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Diversity Of Large Mammals In Ujung Kulon National Park
(Diversity Of Large Mammals In Ujung Kulon National Park)

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Abstract

This study aims to find out the diversity of species of large mammals in Ujung Kulon National Park. This research was conducted at 4 research stations, namely Peucang Island, Handeuleum Island, Cigenter, and Cidaon on March-June 2021. The research method used was path transect combined with Variable Circular-Plot (VCP) method with direct and indirect observation research techniques. The results of observations in Taman Nasional Ujung Kulon were found as many as 6 species of large mammals, namely Macaca fasicularis, Cervus timorensis, Bos javanicus, Sus scrofa vitalus, Rhinoceros sondaicus, and Cuon alpinus. Based on the research result the species diversity index is 1.50 was a medium category, species richness index is 0.93 was a low category, and species evennes index is 0,84 was a medium category. The results of this study will be implemented as a preliminary study of vertebrate subconcepts development research.

Introduction

Ujung Kulon National Park according to its administrative location is located in the Sumur District and Cimanggu District, Pandeglang Regency, Banten, while according to its geographical location it is between 06º52'17"S 105º37'37"E and 06º30'43"S 105º37'37"E (Park Office Ujung Kulon National, 2009). Officially on February 26, 1992 Ujung Kulon National Park became a national park based on the Decree of the Minister of Forestry Number: 284/KPTS-II/1992 with a total area of 122,956 Ha (Ujung Kulon National Park Office, 2009). Ujung Kulon National Park has a relatively high level of biodiversity covering various types of ecosystems, including grassland ecosystems, lowland rain forest ecosystems, coastal forest ecosystems, freshwater swamp forest ecosystems, and mangrove forest ecosystems (Ujung Kulon National Park Office, 2017). The diversity of ecosystems owned by Ujung Kulon National Park is able to support the life and development of plants and animals, one of which is the mammal group.

Mammals belong to the group of vertebrate animals, are homoiothermic, their body skin is overgrown with hair and have mammary glands or mammary glands (Nurhakim, 2016). Based on their body size, mammals can be categorized as large mammals (mammals with an adult body weight >5 kg) and small mammals (mammals with an adult body weight <5 kg) (Nasir et al., 2017). Mammal taxa have an important role in the ecosystem, namely as seed dispersing agents, helping to pollinate flowers, controlling insects, and loosening soil (Sulistyadi, 2016). Kartono (2015) explained that mammalian taxa have an important role in the process of defense and continuity of ecological processes that have great benefits for human life. Considering that this group of animals tends to be vulnerable to extinction due to habitat

destruction, habitat fragmentation and low reproduction rates (Cardillo et al., 2005), as well as the limited number of sampling locations resulting in less variation of habitat at sampling locations in previous studies on the diversity of large mammals in parks Ujung Kulon National, further research is needed. In this study, the focus will be on the order primates and artiodactyla.

This study aims to collect data on species diversity, species evenness, and species richness of large mammals in Ujung Kulon National Park (As a Preliminary Study on the Development of Vertebrate Subconcepts). in Ujung Kulon National Park.The data from this research will also be implemented in the field of education as an initial research study on the development of vertebrate sub-concepts in KD 3.9 and KD 4.9 class X SMA.

Method

The research was carried out from March to June 2021 in Ujung Kulon National Park. In this study the sampling locations were determined through a direct survey process at locations where there were large mammals in the Ujung Kulon National Park area. Sampling locations were determined based on the type of habitat that supports large mammals by using a purposive sampling method. The research stations were made as many as 4 stations, namely station 1 Peucang Island, station 2 Handeuleum, station 3 Cigenter Island and station 4 Cidaon. Data collection was carried out using 2 data collection techniques, namely Direct observation and Indirect observation. Indirect data collection was carried out by looking at the marks left from the observed objects such as footprints, feces, nests, sounds or animal scratch marks. The methods used in data collection are Line transect and Variable circular-plot (VCP). Observations were carried out in the morning at 06.00-10.00 WIB and in the afternoon at 15.00-18.00 WIB. The object of research in this study is limited to large terrestrial and arboreal mammals. The coordinate points for data collection at each research station are determined using the GPS (Global Position System). The cruising route starts from the coast to the forest traced. The length of the transect is determined to be approximately 1000 m with a distance between center points of 100 m and a radius of 20 m. Observations were made by walking at a constant speed of approximately 10 meters/minute, then stopping to wait for the animals to arrive. For 20 minutes observations were made at each stopping point after that moving on to the next point. The number of individuals and individual behavior of each mammal species encountered were counted and observed for further processing to obtain a species diversity index, large mammal richness index, and species evenness index. During the data collection process, measurements of environmental parameters were carried out.

Secondary data in this study included collecting data on the general condition of the Ujung Kulon National Park Area, including: profiles from the research location including location and area data, environmental parameters in the Ujung Kulon National Park Area in the form of air temperature, air humidity, and light intensity, as well as data related to identification characteristics of large mammals, data on the number of species of large mammals found in Ujung Kulon National Park, and other supporting data according to the research topic.

