *Tropical Development, 1880-1913: Studies in Economic Progress, Kuala Lumpur.* London: Oxford University Press.

Lindenmayer, D.B., & Hobbs, R.J. 2004. Fauna conservation in Australian plantation forests—a review. *Biological Conservation*, 119: 151–168.

Lucey, J.M., & Hill, J.K. 2012. Spillover of insects from rain forest into adjacent oil palm plantations. *Biotropica,* 44: 368-377.

Malaysian Palm Oil Board, MPOB. 2015. Oil Palm Planted Area 2015. Retrieved on 02nd September 2016 from: http://bepi.mpob.gov.my/index.php/statistics/area/134-area-2015/732-oil-palm-planted-area-2015.html.

Malaysian Palm Oil Board, MPOB. 2015. Oil Palm Production Statistics 2015. Retrieved on 02nd September 2016 from: http://bepi.mpob.gov.my/index.php/statistics/production/135-production-2015/737-production-of-oil-palm-products-2015.html.

Malaysian Palm Oil Council, MPOC. 2016. Monthly Palm Oil Trade Statistics - May, 2016. Retrieved on 02nd September 2016 from: http://www.mpoc.org.my/monthly_sub_page.aspx?id=f82c0e94-7665-4593-a43c-955a2cd5edfe.

Malek, M., & Barlow, C. 1988. Malaysian palm oil industry with special reference to the smallholders: The production structure of the sub-sector. *PORIM Occasional Paper*, 24: 53.

Marshall, A.G., 1983. Bats, flowers and fruit: evolutionary relationships in the Old World. *Zoological Journal of Linnean Society*, 20: 115–135.

Marshall, A.G. 1985. Old World phytophagous bats (Megachiroptera) and their food plants: a survey. *Zoological Journal of the Linnean Society,* 83: 351-369.

May, C.Y. 2012. Malaysia: Economic Transformation Advances Oil Palm Industry. Retrieved on 02nd March 2016 from: http://www.aocs.org/stay-informed/read-inform/featured-articles/malaysia-economic transformation-advances-oil-palm-industry-september-2012.

McCarthy, J.F., & Cramb R.A. 2009. Policy narratives, landholder engagement, and oil palm expansion on the Malaysian and Indonesian frontiers. *The Geografical Journal* 175: 112–123.

Meyer, C.F.J., Frund, J., Lizano, W.P., & Kalko, E.K.V. 2008. Ecological correlates of vulnerability to fragmentation in Neotropical bats. *Journal of Applied Ecology*, 45: 381-391.

McNeely, J.A., & Scherr, S.J. 2003. *Ecoagriculture: strategies to feed the world and save wild biodiversity.* Island Press, Washington.

Mendenhall, C.D., Karp, D.S., Meyer, C.F.J., Hadly, E.A., & Daily, G.C. 2014. Predicting biodiversity change and averting collapse in agricultural landscapes. *Nature,* 509: 213–217.

Michel, N., Burel, F., Legendre, P., & Butet, A. 2007. Role of habitat and landscape in structuring small mammal assemblages in hedgerow networks of contrasted farming landscapes in Brittany, France. *Landscape Ecology,* 22: 1241–1253.

Mickleburgh, S.P., Huston, A.M., & Racey, P.A. 2002. A review of the global conservation status of bats. *Oryx,* 36: 18-34.

Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J., & da Fonseca, G.A.B. 2005. *Hotspots Revisited: Earth's Biologically Richest and Most Threatened Terrestrial Ecoregions*. Cemex, Conservation International and Agrupacion Sierra Madre, Monterrey, Mexico.

Morrison, M.L., Block, W.M., Strickland, M.D., Collier, B.A., & Peterson, M.J. 2008. *Wildlife Study Design.* Springer, USA, pp. 148-151.

Moro, D., & Gadal, S. 2007. Benefits of habitat restoration to small mammal diversity and abundance in a pastoral agricultural landscape in mid-Wales. *Biodiversity Conservation*, 16: 3543–3557.

Murphy, D.J. 2007. Future prospects for oil palm in the 21st century: biological and related challenges. *European Journal of Lipid & Science Technology*, 109: 296–306.

