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The diversity and conservation status of snakes in the eastern part of PT GAN, Riau Province

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Abstract*. PT Global Alam Nusantara (GAN) is one of the ecosystem restoration concessions in the Kampar Peninsula managed by Riau Ecosystem Restoration (RER). Unlike other companies under RER, information on the diversity of snake species in PT GAN is not yet available. Therefore, this study aims to determine the diversity and status of snake species in the eastern part of PT GAN based on the distance to water sources (river and rivulet); and the status of snakes based on Minister of Environment and Forestry Regulation (P.106/MENLHK/SETJEN/KUM.1/12/2018, International Union for Conservation of Nature (IUCN), and Conventional of International Trade in Endangered Species (CITES). Observations were made using the Visual Encounter Survey (VES) method on four observational transects. We found 16 individuals representing 11 species, namely:* Ahaetulla prasina, Boiga jaspidae, Boiga cynodon, Boiga drapiezii, Coelognathus flavolineatus, Dendrelaphis caudolineatus, Dryocalamus subannulatus, Lycodon subcintus, Sibynophis melanochepalus, Tripodolaemus wagleri, *and* Calliophis bivirgatus*. Shannon-Wiener snake diversity index from highest to lowest, respectively, were 1.5, 1.39, 0.94, and 0. The Sorensen similarity index between transects was low. All snake species found are unprotected, with low-risk IUCN status, and have not been included in the CITES appendix.*

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INTRODUCTION

Peat swamp forest is one of the wetland ecosystems that is composed of organic matter that is saturated with water and has a low pH. Peat swamp forest plays a role as a provider of water sources for downstream communities. The unique condition of peat swamp forests creates a habitat structure and species diversity that is different from other ecosystems. Riau Province is an area with the largest expanse of peat forest in Sumatera, with an area of 4,044 million ha (representing about 56% of the peat area in Sumatera), and 65% of the natural forest in Riau Province is dominated by peat swamp forest (Muslim and Kurniawan 2008). The area of peat swamp forest in the Kampar Peninsula, Riau, currently covers 150,000 ha, which is managed by Riau Ecosystem Restoration (RER).

The RER area is a restoration and conservation area that includes four concession areas, namely PT Gemilang Cipta Nusantara (GCN), PT The Best One Unitimber (TBOT), PT Sinar Mutiara Nusantara (SMN), and PT Global Alam Nusantara (GAN) (RER 2015). PT GAN has an area of 36,524 ha with a topography ranging from 2 to 16 m. Apart from being a concession area, PT GAN allegedly stores biodiversity and habitat

for various types of fauna, one of which is snakes. Snakes are poikilothermic vertebrates that belong to the Serpentes order. Snakes have an important role in ecosystems in the food chain (Kamsi et al. 2017; Tuniyev et al. 2019). Snake habitats in peat swamp forests are quite diverse, including in trees (arboreal), among litter (terrestrial), and near water (semi-aquatic) (Malkmus et al. 2003). As poikilothermic animals, snakes are very sensitive to environmental changes. Snake distribution is affected by rainfall and temperature changes (Leo et al. 2020).

Several studies related to the diversity of snake species in peat swamp forests have been carried out. At Tanjungpura University, Pontianak, 10 snake species were found (Rambosius et al. 2019), and in Zamrud National Park, Riau, 10 snake species were identified (Leo et al. 2020). In the peat swamp forest of the Kampar Peninsula, which includes three concession areas, the RER (PT SMN, PT TBOT, and PT GCN) identified 39 species of snake (Geonarto and Iqbal 2020). Data collection was focused on the eastern part of PT GAN. Considering that information on snakes had never been obtained from the area of PT GAN, the survey was carried out in stages, and the eastern part is the closest and easiest to reach. This study aims to determine the diversity and conservation status of snakes in the eastern part of PT GAN and to complete data on herpetofauna diversity in the RER area. This data serves as the basic data and are expected to be the basis for future snake monitoring, which is important for concession area management.

METHOD

Study Area and Research Period

Sampling was carried out in March 2021 at PT GAN East, Riau. Data were collected on four transects based on the distance to water sources: river and rivulet (Figure 1). Two of the four transects are near the river (marginal peat swamp). Transect 1 is the closest transect to the Serkap River, with a riparian ecosystem. The forest floor on this transect has a litter thickness of 1–3 cm and is partially submerged in water to a depth of 20–30 cm when it rains, especially in areas 50–100 m from the Serkap River. Transect 2 is about 50 m from the Serkap tributary. The forest floor on this transect is slightly wet, but it is not submerged in the water when it rains. The other two transects (transect 3 and transect 4) have the characteristics of a dry forest floor with litter thickness ranging from 2 to 6 cm. This area is also the location of the deepest peat among the four transects and is thought to be a peat dome (Wahyunto et al. 2005). Stands of vegetation in transect 3 are denser than in transect 4.

