Journal of Natural Resources and Environmental Management
http://dx.doi.org/10.29244/jpsl.15.1.111

RESEARCH ARTICLE

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Land-cover Dynamics and Oriental Honey-buzzard Winter Habitat Preference in Borneo, Indonesia

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Article History
Received 5 October 2023
Revised 30 May 2024
Accepted 1 August 2024

Keywords
migratory behavior,
oriental honey-buzzard,
Pernis ptylorhynchus,
satellite-tracking

ABSTRACT

Migration is part of an individual's behavioral adaptation to seasonal environmental changes. Migration can take advantage of organisms facing cyclical changes in limited resources. Borneo island is one of the wintering migration destinations for Oriental Honey-buzzard in Indonesia. The confluence of deforestation, industrialization, and urbanization has placed Kalimantan at a critical juncture. Borneo Island has led to the fragmentation habitat. ARGOS is a satellite tracking tool that has been used to monitor the movements and behavior of Oriental Honey-buzzards since 2003. Three individuals were investigated in this study to determine the response to land-cover changes that occurred in Borneo in 2003, 2006, and 2009. The ecological complexity and species-environment connections that support Oriental Honey-buzzard responses are highlighted in this study. The analysis of responses suggests that Oriental Honey-buzzard was more commonly encountered in forested areas in Borneo than in 11 other land-cover areas during three years 2003, 2006, and 2009. Time duration spent in forested areas consistently exhibited the longest presence duration, with durations of 136.88 hours, 1,121.17 hours, and 1,160.53 hours in 2003, 2006, and 2009, respectively. The shortest duration of presence in mangrove and swamp areas was during 2003, 2006, and 2009.

Introduction

The phenomenon of migration is part of the process of adapting individual behavior to seasonal environmental changes. Migration behavior is characterized by cyclical variations in the quality and/or quantity of limiting resources and imparts benefits to creatures living in seasonal habitats [1], as well as evidence of intricate relationships between individual, genetic, and environmental factors [2,3]. Therefore, animal migration can be characterized as a movement activity undertaken to meet the requirements for adaptability owing to seasonal changes in environmental conditions in their original habitat. Oriental Honey-buzzard is a long-distance migratory bird endemic to Japan's plains [2].

Oriental Honey-buzzard was the most prevalent migratory species in 2000 to 2001, accounting for 93% of all migrating birds of prey [4]. The main reason for Oriental Honey-buzzard migration is to avoid extremely cold temperatures and situations that do not allow them to survive [5]. Borneo Island is one of the destinations for wintering in the Oriental Honey-buzzard during the migration season [2]. Mature birds migrate first, followed by juvenile birds, all of which cross the East China Sea to reach the continent [6]. In a previous study, the Oriental Honey-buzzard route decision was influenced by the amount of prey available at each migratory location [7]. The hunting behavior of the Oriental Honey-buzzard is a crucial aspect of its foraging

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strategy. They possess specific skills for capturing prey on the ground or in lower environments, such as shrub layers and paper wasp nests beneath the forest canopy [8].

The movement of the Oriental Honey-buzzard was influenced by a wide range of conditions. Food supply, weather conditions, temperature, rainfall, and dangers are all factors influencing this migration [1,9]. Cold winds from the northwest with severe gusts have been identified as a significant factor influencing migration [10]. Migratory raptors must adapt to two or more diverse environments, each with its own habitat, climate, food sources, competition, predators, and parasites [11].

Borneo Island, which is characterized by natural forests and vegetative cover, is noteworthy because it raises concerns about conflict and the likely reduction in regions that could support the resources required for Oriental Honey-buzzard survival throughout the migration period. OHB (Oriental Honey-Buzzard) is listed as Least Concern on the IUCN (International Union for Conservation of Nature and Natural Resources) Red List, but its population is likely to decline due to habitat loss and degradation. According to Safitri et al. [12], the island of Borneo's land-cover has changed dramatically due to deforestation. Long et al. [13] identified industrialization, population increase, and urban migration as the key and most impactful variables contributing to land-cover changes.

This is inextricably linked to the various land clearing activities that continue to rise year after year because of the National Capital expanses in the Borneo [14], industrial plantations and mining operations [15], also causing habitat fragmentation [1] that are increasing year after year. Changes in land-cover can affect landscape structure, resulting in changes in landscape function and major implications for biodiversity and resource contribution [16]. In a recent study [17], the fragmentation of natural habitats where honeybees nest, which is the main food supply for Oriental Honey-buzzard, drives forest honeybees to nest in urban areas, thereby increasing the possibility of conflict between the Oriental Honey-buzzard and humans.

Satellite tracking and remote sensing technologies have been used as applications of current technological advances to determine the response of Oriental Honey-buzzards to environmental conditions, including the determination of migration routes and patterns [2], habitat modelling [18], landscape structure characteristics [19], migration behavior [20], range contraction due to climate change [21], identification of migration route selection [2,4,22,23], and hunting behavior [17]. However, no study has directly investigated the relationship between land-cover changes and habitat selection responses during the wintering migration phase. This study aims to identify land-cover change and analyze the migration response of the Oriental Honey-buzzard to land-cover change in Borneo, Indonesia, using satellite-tracking data (2003–2010) as a first step toward the protection of the Oriental Honey-buzzard wintering habitat on the island of Borneo.

This study employed satellite tracking technologies to trace the movements of the Oriental Honey-buzzard during migration. The data were subsequently evaluated to determine habitat preferences and species responses to changes in land-cover. By better understanding how changes in habitat land-cover affect the migration duration of the Oriental Honey-buzzard during winter migration, conservation strategies to protect the species' wintering habitat in Borneo can be implemented. This study provides fresh insights into the interaction between migration and the environment, as well as valuable information for the conservation of the Oriental Honey-buzzard and biodiversity on Borneo Island, Indonesia.