Data on the diversity of large mammal species that have been obtained will be analyzed using the Shannon - Wiener Index to determine the level of diversity of mammal species (Sulistyani *et al.,* 2014), with the formula **Eq. (1)**:

$$H' = \sum Pi \; ln \; Pi \qquad (1)$$

With:

H' = diversity index

Pi $= \frac{Ni}{N}$

Ni = Total number of individuals of type i

N = Total number of individuals

Table 1. Mammal diversity index criteria

Criteria	Score
Low diversity	H' < 1
Medium diversity	1 ≤ H' ≤ 3
High diversity	H' > 3

[Wahyuningsih *et al.,* 2019]

1. Margalef species richness index

The species richness index is the number of species of an animal in a certain area. The Margalef method is used to calculate the species richness of mammals. The Margalef species richness index is the

value of the abundance of an individual in the same habitat (Rachman & Hani, 2017), which can be calculated using the formula **Eq. (2)**:

$$D_{mg} = \frac{S-1}{ln(N)} \quad (2)$$

With:
D_{mg} = Margalef species richness index
S = Total number of individuals
N = Total number of types

Table 2. Mammal species richness index criteria

Criteria	Score
Low species richness	D < 2.5
Medium species richness level	2.5 ≤ D ≤ 4
High species richness	D > 4

[Wahyuningsih *et al.,* 2019]

2. Evenness Type Evenness Index

The evenness index is calculated to find out the even distribution of each type of large mammal in a predetermined observation area so that it can be known which species are dominant in that area (Sulistyani *et al.,* 2014), using the **Eq. (3)** :

$$E = \frac{H'}{Hmax} \text{ with } Hmax = \ln S \quad (3)$$

With:
E = Evenness evenness index
H ' = Shannon-Wiener diversity index
Hmax = Maximum diversity index
ln S = Total number of large mammal species

Table 3. Mammal species evenness index criteria

Criteria	Score
Low degree of evenness	E < 0.31
Moderate level of evenness	0.31 ≤ E ≤ 1
High degree of evenness	E > 1

[Wahyuningsih *et al.,* 2019]

Result and Discussion

A. Mammal Diversity

It can be seen from the results of research on the diversity of large mammal species in Ujung Kulon National Park that there are six species of Kulon from the four orders of large mammals encountered, namely the Javan rhinoceros (*Rhinoceros sondaicus*) of the order Perissodactyla, the Timor deer (*Cervus timorensis*) of the order Artiodactyla, the forest dog (*Cuon alpinus)* order Carnivora, bull (*Bos javanicus*) order artiodactyla, long-tailed monkeys (*Macaca fascicularis*) order primate, and wild boar (*Sus scrofa vitalus*) order artiodactyla. Four species including the Javan rhinoceros (*Rhinoceros sondaicus*), Timor deer (*Cervus timorensis*), coyote (*Cuon alpinus*), and bull (*Bos javanicus*) are protected species based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 106 of 2018, while two other species, including long-tailed monkeys (*Macaca fascicularis*) and wild boar (*Sus scrofa vitalus*) based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 106 of 2018 are not listed as protected animals due to their high population levels.

Tabel 4. Types of large mammals found in Ujung Kulon National Park

No	Local/Scientific Name	Family / Order	Encounter Type	S 1	S 2	S 3	S4	Total
1	Long Tailed Monkey (*Macaca fasicularis*)	Cercopithecidae / Primata	L	46	31	-	1	78
2	Timor deer	Cervidae /	L	44	26	-	-	70

No	Local/Scientific Name	Family / Order	Encounter Type	S 1	S 2	S 3	S4	Total
	(*Cervus timorensis*)	Artiodactyla						
3	Bull (*Bos javanicus*)	Bovidae / Artiodactyla	L	-	-	16	29	45
			TL (F)	-	-	1	-	1
4	Wild boar (*Sus scrofa vitalus*)	Suidae / Artiodactyla	L	14	-	-	-	14
5	Javanese rhino (*Rhinoceros sondaicus*)	Rhinocerotidae / Perissodactyla	TL (K)	-	-	1	-	1
			TL (TK)	-	-	-	1	1
6	Coyote (*Cuon alpinus*)	Canidae / Carnivora	TL (S)	-	-	-	2	2
Total Individu (N)				104	57	19	33	213
Total Spesies (S)				3	2	2	4	6

Keterangan:

S 1 : Pulau Peucang	L : Langsung	S : Suara
S 2 : Pulau Handeuleum	TL : Tidak Langsung	K : Kubangan
S 3 : Cigenter	P : Pengamatan Pagi	TK : Tapak Kaki
S 4 : Cidaon	S : Pengamatan Sore	F : Feses

1. Long-Tailed Monkey

The monkey species found in the Ujung Kulon National Park Area is the *Macaca fascicularis* species which has been internationally listed on the IUCN red list data with a vulnerable conservation status (Eudey et al., 2020). In Indonesia, long-tailed monkey species are not included in the protected species because based on the literature Sajuthi *et al*. (2016) the long-tailed monkey species is the most commonly known type of ape because it has a wide distribution and is highly adaptable to new environments, so that the long-tailed monkey population is still abundant and in some places it often becomes a pest for farmers. Risdiyansyah *et a*l. (2014) explained that because long-tailed monkeys are not protected animals, this type of animal is most vulnerable to exploitation, whether being hunted, traded or used as a spectacle object.

The long-tailed monkey (*Macaca fascicularis*) belongs to the Primate Order. Long-tailed monkeys have hair color on the upper body that is gray with a thin golden color with a paler color on the lower body, the top and sides of the head are golden gray, the mouth and eyelids are grayish white, the legs are, hands and ears are black, and has a tail that is longer than the length of the body. Long-tailed monkeys (*Macaca fascicularis)* can be seen in Figure 1.

Gambar 1. Long-tailed monkey (*Macaca fascicularis*)
[Source: Personal document]

Table 4 shows that the species most commonly found in Ujung Kulon National Park is the long-tailed macaque (*Macaca fascicularis*). Long-tailed monkeys have high adaptability, this is evidenced by the discovery of individual long-tailed monkeys in almost all research stations. Long-tailed monkeys have a high adaptability so that they can make long-tailed monkey populations have a wide distribution (Sari *et al*., 2015). The success of this adaptation is driven by the behavior of long-tailed monkeys that are able to adapt to their environment (Supriatin *et al*., 2019).

