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Population Structure Analysis of Javan Rhinoceros at Ujung Kulon National Park, West Java

(Analisis Struktur Populasi Badak Jawa di Taman Nasional Ujung Kulon, Jawa Barat)

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ABSTRAK

Badak jawa (*Rhinoceros sondaicus*) merupakan salah satu satwa langka yang terancam punah. Taman Nasional Ujung Kulon (TNUK) merupakan habitat badak jawa yang terus dipantau jumlah populasinya. Penelitian ini bertujuan untuk menganalisis data struktur populasi badak jawa berdasarkan data pengamatan dari tahun 2011 sampai 2019 di TNUK. Hasil analisis data populasi menunjukkan bahwa nilai *natural increase* (NI) dan *birth rate* (BR) masing-masing sebesar 17,34% (sedang) dan 67,33% (tinggi). Nilai *net return rate* (NRR) pada populasi badak jawa sebesar 15,38% (jantan) dan 14,28% (betina). Nilai NRR pada penelitian ini lebih kecil dari 100% karena terdapat kekurangan jumlah individu untuk berkembang biak selama 30 tahun ke depan. Selain itu, nilai laju *inbreeding* pada populasi badak jawa di TNUK tahun 2019 sebesar 0,01 (rendah). Disimpulkan bahwa perkembangan alami populasi badak jawa di TNUK masih menunjukkan parameter yang baik namun jumlah populasi masih perlu ditingkatkan.

Kata kunci: Badak jawa, *natural increase*, struktur populasi, TNUK.

ABSTRACT

Javan rhino (*Rhinoceros sondaicus*) is one of the rare animals with critically endangered status. The Ujung Kulon National Park (UKNP) is one of javan rhino habitat in Indonesia. Every year the monitoring program for javan rhino in UKNP was performed to identify the animals. This research was aimed to analyze the population structure of javan rhino based on the records data from 2011 to 2019 in UKNP. Research showed that the natural increase (NI) and birth rate (BR) values were 17.34% (moderate) and 67.33% (high) respectively. The net return rate (NRR) value was 15.38% (male) and 14.28% (female). The NRR value in the present study was lower than 100% and caused by less number of animals in a population for 30 years of breeding length. Despite this, the inbreeding rate of javan rhino at UKNP in 2019 was 0.01 (low). It was concluded that the natural increase of javan rhino at UKNP showed a good parameter but the population number needs to be increased.

Keywords: Javan rhino, natural increase, population structure, UKNP.

INTRODUCTION

In the world, five species of rhinoceros (rhino) such as white rhino (*Ceratotherium simum*), black rhino (*Diceros bicornis*), indian rhino (*Rhinoceros unicornis*), sumatran rhino (*Dicerorhinus sumatrensis*), and javan rhino (*Rhinoceros sondaicus*) are under critically endangered. Javan rhino was included of the rare species in the world and is categorized as critically endangered based on red list data book from International Union for Conservation and Natural Resources/IUCN (Sadjudin et al. 2013). Also, javan rhino was listed in Appendix I Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), because of less population number (Soehartono and Mardiastuti 2002). Javan rhino was found in Vietnam (Schaller et al. 1990), but recently was reported extinct (Janssens and Trouwborst 2018). In Indonesia, javan rhino was found in the Ujung Kulon National Park (UKNP) with less population numbers (Rahmat et al. 2008). Javan rhino has shoulder height about 128–160 cm; body length from the end of the head to end of tail about 251–315 cm, and bodyweight about 1,600–2,700 kg (Ramono 1973). According to the Cytochrome *c* oxidase subunit I (COI) and Cytochrome *b* genes of mtDNA, javan rhino was closed to indian rhino and black rhino respectively (Zein et al. 2019). Setiawan et al. (2018) reported that javan rhino capable to explore in their habitat of 14.20 km^2 (female) and 105.53 km^2 (male) with daily explore about 3 km/day. Mostly javan rhino are distributed in the shrub and flat areas with an altitude of 0–50 masl. Thus, javan rhino presence is greatest in the areas within the distance 0–1,000 m from the river, coast, and wallow (Santosa et al. 2013).