Materials and Methods

Study Area

This research was conducted with Indonesian Borneo Island as the object of research with the boundaries of the area, as shown in Figure 1. Borneo Island, situated in Southeast Asia, is the world's third-largest island, spanning an area of roughly 743,330 square kilometers. Borneo is depicted as an area with intense logging activity [15]. While Borneo also provides wintering habitats for Oriental Honey-buzzard's, and these habitats are distributed across the island but a notable finding is the existence of a core wintering habitat, which covered approximately 20.7% of the entire land area of Borneo which essential for the birds during the wintering season [19].

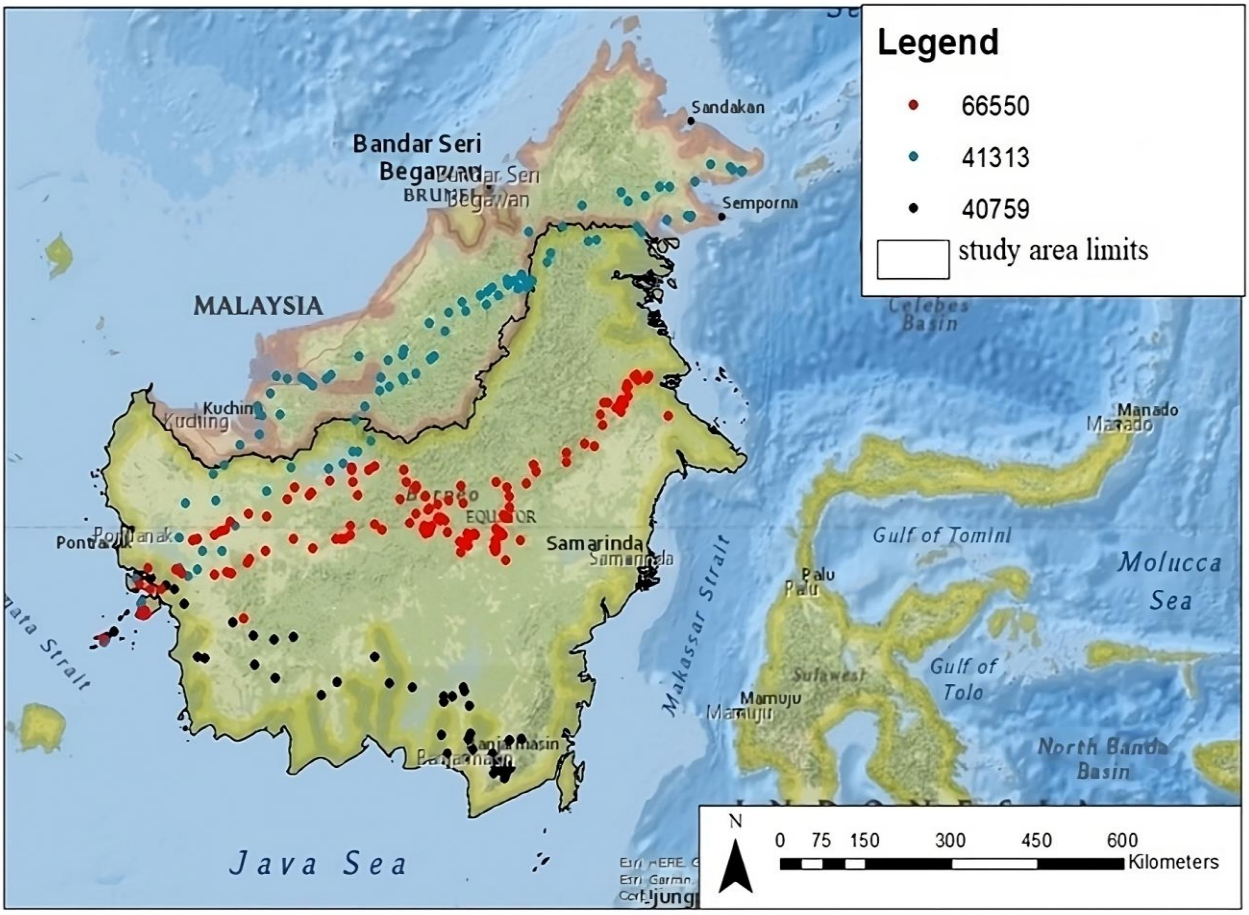

Figure 1. Research location oriental honey-buzzard satellite tracking data from 2003, 2006, and 2009 on Borneo Island, Indonesia (Source: ARGOS (https://www.argos-system.org/ accessed on 22 July 2022)).

Data Collect Method

The processing of land-cover change data and habitat choice data from the Oriental Honey-buzzard was a key stage in our study. The data used were derived from numerous sources, which are listed in Table 1, with secondary data information sources from 2003, 2006, and 2009. We used data satellite-tracking analysis in the form of 3 individuals Oriental Honey-buzzard distributions, operated by the US National Oceanic and Atmospheric Administration (NOAA) and the European Organization for the Exploitation of Meteorological Satellites (MetOp-A). This analysis included percentage range shift, movement ability (i.e., distance and direction), and location shifts across latitude, longitude, and duration to comprehensively understand the migration phenomenon and the impact of land-cover change on the Oriental Honey-buzzard. The data were processed using Microsoft Office and ArcGIS before being evaluated and presented as a combination of figures and tables.

Table 1. Research data types and sources.

