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The dominant species of herpetofauna in the coal mining area at East Kalimantan, Indonesia

TEGUH MUSLIM[1,2], ULFAH KARMILA SARI[1,♥], ISHAK YASSIR[1]

[1]Research and Technology Development Institute of Conservation of Natural Resources. Jl. Soekarno-Hatta Km 38 Samboja, Kutai Kartanegara 75271, East Kalimantan, Indonesia. Tel.: +62-542-7217663, Fax.: +62-542-7217665. ♥email: opeh_nazri@yahoo.com

[2]Department of Forestry Science, Faculty of Forestry, Universitas Mulawarman. Jl. Ki Hajar Dewantoro, Gunung Kelua, Samarinda Ulu, Samarinda 75119, East Kalimantan, Indonesia. Tel./Fax.: +62-541-741033,

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Abstract. *Muslim T, Sari UK, Yassir I. 2017. The dominant species of herpetofauna in the coal mining area at East Kalimantan, Indonesia. Biodiversitas 18: 773-779.* Changing of habitat condition influences the variety of species including Herpetofauna. Herpetofauna is one of the components in the ecosystem that plays an important role, both from the ecological and economical aspect. From the ecological aspect, it has a specific role in the food chain, and it can also be used as a bio-indicator of the environment's condition. Furthermore, herpetofauna found in reclamation area of coal mining not only stabilizes the ecosystem in the food chain, but also it can be used as a bioindicator of environment changes and the success rate of reclamation. The aim of this research was to find out the community of herpetofauna comprising and dominating the coal mining reclamation area, especially the wet and dry areas. The research location was located at PT. Singlurus Pratama Kalimantan Timur. The methods used in this research were visual encounter survey and patch sampling. This research found 10 species from 5 families of reptiles and 11 species from 6 families of amphibians. The highest dominant index score for reptile was 0.71, found in the fragmented forests. Meanwhile, the dominant reptile species were *Eutropis multifasciata* (20 individuals), *Enhydris enhydris* (4 individuals), and *Dendrelaphis pictus* (4 individuals). The highest dominant index score for amphibian was 1, found in the settling pond. Moreover, the dominant amphibian species were *Polypedates leucomystax* (42 individuals) and *Fejervarya cancrivora* (41 individuals). These two species were the ones able to survive in the degraded areas and they were easily found in the areas with disrupted habitats.

Keywords: Coal mining, dominant species, herpetofauna, microhabitat, wet area

INTRODUCTION

Herpetofauna is one of the components comprising the ecosystem which plays an important role, both ecologically and economically. Ecologically, it has a crucial position in the food chain as a primary predator of insects or other invertebrates (Iskandar 1998). Moreover, it can also be used as a bioindicator of the environmental condition (Stebbins and Cohen 1997) because it can be found in almost all types of habitat, including several species which exist only in a specific type of habitat; therefore it is good to be used as an indicator of an environmental change

The change of vegetation which occurs consecutively in a particular area influences the succession of animals including herpetofauna. Concerning the wildlife reclamation activities, herpetofauna, in this case, the ones existing in the reclamation areas can be used as an indicator of the success of the reclamation activities. The existence of herpetofauna can be determined by the areas surrounding the mining which remain as either natural or fragmented forest. The bigger density of vegetation will normally result in a particular microclimate condition which provides a microhabitat for herpetofauna.

Habitats do not only concern the provision of the life necessities for a particular organism but also where and how the particular fauna can live (Goin and Goin 1971).Based on its habitat, herpetofauna lives in human residential areas; trees; disrupted habitat, river and stream areas as well as primary and secondary forests (Iskandar 1998). A lot of herpetofauna types use different habitats in different periods of time. However, they need to go to the wetlands to procreate. Furthermore, most amphibians are found in the locations where water sources exist (Rahayuningsih and Abdullah 2012).