Recently, previous studies reported that the number of bantengs (*Bos javanicus*) population at UKNP can affect to javan rhino population because of the limited carrying capacity for feeding (Muntasib and Masy'ud 2000; Nardelli 2016; Harjanto 2017). Despite this, causes of mortality, a decline in rhino food plants, decrease in genetic fitness, natural disaster, poaching, disease epidemics (anthrax and trypanosoma), and nematodes parasite (*Anoplochepalidae, Paramphistomidae, Bunostominae, Oesophagostominae, Trichostrongylinae, Strongylinae*) are possible causes in the reducing of javan rhino population (Palmieri et al. 1980; Nardelli 2016).

Monitoring the javan rhino population is important for the conservation program. Also, the number of adults and young javan rhinos in a population can be used for population structure analysis. Despite this, the population structure analysis was widely used to evaluate the local livestock population (Salamena et al. 2014). Furthermore, the population structure analysis can be used as the parameter detecting the breeding tract of the animal. This research was carried out to analyze the population structure of javan rhino based on the records data from 2011 to 2019 in UKNP.The result of this research is important as the support information for developing a conservation program in javan rhino in the future.

MATERIAL AND METHOD

The records data of javan rhino from the Bureau of Ujung Kulon National Park (BUKNP) was used in this study. The size area of UKNP is about 1,206 km^2 and located at longitude 102º02'32"–105º37'37"E and latitude 06º30'43"–06º52'17"S. Detection of javan rhino in UKNP was obtained using a video trap of trophy camp (Bushnell 119405) that was set up in many point areas. Thus, the detection of javan rhino was performed based on the phenotypic characteristics in each animal that captured in video clips. Eight phenotypic characteristics were used for animal identification namely body shape, horn position, skin wrinkle around the eye, face wrinkle, neck folds, ear position and shape, physical disability, wound, and skin color. The data sources in this study consisted of

population structure and recorded death cases of Javan rhinos as presented in Table 1 and Table 2 respectively. Hence, the population structure analysis was calculated with formula according to Samberi et al. (2010) as follows:

$$\text{Percent of adult animal (\%)} = \frac{\text{Number of adult animal}}{\text{Number of total population}} \times 100\%$$

$$\text{Percent of young animal (\%)} = \frac{\text{Number of young animal}}{\text{Number of total population}} \times 100\%$$

$$\text{Birth rate based on adult female animal (\%)} = \frac{\text{Number of young animal}}{\text{Number of adult female population}} \times 100\%$$

$$\text{Birth rate based on population (\%)} = \frac{\text{Number of young animal}}{\text{Number of total population}} \times 100\%$$

$$\text{Mortality rate (\%)} = \frac{\text{Number of death animal}}{\text{Number of total population}} \times 100\%$$

$$\text{Requirement of animal replacement (\%)} = \frac{\text{Number of adult animal (\%)}}{\text{Breeding length (years)}}$$

$$\text{Remains of young animal (\%)} = \frac{\text{Percent of young animal (\%)}}{\text{Requirement of animal replacement (\%)}}$$

$$\text{Natural increase (\%)} = \frac{\text{Birth rate based on population (\%)}}{\text{Mortality rate (\%)}}$$

$$\text{Net replacement rate (\%)} = \frac{\text{Number of young animal (heads)}}{\text{Remains of young population (heads)}} \times 100\%$$

The inbreeding rate was calculated based on Weiner (1994) and Falconer and MacKay (1996) as follow:

$$\text{Inbreeding rate (\%)} = \frac{1}{8(N_m)} + \frac{1}{8(N_f)}$$

where, N_m is the number of adult male animal and N_f is the number of adult female animal.

Moreover, the population dynamic of javan rhino was predicted using arithmetic model according to Supranto (1993) as follows:

$$P_n = P_o\,[1 + (r.n)]$$

where P_n is the number of animal after n^{th} year, P_o is the number of animal in early year, r is the growth rate and n is the duration time (years).

