IMPACT OF LAND USE LAND COVER CHANGES ON WILDLIFE PRESENCE IN ENDAU ROMPIN JOHOR (PETA) NATIONAL PARK

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Abstract *Endau-Rompin Johor (Peta) National Park (ERJNP) in Johor, Malaysia, is a protected areas (PAs) with major biodiversity that protects endangered species. This study hypothesizes that anthropology activities and rural area development surrounding the area has change the land use patterns that altering the wildlife presence of the area. Land use land cover of year 2016 and 2020 were classified using Random Forest approach on multi-temporal Landsat 8. In this study, camera traps dataset of four different places along a "logging road" as a forest corridor to monitor wildlife presence trends. These sites were chosen due to the land use land cover of this area has high potential of changes as it was a location for human or wildlife to commute called as "permatang". Land use land cover change detection was employed to identify the land use land cover change between year 2016 and 2020. The one-way ANOVA was utilized to identify the significant impact of the land use changes on wildlife presence in the area. Result shows that there was significant (F=237.44, p-val: <0.001) impact of LULC changes on wildlife presence. Results suggested that the land use changes of surrounding the ERJNP may cause in effectiveness as wildlife habitat conservation.*

Keywords: Forest changes, wildlife presence, tropical rainforest, remote sensing, geospatial approach

Introduction

Land use land cover (LULC) changes in of tropical rainforest in Malaysia have been increasingly monitored using remote sensing technology, facilitating accurate and timely detection of spatial changes. Numerous of remote sensing analysis using multiple types of remotely sensed data combined with machine learning classifiers such as Random Forest revealed a decline in total forest cover (Hassan & Abdullah, 2023). This reduction in forested areas highlights ongoing deforestation pressures, possibly from agricultural expansion and other anthropogenic activities near or within the park's boundaries. Such changes threaten the ecological integrity of this protected area and can directly impact habitat availability for wildlife populations that depend on contiguous forest ecosystems for survival and movement within wildlife corridors (Sin Foo & Numata, 2019).

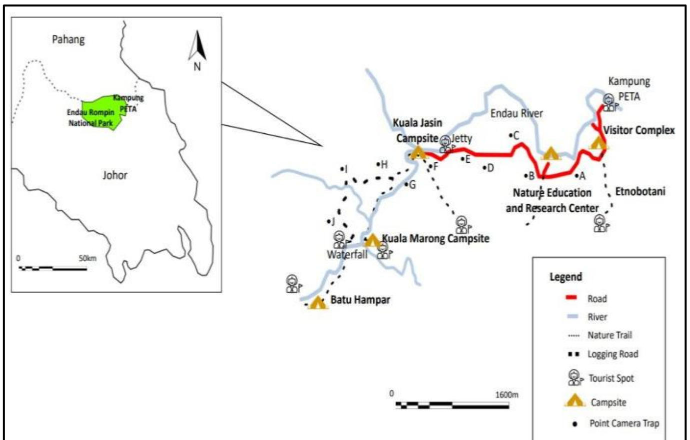
The use of advanced remote sensing techniques allows ecologists and conservationists to track changes not only in forest quantity but also in forest quality and fragmentation patterns. Increased fragmentation resulting from LULC changes can isolate wildlife populations and prevent gene flow, which is essential for maintaining viable populations. Agricultural encroachment and development often replace natural habitats with less hospitable land covers, which reduces the diversity of species that the habitat can support (Chaplin-Kramer et al., 2015). Moreover, fragmentation increases edge effects, where altered conditions along habitat borders may lead to increased predation, microclimate changes, and exposure to invasive species, further destabilizing wildlife populations. The accuracy of remote sensing classifications improves decision-making for conservation management by quantifying these risks spatially and temporally (REF).

Land cover transitions toward more agricultural or developed uses near the park can increase the frequency of encounters between humans and wildlife, leading to conflicts that often result in wildlife mortality or displacement (REF). By detecting and mapping changes in land cover, remote sensing can help identify high-risk zones where mitigation strategies such as buffer zones or community outreach programs may be implemented. This proactive approach aligns with conservation goals to balance human needs and wildlife protection, by understanding spatial patterns of land use pressure that threaten the park's biodiversity and endemic species.

