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Global Forest Journal

Analysis of wildlife threat findings based on the SMART patrol application at Pemerihan Resort, Bukit Barisan Selatan National Park

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ARTICLE INFO

Article history:
Received 9 February 2024
Revised 25 June 2024
Accepted 18 July 2024
Available online 30 July 2024

E-ISSN: 3024-9309

How to cite:
Andhika, S. P. Harianto, D. Iswandaru, A. Darmawan, I. G. Febryano, Subki, "Analysis of wildlife threat findings based on The SMART Patrol Application at Pemerihan Resort, Bukit Barisan Selatan National Park," *Global Forest Journal*, vol. 02, no. 02, July 2024.

http://doi.org/10.32734/gfj.v2i02.15657

ABSTRACT

Monitoring, managing, and maintaining conservation areas are challenges faced by various parties. The Spatial Monitoring and Reporting Tool (SMART) is an application used to measure, collect, evaluate, and improve the effectiveness of location-based monitoring and conservation activities and has been implemented at the Pemerihan Resort, Bukit Barisan Selatan National Park (TNBBS). Based on the SMART application, the research aims to analyze the findings of threats and wildlife on active patrol routes. The methods used are documentary studies and field observations. The data obtained from the documentary study is in the form of data from forest patrols for two years (2020-2022), then processed, classified, and analyzed into data on threat findings and wild animal encounter data directly or through signs of presence, which is then verified through field observations. The research results show that the data found from the SMART application during four patrol periods from 2020-2022 consisted of 143 threat findings and 841 wild animal encounters. The highest threat finding was animal hunting, with 56 findings (39%), and the lowest was logging, with three findings (2%). Twenty-three wild animal encounters were found directly or through signs of presence such as tracks, feces, scratches, and food remain. The highest wildlife encounter was the sambar deer (*Rusa unicolor*). The high threat findings indicate much human activity in the Pemerihan Resort Area, TNBBS, which can disturb wildlife and its habitats.

Keyword: SMART Patrol, Threats, TNBBS, Wildlife

1. Introduction

Wild animals are one component of the ecosystem. Types of wild animals, both individually and in groups, have their respective roles in maintaining the balance of processes in nature. The condition of their populations influences the survival of wild animals. A smaller wild animal population can trigger ecological problems in the food chain and energy cycle [1]. One of the activities that triggers the decline in wild animal populations is hunting. Human disturbance in habitat narrowing and hunting can cause a drastic reduction in wild animal populations, or the territorial area of wild animals becomes narrower so that the intensity of the decline in animal populations increases yearly [2]. Bukit Barisan Selatan National Park is one of Indonesia's national parks, stretching over ±355,511 hectares. Bukit Barisan Selatan National Park is home to three of the rarest and most charismatic animals, namely the Sumatran rhino (*Dicerorhinos sumatrensis*), Sumatran elephant (*Elephas maximus sumatranus*), and Sumatran tiger (*Panthera tigris sumatrae*) [3]. Many problems occur in Bukit Barisan Selatan National Park, including poaching of wild animals. On the other hand, the diversity of wild animals contains various benefits and functions, so their conservation is very important [4], so efforts and optimization of security and protection of forest areas need to be made by utilizing technology.

Security and protection of forest areas are all activities, efforts, and endeavors carried out by forestry officials with the support of related agencies in guarding, protecting, and defending forests from disturbances that can

disturb and damage natural resources in a planned and continuous manner [5]. One form of security and protection of forest areas is forest patrol activities. Forest patrol is a preventive activity against security disturbances in forest areas and forestry crimes to maintain the integrity of forest areas. So far, forest patrol activities have been considered less than optimal. This is caused by the decline in animal populations due to hunting. In 2016, six animal snares were found on the SMART-based active patrol route at Pemerihan Resort, Bukit Barisan Selatan National Park [6]. The Spatial Monitoring and Reporting Tool (SMART) is a new application developed to measure, evaluate, and improve the effectiveness of location-based monitoring and conservation activities. The SMART system was created to assist conservation area managers in planning, implementing, and evaluating conservation interventions in the field [7]. SMART-based forest patrol activities are expected to be a solution for protecting forests and minimizing the risk of hunting for wild animals. Research must be carried out on all information from SMART-based patrols regarding the characteristics of wild animal hunting. It is hoped to be used as a reference in subsequent patrol activities. This research aims to analyze the findings of threats and wildlife on active patrol routes based on the SMART application at Pemerihan Resort, Bukit Barisan Selatan National Park.