Amphibians and reptiles are ectothermic and poikilothermic, which means that they gain the energy by using the thermal sources from their surroundings (Kusrini et al. 2003). This characteristic requires amphibians to live in a terrestrial and aquatic habitat, whereas reptiles occupy both general and specific habitats. Moreover, reptiles can live in the terrestrial, aquatic and even in the riverbanks which do not belong to the aquatic ones (Iskandar 1996; Mistar 2003). Nevertheless, some specific types are only found in the open areas (Iskandar 1998; Boer et al. 2014).

The biodiversity of herpetofauna has decreased as the vegetation has become more open and more homogenous (Riyanto 2010). Thus, the mining activities influence the diversity of herpetofauna. Santosa (1995) stated that homogeneity could be used as an indicator of the existence of dominant species in a community. The dominance level of a species will be high if the homogeneity is low and vice versa, when the homogeneity is high the dominance will be low. Therefore, the objective of this research would be to find out the formed herpetofauna species communities

which dominate the coal mining reclamation areas, especially in the dry and wetlands. The findings of this research would be expected to add to the existing information related to the development of concepts of synergizing with the nature in doing the reclamation activities in the post-coal mining areas.

MATERIALS AND METHODS

Study area

This research was conducted from August to December 2015. The research site was located in the area of coal mining at Merdeka Block of PT Singlurus Pratama, Kutai Kartanegara, East Kalimantan, Indonesia with the following geographical coordinates 1^0 08'00'-0^0 53' 00.1" SLand 117^0 11' 00"-116^0 52' 00" EL. Most of the mining areas were located inside the forests through the borrow-to-use permit schemes.

Materials

The materials used in this research were: meters, flagging tape, headlights, GPS, cameras, grab stick snake, specimen bags, scales, thermo-hygrometer, caliper and the field manual book to identify the species which included such references as Das (2004), Inger and Stuebing (2005), Iskandar (1998), and Mistar (2003).

