JPPIPA 11(1) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Herpetofauna Diversity at the Nusa Cendana University

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Received: June 15, 2024
Revised: November 02, 2024
Accepted: January 25, 2025
Published: January 31, 2025

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DOI: 10.29303/jppipa.v11i1.8130

Abstract: University campuses are built to carry out the learning process. Therefore, this area has dramatically developed and impacted on the environment and biodiversity. The Nusa Cendana University (Undana) campus area as a habitat for wild animals is included in the built and managed habitat categories. In human-dominated habitats in urban areas such as Undana, it is still possible for animal species to find habitats to find food, shelter, and water sources. This research aims to analyze herpetofauna diversity and update information on preliminary studies of herpetofauna at Nusa Cendana University so that it can be used as primary data for assessing time series. Data was collected using the Visual Encounter Survey combined with the time-constrained search method for three hours from 18.30 to 21.30 WITA at three habitat types (Agricultural, open-area, and built-area habitat). The observation period is divided into two categories: dry and rainy season. Twelve species from eight herpetofauna families, consisting of four amphibians and eight reptiles, were recorded in three habitat types in the Undana campus area. It was recorded that there were six additional herpetofauna species compared to the preliminary study.

Keywords: Amphibians; Conservation; Diversity; Lesser sunda islands; Reptiles

Introduction

University campuses are built to carry out the learning process. Therefore, this area has dramatically developed and impacted the environment and biodiversity (Pievani, 2014; Rochmyaningsih, 2021; Sponsel, 2013). As implementers of higher education in Indonesia, universities provide several fields of knowledge to support the development of educated human resources (Hanan, 2013; Lukita, Suwandi, Harahap, Rahardja, & Nas, 2020; Tien, Dana, Jose, Vu, & Hung, 2019). This requires ample space to accommodate and carry out all daily activities related to the existing knowledge (Hanan, 2013). On campus, there is continuous interaction between people, academics, and the environment (Anis, Afiff, Kiswanto, Suwartha, & Sari, 2018; Susilowati et al., 2021; Yulia et al., 2023). Nusa Cendana University (Undana), located in Kupang City, Timor Island, East Nusa Tenggara, has a unique geographical position because it is transitional between Indo-Malayan and Australasian (Ali & Heaney, 2023; Bacon et al., 2013). Administratively, this campus is in the Maulafa sub-district and is located close to the airport and other strategic access.

Disturbances to biodiversity in built environments such as the Undana campus have resulted in several hypotheses following Dunn et al., (2022), which state that species will adapt more quickly to large cities and the evolutionary process. Excessive human population and urbanization are the main causes of habitat fragmentation, which will affect the loss of biodiversity (Cafaro, Hansson, & Götmark, 2022; Delaney, Busteed,

How to Cite:
Pramatana, F., Aini, Y., Purnama, M. M. E., Sipayung, R. H., & Hidayat, O. (2025). Herpetofauna Diversity at the Nusa Cendana University. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 742–750. https://doi.org/10.29303/jppipa.v11i1.8130

Fisher, & Riley, 2021). Manhas, Kotwal, Wanganeo, & Wanganeo (2015) state the campus has threats to wildlife from various human disturbances, including habitat destruction for various purposes. According to Mardiastuti (2015), there is a tendency for species richness in landscapes that are dominated/modified by humans, making it possible for animals to survive in these human-dominated landscapes.

The Undana campus area as a habitat for wild animals is included in the built habitat and managed habitat categories. It is hoped that there will be species of wild animals that can still be found and utilized in the Undana campus area to support the conservation of the biodiversity of dry land islands. Therefore, this research was carried out to provide data on the diversity of wild animals, namely herpetofauna, and to prove the use of human-dominated areas as habitats for these species. Furthermore, amphibian species have been proven to be environmental indicators to indirectly determine the quality of the environment in the Undana campus area (Adil, Kanwal, Aslam, Ijaz, & Afsheen, 2019; Homyack, O'Bryan, Thornton, & Baldwin, 2014; Prasad, Verma, & Shahabuddin, 2018; Rohman, Permana, Akhsani, Wangkulangkul, & Priambodo, 2020; Saber, Tito, Said, Mengistou, & Alqahtani, 2017).

