

Mapping mammal diversity in the Central Highlands and South Central Coast of Vietnam

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Xây dựng bản đồ đa dạng các loài thú tại khu vực Tây Nguyên và Duyên hải Nam Trung Bộ, Việt Nam

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ABSTRACT

This study constructed and analyzed spatial diversity maps of mammalian species to enrich biodiversity information and assess diversity levels based on the distribution data of mammals in the Central Highlands and South Central Coast of Vietnam. The research utilized mammal spatial distribution maps from the IUCN Red List of Threatened Species as input data. Species maps were overlaid, analyzed, and synthesized using GIS software for comprehensive analysis. Additionally, the study developed a species richness map specifically for threatened mammalian species in the region. Key findings revealed that the Central Highlands and South Central Coast of Vietnam exhibit high mammalian diversity, with 187 species. The area with the highest diversity supports up to 122 species, while the least diverse area includes only 75 species. High-diversity regions are primarily concentrated in the Kon Tum and Da Lat plateaus. Mountainous and plateau regions support greater species diversity, whereas coastal areas exhibit the lowest diversity levels. A total of 64 threatened mammal species were identified within the Central Highlands and South Central Coast regions. The most diverse areas support up to 35 threatened species, while the least diverse areas host 15 species. These findings contribute to the understanding of the region's biodiversity, offering valuable insights to inform conservation planning and the development of effective management strategies.

TÓM TẮT

Nhằm bổ sung thông tin sự đa dạng sinh học của một số khu vực tại Việt Nam, trong nghiên cứu này, chúng tôi đã tiến hành xây dựng bản đồ đa dạng cho các loài thuộc lớp thú tại khu vực Tây Nguyên và Duyên hải Nam Trung Bộ. Nghiên cứu đã sử dụng các dữ liệu đầu vào là bản đồ phân bố từng loài thú từ Sách đỏ IUCN về các loài bị đe dọa. Các bản đồ của từng loài thú đã được chồng ghép, phân tích, tổng hợp cùng với các lớp bản đồ khác bằng các phần mềm GIS. Đồng thời, chúng tôi cũng xây dựng bản đồ đa dạng cho các loài thú quý hiếm có phân bố tại khu vực nghiên cứu. Kết quả chính nghiên cứu cho thấy, tại khu vực Tây Nguyên và Duyên hải Nam Trung Bộ có mức độ đa dạng các loài thú rất cao với 187 loài. Trong đó, vùng có mức độ đa dạng các loài thú lớn nhất là 122 loài, ít đa dạng nhất là 75 loài. Các khu vực có mức độ đa dạng cao tập trung ở cao nguyên Kon

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Loài quý hiếm, Nam Trung Bộ, Tây Nguyên, thú, xây dựng bản đồ.

Tum và cao nguyên Đà Lạt. Mức độ đa dạng các loài thú cũng phân hóa theo khu vực, càng lên các khu vực cao như vùng núi, cao nguyên có mức độ đa dạng các loài thú càng tăng lên, khu vực ven biển là nơi có mức độ đa dạng thấp nhất. Đối với các loài thú quý hiếm có giá trị bảo tồn cao, nghiên cứu đã xác định được có 64 loài. Các khu vực đa dạng nhất là nơi có phân bố của 35 loài thú bị đe dọa khác nhau, trong khi khu vực ít đa dạng nhất có 15 loài. Kết quả nghiên cứu đã bước đầu góp phần trong việc bổ sung thông tin về mức độ đa dạng sinh học cho khu vực Tây Nguyên và Nam Trung Bộ, từ đó có thể giúp các nhà quản lý đưa ra được những kế hoạch và chiến lược bảo tồn hợp lý.

