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DIVERSITY OF AMPHIBIANS IN TROPICAL PEATLAND ECOSYSTEM: CASE IN BUFFER VILLAGE AROUND CONSERVATION AREA

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ABSTRACT

Peatlands are vulnerable to fire, causing ecological damage that threatens biodiversity, one of which is amphibians. The nature of amphibians which are sensitive to environmental changes can be used as a bioindicator of the quality of a disturbed environment, including in buffer villages around conservation areas. This research aims to analyze the diversity of amphibians and their relationship with temperature and air humidity. The method used is Visual Encounter Survey (VES) in two types of habitats, namely oil palm plantations and swamps. Data analysis used the Shannon-Wiener species diversity index, the Pielou species evenness index, and the Pearson correlation test. The research results found 6 species of amphibians, namely *Hylarana erythraea, Hylarana nicobariensis, Fejervarya limnocharis, Fejervarya cancrivora, Duttaphrynus melanustictus, and Hylarana baramica*. The diversity index (H') in oil palm plantations and swamps is H'=1.46 and H'=1.10 in the medium category. This shows that ecologically, the conditions of the habitat types of oil palm plantations and swamps in the buffer villages around the Orang Kayo Hitam Forest Park after land burning can support amphibian life. Continuous monitoring efforts involving stakeholders and buffer village communities are needed to increase education on amphibian conservation.

Keywords: *Amphibians, conservation area, diversity, tropical peatland.*

INTRODUCTION

The peat ecosystem is a wetland ecosystem that is fragile (Wulandari et al. 2021; Wösten et al. 2006) to degradation and sensitive to climate change (Sudrajat and Subekti 2019). The peat ecosystem has unique physical, biological, and chemical characteristics that are very different from other soil minerals (Yuwati et al. 2021). Peatlands have an important role in the ecosystem, namely maintaining hydrological functions and as a carbon sink (Yule 2010), playing a role in controlling climate (Wahyunto and Subagjo 2004; Yuliani and Rahman 2018) and supporting various types of biodiversity, such as amphibians (Page and Rieley 2018; Posa et al. 2011; Rieley 2016). However, peatlands are susceptible to fire due to their high organic material content (Najiyati et al., 2005; Triadi, 2020). Widespread degradation and the conversion of peatlands to plantations and agriculture have disrupted the ecological function of peatlands (Cole et al. 2021; Mishra et al. 2021; Mubekti 2011; Yuliani and Rahman 2018) making them easily flammable (Marlina 2017; McCarter et al. 2021). The increasing rate of peatland destruction makes peatlands fragile. If they experience a decline in function or even become damaged, it will not be easy to restore them to their original condition (Wetlands International 2015). Disturbances in peat forests result in increased climate change and

reduced biodiversity (Posa et al. 2011; Roucoux et al. 2017; Yule 2010), including threatening amphibian diversity (Bolochio et al. 2020; Stuart et al. 2008).
Amphibians are part of biodiversity that can live in terrestrial, aquatic, and arboreal habitats (Prasetyo et al. 2012; Yani and Said 2015). Ecologically, amphibians have an important role in the food chain (Atkinson et al. 2021; Hocking et al. 2014; Zakaria et al. 2022) such as predators of insects or invertebrate animals (Kusrini 2013). Amphibians also act as bioindicators of environmental quality because they are sensitive to environmental changes (Roach et al. 2020; Soomets et al. 2023). The nature of amphibians, which are very sensitive to changes in environmental conditions such as temperature and humidity (Devi et al. 2019) can be used as an indicator of the quality of an environment, especially in peat ecosystems (Soomets et al. 2023). Climate change, environmental pollution, deforestation, and forest degradation can threaten amphibian habitats (Bobi et al. 2017; Decena et al. 2020; Kusrini et al. 2020). One of the amphibian habitats vulnerable to environmental change is the peat forest ecosystem (Azhari et al. 2022; Leo et al. 2020), including in the buffer villages around the Orang Kayo Hitam Forest Park.

Orang Kayo Hitam (OKH) Forest Park is the only conservation area for collection purposes that has a peat ecosystem (Wulandari et al. 2021). The main problem in managing OKH Forest Park is repeated forest fires, which create degraded peatlands (Saleh et al. 2021; Tamin et al. 2021). Peatland fires occur almost every year in OKH Forest Park, causing damage and loss of habitat for flora and fauna (Nurfitri et al. 2022; Prasetia et al. 2020), thus affecting the ecological function of the peat ecosystem, including in the surrounding villages (Girkin et al. 2022). A buffer village is an area outside and around and directly adjacent to a conservation area and is legally a place where specific communities live. The Indonesian Regulation (UU No. 5/1990: Conservation of Biological Natural Resources and Ecosystems) states that areas directly adjacent to conservation areas are designated as buffer areas. The buffer area (if the form of a village is called a buffer village) has a vital role in supporting the sustainability of the conservation area, OKH Forest Park, because it prevents all forms of pressure and disturbance that threaten the sustainability of the conservation area. This means that optimizing the welfare of buffer village communities is one factor that influences the sustainability of conservation areas (Pereira et al. 2023). Apart from that, buffer villages are an important area to be developed to support local economic sustainability so that illegal practices in conservation areas can be stopped (Iswandaru et al. 2023).