Muyanga, M., & Jayne T.S. 2014. Is small still beautiful? The farm size-productivity relationship revisited. *Paper prepared for presentation at the 2014 conference on land policy in Africa African Union Conference Center*. Addis Ababa, Ethiopia November 11-14, 2014.

Myint, H. 1965. *The Economics of Developing Countries*. New York: Praeger.

Na´jera, A., & Simonetti, J.A. 2010. Enhancing avifauna in commercial plantations. *Conservation Biology,* 24: 319–324.

Najera, A., & Simonetti, J.A. 2010. Can oil palm plantations become bird friendly? *Agroforestry Systems*, 80: 203-209.

Nowak, R.M., 1999. *Walker's mammals of the world*. United States: Johns Hopkins University Press.

Nur Juliani, S., Shahrul, A.M.S., Nurul, S.A.L., Nur, Munira, A., & Nurul, Liyana, K. 2011. Diversity pattern of bats at two contrasting habitat types along Kerian River, Perak, Malaysia. *Tropical Life Science Research,* 22: 13-22.

O'farrel, M., & Gannon, W. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. *Journal of Mammology*, 80(1): 24-30.

Ooi, J.B. 1963. *Land, People and Economy in Malaya*. London: Longman

Pakiam, R., 2013. *Palm Oil Advances as Malaysia's Export Tax May Boost Shipments*. Retrieved on 5 January, 2013 from: http://www.theborneopost.com/2013/01/05/palm-oil-advances-as-malaysias-export-tax-may-boost-shipments/.

Parsons, K., Crompton, R., Graves, R., Markham, S., Matthews, J., Oxford, M., Shepherd, P., & Sowler, S. 2007. *Bat Surveys – Good Practice Guidelines*. Bat Conservation Trust, London, 82.

Peh, K., Sodhi, N., de Jong, J., Sekercioglu, C., Yap, C., & Lim, S. 2006. Conservation value of degraded habitats for forest birds in southern Peninsular Malaysia. *Diversity Distribution*, 12: 572–581.

Petit, S., Pors, L., Surrel, M., & Petit, J. 1994. Capture of a nectar-feeding bat species with a modified harp trap. *Bat Research News,* 45: 62.

Petrushenko, Y., Godlevska L., & Zagorodniuk, I. 2001. Investigations of bat communities in the Siversky Donets flood-lands. *Scientific bulletin of Lugansk University*, 11: 114-117.

Pogue, D.W., & Schnell, G.D. 2001. Effects of agricultural on habitat complexity in a prairie-forest ecotone in the Southern Great Plains of North America. *Agriculture, Ecosystems & Environment,* 87: 287–298.

Price, L. 2000. Bats in dark cave at Batu Caves. *Malayan Naturalist*, 54: 44-45.

Quesada, M., Stoner, K.E., Rosas-Guerrero, V., Palacios-Guevara, C., & Lobo, J.A. 2003. Effects of habitat disruption on the activity of nectarivorous bats (Chiroptera: Phyllostomidae) in a dry tropical forest: implications for the reproductive success of the neotropical tree *Ceiba grandiflora*. *Oecologia,* 135: 400-406.

Racey, P.A., & Entwistle, A.C. 2002. Conservation ecology of bats. In: Kunz, T.H., & Fenton, M.B. (Eds.), *Bat Ecology*. The University of Chicago Press, U.S.A.

Rose, K.D., & Archibald, J.D. 2005. *The rise of placental mammals: Origins and relationships of the major extant clades.* The John Hopkins University Press, pp. 160-173.

RSPO. RSPO Principles and Criteria for Sustainable Palm Oil Production. Including Indicators and Guidance. Retrieved on October 2015 from: http://www.rspo.org/files/resource_centre/RSPO%20Principles%20&%20Criteria%20Document.pdf.

RSPO. 2009. RSPO and National Implementation Working Group (PNG NIWG). Indicators and guidance required to establish the RSPO Principles and Criteria. Retrieved on February 2015 from: http://www.rspo.org/file/PDF/RSPO_national%20interpretation/papua/PNG%20NIWG%20Indicators%20and%20Guidance%20for%20RSPO%20rev%2020080317%20%28FINAL%29.pdf.

Ruprecht, A.L. 1979. Bats (Chiroptera) as constituents of the food of barn owls *Tyto alba* in Poland. *Ibis,* 121: 489-494.

