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CURRENT BIODIVERSITY AND THE CHALLENGES FOR BIODIVERSITY CONSERVATION IN THE PU MAT NATIONAL PARK

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Abstract. This research synthesizes the most advanced progress on biodiversity in recent decades to develop a set of information about the current condition of biodiversity in the Pu Mat national park. Data was collected from reliable documents nationally, updated statistics, and maps from management committees associated with field surveys in the study area. After implementing data synthesis, analysis, and inheritance from the previous related research and using a geographic information system (GIS), the findings indicated that: 1) Pu Mat National Park protects the rare genetic resources of Vietnam, which include 2600 floral species, 1121 animal species, and four typical ecosystems of evergreen- broadleaf natural forest, mixed wood-bamboo ecosystem, natural bamboo ecosystem and grass-shrubs ecosystem; 2) establishing an ecosystem map based on the integration of the forest current maps, forest inventory maps, land use current maps in Pu Mat National Park area, scale 1:50,000; and 3) identifying factors challenging in biodiversity conversation in Pu Mat national park. The main challenging factors present, (1) the need of using biodiversity resources; (2) the urbanization process; (3) the interference with the environment and habitat from human beings; (4) climate change; and (5) the development of tourism. Understanding the current state of the study area and gaining a comprehensive understanding of biodiversity would allow for the most feasible and practical conservation strategies to be suggested for Pu Mat National Park.

Keywords: conservation of biodiversity, challenges, and Pu Mat National Park.

1. Introduction

Biodiversity is an essential resource for maintaining the sustainable development of human society. It is a common term for all species of organisms, the genetic variation within the species and ecosystems in which they form habitat [1, 2]. Around the world,

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there are various studies about biodiversity. The biodiversity conversation and sustainable usage are closely linked to the socio-economic development in each nation. This not only is a hot issue in separated nations but has also become an important mission around the world, and the core research in the 21st century [1, 3]. As a shorthand description of this great variety of life, the term "biodiversity" is a contraction of "biological diversity", and was first coined by Walter Rosen for the 1986 National Forum on Biodiversity [4]. However, biodiversity refers to more than just an accumulation of species. If only that were the case, we may hope to preserve biodiversity in a particular area, similar to a zoo. Instead, biodiversity also refers to organisms' existence in situ and incorporates the ecological and evolutionary interactions among them. For example, the UN Convention on Biological Diversity defines biodiversity as "... the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" [5]. Nowadays, the urbanization process imposes major challenges to biodiversity conservation as it has already induced a profound transformation at the landscape level and is regarded as a major threat to biodiversity [6]. As the human population grows extraordinarily, especially in developing countries [7, 8], so do conflicts with conservation aims [9-13].

Pu Mat National Park, which is part of the Western Nghe An Biosphere Reserve, has a sizable amount of natural forest, a rich and varied flora, and several species that are classified in Vietnam's Red Book [14]. According to national and international scientists, the Western Nghe An Biosphere Reserve is considered one of the special-use forests with high biodiversity value, and biodiversity resources, and was recognized by UNESCO as a world biosphere reserve in November 2007. However, Pu Mat National Park's biodiversity has been severely compromised as a result of environmental pollution, over-exploitation of natural resources, the conversion of land without adequate scientific justification, the rapid development of infrastructure, the expansion of agriculture to keep up with the rapid population growth, and the impossibility of managing biological resources in a sustainable manner. Therefore, biodiversity in Pu Mat national park is facing many challenges in conservation and development in the area.

Many researches were conducted on endangered plant species in Pu Mat National Park such as Nguyen Thi Nhan et al (2015), and her research supplemented in 2021 on the diversity of higher vascular plants in Pu Mat National Park. Previously [15], Nguyen Nghia Thin (2004) studied biodiversity in the amount of floral and animal species at Pumat National Park [16]. Also, there are several researches related to the biodiversity in Pumat National. Although, researches at Pu Mat National Park on forest biodiversity and forest impacts on the environment are conducted continuously and comprehensively in terms of content, space, as well as research subjects. However, generally, these comprehensive studies were scattered and not systematic.

This paper synthesizes a dataset on the current biodiversity of flora and fauna species in Pu Mat Nation Park, and identifies challenges and threats affecting to biodiversity. Additionally, this research creates a new map of ecosystems using

overlapping maps. This aims to provide readers with an intuitive understanding of biodiversity and ecology, which serves as a foundation for outlining the most practical and efficient approaches to preserving biodiversity in Pu Mat National Park.

