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Biodiversity potential and scientific basis for conservation in the Song Hinh - Tay Hoa area, Dak Lak province, Vietnam

Nguyen Dang Hoi[1*], Le Xuan Dac[1], Dang Hung Cuong[1], Ngo Trung Dung[1], Pham Hong Phuong[1], Dinh The Dung[1], Pham Mai Phuong[1], Luong Van Dung[2], Nguyen Cao Huan[3], Poyarkov N.A.[4], Kuznetsov A.N.[1]

[1]*Institute of Tropical Ecology, Joint Vietnam-Russia Tropical Science and Technology Research Center, Hanoi, Vietnam*
[2]*Dalat University, Lam Dong, Vietnam*
[3]*University of Science, Vietnam National University, Hanoi, Vietnam*
[4]*Lomonosov Moscow State University, Leninskiye Gory, Moscow, GSP-1, 119234, Russia*

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ABSTRACT

The Song Hinh - Tay Hoa area harbors exceptional ecological and biodiversity values. Two characteristic forest ecosystems are represented: lowland and mid-montane evergreen tropical forests, which collectively support remarkable biodiversity, comprising 1,163 vascular plant species, 58 mammalian species, 219 bird species, 125 reptile and amphibian species, and 65 freshwater fish species. Of these, 41 plant species, 20 mammal species, 32 bird species, 14 reptile species, 6 amphibian species, and 6 freshwater fish species are listed as Near Threatened or higher on the IUCN Red List (2025), the Vietnam Red Data Book (2024), and Government Decree No. 84/2021/ND-CP. A defining feature of the area is its high level of endemism, including several narrowly distributed taxa recorded exclusively within the site. In comparison with the ecological and biological criteria stipulated in the current Law on Biodiversity and the Law on Forestry, the area exceeds the thresholds required, thereby meeting both scientific and practical conditions for designation as a provincial- or national-level nature reserve. Drawing upon these research findings and the integrated analysis of landscape and ecosystem maps, a proposal is made for the establishment of a nature reserve, comprising three functional zones: a strictly protected core (13,708 ha), an ecological restoration zone (23,037 ha), and an administrative and service area (362 ha).

Keywords: Nature reserve, ecosystem, rare species, conservation value, functional zone.

1. Introduction

Protecting nature and conserving biodiversity, while promoting socioeconomic development and environmental protection, is an urgent requirement for countries and territories worldwide, including Vietnam (Nguyen Dinh Duong et al., 2021; Nguyen Van Long et al., 2024; Linh Manh Nguyen et al., 2024). Given Vietnam's position and role, the requirement to protect nature and conserve biodiversity is at a higher level, demonstrating Vietnam's position and responsibility towards global issues. As a member of the Convention on Biological Diversity since 1994, Vietnam has consistently affirmed its position, role, and commitment in implementing the Convention through specific and practical actions, including the establishment of nature

*Corresponding author, Email: danghoi110@gmail.com

reserves (NRs) and the implementation of tasks related to managing and conserving wild species (Massimo Sarti et al., 2023).

Since participating in the Convention on Biological Diversity in 1994, Vietnam has shown remarkable efforts to protect its natural habitats and wildlife. By the end of 2022, Vietnam had 178 NRs, comprising 34 national parks, 59 nature reserves, 23 species and habitat conservation areas, and 62 landscape protection areas (Decision No. 1352/QD-TTg, 2024), with a total area of 2,663,265 ha, accounting for 8.03% of the total natural area of the country. Many NRs have been recognized with international titles, such as ASEAN Heritage Parks and World Biosphere Reserves, and their scopes of protection have been expanded through planning and the establishment of biodiversity corridors, key biodiversity areas, important natural and ecological landscapes, and important wetlands.

One of Vietnam's goals in biodiversity conservation is to "Expand and improve the effectiveness of the management of the system of natural heritages and NRs, ensuring the achievement of the following basic targets: the area of NRs on the mainland strives to reach 9% of the mainland area;... 70% of NRs and natural heritages are assessed as effectively managed;... the national forest cover rate remains stable at 42–43%; at least 20% of the area of degraded natural ecosystems is restored" (National Strategy,... 2022).

The Song Hinh - Tay Hoa area, Dak Lak Province (part of Phu Yen Province (former)), with an area of up to tens of thousands of hectares, is characterized by a mountain range jutting out into the sea, forming a wall that blocks southern Dak Lak, which is north of Khanh Hoa. Terrain characteristics have created unique ecosystems and landscapes. This area serves not only as a meeting place and intersection of biological elements but also as a natural barrier and boundary for many species (Nguyen Dang Hoi et al., 2020; 2021; 2024).

To date, most of the area is under the management of the Tay Hoa Protection Forest Management Board and Song Hinh Protection Forest Management Board. The biodiversity and ecological characteristics of this area remain poorly studied. Recent studies have demonstrated that this area is characterized by a high level of biodiversity, featuring several endemic species (Nguyen Dang Hoi et al., 2024; Nguyen Thanh Luan et al., 2019; 2021). Therefore, the establishment of provincial-level nature reserves, as mandated by the Law on Biodiversity (2018) and the Law on Forestry (2024), has profound theoretical and practical significance, aligning with the Party's Policy and the National Strategy on Biodiversity to 2030, with a vision to 2050.

To clarify the rationale for establishing a provincial-level nature reserve, this paper focuses on the legal framework of Vietnam as stipulated in current laws, together with an assessment of the present status of biodiversity and ecosystems and their conservation values. It further examines the delineation of conservation functional zones based on landscape and ecosystem approaches (Fig. 1), thereby providing the foundation for proposing subsequent steps toward expanding the area of special-use forests in Dak Lak Province, in particular, and in Vietnam as a whole.

2. Materials and methods

2.1. Study area

The Song Hinh - Tay Hoa area is located in the southern part of Phu Yen Province (formerly), bordering Khanh Hoa Province (Fig. 1). The study area is located in four communes: Song Hinh, Duc Binh, Hoa My, and Hoa Thinh (Dak Lak Province), covering a total area of 78,411 hectares.

Figure 1. Location of the Song Hinh - Tay Hoa area

Geology and Landforms: The study area exhibits a relatively diverse lithological composition, including medium- to coarse-grained biotite granite and gray syenite. In the northern part, an olivine basalt cover layer with a thickness of 20–50 m is present. The western region is characterized by calcareous sandstone, calcareous shale, and clayey limestone formations, with thicknesses ranging from 500 to 700 meters. In contrast, the eastern part predominantly consists of conglomeratic sandstone and shale. Landforms in the southern mountains are primarily shaped by planation, denudation, and gravitational slope processes, with accumulation and surface wash processes prevailing on low- to medium-elevation mountains. Similarly, the western area is dominated by planation, denudation, and slope processes, accompanied by significant surface accumulation and washing. In the eastern region, erosional and depositional processes are more prominent.

Climate - Hydrography: The climate is marked by two distinct seasons: a rainy season from September to December and a dry season from January to August. The average annual temperature is approximately 26.6°C, while annual precipitation ranges from 1,600 to 2,400 mm. The hydrographic network is relatively dense and diverse. The Ba River flows from west to east, supplemented by several smaller tributaries. Numerous reservoirs, including the Song Hinh hydropower reservoir, Dong Khon, and Hao Son Reservoirs, provide water for hydropower generation and irrigation.

Soils - Vegetation: In the southern mountainous region, red-yellow soils developed on acidic magmatic rocks are dominant. Medium mountain terrains feature red-yellow humus soils, also formed on acidic magmatic rocks. The western hilly areas are characterized by red to yellow soils over shale and metamorphic rocks. Dark brown soils on basalt are found on the northern plateau, whereas alluvial soils dominate the eastern plains, particularly along the Hinh and Ba rivers. Natural vegetation is dominated by closed evergreen forests on low to medium mountains. Grasslands, shrubs, and regenerating trees are common in the eastern hilly and sandy dune areas. Planted forests occur on hills and foothills in the northern region. Flat northern areas are mainly cultivated with wet rice, annual crops, and various perennial and fruit tree species.

Human Activities: Human activities are diverse across the study area. In the eastern part, mainly within Dong Hoa town, the focus is on fisheries, aquaculture, industrial development, and management of special-use forests. Agricultural activities, particularly wet rice cultivation and afforestation, dominate the northern region. The southern and western areas, characterized by hilly and mountainous terrain, emphasize forestry and biodiversity conservation, including the protection of watershed forests and the management of protection and production forests.

