ANURAN SPECIES ABUNDANCE IN TROPICAL AGRICULTURAL LANDSCAPES

SITI WAHDANIYAH BINTI MOHAMAD ISMAIL

FH 2018 117

ANURAN SPECIES ABUNDANCE IN TROPICAL AGRICULTURAL LANDSCAPES

By

SITI WAHDANIYAH BINTI MOHAMAD ISMAIL

A Project Report Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry Universiti Putra Malaysia

2018

© COPYRIGHT UPM

DEDICATION

For my beloved family:

Mohamad Ismail B. Angu

Rosseliiah Bt. Bokhari

Also my siblings.

To all my friends,

and Lalah River Village residents

Thank you for your encouragements supports

And the sacrifices that you have given.

Last but not least,

I dedicated this dissertation to Dr. Mohamad Roslan Mohamad Kasim and Dr. Badrul Azhar Md. Sharif

Who has encouraged me, helped and give so much support during conducting this research.

Thank you for everything. May Allah Bless All of us.

© COPYRIGHT UPM

ABSTRACT

The expansion of agricultural crops throughout the tropical region has become the biggest threat to biodiversity. Therefore, study aimed to gain baseline data on anuran abundance in the Malaysian oil palm plantation (OPP) and traditional fruit orchard (TFO). Present study was conducted in Kuala Lumpur Kepong Oil Palm Plantation (OPP) and Kampung Sungai Lalah and Kampong Sungai Batu Traditional Fruit Orchard (TFO), in Pedas, Negeri Sembilan. Data collection was conducted from July till August 2017 and January till February 2018. A total of 40 points were set up in both TFO and OPP with two cycles of observation, giving it a total of 160 observations. The survey design for this research was the systematic point sampling with random start. The survey was conducted during night time, 8.00 p.m to 10.00 p.m where it is the active period for the anurans. Aural and visual search method were used in this study. The result showed the total number of anurans for OPP in both visits are 394 individuals while 290 individuals in TFO. However, analysis indicated that the anuran abundance has no significant difference in both tropical agricultural landscapes. Overall, there were four families of the anuran species recorded in both tropical agricultural landscapes. The four families of anurans consist of Rhacophoridae (*Polypedates leucomystax*), Microhylidae (*Microhyla heymonsii, Microhyla butleri* and *Kaloula pulchra*), Dicroglossidae (*Fejervarya limnocharis*) and Ranidae (*Hylarana glandulosa)*. These species are typically inhabit disturbed habitats associated with human activities.

© COPYRIGHT UPM

ABSTRAK

Perkembangan tanaman pertanian di seluruh rantau tropika telah menjadi ancaman terbesar kepada kepelbagaian biodiversiti. Oleh itu, kajian ini bertujuan untuk mendapatkan data asas mengenai taburan anura di ladang kelapa sawit Malaysia (OPP) dan kebun buah (TFO). Kajian ini dijalankan di Ladang Kelapa Sawit Kepong (OPP) Kuala Lumpur dan Kampung Sungai Lalah dan Kampung Buah Kampong Sungai Batu (TFO), di Pedas, Negeri Sembilan. Pengumpulan data telah dijalankan dari Julai hingga Ogos 2017 dan Januari hingga Februari 2018. Sejumlah 40 titik sampel ditubuhkan di kedua-dua TFO dan OPP dengan dua pusingan pemerhatian, dengan memberikan sejumlah 160 pemerhatian. Reka bentuk kajian untuk kajian ini adalah pensampelan titik sistematik dengan permulaan rawak. Tinjauan ini dijalankan pada waktu malam, 8.00 p.m hingga 10.00 p.m di mana ia merupakan tempoh aktif untuk anura. Kaedah pencarian aural dan visual telah digunakan dalam kajian ini. Hasilnya menunjukkan jumlah anura bagi OPP dalam kedua-dua lawatan ialah 394 orang manakala 290 individu dalam TFO. Walau bagaimanapun, analisis menunjukkan bahawa taburan anura tidak mempunyai perbezaan yang signifikan bagi kedua-dua kawasan. Secara keseluruhan, terdapat empat keluarga spesies anura yang dicatatkan di kedua-dua kawasan. Keempat-empat keluarga anura tersebut terdiri daripada Rhacophoridae (*Polypedates leucomystax*), Microhylidae (*Microhyla heymonsii, Microhyla butleri* dan *Kaloula pulchra*), Dicroglossidae (*Fejervarya limnocharis*) dan Ranidae (*Hylarana glandulosa*). Spesies- spesies ini kebiasaannya menghuni habitat terganggu yang berkaitan dengan aktiviti manusia.

