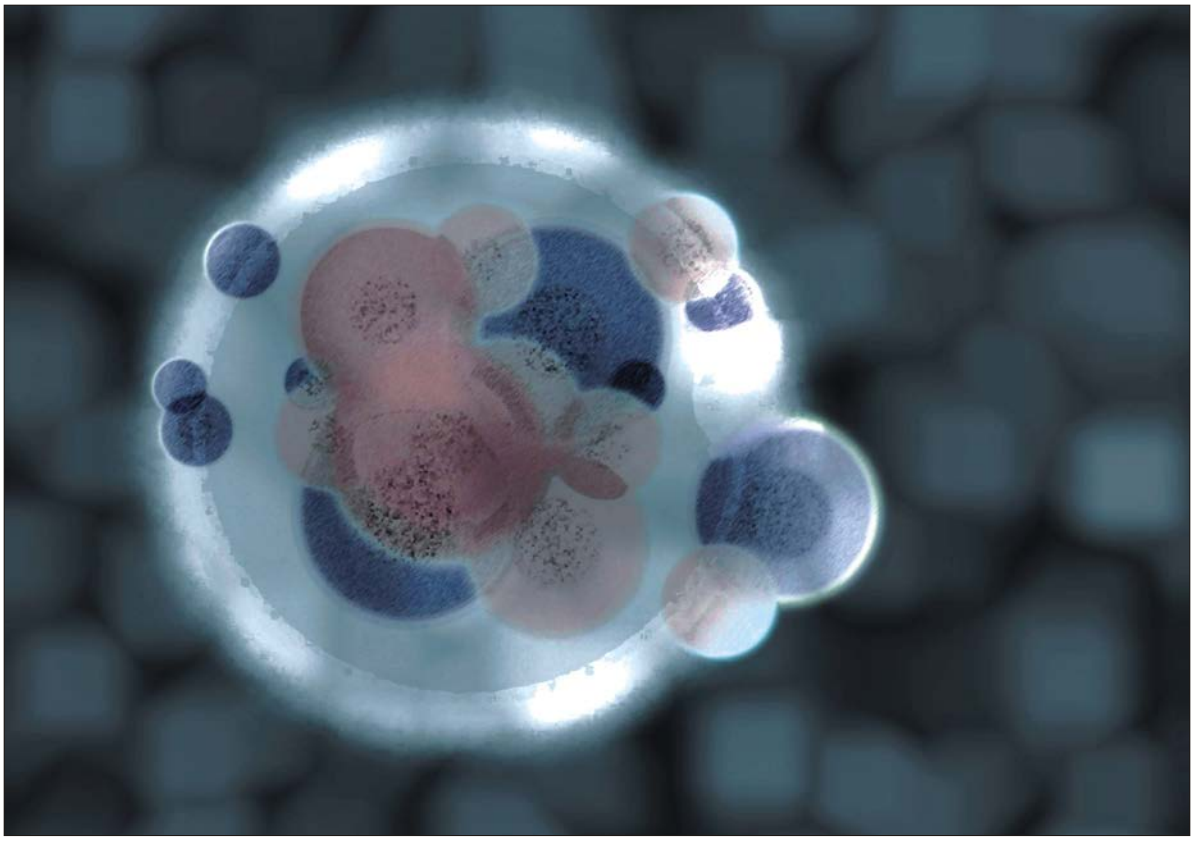

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Evidence of Banteng (*Bos javanicus*) Decline in Baluran National Park, Indonesia

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Abstract: A critical step for a successful conservation of endangered species is the correct diagnosis why the species of interest is decline. A failure of diagnosis what is wrong is at the heart of much unsuccessful conservation. The research assessed changes of population size of banteng between 2002 and 2006 and discussed the role of predation by dholes on the decline of banteng in Baluran National Park. Concentration counts in 13 waterholes in 2002 and in 11 waterholes in 2006 were conducted to monitor the population change. Observations of predation on banteng by dholes were done through series of observations from April to July 2002 and from March to July 2003 in the feeding ground of 350 ha in Bekol. Disproportional number of young banteng and change of sex ratio in population in 2002 indicated a possible decrease of the population. During four years, the number of animal diminished from 126 to only 15 banteng. An estimate of rate per capita of population growth (r) was -0.53 year^{-1}. The data suggested that high predation rate by dholes was the responsible factor of population decline. However, an action to reduce dholes in BNP was an agony of choice, because both banteng and dhole were classified as endangered species. A reduction of pack size of dholes was the best remaining options to prevent banteng from extinction. If the pack size of dholes was small enough, they would switch to prey the smaller animals.

Key words: Banteng, dhole, population, conservation, predation

INTRODUCTION

Banteng (*Bos javanicus* d'Alton 1823) is classified as an endangered species by the IUCN Red List, because the decline parts of the species range were more than 80% and overall decrease of at least 50% was likely (IUCN, 2006). The natural range of the animal includes Borneo, Burma, Cambodia, S Yunnan, Java, Laos, Thailand and Vietnam and was introduced to Australia, Bali, Enggano and Sangihe (Wilson and Reeder, 2005). On Peninsular Malaysia, banteng have been extinct since the 1950s (IUCN, 2006). The main causes for banteng decline were poaching for medicine, food and trophies and habitat losses as well as transmission of diseases lead by house cattle. Only one or two subpopulation of more than 50 animals was known to remain in mainland Asia (Hedges, 2000). Most of the larger subpopulations with more than 150 banteng were living in Java Island, Indonesia (Pudyatmoko, 2005b). In this island, however, most banteng are living in small and isolated protected areas and threatened with extinction.