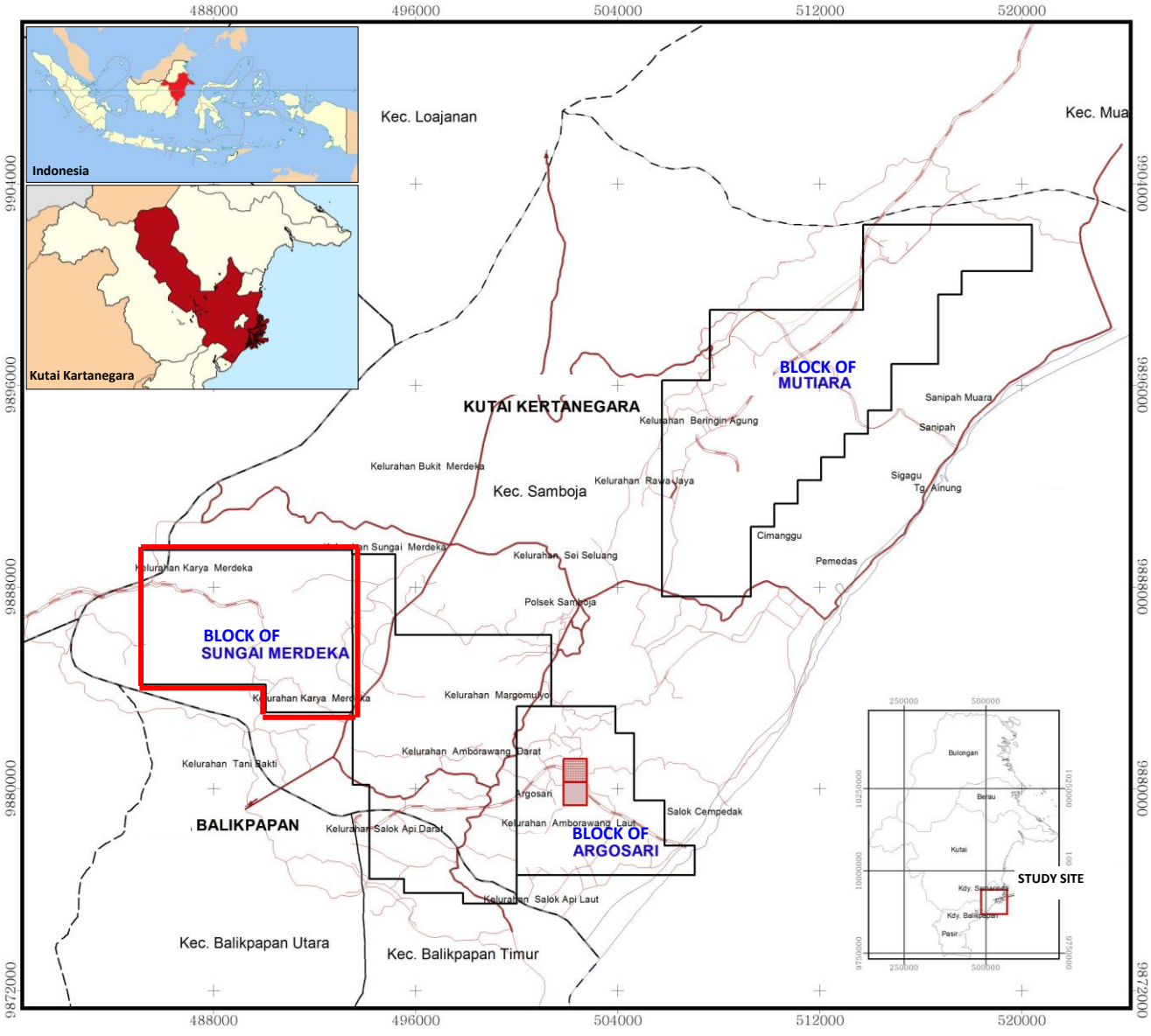

Figure 1. Location of research at mining area of PT Singlurus Pratama's Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia. Location in shaded black is the location of sampling plots of herpetofauna community (PT. Singlurus Pratama 2015)

Table 1. Detail of data collection time of PT Singlurus Pratama, Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia

Date	A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		P	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
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	8	2	2	6	0	15	2	2	21	4	24	3	58	10	6	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	4

Note: * A. Settling Pond 1 and seedling; B. Fragmented forest; C. Housing and office; D. Outer forest; E. Settling Pond 13-15; F. KM 5; G. KM 36; H. KM 7; I. Post *Nepenthes*; J. Revegetation area in 2010; K. Revegetation area in 2011; L. Revegetation area in 2012; M. Revegetation area in 2012 (Plot research BPTKSDA); N. Revegetation area in 2013; O. Revegetation area in 2014; P. Pond beside of worker accommodation

Procedures

The survey method employed was the active method by direct searching which combined the Visual Encounter Survey, Transect Sampling (Path) and Patch Sampling (survey done at a particular microhabitat). The exploration was done during the daytime, from 05.00-11.00 a.m. Central Indonesian Time (GMT +8) and during the night time from 17.00-22.00 p.m. Central Indonesian Time (GMT+8). The surveyed areas covered the following: the forest areas which had the borders with the mining areas (outside the concession areas), the reclamations/ re-vegetation areas, settling pond, retention basin as well as natural water spots. The exploration was mainly done at the area/ spot rarely occupied by the ground vegetation (shrubs) so that the herpetofauna could be easily seen in the fields. These surveyed areas could be classified into two, namely the wet areas (wetlands) and dry areas. The wet areas included the areas in which the water sources were within up to 10-meter proximity whereas the dry areas were the areas in which the distance to the water sources was more than 10 meters away. Specimens were collected whenever possible. The suitable techniques of collecting of the species are lighting; the frogs are temporarily blinded when the flashlights shine in their eyes, making them easy to catch, and catching by hand or tool; this technique is suitable for snake and lizard by searching in microhabitat. Collection data herpetofauna is done by three repetitions of each area or track which can be seen in Table 1

Data analysis

The field data were collected in the forms of herpetofauna animals and their habitat conditions. Furthermore, the data were analyzed by using the Dominance Index (Simpson) formula as follows:

$$D = \sum_{n=0}^{n} \frac{(n1(ni-1))}{(N(N-1))}$$

The Dominance Index was used to find out the concentration or the spread of dominant species. If the dominance concentrates on a particular species, the value of the Dominance Index will increase whereas if several species dominate simultaneously, the Dominance Index value will be low.

