Fauna & Flora International's Indonesia Programme

THE DIVERSITY OF HERPETOFAUNA IN PT GLOBAL ALAM NUSANTARA (PT GAN) RIAU ECOSYSTEM RESTORATION

REPORT 2021

THE DIVERSITY OF HERPETOFAUNA IN PT GLOBAL ALAM NUSANTARA (PT GAN) RIAU ECOSYSTEM RESTORATION

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OVERVIEW

An extensive herpetofauna survey was carried out in PT Global Alam Nusantara (GAN) from March to July 2021. The survey aimed to identify and describe herpetofauna diversity and its threats and is a continuation and completion of surveys in Riau Ecosystem Restoration (RER) that was initiated in 2015 that aims to provide reliable biodiversity baseline data in the 130,095 ha Riau Ecosystem Restoration program area located on the Kampar Peninsula in Sumatra. A total of 36 species (9 amphibians and 27 reptiles) were recorded using Visual Encounter Survey (VES) methods. The total species count could potentially increase, as the calculated species accumulation curve did not reach an asymptote.

Two turtle species were recorded as threatened, based on IUCN Red List, whilst riparian habitats were found to be preferred by more species than other habitats. Collett's tree frog (*Polypedates colletti*) had the highest relative abundance value (rav) in 6 out of 12 transects, with the highest rav being 0.79. This survey has revealed a new distribution area for Smooth-skinned wart frog (*Theloderma licin*) in peat swamp habitat in Kampar Peninsula, Riau.

I. INTRODUCTION

1.1 Background

Peat swamp forest is a unique and fragile ecosystem under threat from human-caused disturbance such as forest conversion from plantation development, encroaching agriculture, illegal logging, and forest fire (Posa et al., 2010). Consequently Sumatra, which historically held the largest area of peat swamp (7 million hectares) has experienced peat swamp forest loss of about 78% (Purba et al., 2014). Riau Province currently has the largest peatland area in Sumatra (4 million hectares) with around 671,125 ha of this on Kampar Peninsula (Tropenbos International Indonesia Program, 2010). The peat swamp forest in Kampar Peninsula is an important site for biodiversity, providing a home for many endangered species as well as ecosystem services, such as carbon storage (approx. 2.14 – 2.68 million tonnes CO_2e), clean water, and flood prevention (Tropenbos International Indonesia Program, 2010). Forest degradation occurred during decades of selective logging, peat drainage, illegal logging and fires. The most degraded forests on the perimeter of the Kampar Peninsula were developed into a ring of productive fibre plantations that surrounds a large central core of peat swamp forest now managed by the Riau Ecosystem Restoration (RER) program.

The Restorasi Ekosistem Riau program was established by APRIL in 2013. With a total area of 150,694 ha, RER aims to protect, restore and conserve the peat swamp forest ecosystem in Kampar Peninsula and Padang Island as part of the Ministry of Environment and Forestry programme for protecting 2.6 million hectares of forest through ecosystem restoration concessions (ERC). Four concessions under RER management on Kampar Peninsula have obtained an ERC license: PT Gemilang Cipta Nusantara (20,123 ha), PT Sinar Mutiara Nusantara (32,781 ha), PT The Best One Unitimber (40,666 ha), and PT Global Alam Nusantara (36,525 ha).

RER's restoration and conservation efforts on Kampar Peninsula include approximately 29% of the Tasik Besar Serkap Forest Management Unit (513,276 ha). RER is collaborating with FFI's IP to develop frameworks, policies, and management plans relating to the Community, Climate, and Biodiversity landscape assessment. This assessment will contribute to the restoration of the ecological processes and functions of the peat swamp forests, so that it can generate environmental services that benefit the communities that live within it (RER, 2015).

Biodiversity is an important component of the ecosystem, helping to ensure the functioning of ecological processes and, in any restoration efforts, biodiversity monitoring becomes an indicator of effective management. Before effective management and monitoring can occur, it is necessary to have baseline biodiversity data to develop management strategies and conservation plans.

Our understanding of herpetofauna (amphibians and reptiles) in peat swamp forest is very limited (e.g., Yule, 2010; Inger *et. al.* 2005; Posa *et. al.* 2011). This taxonomic group is very sensitive to human disturbance (Inger & Stuebing, 2005; Zug *et. al.* 2001; Leyte-Manrique *et. al*., 2019; Hernandez-Ordonez *et. al.*, 2015)), so its diversity and population sizes can be used as indicators of environmental change (Herrmann *et. al.* 2005; Thompson *et. al.* 2008, Browne *et. al.* 2009).

RER and FFI's IP have been conducting studies on biodiversity in Kampar Peninsula Landscape since 2015 (PT Gemilang Cipta Nusantara, PT Sinar Mutiara Nusantara, and PT The Best One Unitimber) with a total area of 92,507 ha. In 2021, this biodiversity study was continued in PT Global Alam Nusantara, allowing for a comprehensive biodiversity baseline dataset for RER's peat swamp forest area.

FFI's IP carried out a dedicated survey of PT Global Alam Nusantara (PT GAN) to identify and describe the current state of herpetofauna biodiversity and the presence of any threats to its survival.

II. METHOD

2.1 Study site description

PT GAN is situated on the peat dome in the low-lying Kampar Peninsula Landscape (2-16m asl). PT GAN has a tropical wet climate with an annual-average humidity of around 82%. Annual rainfall ranges between 1,949-2,951 mm/year, with a monthly average air temperature of between 26.1 and 27.5°C (PT. GCN, 2012).

The Kampar Peninsula is primarily peat swamp forest with minor amounts of mangrove forest and riparian forest on the coastline. For the RER area, the dominant ecosystem is peat swamp forest classified, as either: 1) mixed peat swamp forest (peat swamp forests with uneven canopy heights); 2) tall pole forest (peat swamp forests with a relatively flat and high tree canopy and uniform tree diameters); 3) low pole forest (peat swamp forests with low canopy), or 4) riparian forest. Riparian forests in the RER are located along three rivers; Turip, Serkap and Sangar rivers. During the highest tide, the flood water inundation width of these rivers can reach up to 1.5 km radial distance The peat depth in RER reaches 15 m, with an acidity (pH) ranging from 3.1 to 3.9 (Tropenbos International Indonesia Program, 2010; PT. GCN, 2012).

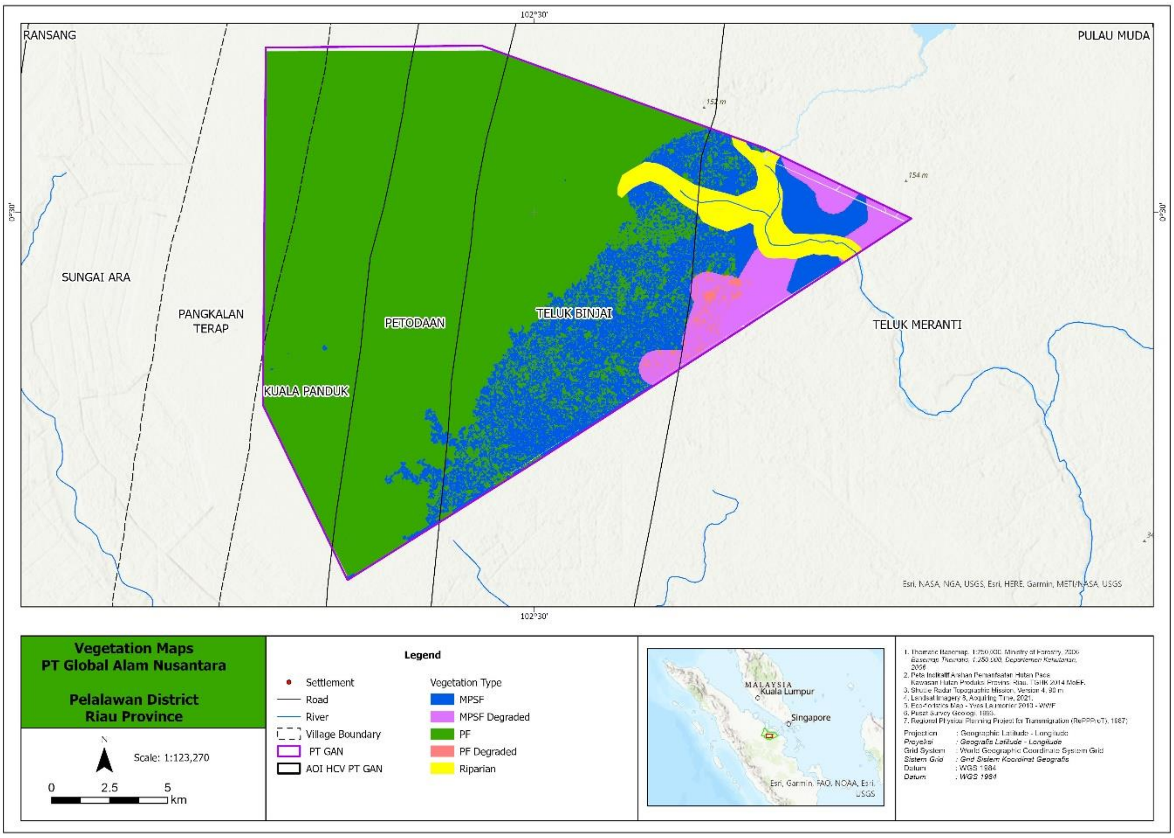

Figure 1. Vegetation type distribution on PT GAN.