2.2. Methods

2.2.1. Field survey

Three field trips were conducted to study biological groups, landscapes, and ecosystems: May 2020, January 2021, and June 2024. For plants and ecosystems, research was conducted along transects established across various types of vegetation and landscapes, including valley forests, mountain slopes, mountain ridges, and trails along large streams. On each transect, the characteristics of vegetation types and landscapes were recorded. Plant species encountered within a range of 15 m on each side of the transect were documented through statistical counts and descriptive notes.

Animal surveys were conducted in accordance with typical habitats. Information, including species, abundance, signs, coordinates, time, and habitat, was recorded in field notebooks. Photographs of species were taken when possible. Ten camera traps and 60 cage traps (29 × 14.5 × 14.5 cm) were deployed along the survey routes. Six TERINO CAM12MP infrared camera traps (Fig. 2) were also used to record images and activities of animals in the Song Hinh Protective Forest. Interviews were conducted with experienced foresters and residents, utilizing species photographs to verify the information.

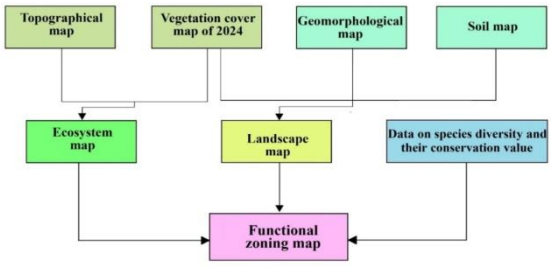

Figure 2. Process and steps for establishing ecosystem maps and functional zoning maps of the study area

Bird surveys were conducted during daylight hours, from 05:00 to 11:00 and 15:00 to 18:00. Species composition was documented through observations and photographs. Equipment included Nikon binoculars (10 × 42) and a Nikon D5 camera with a 600 mm lens. Bird call playback devices were employed to attract species.

Herpetofaunal surveys were conducted twice daily, in the morning (07:00–12:00) and evening (16:30–19:00). Along transects, amphibians and reptiles were recorded based on direct observation, with notes on activity patterns and preliminary identifications.

Fish surveys were carried out at designated sites and transects within the Song Hinh hydropower reservoir, Ea Nhue stream, and My Lam River. Gillnets (three-panel, mesh size 2a = 2 cm) and traditional "bat quai" traps baited with fermented attractants were deployed across habitats and substrates. Fish were also obtained from local fishermen operating in the Song Hinh reservoir and tributaries.

2.2.2. Sample collection and preservation

Plant specimens were collected along survey transects, processed, and prepared according to the methods outlined by the Vietnam Museum of Nature (2015), Hoang Chung (2009), and Nguyen Nghia Thin (1997, 2024). Vascular plant specimens were immediately pressed in the field using a standard plant press, with paper changes made regularly to prevent mold and maintain morphological integrity. After drying, specimens were insect-proofed by freezing or controlled heating, mounted on herbarium sheets according to APG IV standards, and stored in specialized cabinets under controlled humidity and temperature for long-term scientific use.

Animal samples were collected using cage traps and camera traps. For amphibians and reptiles, collection was carried out with nets of various sizes, fishing rods, and snake-catching sticks. Fish samples were obtained using gillnets, traditional traps, and purchases

from fishermen. All collected specimens were preserved in accordance with standardized zoological procedures to ensure their usability for later identification and taxonomic analysis. The collected amphibian, reptile, and fish specimens were photographed using Nikon D300S and Nikon D7200 cameras with a Nikon AF-S Micro NIKKOR 105 mm macro lens and a Nikon Speedlight SB-900 flash equipped with a diffuser.

2.2.3. Species identification

Plant specimens were identified based on standard botanical taxonomic references, following Vietnamese methodologies cited above. Taxonomic identification was primarily based on morphological characteristics, with reference to the classical floristic works of Pham Hoang Ho (1999, 2003) and Takhtajan A. (1997).

Animal species were identified according to Charles M. Francis (2019), based primarily on external morphological characteristics, diagnostic features, and comparison with standard taxonomic keys. Whenever possible, photographic records and field notes on size, coloration, and habitat were also used to support identification.

Bird identification was based on morphological characteristics observed in the field, as well as the methods of Tordoff A. W. et al. (2002), Nguyen Cu et al. (2004), Le Manh Hung (2012), and Robson (2008). Scientific names and taxonomic classification followed Clements (2018) and the BirdLife International checklist (2014). Vietnamese common names were based on Vo Quy and Nguyen Cu (1995).

Herpetofaunal identification and taxonomic status were determined in accordance with recent reviews of Vietnamese herpetofauna (Nguyen et al., 2009; Poyarkov et al., 2021, 2023; Frost, 2025; Uetz et al., 2025). Species were identified mainly based on external morphological characteristics, coloration, body proportions, and other diagnostic traits. Information on ecological habits, behavior, and acoustic signals (for amphibians) was also considered to support taxonomic determination.

Fish identification was conducted in accordance with the works of Ken Schultz (2003), Mai Dinh Yen (2000), and Kottelat (2001). Species were identified primarily based on external morphological features, including body shape, fin structure, scale counts, and coloration patterns.

2.2.4. Questionnaire survey interviews

A questionnaire was used to investigate and interview 80 households in the Song Hinh and Hoa Thinh communes. The investigation contents include ethnicity, family economic status, main types of farming activities, people's participation in forest management, protection, and exploitation of forest products, and people's views on and aspirations for the establishment of Song Hinh - Tay Hoa Nature Reserve.

2.2.5. Building maps

The application of thematic mapping methods is particularly important in ecosystem research, as it enables the visualization and analysis of spatial patterns, thereby contributing to territorial planning, resource management, and biodiversity conservation (Nguyen Viet Luong et al., 2017). The ecosystem map of the Song Hinh - Tay Hoa area was developed based on topographic data, current vegetation cover maps, a Sentinel-2 multispectral satellite image from 2024, and results from field surveys and ground verification. Accordingly, representative ecosystems were classified by elevation zones: below 500 m, between 500 and 1,000 m, and above 1,000 m. These classifications were further refined by considering the level of anthropogenic influence, resulting in the delineation of natural and anthropogenic ecosystems.

The functional zoning map was developed

based on the landscape and ecosystem maps of the Song Hinh - Tay Hoa area, as well as data on species diversity and their conservation value (Fig. 2). Accordingly, natural forest landscapes and ecosystems located at elevations above 700 m have been prioritized for strict protection; those below 700 m are designated for ecological restoration. Landscapes and ecosystems situated on relatively flat terrain, suitable for the establishment of administrative offices and restoration nurseries, are assigned to administrative and service zones. Surrounding landscapes and ecosystems serve as buffer zones to support sustainable economic development and agroforestry activities.

2.2.6. Determination of species conservation status and significance

To assess the conservation status and value of species within the study area, the following references were used for comparison and evaluation: the Vietnam Red Book (2024); the IUCN Red List of Threatened Species (2025); the Law on Biodiversity of Vietnam (2018); the Forestry Law of Vietnam (2024); and Government Decree No. 84/2021/ND-CP. The latter amends and supplements several articles of Decree No. 06/2019/ND-CP dated January 22, 2019, which regulates the management of endangered, precious, and rare forest plants and animals, and implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

3. Results

3.1. Biodiversity and conservation value of forest ecosystems in the Song Hinh - Tay Hoa area

3.1.1. Diversity of forest ecosystems

The study area comprises two distinct types of ecosystems: the lowland evergreen tropical forest (500–1,000 m) and the mid-mountain evergreen tropical forest (>1,000 m). These ecosystems have developed through the interaction of multiple components and natural factors over millions of years. Key factors include the lithology of the Deo Ca formation, topography acting as a climatic barrier, soil type diversity, and primarily biological factors. This area represents a convergence zone where various biological elements, particularly at the species level, interact with one another. Over its long developmental history, numerous plant and animal species have become endemic to this region.

Another notable feature is that forest ecosystems at elevations above 700 m still have relatively pristine vegetation or have been selectively exploited in the past but have since recovered. These forests now have high biomass stocks, creating an ideal habitat for many forest animal species.