The average daily environmental temperature conditions in Ujung Kulon National Park range from 26.5-28.5ºC, this temperature is preferred and ideal for the survival of long-tailed monkeys. Long-tailed monkeys have an optimum environmental temperature ranging from 24-36oC (Fakhri *et al*., 2012), long-tailed macaques require high air humidity, which is 71 – 93% (Musyaffa & Susanto, 2020), humidity in

Ujung Kulon National Park also supports the habitat of long-tailed monkeys where humidity in Ujung Kulon National Park ranges from 78.7-86 %.

2. Timor Deer

The species of deer found in the Ujung Kulon National Park area is the *Cervus timorensis species* which has been internationally listed on the IUCN red list data with a *vulnerable conservation status* (Hedges *et al*., 2015). In Indonesia, the Timor deer species are included in protected species regulated in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 106 of 2018. Based on research by Prayoga *et al*. (2021) the Timor deer population continues to decline from time to time due to habitat destruction, as well as pressure from catching and poaching.

Timor deer (*Cervus timorensis*) belongs to the order Artiodactyla. The Timor deer has hair color on the back and tail which is brown to yellowish, the chin, under the neck, stomach and legs are grayish brown, the male deer has antlers which are three-pronged, the male Timor deer has a larger body compared to female timor deer. Timor deer (*Cervus timorensis*) can be seen in Figure 2.

Figure 2. Timor Deer (*Cervus Timorensis*)
[Source: Personal document]

The existence of the Timor deer in Ujung Kulon National Park is due to the habitat that supports the survival of the Timor deer in Ujung Kulon National Park, at least Ujung Kulon National Park has 3 types of habitat which are mostly used by the Timor deer (*Cervus timorensis*), which include mangrove forests, forest beaches and meadows. Apart from being a feed provider, Ujung Kulon National Park also has several types of plants that can be used as a source of food so that Timor deer are used as shelter and to avoid predators and human disturbance (Rumakar, 2019).

The average daily environmental temperature conditions in Ujung Kulon National Park range from 26.5-28.5ºC, this temperature is preferred and ideal for the survival of the Timor deer, the Timor deer has an optimum environmental temperature ranging from 26-38º C (Nurhayati *et al*., 2020) , most mammals require humidity ranging from 30-70% (Janet, 2011), humidity in Ujung Kulon National Park also supports the living habitat of Timor deer where humidity in Ujung Kulon National Park ranges from 78.7-86%.

3. Bull

Bull (*Bos javanicus*) belongs to the Order Bovidae. The bison species found in the Ujung Kulon National Park area is the *Bos javanicus* species which has been internationally listed on the IUCN red list data with an endangered conservation status (Gardner *et al*., 2016). In Indonesia, the bull species are included in protected species regulated in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No 106 of 2018. According to Mangunjaya *et al*. (2017) The decline in the bull population in Indonesia is caused by poaching, habitat destruction and exploitation.

The bull (*Bos javanicus*) belongs to the order Artiodactyla. Male bulls have a black body, while female bulls have a reddish brown color, around the eyes, muzzle, buttocks and lower legs are white, male bulls have long horns curved upwards, while the horns of female bulls have short horns and curved inwards. Bull (*Bos Javanicus*) can be seen in Figure 3.

Figure 3. Bull (*Bos javanicus*)
[Source: Personal document]

In Ujung Kulon National Park, bull live in open habitats such as grasslands and shrubs. The location and composition of these habitat components will determine the carrying capacity of the habitat for bull, especially the availability of feed in the form of grass and leaves as well as cover which functions as a shelter, protection from predators and weather threats, a place for mating and resting (Lathifah *et al.*, 2019). It is easy to find groups of bull in Ujung Kulon National Park in the morning and evening when they are doing feeding activities. Bull in Ujung Kulon National Park are very sensitive to human movement, based on direct observations the researchers only examined them from a distance of ±150 m. The movement and sound that is generated when conducting research can distract the bull and enter the forest to escape. The distribution of the bull population in Ujung Kulon National Park occurs in groups, consisting of males, females and children. In addition, during the observation, it was found that the bull was solitary, this was because the bull could not compete in his group due to his old age.

4. Wild boar

Wild boar belongs to the Order Artiodactyla. The wild boar species found in the Ujung Kulon National Park area is a species of *Sus scrofa vitalus* which is internationally listed on the IUCN red list data with the status of least concern for conservation (Keuling & Leus, 2019). In Indonesia wild boar is not included in the protected species. Wild boar has a low risk status because it has a wide distribution, high abundance, tolerance for habitat disturbance, and its presence in many protected areas.

Wild boar belongs to the order Artiodactyla. Wild boar has a fat body ranging from 80-100 kg and short legs, dark black body, body parts covered with long, hard and sparse hairs, nostrils facing forward, male wild boars have longer fangs compared to pigs. female forest. Wild boar (*Sus scrofa vitalus*) can be seen in Figure 4.

Figure 4. Wild Boar *(Sus scrofa vitalus)*
[Source: Personal documentation]

Average daily environmental temperature conditions in Ujung Kulon National Park range from 26.5-28.5ºC, this temperature is preferred and ideal for the survival of wild boars, wild boars have optimum environmental temperatures ranging from 20-26º C (Sihombing, 2006), most mammals need humidity ranging from 30-70% (Janet, 2011), humidity in Ujung Kulon National Park also supports wild boar habitat where humidity in Ujung Kulon National Park ranges from 78.7-86%.