This approach drives adaptive management and policy formulation for Endau-Rompin Johor (Peta) National Park by providing empirical, up-to-date data on landscape change and its consequences for wildlife presence. The ability to project future scenarios of LULC change based on recent trends enables conservation strategists to prioritize critical habitats for protection and restoration. Moreover, integrating remote sensing data with ground surveys enhances validation and fine-tuning of conservation actions tailored to prevent further habitat loss and fragmentation. Protecting this biodiversity hotspot requires continuous monitoring facilitated by remote sensing tools to ensure long-term ecological sustainability and wildlife conservation within this vital national park.To address these problems and provide data-driven conservation management suggestions, this study objectives are (1) to identify the LULC changes occurrences in Endau-Rompin (Peta) National Park from 2016 to 2020. This entails measuring the extent of forest loss, agricultural expansion, and other land cover changes using geospatial approaches. While objective (2) to investigate how LULC changes between 2016 and 2020 affect the frequency (presence) of wildlifes along the forest corridor. This study investigates the link between habitat modification and species presence as recorded at camera trap locations, revealing how different levels of disturbance to habitat impact biodiversity patterns in relation to infrastructure categories.

Study Area

The study was in Endau-Rompin Johor (Peta) National Park, established in 1993, is a vast protected area covering approximately 48,905 hectares (about 489 square kilometers) in the northeastern part of Johor, Malaysia. It is the largest protected area in the southern half of Peninsular Malaysia. The park was managed by Johor National Park Corporation (JNPC)The park features an ancient rainforest that is one of the last remaining large tracts of pristine lowland tropical rainforest in the region. It is known for its rugged wilderness, pristine rivers, and spectacular waterfalls. Biodiversity in the park is exceptionally rich, harboring a wide variety of species, including critically endangered megafauna such as the Malayan Tiger, Malayan Tapir, and Asian Elephant. The park is home to 149 mammal species across 11 orders, including Carnivora, Cetartiodactyla, Chiroptera, Dermoptera, Eulipotyphla, Perissodactyla, Pholidota, Primates, Proboscidea, Rodentia, and Scandentia, as reported by Aihara et al. (2016), highlighting the diverse mammalian fauna inhabiting Endau-Rompin Johor (Peta) National Park.



(Figure from Salleh et. al.

Figure 1: Location of study area. The study area was in Endau-Rompin Johor (Peta) National Park which focused on logging road.

Materials and Methodology

a. Materials

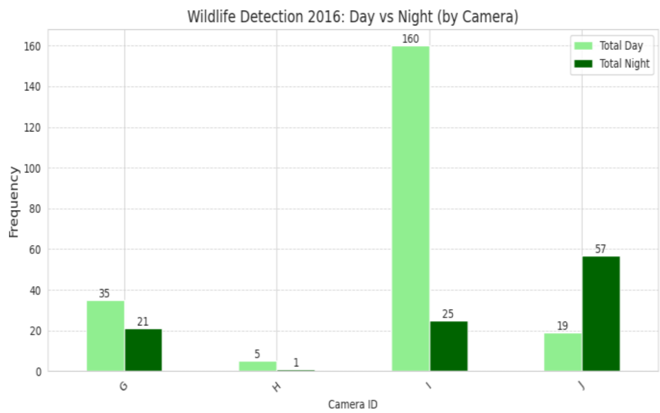
Remotely sensed data

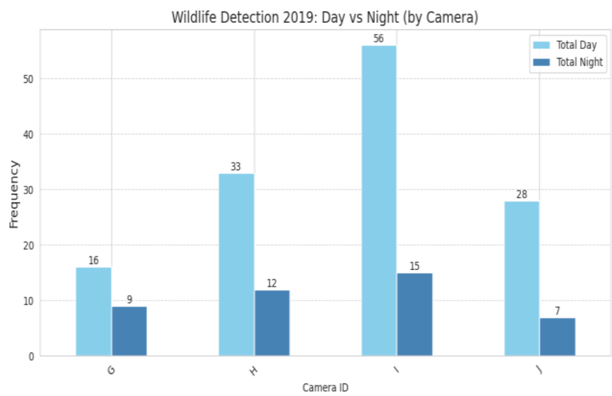
Land use/cover categorization was performed using Landsat 8 OLI (Operational Land Imager) data at a spatial resolution of 30 meters. The data were acquired from year 2016 to 2020. The satellite imagery, obtained from the USGS Earth Explorer (http://earthexplorer.usgs.gov/). Multispectral Landsat 8 images were gathered over a decade, with cloud cover kept below 30% to maintain image quality. Additional preprocessing processes were performed to increase the image's quality and enable accurate land use/cover categorization. Landsat 8, which includes OLI and TIRS sensors, collects data in 11 spectral bands, resulting in improved radiometric performance and a 12-bit dynamic range. Pan sharpening was employed to improve the spatial resolution of the multispectral Landsat8 imagery. This approach sharpens the multispectral picture by employing a panchromatic image with increased spatial resolution. Panchromatic and multispectral images were combined to obtain higher-resolution true-color photographs. To achieve proper alignment, the images were co-registered. Each channel (Red, Green, and Blue) was assigned to a separate band and produced various combinations of the true-color and false-color composites of the study region. The composite image is then subset into the research region to accelerate image processing and analysis. In this study, a pan- sharpening technique was employed using Landsat Band 8 to further enhance the quality of the images. By utilizing Landsat Band 8 for pan-sharpening, a higher level of detail and clarity was achieved in the images. This improved spatial resolution played a crucial role in accurately identifying and distinguishing different land cover classes. The enhanced image quality facilitated better interpretation and classification of the land use land cover types within the study area. The cloud removal approach is one of the radiometric adjustments required before image processing can begin to accurately categorize the features (Gilbertson et al., 2017).