On the other hand, peatland management in buffer villages is a factor that influences the sustainability of wildlife and its conservation. However, much still needs to be discovered about these ecosystems' wildlife (including amphibians), thus hindering effective conservation action (Harrison and Rieley 2018). Thus, it is very important to study amphibian diversity and its relationship with the recovery of post-burning peat ecosystems. Therefore, it is important to measure the initial recovery process of peat forests after burning through amphibian diversity because their distribution and ecological niche are representative of humidity and temperature patterns. This research aims to analyze the diversity of amphibians and their relationship to environmental conditions in buffer villages around the Orang Kayo Hitam Grand Forest Park.

METHOD

Study Site

The research focused on Jebus Village, Muaro Kumpeh Subdistrict, Muaro Jambi District. Apart from being the closest buffer village to OKH Forest Park, Jebus Village has the most significant fire impact from the 2019 forest and land fires. Geographically, Jebus Village is located at 1º20'38.85" S 104º01'58.90" E (Figure 1). The land cover of Jebus Village consists

of settlements and swamps, and the condition of the yards around the housing is dominated by plantation plants such as *Elaeis guineensis*. This village is on the banks of the Batanghari River, so several locations are flooded throughout the year and form swamps. The swamp conditions are overgrown with grass over one meter high and water plants such as Eichhornia crassipes. The depth of the swamp is between 2 – 3 meters, with mud depth of more than 2 meters (Figure 2).

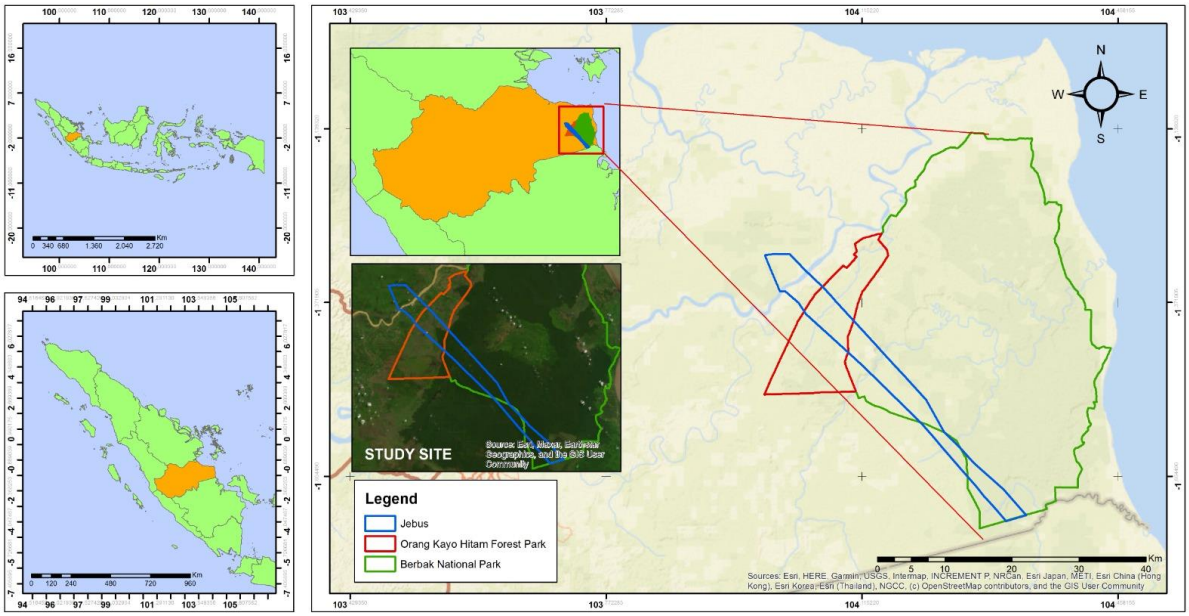


Figure 1. Maps of the study site in the Jebus Village around OKH Forest Park

Figure 2. Site condition: palm oil plantation (left); swamp (right).

Data Collection

Data collection was carried out in September 2022. Amphibian data was collected using the VES (Visual Encounter Survey) method to search for amphibians in representative locations over a certain period (Kusrini et al. 2020; Zakaria et al. 2022). The VES method was chosen because it assumes an equal chance of detecting all developmental stages and sex of amphibians (Boullhesen et al. 2021). In oil palm plantations, the VES method is carried out by exploring/exploring the space between oil palm plants in the form of a zig-zag path 200 meters long. The VES method is carried out in swamp areas by exploring around and surrounding the swamp's edge. The sampling time is set for 3 hours every morning (07.00 – 10.00 WIB) and evening (19.00 – 22.00 WIB). Amphibians have different active times, namely day and night,

so two sessions in one day are needed to maximize the chances of encountering species both during the day and at night (Zakaria et al. 2022). Recording of species is based on direct encounters at observation locations (Bobi et al. 2017) and identification of amphibian types based on Stuart et al (2008). The environmental data collected is temperature and humidity. Temperature and humidity measurements were carried out in the morning and evening over the same time as amphibian observations.