In stable forest areas, the structure typically consists of three to four layers, with many tree species reaching heights of 30–40 meters. Dominant species are those representative of lowland or southern Vietnam forest ecosystems, such as *Dipterocarpus alatus*, *D.* turbinatus, *D. hasseltii*, *D. retusus*, *D. costatus*, *Hopea odorata*, and *Shorea cochinchinensis.*

The lowland evergreen tropical forest ecosystem (500–1,000 m) features degraded and recovering soils, as well as a multilayered canopy structure. Some tree species in this area are tall, with diameters ranging from 80 to 120 cm. The species composition is relatively simple due to past selective exploitation, with dominant species, including those from Dipterocarpaceae, such as *Dipterocarpus turbinatus* and *Shorea* sp., as well as those from Malvaceae, represented by species like *Herritiera javanica.*

The eastern area belongs to the Tay Hoa protective forest, where vegetation grows on rocky soil mountains, creating an ecosystem characterized by a mix of dicotyledonous and monocotyledonous plants, interwoven with gymnosperms and ancient broadleaf trees. The main species belong to the Arecaceae family, such as *Arenga saccharifera*, *Areca triandra*,

Calamus poilanei, and *Calamus draco*. The species of ferns and cycads such as *Cyathea latebrosa* and *Cycas rumphii*. The species are typically found in dry and harsh climates, such as *Aidia oxyodonta*, *Baringtonia* sp., and *Rothmannia vietnamensis*.

On satellite images, the forest ecosystems in the Song Hinh - Tay Hoa area represent the only remaining large area of natural forest (tens of thousands of hectares), stretching from the eastern slopes of the Truong Son Range toward the coastal plain (Fig. 3). These forests are almost surrounded by anthropogenic ecosystems that have developed on flat terrain, low hills, and gentle slopes, interspersed with transportation networks and residential areas. As a result, they are under constant pressure from human influence.

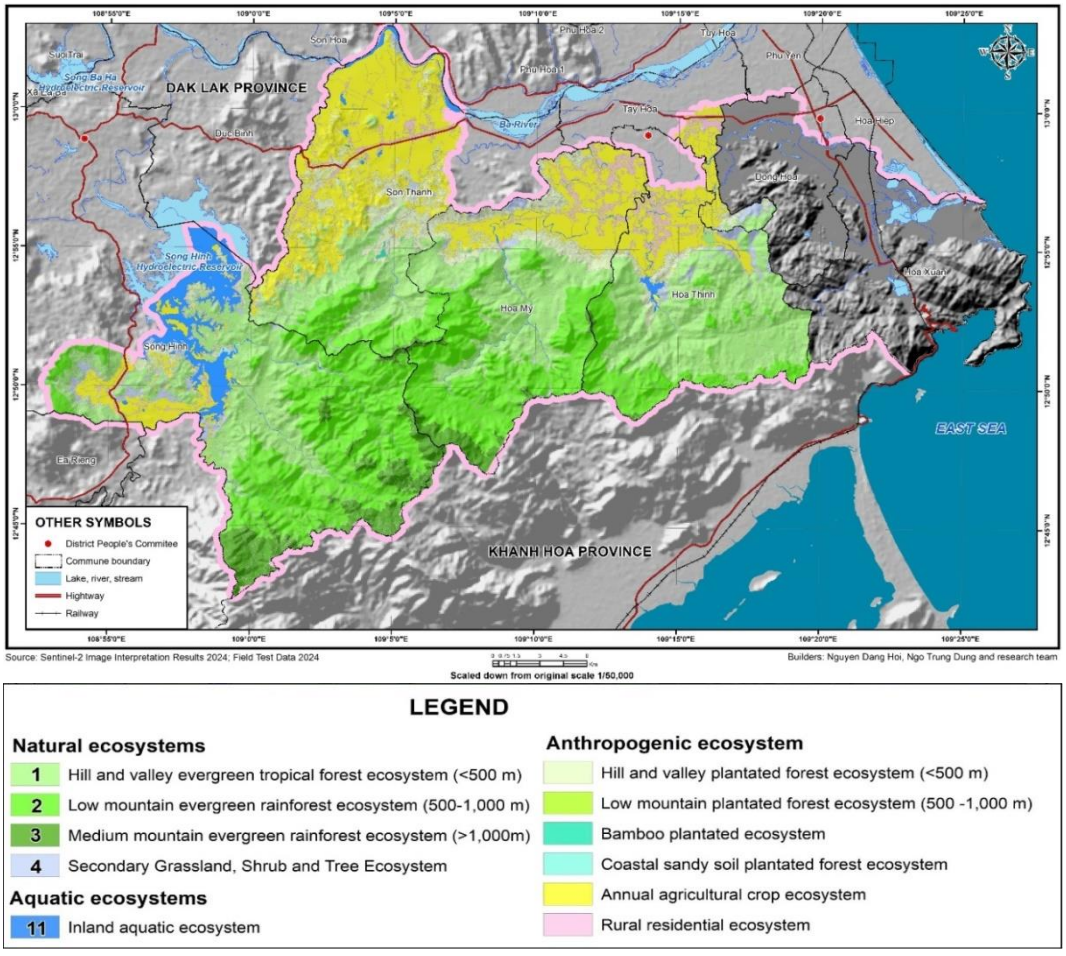

Figure 3. Map of ecosystems in the Song Hinh - Tay Hoa area

3.1.2. Diversity and conservation value of wild animals and plants

**Diversity and conservation value of plant species*

Among the 1,163 recorded vascular plant species in the study area, 41 species have been identified as having conservation value according to the IUCN Red List (2025), the Vietnam Red Book (2024), and Government Decree No. 84/2021/ND-CP. According to the IUCN Red List 2025, two species are classified as Critically Endangered (CR), four species as Endangered (EN), four species as

Vulnerable (VU), and two species as Near Threatened (NT). The Vietnam Red Book lists 2 species as Critically Endangered (CR), 3 as Endangered (EN), 5 as Vulnerable (VU), and 4 as Near Threatened (NT). In addition, 7 species are listed under Groups IB and IIB in Decree No. 84/2021/ND-CP for the management of endangered, precious, and rare forest plants and animals and for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Table A1, Appendix A).

**Diversity and conservation value of mammal species*

Research results and reference materials (Le Xuan Dac, 2024) have recorded over 58 mammal species in the Song Hinh - Tay Hoa area. Of these, 20 species have conservation value according to the IUCN Red List (2025), the Vietnam Red Book (2024), and Government Decree No. 84/2021/ND-CP. According to the IUCN Red List, 2 species are classified as Critically Endangered (CR), 3 species as Endangered (EN), 5 species as Vulnerable (VU), and 3 species as Near Threatened (NT). The Vietnam Red Book lists 4 species as Critically Endangered (CR), 4 species as Endangered (EN), and 10 species as Vulnerable (VU). Furthermore, 17 species are listed under Groups IB and IIB in Decree 84/2021 for the management of endangered, precious, and rare forest species and to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Table A2, Appendix A).

**Diversity and conservation value of bird species*

Research results on the avifauna of the Song Hinh-Tay Hoa area recorded a total of 219 bird species. Among these, 32 species are considered of conservation concern according to the IUCN Red List (2025), the Vietnam Red Book (2024), and Government Decree No. 84/2021. According to the IUCN Red List, one species is classified as Critically Endangered (CR). In the Vietnam Red Book, one species is listed as Critically Endangered (CR), two species as Endangered (EN), and five species as Vulnerable (VU). Thirty species are classified under Groups IB and IIB according to Decree 84/2021 for the management of endangered, precious, and rare forest species and the implementation of CITES. Table A3 (Appendix A) presents the list of bird species of conservation significance in the Song Hinh - Tay Hoa area.

**Diversity and conservation value of reptile and amphibian species*

Research findings on the herpetofauna of the Song Hinh-Tay Hoa area recorded a total of 125 species, including 20 species considered of conservation concern according to the IUCN Red List (2025), the Vietnam Red Book (2024), and Government Decree No. 84/2021. According to the IUCN Red List, one species is classified as Critically Endangered (CR), four species as Endangered (EN), four species as Vulnerable (VU), and two species as Near Threatened (NT). In the Vietnam Red Book, two species are listed as Critically Endangered (CR), three as Endangered (EN), five as Vulnerable (VU), and four as Near Threatened (NT). Additionally, seven species are included in Groups IB and IIB under Decree 84/2021 for the management of endangered, precious, and rare forest species, as well as the implementation of CITES (Table A4, Appendix A).

**Diversity and conservation value of freshwater fish species*

Research conducted in the aquatic ecosystems of the Song Hinh hydropower reservoir and several upstream streams, including the Ea Nhue stream, recorded a total of 65 freshwater fish species belonging to 24 families across 9 orders. The number of rare species in the area is relatively low, with only six species identified. The stone goby (*Rhinogobius lineatus*) is classified as Endangered (EN) on the IUCN Red List

(2025), while the marbled eel (*Anguilla marmorata*) is listed as Endangered (EN) in the Vietnam Red Book (2024). Other species of conservation concern are classified as Vulnerable (VU) or Near Threatened (NT) according to the IUCN Red List (2025) or the Vietnam Red Book (2024). The list of fish species of conservation significance is presented in Table A5 (Appendix A).