The peat swamp forest ecosystem in Kampar Peninsula is an important habitat for endangered fauna and flora. Several endangered flora species, with high economic value, are ramin (*Gonystylus* sp.), other dipterocarp species (*Shorea* spp.), durian (*Durio* sp.), kempas (*Kompassia malacensis*) and punak (*Tetramerista glabra*). Some of the critically endangered and threatened mammals include Sumatran tiger (*Panthera tigris sumatrae*), pangolin (*Manis javanica*), and sun bear (*Ursus malayanus*). Several species of hornbill and raptor, and reptiles like false gharial (*Tomistoma schlegelii)* and painted terrapin (*Batagur borneoensis*), can also be found in this area (Tropenbos International Indonesia Program, 2010).

A series of surveys, along 12 transects, was conducted in PT GAN from March–July 2021 (Figure 2). Three transects (RK_GA08, RK_GA10 dan RK_GA11) located near the Serkap and Sianyir rivers were inundated with flood waters (60–70 cm). All other transects were dry, with forest litter depth ranging from 2–7cm. Relative-humidity, temperature, and canopy cover in all transects were 98.8%, 25–28^{o}C, and 57–97%, respectively. Besides several dominant tree species, such as *Shorea teysmaniana, Calophyllum calaba, Campnosperma cariaceum, Tristaniopsis merguensis, Ormosia sumatrana* and *Ilex hypoglauca*, other common floras were "mengkuang" (*Pandanus andersonii*), "rasau" (*P. helicopus*), and pitcher plant (*Nepenthes ampullaria*) (Figure 3).

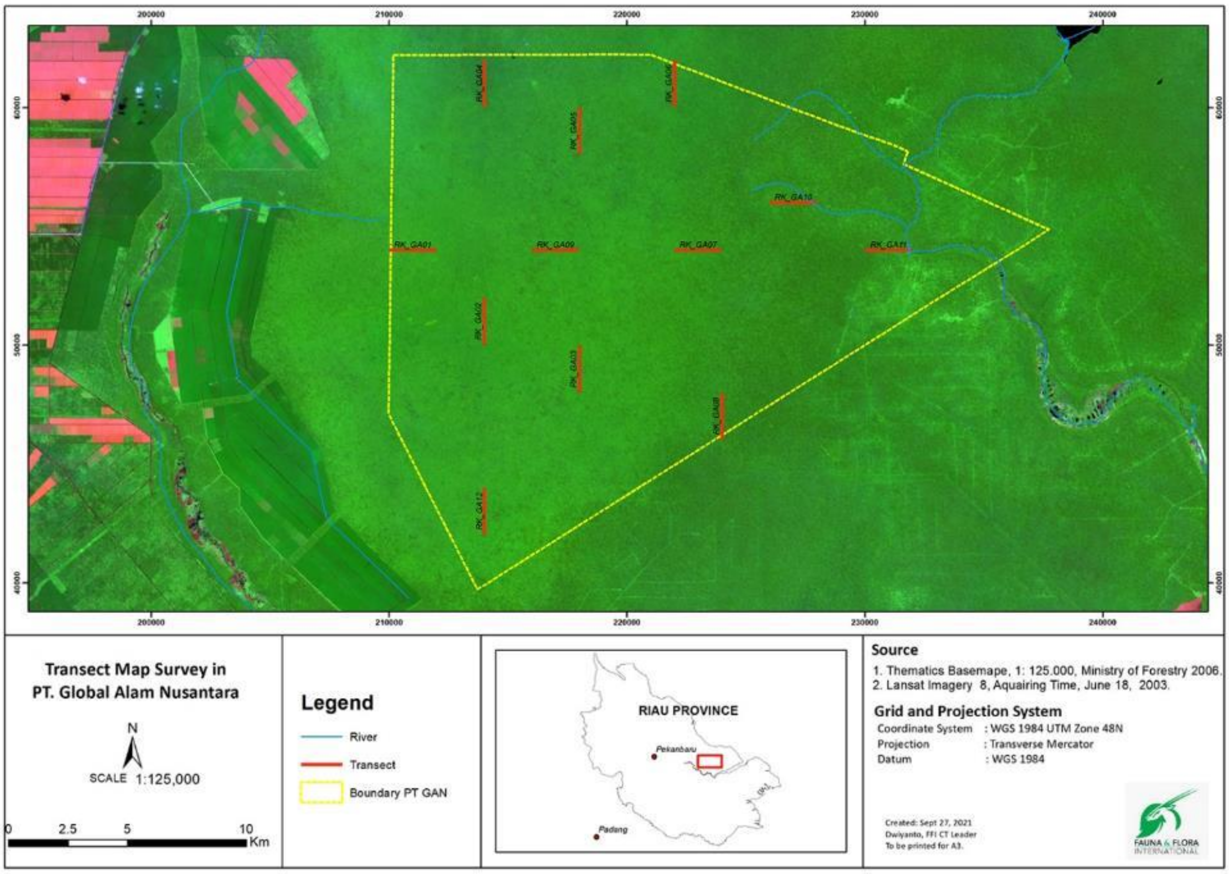

Figure 2. Transect distribution within PT GAN.

Figure 3. Mengkuang and rasau become dominant vegetation on several segments inside the transects.

2.2 Data Collection

2.2.1 Herpetofauna data collection

A Visual Encounter Survey (VES) method (Heyer et al., 1994) was used to collect herpetofauna data along the 12 transects. Each transect consisted of five 100x20m plots with an inter-plot distance (segment) of 400m. Observations on the transects were carried out in two time-periods: from 09:00 to 12:00 and from 19:00 to 22:00. The data collected included time and number of plot/segments, name of species observed, distance (cm) of individual from the transect, vertical position (cm) of individual from forest floor, occupied microhabitat (substrate), and activity of each individual. In addition, specimens were caught by hand (or snake hook) and measurements (snout-vent length (SVL) and, for reptiles only, tail length (Tal) taken. Each was re-released at the point of capture immediately after (although a voucher specimen was taken for species that could not be readily identified directly in the field; see below).

2.2.2 Voucher specimen collection and identification

Ethanol 70% was used to euthanize amphibian and reptile specimens, by injecting it into their brain from the nape. Specimens were labelled and put inside a specimen box; its body position set in such a way as to facilitate identification in the laboratory later. Several amphibian and reptile field guides were used to perform species identification, including Iskandar (2000), Liat & Das (1999), Malkmus et al. (2002), Manthey & Grossmann (1997), Inger & Stuebing (2005), Stuebing & Inger (1999), and Grismer (2011).

Amphibian and reptile species names referred to Frost (2021) and Uetz et al. (2021) while conservation status was assigned with reference to the IUCN Red List, CITES

(UNEP-WCMC, 2021), and Permen LHK No 106/2018 list of protected plant and animal species in Indonesia.

2.3 Data Analysis

2.3.1 Herpetofauna diversity

All data used for analysis was collected along the transects. The Shannon-Wiener (H’) diversity index was used to measure herpetofauna diversity on each transect, using the equation:

$$H' = -\sum_{i} \frac{ni}{N} \ln \frac{ni}{N}$$

H’ : Shannon-Wiener diversity value
ni : number of individuals of i-th species
N : total number of individuals

This index measures both species richness and relative abundance (evenness) whereby the calculated value will increase with increasing species richness and evenness (Brower et al., 1998).