Hopefully, the diversity of wild animal species recorded on the Undana campus will support the campus' criteria as a biodiversity campus. Biodiversity is the most crucial component of developing a biodiversity campus. Previously, IPB University had used the term Biodiversity campus since 2010 and announced a biodiversity campus in 2016 and a Green Campus in 2020. This aims to raise awareness of the campus community and academics regarding the diversity of plant and animal species living in the campus area (Mustari, 2021). Furthermore, this biodiversity campus study will create a commitment for the community and scholars in the current and future campus development process (Destrinanda, Kartika, & Mansor, 2022; Sisriany & Fatimah, 2017). This research aims to analyze herpetofauna diversity and update information on preliminary studies of herpetofauna at Nusa Cendana University so that it can be used as primary data for assessing time series.

Method

The Undana campus is covered with trees and bushes in addition to lecture buildings, offices, and laboratories. The natural landscape on the Undana campus is not very varied because sloping areas, coral cliffs, and limestone rocks dominate it. There are no natural water sources on the Undana campus, but small ponds are distributed within this area. Furthermore, habitat types on this campus are predominantly the result of human modification. There are only small patches of natural habitat for biodiversity between massive development on campus to support learning activities. The research was carried out throughout the Nusa Cendana University campus area (Figure 1), divided into three habitat types: agricultural habitat, open area, and built areas (Figure 2). The observation period is divided into two categories: dry and rainy season. The estimated rainy season for Kupang City is November-March, and the estimated dry season is April-October (Natayu, Kamila, Dananjaya, Reflin, & Fikri, 2021; Zepner, Karrasch, Wiemann, & Bernard, 2021). The dry season in Kupang and East Nusa Tenggara is generally longer than the rainy season (Zepner et al., 2021). So, the observation time is adjusted to represent each season.

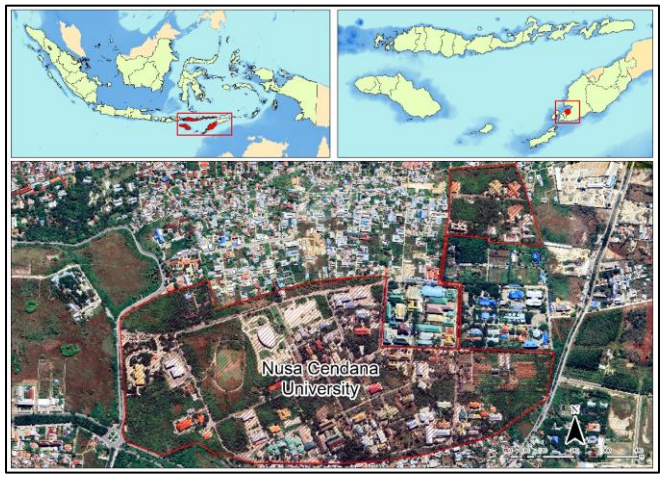

Figure 1. Research site map

Figure 2. Three habitat types in the study: (a) Agriculture; (b) Open-area; and (c) Built-area

Herpetofauna data was collected using the Visual Encounter Survey combined with the time-constrained search method for three hours from 18.30 to 21.30 WITA (Barnes, 2017; Boynton, Toenies, Cornelius, & Rich, 2021; Erawan et al., 2021; Karthik, Kalaimani, & Nagarajan, 2018; Peek, Yarnell, & Lind, 2017). Stages of collecting data on herpetofauna observations include 1) Recording

the temperature at the start, at the end, and when the observation starts; 2) Observing all herpetofauna that can be kept. Then, the herpetofauna found in the observation grid will be captured and placed in 2 kg plastic; 3) After the observation, the obtained species will be identified and documented. Herpetofauna that has not been identified will be a specimen using 95% alcohol; 4) The final step is to release the species. All samples will be released back to the original place where they were caught. For the nomenclature of each type of herpetofauna, the naming guide from (Frost, 2024). Furthermore, amphibian and reptile field guides help with species descriptions (Alhadi, Kaprawi, Hamidy, & Kirschey, 2021; de Lang, 2011; Kamsi, Handayani, Siregar, & Fredriksson, 2017).

The results of recording the herpetofauna species found at the study location were then analyzed using diversity indices, including the Shannon diversity index (H'), evenness index (E), Margalef species richness index (Dmg), and Simpson dominance index (C) using tools Past4 software version 4.14. Researchers widely use these indices to assess a habitat, compare habitats, and the relationship between habitat and wildlife (Amarasinghe et al., 2021; Mirza D Kusrini et al., 2021; Mirza Dikari Kusrini et al., 2020; Rejeki & Santosa, 2020; Rohman et al., 2022; Samitra & Rozi, 2020).