Camera trapping dataset

The position of camera traps provides the key data for analyzing wildlife occurrence. When a wildlife crosses within their detecting range, these isolated devices' advanced motion and heat sensors start to record a picture or video. When applied scientifically and with appropriate spatial distribution, this method has the potential to produce precise predictions of species density or relative occurrence within a defined ecological area. Its non-invasiveness, direct photographic evidence of species presence, and detailed insights into wildlife activity patterns are just a few of its benefits. For the temporal examination of wildlife activity, time stamps on camera trap data are particularly important.

The temporal dimension of wildlife activity is the subject of this study, which classifies and counts wildlife detections from camera trap film according to whether they were present during the day or night hours in 2016, 2019, and 2020. A midpoint reference for observing any trends or transitional changes over the research period is provided by 2019. A thorough comparison of the three years' worth of activity patterns is made possible by this temporal split. Understanding species- specific activity patterns and potential resource distribution throughout time, as well as how these patterns may change over time or in reaction to human disturbance levels or shifting environmental circumstances, is the aim. 2019 is included in the study to help determine if the reported behavioural changes are abrupt, gradual, or related to certain human or environmental occurrences.





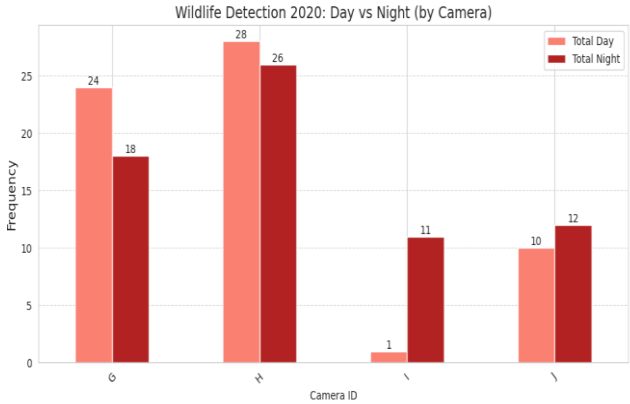


Figure 2: Camera trapping datasets of year (a)2016, (b) 2019 and (c) 2020 for day and night.

Figure 2 show the specific number of day and night detections for each camera (G, H, I, J) in each year. For instance, in 2016, Camera I showed very high day activity, while Camera J recorded more night detections. This section describes the analysis, which aimed to identify and quantify the total number of different wildlife detections or the frequency of occurrence for distinct species at every recorded trap location throughout the research years (2016 and 2020). This includes aggregating the processed camera trap data to identify which trap sites produced the highest counts of each species or the greatest overall species richness (number of species identified). The goal is to identify regions of intense wildlife activity or considerable biodiversity benefits on a local level.

b. Methodology

Random Forest Classification

The Landsat-8 OLI of year 2016, 2019 and 2020 were classified by the supervised classification utilising the Random Forest algorithm (Figure 3). User-defined sample locations, or training sites, that match each unique Land Use/Land Cover (LULC) category such as Forest, Agriculture, Water Body, and Bareland were used to train this machine learning approach. After learning the spectral characteristics of these classes, the algorithm uses this knowledge to classify the entire image and produce an extensive LULC map. Due to the ability of Random Forest to handle high-dimensional data, stability, and resistance to overfitting, the Random Forest approach is especially popular for categorizing land cover from intricate remote sensing imagery.