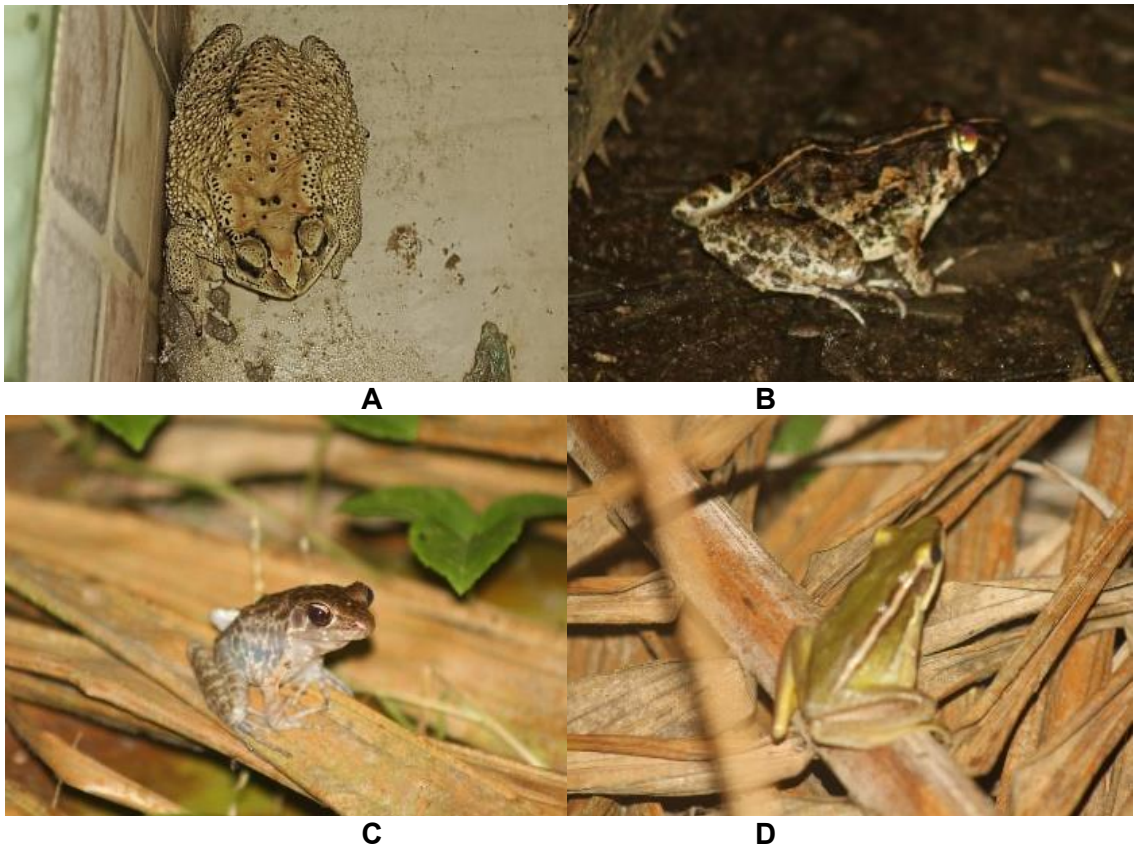
Data Analysis

Quantitative analysis is used to calculate species diversity and species' evenness. The Shanon-Wiener Diversity Index (H') is used to analyze amphibian species diversity, and the Pielou Evenness Index (E) is used to analyze the evenness of amphibian species in both habitat types.

RESULTS and DISCUSSION,

Amfibi in the Tropical Peatland

The species of amphibians found in buffer villages around Tahura OKH consist of 6 species from 3 families (Fig. 3). These six species were found during six days of observation (Fig. 4). Of the six species, *Hylarana erythraea* paling sering ditemukan di semua lokasi, selanjutnya *Fejervarya limnocharis, Fejervarya cancrivora, Hylarana baramica*, *Hylarana nicobariensis* and *Duttaprhynus melanostictus*.



A **B**

C **D**

E **F**

Figure 3. Amphibians in the buffer village around OKH Forest Park. A. *Duttaprhynus melanostictus,* B. *Fejervarya limnocharis,* C. *Hylarana baramica,* D. *Hylarana erythraea,* E. *Fejervarya cancrivora,* F. *Hylarana nicobariensis.*

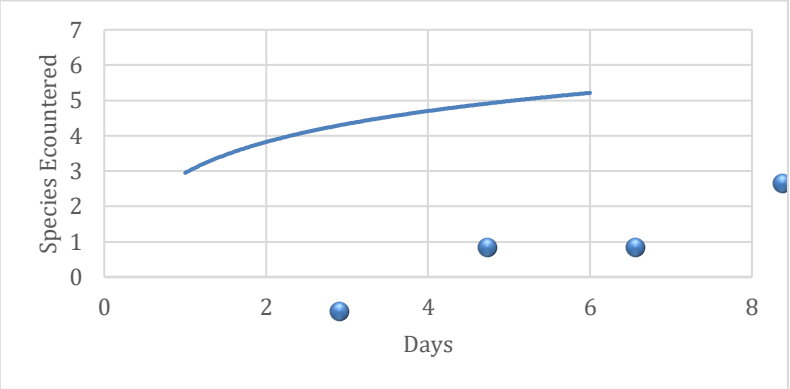


Figure 4. Species accumulation curve illustrates the accumulation of the encountered species during the 6 days of field sampling.