RESULT AND DISCUSSION

The natality rate of javan rhino at UKNP was presented in Table 3. The birth rate (BR) of javan rhino was 67.33% (based on the adult female animal) and 23% (based on population). The BR value has three categories of low (<20%), moderate (20–30%), and high (>3.0%). Meanwhile, the mortality rate (MR) has three categories of low (<13%), moderate (14–18%), and high (>18%). According to Hardjosubroto (1994), the BR value can be improved by increasing the number of adult female animal. Moreover, the BR based on adult female animal was mentioned as a rhino's calf crop. The BR and MR values of javan rhino in this study were high and low respectively.

The natural increase (NI) of javan rhino in this study was 17.34% (Table 3) and classified into a moderate category. Samberi et al. (2010) reported that the NI has three categories of low (<15%), moderate (16–30%), and high (>30%). Thus, the net return rate (NRR) of javan rhino in this study was 15.38% (male) and 14.28% (female) as presented in Table 4. The NRR values in this study were lower than 100% and indicated that the number of javan rhino in UKNP is not sufficient for 30 years of breeding length. Moreover, the negative value in the remaining of the young animals (Table 4) i.e. -44 heads (male) and -54 heads (female) indicated that the javan rhino population deficit of 98 animals (44 males and 54 females) for 30 years of breeding length.

Table 1. The population structure of javan rhino from 2017 to 2019 at UKNP*.

Group	Year		
	2017	2018	2019
Adult (heads)			
Male	30	29	28
Female	24	23	23
Young (heads)			
Male	7	8	8
Female	6	9	9
Total (heads)	67	69	68

*BUKNP (2019).

Table 2. The recorded death case of Javan rhino at UKNP*.

Name/ID	Time	Sex	Diagnosis
Sudara (ID: 009.2011)	Februari, 2012	Male	-
Samson (ID: 037.2012)	April, 2018	Male	Intestinal torsion
Sari (ID: 046.2012)	July, 2018	Female	-
Manggala (ID: 070.2017)	March, 2019	Male	Infectious desease

*BUKNP (2019).

Ferreira et al. (2019) reported that in the year 2017 the mortality rate of black and white rhino at Kruger National Park (KNP) of South Africa was 4.34% and 12.68% respectively. Meanwhile, the birth rate based on the population in black and white rhino in the same year and location was 6.50% and 6.71% respectively. According to the previous study, the birth rate of javan rhino at UKNP was higher than black and white rhino in KNP. Meanwhile, the mortality rate in javan rhino was higher than black rhino but showed lower than white rhino. Hariyadi et al. (2011) obtained the average birth rate and mortality rate in javan rhino at UKNP (from 2000 to 2010) were 1.4 births/year and 0.90 deaths/year respectively. The average birth rate and mortality rate in this study (from 2010 to 2019) were 3 births/year and 1.3 deaths/year respectively and higher than the previous study. The inbreeding rate based on adult animals in javan rhino at UKNP was 0.01 and categorized as a low category. Loeske et al. (2002) stated that the inbreeding rate of more than 2% was categorized as a high category. Highly inbreeding rate in the javan rhino population would affect the mortality rate and increase of physical disability risk in their offspring.

In the future, the new habitat for javan rhino is important to be established. The UKNP has a total area of 1,206 km^2 and about 50% (603 km^2) is considered as a suitable habitat for javan rhino (Griffiths 1993). Hence, a javan rhino needs a territorial area about 12–20 km^2 (male) and 3–14 km^2 (female). So, it can be calculated that the optimum number of javan rhino at the suitable habitat of UKNP (603 km^2) was 60 heads with assumption carrying capacity of 1 head per 10 km^2.