5. Javanese rhino

The Javanese rhino belongs to the Order Perissodactyla. The Javanese rhinoceros is a protected animal and is listed on the IUCN red list data with a critically endangered conservation status (Ellis & Takludar, 2020). In Indonesia, the Javanese rhinoceros is protected, which is regulated in the Regulation of

the Minister of Environment and Forestry of the Republic of Indonesia No. 106 of 2018. In this study the Javan rhinoceros was identified through footprints that were ± 7 days old, marked by footprints imprinted on the ground that were not very clear with a width of approximately 25 cm, there were three hoof marks that formed the letter U, and there is litter or fallen leaves in the footprints.

At the research location, rhino wallows were found which had a length and width ranging from 6 mx 4 m. A puddle that is more than 7 meters in size indicates a wallow used by a herd of mother and baby rhinos or used by different types of animals at different times, such as a herd of bison (*Bos javanicus*) which can make the size of a rhinoceros wallow much wider than the wallow normally used averaged by one rhinoceros (Santosa, 2010), whereas in this study found rhino wallows measuring 6 m x 4 m, this is in accordance with the statement of Rahmaningsih (2013) that the length of the Javanese rhinoceros wallow ranges from 6- 7 meters and the width of the Javanese rhino puddle ranges from 3-5 meters. Based on the literature, the puddles chosen by the Javanese rhino are watery and muddy puddles with mud depths between 22-100 cm and water depth between 5-50 cm (Candradewi, 2010). The footprints and wallows of the Javanese rhinoceros (*Rhinoceros sondaicus*) can be seen in Figure 5, Figure 6, Figure 7 and Figure 8.

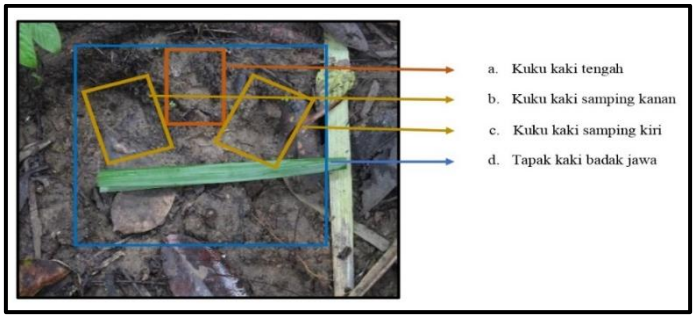

Figure 5. Footprints of the Javanese Rhinoceros
[Source : Personal Documentation]

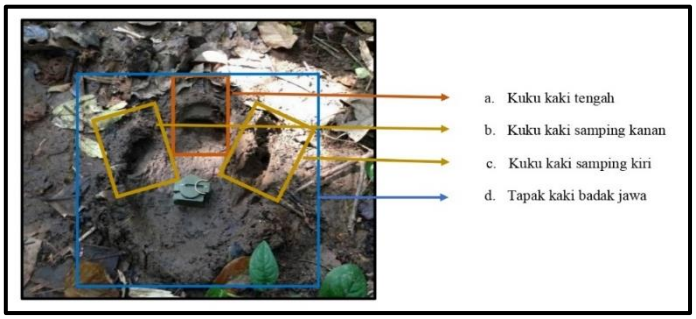

Figure 6. Footprints of the Javanese Rhino Based on Literature
[Source: Kurnia, 2016]

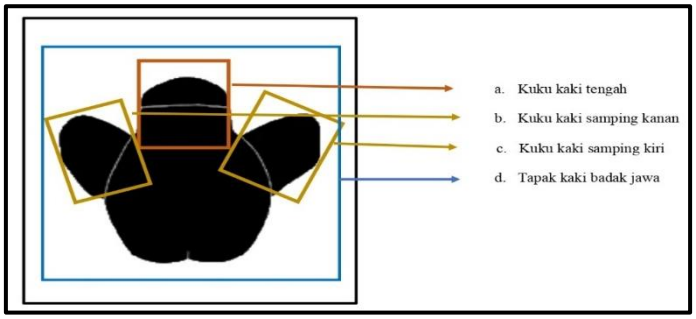

Figure 7. Sketch of the Foot of the Javanese Rhinoceros
[Source: KLHK, 2018]

Figure 8. Javanese rhino puddle
[Source : Personal Documentation]

Among the large mammal species found in Ujung Kulon National Park, the Javanese rhino species is one of the least encountered species. Based on the table indirectly the Javanese rhinoceros was found as many as 2 individuals at 2 stations. Indirectly individual Javanese rhinos in Ujung Kulon National Park were identified through footprints and wallows. Based on the literature, there are several factors that threaten the sustainability of the Javanese rhinoceros in Ujung Kulon National Park, namely the large potential for *inbreeding* , the tendency for the potential for rare plants to occur, the threat of natural disasters, and the occurrence of forest conversion.

Air temperature is one of the physical components of the habitat that influences the behavior and body of the Javanese rhino. The average air temperature at each observation station where there are Javanese rhinos ranges from 27.3-28o C, based on the results of these temperature measurements it is classified as suitable as a habitat for the Javanese rhino, the Javanese rhino has an average daily air temperature of 26.2-28.7° C (Ribai *et al*., 2015). The results of measurements of air humidity at each observation station where there are Javanese rhinos range from 81-82.2%, this is classified as suitable as a habitat for the Javanese rhino, the habitat for the Javanese rhino has humidity ranging from 75-91% (Rahmat *et al*., 2008).

6. Coyote

Coyote belongs to the Order Carnivora. The coyote species found in the Ujung Kulon National Park area is the *Cuon alpinus species* which is internationally listed on the IUCN red list data with an endangered conservation status (Kamler *et al*., 2015). Based on Table 4, coyotes are among the few species found in Ujung Kulon National Park, with 2 individuals. Coyote is identified by howling that is clear and loud at station 4. This is in accordance with the literature according to Megumi (2020), ajag has a howling that sounds clear and loud while its bark sounds soft, like short, repeated squeals (sounds) kik-kik-kik"). Based on the literature, the coyote has reddish-brown upper body hair with a pale underside (belly) with a white stripe in the middle, the coyote has a tail that is densely haired and black on the underside of the tail. Coyote can be seen in Figure 9.