No.	Types	Year	Form	Source
1.	Borneo administrative boundaries		Vector, Shp	BIG (*Badan Informasi Geospasial*)
2.	Data Satellite-tracking Oriental Honey-buzzard (Figure 2)	2003–platform no 41313 2006–platform no 66550 2009–platform no 40759	Vector, Point 3 individual Oriental Honey-buzzard	ARGOS
3.	Borneo's Land-cover	2003, 2006 and 2009	Vector, shapefile	MoEF (Ministry of Environtment and Forestry)

We excluded outliers and records with significant uncertainty based on movement time and distance to ensure the data quality of satellite tracking. Location data were classified into seven Location Classes (LC) based on accuracy: Z (least accurate), B, A, 0, 1, 2, and 3 (most accurate). All records lacking data and location information were omitted from the analysis. Records with location classes 0, 1, 2, and 3 were exclusively used. This corresponds to spatial accuracies slightly over 1,500 m, (500–1,500) m, (250–500) m, and less than 500 m [2]. From 2003 to 2009, we summarized event data from daily tracking records.

Method of Analysis

Land-cover Change

Land-cover change detection quantifies the changes associated with the correction for each land-cover class. In the next step, we merged all the corrected land-cover classes using the ArcToolbox merge function. Although each feature is unique, based on the polygons created, the attribute table contains much information. Consequently, generalization or simplification is required based on the entity required, in this case, the land-cover. This can be accomplished using one of the ArcToolbox utilities, i.e. Dissolve. In this case, we sorted all the attribute data in the attribute table by the name of the land-cover class. Twelve land-cover types were calculated in 2003, 2006, and 2009, including seven core habitats and five edge habitats.

Response of Oriental Honey-buzzard's

Data on the frequency of Oriental Honey-buzzard presence were used to examine the response of Oriental Honey-buzzard to significant shifts in land-cover types in the past three years. The Oriental Honey-buzzard response is the land-cover preference and duration of the Oriental Honey-buzzard presence in 2003, 2006, and 2009, calculated in hours based on land-cover on the island of Borneo. Table 2 shows the data from three individuals with platform numbers 41313, 66550, and 40759.

Table 2. Oriental Honey-buzzard's point of presence frequency in four migratory periods.

Year	No. Platform	Migratory periods	
		Jan–Mar	Oct–Des
2003	41313	-	18
2006	66550	-	69
2009	40759	11	18

Land-cover Preference Response

We examined the patterns and inclinations demonstrated by the Oriental Honey-buzzard in the selection of land-cover types throughout the wintering migration period in Kalimantan, Indonesia. The frequency of Oriental Honey-buzzard sightings was systematically recorded over 12 land-cover types. This method was used to systematically determine the habitat preferences of the Oriental Honey-buzzard across various land-cover types. This comprehensive method significantly adds to a better knowledge of the delicate interaction between the Oriental Honey-buzzard and habitat preferences. We also observe time-activity budgets by quantifying the time spent on land-cover to identify patterns in activity duration and determine if specific factors are associated with longer or shorter durations of certain behaviors.

Data Analysis

Land-cover Change

Land-cover change detection quantifies the changes associated with the correction for each land-cover class. The purpose of conducting land-cover corrections is related to the large number of classes produced. The initial number of land-cover types was 23. The decision to classify them into 12 types was based on the similarity of the land-cover type characteristics, allowing them to be merged without losing important information about the land-cover.

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Results and Discussion

Land-cover

Three distinct years were used to calculate the land-cover in 2003, 2006, and 2009 from 12 distinctive land-cover types. The land-cover change graph for Kalimantan Island, Indonesia, is shown in Figure 2. Forests dominate Kalimantan's land-cover, emphasizing their importance to the island's environment. However, a notable tendency is the decreasing extent of other land-cover types, such as wetlands, mangroves, shrublands, and peats, which are vital habitats for the Oriental Honey-buzzard [19]. This trend has serious consequences for the survival of the species.

Habitat loss and degradation caused by human development activities and land-cover change result in the fragmentation of habitats that play a significant role in the migration route [1]. The loss of these habitats puts a significant strain on the Oriental Honey-buzzard, as they face increased challenges in their search for essential resources, such as food and shelter. These land-cover expansions often create transitional zones between different ecosystems, potentially providing more food variety. Furthermore, as these species are forced to move closer to human settlements in the quest for crucial resources, the likelihood of conflict between humans and wildlife increases [17]. In contrast, an undisturbed and non-fragmented landscape enhances the mobility of species within the region, affording them greater opportunities to exploit available resources [24].