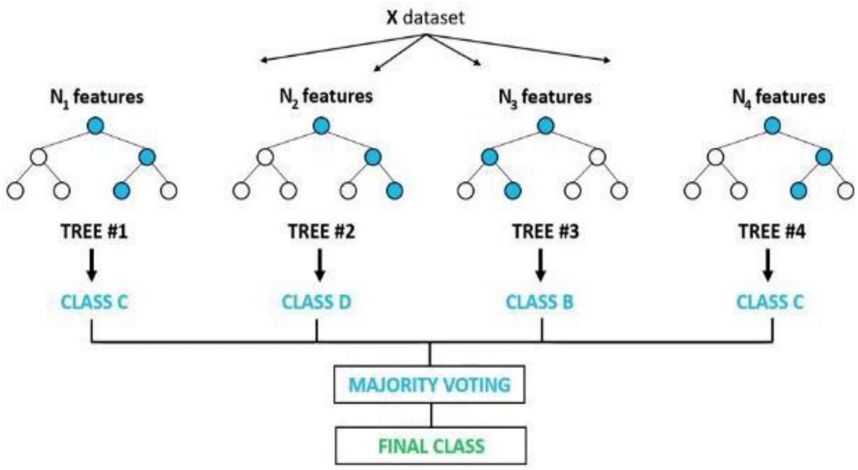


Figure 3 : Random Forest conceptual framework

Random forest classification accuracy assessment

Accuracy evaluation in remote sensing is an important step in determining the dependability of a classified land use/land cover (LULC) to a reference dataset. It contributes to determining how well satellite data categorization corresponds to actual ground truth information. This procedure usually involves calculating overall accuracy, producer and user accuracy, and examining both errors and mistakes (Olofsson et al., 2014). In this study, accuracy was evaluated by utilizing confusion matrix approach based on total accuracy and the kappa statistic. The total accuracy of the map is obtained by comparing the proportion of properly identified pixels to the reference data. The total accuracy of the map is obtained by comparing the number of properly identified pixels to the reference data. The kappa statistics are used to assess the level of agreement between the classification and reference datasets, by taking consideration the likelihood of random chance agreement (Feizizadeh et al., 2022). The accuracy assessment was conducted on image classification employed to image of 2026, 2019 and 2020.

Endau-Rompin (Peta) National Park land use changes

Change detection was accomplished by analyzing two or more satellite images of the same region obtained at various times and comparing the final classification maps pixel-by-pixel. This technique identifies changes in land use and land cover (LULC) throughout time. Change detection was carried out utilizing the findings of Random Forest classification applied to Landsat-8 OLI imagery. A simple mathematical combination of pixels was used to compare the independently created classifications from several time points. This approach generated a matrix of change classes that reflected the variations in LULC. The area of change in each LULC class during a ten-year period was computed using ArcGIS's "Tabulate Area" feature.

The whole spatial size of the research region was precisely calculated for each of the following years: 2016, 2019, and 2020, to provide an effective foundation for corresponding analysis. This involved adding up the area values for every year's established land use/land cover (LULC) classes that were determined using Random Forest (RF) classification. The percentage share of each LULC category was calculated using the total area computation as a guide. The following formula was used to determine each class's percentage:

$$Percentage\ of\ LULC\ Class = \left(\frac{\text{Area of Specific LULC Class}}{\text{Total Study Area for that Year}}\right) \times 100\%$$

The changes over the forested area were identified based on the land used changes analysis. Thus, the impact of land use changes on wildlife presence over the area were analyzed by using one-way ANOVA analysis.

Results and Discussion

a. Endau Rompin (PETA) Land Use Land Cover Changes (2016-2020)

Results shows that land cover has changed over time and between various categories in a consistent way (Table 1). The main land cover type in 2016 was forest, which made up 155,625.43 hectares, or 92.93%, of the studied area. 8,307.93 hectares (4.96%) were covered by agricultural land, while 3,219.05 hectares (1.92%) were made up of built-up or barren land. With a total area of 1,204.29 hectares, or 0.72%, water bodies were the least extensive. The amount of forest cover had drastically decreased by 2019 to 140,582.29 hectares (around 83.50%), reflecting the first signs of land conversion or deforestation. There was a significant increase in bare land to 5,136.99 hectares (about 3.05%) and agriculture to 16,246.57 hectares (approximately 9.65%). A little expansion of water bodies was also seen, reaching 1,336.86

hectares (around 0.79%).