2.3.2 Evenness index

Species evenness on each observation transect was measured using Pielou Evenness Index (Brower et al., 1998), following the equation:

$$E = \frac{H'}{\ln S}$$

E : Pielou Evenness index value
H’ : Shannon-Wiener diversity index value
S : A total number of species found on a transect

The value of E ranges from 0 to 1: the closer E is to 1 the more uniform in number are the members of the community on any observed transect is (i.e., a uniform community has no dominant species).

2.3.3 Species accumulation curve (SAC)

This curve was used to investigate trends in the number of species observed based on the number of sampling units (days of observations). To perform this analysis, we used PAST 4.06 (Hammer, 2021). When the curve still shows an increasing trend, rather than a levelling of the curve (asymptote), more species are likely to be observed as sampling units (time) are added.

2.3.4 Cluster analysis

This analysis was performed using PAST 4.06 (Hammer, 2021) to measure the level of similarity, of the observed herpetofauna community, between surveyed transects. A pair or group of transects that have similar composition of herpetofauna species will be clustered into the same group, with a certain degree of similarity values; transects showing different species compositions will be separated into different groups.

The Bray-Curtis Similarity Index was used to make a herpetofauna community tree (dendrogram) using species abundance data. The index value ranges from 0 to 1, whereby a community's composition is completely similar when the similarity index value is 1; an index value closer to 0 indicates a different community.

III. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Amphibian and reptile richness, abundance, and composition

A total of 36 species (9 amphibians and 27 reptiles) were recorded in the PT GAN area. Ranidae and Rhacophoridae were the dominant amphibian families (with three species each) whilst, for reptiles, the Colubridae was the most abundant (10) species (Figure 4). Colubridae is reported to have the most species richness among snake families. About 92 species are reported from Sumatra Island, 195 species in Indonesia and total of 2,046 species in the world (Uetz et. al., 2022).

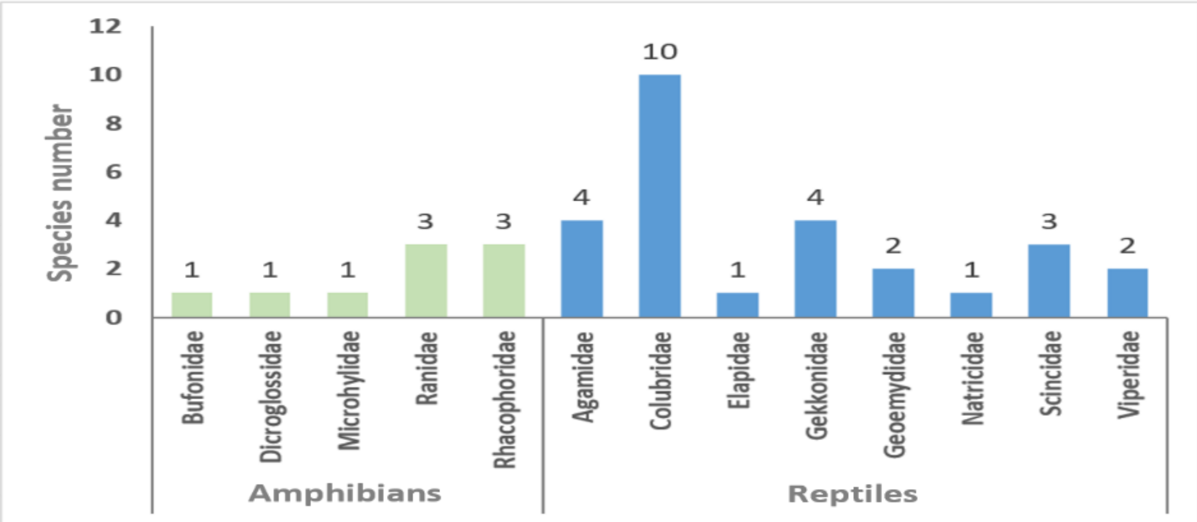

Figure 4. The quantity of amphibian and reptile per family recorded in PT GAN.

The total number of species of herpetofauna recorded in PT GAN could potentially increase if the sampling effort (days of observation) was extended, as no asymptote was reached (Figure 5). When looking at separate curves for the amphibians and reptiles, it is revealed that the amphibian curve is very close to an asymptote and so, any additional records would most likely come from the reptile group (Figure 5). Based on a jack-knife estimation, the total species number of amphibian, reptile, and herpetofauna may reach 10, 39, and 49 species respectively.

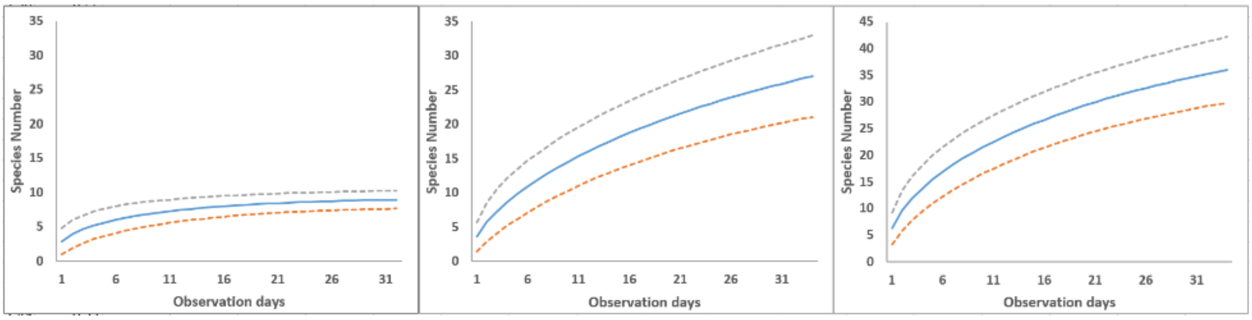

Figure 5. Species accumulation curve of amphibian (left), reptile (middle), and herpetofauna (right) in PT GAN.

The highest level of herpetofauna species richness was recorded along transects RK_GA10 and RK_GA11, with 18 species followed by RK_GA08 with 17 species. Each of these transects are located near a river. The lowest species richness was recorded along RK_GA02, with five species (Figure 6) on the peat dome. In general, the number of individual amphibians was much higher than for reptiles, with this pattern observed along all surveyed transects (Figure 6).

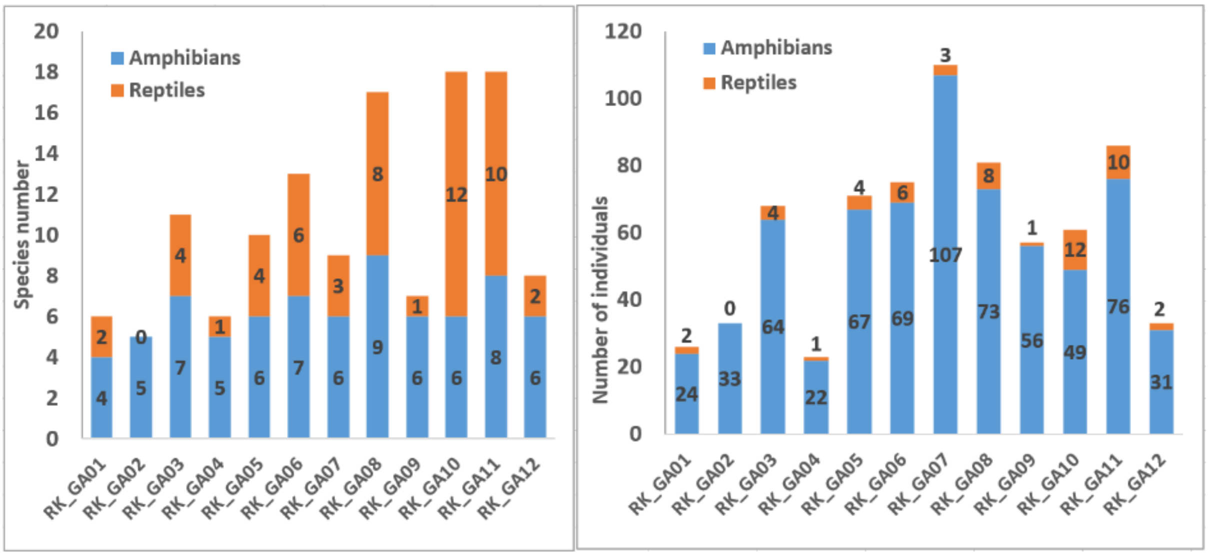

Figure 6. Comparison of species richness and abundance of amphibians and reptile in each transect.