2. Content

2.1. Data and Methodology

**** Data***

In the districts of Anh Son, Con Cuong, and Tuong Duong in the province of Nghe An, information on biodiversity, socioeconomic statistics, statistical yearbooks for 2021 and 2022, maps of current land use in the three districts in 2020 at a scale of 1:50.000, maps of current forest in Pu Mat National Park in 2020 at a scale of 1:50.000, and maps of forest inventory in Pu Mat National Park in 2015 at a scale of 1:50.000 were used to collect data.

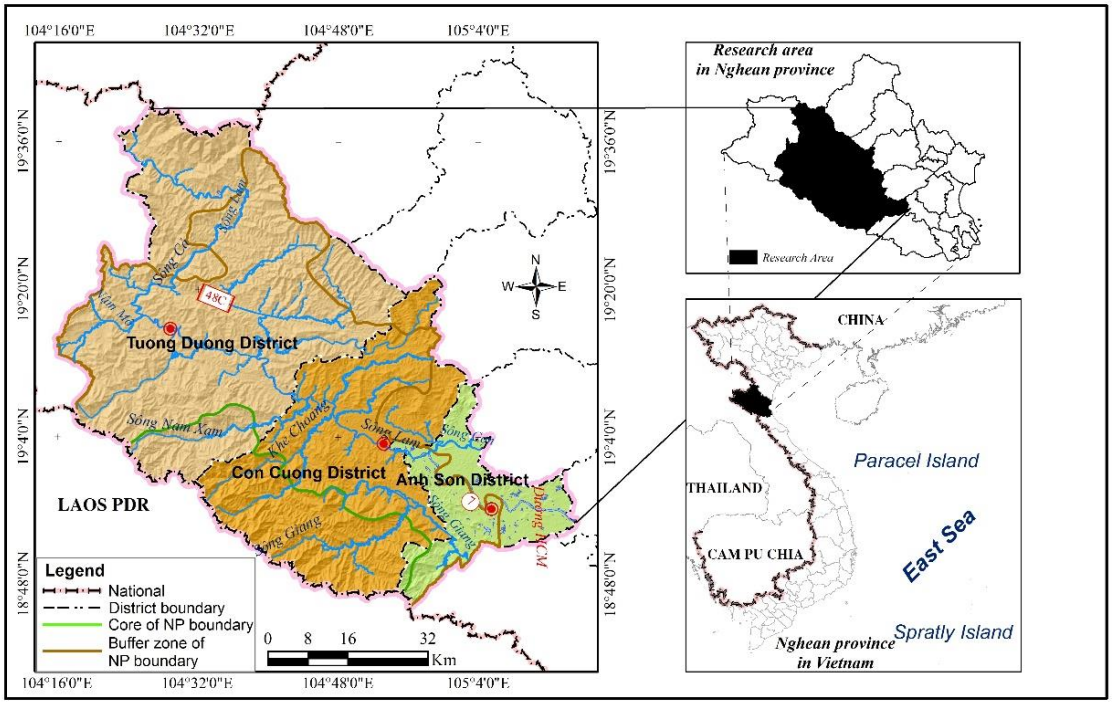

Figure 1. Position map of the research area

**** Methodology***

- Data collection, synthesis, and analysis

Using this strategy, information on the local biodiversity will be gathered from earlier studies, published works, journals, and relevant maps. The data analysis, data evaluation, data synthesis, and data update are conducted and processed in order to make the most corrective suggestions and development orientations in line with the inherent potential of the study area aimed to serve the research purposes.

- *Field surveys*

This method gives us more complete information about the characteristics of the natural components, the socio-economic characteristics, and the factors affecting biodiversity. The authors of this article conducted following field surveys: A field survey along National Highway 7 and sociological investigation into how socio-economic activity affects ecosystems in four villages in Con Cuong district (Yen Khe, Chi Khe, Mon Son, Cam Son, and Thach Ngan); three villages in Tuong Duong district (Xa Luong, Thach Giam, and Yen Na), and three villages in Anh Son district (Thach Son, Hoi Son, Khai Son).

- *Mapping and GIS*

In the geographical study, a geographic information system (GIS) is a distinctive and essential technique. Building and editing the component maps and natural ecosystem maps in Pu Mat national park were carried out in the ArcGIS 10.5 environment setting with the support of available tools - Union Tool. The built map results would clarify the spatial and area division of natural ecosystem units. Statistics are made to show the percentage of the area of natural ecosystems compared to the total area of natural ecosystems and the total area of the whole region.