Result and Discussion

The research found 12 species of herpetofauna from eight families, with 281 individuals. Seven species were observed in agricultural habitats, six species in open-area, and 12 species in built-area. There are five species found in the three habitat types, including *Duttaphrynus melanostictus*, *Polypedates* cf *leucomystax*, *Cyrtodactylus* sp, *Gekko gecko*, and *Hemidactylus frenatus*. Apart from that, three species are only found in the built area habitat, namely *Fejervarya limnocharis*, *Liasis mackloti*, *Coelognathus subradiatus*, and *Draco* sp.

Based on the seasonal period during data collection, eight species were found in both seasons: *D. melanostictus*, *F. limnocharis*, *K. baleata*, *P. leucomystax*, *Cyrtodactyus* sp, *G. gecko*, *H. frenatus*, and *H. tenkatei*. Apart from that, three species were found only in the rainy season including *L. mackloti*, *L. capunicus*, and *C. subradiatus*. Additionally, one species was found only in the dry season namely *Draco* sp. The difference in temperature conditions is not very significant between the two seasons and is not linear (Zepner et al., 2021). In the dry season, the monthly temperature reaches 24.80°C, while in the rainy season, the monthly temperature can reach 27.50°C (Zepner et al., 2021). If we refer to the monthly rainfall, during the dry season (April-October), the lowest rainfall was 2.1 mm, and the highest rainfall was 26.7 mm. In the rainy season (November-March), the lowest rainfall was 45 mm, and the highest rainfall was 377.4 mm (Zepner et al., 2021). It is predicted that species found only during the rainy season are highly dependent on the air humidity (Brown & Shine, 2002).

Three reptiles endemic to the Lesser Sunda Islands were found: *Hemidactylus tenkatei*, *Liasis mackloti*, and *Coelognathus subradiatus*. Referring to conservation status, the species found to be dominant have the Least Concern (LC) category based on the IUCN Red List. All species are not protected by the Minister of Environment and Forestry Regulation of the Republic Indonesia Number P. 106/2018 on Protected Plant and Animal Species (KLHK, 2018), and one species has appendix II status based on CITES, namely the *L. mackloti*. For more details, the data is presented in Table 1.

Tabel 1. Herpetofauna species composition at the Nusa Cendana University

Family	Species	Location	∑	Endemic	IUCN	CITES	P.106	Period
Buffonidae	*Duttaphrynus melanostictus*	AG, OA, BA	96	N	LC	-	-	D R
Dicroglossidae	*Fejervarya limnocharis*	BA	10	N	LC	-	-	D R
Microhylidae	*Kaloula baleata*	AG, BA	18	N	LC	-	-	D R
Rhacophoridae	*Polypedates cf leucomystax*	AG, OA, BA	57	N	LC	-	-	D R
Gekkonidae	*Cyrtodactylus sp*	AG, OA, BA	24	Y/?	NE	-	-	D R
	Gekko gecko	AG, OA, BA	24	N	LC	-	-	D R
	Hemidactylus frenatus	AG, OA, BA	40	N	LC	-	-	D R
	Hemidactylus tenkatei	OA, BA	4	Y	LC	-	-	D R
Pythonidae	*Liasis mackloti*	BA	1	Y	LC	II	-	R
Colubridae	*Lycodon capucinus*	AG, BA	5	N	LC	-	-	R
	Coelognathus subradiatus	BA	1	Y	LC	-	-	R
Agamidae	*Draco* sp.	BA	1	Y/?	NE	-	-	D

Notes: AG = Agriculture; OA = Open-area; BA = Built-area; ∑ = Number of individuals; N = No; Y = Yes; Y/? = Possibly endemic; D = Dry season; R = Rainy season

According to Reilly (2021), *H. tenkatei* was described from Rote Island. This species is also included in records of discoveries in the Timor region of Indonesia, including Timor Leste (Kathriner, O'Shea, & Kaiser,

2014). Furthermore, Reilly (2021) also reported that this species is resident in the Lesser Sunda Islands in Indonesia and Timor Leste. Another endemic species, *L. mackloti*, is reported to be resident in eastern Indonesia, including Timor Leste (Arida, Gillespie, & Reilly, 2021). Barker, Auliya, & Barker (2018) further reported in their book Pythons of Asia and the Malay Archipelago that this species can be found in eastern Indonesia, including Timor Leste, Rote, Semau, and Alor islands. The international pet trade is the main threat to this species (Arida et al., 2021). Several studies also report that *L. mackloti* is imported for international trade (Ciavaglia, Dridan, & Linacre, 2019). Therefore, CITES categorizes this species into Appendix II, which means the species will be threatened if trade is uncontrolled. The last species identified as endemic is *C. subradiatus*. This species is reported to spread across the Lesser Sunda Islands, including West Nusa Tenggara, East Nusa Tenggara, Maluku (Wetar Island), and Timor Leste (Reilly, 2021a).