© COPYRIGHT UPM

ACKNOWLEDGEMENTS

Alhamdulillah and thank to Allah S.W.T with all His Gracious and His Merciful for giving me strength and the ability to accomplish this project successfully. I would like to take the utmost opportunity to express my sincere and gratitude to my supervisor, Dr. Mohamad Roslan Mohamad Kasim and co-supervisor, Dr. Badrul Azhar Md. Sharif, who is always giving me supports and guidance.

My greatest appreciation also goes to the people that have been involved directly or indirectly in making this research project paper success. They are the residents of Lalah River Village, Makcik Ani, Haji Sharoom, Pak Hanif and others. Thank you for providing a comfortable place and taking care of me while I'm in the Lalah River Village and also their cooperation and assistance during the field survey had been very helpful to me.

Finally, to my parents and siblings, special thanks are given to them. Appreciation and gratitude are also expressed to my special friends and colleagues for their help and constructive suggestion through this study, especially to Farid B. Ramli, Nor Shenurain Zuliksa, Abu Hassan Dean, Syafiq, Najihah Zakaria, Megat Naqiuddin, Rexie Mackenddy, Syafiq and Fatin Afiqah Roslan. Last but not least to those whose names are not mentioned, I wish to express my special thanks for their helps in one way or another during this project.

© COPYRIGHT UPM

APPROVAL SHEET

I certify that this research project report entitled “Anuran Species Abundance In Tropical Agricultural Landscapes” by Siti Wahdaniyah Bt. Mohamad Ismail has been examined and approved as a partial fulfillment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Univeristi Putra Malaysia.

_____

Dr. Mohamad Roslan Mohamad Kasim
Faculty of Forestry
Universiti Putra Malaysia
(Supervisor)

_____

Prof. Dr. Mohamed Zakaria Bin Hussin
Dean
Faculty of Forestry
Universiti Putra Malaysia

Date: 04 June 2018

© COPYRIGHT UPM

TABLE OF CONTENTS

© COPYRIGHT UPM

© COPYRIGHT UPM

LIST OF TABLES

© COPYRIGHT UPM

LIST OF FIGURES

© COPYRIGHT UPM

LIST OF ABBREVIATIONS

OPP	Oil Palm Plantation
TFO	Traditional Fruit Orchard
PL	*Polypedates leucomystax*
FL	*Fejervarya limnocharis*
KP	*Kaloula pulchra*
MH	*Microhyla heymonsii*
MB	*Microhyla butleri*
HG	*Hylarana glandulosa*

© COPYRIGHT UPM

CHAPTER ONE

INTRODUCTION

1.1 General Background

Forests is particularly significant in the Malaysian context where the Malaysian forests are rapidly disappearing while its conversion into 'forest' plantations areas are expanding. Malaysia currently has 32.8 million hectares of land area, of which 24.8 million hectares - 75.5 per cent of total land - are classified as forest and tree cover. Of these, 19.5 million hectares are forest cover and 5.3 million hectares are tree cover (Ngo, 2008).

Forest cover is any area with a lot of trees [tree canopy density more than 10%] whether it is officially protected by the government or not (Viswanathan, 2015). Meanwhile, tree cover comprises of tree patches outside the recorded forest area exclusive of forest cover and less than the minimum mapped area (1 ha) (Open Government Data Platform India, 2015).

Of the total forest cover, 9.2 million hectares (47.4 per cent) are found in Sarawak, 5.9 million hectares (30.1 per cent) are found in Peninsular Malaysia and 4.4 million hectares (22.5 per cent) in Sabah. Moreover, Sabah claims it has the least forest (Ngo, 2008).

© COPYRIGHT UPM

Although Malaysia is known as the equatorial rain forests of the world due to its location and its forested area, the historical fact is that in the year of between 1990 and 2005, Malaysia has lost 6.6% of its forest cover, or around 1, 486 000 hectares (Ngo, 2008).

Deforestation is the removal of a forest or tree stand where the land is thereafter converted to a non-forest use such as conversion of forestland to agriculture or urban use. The removal of trees without sufficient reforestation has resulted in damage to habitat, biodiversity loss and aridity (Ngo, 2008). Biological diversity loss is most commonly attributed to habitat loss and alteration (Todd et.al, 2009).