This would be the basic contribution for managers to make decisions on the organization and the use of the territory quickly and effectively, and to develop planning approaches and territorial design reasonably.

2.2. Results and discussion

2.2.1. Current biodiversity in Pu Mat National Park

According to the Law on Biodiversity 2008, biodiversity is the richness of genes, biological species, and ecosystems in nature, and the conservation of biodiversity is the protection of the richness of important natural ecosystems. Raising, planting, and taking care of species on the list of endangered precious and rare species are prioritized for the protection, preservation, and long-term preservation of genetic specimens. The interdependence of the four elements of ecosystems, species, genetic diversity, and the benefits that nature brings to humankind provides an excellent opportunity to plan current and future policies and actions to coordinate and interact [17]. Thus, three components make up biodiversity: the ecosystem, the species, and the genetic information.

2.2.2. Biodiversity

Pu Mat National Park, situated on the northern Annamite range (Northern Truong Son), is the largest biodiversity conservation area representing the largest typical tropical and subtropical forest ecosystem in the Northern Truong Son area with 4 typical ecosystems. They include evergreen-broadleaf natural forests, mixed wood-bamboo ecosystem, bamboo ecosystem, and grass-shrubs ecosystem.

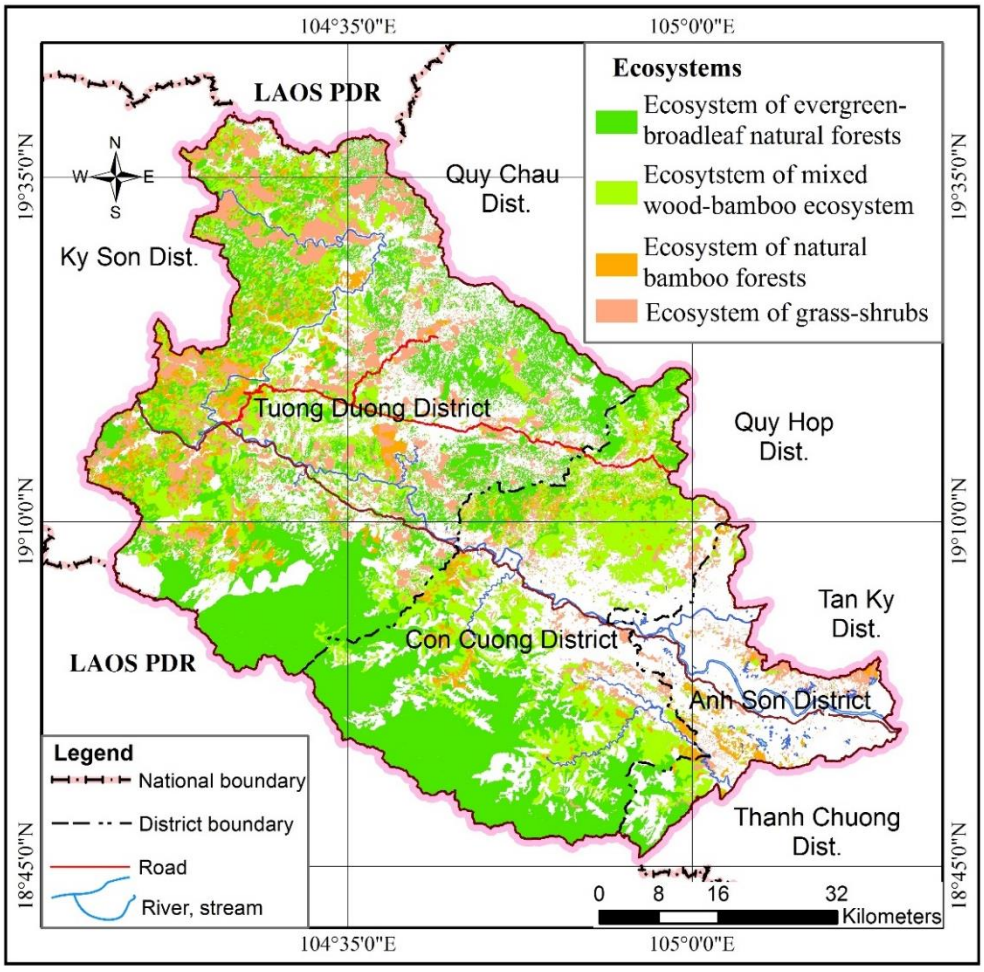

Figure 2. Distribution map of ecosystems in Pu Mat National Park

Table 1. Areas and percentages of ecosystems in Pu Mat National Park

No.	Names of the natural ecosystems	Areas	Percentages on each natural ecosystem	Percentages on the whole area
1	Ecosystem of Evergreen-broadleaf natural forests	152.975,29	42,75	29,72
2	Ecosystem of natural bamboo forests	24.689,40	6,90	4,80
3	Ecosystem of mixed wood-bamboo	86.636,20	24,21	16,83
4	Ecosystem of grass-shrubs	73.249,62	20,47	14,22
	The total area of the natural ecosystems	*357.820,60*	*100,00*	*69,51*
	The total area of the whole area	*514.797,95*		*100,00*

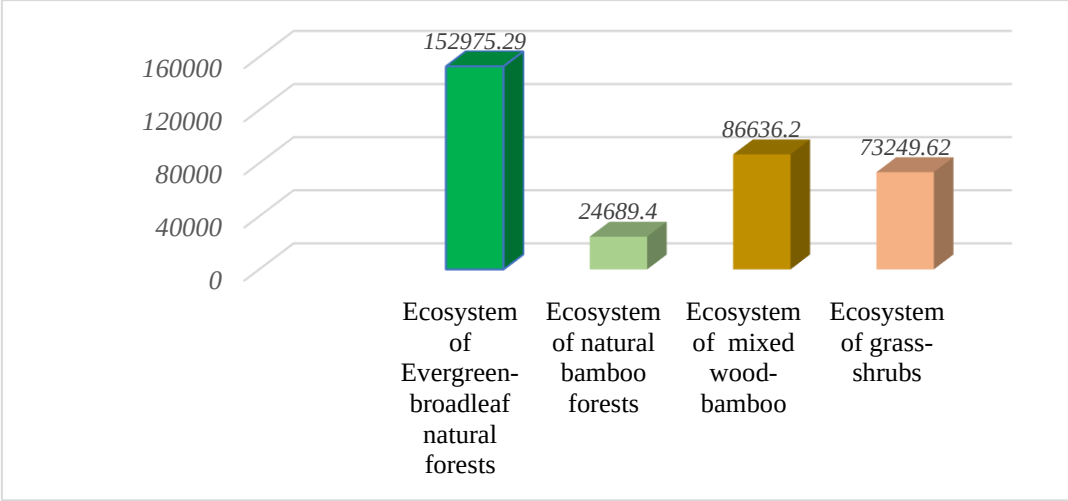