RESULTS AND DISCUSSION

Dominant species in mining area

The habitat of herpetofauna spread away in almost all mining areas which covered the following: the revegetation areas, the fragmented forest areas, the mining area border forests, rivers and streams in the areas as well as the settling ponds. The order of areas of acquaintances with the herpetofauna under study was as follows: the mining area

border forests, settling pond areas, fragmented forest areas, and re-vegetation areas.

The findings of the research revealed that there were 21 species of herpetofauna which comprised of 10 species of reptiles and 11 species of amphibians. The dominant reptiles were *Eutropis multifasciata* (many-lined sun skink) 20 individuals, followed by *Gehyra mutilata* (four-clawed gecko) 12 individuals and *Enhydris enhydris* (rainbow water snake) 4 individuals. Meanwhile, the dominant amphibians were *Polypedates leucomystax* (four-lined tree frog) 42 individuals, *Fejervarya cancrivora* (rice-field frog) 41 individuals and *Duttaphrynus melanostictus* 28 individuals. The obtained data were further analyzed in order to obtain the Dominance Index (Simpson), which can be seen in Figure 2.

Based on the Simpson Dominance Index, the herpetofauna of reptile species was mostly found in the areas of fragmented forest, worker accommodation and office areas, the pond next to the worker accommodation, the KM 5 area, the KM 36 area and Settling Pond 1. The Simpson Dominance Index for the reptile species indicated the highest value, i.e., 0.71, at the fragmented forest areas.Furthermore, the value showed that in the fragmented forest areas the dominant species was *E. multifasciata*, as many as six individuals. Meanwhile, the herpetofauna of amphibian species was mostly found in the areas of Settling Pond 1, Settling Ponds 13-15, Camp *Nepenthes* areas, KM 36 and KM 7 areas. The highest Simpson Dominance Index obtained for the amphibians was 1 in the settling pond areas. The dominant species was *F. cancrivora* as many as 20 individuals.

The Dominance Index to find out the concentration/ spread of the dominant species implied that if the dominance were concentrated only on one species, the index value would increase. On the other hand, if there were some groups of species dominated simultaneously, the dominance index value would be low. Dominance indicated the main influential species which influenced and controlled the community by its number, size and dominant growth (Fachrul 2007).

The description of herpetofauna habitat in the mining areas

Based on the field survey results, the herpetofauna was most likely to be found in the water spot which was formed for a longer period. Furthermore, a permanent water spot, a location which was both naturally and artificially formed with a watery condition in rainy and dry seasons, had more potential for herpetofauna acquaintance. Therefore, the existence of herpetofauna would be influenced by the microhabitat conditions of a particular location.

The settling pond areas were the water treatment areas established in the PT Singlurus Pratama mining areas. In the Settling Pond 1 area, there was a nursery which had a border with the fragmented forests. The areas of Settling Pond 1 as well as Settling Ponds 13-15 had three ponds. At the banks of the ponds, such plants as *Cyperus rotundus*, *Paspalum* sp., *Panicum* sp., and *Scleria* sp. grew. Meanwhile, particularly in the nursery areas, *F. cancrivora* and *P. leucomystax* were found in between the plots. It was assumed that in between the plot nursery was an ideal location for a particular species of frogs since it had a relatively lower temperature than other more open locations and it could be an ideal place to hide from predators as well. *P. leucomystax* is an adaptable arboreal species and lays its eggs on vegetation above water. Their eggs hatch into tadpoles before dropping into the water below (Bickford et al. 2010)