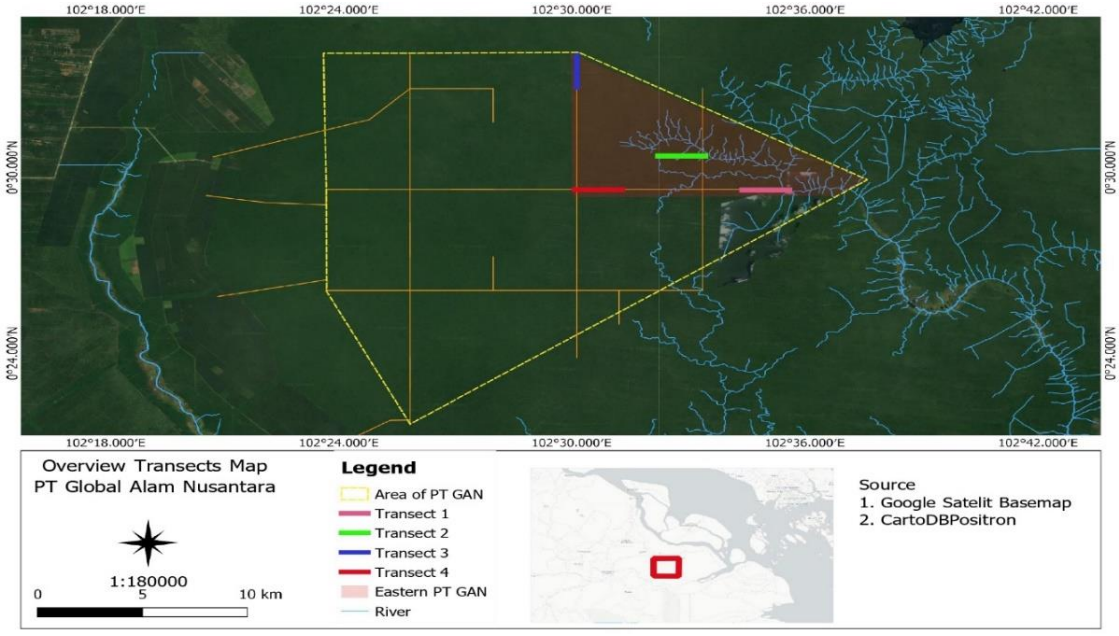

Figure 1 Map of the research location and laying of the transect in the eastern part of PT GAN

Data Collection Method

Data were collected using the Visual Encounter Survey (VES) Method combined with the Transect Method (Crump and Scott 1994). For each habitat type, an observation transect was made in the form of a two-kilometer line. Observations focused on the snake habitat's location by following each path in the morning (09.00–12.00 WIB) and evening (19.00–22.00 WIB) with a roaming area of 10 m to the right and left. Three observers searched for snakes along the transect at the same time, with one recording species encounters, the number of snake individuals, encounter times, activity, and the substrate in which the snakes were discovered. Observations were made three times.

Individuals who had not been identified will be caught using the hand-collecting method for benign snake species. If the snake was highly venomous and dangerous, image capturing using a camera was sufficient. For further identification, references from Malkmus et al. (2003), Marlon (2014), and O'shea (2018), as well as a snake naming guide based on *reptile-database.org*, were used. Data collection of environmental parameters of temperature and humidity using a pocket weather meter were performed. Measurements were made three times on each transect during the morning and evening observations.

Data Analysis Method

Data on snakes in each transect and their environmental parameters were tabulated in graphical form. Each species of snake found was described. We calculated snake diversity for each transect using the Shannon-Wiener Diversity Index (H'), which incorporates the species richness and evenness. The Shannon-Wiener index obtained was grouped into three categories, namely, (a) $H' < 1$ in which the diversity index is low; (b) $1 < H' < 3$ is classified as moderate, and (c) $H' > 3$ is classified as high. Furthermore, to see the Sorensen similarity index between 2 transects, the Multi-Variate Statistical Package (MVSP) var 3.22 was used. Snake conservation status is determined based on P.106/MENLHK/SETJEN/Kum.1/6/2018. The status of international snakes is threatened with extinction based on the International Union for Conservation of Nature (IUCN) Red List. To check out the status of international trade, please refer to the Convention on International Trade in Endangered Species/CITES (CITES 2022).