Russo D., Jones G. 2002. Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *Journal of Zoology*, 258: 91-103.

Sandker, M., Suwarno, A., & Campbell, B.M. 2007. Will forests remain in the face of oil palm expansion?. Simulating change in Malinau, Indonesia. *Ecology and society,* 12: 37.

Sargeant, H.J. 2001. *Oil Palm Agriculture in the Wetlands of Sumatra: Destruction or Development?* European Union Ministry of Forestry, Brussels, 50.

Sayer, J., Ghazoul, J., Nelson, P., & Boedhihartono, A.K. 2012. Oil palm expansion transforms tropical landscapes and livelihoods. *Global Food Seciety*, 1: 114–119.

Savilaakso, S., Garcia, C., Garcia-Ulloa, J., Ghazoul, J., Groom, M., Guariguata, M.R., Laumonier, Y., Nasi, R., Petrokofsky, G., Snaddon, J., & Zrust, M. 2014. Systematic review of effects on biodiversity from oil palm production. *Environmental Evidence,* 3: 1-21.

Scharlemann, J.P.W., Laurance, W.F. 2008. How green are biofuels?. *Science*, 319: 43–44.

Sheil, D., Casson, A., Meijaard, E., Van Noordwjik, M., Gaskell, J., Sunderland-Groves, J., Wertz, K., & Kanninen, M. 2009. The impacts and opportunities of oil palm in Southeast Asia. What do we know and what do we need to know?. *Center for International Forestry Research*.

Sheldon, F.H., Styring, A., & Hosner, P.A. 2010. Bird species richness in a Bornean exotic tree plantation: a long-term perspective. *Biological Conservation*, 143: 399–407.

Shilton, L.A., Altringham, J.D., Compton, S.G., & R.J. Whittaker. 1999. Old World fruit bats can be long-distance seed dispersers through extended retention of viable seeds in the gut. *Proceedings of the Royal Society of London B*, 266: 219–223.

Sikes, R.S., Gannon, W.L., & The Animal Care and Use Committee of the American Society of Mammalogists. 2011. Guidelines of the American society of mammalogists for the use of wild mammals in research. *Journal of Mammalogy,* 92: 235-253.

Simmons, N.B., & R.S., Voss. 1998. The mammals of Paracou, French Guiana, a Neotropical lowland rainforest fauna. Part 1, Bats. *Bulletin American Museum of Natural History*, 237.

Smith, R.J., Muir, R.D., Walpole, M.J., Balmford, A., & Leader-Williams, N. 2003. Governance and the loss of biodiversity. *Nature,* 426: 67-70.

Sodhi, N.S., Koh L.P., Brook B.W., & Ng, P.K.L. 2004. Southeast Asian biodiversity: an impending disaster. *Trends in Ecology and Evolution,* 19: 654–660.

Sodhi, N.S., & Brook, B.W. 2006. *Southeast Asian biodiversity in crisis*. Cambridge University Press.

Sophia, E. 2010. Foraging behavior of the Microchiropteran bat, *Hipposideros ater* on chosen insect pests. *Journal of Biopesticide*, 3(1): 68-73.

Start, A.N., & Marshall, A.G. 1976. Nectarivorous bats as pollinators of trees in western Malaysia. In: Burley, J., & Styles, B.T. (Eds.), *Tropical Trees: Variation, Breeding and Conservation, Linnean Society Symposium Series 2*. Linnean Society of London and Academic Press, London, pp. 141-150.

Struebig, M.J., Kingston, T., Zubaid, A., Adura, M.A., & Rossiter, S.J. 2008. Conservation value of forest fragments to Palaeotropical bats. *Biological Conservation,* 141: 2112-2126.

Speakman, J.R. 1991. The impact of predation by birds on bat populations in the British Isles. *Mammal Review,* 21: 123-142.

Sulai, P., Nurhidayu, S., Aziz, N., Zakaria, M., Barclay, H., & Azhar, B. 2015. Effects of water quality in oil palm production landscapes on tropical waterbirds in Peninsular Malaysia. *Ecological Restoration,* 30: 941-949.