Furthermore, the fragmented forest areas were the secondary forests which were located in the areas of mine reclamation. The fragmented forest areas had a direct border with the river. In these fragmented forest areas, a micro climate was created because the temperature and humidity in these areas were different from the re-vegetation areas in the mining areas. In the fragmented forests, there were pioneer plants such as *Macaranga gigantea, Macaranga triloba, Peronema canescens, Melastoma malabathricum, Bauhinia lingua.* In addition, there was also standing stock of *Eusideroxylon zwageri* spotted there. Forest fragments offer suitable conditions for maintaining a portion of amphibian species of the region (Meza and Pineda 2015).

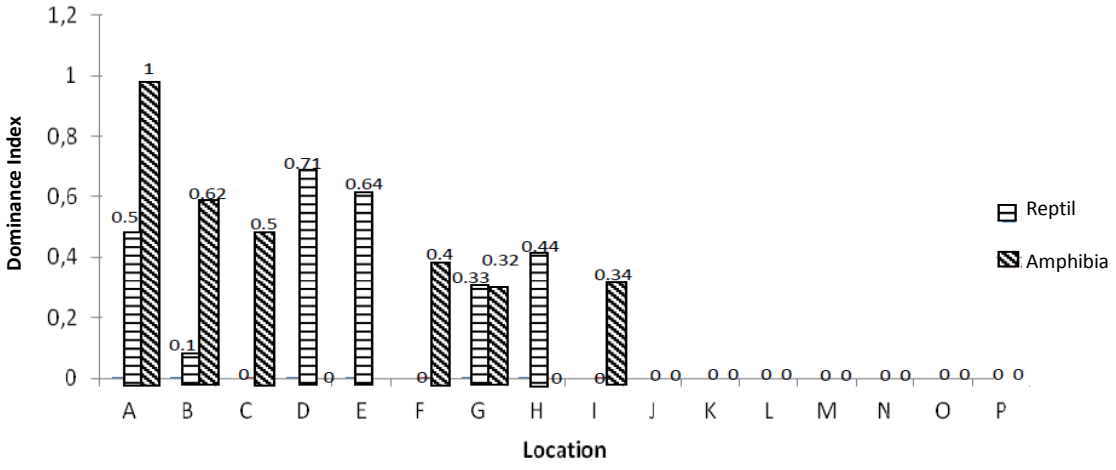

Figure 2. Dominance Index of herpetofauna in the mining area of PT Singlurus Pratama, Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia. Note: A-P refers to Figure 1.

In the KM 5 location, there were holes created from the open pit, namely PIT B 74 and PIT B 85, which were filled by the acid mine drainage. The access to the areas of mined land was through a rubber plantation and secondary forests, in which there as a small stream behind the secondary forests. In addition to the retention basin which was filled by the acid mine drainage, there was also a natural retention basin formed in the KM 5 location, especially on the dirt road path, in which there were puddles whenever it rained.

Meanwhile, in the KM 36 location, the holes from open pit namely ID PIT 99 was also found. Similar to that of the KM 5 area, this open pit hole was filled by the acid mine drainage as well. Furthermore, on its banks, there were some natural plants from the species of Scleria sp.The access from KM 36 to the area of ID PIT 99 was through the settlements and plantations. In the KM 36 location, particularly on the banks of the open pit area, there were Scleria sp. plants. The KM 36 location was also an open location with different temperature and humidity, especially from the nursery location and Settling Pond 1 area, just like the KM 5 location.

The outer forest was a type of a secondary forest. The coal mining areas of PT Singlurus Pratama were located inside the forest areas with the Borrow-to-Use Permit schemes. There was a river flowing through the forests which were located outside the mining areas.