2. Method

This research was carried out from July to August 2023 at Pemerihan Resort, Bukit Barisan Selatan National Park, Lampung Province, Indonesia. The tools used in this research are a camera to take pictures, a laptop as a data input tool, and GPS to record the coordinates of the points found. The materials used in this research are observation data (finding data recorded in patrol books), documentation data (photos, videos, and sound recordings), and spatial data (traces and coordinates).

Data collection was carried out using documentary study and observation methods. A documentary study was carried out to collect information and data on findings from forest patrols using the SMART application in 2020 to 2022 (September to December 2020 is called Period 1; March to June 2021 is called Period 2; September to December 2021 is called Period 3 and March to June 2022 is called Period 4). The data collected is from forest patrols using the SMART Patrol application, which consists of finding threats and encounters with wild animals. Threat data includes perpetrators, encroachment, illegal hunting, logging/logging, fishing, mining, NTFP collection, road access, natural disasters, work equipment and transportation, and fire. Data on wildlife findings includes signs of animals, direct encounters with animals, and dead animals. The input data in the SMART application resulting from forest patrols is then exported, tabulated, and classified into threat discovery data and wildlife encounter data in Microsoft Excel. Observations were conducted by exploring active forest patrol routes to verify data on threats and encounters with wild animals.

The patrol data that has been processed is then analyzed descriptively based on threat findings and wildlife findings to provide an overview in the form of serial data dynamics so that it will produce trends in findings for each forest patrol period. The results of data analysis will be presented in the form of a table, line graph, or histogram graph.

3. Results and Discussion

3.1. Findings of Threats and Types of Wild Animals at Pemerihan Resort

Based on patrol activities for 2020 to 2022, 984 findings were found, both threats and wildlife at the Pemerihan Resort. Based on the findings obtained, the data was grouped based on four patrol periods: the September to December 2020 patrol period, the March to June 2021 patrol period, the September to December 2021 patrol period, and the March to June 2022 patrol period (Table 1).

Table 1. Threat findings and wildlife findings at Pemerihan Resort

Period	Discovery	Category	Description
September to December 2020	65	Threat	In this period, the most frequently encountered threat was animal hunting, with 21 findings or 32.31% of the total findings (n = 65)
	200	Wild animal	In this period, the wild animal that was most often found was 51 finds of sambar deer, or 25.5% of the total finds (n = 200).
March to June 2021	27	Threat	In this period, the most frequently encountered threat was the construction of road access, with 15 findings or 55.56% of the total findings (n = 27)
	174	Wild animal	In this period, the most common wild animal found was the rhino hornbill, with 29 finds or 16.67% of the total finds (n = 174).

Period	Discovery	Category	Description
September to December 2021	16	Threat	In this period, the most frequently encountered threat was animal hunting, with ten findings or 62.5% of the total findings (n = 16)
	215	Wild animal	In this period, the most common wild animal found was the rhino hornbill, with 49 finds or 22.80% of the total finds (n = 215).
March to June 2022	35	Threat	In this period, the most frequently encountered threat was animal hunting, with 20 findings or 57.14% of the total findings (n = 35)
	252	Wild animal	In this period, the most common wild animal found was 52 finds of sambar deer, or 20.63% of the total finds (n = 252).

3.2. Threat Findings

Based on patrol activities at the Pemerihan Resort for 2020 to 2022, 143 signs of threat were found. Threats are the discovery of objects of criminal activity that could threaten plant or wildlife life in the area. Human activities in forest areas, such as hunting and development, are severe threats to the existence of animals [8]. Based on the patrol results, various subcategories of threat findings were obtained (Figure 2).