1. INTRODUCTION

Under the impact of anthropogenic disturbance and climate change, the decline in biodiversity over recent decades is extremely concerning. However, our knowledge of the distribution of biodiversity remains very limited. Understanding the patterns of biodiversity is a key factor in guiding species conservation strategies, habitat preservation, and ecosystem restoration [1]. Therefore, studying the distribution pattern of natural biodiversity is crucial for research programs and management policies [2, 3]. Recently, increasing attention has been directed toward using maps to tackle the challenges of protecting biodiversity [4-6].

Establishing species diversity maps involves building, searching for, and compiling data about species' distribution and representing them systematically. Recently, the application of information technology in biodiversity management, particularly Geographic Information Systems (GIS), has become increasingly widespread due to its convenience, accuracy, ability to store large amounts of information, and ease of data retrieval, updating, and editing. Numerous studies have focused on developing databases for the distribution of one or multiple animal species, increasingly highlighting their advantages [4, 6, 7]. Distribution data, containing both spatial and non-spatial information across multiple layers, provides viewers with a comprehensive overview of species distribution. It serves as a vital

database for identifying priority areas for conservation [7].

The Central Highlands and South Central Coast of Vietnam, with diverse terrain and a large mountainous area, exhibit unique biodiversity, particularly in mammal species [5, 8, 9]. However, it should be noted that the fauna in Vietnam is undergoing a significant decline due to human activities and environmental impacts [10]. Mammals are a highly diverse group in the Central Highlands and South Central Coast, and they also possess large biomass and high economic value, leading to extensive exploitation, especially of large mammals [11]. This exploitation has considerably affected ecological balance and mammalian diversity. However, no studies have been conducted to develop distribution data for mammal species in the region, while most research has focused on the mammalian fauna and identifying species in the area. Given the current situation, the research "Mapping Mammal Diversity in the Central Highlands and South Central Coast of Vietnam" is necessary and highly meaningful in practical terms. The study aims to create a map of mammal species diversity, then identify areas that should focus conservation efforts. This study will serve as a foundation to help conservationists, and managers address issues related to mammal conservation in the region and make informed strategic development decisions.

2. RESEARCH METHODS

2.1. Materials

The study area: The research only processes data within the terrestrial boundaries of the provinces in the Central Highlands (including Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong provinces) and South Central Coast regions of Vietnam (including Khanh Hoa, Ninh Thuan, Binh Thuan, Quang Nam, Quang Ngai, Binh Dinh, and Phu Yen provinces, and Da Nang city).

Mammal species maps were downloaded from the website <http://www.iucnredlist.org> in the polygon format on 22th December 2024. Then, these maps were clipped according to the boundaries of the Central Highlands and South Central Coast regions. Furthermore, we also verified the distribution

of mammal species with the distribution region of each species outlined in Francis (2019) [12], Nguyen & Le (2009) [13], and Dang et al. (2008) [14]. The boundaries of protected areas were downloaded from the website: <https://www.protectedplanet.net>.

2.2. Data analyses

2.2.1. Developing distribution map for mammal species

The process of developing mammal distribution maps in the Central Highlands and South Central Coast regions is carried out according to the following workflow (Figure 1).