Figure 3. The areas of the natural ecosystems in Pu Mat National Park

**** The ecosystem of evergreen - broadleaf natural forests***

Closed evergreen forest system in the rainy season on the high mountains

The vegetation belonging to the subclass of the closed evergreen seasonal rain forest on the high mountains represents the characteristics of the subtropical vegetation. The structure consists of 4 layers. The fresh vegetation layer is mainly regenerated young trees of the wood tree layers. The ecological dominant layer includes species over 20 m high [15, 16]. The lower canopy layer consists of species from 10 m to 20 m high. The low and shrubs layer consists of trees with a height of 5 m to less than 10 m. The current forest is rich, there is no layer over the canopy, few trees, and very few woody vines.

Dwarf forest system

This type of forest occurs at an altitude of over 1,500 m on steep slopes and mountains with strong winds. This is a very special type of vegetation belonging to the high belt on the terrain of Pu Mat National Park. The characterized type of forest is often very low tree species, which is suitable for high mountainous terrain, reaching only about 10 m. Because of this structure, the vegetation has only one layer of standing trees made up of these trees. The whole area of the dwarf peak forest is more than 14,000 ha (accounting for nearly 1/7 of the core area of the national park) [15, 16].

Closed evergreen forest system with low, steep seasonal rain

At an altitude of below 800 m, this type of forest occupies a relatively large area, with a rich composition and a number of tree species. The average height of the tree species is from 13 - 15 m. The regeneration situation is good, in which the species of Tram, Gioi, Nhac, Oak, and bamboo leaf grow, develop and regenerate the best. One characteristic is that although Chukrasia tabularis species is not dominant, it is relatively widely distributed in the belt below 600 m. In the north of this area, there is a monophyletic (Hopeamollissima), its predominance has created an evergreen closed forest. The vegetation is composed of four layers and is primarily made up of woody vines.