Overall, the diversity (H') and evenness (E) index values were 2.19 and 0.61, respectively. The highest H' value (2.27) was observed along RK_GA10; the lowest (0.89) was along RK_GA07 (Figure 7).

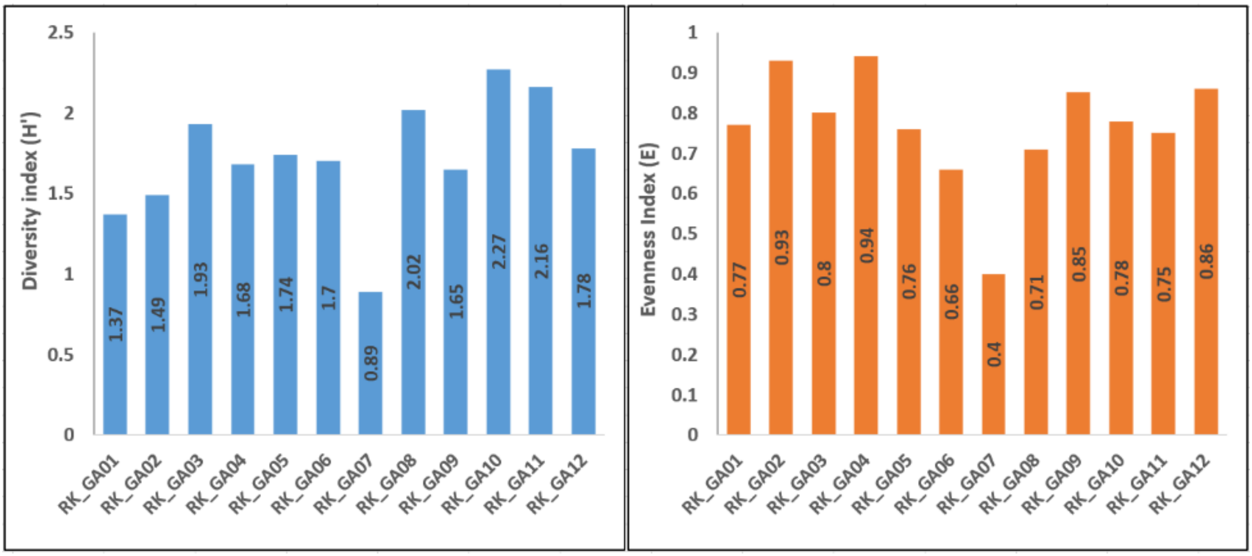

Figure 7. The diversity (H') and evenness (E) index values of surveyed transects in PT GAN.

RK_GA04 had the highest E value (0.94), while the lowest (0.40) was found along RK_GA07, which probably indicates the presence of one or several species with relatively higher abundance than others.

Three amphibians and three reptiles had higher relative abundance than the others: among the amphibians, *Polypedates colletti* (0.36), *Pulchrana baramica* (0.16), and *P. rawa* (0.028) and, for the reptiles, *Cyrtodactylus majulah* (0,16), *Gonocephalus liogaster* (0.07), and *Tropidolaemus wagleri* (0,04).

P. colletti was the most abundant species of amphibian in eight transects, with the highest relative abundance (0.79) in RK_GA07 (Table 1), followed by *P. baramica* in the remaining four transects with its highest relative abundance (0.46) found in RK_GA01. *P. rawa* was found in RK_GA08 only.

Amongst the reptiles, *C. majulah* had the higher relative abundance in seven transects, while higher relative abundances of *G. liogaster* were found in four transects. *T. wagleri* was found to have higher relative abundance in RK_GA04 only (Table 1).

Table 1. Six species of herpetofauna with high abundance in each transect in PT GAN.

Species	RK_GA01 n=26	RK_GA02 n=33	RK_GA03 n=71	RK_GA04 n=23	RK_GA05 n=71	RK_GA06 n=77
Polypedates colletti	4(0,15)	**11(0,33)**	12(0,17)	5(0,22)	**22(0,31)**	**43(0,56)**
Pulchrana baramica	**12(0,46)**	5(0,15)	**16(0,23)**	**6(0,26)**	21(0,3)	5(0,07)
Pulchrana rawa	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Cyrtodactylus majulah	**7(0,27)**	7(0,21)	**21(0,3)**	3(0,13)	8(0,11)	4(0,05)
Gonocephalus liogaster	0(0)	**8(0,24)**	6(0,09)	3(0,13)	**9(0,13)**	**6(0,08)**
Tropidolaemus wagleri	0(0)	2(0,06)	6(0,08)	**5(0,22)**	6(0,08)	3(0,04)
Species	RK_GA07	RK_GA08	RK_GA09	RK_GA10	RK_GA11	RK_GA12

	n=110	n=82	n=58	n=72	n=93	n=34
Polypedates colletti	**87(0,79)**	9(0,11)	**14(0,24)**	**27(0,38)**	**28(0,3)**	**8(0,24)**
Pulchrana baramica	1(0,01)	**28(0,34)**	11(0,19)	5(0,07)	7(0,08)	1(0,03)
Pulchrana rawa	0(0)	**20(0,24)**	0(0)	0(0)	1(0,01)	0(0)
Cyrtodactylus majulah	5(0,05)	**8(0,1)**	**19(0,33)**	**9(0,13)**	**21(0,23)**	**11(0,32)**
Gonocephalus liogaster	**6(0,06)**	1(0,01)	7(0,12)	4(0,06)	1(0,01)	5(0,15)
Tropidolaemus wagleri	0(0)	2(0,02)	4(0,07)	0(0)	1(0,01)	4(0,12)

n: total abundance of herpetofauna in each transect; the highest relative abundance value in each transect is indicated in bold.

Based on the cluster analysis, the herpetofauna community in PT GAN was clustered into three groups (Figure 8). Group I consisted of RK_GA08; Group II consisted of RK_GA02, RK_GA12, RK_GA04, RK_GA03, RK_GA09, RK_GA05, and RK_GA01; and Group III consisted of RK_GA06, RK_GA10, RK_GA10, RK_GA11, and RK_GA07. Based on Bray-Curtis's similarity index, RK_GA09 and RK_GA03 had the highest community similarity value of 0.82.

The herpetofauna community clusters are based on similarities in species richness and abundance. Group III consisted of transects that had higher species richness and with an abundance of *Polypedates colletti*, when compared to others. If *P. colletti* was more abundant in Group III, the most abundant amphibian species in Group II was *P. baramica*. In addition, *Cyrtodactylus majulah* also recorded higher levels of abundance, amongst reptiles, in Group II. RK_GA08, in Group I, tended to have similar compositions of species to Group II, as *P. baramica* had a higher relative abundance than *P. colletti* (Table 1). This group might be separated from others due to the presence of *Pulchrana rawa*, that could only be found in this transect.