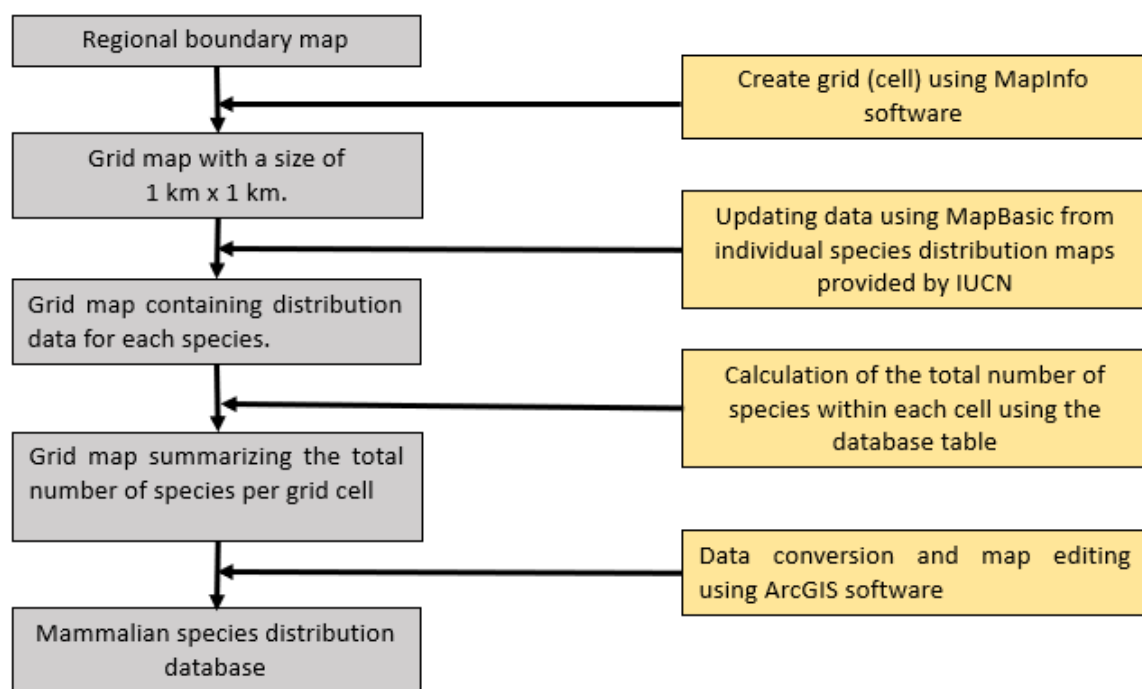


Figure 1. Workflow for developing distribution data for mammal species in the Central Highlands and South Central Coast

We created 103,233 cells with dimensions of 1 km x 1 km (Figure 02) using MapInfo software for the entire Central Highlands and South Central Coast regions. Then, after overlaying all species maps on the study area, to represent diversity levels, the maps were

integrated by assigning the species data from each map to the grid cells across the region, with the support of MapBasic software. For cells located within a species' distribution range, the corresponding field value for that species was updated to 1; otherwise, it was

set to 0. The resulting dataset for each grid cell includes information about the total number of species and a list of mammal species distributed within that cell. Finally, we edited the mammal diversity map using

ArcMap 10.5 software. The total number of species was calculated based on the species whose distribution overlaps the boundary of the Central Highlands and the South Central Coast.