Closed evergreen forest system in the rainy season on limestone soil

Limestone mountains in Pu Mat National Park occupy a rather large area, mainly bordering between the buffer zone and the core zone, close to National Highway 7, scattered throughout from Anh Son district to Tuong Duong district, alternating among mountains earth.

On the top of the mountain, the vegetation is made up of small trees, the trunk is dense and curved, the leaves are small, and the structure consists of 2 layers of trees.

At the mountainside, the vegetation has 3 layers, including 2 layers of trees and 1 layer of fresh vegetation. The canopy cover is about 60 - 70%, the reserve is about 30 m^3/ha. [15, 16] At the foothill's valleys, the soil is moist and thick, the number of layers of this vegetation type can be up to 4 layers, the cycads and vines are abundant, and the biomass is relatively large. In addition, there are some other features such as tree trunks. This vegetation layer is often occurred on the slopes of limestone mountains, in arid places with poor soil. The feature of this vegetation is low biomass, the tree height gets a maximum of about 15m, and there are 3 layers of extraterrestrial plants.

**** The Mixed Wood-Bamboo Ecosystem***

This ecosystem occupies a relatively large area (nearly 11%) of the total area of the park. This type of forest is also the result of natural regeneration from the affected forest after shifting cultivation on fallow land. On fallow soil, the thick soil layer and the relatively high humidity ensure a favorable environment for bamboo to grow alternatively with the remaining broadleaf trees or regenerate from the previous broadleaf forest and adjacent broadleaf forests.

The mixed wood-bamboo ecosystem has many economically valued trees that continue to regenerate, grow and develop well, such as Lithocarpus dealbatus (*Lithocarpus cornea*), (*Peltophorum dasyrhachis, Chukrasia tabularis* A. Juss., Vatica odorata, etc. with an average reserve of 100 - 120 m^3/ha [15, 16].

**** The Bamboo Ecosystem***

Bamboo forests develop on arable land after shifting cultivation land that has not been eroded and depleted. However, because the strong impacts of shifting cultivation make the land arid and degraded, a few broadleaf species develop well. Therefore, bamboo occurred, strongly thrived, and become dominant.

**** The Grass-Shrub Ecosystem***

The grass-shrub ecosystem is the previously cultivated area after a period of fallow, but it is not enough time to proceed to the next process of the forest. With a height of 5 to 8 m, and sparse coverage, it includes trees, the typical species are grasslands, reeds, myrtle, etc., and sometimes shrubs and small trees such as Sau sau (Liquidambar formosora), Thanh nganh, Ba soi (Macaranga denticulata). This type of ecosystem is found in many places in the buffer zones of Pu Mat protected areas (Chau Khe, Chi Khe, Khe Khang, Yen Khe), Pu Huong (Chau Thai, Chau Cuong, Chau Phong, Chau Ly), Pu Hoat

(Tri Le, Tien Phong) and the villages of Luu Kien, Nga My, Thach Giam (Tuong Duong) [15, 16].

2.2.3. Species diversity

Plant diversity

A summary of research results from national and international experts so far shows that the flora of Pu Mat comprises a large number of species with 2,600 species of plants, and 943 genera belonging to 204 families [15, 16].

Table 2. List of the plant in Pu Mat National Park

The Flora Phyla	Families		Genera		Species	
	Number	***%***	***Number***	***%***	***Number***	***%***
Phylum of Psilotophyta	1	0.49	1	0.11	1	0.04
Phylum of Lycopodiophyta	2	0.98	3	0.32	18	0.69
Phylum of Equicetophyta	1	0.49	1	0.11	1	0.04
Phylum of Polypodiophyta	24	11.76	69	7.32	150	5.77
Phylum of Conifer (Pinophyta)	7	3.43	12	1.27	18	0.69
Phylum of Magnolia (Magnoliophytal)	169	82.84	857	90.88	2412	92.77
Total	***204***	***100***	***943***	***100***	***2.600***	***100***

(Source: [15])

The Magnoliophyta is the most abundant in 2412 species, accounting for 92.80% of the total species of the higher vascular flora of Pu Mat National Park. It is followed by polypodiophyta, pinophyta, lycopodiophyte. Especially, the highlight is the diversity of the group of trees providing oil, resin, and camphor family in Pu Mat National Park.

On the other hand, in addition to indigenous elements and a practical location, this abundance has made it simple to introduce several vegetative streams from various places (Table 3), resulting in a diversity of geographical elements in the flora of Pu Mat National Park.