According to Table 5, the prediction of the javan rhino population in 2026 at UKNP reached more than 90 heads with the assumption of a similar technical coefficient and higher than the estimated carrying capacity (60 heads). Moreover, the number of young animals for replacement was less every year (signed by negative value) based on the simulation with similar technical coefficients (Table 6). So, the distribution or relocation of javan rhino in a new habitat is very important to reduce the inbreeding effect and feed crisis. Hence, reducing the inbreeding effect in javan rhino will affecting the number of population (Rahmat 2009). Translocation in javan rhino can be conducted in the new habitat or second habitat near UKNP such as Cikepuh Wildlife Reserve Park (8,127.5 ha) as reported by Ribai et al. (2015). Moreover, the other protected animal in UKNP i.e. banteng (*Bos sondaicus*) has a similar type of feed consumption and affecting of javan rhino's population. Thus, some animal's decease can be affected by banteng as the vector's decease (Harjanto 2017).

Table 3. The technical coefficient for population structure analysis of javan rhino at UKNP.

Component	Value
Birth rate based on adult female animals (%)	67.33
Birth rate based on population (%)	23.00
Mortality rate (%)	5.66
Natural increase (%)	17.34
Number of adult animal (%)	
Male	41.18
Female	33.82
Sex maturity (years)*	
Male	7
Female	7
Breeding length (years)*	
Male	30
Female	30
Sex ratio (male/female)	1.2/1
Number of population observed (heads)	68

*Haryono et al. (2016).

Table 4. The population structure analysis of javan rhino at UKNP.

Components	Heads	Percent (%)
Number of young animals		
Male	8	11.76
Female	9	13.24
Total	17	25.00
Requirement of animals replacement		
Male	52	76.67
Female	63	93.33
Total	115	170
Remains of young animals		
Male	-44	-64.91
Female	-54	-80.09
Total	-98	-145
Net replacement rate		
Male	-	15.38
Female	-	14.28
Total	-	29.66
Inbreeding rate	-	0.01

Table 5. The population dynamics of javan rhino at UKNP.

Actual				Predicted			
Year	Heads	Deviation (heads)	Percent (%)	Year	Heads	Deviation (heads)	Percent (%)
2011	47	0	0.00	2020	71	0	0.00
2012	51	4	7.84	2021	75	4	5.33
2013	58	7	12.07	2022	78	3	3.85
2014	57	-1	-1.75	2023	82	4	4.88
2015	63	6	9.52	2024	85	3	3.53
2016	67	4	5.97	2025	88	3	3.41
2017	67	0	0.00	2026	92	4	4.35
2018	69	9	13.04	2027	95	3	3.16
2019*	68	-1	-1.47	2028	99	4	4.04
Average		3	4.92	Average		3.11	3.17

*recorded until 21 March 2019 (BUKNP 2019).

Table 6. The prediction of population stucture in javan rhino with a similar technical coefficients in the future.

Components	Years								
	2020	2021	2022	2023	2024	2025	2026	2027	2028
Number of animal (heads)									
Male	36	38	39	41	43	44	46	48	50
Female	35	37	39	41	42	44	46	47	49
Total	71	75	78	82	85	88	92	95	99
Number of young animal (heads)									
Male (11.76%)	8	9	9	10	10	10	11	11	12
Female (13.24%)	9	10	10	11	11	12	12	13	13
Total (25%)	18	19	20	21	21	22	23	24	25
Requirement of animals replacement (heads)									
Male (76.67%)	54	58	60	63	65	67	71	73	76
Female (93.33%)	66	70	73	77	79	82	86	89	92
Total (170%)	121	128	133	139	145	150	156	162	168
Remains of young animal (heads)									
Male	-46	-49	-51	-53	-55	-57	-60	-62	-64
Female	-57	-60	-62	-66	-68	-70	-74	-76	-79
Total	-103	-109	-113	-119	-123	-128	-133	-138	-144

CONCLUSION

The natural increase of javan rhino at UKNP was categorized as a moderate category, with an average birth rate of 3 births/year. Unfortunately, the mortality rate of javan rhino was increased to 1.3 deaths/year. The javan rhino population in this study had a deficit of 44 males and 54 females for 30 years of breeding length. However, the inbreeding rate of javan rhino in this study was 0.01 and still under the low category. The second habitat for javan rhino is important to be established because in 2026 the predicted javan rhino population will be higher than the predicted carrying capacity. Moreover, the relocation of javan rhino into the new habitat is important to reduce the inbreeding effect and feed competition.

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