RESULTS AND DISCUSSION

Habitat Condition

In general, the abiotic and biotic factors, as well as the type of vegetation in all transects, are not significantly different. The air temperature ranges from 24 to 31 °C, with humidity ranging from 91.4 to 100%. Most of the vegetation on the entire transect is dominated by mengkuang (*Pandanus andersonii*), rasau (*Pandanus helicopus*), meranti (*Shorea* spp.), and tropical pitcher plants (*Nepenthes* sp.). In the stand of *Pandanus* sp., there is a species of hourglass tree frog (*Polypedates colletti*) (Irawan and Cahyadi 2016) in the RER area (including PT GAN). *P. colletti* is allegedly the prey for snakes. In addition to a few of snakes are facultative *Pandanus*-dwellers. The snake may also frequent *Pandanus* plant for feeding, thermoregulating, and resting (Lehtinen 2002). Pradana et al. (2020) also wrote down that several types of arboreal and terrestrial snakes are more commonly found at a distance of 50 meters from the river and covered by plantations or shrubs. Thus, *Pandanus* sp and rivers at the survey site are important microhabitats for snake.

Snake Species Composition

This study succeeded in identifying 16 snake individuals belonging to three families and 11 species, with *Boiga cynodon* as the newly recorded snake species in the RER. The three families found were Colubridae, Viperidae, and Elapidae. In general, the Colubridae family is the highest number of members found at all observational locations, with 9 species including *Dendrelaphis caudolineatus*, *Dryocalamus subannulatus*, *Lycodon subcintus*, *Boiga jaspidae*, *Boiga cynodon*, *Boiga drapiezii*, *Ahaetulla prasina*, *Coelognathus*

flavoneatus, and *Sibynophis melanochepalus*. *Tripodolaemus wagleri* belonging to the Viperidae family, and *Calliophis bivirgatus* belonging to the Elapidae Family. The high number of encounters with the Colubridae family is due to the adaptability of this snake species to the environment, both in habitats near and far from water. In addition, the Colubridae family has high heterogeneity in its ecology and belongs to family that dominate the whole world, including Indonesia, except for Australia (Kamsi et al. 2017; Malkmus et al. 2003).

The highest number of snake individual species found was that of *T. wagleri* (4 individuals). *T. wagleri* was found while it was waiting for prey on a tree branch. The distribution of this snake is quite wide, ranging from lowland forests, including peat swamp forests, to the highlands in Southeast Asia (Reza 2018). This species often resides on shaded branches and hunts by lurking on its prey. Reza (2018) states that adult snakes are more commonly found in shrubs or trees that have a low elevation, while juveniles are often found in the branches of tall trees. Shine and Sun (2003) further explained that adult pit vipers are at low elevations on terrestrial because large prey is often found on terrestrial, while the juvenile pit-viper is arboreal because of its inability to swallow large prey due to its limited jaws.

Most of the snake species found in this study were arboreal snakes, such as *D. caudolineatus*, *T. wagleri*, *B. drapiezii*, and *D. subannulatus*. This species of snake is often found in bush areas and saplings. Arboreal snake species were found in the eastern part of PT GAN's peat swamp forest in the height of the vegetation stand between 2 to 5 meters. These conditions allow arboreal snakes to find food and shelter. The snakes were found not only in arboreal but also in terrestrial. Terrestrial snakes use litter for camouflage such as *C. bivirgatus* and *S. melanochepalus* were also found. These species were found in the litter during the day. According to Kamsi et al. (2017), *C. bivirgatus* is sometimes found during the day in areas understorey and near rivers.

The transect area near the river (transects 1 and 2) tends to have a more diverse composition of snake species (Figure 2) than those far from rivers (transects 3 and 4). The area near the river is a riparian area, which is a transition between terrestrial and aquatic ecosystems (Rochmayanto et al. 2021). Riparian areas provide a variety of habitats that support the presence of more snake species. *T. wagleri* and some *Boiga* species are often found on twigs and shrubs in riparian areas (Marlon 2014; Reza 2018). This is consistent with the statement that the abundance of wildlife (including snakes) is lowest in the area towards the peat dome and the highest in the marginal peat swamp area (near the river direction) (Phillips 1998).