Table 3. Vegetation Streams to Pu Mat National Park

Vegetative Migration Streams	**Species Representative**
The Himalayan - Yunnan - Guizhou vegetative stream migrates down	Species representative for Pinophyta and deciduous broadleaf species
Malaysia - Indonesia vegetative stream from the south up	Representative for Dipterocarpaceae
India - Myanmar vegetative stream immigrated to from the West	Representative for Lythraceae, and Combretaceae

[Source: 14]

In addition to the diversity of species composition, diversity of geographical factors, the flora of Pu Mat National Park also has a diversity of valued uses such as medicinal plants, timber trees, and food crops, ornamental plants, plants for fatty oils, plants for essential oils, fiber plants and plants with toxic substances. The vascular flora of Pu Mat National Park consists of 2,369 species and 1,567 species with known valued uses, accounting for 60.27% of the total species of the whole system [14-17]. This is a relatively high rate compared to other special-use forests. It also has a significant orientation in conservation as well as in exploiting the potential of the socio-economic development in the region.

Animal diversity

The fauna of Pu Mat National Park is known for three endemic species of Indochinese mammals, including Sao La (Pseudoryx ngotinhensis), striped rabbit (Nesolagus timminsi), white-cheeked gibbon (Nomascus leucogenys) [17]. Species composition: Results of surveys from national and international scientists presents 1121 animals belonging to the groups of mammals, birds, reptiles, amphibians, fish, etc (Table 4).

Table 4. List of animals in Pu Mat National Park

Class	Numbers of order	Numbers of family	Numbers of species	Number of species on the red list of IUCN 2007	Number of species listed in the Red Book of Vietnam (RBD 2007)
Mammals	11	30	132		
Birds	14	49	361		
Reptiles	2	15	53	17	20
Amphibians	2	6	33	23	3
Fish	5	19	83		5
Day Butterflies	1	11	365		3
Night Butterflies	1	2	94		
Total	**36**	**132**	**1121**		

(Source: [17-19])

Especially, populations of some birds and large mammal species, at risk of being destroyed in Vietnam and around the world, still have the potential to be preserved and developed in the process of managing and protecting Pu National Park. They are Elephant (Elephas maximus), Tiger (Panthera tigris), Saola (Pseudoyx Nghetinhensis), Bear (Bos gaurus), etc.

In addition, Pu Mat National Park, with the characteristics of tropical forests on limestone mountains, many caves, and small streams, has created a suitable environment for many bats species. This is one of the greatest diverse areas of numbers of bat species compared to many other regions in the country with 43 species of bats, belonging to 6 families.

The fauna of Pu Mat National Park has a high diversity of endemic elements. There are typical species such as Heude's pig (Chao vao, Sus bucculenus), Saola (Pseudoryx Nghetinhensis), Giant muntjac (Megamuntiacus vuquangensis), Truong Son Muntjac (Muntiacus truongsonensis), Brown-shanked Douc (Pygatherix nemaeus), Yellow-cheeked gibbon (Hylobates leucogenys), Phayre's leaf monkey (Trachypithecus phayrei) Striped rabbit (Nesolagus temminsii), Striped civet (Chrotogale owstoni), Star pheasant (Rheinardia ocellate), Long-beaked babbler (Jaboulleia danjoui). Thus, in the field of species conservation, Pu Mat is not only a national-scale area.

The values brought by the fauna include 1) direct economic values for daily consumption and production, 2) indirect economic values such as value from decomposing bacteria playing a role as an important link in the ecological food chain, 3) educational and scientific values.

2.2.4. Diversity in genetic resources

Biodiversity studies at the gene level are very limited, so the diversity of rare genetic resources in Pu Mat National Park has not been fully listed. According to the research results, there are a total of 72 rare and precious floral species investigated in Pu Mat National Park, of which: According to government decree 32/2006 NDCP, there are 18 species; according to the Vietnam Red Book (2007) there are 63 species and according to the IUCN/2014 Red Book there are 7 species (a species can be found in both Decree 32 and the Red Book) [15, 17-20].