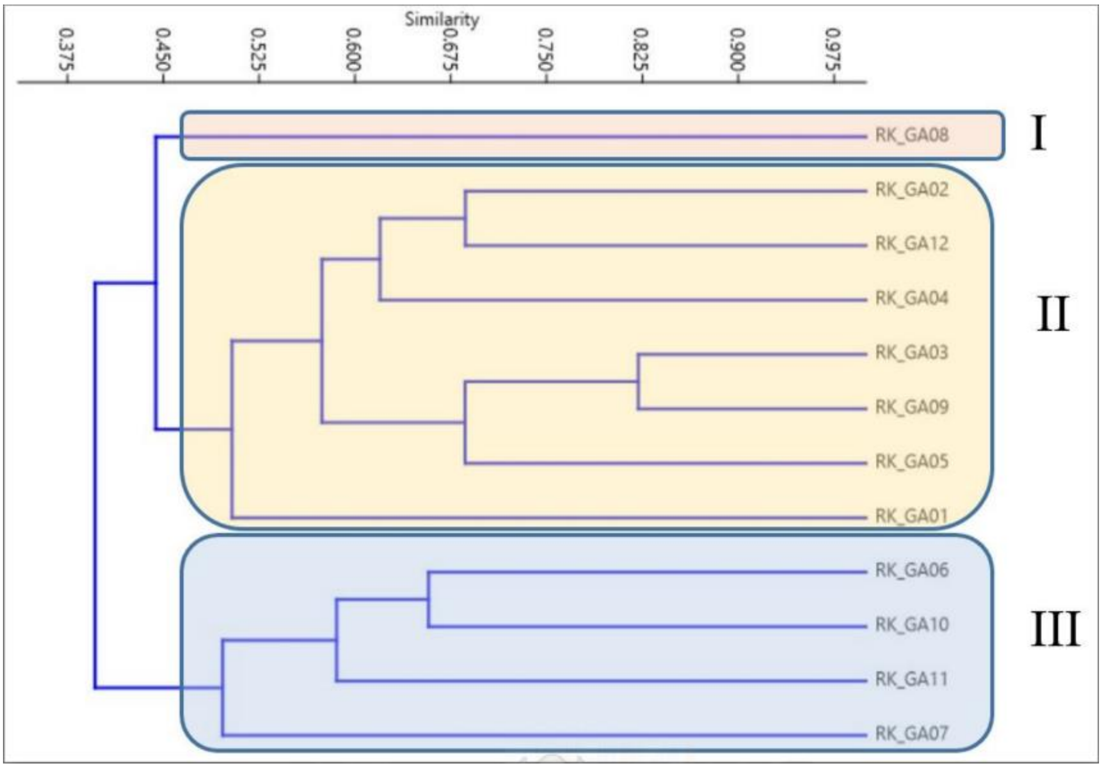

Figure 8. Similarity tree of herpetofauna community between surveyed transects in PT GAN.

3.1.2 Important herpetofauna species in PT GAN

Three species, masked swamp frog (*Limnonectes paramacrodon*), spiny turtle (*Heosemys spinosa*) and Asian leaf turtle (*Cyclemys dentata*), are listed under IUCN Red list as near threatened (NT), endangered (EN), and near threatened (NT), respectively; the remaining 33 species are all listed as least concern (LC). There were no protected herpetofauna species recorded in PT GAN. However, Irawan & Cahyadi (2016) have reported that several protected species, such as giant river turtle (*Orlitia borneensis*), saltwater crocodile (*Crocodylus porosus*), and false gharial (*Tomistoma schlegelii*), were confirmed to be present in Serkap River that also flows through the PT GAN concession.

3.1.3 New record of *Theloderma licin* in Riau

A single individual of frog was encountered in RK_GA11 with the following characteristics: tips of fingers and toes enlarge into semi-circular discs, a circum marginal groove on finger and toe disc, and many small bumps scattered on its lower back. Its dorsal body has a pale brown coloration, with dark brown circular markings on its waist. The ventral parts of its body (throat, chest, abdomen, underside of thigh) have a dark brown coloration, similar to the markings on its waist. This frog was not recorded during the 2015 surveys in RER concessions. Based on its morphological characters, this specimen is similar to *Theloderma licin* (McLeod & Ahmad, 2007) (Figure 9).

Theloderma licin was described as a new species by McLeod & Ahmad in 2007, first known in Peninsular Malaysia and expected to have a range that extended to the Isthmus Kra, Thailand. However, Das et al. (2013) later recorded it in Sarawak, Borneo. In Indonesia, this species was first reported by Kurniati (2008) from the secondary forests of Muara Labuh, West Sumatra. Interestingly, all known *T. licin* records have been reported from mineral forests with elevations ranging from 82m (in Pahang, Peninsular Malaysia; McLeod & Ahmad, 2007) to 800m (in Muara Labuh, West Sumatra; Kurnati, 2008) and no records from peat swamp forest. This record has been confirmed and so provides a new record for *T. licin* in peat swamp forest and has extended its distribution area in Sumatra Island, particularly to the Kampar Peninsula, Riau Province.

Figure 9. Comparison of individual frog encountered in RK_GA11 (left) with the holotype of *Theloderma licin* McLeod & Ahmad, 2007 based on its original publication (McLeod & Ahmad, 2007) (right).

3.1.4 Threats to amphibians and reptiles in PT GAN

Threats to amphibians and reptiles are categorized as direct threats, such as poaching, and indirect threats to its habitat including illegal logging, forest fires, and land-conversion. No direct or indirect threats were recorded during the survey period in PT GAN.

3.2 Discussions

3.2.1 Herpetofauna species richness in Restorasi Ekosistem Riau

The current survey in PT GAN has updated the total number of amphibian and reptile species present in the RER area from 75 species (14 amphibians and 61 reptiles; Irawan & Cahyadi (2016) to 81 species (15 amphibians and 66 reptiles). The six additional species records included one amphibian *Theloderma licin*, and five reptiles: three snakes (*Boiga cynodon, Calliophis bivirgatus,* and *Sibynophis melanocephalus*), one flying lizard (*Draco melanopogon*), and one forest skink (*Lygosoma* sp).

The total of 36 herpetofauna species in PT GAN represent 44% of the total 81 herpetofauna species in RER's peat swamp forests on Kampar Peninsula. This number is relatively low compared to other RER Ecosystem Restoration Concessions, such as PT GCN, with 56% (12 amphibians and 33 reptiles), PT SMN, 57% (11 amphibians and 35 reptiles), and PT TBOT, with 64% (11 amphibians and 41 reptiles) (see Irawan & Cahyadi, 2016).

Although the species richness in PT GAN was relatively low compared to the three other ERCs, the species number in PT GAN retains the potential to increase, as the species accumulation curve had not reached its asymptote (particularly for the reptile group). For example, when carrying out the PT GAN survey we did not record any monitor lizards (varanids). Based on previous surveys, three varanids (*Varanus dumerilii, V. rudicollis*, and the common *V. salvator*) were observed in the other RER ERCs (Irawan & Cahyadi, 2016). In addition, several water-associated snake genera (Rhabdophis, *Xenelaphis*, *Homalopsis*, and *Acrochordus*), and members of the turtle genera *Cuora*, *Siebenrockiella*, *Orlitia*, and *Amyda*, were not observed during the survey period in PT GAN. This is contrary to expectations as all these groups are commonly found on the kind of riverbank and riparian forest habitats that are typical of PT GAN. Increased survey effort in those areas could further expand the herpetofauna species records in PT GAN.

The total number of reptile species (richness) in PT GAN was much higher (threefold) than that found for amphibians, whilst abundance was the opposite. As predators, reptiles are relatively hard to detect, moving through the forest with stealth (Beebee, 2013). They also cover a wide range of habitats (Barve et al., 2013). Most reptiles do not depend on water to breed. In addition as a predator in food webs and can therefore be considered as naturally rare. As the biomass pyramid applies, that the abundance (biomass) of predators or consumers with a higher trophic level will have a lower abundance than the lower trophic level.

3.2.2 Comparison of RER's herpetofauna richness with other sites

The main ecosystem type in all four ERCs is mixed peat swamp forest and had levels of species richness, amongst the amphibians, that ranged from nine to 12 species, with an overall richness of 15 species. Several studies on amphibian diversity in mixed peat swamp forest in Borneo have reported similar levels for this eco-type with estimates ranging from seven to 17 species (Husson *et. al.* 2018; Harrison *et. al.* 2010; Inger *et. al.* 2005; Waddell, 2010; dan Klys, 2011). In Sumatra, several studies on the amphibians in Giam Siak Kecil (Matsui *et. al.* 2011) and Zamrud National Park (Leo *et. al.* 2020) in Riau Province; Sungai Buluh, Tanjung Jabung Timur, Jambi Province (Nugraha *et. al.* 2021); and Banyu Asin, South Sumatra Province (Kharisma, 2021) also reported similar results, with species richness amongst amphibians in peat swamp forest ranging from 10 to 12 species.

Amphibian species richness in peat swamp forest is much lower, when compared to mineral soil forest habitats. Several comprehensive studies of amphibians and reptiles carried in several landscapes in Sumatra, such as in Kerinci Seblat National Park (Kurniati, 2008), Batang Toru (Kamsi et al., 2017), Harapan Forest (Hutan Harapan, 2022), and Batang Gadis National Park (Kaprawi et al., 2020), and had total amphibian richness values of 71, 64, 55, and 48 species respectively.