Table 1: Land use land cover changes for year 2016, 2019 and 2020 based on Random Forest classifier.

Class	Area (ha)_2016	%_2016	Area (ha)_2019	%_2019	Area (ha)_2020	%_2020
Forest	155625	92.93%	140582	86.09%	141160	84.28%
Agriculture	8307.92	4.96%	16246.6	9.95%	18169.9	10.84%
Built up/ Bare L	3219.05	1.92%	5136.99	3.15%	7422.66	4.43%
Water Body	1204.29	0.72%	1336.86	0.82%	1604.59	0.96%
Total	167757	100.00%	163303	100.00%	168357	100.00%

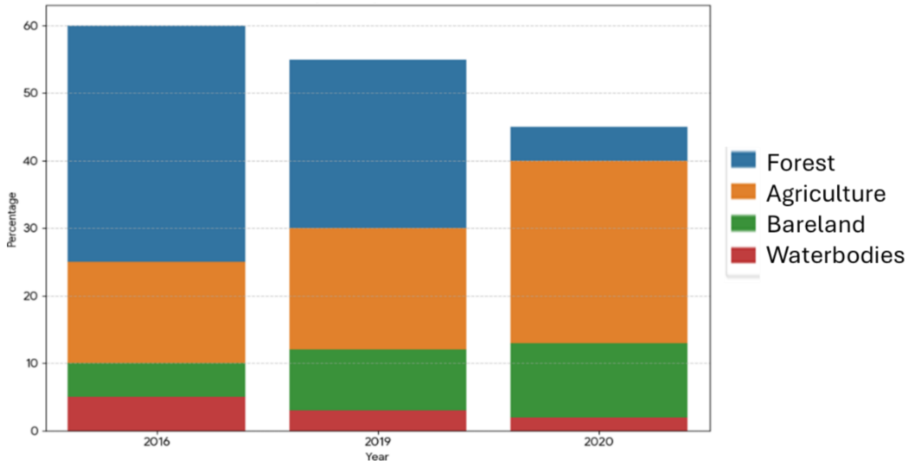


Figure 4: Land use land cover changes for each year indicate that the forested areas has changed over time into agricultural and rural areas development.

This pattern of expanding human-modified land covers and decreasing forest cover persisted by 2020 (Figure 4). 141,159.53 hectares (84.28%) of forest area recovered somewhat from 2019; this might be due to replanting or changes in mapping. Agriculture occupied 18,169.92 hectares (10.84%), continuing its rising trend. The amount of bare and built-up land increased to 7,422.66 hectares (4.43%). The increase in water bodies to 1,604.59 hectares (0.96%) may indicate better detection or natural hydrological change. All things considered, the 2016–2019–2020 statistics show a distinct trend of declining forest dominance and increasing human influence on the terrain.

b. Impact of Land Use Land Cover Changes on Wildlife Presence

The temporal changes of wildlife observations (Figure 5) show wildlife presence changed over the course of 2016, 2019, and 2020 across several locations. A constant and comparable level of wildlife presence is clearly suggested by the box plots' close closeness in median lines and overlapping interquartile ranges in 2016 and 2019. During these years, most of the wildlife was between 180 and 210 individuals. The statistical study, which produced a p-value of 0.3257, confirming this visual consistency, showed no statistically significant variation in the mean wildlife presence between 2016 and 2019. The 2020 box plot, on the other hand, is significantly smaller and completely non- overlapping with those of the previous years. With observed counts mostly limited to a range of 80– 95 individuals, this significant change indicates a sharp drop in wildlife presence. Therefore, the plot provides strong evidence of a significant drop in wildlife populations in 2020, which encourages more research into possible contributing variables.

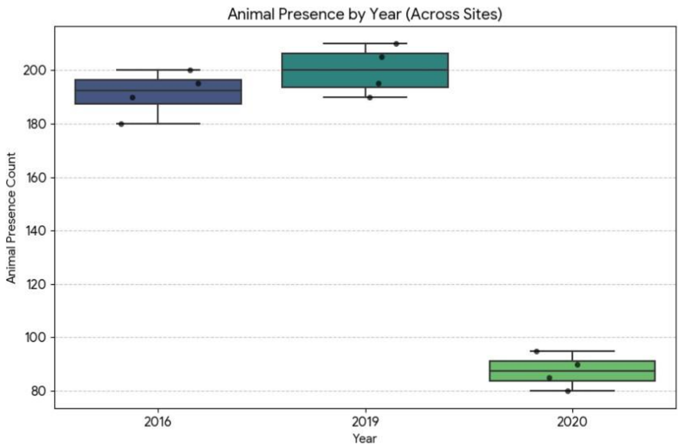


Figure 5: Wildlife presence according to year 2016, 2019 and 2020.