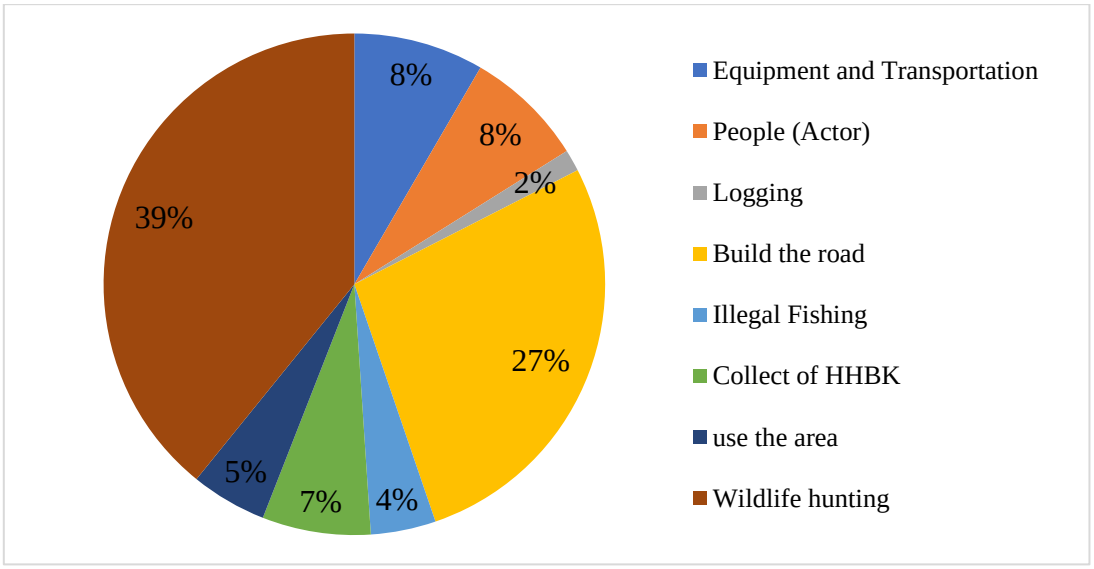

Figure 2. Threat Findings at Pemerihan Resort

There are eight subcategories of threat findings during patrol activities in the Pemerihan Resort area, including 39 road access findings of footpaths and vehicle roads (Figures 3 and 4). There were 12 work equipment and transportation found, consisting of huts, machetes, shoes, and motorbikes. The perpetrators found were 11 people. Two findings were found in logging: processing of jabon (*Anthocephalus* spp.) and pulai (*Alstonia scholaris*) wood. Taking non-timber forest products (NTFPs), a total of 10 findings were found in the form of harvesting cat's eye resin (*Shorea javanica*) and jolang-jaling fruit (*Arenga pinata*). There were seven findings regarding using forest areas, consisting of mixed garden findings. There were six illegal fishing findings. The highest threat found was 56 animal hunting findings (39%) of the total threat findings (n = 143).

Figure 3. Footpath findings at Pemerihan Resort

Figure 4. Vehicle road findings at Pemerihan Resort

Figure 5. Findings of community activities at Pemerihan Resort

Based on four patrol periods, animal poaching was the highest threat (Figure 6). Findings of wild animal hunting were recorded to have decreased from period 1 (21 finds) to period 2 (5 finds) but increased in periods 3 and 4 with ten finds and 21 finds. This indicates that wild animal hunting activities at the Pemerihan Resort are still occurring dynamically. The discovery of access roads in forest areas also proves that illegal activities

are still occurring today. Road access was the highest finding in period two, decreased in period 3, and increased in period 4. Other findings during the four forest patrol periods experienced fluctuations.