According to Inger et al. (2005), the relatively low levels of amphibian species richness, in peat swamp forests, might be a result of three ecological factors:

1. A lack of relatively fast-moving rocky streams (a feature favoured by 33% of frog species in Borneo)
2. Relatively low water acidity in peat swamp forest (suitable for only a few species of frog)
3. The presence of predatory fish in many of the puddles typical of peat swamp, that are potentially used as breeding sites by amphibious species.

Although the species richness of amphibians in peat swamp forest ecosystems tends to be much lower than mineral soil forest ecosystems, this is not the case with reptile richness. The RER area has a total of 66 reptile species; almost twice that found in a comparative study in the Kerinci Seblat Landscape (2005–2008) with 38 reptile species (Kurniati, 2008). Other comprehensive biodiversity surveys, carried out in the Harapan Forest Landscape (Jambi) and Batang Toru Landscape (from 2003 to 2015), recorded a total of 71 and 80 reptile species respectively (Hutan Harapan, 2022; Kamsi *et. al.* 2017), suggesting that peat swamp forests may not typically hold fewer reptile species than mineral soil forest ecosystems. Further surveys and monitoring may increase reptile species richness in RER's peat swamp forests.

The limiting factors contributing to low numbers of amphibian species, in peat swamp forest, do not seem to apply to the reptile group. Reptiles are more adapted to the terrestrial ecosystem, and they may not depend on water to breed. This less specialised strategy allows them to occupy a variety of terrestrial habitat types within the peat swamp forest ecosystem. On the forest floor, species of *Eutropis, Lygosoma*, *Bungarus, Ophiophagus, Naja*, and *Sybynophis dwell*. The scansorial and arboreal genera that occupy the shrubs and trees find homes in tree-holes, crevices and under tree bark, include many geckoes (Cyrtodactylus, Gehyra, Cnemaspis, Gekko, Hemidactylus, and Hemiphyllodactylus), agamids (*Gonocephalus, Draco*, and *Aphaniotis*), Colubridae tree-snakes (*Boiga, Dendrelaphis, Lycodon, Pareas,* and *Chrysopelea*) and vipers (*Tropidolaemus* and *Trimeresurus*).

3.2.3 Herpetofauna species composition

Among all frog species, Collett's tree frog (*Polypedates colletti*) had the highest relative abundance in many of the transects, regardless of distance from rivers; as was the case in 2015 surveys in PT GCN, PT SMN, and PT TBOT. This species tends to be abundant in mixed peat swamp forest areas with a dense canopy cover, and in the forest that has mixed vegetation, with *Pandanus andersonii* in tree form (Irawan & Cahyadi, 2016). Based on Inger *et. al.* (2017), Collett's tree frog is commonly found in lowland forests, as well as both primary and old secondary peat swamp forests.

The Baram River frog (*Pulchrana baramica*) is the second most abundant frog species, common in transects with puddles and overgrown with bushes, and was often seen on leaves or twigs around the puddles, as well as on the forest floor.

The forest gecko (*Cyrtodactylus majulah*), blue-eyed anglehead lizard (*Gonocephalus liogaster*), and Wagler's pit viper (*Tropidolaemus wagleri*) were the three most abundant reptiles in PT GAN, often found perching on bushes or small trees. *C. majulah* tended to be found on shrubs or tree twigs at heights of about 1 or 2 meters. In general, most geckoes, including Cyrtodactylus, prey on arthropods such as spiders, beetles, and other insects such as forest cockroaches and crickets (Bauer, 2013; Purkayastha *et. al.* 2020).

The differences in vegetation structure may influence arthropod communities, in terms of species and abundance and, therefore, will impact variations in the abundance of their predators. On the other hand, *C. majulah* tended to be most abundant in transects with more tree stands, but less abundant in bush habitat types containing *P. andersonii*. During night-time observations, *G. liogaster* tended to occupy much higher tree branches, at a height of three meters and above; as a diurnal species, it will retreat to higher places to sleep and avoid predators.

Tropidolaemus wagleri was a common venomous snake in the PT GAN survey, preferring the shade of twigs to wait in ambush for small mammals, birds and other small reptiles and amphibians. Indeed, it is known to perch on the same twig for days, or even weeks, to wait for prey (David & Vogel, 1996).

Although the sun skink (*Eutropis multifasciata*) was one of the most abundant reptiles in PT SMN (Irawan & Cahyadi, 2016), this species was rarely seen in PT GAN. The conditions of many of the transects, with relatively thick and dry litter, in PT GAN may be a cause of lower detection rates for this species.

Based on results of the cluster analysis, several transects adjacent to rivers tended to have a more diverse species composition. Riparian habitat, as a transitional area between aquatic and terrestrial zones, may provide more variety of microhabitat types and be able to support more species of herpetofauna. Three transects located close to the river (RK_GA08, RK_GA10, and RK_GA11), had more herpetofauna species than other transects. In these transects we recorded several species of reptile commonly found in shrubs or bushes near rivers (e.g., *Boiga cynodon*, *B. dendrophila*, and *Xenochrophis maculatus;* Stuebing & Inger, 1999).

IV CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The peat swamp forests in all four RER concession on the Kampar Peninsula (PT GAN, PT GCN, PT SMN, and PT TBOT):

1.Have low amphibian species richness, but provide habitat for a variety of reptiles, with species' numbers that may be close to its species richness in non-peat swamp forest ecosystems.

2. Additional records on several species of herpetofauna in the RER's PT GAN area, and even a new distribution record for *Theloderma licin* in peat swamp forest, indicates that further biodiversity surveys and monitoring, focusing on herpetofauna, need to be carried out.

4.2 Recommendations

Based on this study, recommendations for further work are:

1. Awareness-raising program to highlight the important and threatened reptiles within the RER area. This could include the placement of information boards and posters in the public areas of each estate, and at the bridges crossing the main rivers, which function as access points for fishers.
2. Maximize the function of rangers, and ranger posts, through inspection activities designed to minimize by-catch in fishermen's nets, poaching and other illegal activities.
3. Establish several permanent transects in each concession to be used as monitoring locations for herpetofauna and other taxa. The transects should cover a variety of habitat types, with surveys carried out every six months, to account for seasonal variation (wet/dry seasons).
5. Write a publication on herpetofauna in Kampar Peninsula particularly for herpetofauna in the peat swamp ecosystem to provide an insight into the importance of protecting this ecosystem for herpetofauna conservation.

V. REFERENCES

Barve, S., Bhaisare, D., Giri, A., Shhankar, P.G., Whitaker, R. & Goode, M. (2013) A preliminary study on translocation of ‘rescued’ King Cobras (*Ophiophagus hannah*). *Hamadryad*, 36, 80–86.

Bauer, A. M. 2013. *Geckos, the Animal Answer Guide*. The Johns Hopkins University Press, Baltimore, Maryland.

Beebee, T.J.C. (2013) *Amphibians and reptiles*. Pelagic Publishing, Exeter, UK.

Brower, J., Zar, J. & Von Ende, C.N. (1998) *Field and Laboratory Methods for General Ecology, 4th edition*. WCB Mc Graw - Hill, Boston, Ma.

Browne, C.L., Paszkowski, C.A., Foote, A.L., Moenting, A. & Boss, S.M. (2009) The relationship of amphibian abundance to habitat features across spatial scales in the Boreal Plains. *Ecoscience*, 16, 209–223.

Das, I., Grinang, J., & Min, P. Y. (2013) *Theloderma licin* McLeod and Ahmad, 2007 (Lissamphibia: Anura: Rhacophoridae), a new frog record for Borneo. *Asian Herpetological Research*. Serial 2, 4: 221–223.

David, P., & Vogel, G. (1996) *The snakes of Sumatra: an annotated checklist and key with natural history notes*. Ed. Chimaira, Germany.

Frost, D. R. (2021) *Amphibian Species of the World: an online reference*. Version 6.1 (2 Nov 2021). Electronic Database accessible at https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA.

Grismer, L. L. (2011) *Lizard of Peninsular Malaysia, Singapore, and Their Adjacent Archipelagos: Their description, distribution, and natural history*. Ed. Chimaira, Germany.

Hammer, Ø (2021) PAST. *Paleontological Statistics version 4.06 reference manual*. Natural History Museum University of Oslo, Oslo.

Harrison, M.E., Hendri, Dragiewicz, M.L., Krisno, Cheyne, S.M. & Husson, S.J. (2010) *Baseline Biodiversity and Ape Population Assessment and Preliminary Monitoring Protocol in The Katingan Peat Swamp, Central Kalimantan, Indonesia*. Palangka Raya, Indonesia.