The rise in global demand for agricultural commodities is a major driver of habitat modification, and the amount of land under cultivation is predicted to expand substantially in the next 4 decades (Wanger et. al, 2009). A large component of this conversion to cropland is for oil-palm plantations, much of which has occurred in Southeast Asia (Koh 2007). The effects of habitat loss and alteration on amphibian biological diversity in the worldwide have been recognized. Yet, results of studies of anurans responses to such changes are inconsistent among studies (Hecnar & M'Closkey, 1997; Gibbs, 1998; Parris, 2004).

Moreover, pollution, overharvesting, and infectious diseases have contributed to a global amphibian decline, but habitat alteration consistently ranks as the largest threat (Faruk et al., 2013). Therefore,

© COPYRIGHT UPM

Faruk et al., (2013) stated that land-use changes can make an area improper for anurans reproduction and survival. However, in other circumstances disturbed or converted areas are still be known to support a substantial subset of the original anuran community (Gibbs, 1998).

1.2 Problem Statement

A major topic to be given attention to is the impoverishment of Southeast Asian forest due to the expansion of agricultural activities. The widening of this equatorial crops throughout the tropical region has become the biggest threat to biodiversity (Green et al., 2005). Equatorial crops production and the expansion of the forest area into the conventional agricultural area has caused damage to natural environment and the effect of this damage to the environment is irreversible (Aikanathan et al., 2011). It was stated that the impacts of deforestation also includes the habitat loss of critically endangered species. All faunas have their own conservation value since they have their own ecological role or niche that helps to balance the ecosystem cycle.

The natural forest habitat is more complex and diverse compared to oil palm monoculture plantation and fruit orchard conventional agricultural practices. Generally, natural forest is the best place for these faunas since it owns a stable microclimate, less human disturbance and variety age structures, compared to this both agricultural systems (Corley and Tinker, 2003). These two different agricultural systems especially the

© COPYRIGHT UPM

equatorial crops usually hold only 15% of the forest species and the remaining 85% were considered lost during the area conversion.

The affected species were vertebrate group especially small mammals, bats, anurans, reptiles, carnivores and birds. It is stated that, the reduction in species richness, species diversity and shifts in community composition of beetles (Chung et al., 2000), reptiles (Glor et al., 2001), birds (Koh & Wilcove, 2008) and ants are all related to equatorial crops which include both agricultural practices. Besides that, the International Union for Conservation of Nature (IUCN) Red List reports 41% of 6300 described, extant anuran species are at risk of extinction (IUCN, 2010).

The impoverishment of wildlife from this land conversion has encouraged environmental NGO's especially from external Southeast Asian region to campaign against equatorial crops production (Lam et al., 2009). There is a need to study anurans ecology, focusing on the interaction between anurans abundance and habitat quality. Hence, past study have been contradictory in whether the abundance and diversity of a species is positive correlated with habitat quality. In this two different agricultural landscapes, the habitat quality is closely associated with the agricultural practices in each of the area such as herbicides and pesticides types, frequency application and cutting which will affect the anurans abundance in both equatorial crops due to their close relation with the habitat quality and the sensitivity to habitat change.

© COPYRIGHT UPM

It is essential to manage these two different equatorial crops practices for conservation outcomes since biodiversity has taken place on both agricultural area due to rapid expansion of both crops. Moreover, this equatorial crops has taken place on the area that was once a forested area.

Knowing the key factor which is most correlated with anurans abundance and richness, the anurans community in this two different type of agricultural landscapes can be improve. Since agricultural area are now expanding very fast, replacing the forest cover, it was crucial to protect the biodiversity in both of the area. It is also crucial to make the readily exist equatorial crops into a more wildlife area since the population are now increasing and various land will be cleared. Plantation manager and villagers who own the fruit orchard also have to work together in order to manage the wildlife community, especially the anurans species in both of the tropical agricultural landscapes effectively.

1.3 Objectives

The main aim of this study was to determine the anurans species abundance in two different tropical agricultural landscapes consisting of oil palm plantation (OPP) and traditional fruit orchard (TFO) which are closely associated and correlated with the key factors of habitat quality measurement at both of the study site. This study also focused on specific objectives which are:

© COPYRIGHT UPM

i. To quantify number of anurans abundance according to species in both area.

ii. To compare species abundance between oil palm plantation (OPP) and traditional fruit orchard (TFO).

iii. To determine the key environmental factors that influence anuran biodiversity in agricultural landscapes

1.4 Significance of study

This study was conducted to determine the anuran species abundance in tropical agricultural landscapes which include oil palm plantation and fruit orchard located in Pedas, Negeri Sembilan. Faruk (2013) stated that data on anuran diversity in agricultural area are lacking as most of the studies are comparing the frog abundance and richness between forest and agricultural area. Meanwhile, this study is related to the comparison between two tropical agricultural areas with different management systems.