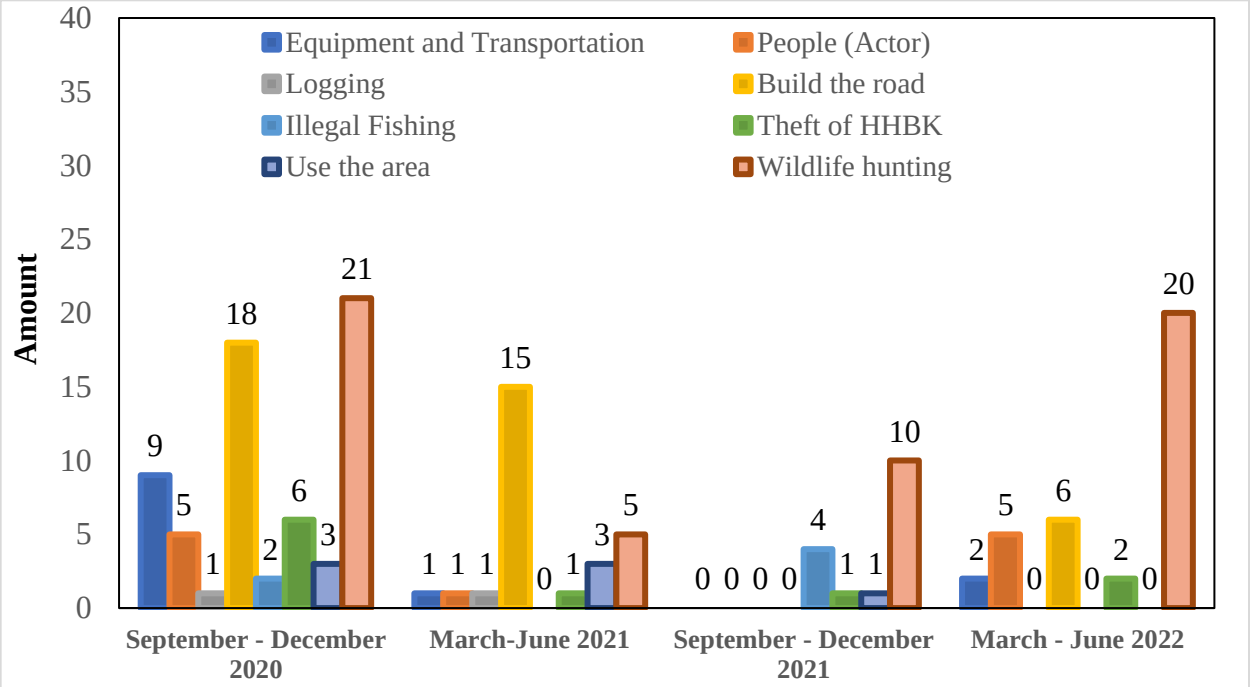

Figure 6. Threat findings during each patrol period at Pemerihan Resort

High levels of hunting for wild animals can result in declining wild animal populations. They can negatively impact the continuity of the food chain in the ecosystem and increase the extinction rate [9]. Apart from that, high hunting activity is also driven by market demand because wild animals are considered to have economic value [10]. Apart from that, the high number of findings regarding illegal hunting activities is also supported by the findings on road access. Road access is a route for perpetrators to enter and exit the forest area [11]. All activities indicate that the community has illegal activities in wildlife habitats, thus potentially causing human-wildlife conflict. Based on research results [12], conflict between wild animals and humans is a serious threat due to the intersection of human and wild animal activity areas.

3.3. Wildlife Finds

Based on patrol activities for the 2020 to 2022 period, 841 wildlife discoveries were found, both direct and indirect. Wildlife findings are important information regarding the existence and distribution of key, umbrella, or flag species. Based on signs of the presence of wild animals, such as tracks, body rubs, scratches, food marks, or wallows, 23 types of wild animals have been identified at Pemerihan Resort (Table 2).