3.2. Scientific basis for conservation in the Song Hinh - Tay Hoa area

3.2.1. Legal framework for establishing the Nature Reserve

**Nature reserves as defined under the Law on Biodiversity of Vietnam*

According to the Law on Biodiversity of Vietnam (2018), protected areas include national parks, nature reserves, species and habitat conservation areas, and landscape protection areas. These areas are classified into national-level and provincial-level categories to ensure the development of appropriate management and investment policies based on their biodiversity, conservation value, and size.

A provincial-level nature reserve is a protected area that is included in provincial biodiversity conservation planning, designed to preserve natural ecosystems within the province. According to Decree No. 65/2010/NĐ-CP, a provincial-level nature reserve must meet the following key criteria: (a) it contains natural ecosystems that are important to the locality and represent typical or unique ecosystems of that locality; and (b) it possesses exceptional ecological and environmental value, serving purposes such as scientific research, education, tourism, and recreation.

To establish a provincial-level nature reserve, Clause 1, Article 24 of the Law on Biodiversity (2018) stipulates that the Provincial People's Committee shall decide on the establishment of a provincial-level protected area based on the biodiversity conservation content outlined in the provincial plan. Clause 2, Article 24 specifies that the competent state authority responsible for managing protected areas, as defined in Clause 1, Article 27 of this Law, shall take the lead and coordinate with relevant ministries and ministerial-level agencies to regulate the procedures for preparing and appraising the project for establishing a provincial-level protected area, as well as the contents of the decision on its establishment.

**Nature reserves as defined under the Forestry Law of Vietnam*

According to the Vietnam Forestry Law (2024), a nature reserve is classified as a special-use forest. Clause 2, Article 5 of the Law states that special-use forests are primarily established for the conservation of natural forest ecosystems, the genetic resources of forest species, scientific research, preservation of historical and cultural monuments, religious sites, and scenic areas, combined with ecotourism, recreation, and relaxation, except for the strictly protected zones of special-use forests. They also provide environmental services, including: (a) national parks; (b) nature reserves; (c) species and habitat conservation areas; (d) landscape protection areas, which include forests protecting historical and cultural monuments, scenic spots, religious forests, urban environmental protection forests, forests in industrial zones, export processing zones, economic zones, and high-tech zones; and (e) research and experimental forests, national botanical gardens, and national seed forests.

According to the Forestry Law of Vietnam (2024), a nature reserve must meet the following four criteria: (a) it contains natural ecosystems that are important at the national or international level, are unique, or represent a specific ecological region; (b) it serves as the natural habitat for at least five species of endangered, rare, or threatened forest plant and animal species; (c) it holds special value

for science, education, ecotourism, recreation, or leisure; and (d) it has a minimum contiguous area of 5,000 hectares, with at least 90% of the area consisting of forest ecosystems.

To establish a nature reserve, Decree No. 156/2018/ND-CP, dated November 16, 2018, provides detailed guidance for implementing several provisions of the Forestry Law. This decree outlines the principles and procedures for establishing special-use forests in general, and nature reserves in particular.

3.2.2. Functional zoning of Song Hinh - Tay Hoa area

**Functional zoning criteria*

According to Decree No. 91/2024/ND-CP dated July 18, 2024, of the Government, which amends and supplements several articles of Decree No. 156, the functional zones of the conservation area are defined as follows:

- Strictly protected areas must meet two criteria: (1) They contain intact natural ecosystems or natural ecosystems that ensure the natural development laws of forest ecosystems; and (2) They serve as natural distribution and are habitats for endemic, endangered, precious, and rare wild animals and plants.

- The ecological restoration zone meets two criteria: (1) it contains a forest ecosystem that requires restoration through silvicultural techniques to attain the natural conditions characteristic of the ecosystem; and (2) it encompasses natural habitats that sustain food resources and allow for regular movement of wildlife.

- The service and administrative areas meet two groups of criteria: (1) they provide technical infrastructure, including facilities for office work, accommodation, research, scientific experimentation, and rescue and propagation of organisms within the special-use forest management board, as well as facilities supporting ecotourism, recreation, entertainment, and other legally mandated functions; and (2) the service and administrative zone is spatially concentrated, minimizing scattered sites, in accordance with the scale of the special-use forest management board, the current forest status, and the total natural area of the special-use forest.

**Functional zones*

- *Strictly protected area*

The strictly protected area covers an area of approximately 13,708 hectares, concentrated in the low- and medium-elevation mountainous areas southwest of the study area, belonging to the communes of Song Hinh and Hoa My (Fig. 4).

The medium and low mountain terrains have slopes ranging from medium to high. The zone includes rich to medium evergreen closed forest ecosystems with high biodiversity, especially among Dipterocarpaceae plants, mammals, birds, reptiles, and amphibians.

The primary activities currently occurring in the area are the management and protection of upstream forest reserves. There is very little in-depth research in this area, and the protection efficiency is not high, particularly due to the lack of force, robust mechanisms, and support tools.

- *Ecological restoration zone*

The ecological restoration zone covers a total area of 23,037 hectares and is distributed in the hilly and low mountain terrain in the southwestern part of the study area, belonging to the communes of Song Hinh and Hoa My (Fig. 4).

In the zone, the current situation is primarily characterized by poor, evergreen, closed forest due to human impact. Many areas are undergoing restoration, but the structure and species composition have changed significantly compared to the primary forest in the strictly protected area.

Current activities focus on protecting and restoring upstream forest areas and harvesting raw materials from small-, medium-, and short-lived timber species, typically *Acacia auriculiformis*.

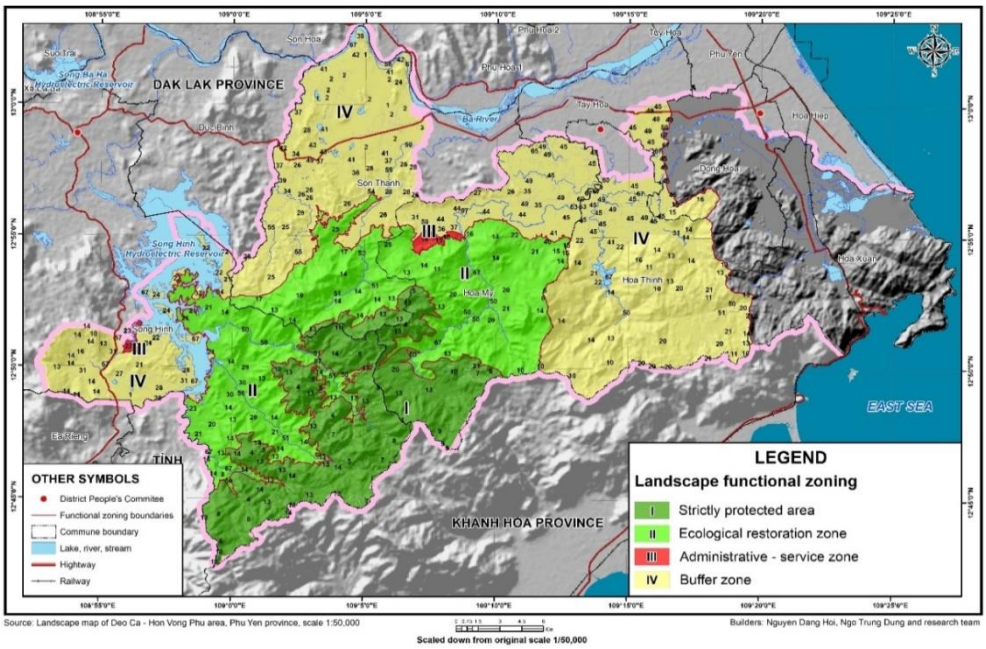

Figure 4. Functional zoning map of Song Hinh - Tay Hoa area

- *Administrative and service area*

Due to the large area, complex internal terrain, and traffic difficulties, this study proposes a fairly large-scale service-administrative area, covering a total area of 362 hectares (Fig. 4).

The proposed service-administrative area is located at 2 locations: (1) West Song Hinh Lake (point 1) and the Center of Hoa My commune (point 2).

- *Buffer zone*

The buffer zone has a total area of 41,304 ha, located west of the Song Hinh community and to the north and east of the study area (Fig. 4). Plains and low hills dominate the terrain. The main vegetation types are *Acacia auriculiformis* plantations and annual crops.