Pu Mat National Park has now identified four species as Critically Endangered (CR) and Vulnerable (VU) in the 2007 Vietnam Red Book [20]. In which, there is one critically endangered (CR) species, which is Cinnamomum parthenoxylon (Jack.) (Meisn). Endangered species of oval fruit (Actinodaphne elliptibacca Kosterm.), Cinnamomum balansae Lecomte, Cinnamomum cambodianum Lecomte (VU) are endangered. Cinnamomum balansae Lecomte (Cinnamomum balansae Lecomte) is on the World Red List (IUCN, 2017) [17] at Endangered (EN) and ND32/CP (2006) [11] prohibits exploitation and trade for commercial purposes. These are species with economic value such as essential oils, for medicinal purposes. Especially, since the wood is very good, it has been thoroughly exploited, which leads to only small regenerated trees remaining.

2.3. Challenges in biodiversity conservation in Pu Mat National Park

Currently, biodiversity in Vietnam as well as Pu Mat National Park are facing many challenges in biodiversity conservation. According to Carew-Reid et al (2010) and Rhind (2012) [21, 22], the main threats to Vietnam's biodiversity in descending order are the following: 1) illegal hunting and trading of wild animals; 2) infrastructure development; 3) deforestation and illegal timber trade. From the integration of the results of the literature review, the list of threats mentioned in the protected areas of the national park, and the field surveys in the study areashow that Pu Mat NP is also facing challenges as follows:

First of all, using biodiversity resources necessitates engaging in hunting and trapping uncommon species as well as logging and cultivating terrestrial plants. Despite

the provisions of the law, there is a large market for the illegal trading and consumption of wildlife parts and their derivatives. Although many subjects have been handled for hunting, trading, and transporting rare animals, this situation is still occurred in the territory of Pu Mat National Park (Con Cuong, Nghe An. An) [23, 24]. That makes the population of wildlife species in Pu Mat National Park decrease, especially, Saola (Pseudoryxghetinhenis). It is a mysterious animal species in the world discovered for the first time in Vu Quang National Park in Ha Tinh province in 1992 and first photographed in the wild in October 1998 at Pu Mat National Park. However, information about Saola has gradually decreased, many surveys had been taken place in the area from 1999 to 2004 in combination with camera traps but there have still been no results.

Although illegal logging occurs along with riverbanks and valleys within the national park, these activities take a long time at several sites. This changes forest structure and affects populations of several important tree species, including globally threatened species such as Po mu Fokienia hodginsii, and oilseeds plants (Dipterocarpaceae). The exploitation of rattan and orchid also threatens to wipe out these species in the national park.

This is a big risk in Pu Mat National Park area. The heavy dependence on mankind's living resulted from their difficult living conditions, and limited awareness, it gradually leads to harmful activities to forest resources. This is mainly the cause threatening the extinction of many animal species. If there is a plan to change local people's lifestyles, it will help reduce pressure and impact the quality of the living environment in the study area. This is also one of the major challenges in biodiversity conservation at Pu Mat National Park

Secondly, the process of urbanization includes pressure on population growth and infrastructure development.

Table 5. Average population and population density in Pu Mat National Park over the years

No	Administrative units	Area (km^2)	2017 (people)	2018 (people)	2019 (people)	2020 (people)
1	Tuong Duong District	2.808	75.673	76.813	77.940	78.272
2	Con Cuong District	1.738	73.856	74.822	75.681	76.234
3	Anh Son District	604	114.085	115.825	117.507	118.106
4	The study area	5.150	263.614	267.460	271.128	272.612

(Source: [25])

The area of the study area is 5,150.28 sq.km, accounting for 31% of the province's area. The area of Nghe An is 16,486.50 km^2. The average population in 2020 Pu Mat National Park is 269,920 people, and density is 53%, accounting for 8.1% of the whole population of Nghe An (3,365,198 people). The population is densely distributed and the population density is high in the centers, in the towns, and gradually low in the villages.The urban population is 521,606 people, accounting for 16% of the whole study

area; the rural population is 2,843,592 people, accounting for 84.50% of the whole population of the study area [25]. The local labor force is large, but the structure of occupations in the study area is simple, people are mainly engaged in agriculture. In recent years, the economic opening policy, the increase in population density, and deforestation and environmental degradation have created a crisis in upland agriculture, which leads to the degradation of natural ecosystems and natural resources. The overabundance of labor and life difficulties have led people to Pu Mat National Park to illegally exploit forest products and natural resources, affecting biodiversity conservation. Lack of land and investment capital, the poor have to use natural resources to maintain their lives, which makes these resources degrade rapidly, and leads to biodiversity loss.