Table 2. Wild animals identified at Pemerihan Resor

No	Local Name	Scientific name	Family	Types of Findings		Conservation Status (IUCN)
				D	I	
1	Babi Hutan	*Sus scrofa*	Suidae	✓	✓	Least Concern
2	Badak Sumatera	*Dicerorhinus sumatraensis*	Rhinocerotidae		✓	Critically Endangered
3	Beruang Madu	*Helarctos malayanus*	Ursidae	✓	✓	Vulnerable
4	Beruk	*Macaca nemestrina*	Cercopithecidae	✓	✓	Endangered
5	Enggang Klihingan	*Anorrhinus galeritus*	Bucerotidae	✓	✓	Near Threatened
6	Gajah Sumatera	*Elephas maximus sumatranus*	Elephantidae		✓	Critically Endangered
7	Harimau Sumatera	*Panthera tigris sumatrae*	Felidae		✓	Critically endangered
8	Julang Emas	*Rhyticeros undulatus*	Bucerotidae	✓	✓	Vulnerable
9	Kangkareng Perut Putih	*Anthracoceros albirostris*	Bucerotidae	✓	✓	Least Concern
10	Kijang Muncak	*Muntiacus muntjac*	Cervidae	✓	✓	Least Concern
11	Kuau Raja	*Argusianus argus*	Phasianidae	✓	✓	Vulnerable

No	Local Name	Scientific name	Family	Types of Findings		Conservation Status (IUCN)
				D	I	
12	Landak Sumatera	*Hystrix sumatrae*	Hystricidae	✓		Least Concern
13	Lutung Kelabu	*Trachypithecus cristatus*	Cercopithecidae	✓		Vulnerable
14	Lutung Simpai	*Presbytis melalophos*	Cercopithecidae	✓	✓	Endangered
15	Macan Dahan	*Neofelis diardi*	Felidae	✓	✓	Vulnerable
16	Monyet Ekor Panjang	*Macaca fascicularis*	Cercopithecidae	✓		Endangered
17	Owa Ungko	*Hylobates agilis*	Hylobatidae	✓	✓	Endangered
18	Rangkong Badak	*Buceros rhinoceros*	Bucerotidae	✓	✓	Vulnerable
19	Rangkong Gading	*Rhinoplax vigil*	Bucerotidae	✓	✓	Critically Endangered
20	Rangkong Papan	*Buceros bicornis*	Bucerotidae	✓	✓	Vulnerable
21	Rusa Sambar	*Rusa unicolor*	Cervidae	✓	✓	Vulnerable
22	Siamang	*Hylobates syndactylus*	Hylobatidae	✓	✓	Endangered
23	Tapir Asia	*Tapirus indicus*	Tapiridae	✓	✓	Endangered

Note: D = Direct; I = Indirect

There were 12 families of identified species from 23 types of animals, including Bucerotidae, Cercopithecidae, Cervidae, Elephantidae, Felidae, Hylobatidae, Hystricidae, Phasianidae, Rhinocerotidae, Suidae, Tapiridae, and Ursidae. The family with the most frequently found species is Bucerotidae, which has six species. Bucerotidae is a family of birds consisting of birds (hornbills, hornbills and kengkareng) with a characteristic large, sturdy, curved, long, and light beak. The presence of birds from the Bucerotidae family indicates that the environment and ecosystem are still good [13].

Indirect identification of wild animals based on signs of their presence. Signs of animal presence include droppings, tracks, scratches, wallows, and nests. Signs of wild animals in forest areas include footprints, animal sounds, food marks, scratches, body rubs, horn rubs, nests, droppings, puddles of water, animal carcasses, bones, and skulls [14]. Most large mammals are easily detected using tracks [15]. In addition, droppings are easy to find and record their presence. This can help in the identification of wildlife [16]. Some examples of signs of animal presence that the patrol team found include deer droppings (Figure 7), deer footprints (Figure 8), and dancing ground areas (Figure 9).