The purpose of this study was also to determine the key habitat quality that influences anurans abundance in both of the area. It is because, most of the previous studies are more comparative type of study instead of finding the relationship between the habitat quality and to what degree of associated does a habitat quality has to relate with anurans abundance in both tropical agricultural landscapes. (Faruk, 2013) stated that the study investigated how anuran biological diversity differs

© COPYRIGHT UPM

between forest and oil-palm plantation, and whether observed differences in biological diversity of these areas is linked to specific environmental factors.

In the other hand, these sets of data were important to identify the significant factors that influenced the anurans biodiversity. Under this two different tropical agricultural landscape, these sets of data can be applied as a guideline for the future studies of this anurans species.

© COPYRIGHT UPM

REFERENCES

Aikanathan, S., Chenayah, S., & Sasekumar, A. (2011). Sustainable agriculture : a case study on the palm oil industry, *Malaysian Journal of Science*, 30(1), 66–75.

Anonymous. (2018), Ecology Asia. 2018, Microhyla heymonsii https://www.ecologyasia.com/verts/amphibians/dark-sided_chorus_frog.htm (Accessed February, 2018)

Azhar, B., Lindenmayer, D. B., Wood, J., Fischer, J., Manning, A., McElhinny, C., et al. (2013b). The influence of agricultural system, stand structural complexity and landscape context on foraging birds in oil palm landscapes. Ibis, 155, 297–312.

Azhar, B., Leong, C., & Zakaria, M. (2014). Effects of monoculture and polyculture practices in oil palm smallholdings on tropical farmland birds. *Basic and Applied Ecology*, 15(4), 336–346. https://doi.org/10.1016/j.baae.2014.06.001

Barlow, J. et al. (2007). Quantifying the biodiversity value of tropical primary, secondary, and plantation forests. *Proceedings of the National Academy of Sciences*. USA, 104, 18555–18560.

Corley, R.H.V., and Tinker, P.B. (2003). The Oil Palm. Oxford: John Wiley & Sons, doi: 10.1002/9780470750971

Chung, A. Y. C., P. Eggleton, M. R. Speight, P. M. Hammond, and V. K. Chey. 2000. The diversity of beetle assemblages in different habitat types in Sabah, *Malaysia. Bulletin of Entomological Research*, 90, 475-496

Donald, P.F. (2004) Biodiversity impacts of some agricultural commodity production systems. Conserv. Biol. 18

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(Rspo 2007), 236–242. https://doi.org/10.1111/j.1755-263X.2010.00107.x

Faruk, A., Belabut, D., Ahmad, N., Knell, R. J., & Garner, T. W. J. (2013). Effects of oil-palm plantations on diversity of tropical anurans, *Conservation Biology*, 27(3), 615–624. https://doi.org/10.1111/cobi.12062

Feintrenie, L., Chong, W.K., and Levang, P. (2010). Why do farmers prefer oil palm? Lessons learnt from Bungo district, Indonesia. Small Scale Forestry 9, 379–396. doi:10.1007/s11842-010-9122-2

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Donald, P. F., & Phalan, B. (2008). How will oil palm expansion affect biodiversity ? *Trends in ecology & evolution*, 23 (10), https://doi.org/10.1016/j.tree.2008.06.012

© COPYRIGHT UPM

Fischer J, Brosi B, Daily GC, Ehrlich PR, Goldman R, Gold-stein J, Lindenmayer DB, Manning AD, Mooney HA, Pejchar L, Ranganathan J, Tallis H (2008) Should agricultural policies encourage land sparing or wildlife friendly farming? *Frontiers in Ecology and the Environment*, 6:380–385

Foley, JA. ; DeFries, R.; Asner, GP. ; Barford, C.; Bonan. G.; Carpenter, SR.; Chapin, FS. ; Coe, MT.; Daily, GC. ; Gibbs, HK. ; Helkowski, JH.; Holloway, T.; Howard, EA.; Kucharik, CJ. ; Monfreda, C.; Patz, JA. ; Prentice, IC. ; Ramankutty, N. & Snyder, PK. (2005). Global consequences of land use. Science, 309: 5734, (July 2005), pp.570-574, ISSN 0036-8075

Gibbs, J. P. (1998). Distribution of woodland amphibians along a forest fragmentation gradient, (Sjögren 1991), *Landscape Ecology,* 13: 263–268, Kluwer Academic Publishers. Printed in the Netherlands.