The composition of herpetofauna based on the wet and dry area

From the results of field observation as well as supported by the Simpson Dominance Index data, the herpetofauna in the mining areas were mostly found in the wet areas or the areas which were not far from the water source (the distance was < 10 meter) and less acquainted in the wet areas as well as the areas which were far from the water source (the distance was> 10 meter). Settling Pond 1 was the location with the highest dominance index value for the amphibian species, whereas the fragmented forests were the location with the highest dominance index value for the reptile species. Fragment size is also linked to elevation, so that species richness tends to decrease in fragments of a given size that are located at a higher elevation, compared to those of the same size but at a lower elevation (Meza and Pineda 2015)

Furthermore, the locations with the dominance index values were categorized into two areas namely the wet and dry areas.The categorization was based on the distance from the herpetofauna discovery location to the water source. This was done to see the microhabitat for the dominant species in those respective areas.

There were six species of herpetofauna from reptile species in the wet areas, and four species were found in the dry areas (Table 1). While, for the amphibian species, six species were found in the wet areas and four were found in the dry areas (Table 2). The spread of the herpetofauna species in the dry areas was not equal, and it was mostly dominated by *D. melanostictus* and *G. mutilata*. In contrast, the species of herpetofauna in the wet areas were

Table 2. Reptile species in the wet and dry area of PT Singlurus Pratama, Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia

Species	Number of species
Wet area	
Eutropis multifasciata	20
Enhydris enhydris	4
Dendrelaphis pictus	4
Hemidactylus frenatus	2
Cyrtodactylus baluensis	1
Coura sp.	1
Total	32
Dry area	
Gehyra mutilata	12
Gekko monarchus	2
Apterygodon vittatum	1
Bronchocela cristatella	1
Total	16

Table 3. Amphibians species in the wet and dry areas of PT Singlurus Pratama, Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia

Species	Number of species
Wet area	
Polypedates leucomystax	42
Fejervarya cancrivora	41
Polypedates macrotis	3
Hylarana chalconota	2
Odorrana hosii	1
Leptolalax dringi	1
Total	90
Dry area	
Duttaphrynus melanostictus	28
Fejervarya limnocharis	2
Bufo divergens	1
Ingerophrynus biporcatus	1
Kaloula baleata	1
Total	33

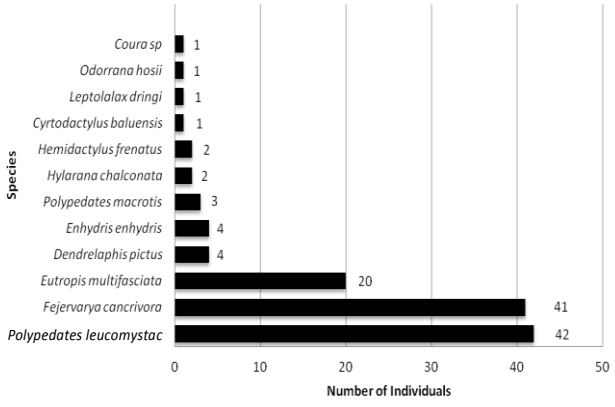

Figure 3. Composition species of herpetofauna on wet area of PT Singlurus Pratama, Sungai Merdeka Block of Kutai Kartanegara, East Kalimantan, Indonesia

spread in almost all areas in the mining location which covered the forest areas bordering with the mining areas (outside of the concession), reclamation/ re-vegetation areas, settling ponds and natural water spots.

The water spot areas were dominated mostly by *F. cancrivora* and *P. leucomystax* frogs, *E. multifasciata* lizards and *E. enhydris* as well as *Dendrelaphis pictus* snakes. These five herpetofauna species were spotted together in four water spots (wet) out of six survey wet area locations. In the other two wet spots, the species found were *F. cancrivora* and *P. leucomystax*.