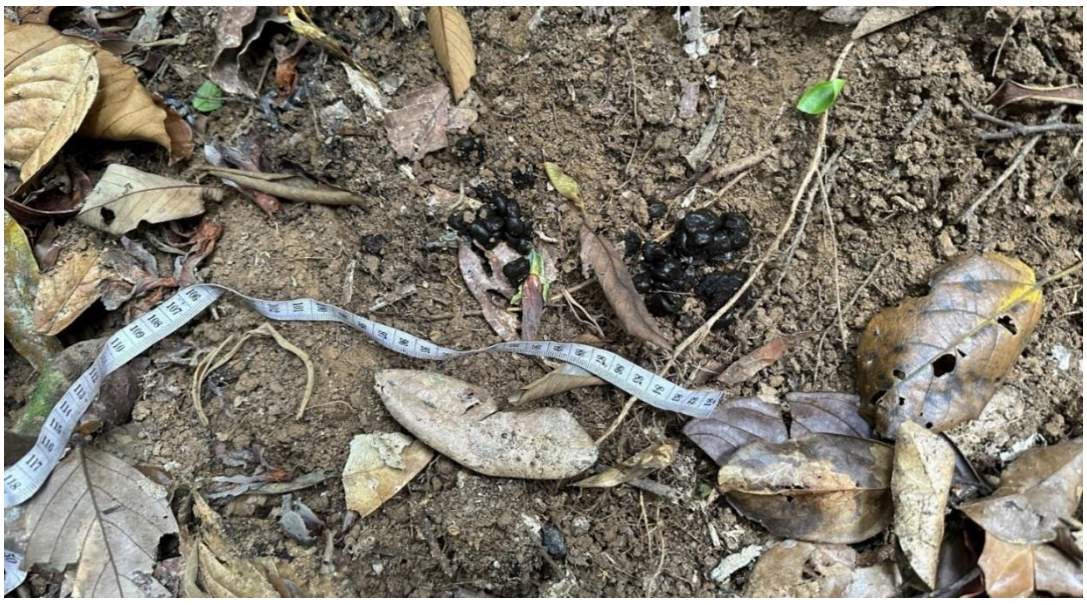

Figure 7. Deer droppings

Figure 8. Deer footprints

Figure 9. Kuau Raja dancing area

3.4. Wildlife Conservation Status

There are nine groups of species based on their conservation status, namely Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), and Extinct (EX) [17]. From the 23 species of wild animals that were identified, four species (17%) have Least Concern status, one species (5%) has Near Threatened status, eight species (35%) have Vulnerable status, six species (26%) have Endangered status, and four species (17%) have Critically Endangered status (Figure 10).