Figure 4.7 Coyote (Cuon alpinus)
[Source : Mossbrucker, (2020)]

The coyote is an endemic predator in Indonesia that is threatened with extinction due to forest degradation, reduced game (prey), and poaching (Sukmasuang *et al*., 2020). Coyote plays an important role in controlling prey populations through the predation process they carry out (Darmawan, 2021). The small number of coyotes found in Ujung Kulon National Park is due to indirect encounters. It is possible that the coyotes that were encountered were carrying out reconnaissance of the calves, because at the observation

site there were herds of banteng. Coyote hunts in groups of 3-20 individuals to get large prey such as deer or bull calves (Venkataraman *et al*., 1995).

Table 5. Environmental parameters in Ujung Kulon National Park

Environmental Parameters	Station 1 Peucang	Station 2 Handeuleum	Station 3 Cigenter	Station 4 Cidaon
Time	06.00-18.00 WIB	06.00-18.00 WIB	06.00-18.00 WIB	06.00-18.00 WIB
GPSPoint	6 °44'34" S - 105°15'23" E	6 °44'49" S - 105°15'46" E	6 °45'1" S - 105°24'6" E	6 °44'39" S - 105°15'53" E
Air Temperature (°C)	26.6 °C	27.3 °C	28 °C	27.3 °C
Air Humidity (%)	86%	78.7%	82.8%	81%
Light Intensity (Lux)				
Morning	832 lux	1093 lux	873 lux	847 lux
Afternoon	973 lux	1274 lux	2308 lux	1443 lux
Afternoon	852 lux	1143 lux	1271 lux	1265 lux

Based on the physical conditions of the environment at each research station, the important factors that influence animal activity are the temperature and humidity conditions of the environment. Temperature and humidity are physical components of the habitat that can affect wildlife including large mammals. Temperature and humidity can affect animal activity and affect the index value of diversity, richness and evenness of large mammal species in Ujung Kulon National Park. In general, temperature affects the behavior and body size of wildlife (Alikodra, 2002). Based on the literature, if the air temperature is too high, it can affect the physiology of animals, such as changes in respiration (Suprayogi *et al*., 2006). Observations of environmental parameters at each station including daily average air temperature, daily average humidity, and daily light intensity are presented in Table 5. Based on table 5, it can be seen that the results of environmental parameter calculations show that Ujung Kulon National Park is a preferred and ideal habitat for the survival of mammals large, large mammals have different optimal environmental temperatures making it difficult to measure accurately (Delfita, 2019).

B. Index of Diversity, Richness and Evenness of Large Mammal Species in Ujung Kulon National Park

Table 6. Index of diversity, richness and evenness of mammal species

Index	Amount				Total
	S.1	S.2	S.3	S.4	
N	104	57	19	33	213
S	3	2	2	4	6
H'	1	0.69	0.34	0.50	1.50
dmg	0.43	0.25	0.34	0.86	0.93
E	0.91	1	0.49	0.36	0.84

Information:

S. 1	: Peucang Island	S	: Total number of types
S. 2	: Handeuleum Island	H'	: Species Diversity Index
S. 3	: Cigenter	D_{mg}	: Species Richness Index
S. 4	: Cidaon	E	: Species Evenness Index
N	: Total number of individuals		

Species diversity is a community level characteristic based on its biological organization that can be used to express community structure (Evanjeli *et al*., 2019). Table 6 shows that the diversity index reaches a value of 1.50 or is included in the moderate species diversity category as Shanon-Wiener's statement that the index value > 1 is included in the moderate species diversity category. This is according to research by

Sirait *et al*. (2018) this condition will create a stable ecosystem, namely moderate diversity, moderate distribution of the number of individuals of each species and moderate community stability.

The value of diversity is highly dependent on several factors, one of which is the species factor and the number. According to Kasayev *et al*. (2018) domination of a species over other species will cause a low value of diversity or vice versa if the numbers are evenly distributed then the value of diversity will be high. In addition, the most important factor affecting the value of diversity is the condition of the habitat, because in general the habitat functions as a shelter, provider of food sources, and breeding grounds. According to Susanto and Ngabekti (2014) different habitats will get different diversity values.

The species richness index of large mammals is an index that shows the number of large mammal species present in the observation area. Based on the literature according to Rianto and Darmawan (2022), the species richness index value shows the ratio of the number of species to the number of all species. The greater the number of species found in the observation area, the higher the species richness index value (Wahyuningsih *et al*., 2019). Based on Table 6, the species richness index value for large mammals in Ujung Kulon National Park is 0.93 or it is included in the low species richness category as Margalef stated that the richness index value < 2.5 is included in the low species richness category. This shows that the number of species (species) in Ujung Kulon National Park is low.

The difference in species richness index at each observation station is influenced by the area and habitat conditions (Nahlunnisa *et al*., 2016). Based on research by Ekowati *et al*. (2016), habitat destruction that causes a reduction in food sources for large mammals can cause animals to move, this is why the value of species richness of large mammals in Ujung Kulon National Park depends on the number of mammal species found in one observation station. In line with the research by Santosa *et al*. (2008) that the difference in species richness at each observation station is related to whether or not the availability of food sources for mammals is abundant.

The species evenness index shows the balance between a mammal community and other mammal communities, this index is influenced by the number of species found in an observation area (Mustari *et al*., 2011). The evenness index value (E) can be used as an indicator of dominance symptoms among each species in an observation area. Based on Table 6 the evenness index value for large mammal species in Ujung Kulon National Park is 0.84 or it is included in the medium evenness category as Evenness said that the species evenness index value ≤ 0.31 and ≤ 1 is included in the medium evenness category. This shows that large mammals in Ujung Kulon National Park are distributed evenly, an evenness value close to 1 indicates that a community is more evenly distributed, whereas if the value is close to 0, the distribution is more uneven (Magurran in Nahlunnisa, 2016).