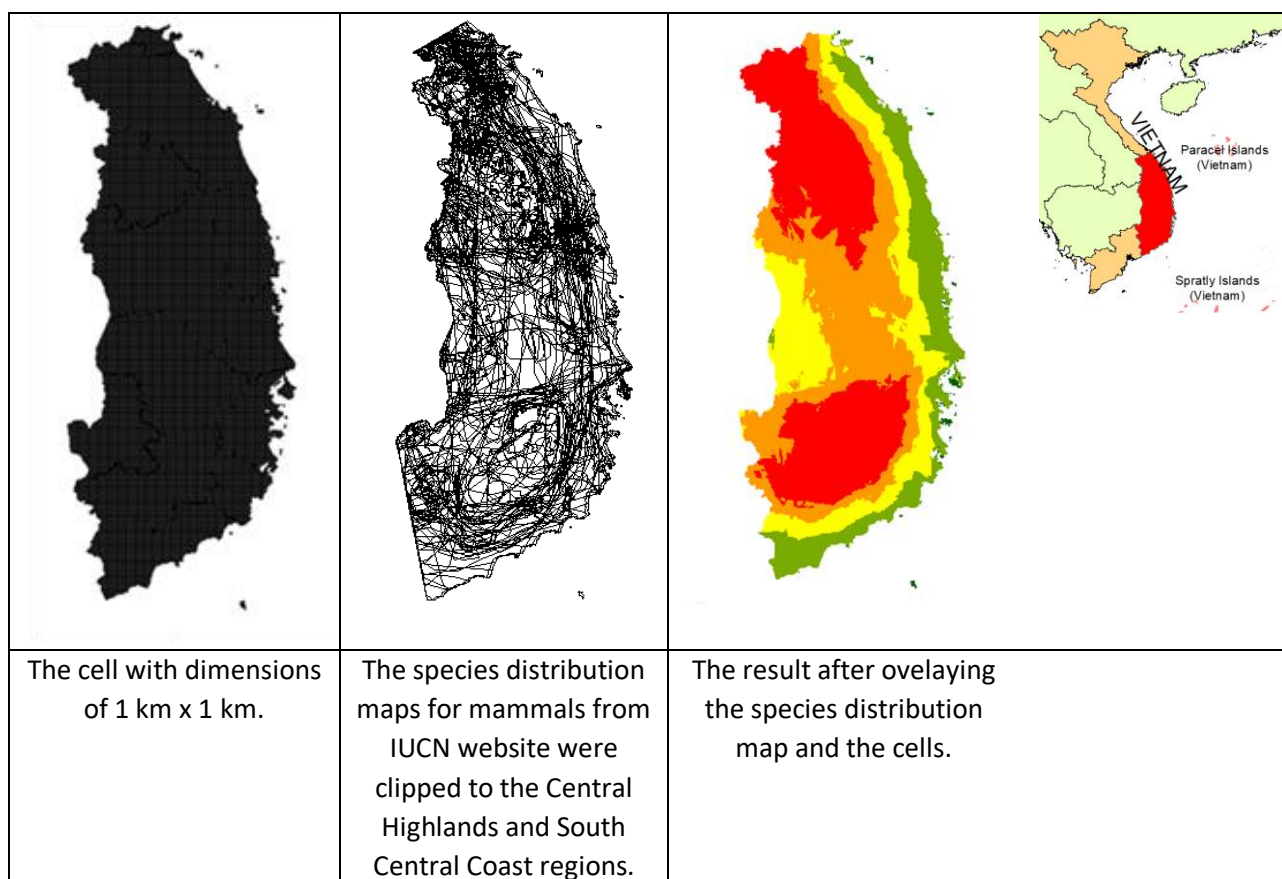


Figure 2. The illustration for creating mammal distribution map in Cental Highlands and South Central Coast regions

The study classified the species richness of mammal species distributed in the Central Highlands and South Central Coast regions based on the following classification scale: very low (76–84 species); low (85–94 species); medium (95–104 species); high (105–114 species), and very high (>115 species).

2.2.2. Developing distribution map for threatened mammal species

We used three criteria for identifying threatened mammal species distributed in the Central Highlands and South Central Coast of Vietnam: the IUCN Red List of Threatened Species (2025) [15], the Vietnam Red List of

Threatened Species (2024) [16], Decree No. 84/2021/ND-CP [17], and Decree No. 64/2019/ND-CP [18]. In the IUCN Red List of Threatened Species (2024) and Vietnam Red List of Threatened Species (2024), the species is considered as a threatened species if the species is listed as Vulnerable, Endangered, or Critically Endangered. The process of compiling distribution data for these threatened species followed the procedure for creating distribution maps for mammals (section 2.2.1). The species richness of threatened mammal species was also equally categorized into five levels: very low (<15 species); low (15–19

species); medium (20–24 species); high (25–29 species), and very high (≥ 30 species). Additionally, we integrated the boundary maps of protected areas with the distribution maps of mammal species to identify priority regions for mammal conservation.

3. RESULTS AND DISCUSSION

3.1. Mammalian diversity map in the Central Highlands and South Central Coast

We identified a total of 187 mammal species distributed across the Central Highlands and South Central Coast regions of Vietnam. The order Chiroptera includes the highest number of species, with 66 recorded, followed by Rodentia with 48 species and Carnivora with 31 species. In contrast, the orders Dermoptera, and Proboscidea have the fewest representation, with only one species in each order (Figure 3).