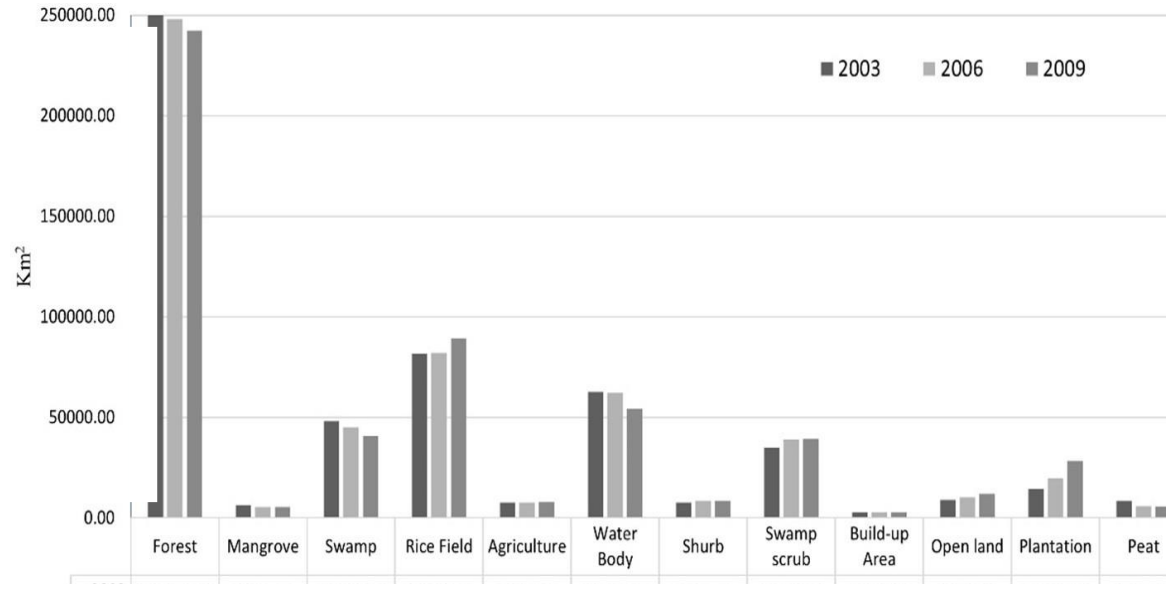

Figure 2. Kalimantan's, Indonesia land-cover change in 2003, 2006 and 2009.

Table 4. Land-cover area, percentage and change of the Kalimantan Island.

Land-cover Type	2003		2006		2009		Change (%)		
	km²	%	km²	%	km²	%	a	b	c
Forest	252,314.18	47.02	247,919.32	46.20	242,302.57	45.15	–0.82	–1.05	–1.87
Mangrove	6,391.44	1.19	5,520.57	1.03	5,332.66	0.99	–0.16	–0.04	–0.20
Swamp	48,002.78	8.94	45,192.03	8.42	40,807.58	7.60	–0.52	–0.82	–1.34
Rice field	81,699.17	15.22	82,017.50	15.28	89,184.24	16.62	0.06	1.34	1.39
Agriculture	7,667.75	1.43	7,690.69	1.43	7,956.47	1.48	0.00	0.05	0.05
Water body	62,762.71	11.70	62,203.86	11.59	54,338.99	10.13	–0.10	–1.47	–1.57
Shrub	7,781.41	1.45	8,345.64	1.56	8,476.83	1.58	0.11	0.02	0.13
Swamp scrub	35,160.79	6.55	38,973.47	7.26	39,334.30	7.33	0.71	0.07	0.78
Build-up area	2,913.85	0.54	2,991.68	0.56	3,034.53	0.57	0.01	0.01	0.02
Open land	8,958.62	1.67	10,111.74	1.88	11,985.33	2.23	0.21	0.35	0.56
Plantation	14,452.29	2.69	19,734.13	3.68	28,161.39	5.25	0.98	1.57	2.55
Peat	8,547.72	1.59	5,952.09	1.11	5,737.82	1.07	–0.48	–0.04	–0.52
Total	536,652.71	100.00	536,652.71	100.00	536,652.71	100.00			

Note: a: (2003–2006); b: (2006–2009); c: (2003–2009).

The land-cover area, percentage, and trends on Kalimantan Island in 2003, 2006, and 2009 are shown (Table 4) to investigate land-cover dynamics. In 2003, forests occupied the largest land area, constituting 252,314.18 km² or 47.02% of the total. Over subsequent years, there was a gradual decline in forest cover, with percentages decreasing to 46.20% in 2006 and 45.15% in 2009. This represented a negative change of –0.82% from 2003 to 2006 and a further –1.05% from 2006 to 2009, resulting in a cumulative decrease of –1.87% from 2003 to 2009. Similarly, mangrove areas declined from 2003 to 2009, decreasing by –0.20% over this period. Swamp experienced a notable decrease of –1.34% from 2003 to 2009, while rice fields and agriculture both showed increases in land area and percentage representation, particularly rice fields, which exhibited a rise of 1.39%.

Plantation demonstrated substantial expansion over the years, increasing by 2.55% from 2003 to 2009. Open land and swamp scrubs also expanded with increases of 0.56% and 0.78%, respectively. However, waterbodies displayed declining trends, with peat experiencing the most substantial decrease of –0.52% from 2003 to 2009. Notably, forest cover decreased, whereas plantations and rice fields expanded. These trends represent significant alterations in the landscape during this period, affecting the distribution of land-cover types. Compared with unfragmented habitats, fragmented habitats frequently exhibit diverse climatic conditions, microclimates, and ecological processes [25]. In addition, fragmented habitats play a critical role in structuring species, as the abundance of inner species within fragments is more strongly connected to the core area than to the total area [26]. This means that the conditions and resources in the core or central parts of these fragments have a more significant impact on the abundance and distribution of species than the conditions in the entire area.

Oriental Honey-buzzard's Presence Response

The bar chart (Figure 3) shows the responses of three individuals in the Oriental Honey-buzzard, with platform numbers 41313, 66550, and 407550 representing the outcomes of satellite tracking. The data shown here were calculated as examples of the frequency of Oriental Honey-buzzard's presence in 2003, 2006, and 2009 for 12 land-cover types. The bar chart (Figure 3) provides a comprehensive overview of the presence of the Oriental Honey-buzzard. In 2003, the Oriental Honey-buzzard presence was the most prevalent in forest land-cover, with a frequency of approximately seven occurrences. This was closely followed by Agriculture and Swamp, with registering frequencies of approximately six and four occurrences, respectively. Forest land-cover type is the land-cover that Oriental Honey-buzzard most commonly chooses as wintering habitat [27]. In 2006, some notable shifts were observed. Forests continued to be the most common habitat for the Oriental Honey-buzzard, with a frequency of approximately 56 occurrences. However, agriculture and shrubs saw a noticeable increase in presence, nearly doubling their frequency since 2003. The shifting frequency of Oriental Honey-buzzard attendance in 2009 was inextricably linked to factors such as food supply, weather conditions, temperature, rainfall, and dangers [1,9,21,28,29].