The Ranidae family found at the research location consists of three species from the genus Hylarana, namely *H. Erythraea, H. nicobariensis, and H. baramica*. The Ranidae family is often found in human habitats with water, starting from the lowlands to 1,200 meters above sea level (Kusrini 2007; Sari et al. 2022). *H. erythraea* is a type of amphibian that was found at an observation location with 24 individuals. This frog has a sizeable dorsal-lateral fold that extends to the cloaca. Apart from that, this frog has a visible tympanum. *H. erythraea*, often found, can be influenced by the plants in a location (Kurniati, 2010; Azhari *et al*., 2022). Wanda *et al* (2012) stated that this type of frog can live in disturbed habitats and adapt to varied habitats. *H. nicobariensis* is a type of amphibian found in oil palm plantations. The size of *H. nicobariensis* is more diminutive than *H. erythraea*. The body and legs are slender, the color of the tympanum is almost the same as the color of the body, and the texture of the body has fine nodules. *H. baramica* can occupy various habitats, such as primary forests, secondary forests, and around settlements. *H. baramica* was found in a pile of oil palm frond litter close to a body of water with an SVL size of 47.5 mm and a body color of blackish brown with dark spots. The skin texture of this frog is rough and has pimples.

The Bufonidae family found at the research location was only one species, namely *Duttaphrynus melanotictus*, with two individuals. It is characterized by a rough body with spots over it. *D. melanotictus* is found in swamps near human settlements and were found around human settlements and the only type of amphibian that can associate with the human environment (Miftakhurrohmah et al. 2019).

The Dicroglossidae family found at the research location is *Fejervarya cancrivora* and *Fejervarya limnocharis*. There were eight individuals of *F. cancrivora* and eight individuals of *F. limnocharis* in the oil palm plantation with muddy soil conditions and little grass. In the swamp were four individuals of *F. cancrivora* and six of *F. limnocharis*. To differentiate between *F. cancrivora* and *F. limnocharis*, you can look at the shape of the hind legs, one of which is that the web of the rear toes on F. cancrivora reaches the top of the toe. In contrast, the net on the toes of *F. limnocharis* only gets half of it (figure 6**)** (Kusrini 2013).

(a) **(b)**

Figure 5. Differences in the membranes on the hind toes between individual *Fejervarya cancrivora* (a) and *Fejervarya limnocharis* (b).

Amphibians Compotition

Of the six species recorded, five species were found in oil palm plantations, and four species were found in swamps (Table 1). Composition based on individuals in the swamp showed that Hylarana erythraea had the highest number of individuals and Duttaphrynus melanostictus had the fewest. In oil palm, most individuals found were Hylarana erythraea; the rarest were Hylarana nicobariensis and Hylarana baramica. Composition based on family shows that Ranidae has the highest number of species, namely three species (50%), Dicroglossidae has two species (33%) and Bufonidae has the lowest number of species, namely one species (17%) (Fig. 6).

Table 1. List of amphibians in the Buffer Village of Orang Kayo Hitam Forest Park

No.	Family	Species	Common Name	Swamp	Palm Oil	Conservation Status
1.	Ranidae	*Hylarana erythraea*	Green Paddy Frog	√	√	LC
2.	Ranidae	*Hylarana nicobariensis*	Cricket Frog	-	√	LC
3.	Ranidae	*Hylarana baramica*	Brown Marsh Frog	-	√	LC
4.	Dicroglossidae	*Fejervarya cancrivora*	Crab-Eating Frog	√	√	LC
5.	Dicroglossidae	*Fejervarya limnocharis*	Grass Frog	√	√	LC
6.	Bufonidae	*Duttaphrynus melanostictus*	Common Sunda Toad	√	-	LC

The conservation status for all types of amphibians found is least concern (LC). This means that all six amphibians have a low risk of extinction. Still, it is important to monitor species in this status to develop appropriate conservation measures to prevent them from being threatened (https://www.iucnredlist.org/about/faqs#PageIndex).