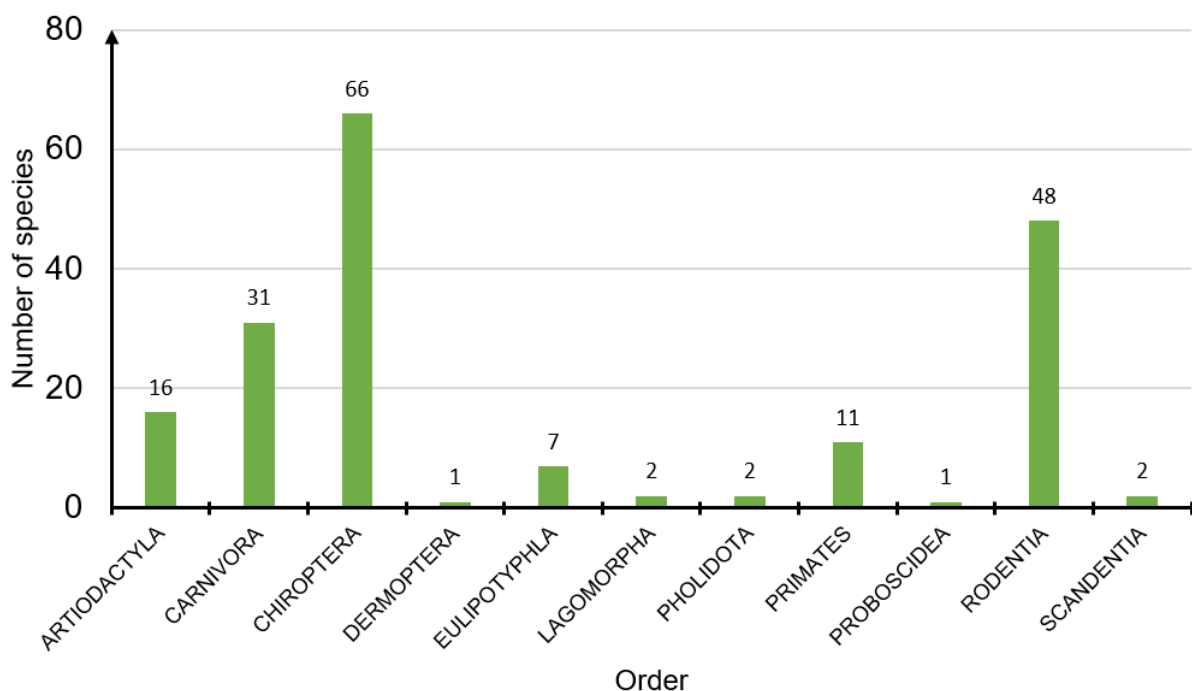


Figure 3. Mammalian Species Count by Order in the Central Highlands and South Central Coast

The cells with the highest number of mammal species contain 122 species, while the cells with the lowest diversity have 75 species. Furthermore, the proportion of grid cells with medium and high species diversity is the largest, accounting for 31.6% and 36.94% of the total cells, respectively (corresponding to 32,618 and 38,134 cells). The very low diversity level accounts for a small fraction, approximately 4% of the total grid cells. Meanwhile, low and very high diversity levels are relatively balanced, each representing about 13% of the total grid cells (Figure 4). The

low diversity level is primarily concentrated along the coastal strip of the South Central Coast region. The high and very high diversity levels are distinctly divided into two main areas. The first area is located in the western part of Quang Nam province and the northern Central Highlands (accounting for 22.81% of the total cells), covering provinces such as Kon Tum and Gia Lai. The second area is in the southern Central Highlands (accounting for 17.53% of the total grid cells), concentrated in Lam Dong province and parts of southern Dak Lak province (Figure 4).