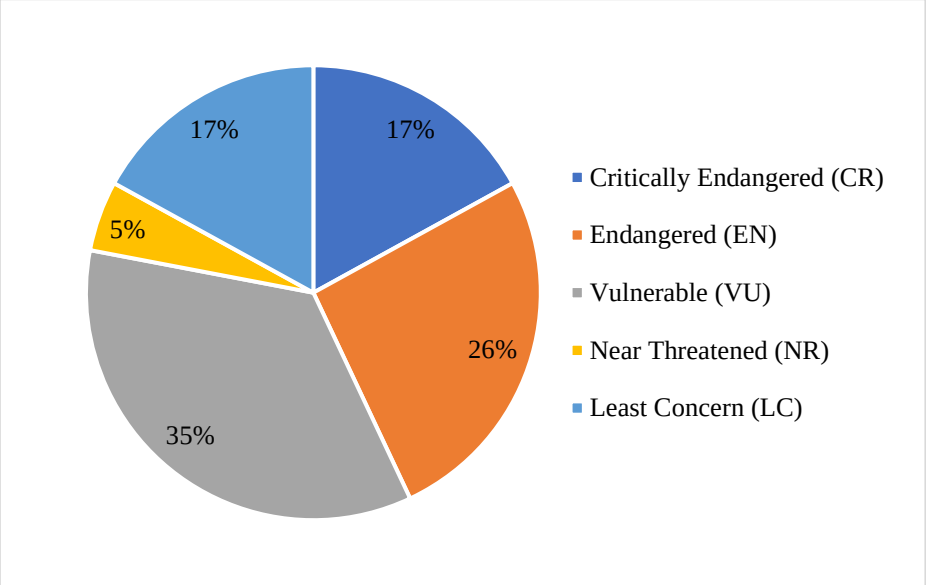

Figure 10. Conservation status of wildlife found at Pemerihan Resort

Based on their conservation status, there are four species of wild animals with Least Concern status, including wild boar (*Sus scrofa*), white-bellied kangkareng (*Anthracoceros albirostris*), muntjac deer (*Muntiacus muntjac*), Sumatran porcupine (*Hystrix sumatrae*). The status of Near Threatened is one species, namely the klihingan hornbill (*Anorrhinus galeritus*). Vulnerable status for 8 species including sun bear (*Helarctos malayanus*), golden hornbill (*Rhyticeros undulatus*), king pheasant (*Argusianus argus*), gray langur (*Trachypithecus cristatus*), clouded leopard (*Neofelis diardi*), rhinoceros hornbill (*Buceros rhinoceros*), plank hornbill (*Buceros bicornis*), sambar deer (*Rusa unicolor*). There are six species of wild animals with Endangered status, including the macaque *(Macaca nemestrina*), hoop langur (*Presbytis melalophos*), long-tailed monkey (*Macaca fascicularis*), ungko gibbon (*Hylobates agilis*), gibbon *(Hylobates syndactylus*), Asian tapir (*Tapirus indicus*). There are four species of wild animals with critically endangered status, including the Sumatran rhino (*Dicerorhinus sumatraensis*), sumatran elephant (*Elephas maximus sumatranus*), sumatran tiger (*Panthera tigris sumatrae*), and the helmeted hornbill (*Rhinoplax vigil*).

3.5. Threats and Findings of Wildlife in Each Period

Based on patrols carried out on the same route for four periods with a route length of around 15 to 30 km, the number of threats encountered by wild animals always changes in each period (Figure 11). The number of threat discoveries can influence the number of wildlife discoveries in each period. Wild animals are very vulnerable to disturbance from human activities. At high levels, human activities in an area can have a negative impact on the habitat and the existence of wild animals.

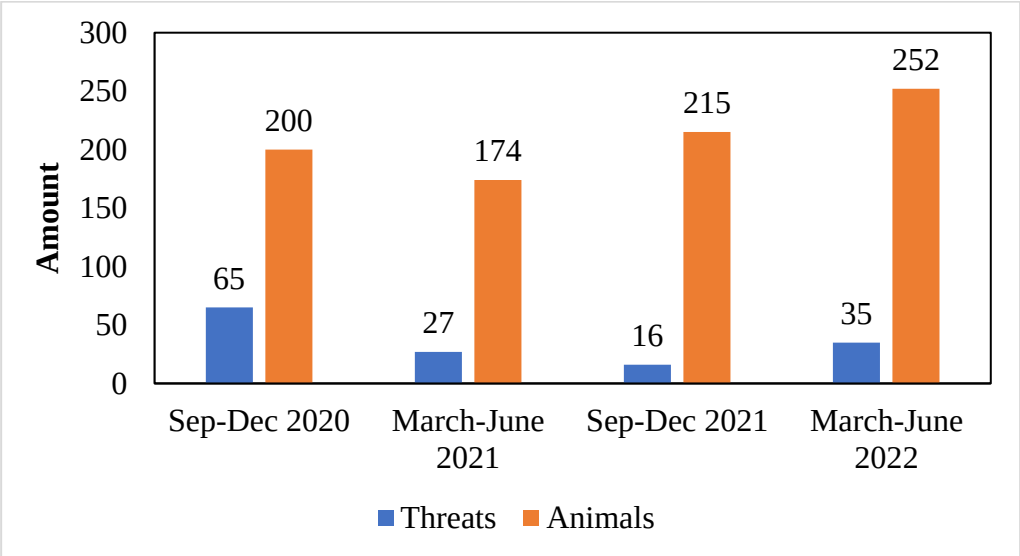

Figure 11. Threat and wildlife findings during each patrol period at Pemerihan Resort

Threat findings in each patrol period experienced a significant decrease or increase. The highest threat findings occurred in the September-December 2020 patrol period, while the March-June 2021 patrol period experienced a decrease from the previous period. The September-December 2021 patrol period also experienced a decrease, where the lowest point of threat found in temporary areas was in the March-June 2022 period, and there was an increase from the previous period. Based on the data obtained, the highest threat period occurred in September-December 2020, while the lowest occurred in September-December 2021.