In 2009, the trend continued, with forest remaining as the primary habitat for the Oriental Honey-buzzard. However, its presence significantly reduced, to approximately twelve occurrences. Oil Palm Plantations reached a frequency of approximately one occurrence, whereas rice fields maintained their higher presence. The other types generally showed minor fluctuations in the presence of the Oriental Honey-buzzard. Forests, shrubs, and agriculture consistently emerged as the preferred habitat for three years, with certain changes,

such as an increase in their presence. The data on land-cover changes in forested areas from 2003 to 2006 indicate that there was no decrease in the frequency of Oriental Honey-buzzard presence in 2006. However, it is important to note that this observation has a significant caveat. The study faced limitations in terms of the number of samples or observations it could gather, leading to an inconclusive stance on whether there is a direct correlation between land-cover and the presence of Oriental Honey-buzzards. Further variables, such as the type of land-cover chosen by Oriental Honey-buzzard's food resources, thermal wind conditions, or migration behaviors, may be more influential in influencing their frequency of presence than changes in the land-cover area [1,17,21,27].

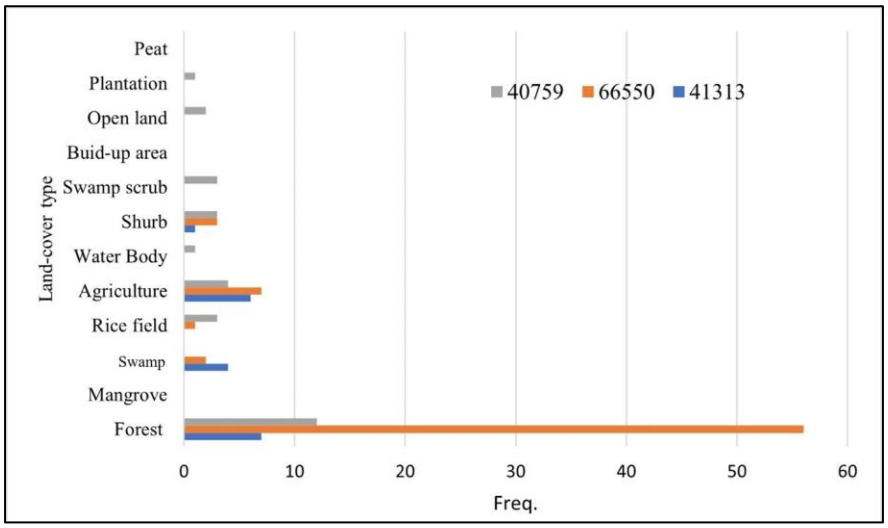

Figure 3. Frequency of presence of three individuals of Oriental Honey-buzzard on Kalimantan Island during 2003, 2006 and 2009.