Human activities are primarily focused on cultivating Acacia auriculiformis plantations for raw material production, with a harvesting cycle of 4–6 years. Additionally, industrial crops such as rubber and pepper are grown, as well as a range of annual crops, including sugarcane, maize, and cassava.

3.2.3. Community participation in forest protection and perceptions of the proposed Nature Reserve

The study selected three villages - My Lam village in Hoa Thinh commune, and Ea Ngao and Ha Roi villages in Song Hinh commune, which have the highest number of households participating in forest protection. The results of the participatory rural appraisal (PRA) conducted with local participants are presented in Table 1.

My Lam village has a homogeneous Kinh population. In contrast, Ea Ngao and Ha Roi villages exhibit more diverse demographic structures, including ethnic minorities such as Cham, Ba Na, and E De. All three villages have a high proportion of residents; however, Ea Ngao and Ha Roi villages host a larger number of people originating from other areas compared with My Lam.

In terms of education, My Lam village demonstrates a higher level of attainment, with 77% of the population having completed junior high school and 23% having completed high school, and no individuals reported as

illiterate. Ea Ngao village shows a lower education level, with over 51.4% of residents having only primary education and 11.4% being illiterate. Ha Roi village falls between the two, exhibiting a relatively even distribution across educational levels and a small proportion of residents with college or university degrees (4.76%).

Table 1. Ethnic composition, farming characteristics, and people's opinions on the establishment of the proposed Nature Reserve (survey results for 80 households in the Song Hinh commune and Hoa Thinh commune)

	My Lam village (%)	**Ea Ngao village (%)**	**Ha Roi villages (%)**
Ethnic	Kinh: 100	Cham: 42.8 Ba Na: 28.5 E De: 22.8 Kinh: 5.7	Ba Na: 62 E De: 23.8 Cham, Chu ru, Kinh: 14.2
People of local origin	90	77	76
People from other places	10	23	19
Type of production			
Cultivation (rice, cassava)	100	80	85,7
Agricultural and forestry planting	28.5	14.2	14
Afforestation	28.5	5.7	23.8
Join the forest protection	81	20	14.3
Service	5	2.8	4.76
Freelance work for someone	38.0	54.3	62
Work with a monthly salary	14.3	-	-
Animal husbandry	-	5.70	4.76
Other activities			
Logging, firewood	4.70	25.7	28.5
Honey exploitation	-	11.4	42.8
Nontimber forest products exploitation	-	40	23.8
Hunting	-	8.57	-
Fishing	4.7	17	4.76
Opinions on the establishment of the proposed Nature Reserve			
Agree with the policy of establishment	95.5	97.1	81
Not interested	0.5	2.9	19
Protesting against	0	0	0

Source: Survey data of the project in 2024

The three villages exhibit distinct patterns of economic activities. In addition to agricultural and industrial crop production, villagers in My Lam engage in firewood collection (4.7%) and fishing (4.7%). In Ea Ngao, firewood collection (25.7%), honey gathering (11.4%), and fishing (17%) are the most prominent supplemental activities. Ha Roi is notable for honey collection (42.8%), nontimber forest product harvesting (23.8%), and hunting of wild animals (8.57%). While all villages engage in some form of natural resource utilization, the scale and diversity of these activities are greater in Ea Ngao and Ha Roi compared to My Lam. Importantly, there is no longer any logging or hunting of wild animals in the study area.

The interview results indicated that most household representatives supported the policy of creating a provincial-level nature reserve. Specifically, in My Lam, Ea Ngao, and Ha Roi villages, the proportions of households in favor were 95.5%, 97.1%, and 81%, respectively; the proportions of households not interested were 0.5%, 2.9%, and 19%; and no households expressed opposition to the reserve in this area.

4. Discussions

Preliminary research results suggest that the Song Hinh - Tay Hoa area exhibits high biodiversity, with distinctive biological and ecological features, and holds significant conservation value for ecosystems, landscapes, and species (Nguyen Dang Hoi et al., 2020; 2021; 2024). Among these, plant diversity, especially vegetation cover diversity, is of vital importance, serving both as habitat and as a primary link in ecosystem and faunal food chains. The existence and development of plant life form the foundation for the evolution and advancement of the biosphere (Cao Van Cuong, 2018; Nguyen Dang Hoi et al., 2011).

The Song Hinh - Tay Hoa area encompasses a full range of ecosystems and landscapes characteristic of the medium mountains, low hills, and upland areas of Central Vietnam. It contains two distinct forest types: the lowland evergreen tropical forest (500–1,000 m) and the mid-mountain evergreen tropical forest (>1,000 m). These forest types are broadly similar to those in other areas, such as Hon Ba Nature Reserve and Kon Ka Kinh National Park (Nguyen Dang Hoi et al., 2014, 2022; Tran Thanh Huong et al., 2018), but the area also harbors unique elements of lowland Dipterocarpaceae, including *Dipterocarpus alatus*, *D. hasseltii*, *D. retusus*, *D. costatus*, and *Hopea odorata*. These species are typical of the flora and vegetation of the South Central Plains and Southeast China (Thai Van Trung, 1999; Kuznetsov, 2015; Vu Manh and Nguyen Van Them, 2015).

Thus, in terms of vegetation, the Song Hinh-Tay Hoa area represents a unique intersection between the South, North, and Central Highlands of Vietnam. Although individuals of these species grow on steep slopes and rocky substrates, their trunks can still reach heights of 30–35 m. Compared with the criteria for Nature Reserves stipulated in the Law on Biodiversity of Vietnam (2018) and the Forestry Law of Vietnam (2024), this area contains ecologically critical natural habitats, not only for Dak Lak Province but also for the broader evergreen tropical forest and coastal forest ecosystems of the Central Region and Vietnam as a whole.

For a protected forest, the establishment of a list of 1,163 plant species is very high and special. Although conducted over a short period of time, this survey revealed a high level of plant diversity, especially when compared with data from Kon Ka Kinh National Park in the Central Highlands with 1,022 species (Kon Ka Kinh NP, 2010) and Hon Ba Nature Reserve in Khanh Hoa Province with 752 species (Kieu et al., 2022). In addition, with 39 species on the IUCN list and the Vietnam Red Book recorded for the first time in the Song Hinh-Tay Hoa area, this study tests the high Diversity of species and their conservation value. Representative species among them include *Dalbergia oliveri; Parashorea chinensis; Diospyros mun; Cinnamomum parthenoxylon* (Fig. 5). In particular, the addition of a large number of species to the local flora within a short research period highlights the novelty of the data source. It highlights the value of plants, including new species that have not been previously recorded.

Compared with the research results of Abramov et al. (Abramov A. V. et al., 2022), the research results on mammal fauna diversity also include many new additions (58 species compared with 34 species). In particular, 20 species have been recorded on the IUCN 2025 list. *Manis javanica* and *Pygathrix nigripes* (Fig. 6b, d) are at the critically endangered (CR) level, and 3 species, *Rhinolophus rex* (Fig. 6f), *Nycticebus bengalensis*, and *Nycticebus pygmaeus*, demonstrate the outstanding value of the local fauna in the region as well as in Vietnam and globally. Thus, considering only the high conservation value of the mammal fauna and the characteristics of the vegetation types, the

Song Hinh - Tay Hoa area meets all the conditions to establish a nature reserve according to the Law on Biodiversity of Vietnam or the Law on Forestry of Vietnam.

Figure 5. Representative plant species of high conservation value in the Song Hinh - Tay Hoa area
a - *Dalbergia oliveri*; b - *Parashorea chinensis*; c - *Diospyros mun*; d - *Cinnamomum parthenoxylon*

Figure 6. Representative animal species of high conservation value in the Song Hinh - Tay Hoa area
a - *Lophura diardi*; b - *Pygathrix nigripes*; c - *Icthyophaga humilis*; d - *Manis javanicus*;
e - *Prionailurus bengalensis*; f - *Rhinolophus rex*

Among the 219 bird species recorded in the avifauna of the Song Hinh - Tay Hoa area, several species are documented for the first time in the regional fauna. Along with *Bubo nipalensis* and *Icthyophaga humilis* (EN) (Fig. 6c), the area also hosts five other species

listed as Vulnerable (VU) in the Vietnam Red Book: *Lophura diardi* (Fig. 6a), *Anastomus oscitans*, *Icthyophaga ichthyaetus*, and *Lophura nycthemera*. Notably, *Rheinardia ocellata*, classified as Critically Endangered (CR) by the IUCN (2025), makes a significant contribution to the avifauna of the study area.