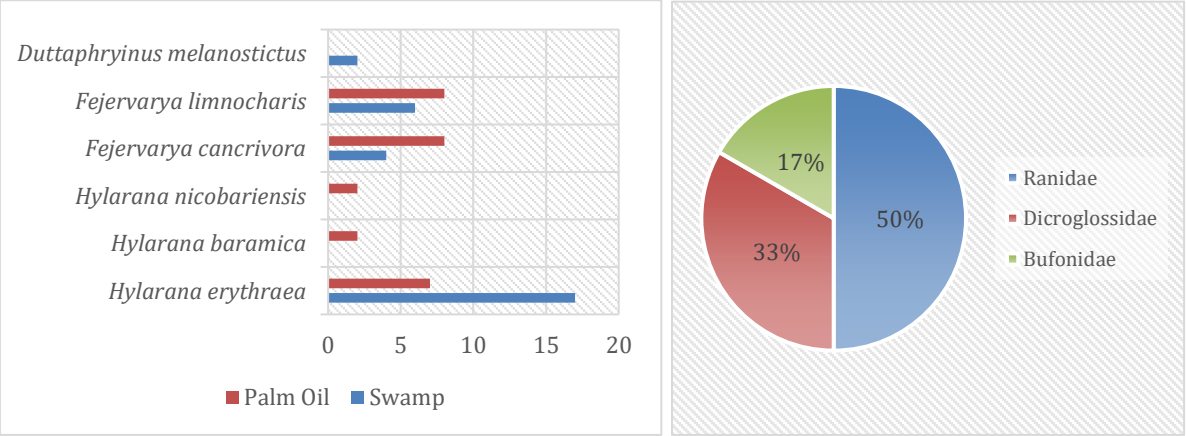


Figure 6. Amphibians Compotition based on Individuals and Family.

Fifty-six individuals of six species of amphibians were recorded at both locations. In oil palm plantations, 27 individuals were recorded, and in swamps, 29 individuals. In addition, the number of individuals of each amphibian found in oil palm plantations and swamps is different. It was recorded that 17 individuals of *Hylarana erythraea* were found in swamps and seven in oil palm plantations. *Hylarana baramica* and *Hylarana nicobariensis* were only found in oil palm plantations in two individuals each. *Fejervarya cancrivora*, four individuals were found in swamps and eight individuals in oil palm plantations. *Fejervarya limnocharis*, eight individuals were found in oil palm plantations and six individuals were found in swamps. *Duttaphrynus melanostictus*, only found in swamps in two individuals.

Diversity and Evenness Index

The diversity index of amphibians in the buffer village (Table 2) is H'= 1<**1.10-1.45**<3, classified as medium. The diversity index in an ecosystem will be lower if the number of species and individuals in that ecosystem is fewer (Irwansyah *et al*, 2022). The higher diversity index of amphibians in palm oil can be caused by abiotic factors such as temperature and humidity. In the palm oil plantations, the average air temperature was 26ºC, while in the swamp, it was 25.17 ºC. The air humidity value in palm oil is higher than in swamp, namely 79.67% in palm oil and 76.5% in swamp. According to Mardinata *et al* (2018), the optimum temperature in amphibian habitats ranges from 25ºC-30ºC. Amphibians are poikilothermic, which means they cannot regulate their body temperature. Therefore, their body temperature depends on environmental conditions (Ariza et al. 2014). The means that amphibians need a moist area to make it easier to regulate body temperature and protect their skin from drying out. The evenness of amphibian species at the research location was evenly distributed, with an evenness index value of 0.79-0.90, which means that species evenness in both research locations was stable. The evenness of species in these two types of habitats is due to water availability, making it a suitable habitat for amphibians to breed.

Table 2. Diversity Index (H') and Evenness Index (E) in the Buffer Village of OKH Forest Park.

Habitat Types	Diversity Index (H')	Evennes Index(E)
Palm Oil Plantation	1.45	0.90
Swamp	1.10	0.79

CONCLUSIONS and RECOMMENDATIONS

Six species of amphibians from three families were recorded in the buffer villages around OKH Forest Park. The families with the most species are Ranidae (50%), Dicroglossidae (33%) and Bufonidae (17%). Based on the IUCN Redlist, the conservation status of the six amphibian

species found is Least Concern (LC). The diversity index (H') value for the oil palm and swamp habitat types is 1<1.10-1.45<3 in the medium category, which shows both types of habitats are relatively capale of supporting amphibians' life. The evennes index for the oil palm and swamp habitat types is close to 1 with a range of 0.79-0.90, which shows the distribution between species is relatively uniform. Continuous monitoring efforts involving stakeholders and buffer village communities are needed to increase education on amphibian conservation.

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References

Ariza, Y. S., Dewi, B. S., and Darmawan, A. 2014. Amphibians Diversity (Ordo Anura) on Several Habitat Types Youth Camp at Hurun Village Padang Cermin Sub Disdtrict Pesawaran. *Jurnal Sylva Lestari,* 2(1), 21–30. DOI: 10.23960/jsl1221-30

Atkinson, C. L., Knapp, D. D., and Smith, L. L. 2021. Long-Term Patterns of Amphibian Diversity, Abundance and Nutrient Export from Small, Isolated Wetlands. *Diversity,* 13(11), 598. DOI: 10.3390/d13110598

Azhari, A., Sukmono, T., Prima Nugraha, A., Ihsan, M., and Suprayogi, D. 2022. Amphibi Diversity (Ordo Anura) in Londerang Peat Protected Forest, East Tanjung Jabung. *Biospecies,* 15(1), 10–15. DOI: 10.22437/biospecies.v15i1.14833

Bobi, M., Erianto, and Rifanjani, S. 2017. The Diversity Herpetofauna Tambling Wildlife Nature Conservation (TWNC) Bukit Barisan Selatan National Park West Lampung. *Jurnal Hutan Lestari,* 5(2), 348–355. DOI: 10.26418/jhl.v5i2.19899