The development of transport infrastructure in the area is identified as a risk affecting the quality of the living environment in Pu Mat National Park. In the area, there are several newly built routes, such as Co Phat - Ban Bung, Khe Choang border route, for patrol works and trade connections. However, it also partly causes the fragmentation of ecosystems, creates opportunities for illegal animal hunting, and negative impact on the quality of the natural environment here.

The development of the hydropower system has been contributing to the socio-economic development of Nghe An province in general and Pu Mat National Park in particular. In the area of Pu Mat National Park, there are 8 hydroelectric power plants that have been put into operation, while the construction of the other two, Yen Thang and Mon Son, are temporarily stopped. In addition to the positive factors, the development of hydroelectricity in the area has a great impact on biodiversity. When forming a reservoir, some areas of the following types of forests are narrowed and damaged: restored forests, poor forests, bamboo forests, mixed bamboo forests, shrubs. Besides, a little agricultural land, natural landscapes nature, and flows are changed, which affects the water demand of different types of land use [26, 27].

Thirdly, the interference with the environment and habitat in the NP by the local people includes deforestation activities for many purposes, such as shifting cultivation due to shifting cultivation; expansion of intensive agricultural production, or conversion of forest land into industrial crops. Moreover, widespread illegal gold mining is also a factor in the threat to biodiversity in Pu Mat National Park. Gold mining is mainly carried out by residents living outside the buffer zone of the national park and is mainly concentrated along Khe Thoi in the northwest. Gold mining activities have changed the shape and structure of riverbanks, caused landslides, and increased the amount of sediment in the water, which affects the lives of many animals [28].

Fourthly, climate change is becoming an increasingly serious cause of biodiversity loss and ecosystem degradation [1], and the change of habitat conditions. According to a forecast by the Institute of Meteorology - Hydrology and Climate Change (Ministry of Natural Resources and Environment), the average annual temperature of Vietnam will increase by about 2.3 ^{o}C by the end of the 21st century. That will change the distribution and population structure of many ecosystems. Scientists have found that the migration of some species due to global warming. Pu Mat National Park is located in the tropical

monsoon region. The Annamite range's impact on air circulation causes the climate in this area to be highly characterized and unique. One of the reasons that forest fires are still occurring in the research area is the effect of the foehn regime during the southwest monsoon season, which results in a harsh climate with persistently high temperatures.

Fifthly, the tourism development of Pu Mat National Park with beautiful landscape valued as a gifted from nature is currently the target of ecotourism exploitation in Nghe An. The highlight tourist attractions, such as Kem Waterfall, Giang River, and the routes to Vietnam's heritage trees, in the core area of the park are being promoted for investment and tourism. However, if tourism activities are not well managed, this is a risk that has an impact on the quality of the living environment in the area, exceeding the carrying capacity of the environment, and causing strong impacts on the environmental quality.

3. Conclusions

Biodiversity is an essential foundation for human existence and development. Therefore, the conservation of biodiversity is a general objective not only in each country but also around the world. Pu Mat National Park is a conservation area with high biodiversity. However, the conservation of biodiversity here is facing many difficulties and challenges. Pu Mat National Park is located in the northern Annamite range (Northern Truong Son), this is a biodiversity conservation area representing the largest typical tropical and subtropical forest ecosystem in the North Truong Son area, where Vietnam's rare genetic resources of Vietnam. Pu Mat National Park has a rich and diverse flora and fauna with 2600 floral species, 1121 faunal species, and four ecosystems types which consist of an evergreen- broadleaf natural forest ecosystem, mixed wood-bamboo ecosystem, natural bamboo forests ecosystem, grass-shrubs ecosystem. Furthermore, the study used the GIS method to establish a map of the natural ecosystem of Pu Mat National Park on the basis of the integration of forest current maps, forest inventory maps, and land use current maps in Pu Mat National Park area, scale 1:50.000. From the final integrated map, the percentage of the area of natural ecosystems can be calculated compared to the total area of natural ecosystems and the total area of the whole region. This study would help readers understand and have a clear overview of the current biodiversity in Pu Mat National Park. The result also identified challenges in biodiversity conversation in Pu Mat national park. The main challenging factors present, firstly, the need of using biodiversity resources, including hunting and catching rare and precious animals, logging, and terrestrial plant species; secondly, the urbanization process including the pressure of population growth and the development of infrastructure; thirdly, the interference to the environment and habitat from human beings, including deforestation and gold mining; fourthly, the climate change; and fifthly, the development of tourism. In consequence, this would make a basic foundation for proposing the most reasonable and effective solutions to biodiversity conservation in Pu Mat national park.

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