Gillespie, G.R., Howard, S., Lockie, D., Scroggie, M., Boeadi, (2005). Herpetofaunal richness and community structure of offshore islands of Sulawesi, Indonesia, *Biotropica*, 37, 279–290

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. https://doi.org/10.1016/j.biocon.2012.03.023

Giam, X., Clements, G.R., Aziz, S.A., Chong, K.W., Miettinen, J., (2011). Rethinking the 'back to wilderness' concept for Sundaland's forests. *Biology Conservation*, 144, 3149–3152.

Glor, R. E., Flecker, A. S., Benard, M. F., & Power, A. G. (2001). Lizard diversity and agricultural disturbance in a Caribbean forest landscape, *Biodiversity and Conservation,* 10:711–723, Kluwer Academic Publishers. Printed in the Netherlands.

Gray, B.S., Hew, C.K., (1968). Cover crop experiments in oil palms on the West Coast of Malaysia. In: Turner, P.D. (Ed.), Oil Palm Development in Malaysia. The Incorporated Society of Planters, Kuala Lumpur, pp. 56e65.

Green, R.E., Cornell, S.J., Scharlemann, J. P., and Balmford, A. (2005). Farming and the fate of wild nature. Science 307, 550–555.doi:10.1126/science.1106049

Groom, M., Gray, E., & Townsend, P. (2008). Biofuels and Biodiversity: Principles for Creating Better Policies for Biofuel Production. Conservation Biology, 22(3), 602-609. Retrieved from http://www.jstor.org/stable/20183427

Hartley, C.W.S., (1988). The Oil Palm, third ed.. Longman, London

Hecnar, S. J., & Closkey, R. T. M. (1997). The effects of p r e d a t o r y fish o n a m p h i b i a n species richness and distribution, 3207(96), 123–131.

© COPYRIGHT UPM

Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.-A.C., & M.S. Foster, (eds.) 1994. Measuring and monitoring biological diversity. Standard methods for amphibians. Washington & London: Smithsonian Institution Press, 364 pp.

Imbun, P. Y. (2014). Amfibia Sabah. Malaysia: Dewan Bahasa dan Pustaka.

Inger, R. F., & Lian, T. F. (1996). Checklist of the Frogs of Borneo, 44(2), 551–574.

IUCN (The IUCN Red List of Threatened Species) 2010. Summary statistic. http://www.iucnredlist.org/about/summary-statistics (Accessed January,2018)

IUCN. (2017), Polypedates leucomystax, http://www.iucnredlist.org/details/58953/0 (Accessed February, 2017)

IUCN. (2017), Microhyla butleri, http://www.iucnredlist.org/details/57878/0 (Accessed February, 2017)

Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity ?, 1, 60–64. https://doi.org/10.1111/j.1755-263X.2008.00011.x

Koh, L. (2007). Impending disaster or sliver of hope for Southeast Asian forests? The devil may lie in the details. Biodiversity Conservation

Koh LP, Wilcove DS. (2008), Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letter,* 1:60–64

Koh LP, Wilcove DS (2007) Cashing in palm oil for conservation. *Nature* 448:993–994

Lam T. P., Lam, B., & Yu, Y. (2009). Medical education reform: The Asian experience., Hong Kong,*Academic Medicine*, 84: 9

Liow, L. E. E. H., Sodhi, N. S., & Elmqvist, T. (2001). Bee diversity along a disturbance gradient in tropical lowland forests of south-east Asia, (Wilson 1987), *Journal of applied ecology*, 38:180–192.

McMorrow, J., Talip, M.A., (2001). Decline of forest area in Sabah, Malaysia: relationship to state policies, land code and land capability. *Global environmental change*, 11, 217–230.

Ngo, A. (2008). Forest governance in Liberia An NGO perspective, (January).

Na´jera A, Simonetti JA (2009) Enhancing avifauna in commercial plantations. *Conservation Biology*, 24: 319–324

Nájera, A., & Simonetti, J. A. (2010). Enhancing avifauna in commercial plantations: Research note., *Conservation Biology*, 24(1), 319–324. https://doi.org/10.1111/j.1523-1739.2009.01350.x

Onn, C. K., D. Belabut, & N. Ahmad. (2010). A revised checklist of the amphibians of Peninsular Malaysia. *Russian Journal of Herpetology* 17:202–206.