When compared with several herpetofauna studies in the campus area, the number of herpetofauna species in the Undana campus area is relatively small; for example, herpetofauna research at Gadjah Mada University 32 species (Qurniawan, 2015), ITERA campus 22 species (Tohir & Siregar, 2021), and Palangkaraya University had the same number of species, namely 12 species (Maulidi, Purnaningsih, Maulina, Gunawan, & Rizki, 2020). Referring to Aini (2022), a preliminary study of herpetofauna at Nusa Cendana University found seven species, four reptile species and three amphibian species. Furthermore, when compared with this study, six of the seven species found were also found in this study. One species that was not found during the research was *Varanus timorensis*. This species was not found during the survey allegedly because it is vulnerable to disturbance from human activities. In his study, Aini (2022) found only one individual of this species and only one encounter with a juvenile age structure.

D. melanostictus is the species with the most significant number of individuals found on the Undana campus. Tohir & Siregar (2021) also reported that *D. melanostictus* has the highest number of individuals along with *F. cancrivora* and significantly differs in the number of individuals with other species on the ITERA campus site. Furthermore, Adhiaramanti & Sukiya (2016) reported the same by finding that *D. melanostictus* in the Yogyakarta State University area had the most significant number of individuals. Hilmi, Prihatin, & Susilo (2020) said that *D. melanostictus* was found in almost all of his research locations on the Jember University campus. In contrast, Maulidi et al., (2020) reported that this species did not have the most significant number of individuals and was not found in the entire research area. Still, this species was only found in the building area habitat, which describes the habitat in the campus area.

All species found were recorded in built-area habitats. This result can also be seen in the diversity indices calculation, resulting in the built-area habitat having the highest Shannon diversity and species richness index (Figure 3). This is because the built-in area on the Undana campus combines buildings with green open space vegetation, providing a habitat for herpetofauna.