The distinctive feature of the herpetofauna in the study area is its endemism, rather than its high biodiversity and conservation value alone. Among the 125 recorded species, 11 amphibian and reptile species endemic to the fauna of Vietnam and Indochina were documented. At least three species, including two frogs and one snake, are currently known only from the forests of this region: *Leptobrachella macrops* (Megophryidae: Duong et al., 2018), *Nanohyla albopunctata* (Microhylidae: Gorin et al., 2023), and *Pareas kuznetsovorum* (Pareidae: Poyarkov et al., 2022). The high frequency of rainy days and substantial annual rainfall provide favorable conditions for the formation of ecological niches for typical montane amphibians, such as *Nanohyla* species, even at relatively low elevations compared to their typical montane distribution. During our survey of the Song Hinh Protected Forest, several other montane species were recorded at relatively low elevations (200–400 m a.s.l.), including megophryids (*Ophryophryne elfina* and *Leptobrachella macrops*) and rhacophorids (*Theloderma truongsonense*). Additionally, *Gonyosoma boulengeri* (Colubridae) was recorded in the Song Hinh Protected Forest, representing the southernmost known locality for this species, which is otherwise typically distributed in southern China and northern Vietnam (Nguyen L.T. et al., 2020). The unique environmental conditions of the Song Hinh Protected Forest, combined with the observed herpetofaunal endemism (Duong et al., 2018; Poyarkov et al., 2022), underscore the need for intensified conservation efforts in this area.

In terms of humanity and socioeconomic aspects, the findings indicate a strong consensus among local communities regarding the establishment of a nature reserve on the land where they have resided for many generations. This demonstrates a significant improvement in awareness among ethnic minorities, particularly, as well as among residents in general, regarding biodiversity conservation, forest protection, and sustainable development. Such progress provides highly favorable and enabling conditions for the effective implementation of government policies on biodiversity conservation, both now and in the future.

Compared to the standards and requirements stipulated in Vietnam's current Law on Biodiversity and the Law on Forestry, all criteria related to ecosystems, biodiversity, and conservation values for establishing a nature reserve are fully satisfied and, in fact, exceeded. This not only provides a robust scientific foundation for establishing a provincial- or national-level nature reserve but also underscores the significant practical implications of conserving natural resources, maintaining essential ecosystem services, and effectively implementing Vietnam's international commitments to biodiversity conservation and sustainable development (Linh Manh Nguyen et al., 2024; Ngo Dang Nghia et al., 2025; Massimo Sarti et al., 2023).

5. Conclusions

Vietnam is a country with high biodiversity and plays an integral role in maintaining and conserving tropical ecosystems, as well as in preserving global biodiversity, both within the region and globally. In practice, Vietnam has consistently affirmed its position, role, and responsibility in implementing the Convention through concrete and practical actions, including the establishment of protected areas (such as parks and nature reserves) and the enforcement of responsibilities in the management and conservation of wildlife species.

The Song Hinh-Tay Hoa area has outstanding and unique values in terms of forest ecosystems and biodiversity. Surveys have recorded 41 plant species, 20 mammal species, 32 bird species, 14 reptile species, 6 amphibian species, and 6 freshwater fish species currently under conservation status, ranging from Near Threatened (NT) or higher, according to the IUCN Red List (2025), the Vietnam Red Data Book (2024), and Decree No. 84/2021. When evaluated against the criteria and requirements set out in the current Law on Biodiversity of Vietnam or the Law on Forestry of Vietnam, all the ecological and biological indicators are fully met or exceeded. This provides sufficient scientific and practical grounds for the establishment of a provincial- or national-level nature reserve.

Based on the characteristics of ecosystems, landscape patterns, and the distribution of species with high conservation value, the proposed Nature Reserve has been delineated into three functional zones: a Strict Protection Area encompassing 13,708 hectares; an Ecological Restoration Zone covering 23,037 hectares; and a Service-Administrative Area totaling 362 hectares, distributed across two locations: (i) west of the Song Hinh Reservoir (Site 1) and (ii) the center of Hoa My Commune (Site 2).

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Appendix A: Species of conservation value in the Song Hinh - Tay Hoa area

Table A1. Plant species of conservation value in the Song Hinh - Tay Hoa area

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
1	*Afzelia xylocarpa* (Kurz) Craib	Gõ đỏ, Gõ cà te, Gõ tò te	EN	EN	IIA
2	*Anoectochilus setaceus* Blume	Lan gấm, Lan kim tuyến			IA
3	*Aquilaria crassna* Pierre Lecomte	Dó bầu, Trầm hương	CR	EN	
4	*Ardisia brevicaulis* Diels	Cơm nguội thân ngắn		VU	
5	*Artabotrys tetramerus* Ban	Móng rồng mỏ nhọn		EN	
6	*Calamus poilanei* Conrard	Song bột		VU	
7	*Campestigma purpurea* Pierre	Kiền tím		EN	
8	*Chukrasia tabularis* A.Juss.	Lát hoa		VU	
9	*Cinnadenia paniculata* (Hook.f.) Kosterm.	Kháo xanh	VU	VU	
10	*Cinnamomum parthenoxylon* (Jack) Meisn	Xá xị, Vù hương		CR	
11	*Curculigo orchioides* Gaertn.	Cồ nốc lan, Sâm cau, Ngải cau		EN	
12	*Curcuma vitellina* Škorničk. & H.Đ.Trần	Nghệ kbang	EN		
13	*Cycas elongata* (Leandri) D.Y.Wang	Tuế lược thuôn	EN	EN	IIA
14	*Cycas inermis* Lour.	Thiên tuế không gai	VU	VU	IIA
15	*Cycas micholitzii* Dyer	Thiên tuế lá chẻ	VU	VU	IIA
16	*Cycas rumphii* Miq.	Thiên tuế Rumphius	NT		IIA
17	*Dalbergia cochinchinensis* Pierre	Trắc, Trắc bông, Trắc đen, Trắc trắng, Cẩm lai Nam Bộ	CR	EN	IIA
18	*Dalbergia oliveri* Prain	Cẩm lai bông	EN	EN	IIA
19	*Dalbergia tonkinensis* Prain	Sưa	VU	EN	IIA
20	*Diospyros mun* A.Chev. ex Lecomte	Mun	CR	VU	IIA
21	*Dipterocarpus alatus* Rob. ex G.Don	Dầu con rái, Dầu nước	VU		
22	*Dipterocarpus grandiflorus* (Blanco) Blanco	Dầu hoa to, Dầu đọt tím	EN	EN	
23	*Drynaria roosii* Nakaike	Ráng đuôi phụng Fortune, Cốt toái bổ		EN	IIA
24	*Goniothalamus vietnamensis* Bân	Bổ béo đen		VU	
25	*Hopea odorata* Rob.	Sao đen	VU		
26	*Hydnophytum formicarum* Jack	Kỳ nam kiến, Trái bí kỳ nam		EN	
27	*Ixodonerium annamense* Pit.	Néo, Dây mô		VU	
28	*Mangifera minutifolia* Evrard	Xoài rừng, Xoài lá nhỏ	EN		
29	*Markhamia stipulata* (Wall.) Seem.	Đinh, Thiết đinh lá bẹ			IIA
30	*Melientha suavis* Pierre	Rau sắng, Ngót rừng		VU	
31	*Myrmecodia tuberosa* Jack	Ổ kiến gai, Kỳ nam gai		EN	
32	*Nervilia fordii* (Hance) Schltr.	Thanh thiên quỳ, Trân châu trắng		EN	
33	*Newmania sessilanthera*	Gừng Newmania		EN	
34	*Parashorea chinensis* Hsie Wang	Chai	EN		
35	*Parashorea stellata* (Kurz) Dyer	Chò đen	VU	EN	
36	*Pterocarpus macrocarpus* Kurz	Giáng hương trái to	EN	EN	IIA
37	*Rauvolfia verticillata* (Lour.) Baill.	Ba gạc vòng, Ba gạc cambot		EN	
38	*Sindora siamensis* Miq.	Gõ mật, Gụ mật		EN	IIA
39	*Sindora tonkinensis*	Gụ lau, Gõ dầu, Gõ sương		EN	
40	*Siphonodon celastrineus* Griff.	Xưng da, Sang đá		VU	
41	*Tribulus terrestris* L.	Tật lê, Bạch tật lê		EN	