The condition of evenness of species in each research station is quite good. According to Aulia (2021), the distribution of large mammals in Ujung Kulon National Park takes place in order to find and obtain sources of food, water, breeding grounds, and find partners. Supported by the research of Mustari *et al*. (2011) that the distribution of mammals is influenced by habitat conditions, such as the availability of abundant water sources, the availability of abundant food sources, and the minimum disturbance by humans. Disturbances from human activities over time can cause loss of biodiversity. The loss of biodiversity does not only have an impact on the extinction of just one species. When the population of plants and animals in a place is depleted, the genetic diversity contained in each species that gives the species the ability to adapt to its environment is also lost. Therefore, each species needs to be preserved so that the extinction of living things does not occur.

C. Biological Implications for Education

Information on the diversity of large mammal species in Ujung Kulon National Park can be used as an initial study for research on the development of vertebrate subconcepts. This information can be applied to vertebrate sub-concept material, namely the demands of KD 3.9 Classifying animals into phyla based on body layers, body cavities, body symmetry, and reproduction and KD 4.9 Presenting a comparative report on the complexity of the animal body layers (diploblastic and triploblastic), body symmetry , body cavities, and reproduction (Permendikbud No. 37, 2018) which has been adapted to the demands of the 2013 curriculum analysis, that in achieving the curriculum must develop graduate competencies that have graduate capability qualifications that include attitudes, knowledge, and skills, especially in knowledge about diversity animals in Indonesia, one of which is the diversity of large mammals in Ujung Kulon National Park which can be used as an initial study for research on the development of the vertebrate subconcept.

Conclusions and recommendations

Based on the results of research that has been conducted on the Diversity of Large Mammal Species in Ujung Kulon National Park, it can be seen that there are six species of large mammals found in Ujung Kulon National Park, these six species of large mammals consist of four different orders, namely: rhinoceros java (Rhinoceros sondaicus) order Perissodactyla, Timor deer (*Cervus timorensis*) order Artiodactyla, Forest dog (*Cuon alpinus*) order Carnivora, banteng (*Bos javanicus*) order Artiodactyla, long-tailed monkeys (*Macaca fascicularis*) order primates and wild boar (*Sus scrofa vitalus)*) of the order Artiodactyla. The diversity index of large mammal species in Ujung Kulon National Park is classified as a category with a value of 1.50. The species richness index of large mammals in Ujung Kulon National Park is in the low category with a value of 0.93. The evenness index of large mammal species in Ujung Kulon National Park is in the moderate category with a value of 0.84. The data from this research were implemented in the form of an initial research study on the development of the vertebrate sub-concept, this information can be used and applied to Biology subjects, especially in the sub-concept of class X vertebrate material in even semester KD. 3.9 and 4.9. Further and in-depth research regarding the species encountered needs to be carried out, especially regarding the relationship of the diversity of large mammal species with altitude and vegetation composition in the Ujung Kulon National Park Area. Further development research regarding educational implementation based on research data needs to be carried out, especially on the subject of the vertebrate subconcept kingdom Animalia in the Biology Education Study Program.

References

Alikodra, H. S. (2002). *Pengelolaan Satwa Liar, Jilid 1*. Bogor: Yayasan Penerbit Fakultas Kehutanan IPB.

Aulia D.R. (2021). *Dasar-Dasar Ekologi Kuantitatif: Teori dan Aplikasi*. Bogor: PT. Penerbit IPB Press.

Balai Taman Nasional Ujung Kulon. (2009). Tentang Taman Nasional Ujung Kulon: Letak dan Luas. Diakses pada 11 Desember 2020 melalui https://www.ujungkulon.org/tentang-tnuk/letak-dan-luas.

Balai Taman Nasional Ujung Kulon. (2017). Tentang TNUK. Online. https://www.ujungkulon.org/tentang-tnuk. Diakses 11 Desember 2020.

Candradewi, D. S. (2010). *Perilaku Berkubang dan Tipologi Kubangan Badak Jawa (Rhinoceros sondaicus) di Taman Nasional Ujung Kulon*. Bogor: Institut Pertanian Bogor.

Cardillo, M., Mace, G. M., Jones, K. E., Bielby, J., Bininda-Emonds, O. R. P., Sechrest, W., Orme, C. D. L., & Purvis, A. (2005). Multiple Causes Of High Extinction Risk In Large Mammal Species. *Science*. 239-1241.

Darmawan Dwi Refandi. (2021). Asu Kikik Si Anjing Hutan Asli Indonesia. Diakses dari https://forestation.fkt.ugm.ac.id/2021/02/21/asu-kikik-si-anjing-hutan-asli-indonesia/ pada 3 Maret 2022.

Delfita, R. (2019). *Fisiologi Hewan Komperatif*. Jakarta: Prenadamedia Grup.

Ekowati, A., A. D. Setiyani., D. R. Haribowo & K. Hidayah. (2016). Keanekaragaman Jenis Burung di Kawasan Telaga Warna, Desa Tugu Utara, Cisarua, Bogor. *Journal of Biology*. 9(2): 87-94.

Ellis, S. & Talukdar, B. (2020). Rhinoceros sondaicus. Diakses dari https://dx.doi.org/10.2305/IUCN.UK.20202.RLTS.T19495A18493900.en. pada 20 Juni 2021.

Eudey, A., Kumar, A., Singh, M. & Boonratana, R. 2020. Macaca fascicularis Diakses dari https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T12551A195354635.en. pada 28 May 2021.