© COPYRIGHT UPM

Open Government Data Platform India. (2015). Data.govin. https://data.gov.in/keywords/tree-cover (Accessed February, 2018)

Pautasso, M., & McKinney, M. L. (2007). The botanist effect revisited: Plant species richness, county area, and human population size in the United States. Conservation Biology, 21(5), 1333–1340. https://doi.org/10.1111/j.1523-1739.2007.00760.x

Parris, K. M. (2004). Environmental and spatial variables influence the composition of frog assemblages in sub-tropical eastern Australia. *Ecography*, 27:392-400

Pellet, J. & Schmidt, B.R., (2005). Monitoring distribution using call surveys: estimating site occupancy, detection probabilities and inferring absence, *Biological Conservation*, 123, 27–35, doi 10.1007/s10531-009-9760-x

Rist L, Feintrenie L, Levang P (2010) ‘‘I want to change my fate now!’’ The livelihood impacts of oil palm in Indonesia. *Biodivers Conserv*, 19:999–1007

Scott Jr., N. J. & B.D. Woodward. (1994). Standard Techniques for Inventory and Monitoring. Surveys at Breeding Sites; p. 118-125. In W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster (ed.). Measuring and Monitoring Biological Diversity. *Standard Methods for Amphibians*. Washington and London: Smithsonian Institution Press.

Soh, M.C.K., Sodhi, N.S. & Lim, S.L.-H. (2006) High sensitivity of montane bird communities to habitat disturbance in Peninsular Malaysia. *Biological Conservation*, 129, 149–166.

Sheridan, J. A., S. D. Howard, P. Yambun, J. L. Rice, R. Cadwallader - Staub, A. Karoulus, and D. Bickford. (2012). Novel behaviors of Southeast Asian rhacophorid frogs (anura: Rhacophoridae) with an updated anuran species list for Danum Valley, Sabah, Malaysian Borneo. *Tropical natural history*,12:1–8.

Sheridan, J. A. (2003). Reproductive variation corresponding to breeding season length in three tropical frog species. *Journal of tropical ecology* 25:583–592.

Teuscher, M., Vorlaufer, M., Wollni, M., Brose, U., Mulyani, Y., & Clough, Y. (2015). Trade-offs between bird diversity and abundance , yields and revenue in smallholder oil palm plantations in Sumatra , Indonesia. *Biological conservation*, 186, 306–318. https://doi.org/10.1016/j.biocon.2015.03.022

Todd, B. D., Luhring, T. M., Rothermel, B. B., & Gibbons, J. W. (2009). Effects of forest removal on amphibian migrations: Implications for habitat and landscape connectivity. *Journal of applied ecology*, 46(3), 554–561. https://doi.org/10.1111/j.1365-2664.2009.01645.x

Viswanathan, B. (2015, August 4). What is the difference between the forest area and the actual forest cover? https://www.quora.com/What-is-the-difference-between-the-forest-area-and-the-actual-forest-cover

(Accessed February, 2018).

Wanger, T. C., Saro, A., Iskandar, D. T., Brook, B. W., Sodhi, N. S., Clough, Y., & Tscharntke, T. (2009). Conservation value of cacao agroforestry for amphibians and reptiles in South-East Asia : combining correlative models with follow-up field experiments, *Journal of applied ecology*, 46:823–832. https://doi.org/10.1111/j.1365-2664.2009.01663.x

Walton. (2001). Fermilab Frog Faqs. https://ed.fnal.gov/projects/frogs/froggiesfaq.html (Accessed February, 2018)

Wilcove, D. S., & Koh, L. P. (2010). Addressing the threats to biodiversity from oil palm agriculture. *Biodiversity and conservation*, 19(4), 999-1007. https://doi.org/10.1007/s10531-009-9760-x

Williams, S. E., and J.-M. Hero. (1998). Rainforest frogs of the Australian wet tropics: guild classification and the ecological similarity of declining species. *Proceedings of the royal society biological sciences,* 265:597–602.

Walton (2001), August 10, Fermilab Frog Faqs. https://ed.fnal.gov/projects/frogs/froggiesfaq.html(Accessed February, 2018)

Wu, Z., Y. Li, and B. R. Murray. (2006). Insular shifts in body size of rice frogs in the Zhoushan archipelago, China. Journal of Animal Ecology 75:1071–1080.

Zug, G. R. (1993). *Herpetology: an Introduction Biology of Amphibians and Reptiles.* Inc. San Diego, Academic Press

© COPYRIGHT UPM