Table A2. Mammal species of conservation value in the Song Hinh - Tay Hoa area

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
1	*Rousettus leschenaulti* (Desmarest, 1820)	Dơi cáo nâu	NT		
2	*Rhinolophus rex* (G. M. Allen, 1923)	Dơi lá mũi	EN	VU	
3	*Hipposideros griffini* (Thong et al., 2012)	Dơi nếp mũi gri-phi-ni	NT	EN	
4	*Galeopterus variegatus* (Audebert, 1799)	Cầy bay		VU	IB
5	*Manis javanica* (Desmarest, 1822)	Tê tê java	CR	CR	IB
6	*Nycticebus bengalensis* (Lacépède, 1800)	Cu li lớn	EN	EN	IB
7	*Nycticebus pygmaeus* (Bonhote, 1907)	Cu li nhỏ	EN	EN	IB
8	*Macaca arctoides* (I. Geoffroy, 1831)	Khỉ mặt đỏ	VU	VU	IIB
9	*Macaca leonina* (Blyth, 1863)	Khỉ đuôi lợn	VU	VU	IIB
10	*Macaca mulatta* (Zimmermann, 1780)	Khỉ vàng		VU	IIB
11	*Pygathrix nigripes* (A. Milne-Edwards, 1871)	Chà vá chân đen	CR	EN	IB
12	*Prionailurus bengalensis* (Kerr, 1792)	Mèo rừng		VU	IIB
13	*Paradoxurus hermaphroditus* (Pallas, 1777)	Cầy vòi hương		VU	IIB
14	*Cuon alpinus* (Pallas, 1811)	Sói đỏ		CR	IB
15	*Helarctos malayanus* (Raffles, 1821)	Gấu chó	VU	CR	IB
16	*Ursus thibetanus* (G. Cuvier, 1823)	Gấu ngựa	VU	CR	IB
17	*Aonyx cinereus* (Illiger, 1815)	Dái cá vuốt bé	VU		IB
18	*Tragulus kanchil* (Raffles, 1821)	Cheo cheo thường		VU	IIB
19	*Petaurista philippensis* (Pallas, 1766)	Sóc bay trâu		VU	IIB
20	*Ratufa bicolor* (Sparrman, 1778)	Sóc đen	NT	VU	IIB

Table A3. Conservation value of bird species in the Song Hinh - Tay Hoa area

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
1	*Lophura diardi* (Bonaparte, 1856)	Gà lôi hông tía		VU	
2	*Anastomus oscitans* (Boddaert, 1783)	Cò nhạn, Cò ốc		VU	
3	*Icthyophaga ichthyaetus* (Horsfield, 1821)	Diều cá đầu xám		VU	IIB
4	*Bubo nipalensis* (Hodgson, 1836)	Rù rì nêpan		EN	IIB
5	*Anorrhinus austeni* (Jerdon, 1872)	Niệc nâu		VU	IB
6	*Arborophila chloropus* (Blyth, 1859)	Gà so ngực gụ			IIB
7	*Rheinardia ocellata* (Elliot, 1871)	Trĩ sao	CR		IB
8	*Elanus caeruleus* (Desfontaines, 1789)	Diều trắng			IIB
9	*Icthyophaga humilis* (Müller & Schlegel, 1841)	Diều cá bé		EN	IIB
10	*Nisaetus nipalensis* (Hodgson, 1836)	Diều núi			IIB
11	*Phodilus badius* (Horsfield, 1821)	Cú lợn rừng			IIB
12	*Ketupa zeylonensis* (Gmelin, 1788)	Dù dì phương đông			IIB
13	*Anthracoceros albirostris* (Shaw & Nodder, 1807)	Cao cát bụng trắng			IIB
14	*Hydrornis soror* (Wardlaw-Ramsay, 1881)	Đuôi cụt đầu xám			IIB
15	*Lophura nycthemera* (Linnaeus, 1758)	Gà lôi trắng*		VU	IB
16	*Pernis ptilorhynchus* Temminck, 1821	Diều ăn ong			IIB
17	*Spilornis cheela* (Latham, 1790)	Diều hoa miến điện			IIB
18	*Haliaeetus leucogaster* (Gmelin, 1788)	Đại bàng biển bụng trắng			IIB
19	*Ictinaetus malayensis* (Temminck, 1822)	Đại bàng mã lai			IIB
20	*Accipiter trivirgatus* (Temminck, 1824)	Ưng ấn độ			IIB
21	*Accipiter badius* (Gmelin, 1788)	Ưng xám			IIB
22	*Tyto alba* (Scopoli, 1769)	Cú lợn lưng xám			IIB
23	*Otus lettia* (Pennant, 1769)	Cú mèo khoang cổ			IIB
24	*Otus sunia* (Hodgson, 1836)	Cú mèo nhỏ			IIB
25	*Otus spilocephalus* (Blyth, 1846)	Cú mèo latusơ			IIB

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
26	*Strix leptogrammica* (Temminck, 1831)	Hù			IIB
27	*Glaucidium cuculoides* (Vigors, 1831)	Cú vọ			IIB
28	*Ninox scutulata* (Raffles, 1822)	Cú vọ lưng nâu			IIB
29	*Glaucidium brodiei* (Burton, 1836)	Cú vọ mặt trắng			IIB
30	*Hydrornis elliotii* (Oustalet, 1874)	Đuôi cụt bụng vằn			IIB
31	*Leiothrix argentauris* (Hodgson, 1837)	Kim oanh tai bạc			IIB
32	*Garrulax leucolophus* (Hardwicke, 1815)	Khướu đầu trắng			IIB

Table A4. Reptile and amphibian species of conservation value in the Song Hinh - Tay Hoa area

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
1	*Ptyas korros* (Schlegel, 1837)	Rắn ráo thường	NT	VU	
2	*Ptyas mucosa* (Linnaeus, 1758)	Rắn ráo trâu		EN	IIB
3	*Ophiophagus hannah* Cantor, 1836	Rắn hổ chúa	VU	CR	IB
4	*Bungarus fasciatus* (Schneider, 1801)	Rắn cạp nong		NT	
5	*Naja kaouthia* (Lesson, 1831)	Rắn hổ mang một mắt kính		VU	IIB
6	*Goniurosaurus* sp.	Thạch sùng mí			IIB
7	*Bronchocela vietnamensis* (Hallermann & Orlov, 2005)	Nhông đuôi dài Việt Nam		VU	
8	*Bronchocela smaragdina* (Günther, 1864)	Nhông đuôi dài smaradina		NT	
9	*Physignathus cocincinus* (Cuvier, 1829)	Rồng đất	VU	VU	
10	*Gekko gecko* (Linnaeus, 1758)	Tắc kè		NT	
11	*Varanus bengalensis* (Gray, 1831)	Kỳ đà vân	NT		IB
12	*Pelodiscus sinensis* Wiegmann, 1835	Ba ba trơn	VU		
13	*Cuora picturata* (Lehr, Fritz & Obst, 1998)	Rùa hộp trán vàng miền nam	CR	CR	IB
14	*Cyclemys pluchristriata* (Fritz, Gaulke & Lehr, 1997, 1997)	Rùa đất punkin	EN		IIB
15	*Rhacophorus kio* (Ohler & Delorme, 2006)	Ếch cây Kio		EN	
16	*Theloderma palliatum* (Rowley, Le, Hoang, Dau, and Cao, 2011)	Nhái cây trá hình	EN	EN	
17	*Ophryophryne gerti* (Ohler, 2003)	Cóc núi Gerti	EN		
18	*Leptobrachella macrops* (Duong, Do, Ngo, Nguyen & Poyarkov, 2018)	Cóc mày mắt to	EN		
19	*Microhyla pineticola* (Poyarkov, Vassilieva, Orlov, Galoyan, Tran, Le, Kretova & Geissler, 2014)	Nhái bầu thông	VU	NT	
20	*Ichthyophis bannanicus* (Taylor, 1960)	Ếch giun		VU	

Table A5. Freshwater fish species of conservation value in the Song Hinh - Tay Hoa area

No	Scientific name	Vietnamese name	Conservation value		
			IUCN 2025	Red Book 2024	Decree No. 84
1	*Anguilla marmorata* (Quoy & Gaimard, 1824)	Cá Chình bông		EN	-
2	*Cirrhinus microlepis* (Sauvage, 1878)	Cá Duồng	VU	VU	-
3	*Bagarius bagarius* (Hamilton, 1822)	Cá Chiên	VU	-	-
4	*Chitala chitala* (Hamilton, 1822)	Cá Thát lát cườm	NT	-	-
5	*Notopterus notopterus* (Pallas, 1769)	Cá Thát lát		VU	-
6	*Rhinogobius lineatus* (Chen, Kottelat & Miller 1999)	Cá Bống đá	EN	-	-

IA - Forest plant species that are critically endangered and strictly prohibited from exploitation and commercial use; includes species naturally distributed in Vietnam listed in CITES Appendix I.
IIA - Forest plant species that are not yet critically endangered but may become so without strict management; their exploitation and commercial use are restricted. The species naturally distributed in Vietnam are listed in CITES Appendix II.