Different things were found in the discovery of wildlife, which has increased in the last three periods. This is influenced by the low number of threat findings during each patrol period. The high-threat findings can influence the low number of wild animals found during patrols. This indicates that human activities greatly influence the existence of wild animals in their habitat. Human activities such as converting forests into plantations and excessive exploitation of forest resources such as illegal logging, illegal hunting, and burning of forest areas can threaten the existence of wild animals and cause conflicts between animals. Wild and human [18]-[19].

3.6. Distribution of Threat Findings

Threat findings obtained during patrols are mapped to determine the distribution of findings. The distribution of threat findings can be used as supporting data for the main purpose of patrol focus. The most frequent discovery of threats indicates low security and high levels of human activity at the location. The distribution map of threat findings is divided into four periods, namely the September to December 2020 period, the March to June 2021 period, the September to December 2021 period, and the March to June 2022 period.

The distribution of threat findings in each period was mostly found in areas bordering or directly adjacent to community settlements. Meanwhile, in other areas, only a few threats were found. This illustrates that there is still community activity in the area. Threats to habitat can affect the existence and distribution of wild animals, so they can disrupt population development. Conflict between wild animals and humans is a serious threat to wild animals due to human encroachment on forest areas. Forest encroachment, hunting of wild animals, and other human activities will seriously threaten the territorial integrity and potential of the Pemerihan Resort area [20].

3.7. Distribution of Wildlife Findings

Wildlife findings obtained during patrols are mapped to determine the distribution of the findings. The distribution of wild animal findings can be used as supporting data as the main objective of patrol focus. The discovery of the most abundant wildlife indicates the high level of wildlife diversity at this location. The wild animal distribution map is divided into four periods: the September to December 2020 period, the March to June 2021 period, the September to December 2021 period, and the March to June 2022 period.

The distribution of wildlife finds was quite even at the Pemerihan Resort. The wild animals often found include primates (gibbons, langurs, and ungko gibbons) and aves (pheasants, golden hornbills, and ivory hornbills). The wild animal found the least based on signs of its presence is the Sumatran rhino (*Dicerorhinus sumatraensis*), while the sambar deer (*Rusa unicolor*) is the most frequently encountered. Wild animals in nature can be disturbed due to human activities such as hunting, forest encroachment, and felling of trees. This SMART-based patrol is hoped to minimize existing threats and restore forest function as it should. For this reason, cooperation from various parties is needed to support the preservation of conservation areas, especially at the Pemerihan Resort. Interaction between national park officers and the community and facilitating conservation understanding activities for the community can be one approach to providing the community with understanding so that they do not repeat activities in the area.

There is a need to increase public awareness regarding the importance of maintaining forest ecosystems to remain sustainable. Apart from that, assistance and involvement of local communities are needed to preserve forest areas at the Bukit Barisan Selatan National Park Pemerihan Resort. The existence of forests and forest-supporting resources in all aspects of human life, wildlife, and plants is largely determined by the level of human awareness of the importance of forests in forest utilization and management [21]-[23].

4. Conclusion

Threat findings and types of wild animals fluctuated in the four patrol periods. The highest threat found was illegal hunting, and the highest number of wild animal encounters was sambar deer (*Rusa unicolor*). The SMART application-based forest security system can detect threats and disturbances to conservation areas, especially at the Pemerihan Resort, Bukit Barisan Selatan National Park. Additionally, the diversity of wild

animals can also be identified with SMART application-based patrols. The still high threat findings reflect the high level of human activity in the Pemerihan Resort area, Bukit Barisan Selatan National Park, which can disrupt wildlife and their habitats.

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