Fejervarya cancrivora was often called 'green frog' or 'rice-field frog'. This species of frog has a natural aquatic habitat. This frog species was mostly found in Settling Pond 1, with an activity inside the water at the pond bank. This indicated that this species of frog had found a place similar to its natural habitat. *Hylarana chalconota* using the ponds and ephemeral puddles to breed were found mainly in smaller, disturbed forests patches and urban parks. These findings are of critical importance for the restoration of small forest fragments where habitat and breeding site heterogeneity augmentation can help conserve amphibian biodiversity (Bickford et al. 2010).

Polypedates leucomystax was normally called 'tree-lined frog' from the family of Rhacophoridae. The habitat of this frog is in the water but often times; it is also found in the land on the branches and leaves around the wet areas. This species of frog lives in between the plants, in the garden or around the swamps and disrupted forests. (Yanuarefa et al. 2012).

Eutropis multifasciata or mostly known as many-lined sun skink is a species of skink with the semi-aquatic habitat type. This species of skink is often found in the open area or disrupted area, covered by the forest floor and it can adapt to this damaged environment (Das 2004).

Enhydris enhydris is often called strip bellied mud snake, from the family of Colubridae. *E. enhydris* lives in the freshwater habitats including marshlands, rural ponds, swamps and rice paddies. This snake species is best identified by the two pale stripes running down the full length of the body and tail on either side of the vertebral line; these two stripes converge on the crown. In this study, *E. enhydris* was found in the water in the settling pond and the former open pit.

Dendrelaphis pictus (Painted Bronze-back Snake) is a medium-sized snake with a relatively wide spread of habitat, which includes the primary and secondary forests, plantations and settlements. It is an arboreal snake that inhabits low elevation (Inger and Stuebing 2005); However, in this current research sites, it was found in the paddy field area. It seemed that in the sites the snake was foraging for frogs, which was its major prey. It inhabits open lowland tropical wet and dry forests especially clearing and edges, and also scrubs, open swamp and plantation. It often lives close to rivers, pond, and other watered environments. This snake is strictly diurnal and fond of basking. It appears to feed nearly exclusively on arboreal frogs, but lizards have also been reported (Malkmus et al. 2002)

Mikrohabitat for dominant species

According to Sudarmadji and Hartati (2016), the general characteristic of the mine area rehabilitation process towards the stable forest succession is signified by the appearance of animals such as insects, amphibians, reptiles, birds and small mammals. This is in line with the synergizing-with-nature concept because most of the mining areas of PT Singlurus Pratama are located inside the forest areas with the Borrow-to-use Permit schemes. The species of invasive animals especially the herpetofauna existing outside the forest areas have started to enter the reclamation areas such as settling ponds and nursery areas as their microhabitats. This has been characterized by the discovery of *E. multifasciata* skink species in the secondary forest and settling pond areas. The settling pond areas themselves are bordered directly with the fragmented forests. Likewise, for the amphibian species, *F. cancrivora* and *P. leucomystax* were found in the settling pond areas, the former open pits of KM 36 as well as KM 7. Those areas had a direct border and or near the outer forests and fragmented forests. The *P. leucomystax* frogs were commonly seen and heard across small and heavily disturbed fragments, sometimes even found in highly urbanized areas. These species are highly adaptable and tolerate disturbance and severe habitat alteration (Bickford et al. 2010). Those areas were bordering with or near the outer forest and fragmented forest. The leaf litter can provide adequate levels of moisture and food resources for amphibians to carry out foraging, courtship and egg-laying and other vital activities (Welsh and Droege 2001).

Finally, the herpetofauna species associated with the wet habitats, especially the frog species, would require water permanently. The permanent wet habitat would form a micro ecosystem which enables a particular animal to live and survive (the habitat support capability). Those locations in the mining areas would include rivers/ streams, settling ponds and water spots. Although half species seem to be restricted to the rain forest, many species of reptiles and amphibians use disturbed habitat as a temporary place, they still need rain forest for their native habitat (Kurniati 2007). The settling ponds built on purpose would naturally form the vegetation in the embankment areas which could potentially be the habitats or hiding places for insects, skinks, snakes and frogs. Each of this animal species plays a role in forming the communities and food chain.

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