Sullivan, T.P., Sullivan, D.S., Hogue, E.J., Lautenschlager, R.A., & Wagner, R.G. 1998. Population dynamics of small mammals in relation to vegetation management in orchard agroecosystems: compensatory responses in abundance and biomass. *Crop Protection*, 17: 1–11.

Suyanto, S., Applegate, G., Permana, R.P., Khususiyah, N., & Kurniawan, I. 2004. The role of fire in changing land use and livelihoods in Riau-Sumatra. *Ecology and Society*, 9: 15.

Swihart, R.K., Lusk, J.J., Duchamp, J.E., Rizkalla, C.M., & Moore, J.E. 2006. The roles of landscape context, niche breadth, and range boundaries in predicting species responses to habitat alteration. *Diversity and Distributions,* 12: 277-287.

Terbogh, J. 1983. *Five New World Primates: A study in a comparative ecology.* Princeton, New Jersey: Princeton University Press.

Tscharntke, T., Klein, A.M., Kruess, A., Steffan-Dewenter, I., & Thies, C. 2005. Landscape perspectives on agricultural intensification and biodiversity-ecosystem service management. *Ecology Letters*, 8: 857–874.

Tuttle, M.D. 1974. An improved trap for bats. *Journal of Mammalogy*, 55: 475-477.

Tyshchenko, V., Matveev, M., & Bovtunova, Y. 2005. In addition to bat fauna (Chiroptera) of Khmelnitsky region. *Scientific bulletin of Uzhgorod University (Series Biology),* 17: 173-183.

UNEP. & UNESCO. 2007. *State of emergency: illegal logging, fire and palm oil in Indonesia's National Parks.* The last stand of the orangutan, 2007.

Vaughan, T., Ryan, J., & Czaplewski, N. 2000. *Mammalogy, 4th Edition*. Toronto: Brooks Cole.

Vlaschenko, A.S., & Gukasova, A.S. 2009. *Development of method for the inventory of species composition and population structure of bats*. Nature reserves in Ukraine, 15(1): 49-57.

Wahid, M.B., Akmar-Abdullah, S.N., & Henson, I.E. 2005. Oil palm-achievements and potential. *Plant Production Sciences,* 8: 288-297.

Walsh, A., Catto, C., Hutson, T., Racey, P., Richardson, P., & Langston, S. 2001. *The UK's National Bat Monitoring Programme Final Report 2001*. Bat Conservation Trust, London, pp 156.

Wilcove, D.S., & Koh, L.P. 2010. Addressing the threats to biodiversity from oil-palm agriculture. *Biodiversity Conservation*, 19: 999–1007.

Wilson, D.E., & Reeder, D.M. 1993. *Mammal species of the world, a taxonomic and geographic reference 2nd edition.* Washington D.C: Smithsonian Institution Press.

Wilson, D.E., Reeder, D.M. (Eds.) 2005. *Mammal Species of the World: a Taxonomic and Geographic Reference* (Vol. 1). Washington D.C: Smithsonian Institution Press.

Wilson, J.D., Morris, A.J., Arroyo, B.E., Clark, S.C., & Bradbury, R.B. 1999. A review of the abundance and diversity of invertebrate and plant foods of granivorous birds in northern Europe in relation to agricultural change. *Agriculture, Ecosystems and Environment,* 75: 13–30.

Wood, W.B. 1990. Tropical deforestation: balancing regional development demands and global environmental concerns. *Global Environmental Change*, 1: 23-41.

WRI. (2007) *EarthTrends: environmental information*. World Resources Institute (WRI), Washington. D.C. Retrieved on November 2016 from: http://earthtrends.wri.org.

WWF. 2002. Oil Palm Plantations and Deforestation in Indonesia. What Role Do Europe and Germany Play? World Wildlife Fund, Switzerland.

WWF 2011. Palm oil: environmental impacts. World Wildlife Fund (accessed 18 August 2011).

Zagorodniuk, I., Godlevska, L., Tyshchenko, V., & Petrushenko, Y. 2002. Bats of Ukraine and adjacent countries: a guide for field investigations. *Proceedings of the Theriological School*, 3: 110.

Zubaid, A. 1993. A comparison of the bat fauna between a primary and fragmented secondary forest in Peninsular Malaysia. *Mammalia,* 57: 201-206.