Ngoc Linh mountain range spanning Quang Nam and Kon Tum provinces. Ngoc Linh Peak, the highest peak in central Vietnam, stands at 2,598 meters above sea level. South of this region is the Pleiku Plateau, with elevation ranging from 800 to 1,400 meters [10]. Mammalian diversity in this region gradually decreases toward the southern part of the plateau. The second region with high mammalian diversity is in the southern Central Highlands, centered around the Da Lat

Plateau. Most of this plateau lies at elevations between 1,200 and 2,200 meters, with the Bidoup Peak (2,163 meters) and Chu Yang Sin Peak (2,410 meters), located along the northeast ridge [10]. Moreover, these two regions are home to evergreen broadleaf natural forests, which are the preferred habitats for mammals [13]. The mammalian diversity decreases toward the southwestern part of the Da Lat Plateau, where the average elevation is between 1,000 and 1,500 meters. In contrast, the northern part of Dak Lak province and the southern part of Gia Lai province, forming a separating strip between the two highly diverse regions, have lower mammalian diversity. This area, part of the Dak Lak Plateau, has a relatively low elevation of 400–800 meters. The predominant forest type is deciduous forest, which is considered less diverse in terms of mammalian species composition.

3.2. Map of threatened mammal species richness in the Central Highlands and South Central Coast Regions

Based on the criteria for identifying rare and highly conserved mammal species, we identified 64 threatened mammal species

distributed across the Central Highlands and South Central Coast regions. The order Carnivora includes the highest number of threatened species, with 25 species, followed by Artiodactyla and Primates, with 14 and 11 species, respectively (Figure 5).

Of these, 27 species are listed in all four major conservation references: the IUCN Red List of Threatened Species (2025), the Vietnam Red List of Threatened Species (2024), Decree No. 84/2021/ND-CP, and Decree No. 64/2019/ND-CP. Additionally, we identified 35 species as threatened according to the IUCN Red List of Threatened Species (2025), classified as VU (13 species), EN (13 species), CR (9 species). Sixty-one species are listed in the Vietnam Red List of Threatened Species (2024). Decree No. 84/2021/ND-CP and Decree No. 64/2019/ND-CP list 37 and 36 species, respectively. Some representatives of highly threatened mammals in the region include the Asian elephant (*Elephas maximus*), Southern yellow-cheeked gibbon (*Nomascus gabriellae*), Grey-shanked douc (*Pygathrix cinerea*), and Annamite striped rabbit (*Nesolagus timminsi*).