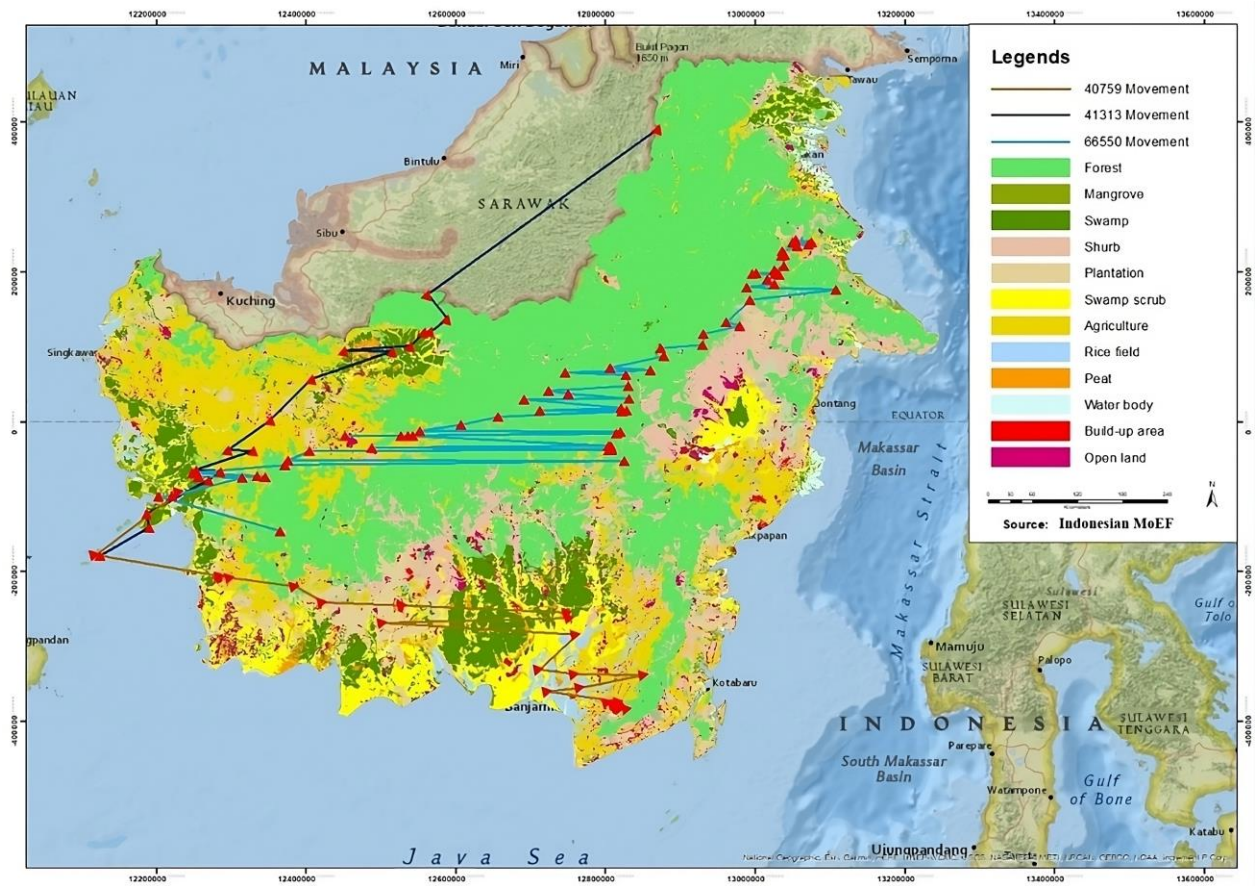

Figure 4. The movement patterns of three Oriental Honey-buzzard individuals in Kalimantan, Indonesia.

The results of the migratory response (Figure 4) analysis indicated that the three individuals of the Oriental Honey-buzzard on Kalimantan Island moved in a winding manner instead of following a straight, direct path. According to satellite monitoring, the three individuals first entered the west side of Kalimantan Island and proceeded to the east side of Kalimantan Island. This supports the theory of meandering migration in the Oriental Honey-buzzard, which consists of two phases: travel to Southeast Asia and local movements that continue until finally settling briefly in the tropics [2]. The results of the migration analysis provide empirical evidence that substantiates the previously proposed theory concerning the migratory behavior of the Oriental Honey-buzzard.

Table 5. Oriental Honey-buzzard wintering duration in hours by land-cover type in Kalimantan during four migration periods.

Land-cover type	No. Platform (duration in hours)			
	41313	66550	40759	
	Oct–Des		Jan–Mar	Oct–Des
Forest	136.88	1,121.17	1,160.53	573.95
Mangrove	0	0	0	0
Swamp	22.33	0.42	0	0
Rice field	0	1.60	0.32	50.18
Agriculture	7.08	72.60	5.45	20.75
Water Body	0	0	48.83	0
Shrub	17.78	7.43	305.43	117.07
Swamp scrub	0	0	116.78	0
Build-up area	0	0	0	0
Open land	0	0	0	30.02
Plantation	0	0	0	120.48
Peat	0	0	0	0
Total	184.08	1,203.32	1,637.35	912.45

The data showcases 12 specific categories of land-cover types: Oriental Honey-buzzard spent (Table 5) during their four migration periods in 2003, 2006, and 2009. Forest demonstrates the longest presence duration in the three years, with 136.88 hours, 1,121.17 hours, and 1,160.53 hours in 2003, 2006, and 2009, respectively. The Oriental Honey-buzzard primarily feeds on the larvae of bees and wasps, which are abundant in forested areas. It also constructs their nests in the forks of trees, commonly found in forested areas. Conversely, mangrove and swamp areas exhibited no recorded presence across years. The duration varied significantly across land-cover types, with forests in the core habitat category having the longest presence duration. The extended stay of the Oriental Honey-buzzard in certain land-covers can be attributed to various factors. The presence of migratory giant honeybees, a key food source, influences their behavior, with birds preying on newly empty nests to minimize the risk of attack [17]. The species also displays a preference for treed habitats, particularly large, continuous forest patches, and can tolerate some level of fragmentation [30].

The spread of invasive dwarf honeybees has facilitated the overwintering of birds in certain areas [29]. Additionally, the species' high spatial consistency in migration, particularly during foraging periods, suggests reliance on specific food resources [23]. These factors collectively contribute to the prolonged presence of the Oriental Honey-buzzard in certain land-cover types. Although the environmental conditions in Kalimantan's wintering habitats for the Oriental Honey-buzzard are similar to those in Flores Island's wintering habitats [27], there is an unexpected difference in the length of time the Oriental Honey-buzzard spends in these two locations. Specifically, the Oriental Honey-buzzard spends a longer period during winter in Kalimantan than its winter stay on Flores Island. This advances prior studies [20] on the total duration that the Oriental Honey-buzzard spends on large islands. Regardless of aspects such as food quantity and thermal wind availability, access to food resources should be recognized as another critical component, according to a previous similar study [31].

Conservation Implications

This study offers preliminary insights into the association between land-cover dynamics and the presence of the Oriental Honey-buzzard on Kalimantan Island, Indonesia. Land-cover fragmentation has the potential to disrupt crucial ecological processes, impede species mobility, and result in habitat deterioration and loss [26]. OHB is not considered vulnerable, but its habitat degradation and tree felling threaten its population. Furthermore, it may exacerbate conflicts between humans and wildlife, as species are increasingly compelled to be in closer proximity to human settlements [17]. These findings underscore the intricate ecological

dynamics and relationships between species and their surroundings. Nevertheless, for a more comprehensive understanding, further investigation is warranted to elucidate additional factors that influence the migratory behavior and population dynamics of the Oriental Honey-buzzard, such as the abundance of food sources. Armed with a deeper understanding of these factors, more appropriate and sustainable conservation strategies can be devised to safeguard both the population and habitat of the Oriental Honey-buzzard within the region.