Bolochio, B. E., Lescano, J. N., Cordier, J. M., Loyola, R., and Nori, J. 2020. A functional perspective for global amphibian conservation. *Biological Conservation,* 245, 108572. DOI: https://doi.org/10.1016/j.biocon.2020.108572

Boullhesen, M., Vaira, M., Barquez, R. M., and Akmentins, M. S. 2021. Evaluating the efficacy of visual encounter and automated acoustic survey methods in anuran assemblages of the Yungas Andean Forests of Argentina. *Ecological Indicators,* 127: 107750. DOI: 10.1016/j.ecolind.2021.107750

Cole, L. E. S., Willis, K. J., and Bhagwat, S. A. 2021. The future of Southeast Asia's tropical peatlands: Local and global perspectives. *Anthropocene,* 34, 100292. DOI: https://doi.org/10.1016/j.ancene.2021.100292

Decena, S. C. P., Avorque, C. A., Decena, I. C. P., Asis, P. D., and Pacle, B. 2020. Impact of habitat alteration on amphibian diversity and species composition in a lowland tropical rainforest in Northeastern Leyte, Philippines. *Scientific Reports Nature*,10(1), 1–15. DOI: 10.1038/s41598-020-67512-6

Devi, S. R., Septiadi, L., Erfanda, M. P., Hanifa, B. F., Firizki, D. T., and Nadhori, Q. 2019. The Community Structure of Anuran at Bedengan Selorejo Village Tourism, Dau District, Malang Regency Sandra. *Jurnal Riset Biologi dan Aplikasinya,* 1 (2),

71–79. DOI: 10.26740/jrba.v1n2.p71-79

Girkin, N. T., Cooper, H. V., Ledger, M. J., O'Reilly, P., Thornton, S. A., Åkesson, C. M., Cole, L. E. S., Hapsari, K. A., Hawthorne, D., and Roucoux, K. H. 2022. Tropical peatlands in the Anthropocene: The present and the future. *Anthropocene,* 40, 100354. DOI: 10.1016/j.ancene.2022.100354

Harrison, M. E., and Rieley, J. O. 2018. Tropical peatland biodiversity and conservation in southeast Asia: Foreword. *Mires and Peat,* 22, 1–7. DOI: 10.19189/MaP.2018.OMB.382

Hocking, D. J., Babbitt, K. J., and Hocking, D. J. 2014. Amphibian contributions to ecosystem services. *Herpetological Conservation and Biology,* 9(1), 1–17.

Irwansyah, R. M., Azzahra, S. I. N., Darmastuti, S. A., Ramadhani, A. R., Firdaus, O., Daeni, F., Safitri, N., Fajri, O. P. A., Nugroho, G. D., Naim, D. M., and Setyawan, A. D. 2021. Crab diversity and crab potential as support ecotourism in Teleng Ria, Grindulu and Siwil Beach, Pacitan, East Java, Indonesia. *International Journal of Bonorowo Wetlands,* 11(2), 75–83. DOI: 10.13057/bonorowo/w110204

Iswandaru, D., Hariyono, H., and Rohman, F. 2023. Birding and Avitourism: Potential Analysis of Birds in the Buffer Villages Around Conservation Area. *Jurnal Sylva Lestari*,11(2), 247–269. DOI: https://doi.org/10.23960/jsl.v11i2.681

Kurniati, H. 2010. Diversity and Abundance of Non-Forest Frogs and Their Relationship with Wetland Vegetation in Ecology Park, LIPI Campus Cibinong. *Berita Biologi,* 10(3), 283–296. DOI: 10.14203/beritabiologi.v10i3.743

Kusrini, M. D. 2007. Conservation of Amphibian in Indonesia: Global Problems and Challenges. *Media Konservasi,* 7(2), 89–95. DOI: 10.29244/medkon.12.2.%25p

Kusrini, M. D. 2013. *Panduan Bergambar Identifikasi Amfibi Jawa Barat*. Fakultas Kehutanan IPB, Bogor.

Kusrini, M. D., Khairunnisa, L. R., Nusantara, A., Kartono, A. P., Prasetyo, L. B., Ayuningrum, N. T., and Faz, F. H. 2020. Diversity of Amphibians and Reptiles in Various Anthropogenic Disturbance Habitats in Nantu Forest, Sulawesi, Indonesia. *Jurnal Manajemen Hutan Tropika,* 26(3), 291–302. DOI: 10.7226/JTFM.26.3.291

Leo, S., Suherman, M., Permatasari, A., Suganda, D., and Winarni, N. L. 2020. Herpetofauna diversity in Zamrud National Park, Indonesia: baseline checklist for a Sumatra peat swamp forest ecosystem. *Amphibian & Reptile Conservation,* 14(2), 250–263.

Mardinata, R., Winarno, G. D., and Nurcahyani, N. 2018. The Diversity Amphibian (Ordo Anura) on Defferent Habitat Types in Balik Bukit Resort Bukit Barisan Selatan National Park. *Jurnal Sylva Lestari,* 6 (1), 58–65. DOI: 10.23960/jsl1659-66

Marlina, S. 2017. Pengelolaan Ekosistem Gambut Pasca Kebakaran Lahan Gambut di Provinsi Kalimantan Tengah. *Media Ilmiah Teknik Lingkungan,* 2(1), 26–30. DOI: doi.org/10.33084/mitl.v2i1.129

McCarter, C. P. R., Wilkinson, S. L., Moore, P. A., and Waddington, J. M. 2021.

