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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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.

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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 km² (female) and 105.53 km² (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 (*Anoplocephalidae, 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 km² and located at longitude 102°02'32"–105°37'37"E and latitude 06°30'43"–06°52'17"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:

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

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

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

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

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

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

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

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

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

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       | Februari, 2012 | Male | -                  |
| Samson       | April, 2018 | Male | Intestinal torsion |
| Sari         | July, 2018  | Female | -                  |
| Manggala     | March, 2019 | Male | Infectious disease |

*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 km² and about 50% (603 km²) is considered as a suitable habitat for javan rhino (Griffiths 1993). Hence, a javan rhino needs a territorial area about 12–20 km² (male) and 3–14 km² (female). So, it can be calculated that the optimum number of javan rhino at the suitable habitat of UKNP (603 km²) was 60 heads with assumption carrying capacity of 1 head per 10 km².

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 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        |
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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