Evanjeli, Annawaty, Ramadanil, dan Ihsan, M. (2019). Keanekaragaman Jenis Burung pada Areal Taman Wisata Alam Wera, Sigi, Sulawesi Tengah, Indonesia. *Biocelebes*. 13(01): 1-10.

Fakhri, K., B. Priyono. & M. Rahayuningsih. (2012). Studi Awal Populasi dan Distribus Macaca fasicularis Rafless di Cagar Alam Ulolanang. *Unnes Journal of Life Science*. 1(2): 199-25.

Gardner, P., Hedges, S., Pudyatmoko, S., Gray, T.N.E. & Timmins, R.J. (2016). Bos javanicus. Diakses dari https://dx.doi.org/10.2305/IUCN.UK.20162.RLTS.T2888A46362970.en. pada 7 Juni 2021.

Hedges, S., Duckworth, J.W., Timmins, R., Semiadi, G. & Dryden, G. (2015). Rusa timorensis. Diakses dari https://dx.doi.org/10.2305/IUCN.UK.20152.RLTS.T41789A22156866.en. pada 28 May 2021.

Janet, C. (2011). *Guide for the Care and Use of Laboratory Animals, 8th edition*. Washington DC: National Academies Press.

Kartono, Agus Priyono. (2015). Keragaman dan Kelimpahan Mamalia di Perkebunan Sawit PT Sukses Tani Nusasubur Kalimantan Timur. *Media Konservasi*. 20(2): 85-92.

Kasayev, T., Nurdin, J., dan W. Novarino. (2018). Keanekaragaman Mamalia di Cagar Alam Rimbo Panti, Kabupaten Pasaman, Sumatera Barat. *Jurnal Biologi Universitas Andalas*. 6(1): 23-29.

Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia. (2018). Peraturan Menteri Lingkungan Hidup Dan Kehutanan Republik Indonesia Nomor P.106/MENLHK/SETJEN/KUM.1/12/2018 Tentang Perubahan Kedua Atas Peraturan Menteri

Lingkungan Hidup Dan Kehutanan Nomor P.20/MENLHK/SETJEN/KUM.1/6/2018 Tentang Jenis Tumbuhan Dan Satwa Yang Dilindungi.

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2018). Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 37 Tahun 2018 Tentang Perubahan Atas Peraturan Menteri Pendidikan dan Kebudayaan Nomor 24 Tahun 2016 Tentang Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah.

Keuling, O. & Leus, K. (2019). Sus scrofa. Diakses dari https://dx.doi.org/10.2305/IUCN.UK.20193.RLTS.T41775A44141833.en. pada 14 June 2021.

Kurnia, Aldy. (2016). KMPA ITB Bantu Konservasi Badak Jawa di Ujung Kulon. Diakses dari https://www.itb.ac.id/berita/detail/5253/kmpa-itb-bantu-konservasi-badak-jawa-di-ujung-kulon.

Lathifah, S. S., Hakim, A. A., & Syaffanah, F. F. N. AKTIVITAS HARIAN BANTENG (Bos javanicus) DI PADANG PENGEMBALAAN CIDAON TAMAN NASIONAL UJUNG KULON BANTEN. In Seminar Nasional Pendidikan Matematika dan Ilmu Pengetahuan Alam (p. 53).

Mangunjaya, F. M., Prabowo, H. S., Tobing, I. SL., Abbas, A. S., Saleh, C., Sunarto, Huda, M., dan Mulyana, T. M. (2017). *Pelestarian Satwa Langka untuk Keseimbangan Ekosistem*. Jakarta: Lembaga Pemuliaan Lingkungan Hidup & Sumber Daya Alam Majelis Ulama Indonesia.

Megumi, S. (2020). Ajag, anjing hutan Indonesia yang langka. Diakses dari https://www.greeners.co/flora-fauna/ajag-anjing-hutan-indonesia-yang-langka.

Mossbrucker, A, M., (2020). SUMATRAN MAMMALS: Photographs from Camera Traps in the Bukit Tigapuluh Landscape, Jambi. Frankfurt Zoological Society.

Mustari, A. H., Surono, H., dan F. Iqro Mansyur. (2011). Keanekaragaman Jenis Mamalia Di Taman Nasional Bantimurung Bulusaraung, Sulawesi Selatan. *Media Konservasi*. 16(3): 156 – 161.

Musyaffa, M. E. F., & Susanto. (2020). Karakteristik Habitat dan Pola Aktivitas Langur Borneo (Presbytis chrysomelas cruciger) di Taman Nasional Danau Sentarum. *Jurnal Penelitian Hutan dan Konservasi Alam.* 17(2): 155-172.

Nahlunnisa, H., E.A. Zuhud & Y. Santosa. (2016). Keanekaragaman Spesies Tumbuhan di Areal Nilai Konservasi Tinggi (NKT) Perkebunan Kelapa Sawit Provinsi Riau. *Media Konservasi*. 21(1): 91-98.

Nasir, M., N. Yulia & H.M. Abdul. (2017). Keanekaragaman Jenis Mamalia Kecil (Famili Muridae) pada Tiga Habitat yang Berbeda di Lhokseumawe Provinsi Aceh. *BioLeuser*. 1(1): 1-6.

Nurhakim. (2016). *Buku Pintar Dunia Mamalia Lebih Dekat Dengan Makhluk Menyusui*. Jakarta: Bestari.

Nurhayati, I., Partaya. & Bambang Priyono. (2020). Kesesuaian Habitat Rusa Timor di PT. Taman Satwa Semarang. *Life Science*. 9(1): 52-61.

Prayoga, H., Dewi, B. S., dan S. P. Harianto. (2021). Masalah Penangkaran Rusa Timor (Cervus timorensis) Di Universitas Lampung. *JOPFE Journal*. 1(2): 1-8.