Ecohydrological trade-offs from multiple peatland disturbances: The interactive effects of drainage, harvesting, restoration and wildfire in a southern Ontario bog. *Journal of Hydrology,* 601, 126793. DOI: https://doi.org/10.1016/j.jhydrol.2021.126793

Miftakhurrohmah, Z., Baskoro, K., and Rahadian, R. 2019. Distribution pattern and habitat preference of asian common toad (Duttaphrynus melanosticus Schneider, 1799) in Districts of Tembalang, Semarang. *Jurnal Biologi Tropika,* 2(2), 74–79. DOI: 10.14710/jbt.2.2.74-79

Mishra, S., Page, S. E., Cobb, A. R., Ser, J., Lee, H., Jovani-, A. J., Sjögersten, S., Jaya, A., and Wardle, D. A. 2021. Degradation of Southeast Asian tropical peatlands and integrated strategies for their better management and restoration. *Journal of Applied Ecology,* 58, 1370–1387. DOI: 10.1111/1365-2664.13905

Mubekti. 2011. Studi Pewilayahan Dalam Rangka Pengelolaan Lahan Gambut Berkelanjutan di Provinsi Riau. *Jurnal Sains dan Teknologi Indonesia*, 13(2), 88–94.

Najiyat, Asmana, and Suryadiputra. 2005. *Pemberdayaan Masyarakat di Lahan Gambut*. Wetlands International – Indonesia Programme.

Nurfitri, A., Iswandaru, D., Wulandari, C., and Novriyanti. 2022. Birds as potential indicator for peat ecosystem recovery at Orang Kayo Hitam Forest Park, Province of Jambi. Anindya. *Jurnal Hutan Tropis,* 10(2), 139–149.

Page, S., and Rieley, J. 2018. Tropical Peat Swamp Forests of Southeast Asia. in: *The Wetland Book: II: Distribution, Description, and Conservation* C. M. Finlayson, G. R. Milton, R. C. Prentice, and N. C. Davidson, eds. Springer Netherlands, Dordrecht 1753–1761. DOI: 10.1007/978-94-007-4001-3_5

Pereira, N., Arief, H., Hermawan, R., and Sudradjat, A. 2023. Empowerment of the Community of Cisantana as a buffer village of Gunung Ciremai National Park through Ecotourism Program. *Journal of Natural Resources and Environmental Management,* 13(1), 156–167. DOI: http://dx.doi.org/10.29244/jpsl.13.1.156–167

Posa, M. R. C., Wijedasa, L. S., and Corlett, R. T. 2011. Biodiversity and Conservation of Tropical Peat Swamp Forests. *BioScience,* 61(1), 49–57. DOI: 10.1525/bio.2011.61.1.10

Prasetia, D., Hidayat, W., and Syaufina, L. 2020. Effects of Groundwater Level on the Occurrence of Forest and Peatland Fires: A Case of Study in Musi Banyuasin Regency. *Jurnal Sylva Lestari,* 8(2), 173–180. DOI: 10.23960/jsl28173-180

Prasetyo, E., Zulfa, U., Roihana, R. Z., Anggraini, S., Dewi, W. M., Hamid, Z. A., Nurjannah, A., Malinda, L., and Muktisari, E. 2012. Species Composition of Amphibians (Order Anura) in Baturraden Botanical Garden , Banyumas. *International Journal of Applied Biology,* 4(2), 26–30.

Rieley, J. O. 2016. BIODIVERSITY OF TROPICAL PEATLAND IN SOUTHEAST ASIA. in: *15TH INTERNATIONAL PEAT CONGRESS 2016* peatlands.org 707–711.

Roach, N. S., Urbina-Cardona, N., and Lacher, T. E. 2020. Land cover drives amphibian diversity across steep elevational gradients in an isolated neotropical

mountain range: Implications for community conservation. *Global Ecology and Conservation,* 22: e00968. DOI: 10.1016/j.gecco.2020.e00968

Roucoux, K. H., Lawson, I. T., Baker, T. R., Del Castillo Torres, D., Draper, F. C., Lähteenoja, O., Gilmore, M. P., Honorio Coronado, E. N., Kelly, T. J., Mitchard, E. T. A., and Vriesendorp, C. F. 2017. Threats to intact tropical peatlands and opportunities for their conservation. *Conservation Biology,* 31(6), 1283–1292. DOI: 10.1111/cobi.12925

Saleh, Z., Tamin, R. P., and Ulfa, M. 2021. Identifikasi Potensi Penyebar Benih Tumbuhan Pada Hutan Rawa Gambut Dalam Rangka Regenerasi Alami Dan Restorasi Lahan Gambut Pasca Kebakaran. *Wahana Forestra: Jurnal Kehutanan,* 16(2), 181–192. DOI: 10.31849/forestra.v16i2.6279