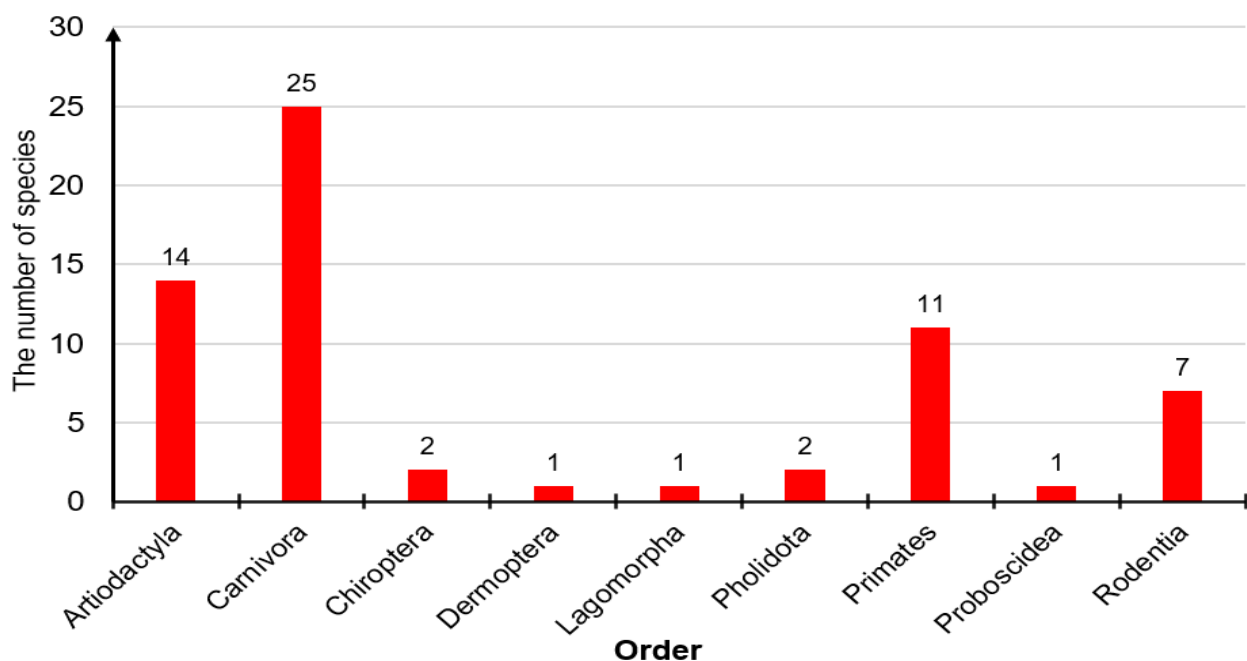


Figure 5. The number of threatened species following order in the Central Highlands and South Central Coast Regions