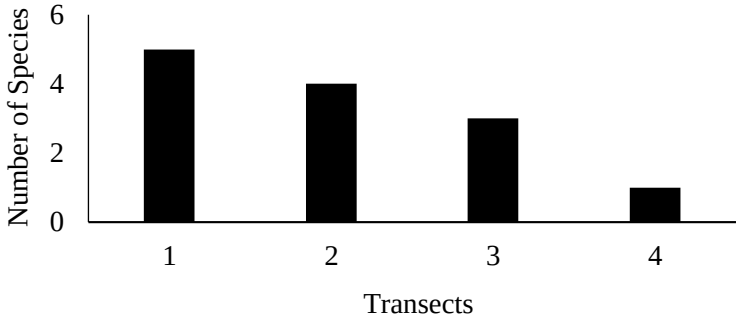

Figure 2 Number of snake species based on habitat conditions along the transect on the eastern part of PT GAN

Species of Venomous Snake in The Eastern Part of PT GAN

In this study, two species of highly venomous snakes were found, namely: *T. wagleri* and *C. bivirgatus*. They have different living habits. *T. wagleri*, which is an arboreal snake, has different adaptations from terrestrial snakes such as *C. bivirgatus*. However, adult *T. wagleri* and other species of pit vipers sometimes prowls at low elevations to the ground (Shine and Sun 2003). Therefore, these snakes are often found from the transect near the river too far from the river, although some of the transect areas are inundated. While *C.*

bivirgatus, juvenile to adult, spends its time surviving and finding prey above the ground. Several submerged areas are thought to affect the existence of this snake species because it can inhibit snake activity in finding prey (Owen et al. 2007).

T. wagleri has solenoglypha fangs. These fangs are very long and venomous, located at the front of the mouth, and can be folded. This snake is the type that waits for prey, then ambushes it by injecting venom efficiently. According to Tan et al. (2017), this snake has a venom that can damage the nervous system (neurotoxin). Handling the bite of a venomous snake must be done quickly because it can be fatal and deadly. *Calliophis bivirgatus* has proteroglyphous fangs. These venom fangs are located on the upper jaw at the front of the snake's mouth and cannot be folded. *C. bivirgatus* has fatal and dangerous types of cytotoxins and neurotoxins (Palasuberniam et al. 2021). This venom can paralyze nerves and damage cells. Consequently, special handling is needed when one is bitten by a snake with this type of venom.

Cases of snakebite by *C. bivirgatus* and *T. wagleri* are quite low. This is because the snake's behavior is very calm and looks tame, but it will attack if stepped on and disturbed. In addition, *T. wagleri* usually lives far from the human environment. Handling of venomous snake bites can be done by splinting the bitten body part (immobilization). This aims to stop the flow of snake venom that can spread through the blood. However, the main problem is the availability of anti-viper venom serum in Indonesia. In contrast, the most frequent cases of venomous snake bites are cases of *Naja* snake (cobra) bites. Cobra's habitat is directly adjacent to humans (Dafa and Suyanto 2021). The least that can be done is to give painkillers and immediately get anti-venom serum in the form of polyvalent (Sutantoyo and Gunawan 2016). This serum can be obtained at the nearest health facility.

The Diversity of Snake Species in The Eastern Part of PT GAN

The value of the Shannon-Wiener diversity index for snake species found in the eastern part of PT GAN as a whole is moderate (Figure 3). The Shannon-Wiener index value ranges from 0.9 to 1.5. The diversity of snakes in the eastern part of PT GAN is classified as moderate. The presence of rivers in transect 1 and 2 affects the diversity in each transect. In these two transects, more snake species were found than in the other two transects. This can be influenced by the more varied ecosystem conditions in the area near the river in that it provides a microhabitat for various types of snakes, as well as their prey. As predators, snakes move to follow the prey population. Some snake prey is found on the banks of rivers (frogs, lizards, and small mammals). This survey also found many types of frogs around the river. Transect 4 has the lowest diversity index because only one individual was found along the transect. This transect is the furthest from the river.