The one way ANOVA analysis (F=237.44, p-val: <0.001) suggests that the variation within each year is significantly smaller than the difference in wildlife presence between the years (2016, 2019, 2020). We consequently firmly reject the null hypothesis that there is no variation in the mean wildlife presence throughout the years considering this strong statistical evidence. The result shows that there is substantial evidence that the mean wildlife presence in 2016, 2019, and 2020 varies considerably from one another. Compared to previous years, the dramatic drop shown in 2020 is statistically significant.

Land Use Land Cover (LULC) changes (Figure 4) are a highly likely contributing reason to the statistically proven and visually obvious substantial drop in wildlife occurrence in 2020, which strongly implies underlying biological processes. For example, a current LULC study might directly contribute to the observed dramatic loss in wildlife presence if it shows a decrease in forest cover and a comparable rise in agricultural area inside or near Endau-Rompin Johor (Peta) National Park (Hassan & Abdullah, 2023). Critical problems including habitat loss, ecological fragmentation, disturbance of wildlife corridors, and heightened human-wildlife conflict are brought on by such LULC changes and are known to have negative impacts on wildlife populations (Muleta Gurmessa et al., 2024). As a result, the patterns in this plot, which are strongly backed by the p-value and F-statistics, act as a powerful signal that demands exact connection with comprehensive LULC change data. The abrupt and drastic decline in wildlife populations in 2020 clearly implies that these LULC changes are a main factor impacting the adaptability of the wildlife population within the research region, even if a direct causal relationship requires more thorough geographical assessment.

Discussion

The changes pattern of wildlife habitat was found when the Land Use Land Cover (LULC) changes in Endau-Rompin Johor (Peta) National Park were analysed between 2016 and 2020. Dense forest cover steadily declined from 92.93% in 2016 to 83.50% in 2019, stabilising at 84.28% in 2020, according to our LULC maps, which were created from Landsat 8 images using Random Forest categorization. The proportion of human-modified landscapes also increased significantly over this time, rising from 4.96% to 10.84% for agricultural regions and from 1.92% to 4.43% for bareland. This obvious change in land cover, which is visually verified by LULC change maps and measured by area data, suggests that human pressures on this crucial hotspot for biodiversity are growing.The concept that habitat degradation carried on by LULC change has a negative impact on wildlife is clearly supported by the fact that camera traps beside concrete roads, which are associated with significant forest loss, recorded fewer species. On the other hand, regions surrounding logging roads with less LULC change maintained greater species richness, highlighting the significance of intact ecosystems.

Conclusion and Recommendation

This study concludes that, between 2016 and 2020, there was a strong correlation between the quantity of wildlife in Endau-Rompin Johor (Peta) National Park and changes in Land Use Land Cover (LULC). Our results demonstrate a distinct pattern of decreasing forest habitat accompanied by an increase in bareland and agricultural land, showing an increase in landuse changes caused on by humans. The biodiversity of the park has been significantly impacted by this methodical environmental change. The most important conclusion is that, after a period of general stability, there was a statistically significant and observable rapid fall in the overall wildlife presence in 2020. The rapid decrease is closely related to the concurrent LULC changes since wildlife detections were lower in locations with major habitat loss (such as those close to concrete roadways) and higher in regions with less LULC alteration. Thus, it is determined that one of the main causes of negative impacts on wildlife populations is the conversion of natural forest into other land uses. This highlights the urgent need for strong conservation plans and sustainable land management techniques to preserve the priceless ecological integrity of Endau-Rompin Johor (Peta) National Park and its endangered species.

Acknowledgement

This research is funded by UTM Fundamental Research (UTMFR) grant, Vot Q.J130000.3852.22H69. We also would like to acknowledge Tokyo Metropolitan University, Japan for camera trapping data support and acknowledge Johor National Park Corporation (PTNJ) and Department of Wildlife and National Park (PERHILITAN) for the permission to conduct this study in Endau-Rompin Johor (Peta) National Park.

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