Rachman, E. & A. Hani. (2017). Potensi Keanekaragaman Jenis Vegetasi Untuk Pengembangan Ekowisata di Cagar Alam Situ Panjalu. *Jurnal Wasian*. 4(1): 1-10.

Rahmaningsih, M.D., (2013). Penyusunan Desain Wisata Minat Khusus Berdasarkan Pola Pergerakan Badak Jawa Di Taman Nasional Ujung Kulon. *Skripsi*. Bogor: Institut Petanian Bogor.

Rahmat, U.M., Santosa, Y. & Kartono, A.P. (2008). Analisis Preferensi Habitat Badak Jawa (Rhinoceros sondaicus Desmarest 1822). *JMHT*. 14(3): 115-124.

Rianto, A. & A, Darmawan. (2022). Keanekaragaman Amphibi Pada Lahan Agroforestry Di Pekon Kota Batu, Tanggamus, Lampung. *Journal Of Forest Science Avicennia*. 5(01): 58-70.

Ribai, Alikodra, H.S., Masu'ud, B. & U.M., Rahmat. (2015). Tingkat Kesesuaian Suaka Margasatwa Cikepuh sebagai Habitat Kedua Badak Jawa (Rhinoceros sondaicus Desmarest 1822). *Media Konservasi*. 20(2): 108-116.

Risdiansyah, Harianto, S. P., dan N. Nuning. (2014). Studi Populasi Monyet Ekor Panjang (Macaca fascicularis) Di Pulau Condong Darat Desa Rangai Kecamatan Ketibung Kabupaten Lampung Selatan. *Jurnal Sylva Lestari*. 2(1): 41—48.

Rumakar, S., M.M.S. Puttileihalat, & A. Tuhumury. (2019). Populasi dan Habitat Rusa Timor (Cervus timorensis). *Jurnal Penelitian Kehutanan*. 13(1): 40-56.

Sajuthi, D., Astuti, D. A., Perwitasari, D., Iskandar, E., Sulistiawati, E., Suparto, I. H., dan Kyes, R. C. (2016). *Macaca fascicularis: Kajian Populasi, Tingkah laku, Status Nutrien, dan Nutrisi untuk Model Penyakit*. Bogor : IPB Press.

Santosa, Y., Ramadhan, E. P., dan Rahman, D. A. (2008). Studi Keanekaragaman Mamalia pada Beberapa Tipe Habitat di Stasiun Penelitian Pondok Ambung Taman Nasional Tanjung Puting Kalimantan Tengah. *Media Konservasi*. 13(3): 1-7.

Sari, D.P., Suwarno, Saputra, A., & Marjono. (2015). Studi Perilaku Monyet Ekor Panjang (Macaca fascicularis) di Taman Wisata Alam Grojogan Sewu Tawangmangu Karanganyar. *PKLH*.

Sihombing DTH. (2006). *Ilmu Ternak Babi*. Yogyakarta: Gadjah Mada University Press.

Sirait, M., Rahmatia, F., dan Pattulloh. (2018). Komparasi Indeks Keanekaragaman dan Indeks Dominansi Fitoplankton Di Sungai Ciliwung Jakarta. *Jurnal Kelautan*. 11(1): 75-79.

Sukmasuang R, Suksavate W, Songsasen N, Khiowree N, Charaspet K, Pla-ard M, Chanachai Y, Thomas W, & Srinopawan K. (2020). Home range, movement and habitat selection of dholes (Cuon alpinus) in Khao Yai National Park, Thailand. *Biodiversitas*. 21: 5915-5926.

Sulistyadi, E. (2016). Karakteristik Komunitas Mamalia Besar di Taman Nasional Bali Barat (TNBB). *Zoo Indonesia* 2016. 25(2): 142-159.

Sulistyani, T. H., R. Margaretha & Partaya. (2014). Keanekaragaman Jenis Kupu-Kupu (Lepidoptera: Rhopalocera) di Cagar Alam Ulolanang Kecubung Kabupaten Batang. *Unnes J Life Sci*. 3(1): 9-17.

Suprayogi, A., & Astuti, D. A. (2006). Physiological status of indoor sheep in the tropical rain forest (HPGW) environment. *J. Agric. Rural Dev. Trop. Subtrop*, 88, 1-5.

Supriatin, Afida, A.N., & Wandita, A.A,A. (2019). Studi Perilaku Monyet Ekor Panjang (Macaca fascicularis) di Tlogo Putri Kawasan Taman Nasional Gunung Merapi, Sleman, DIY. *Jurnal Primatologi Indonesia*. 16(1): 31-33.

Susanto, A dan S. Ngabekti. (2014). Keanekaragaman spesies dan Peranan Rodentia di TPA Jatibarang Semarang. *Jurnal MIPA*. 37(2): 115-122.

Thinley, P., Kamler, J.F., Wang, W.S., Lham, K., Stenkewitz. & Macdonald, D.W. (2011). Seasonal Diet of Dholes (Cuon alpinus) In Nothrwestern Bhutan. *Mamalian Biology*. 76: 518-520.

Venkataraman, A. B., R, Arumugam., dan R. Sukumar. (1995). The Foraging Ecology of Dhole (Cuon alpinus) in Mudumalai Sanctuary. Southern India. *Journal of Zoology*. 237: 543-561.

Wahyuningsih, E. E., Faridah., Budiadi & A. Syahbudin. (2019). Komposisi dan Keanekaragaman Tumbuhan Pada Habitat Ketak (Lygodium circinatum (BURM .(SW.)) di Pulau Lombok, Nusa Tenggara Barat. *Jurnal Hutan Tropis.* 7(1): 92-105.