In the context of Oriental Honey-buzzard conservation, the implementation of sustainable land management policies and the protection of food sources are of paramount importance. Conservation efforts, such as habitat restoration and the development of new protected areas, are essential for maintaining the population of this species. Furthermore, collaborative initiatives involving diverse stakeholders, including government entities, researchers, and local communities, are imperative for preserving habitats conducive to the sustenance of Oriental Honey-buzzard in the wintering habitats of Kalimantan Island, Indonesia.

Conclusions

The investigation of land-cover in Kalimantan for three distinct years, 2003, 2006, and 2009, revealed substantial trends. Kalimantan's landscape is dominated by forest cover, emphasizing the importance of the island's ecosystem. Other land-cover types, such as wetlands, mangroves, shrublands, open ground, and peat, have decreased in area throughout these years, raising concerns about the survival of the Oriental Honey-buzzard. These declining land-cover groups frequently included critical habitats for the species. Human development activities and land-cover changes have resulted in habitat fragmentation, which has impacted migration routes. Habitat degradation makes it difficult for the Oriental Honey-buzzard to locate critical resources, such as food and shelter, thereby increasing interactions with humans.

The presence of the Oriental Honey-buzzard revealed that the forest was continuously the species' preferred habitat across the three years. When forest cover fell, plantation and rice fields expanded, indicating significant landscape changes. However, more variables other than land-cover change, such as food availability, climatic conditions, and migration patterns, may impact bird existence. Migratory behavior studies have revealed that Oriental Honey-buzzards in Kalimantan migrated meanderingly, entering the west and exiting the island's east side, corroborating previous beliefs regarding their migration. During the four migration periods of 2003, 2006, and 2009, the duration of presence data for different land-cover types revealed that the forest had the longest presence duration. Mangroves and swamps, on the other hand, had no recorded presence, while the other groups had different periods. These findings highlight the significance of habitat preservation and management for ensuring the survival of the Oriental Honey-buzzard in Kalimantan.

References

1. Shuter, J.L.; Broderick, A.C.; Agnew D.J.; Jonzén, N.; Godley, B.J.; Milner-Gulland, E.J.; Thirgood, S. Conservation and management of migratory species. *Animal Migration* **2013**, *1,* 172–206, doi:10.1093/acprof:oso/9780199568994.003.0011.
2. Yamaguchi, N.; Tokita, K.I.; Uematsu, A.; Kuno, K.; Saeki, M.; Hiraoka, E.; Uchida, K.; Hotta, M.; Nakayama, F.; Takahashi, M.; et al. The large-scale detoured migration route and the shifting pattern of migration in Oriental Honey-buzzards breeding in Japan. *Journal of Zoology* **2008**, *276*, 54–62. doi:10.1111/j.1469-7998.2008.00466.x.
3. Cresswell, K.A.; Satterthwaite, W.H.; Sword, G.A. Understanding the evolution of migration through empirical examples. In *Animal Migration: A Synthesis*; Milner-Gulland, E.J., Fryxell, J.M., Sinclair, A.R.E.; Oxford University Press: Oxford, UK, 2013; pp. 6–16.
4. Decandido, R. Spring migration of Oriental Honey-buzzards *Pernis ptilorhyncus* and other raptors at Tanjung Tuan. *Forktail* **2006**, *22*, 156–160.
5. Li, Y.D. *An Introduction to the Raptors of Southeast Asia*; Nature Society (Singapore), Bird Group and Southeast Asian Biodiversity Society, Singapore, 2011; pp. 11–15.
6. Agostini, N.; Mellone, U. Migration strategies of Oriental Honey-buzzards *Pernis ptilorhyncus* breeding in Japan. *Forktail* **2007**, *23*, 182–183.