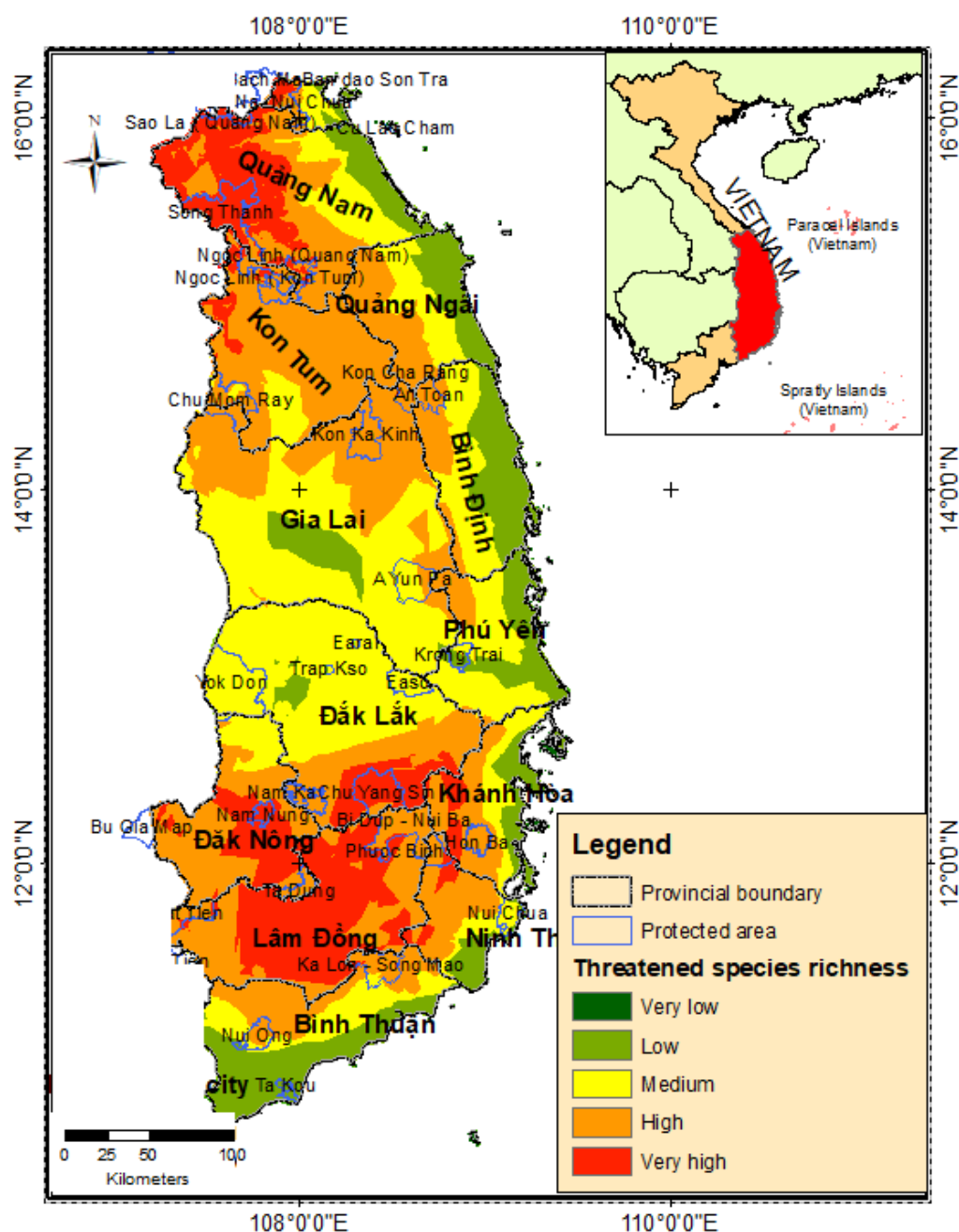


Figure 6. The species richness of threatened mammal species Central Highlands and South Central Coast

The cells with the highest diversity of mammals with high conservation value contain 35 species, while those with the fewest are home to 15 species. The threatened mammal species in the Central Highlands and South Central Coast regions are primarily distributed in the western areas of Quang Nam Province, the northern Central Highlands, and a relatively large area in the southern Central Highlands. These regions are

characterized by the Ngoc Linh and Bidoup – Chu Yang Sin mountain ranges, which result in complex terrain and high altitudes above sea level.

3.3. Mammal species diversity level in protected areas in the Central Highlands and South Central Coast

The map of mammal species diversity distribution shows that most protected areas in the Central Highlands and South Central

Coast are located in areas with high mammal species diversity (Figures 4 and 6). The establishment of protected area for nature conservation is based on various criteria, one of which is the diversity of plant and animal genetic resources. In the northern part of the region, protected areas such as Chu Mom Ray National Park (NP), Kon Ka Kinh NP, Song Thanh NP, and Kon Cha Rang Nature Reserve (NR), along with the Sao La NR (Quang Nam) and Ngoc Linh NR, are located in areas with very high mammal species diversity. The southern Central Highlands also host numerous protected areas, notably Chu Yang Sin NP and Bidoup – Nui Ba NP, which are situated in regions of exceptionally high mammal diversity.

Additionally, areas such as Ta Dung NR, Nam Nung NR, and the Cat Loc sector of Cat Tien NP are also notable for their diverse mammal species composition. Beyond the boundaries of the protected areas, some regions with high mammal diversity include the area between Song Thanh NP and Sao La NR (Quang Nam), the northern area of Chu Mom Ray NP (bordering Laos' Dong Ampham National Biodiversity Conservation Area), and the corridor connecting Ta Dung NR and Bidoup – Nui Ba NP. These areas present significant potential for establishing new protected areas or creating biodiversity corridors to connect existing protected areas.

4. CONCLUSION

The study highlights the variation in mammal species diversity across the Central Highlands and South Central Coast regions with 187 species. The area with the highest mammal diversity hosts 122 species, while the lowest diversity area is found with 75 species. Regions with lower biodiversity are mainly concentrated along the South Central Coast's coastal plains, whereas areas with higher biodiversity are primarily located in the northern and southern parts of the Central

Highlands. A total of 64 threatened mammal species have been identified as distributed within the Central Highlands and South Central Coast. The areas with the highest diversity of rare mammal species host 35 species, while the lowest diversity includes 15 species. Most protected areas are located in areas with high to very high levels of rare mammal diversity. The results of this study provide an initial contribution to the information base regarding mammal biodiversity levels in the Central Highlands and South Central Coast regions.

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