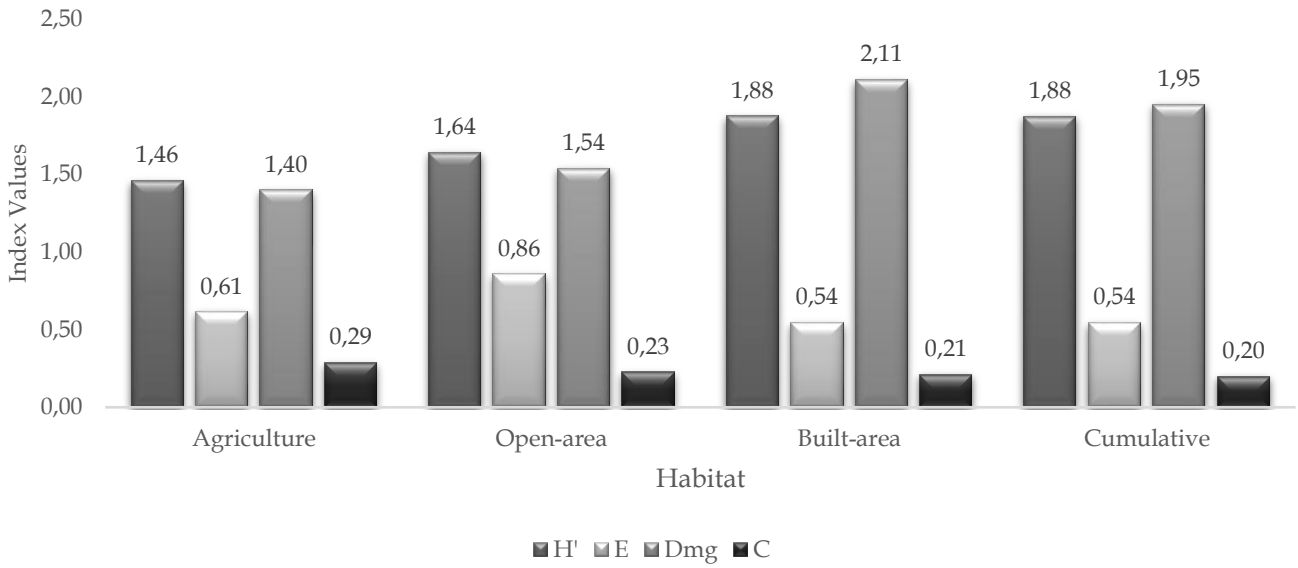

Figure 3. Diversity indices of herpetofauna at the Nusa Cendana University

Compared with herpetofauna research in other campus areas, the biodiversity index on the Undana campus is relatively lower. Tohir & Siregar (2021) reported that H' on the ITERA campus was 2.29, on the Palangkaraya campus, it was divided into several habitats with H' values ranging from 0.86 - 2.06 (Maulidi et al., 2020), and studies of diversity specifically for the Anura on campuses such as Sam Ratulangi University was 1.783 (Liando, Katili, & Wahyudi, 2019). This is thought to be because there is no natural freshwater source. The only water sources on the Undana campus that can be used as a habitat are small tanks for watering the land and several small artificial ponds. Wildlife animals, especially herpetofauna taxa, need terrestrial habitats and aquatic habitats as intact habitats for survival (Disi, Amr, & Hamidan, 2014; Priambodo et al., 2019). The terrestrial habitat on the Undana campus also characterizes a dry land ecosystem dominated by deciduous vegetation typical of a Moonson Forest. Moreover, Undana has a climate with a longer dry season than the rainy season (Fick & Hijmans, 2017; Zepner et al., 2021). However, this H' value has increased from Aini's (2022) preliminary study, which reported that H' on the Undana campus was at a value of 1.82.

Mardiastusti (2015) states that landscapes dominated by human activity are also commonly called human-modified landscapes. This area has changes caused by human activities. The diversity of landscape habitat types is in line with the high and low levels of disturbance from human activities in the area and human dominance over the environment (Cafaro et al., 2022; Delaney et al., 2021; Manhas et al., 2015). This area is intensively used in this category for human activities that require changing the site's natural shape (Manhas et al., 2015). This will directly and indirectly affect the composition of the animal species found. Following Mardiastuti (2015), landscape changes due to human activities on the Undana campus are still classified as high. This is seen from the perspective that habitat is still available for the animals even though they have been separated and become smaller.

There are responses of animals to disturbance from human activities (Adil et al., 2019; Johnson & Russell, 2014; Tablado & Jenni, 2017; Wilson et al., 2020). Several long-term responses are the distribution (Doherty, Hays, & Driscoll, 2021; Nickel, Suraci, Allen, & Wilmers, 2020; Pramatana, Hernowo, & Prasetyo, 2021, 2022), abundance (Coetzee & Chown, 2016; Gilbert, Stenglein, Pauli, & Zuckerberg, 2022; Vargas Soto et al., 2022), or population density of an animal type in a location (Pirotta et al., 2018). Meanwhile, in the short term, changes in behavior and active time are parameters of animal responses to human activity disturbances (Lowry, Lill, & Wong, 2013; Wilson et al., 2020). The amphibian and reptile encounter time on the Undana campus corresponds to the busy time for herpetofauna at night. This indicates that learning activities on the Undana campus do not directly influence amphibian and reptile activities. However, with the intensive construction of buildings and other facilities on campus, there will be changes in the distribution, abundance, and population density of amphibians and reptiles in the long term.

Conclusion

Twelve species from eight herpetofauna families, consisting of four amphibians and eight reptiles, were recorded in three habitat types in the Undana campus area. It was recorded that there were six additional herpetofauna species compared to the preliminary study, although one species, *V. timorensis*, was not found in this study. All species were recorded in built-area habitats because this habitat combines buildings and green open space with vegetation. This herpetofauna diversity data is essential information and is expected to increase awareness about biodiversity. Of course, there is a big hope that the Undana campus can become a biodiversity or green campus that pays attention to biodiversity.

Acknowledgments

We thank the Faculty of Agriculture and Department of Forestry Nusa Cendana University for financial research support. We also thank and appreciate the Undana Herpetologist Group for all the research assistance provided.

Author Contributions

Conceptualization, FP, YA and OH; methodology, FP, YA and OH; validation, FP and YA; formal analysis, FP and YA; data curation, FP and YA; writing—original draft preparation, FA, YA and OH; writing—review and editing, FP, YA and OH; visualization, FP, YA and OH; project administration, FP, MMEP and RHS; funding acquisition, FP, MMEP and RHS.

Funding

This research was funded by Faculty of Agriculture and Department of Forestry Nusa Cendana University (Contract number 796/UN15.13.2/KU/2023).

Conflicts of Interest

The authors declare no conflict of interest.

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