Hernandez-Ordonez, O., Urbina-Cardona, N., Martinez-Ramos, M. (2015) Recovery of amphibian and reptile assemblages during old-field succession of tropical rain forest. *Biotropica*, 0(0): 1 – 12.

Herrmann, H.L., Babbitt, K.J., Baber, M.J. & Congalton, R.G. (2005) Effects of landscape characteristics on amphibian distribution in a forest-dominated landscape. *Biological Conservation*, 123, 139–149.

Heyer, W.R., Donnelly, M.A., Mcdiarmid, R.W., Hayek, L.C. & Foster, M.S. (1994) *Measuring and monitoring biological diversity: standard methods for amphibians*. Smithsonian Institution Press, Washington.

Husson, S. J., Limin, S. H., Boyd, N. S., Brousseau, J. J., Collier, S., Cheyne, S. M., D'arcy, L. J., Dow, R. A., & Schreven, S. (2018) Biodiversity of the Sebangau tropical peat swamp forest, Indonesian Borneo. *Mires and Peat*, 22: 1-50.

Hutan Harapan. (2022) Forest Restoration, Flora and Fauna Identification. https://hutanharapan.id/en/forest-restoration/ accessed on March 1, 2022.

Inger, R.F. & Stuebing, R.B. (2005) *A field guide to the frogs of Borneo, 2nd edition*. Natural History Publication (Borneo), Kota Kinabalu, Sabah.

Inger, R.F., Stuebing, R.B., Grafe, T. U. & Dehling, J. M. (2017) *A field guide to the frogs of Borneo 3rd edition*. Natural History Publication (Borneo), Kota Kinabalu, Sabah.

Inger, R.F., Stuebing, R.B. & Zainudin, R. (2005) *Peat Swamp Frogs of Borneo*. In Wallace in Sarawak– 150 Years Later. An International Conference on Biogeography and Biodiversity (eds A.A. Tuen & I. Das), pp. 178–181. Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, Samarahan, Sarawak, Malaysia.

Irawan, A., & Cahyadi, G. (2016) *Keanekaragaman Jenis Herpetofauna di Kawasan Restorasi Ekosistem Riau, Provinsi Riau*. Biodiversity Report. Fauna & Flora International’s Indonesia Programme, Jakarta.

Iskandar, D.T. (2000) *Kura - kura dan buaya Indonesia & Papua Nugini*. Palmedia - ITB, Bandung, Indonesia.

Kamsi, M., Handayani, S., Siregar, A. J., & Fredriksson, G. (2017) *Buku Panduan Lapangan Amfibi Reptil Kawasan Hutan Batang Toru*. Herpetologer Mania Publishing - Yayasan Ekosistem Lestari, Medan.

Kaprawi, F., Alhadi, F., Hamidy, A., Nopandry, B., Kirschey, T., & Permana, J. (2020) *Panduan Lapangan Amfibi di Taman Nasional Batang Gadis Sumatera Utara*. Medan: Perkumpulan Amfibi Reptil Sumatra (ARS).

Kharisma, R. G. (2021) *Inventarisasi Herpetofauna di Kawasan Hutan PT Global Alam Lestari, Kabupaten Musi Banyuasin, Sumatra Selatan*. Skripsi Sarjana. Jurusan Biologi Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Sriwijaya.

Klys, J. (2011) *An estimation of anurans species richness and abundance in Sebangau Peat-Swamp Forest, Indonesia, Borneo*. University of Roehampton, UK.

Kurniati, H. (2008) *Biodiversity and natural history of amphibians and reptiles in Kerinci Seblat National Park, Sumatra, Indonesia*. Final Report. Indonesian Institute of Science (LIPI).

Leo, S., Suherman, M., Permatasari, A., Suganda, D., Zulamri, & 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.

Leyte-Manrique, A., Buelna-Chontal, A.A., Torres-Diaz, M.A., Berriozabal-Islas, C., Maciel-Mata, C.A. (2019) A comparison of amphibian and reptile diversity between disturbed and undisturbed environments of Salvatierra, Guanajuato, Mexico. *Tropical Conservation Science*, 12: 1–12.

Liat, L.B. & Das, I. (1999) *Turtles of Borneo and Peninsula Malaysia*. Natural History Publication (Borneo), Kota Kinabalu, Sabah.

Malkmus, R., Manthey, U., Vogel, G., Hoffmann, P., Kosuch, J. (2002) *Amphibians and reptiles of Mount Kinabalu, North Borneo*. ARG Ganter Verlag Kommanditgesellschaft, Ruggel, Germany.

Manthey, U., & Grossmann, W. (1997) *Amphibien & Reptilien Südostasiens*. Natur-und-Tier-Verlag, Germany.

Mcleod, D. S. And Ahmad, N. (2007) A new species of *Theloderma* (Anura: Rhacophoridae) from southern Thailand and peninsular Malaysia. *Russian Journal of Herpetology* 14: 65–72.

Matsui, M., Mumpuni, & Hamidy, A. (2012) Description of a New Species of *Hylarana* from Sumatra (Amphibia, Anura). *Current Herpetology*, 31, 38–46.

Nugraha, A. P., Suprayogi, D., Kartika, W. D., & Setiawan, A. (2021). Distribusi Herpetofauna di Kawasan Hutan Lindung Gambut Sungai Buluh Tanjung Jabung Timur. *Majalah Ilmiah Biologi BIOSFERA: A Scientific Journal*, 38(1), 55-59.

Posa, M.R.C., Wijedasa, L.S. & Corlett, R.T. (2011) Biodiversity and Conservation of Tropical Peat Swamp Forests. *BioScience*, 61, 49–57.

PT GCN (2012) *Upaya pengelolaan lingkungan hidup dan upaya pemantauan lingkungan hidup (UKL - UPL)*. Ijin usaha pemanfaatan hasil hutan kayu restorasi ekosistem (IUPHHK - RE).

Purba, C.P.P., Nanggara, S.G., Ratriyono, M., Apriani, I., Rosalina, L., Sari, N.A. & Meridian, A.H. (2014) *Potret keadaan hutan Indonesia periode 2009 - 2013*. Forest Watch Indonesia, Bogor.

Purkayastha, J., Das, M., Bohra, S. C., Bauer, A. M., & Agarwal, I. (2020). Another new Cyrtodactylus (Squamata: Gekkonidae) from Guwahati, Assam, India. Zootaxa, 4732(3), 375-392.

RESTORASI EKOSISTEM RIAU (2015) Restorasi Ekosistem Riau. Http://www.rekoforest.org/id/tentang [accessed 11 February 2016].

Thompson, S.A., Thompson, G.G. & Withers, P.C. (2008) Rehabilitation index for evaluating restoration of terrestrial ecosystems using the reptile assemblage as the bio-indicator. *Ecological Indicators*, 8, 530–549.

TROPENBOS INTERNATIONAL INDONESIA PROGRAM (2010) *Buku I: Data dan informasi dasar penilaian menyeluruh nilai konservasi tinggi Semenanjung Kampar*.

Uetz, P., Freed, P, Aguilar, R. & Hosek, J. (eds.) (2021) *The Reptile Database*, http://www.reptile-database.org, accessed [10 Nov 2021].

Uetz, P., Freed, P, Aguilar, R. & Hosek, J. (eds.) (2022) *The Reptile Database*, http://www.reptile-database.org, accessed [6 Mar 2022].

UNEP-WCMC. (2021) *The Checklist of CITES Species Website*. CITES Secretariat, Geneva, Switzerland. Compiled by UNEP-WCMC, Cambridge, UK. Available at: http://checklist.cites.org. Accessed 10 May 2021.

Waddell, E. (2010) *Amphibian diversity in Bornean forests: a comparison of habitats using different sampling methods and richness estimators*. University of Glasgow, UK.

Yule, C.M. (2010) Loss of biodiversity and ecosystem functioning in Indo-Malayan peat swamp forests 1 C 1 C, 393–409.

Zug, G.R., Vitt, L.J. & Caldwell, P. (2001) *Herpetology: An introductory biology of amphibians and reptiles, 2nd edition*. Academic Press, San Diego, California, USA.