7. McClure, C.J.W.; Westrip, J.R.S.; Johnson, J.A.; Schulwitz, S.E.; Virani, M.Z.; Davies, R.; Symes, A.; Wheatley, H.; Thorstrom, R.; Amar, A.; et al. State of the world's raptors: Distributions, threats, and conservation recommendations. *Biological Conservation* **2018**, *227*, 390–402, doi:10.1016/j.biocon.2018.08.012.
8. Huang, K-Y.; Severinghaus, L. *Nest Provisioninc of The Oriental Honey-Buzzard (Pernis ptilorhyncus)*; Raptor Research Foundation, Inc: Taiwan, 2004;
9. Shi, X.U.; Xiao, X.; Zhao, X.; Sun, R.; Zhao, X.; Choi, C.Y.; Lin, W. Raptor migration at Guantouling, South-west China: phenology, weather influence and persecution pressure. *Bird Conservation International* **2023**, *33*, 1–14, doi:10.1017/S0959270921000356.
10. Bildstein, K.L. Long-Term Counts of Migrating Raptors: A Role For Volunteers In Wildlife Research. T*he Journal of Wildlife Management* **1998**, *62*, 435–445.
11. Newton, I. New insights on the ecology of bird migration. *Trends in Ecology & Evolution* **2005**, *20*, 292–293, doi:10.1016/j.tree.2005.01.013.
12. Safitri, R.; Vonnisa, M.; Marzuki, M. Analisis Dampak Perubahan Tutupan Lahan di Kalimantan Terhadap Temperatur Permukaan. *Jurnal Fisika Unand* **2022**, *11*, 173–179, doi:10.25077/jfu.11.2.173-179.2022.
13. Long, H.; Tang, G.; Li, X.; Heilig, G.K. Socio-economic driving forces of land-use change in Kunshan, the Yangtze River Delta economic area of China. *Journal of Environmental Management* **2007**, *83*, 351–364, doi:10.1016/j.jenvman.2006.04.003.
14. Yahya, H.M. Pemindahan Ibu Kota Negara Maju dan Sejahtera. *Jurnal Studi Agama dan Masyarakat* **2018**, *14*, 21–30, doi:10.23971/jsam.v14i1.
15. Gaveau, D.L.A.; Sloan, S.; Molidena, E.; Yaen, H.; Sheil, D.; Abram, N.K.; Ancrenaz, M.; Nasi, R.; Quinones, M.; Wielaard, N.; et al. Four Decades of Forest Persistence, Clearance and Logging on Borneo. *PLoS ONE* **2014**, *9*, 1–11.
16. Prasetyo, L.B. *Pendekatan Ekologi Lanskap Untuk Konservasi Biodiversitas*; Fakultas Kehutanan IPB: Bogor, ID, 2017; ISBN 978-979-9337-67-2.
17. Kahono, S.; Prawiradilaga, D.M.; Peggie, D.; Erniwati, E.; Sulistyadi, E. First Report on Hunting Behavior of Migratory Oriental Honey-buzzard (Pernis *ptilorhynchus orientalis*) Towards Migratory Giant Honeybee (Apis *dorsata dorsata*) (Hymenoptera: Apidae) on Java Island, Indonesia. *Treubia* **2020**, *47*, 123–132, doi:10.14203/treubia.v47i2.4005.
18. Ameliawati, P. Pemodelan Distribusi Habitat Musim Dingin dari Raptor Migran Sikep-madu Asia (*Pernis ptylorhynchus*) di Jawa Barat Berbasis Data Satellite-tracking. Thesis, IPB University, Bogor, ID, 2014.
19. Syartinilia; Makalew, A.D.N.; Mulyani, Y.A.; Higuchi, H. Landscape characteristics derived from satellite-tracking data of wintering habitats used by oriental honey buzzards in Borneo. *Landscape and Ecological Engineering* **2015**, *11*, 61–71, doi:10.1007/s11355-013-0237-4.
20. Syartinilia; Rafael, R.N.; Higuchi, H. Perilaku Migrasi Sikep Madu-Asia dalam Pemanfaatan Lanskap di Flores Bagian Timur, Indonesia Berdasarkan Data Satellite-tracking. *Journal of Natural Resources and Environmental Management* **2020**, *10*, 479–488, doi:10.29244/jpsl.10.3.479-488.
21. Condro, A.A.; Syartinilia; Higuchi, H.; Mulyani, Y.A.; Raffiudin, R.; Rusniarsyah, L.; Setiawan, Y.; Prasetyo, L.B. Climate change leads to range contraction for Japanese population of the Oriental Honey-buzzards: Implications for future conservation strategies. *Global Ecology and Conservation* **2022**, *34*, e02044, doi:10.1016/j.gecco.2022.e02044.
22. DeCandido, R.; Siponen, M.; Smit, H.; Pierce, A.; Allen, D. Flight Identification of the Oriental Honey-buzzard *Pernis ptilorhynus orientalis* in southern Thailand, 2007–2014. *BirdingASIA* **2015**, *23*, 27–33.
23. Sugasawa, S.; Higuchi, H. Seasonal contrasts in individual consistency of oriental honey buzzards' migration. *Biology Letters* **2019**, *15*, 1–5, doi:10.1098/rsbl.2019.0131.
24. Hobbs, N.T.; Galvin, K.A.; Stokes, C.J.; Lackett, J.M.; Ash, A.J.; Boone, R.B.; Reid, R.S.; Thornton, P.K. Fragmentation of rangelands: Implications for humans, animals, and landscapes. *Global Environmental Change* **2008**, *18*, 776–785, doi:10.1016/j.gloenvcha.2008.07.011.
25. Murcia, C. Edge effects in fragmented forests: implications for conservation. *Trends in Ecology & Evolution* **1995**, *10*, 58–62, doi:10.1016/S0169-5347(00)88977-6.

26. Laurance, W.E.; Yensen, E. Predicting the Impacts of Edge Effects in Fragmented Habitats. *Biological Conservation* **1991**, *55*, 77–92, doi:https://doi.org/10.1016/0006-3207(91)90006-U.

27. Syartinilia; Farisi, G.H.A.; Higuchi, H. Landscape Characteristics of Oriental Honey Buzzards Wintering in Western Part of Flores Island Based on Satellite-Tracking Data. *IOP Conference Series: Earth and Environmental Science* **2017**, *91*, 012031, doi:10.1088/1755-1315/91/1/012031.

28. Mustofa; Syartinilia; Arifin, H.S. Model spasial distribusi habitat orangutan kalimantan (*Pongo pygmaeus* wurmbii) menggunakan logistik regresi di DAS Katingan. *Journal of Natural Resources and Environmental Management* **2020**, *10*, 627–638, doi:10.29244/jpsl.10.4.627-638.

30. Olsson, K.H.; Weiss, N.; Shalev, S.; Schäckermann, J. Spread of the Invasive Dwarf Honey Bee Apis florea Facilitates Winter Presence of Oriental Honey Buzzard *Pernis ptilorhynchus* in Eilat, Israel. *Acta Ornithologica* **2021**, *56*, 189–198, doi:10.3161/00016454AO2021.56.2.005.

29. Howes, C.; Byholm, P.; Symes, C. Forest Availability and Fragmentation Drive Movement Behaviour of Wintering European Honey-buzzard Pernis apivorus in Africa. *Ardea* **2020**, *108*, 115–128.

30. Syartinilia; Mulyani, Y.A.; Makalew, A.N.D.; Higuchi, H. Modeling the Wintering Habitat Distribution of Oriental Honey Buzzards in West Java Indonesia with Satellite Tracking Data Using Logistic Regression. *HAYATI Journal of Biosciences* **2022**, *29*, 9–21, doi:10.4308/hjb.29.1.9-21.