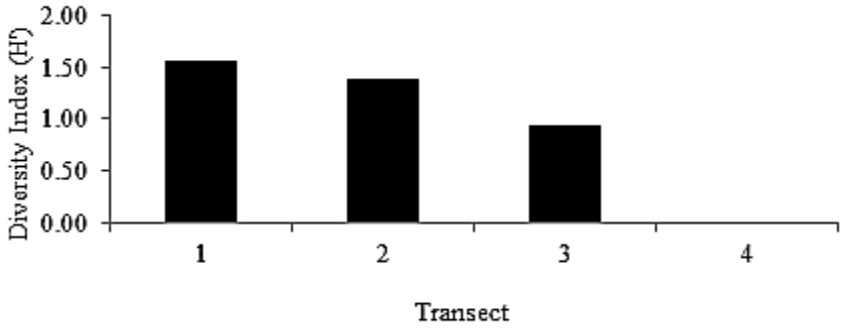

Figure 3 Shannon-Wiener diversity index value based on the composition of the snake communities along the transect in the eastern part of PT GAN

The Sorensen Similarity Index

Transects 1 and 3 have a higher Sorensen similarity index than transects 2 and 4 (Figure 4). This was due to the presence of *T. wagleri* on both transects with a higher number of individuals. Sorensen's similarity index value is low because of the low spatial heterogeneity.

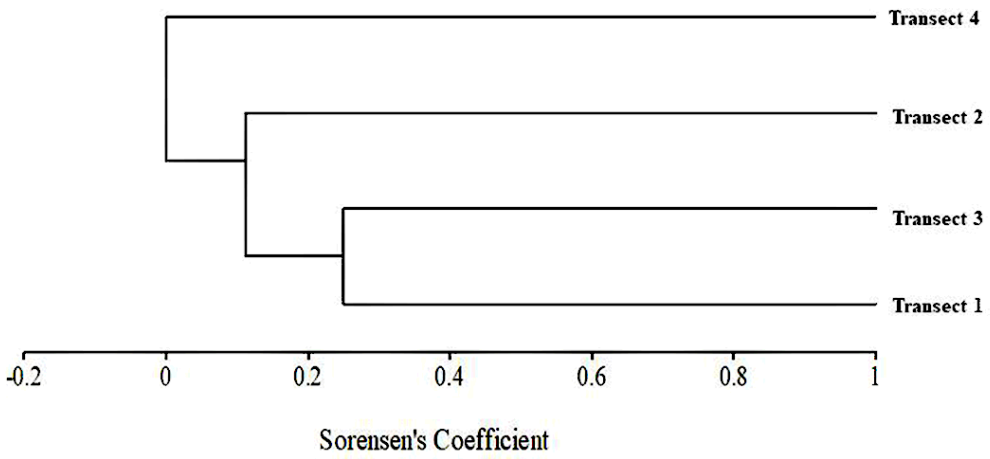

Figure 4 Dendrogram of cluster analysis using Sorensen Similarity Index based on the composition of the snake communities along the transect in the eastern part of PT GAN

Snake Conservation Status

All snake species found in the eastern part of PT GAN are not protected under P.106/MENLHK/SETJEN/KUM.1/6/2018. This indicates that these snake species are still found quite abundantly. Based on the IUCN Red List, all snake species found are classified as at low risk or Least Concern (LC). This indicates that the population of snake species that have been evaluated with a wide distribution and condition are still considered as good in their habitat, so it has not become the focus of conservation. According to CITES, there is no snake included in any of its appendices. This indicates that these species are not species that have been widely traded, so their survival is feared to be.

Implication of Snakes on Concession Areas

In this study, several areas were flooded. Stagnant water usually has a lot of insects. These insects are food for frogs and reptiles such as geckos. Frogs and geckos are used as food for snakes. Venomous snakes are excellent predators because they are equipped with poison as a chemical weapon so that snakes can occupy a dominant position in the food chain (Li et al. 2019). The presence of snakes in their microhabitat maintains the balance of the food chain.

The presence of various species of snake (included *T. wagleri*) in the concession area managed by RER indicates that the forest condition is well maintained. McCleary et al. (2015) state that *T. wagleri* is often found secondary to primary forests, especially in lowland wetlands areas. *T. wagleri* belongs to the pit viper snake (Crotalinae), which is vulnerable to change associated with habitat destruction, climate change, or other long-term trends affecting the ecosystem. Hence the snake's potential as an environmental bioindicator (Beaupre and Douglas 2009). *T. wagleri*, which was quite often in this survey, is very interesting and deserves to be studied further. One of the methods is by comparing it with the abundance of potential prey.

CONCLUSION

There are 11 species of snake found in the eastern part of PT GAN. The Shannon-Wiener snake diversity index from highest to lowest respectively were 1.5, 1.39, 0.94, and 0. The Sorensen similarity index between transects was low. There are no snake species protected or listed in the CITES appendix. All of the snake species found were classified as Least Concern (LC) based on the IUCN Red List.

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