APPENDICES

Appendix 1 List of herpetofauna species recorded in the four concessions of Restorasi Ekosistem Riau

No	Species	Family	IUCN	CITES	GOI[a]	End[b]	GCN	SMN	TBOT	GAN
	Amphibians									
1	*Ingerophrynus quadriporcatus*	Bufonidae	LC	-	-	-	√	√	√	√
2	*Pseudobufo subasper*	Bufonidae	LC	-	-	-	√	√	√	-
3	*Fejervarya limnocharis*	Dicroglossidae	LC	-	-	-	√	-	-	-
4	*Limnonectes paramacrodon*	Dicroglossidae	NT	-	-	-	√	√	√	√
5	*Phrynella pulchra*	Microhylidae	LC	-	-	-	√	√	√	√
6	*Chalcorana parvaccola*	Ranidae	LC	-	-	√	√	√	√	√
7	*Hylarana erythraea*	Ranidae	LC	-	-	-	-	√	√	-
8	*Pulchrana baramica*	Ranidae	LC	-	-	-	√	√	√	√
9	*Pulchrana glandulosa*	Ranidae	LC	-	-	-	√	-	-	-
10	*Pulchrana rawa*	Ranidae	LC	-	-	-	√	√	√	√
11	*Nyctixalus pictus*	Rhacophoridae	NT	-	-	-	-	√	√	-
12	*Polypedates colletti*	Rhacophoridae	LC	-	-	-	√	√	√	√
13	*Polypedates leucomystax*	Rhacophoridae	LC	-	-	-	√	-	-	-
14	*Polypedates macrotis*	Rhacophoridae	LC	-	-	-	√	√	√	√
15	*Theloderma licin*	Rhacophoridae	LC	-	-	-	-	-	-	√
	Reptiles									
16	*Aphaniotis fusca*	Agamidae	LC	-	-	-	√	√	√	√
17	*Bronchocela cristatella*	Agamidae	LC	-	-	-	√	-	√	√
18	*Draco melanopogon*	Agamidae	LC	-	-	-	-	-	-	√
19	*Draco quinquefasciatus*	Agamidae	LC	-	-	-	-	√	√	-
20	*Draco sumatranus*	Agamidae	LC	-	-	-	√	√	√	-
21	*Gonocephalus liogaster*	Agamidae	LC	-	-	-	-	-	√	√

No	Species	Family	IUCN	CITES	GOI[a]	End[b]	GCN	SMN	TBOT	GAN
22	*Cnemaspis sp.*	Gekkonidae	-	-	-	-	-	-	√	-
23	*Cyrtodactylus majulah*	Gekkonidae	LC	-	-	-	√	√	√	√
24	*Gehyra mutilata*	Gekkonidae	LC	-	-	-	√	-	√	√
25	*Gekko kuhli*	Gekkonidae	LC	-	-	-	√	-	-	√
26	*Gekko smithii*	Gekkonidae	LC	-	-	-	-	√	√	√
27	*Hemidactylus frenatus*	Gekkonidae	LC	-	-	-	-	√	√	-
28	*Hemiphyllodactylus typus*	Gekkonidae	LC	-	-	-	√	-	-	-
29	*Dasia olivacea*	Scincidae	LC	-	-	-	-	√	-	-
30	*Eutropis multifasciata*	Scincidae	LC	-	-	-	√	√	√	√
31	*Eutropis rudis*	Scincidae	LC	-	-	-	√	√	-	-
32	*Eutropis rugifera*	Scincidae	LC	-	-	-	√	√	√	√
33	*Lygosoma sp.*	Scincidae	-	-	-	-	-	-	-	√
34	*Acrochordus javanicus*	Acrochordidae	LC	-	-	-	√	√	√	-
35	*Ahaetulla prasina*	Colubridae	LC	-	-	-	-	√	√	√
36	*Boiga cynodon*	Colubridae	LC	-	-	-	-	-	-	√
37	*Boiga dendrophila*	Colubridae	LC	-	-	-	-	√	√	√
38	*Boiga drapiezii*	Colubridae	LC	-	-	-	-	√	√	√
39	*Boiga jaspidea*	Colubridae	LC	-	-	-	-	-	√	√
40	*Boiga nigriceps*	Colubridae	LC	-	-	-	√	-	√	-
41	*Chrysopelea paradisi*	Colubridae	LC	-	-	-	-	-	√	-
42	*Coelognathus flavolineatus*	Colubridae	LC	-	-	-	-	√	-	√
43	*Dendrelaphis caudolineatus*	Colubridae	LC	-	-	-	√	√	√	√
44	*Dendrelaphis formosus*	Colubridae	LC	-	-	-	-	-	√	-
45	*Dendrelaphis pictus*	Colubridae	LC	-	-	-	-	-	√	-
46	*Gongylosoma baliodeirus*	Colubridae	LC	-	-	-	-	√	√	-
47	*Lycodon albofuscus*	Colubridae	LC	-	-	-	√	√	√	-
48	*Lycodon effraensis*	Colubridae	-	-	-	-	-	√	-	-

No	Species	Family	IUCN	CITES	GOI[a]	End[b]	GCN	SMN	TBOT	GAN
49	*Lycodon subannulatus*	Colubridae	LC	-	-	-	√	√	√	√
50	*Lycodon subcinctus*	Colubridae	LC	-	-	-	√	-	-	√
51	*Xenelaphis hexagonotus*	Colubridae	LC	-	-	-	√	√	-	-
52	*Bungarus flaviceps*	Elapidae	LC	-	-	-	√	-	-	-
53	*Calliophis bivirgata*	Elapidae	LC	-	-	-	-	-	-	√
54	*Naja sumatrana*	Elapidae	LC	II	-	-	√	√	√	-
55	*Ophiophagus hannah*	Elapidae	VU	II	-	-	-	√	-	-
56	*Homalopsis buccata*	Homalopsidae	LC	-	-	-	√	√	√	-
57	*Rhabdophis flaviceps*	Natricidae	LC	-	-	-	√	-	-	-
58	*Rhabdophis rhodomelas*	Natricidae	LC	-	-	-	√	-	-	-
59	*Rhabdophis subminiatus*	Natricidae	LC	-	-	-	-	√	-	-
60	*Xenochrophis maculatus*	Natricidae	LC	-	-	-	-	-	√	√
61	*Aplopeltura boa*	Pareidae	LC	-	-	-	√	-	√	-
62	*Asthenodipsas malaccanus*	Pareidae	LC	-	-	-	√	-	-	-
63	*Pareas carinatus*	Pareidae	LC	-	-	-	√	-	-	-
64	*Psammodynastes pictus*	Pseudaspididae	LC	-	-	-	-	√	√	-
65	*Psammodynastes pulverulentus*	Pseudaspididae	LC	-	-	-	√	-	-	-
66	*Malayopython reticulatus*	Pythonidae	LC	II	-	-	√	-	√	-
67	*Sibynophis melanocephalus*	Sibynophiidae	LC	-	-	-	-	-	-	√
68	*Trimeresurus sp.*	Viperidae	-	-	-	-	-	√	√	√
69	*Tropidolaemus wagleri*	Viperidae	LC	-	-	-	√	√	√	√
70	*Xenopeltis unicolor*	Xenopeltidae	LC	-	-	-	-	√	√	-
71	*Cuora amboinensis*	Geoemydidae	EN	II	-	-	√	√	-	-
72	*Cyclemys dentata*	Geoemydidae	NT	II	-	-	√	√	√	√
73	*Heosemys spinosa*	Geoemydidae	EN	II	-	-	-	-	√	√
74	*Orlitia borneensis*	Geoemydidae	CR	II	√	-	√	√	-	-
75	*Siebenrockiella crassicollis*	Geoemydidae	EN	II	-	-	-	√	-	-

No	Species	Family	IUCN	CITES	GOI[a]	End[b]	GCN	SMN	TBOT	GAN
76	*Amyda cartilaginea*	Trionychidae	VU	II	-	-	-	√	-	-
77	*Crocodylus porosus*	Crocodylidae	LC	I/II	√	-	-	-	√	-
78	*Tomistoma schlegelii*	Crocodylidae	VU	I	√	-	-	-	√	-
79	*Varanus dumerilii*	Varanidae	DD	II	-	-	-	-	√	-
80	*Varanus rudicollis*	Varanidae	DD	II	-	-	√	-	√	-
81	*Varanus salvator*	Varanidae	LC	II	-	-	√	√	√	-

a: listed as protected species under Permen LHK No. 106/2018; b: Sumatra endemic species

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