Sari, N., Afriansyah, B., and Hamidy, A. 2022. Keanekaragaman Amfibi (Ordo Anura) Di Taman Wisata Alam Jering Menduyung, Bangka Barat. *Al-Kauniyah: Jurnal Biologi,* 15(1), 1–15. DOI: 10.15408/kauniyah.v15i1.14171

Soomets, E., Lõhmus, A., and Rannap, R. 2023. Restoring functional forested peatlands by combining ditch-blocking and partial cutting: An amphibian perspective. *Ecological Engineering,* 192, 106968. DOI: https://doi.org/10.1016/j.ecoleng.2023.106968

Stuart, S. N., Hoffmann, M., Chanson, J. S., Cox, N. A., Berridge, R. J., Ramani, P., and Young, B. E. 2008. *Threatened Amphibians of the World*. Lyxn Edition, Barcelona. DOI: 10.11606/issn.2316-9079.v7i2p149-150

Sudrajat, A., and Subekti, S. 2019. Pengelolaan Ekosistem Gambut Sebagai Upaya Mitigasi Perubahan Iklim di Provinsi Kalimantan Selatan. *Jurnal Planologi,* 16(2), 219–237. DOI: 10.30659/jpsa.v16i2.4459

Tamin, R. P., Ulfa, M., and Saleh, Z. 2021. Identifikasi Potensi Permudaan Alam Di Hutan Rawa Gambut Taman Hutan Raya Orang Kayo Hitam Provinsi Jambi Pasca Kebakaran Hutan. *Al-Kauniyah Jurnal Biologi,* 14(1), 42–51. DOI: 10.15408/kauniyah.v14i1.15136

Triadi, L. B. B. 2020. Restoration of Peat Swamp Through Rewetting (Canal Blocking) and Paludiculture Method. *Jurnal Sumber Daya Air*, 16(2), 103–118. DOI: 10.32679/jsda.v16i2.677

Wahyunto, S. R., and Subagjo, H. 2004. *Map of Peatland Distribution Area and Carbon Content in Kalimantan 2000-2002*. *Wetlands International - Indonesia Programme & Wildlife Habitat Canada (WHC)*.

Wanda, I. F., Novarino, W., and Tjong, D. H. 2012. Jenis-Jenis Anura (Amphibia) Di Hutan Harapan, Jambi. *Jurnal Biologi Universitas Andalas,* 1(2), 99–107. DOI: 10.25077/jbioua.1.2.%25p.2012

Wetlands International. 2015. *Roadmap (Peta Jalan) Pengelolaan Ekosistem Gambut Berkelanjutan bagi Hutan Tanaman Industri (HTI) untuk Bubur Kayu dan Kertas di Indonesia*. Wetlands International Indonesia.

Wösten, J. H. M., Van Den Berg, J., Van Eijk, P., Gevers, G. J. M., Giesen, W. B. J. T., Hooijer, A., Idris, A., Leenman, P. H., Rais, D. S., Siderius, C., Silvius, M. J., Suryadiputra, N., and Wibisono, I. T. 2006. Interrelationships between hydrology

and ecology in fire degraded tropical peat swamp forests. *International Journal of Water Resources Development,* 22(1), 157–174. DOI: 10.1080/07900620500405973

Wulandari, C., Novriyanti, N., and Iswandaru, D. 2021. Integrating ecological, social and policy aspects to develop peatland restoration strategies in Orang Kayo Hitam Forest Park, Jambi, Indonesia. *Biodiversitas,* 22(10), 4158–4168. DOI: 10.13057/biodiv/d221005

Yani, A., and Said, S. 2015. Species Amphibians Diversity Ordo Anura in Gunung Semahung Protected Forest Areas Sengah Temila District Landak Regen. *Jurnal Hutan Lestari,* 3(1), 15–20. DOI: 10.26418/jhl.v3i1.8877

Yule, C. M. 2010. Loss of biodiversity and ecosystem functioning in Indo-Malayan peat swamp forests. *Biodiversity and Conservation,* 19(2), 393–409. DOI: 10.1007/s10531-008-9510-5

Yuliani, and Rahman. 2018. Metode Restorasi Gambut Dalam Konteks Mitigasi Bencana Kebakaran Hutan Lahan Gambut dan Pemberdayaan Masyarakat. *Sosio Informa,* 4(02), 448–460.

Yuwati, T. W., Rachmanadi, D., Turjaman, M., Indrajaya, Y., Yudono, H., Hadi, S., Qirom, M. A., Narendra, B. H., Winarno, B., Lestari, S., Santosa, P. B., Adi, R. N., Savitri, E., Putra, P. B., Wahyuningtyas, R. S., Prayudyaningsih, R., and Halwany, W. 2021. Restoration of Degraded Tropical Peatland in Indonesia : A Review. *Land,* 10(1), 1–31.

Zakaria, N., Allahudin, M. I. H., Ma'ad, S. N. S., Sulaiman, A. A., Abdullah, N. A., Zamri, M. I. M., Mamat, M. A., and Deraman, M. Y. 2022. Diversity amphibians and reptiles at Sungai Kerteh mangrove forest, Terengganu, Malaysia. *Biodiversitas,* 23(11), 5574–5584. DOI: 10.13057/biodiv/d231105