Appendix B: Species of high conservation value in the Song Hinh - Tay Hoa area

Figure B1. Photos of representative plant species of high conservation value in the Song Hinh - Tay Hoa area

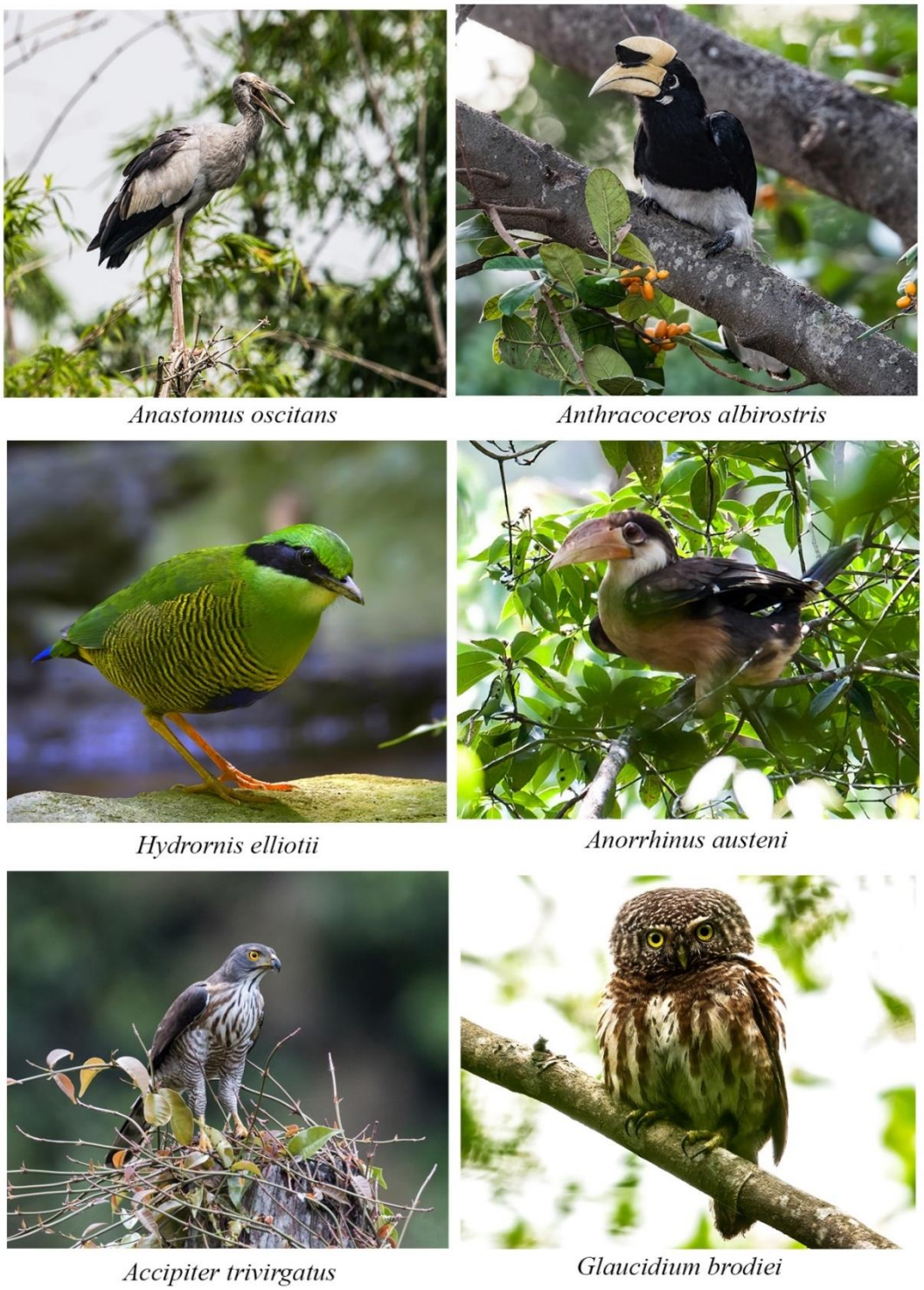

Figure B2. Photos of representative bird species of high conservation value in the Song Hinh - Tay Hoa area

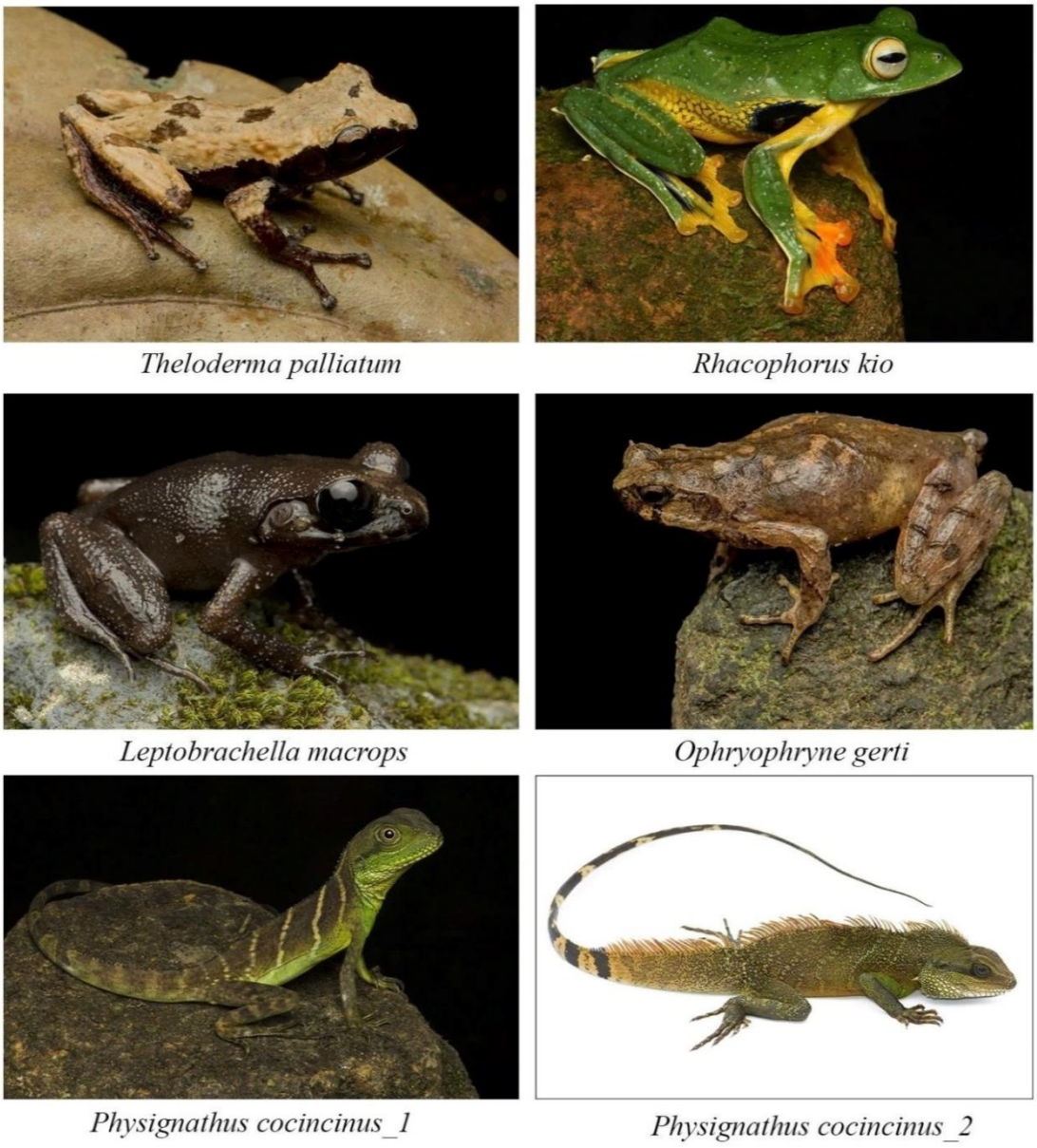

Figure B3. Photos of representative reptile and amphibian species of high conservation value in the Song Hinh - Tay Hoa area