In the first decade of nineteenth century, banteng was still abundant in Java (Hoogerwerf, 1970). Until 1988 there were six large subpopulations known (Ashby and Santiapillai, 1988), but current only four still exist (Pudyatmoko, 2005b). Banteng was reported extinct in Leuweng Sancang Nature Reserve, 4150 ha and decreased sharply in Cikepuh Nature Reserve, 8000 ha (Pudyatmoko, 2005b). The main reasons for decline were severe loss of suitable habitats and unsustainable poaching as impacts of political chaos in Indonesia since the downfall of President Suharto in 1998. The population of banteng increases in Ujung Kulon National Park (122956 ha), where poaching and habitat encroachment can be effectively controlled. In Alas Purwo National Park (43420 ha), the banteng population has been recovering after the sharp decline of its predator dholes *Cuon alpinus* Pallas, 1811 (Pudyatmoko, 2005b). No reliable estimate of population size of banteng is available in Meru Betiri National Park (50000 ha). Based on above reports, the optimistic judgment of Whitten *et al*. (1996) that banteng were not faring badly in Java is in current situation debatable.

In Baluran National Park (BNP), the estimates population size between 1969 and 1995 was about 150 to 250 individuals (Halder, 1976; Hedges and Tyson, unpublished data). It was assumed that strong competition with buffaloes was the responsible factor that inhibited the population growth of banteng. Although this assumption might be not correct (Ashby and Santiapiallai, 1986), removals of buffaloes were carried out

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many times to lessen the competition. In 1985, about 300 animals were caught. Further removals were conducted in 1989 and 1994, in which 205 and 200 buffaloes were captured, respectively. The mortality rate of captured buffaloes was very high; approximately about 30% of buffaloes were died during the capture process. In 2002 only 40 buffaloes were able to survive (Pudyatmoko, 2005a). The impacts of the removal of buffaloes on banteng could not be assessed, because no reliable population data was available between 1996 and 2001. If the assumption was correct, increase of banteng population was expected, because banteng have no potential to be regulated by intrinsic (behavioral) factors, which operate in species that females are territorial, offspring-rearing space (alpha status) is limited and young females exhibit reproductive suppression (Wolf, 1997).

A critical step for a successful conservation of endangered species is the correct diagnosis why the species of interest is decline. A failure of diagnosis what is wrong is at the heart of much unsuccessful conservation (Sutherland, 2000). We conducted long term monitoring of banteng population to document the change of population size. This activity was especially important when the principal objectives of management were to enhance the size of target population (Wilson and Delahay, 2001; Marques *et al*., 2001). We discussed the role of dhole predation on the banteng decline and suggested future conservation measures.

MATERIALS AND METHODS

Study area: The BNP is located in the northeast of Java, Indonesia that encloses the areas between 70°29'10'' to 70°55'55''S and 113°29'10''-113°39'10''E. It consists of 25000 ha with Mt. Baluran (1247 m) in the centre. The park is characterized by monsoon climate with a long dry season from April to November with an average annual rainfall of 1588 mm year^{-1}, with a range between 797 and 3577 mm. Most precipitations fall in December till February and the amount of precipitation during the driest months (August to October) tends against zero (Pudyatmoko, 2005a). BNP area is composed by mosaic of several vegetation formations, such as grassland, monsoon forest and mountain forests. Along in the coastal area mangrove and coastal forests are growing. Large herbivores occur in BNP including banteng, buffalo (*Bubalus bubalis* Linnaeus, 1758), rusa deer (*Rusa timorensis* de Blainville, 1822), Indian muntjac (*Muntiacus muntjac* Zimmermann, 1870) and wild pig (*Sus scrofa* Linnaeus, 1758). The carnivores occurred are leopard (*Panthera pardus* ssp. *mellas* Cuvier, 1809) and dhole.

Assessment of banteng population change: Concentration counts were conducted in November 2002 and in November 2006. The observation was carried out in the peak of dry season, when all temporary waterholes in the forest had already dried up and most banteng left forest area at night and visited the waterholes to drink. However, this survey method could not find out the actual population size, because it was impossible to estimate the number of banteng that did not visit the waterholes. However, it was reasonable to assume that change of the number of banteng in this survey was proportional to the change in actual population. The surveys were conducted in 13 waterholes in 2002. Based on prior observations, only 11 waterholes were selected to observe in 2006. The animal counts were done in all waterholes simultaneously to avoid double counting. Banteng were observed undisturbed from platforms on trees by two enumerators for each waterhole. The observation occurred during the night of full moon from 17:00-06:00 o'clock. Change in population size per capita was projected by using the exponential equation:

$$N_t = N_0 e^{rt} \quad (1)$$

The form was rearranged as follows:

$$\frac{N_t}{N_0} = e^{rt} \quad (2)$$

and

$$\mathrm{Ln}\left[\frac{N_t}{N_0}\right] = rt \quad (3)$$

where e is the base of natural logarithm, r is the per capita rate of increase and t is the unit of time in year.

Predation by dholes: observation on banteng and dholes were done through series of observations from April to July 2002 and from March to July 2003 in the feeding ground of 350 ha in Bekol and its surrounding. It was the best seasons to observed animals because in these periods banteng normally formed large congregations, so that the number and the behaviour of banteng were easy to count and to watch. Because of its small body size, dholes were also much easier to watch in open habitat than in the forest. It was expected that predation events was frequent in this season, when calving season took place. The animals were watched from the tower, which was approximately six m high. It was located on a hill from which the surrounding area to a large extent was visible.

The observations took place at morning (05.00 o, clock till all banteng left the grassland) and in the late afternoon (14.30 till dawn) for 14 days consecutively each month. The behavioural interaction between predator and prey species including hunting and predation events were recorded opportunistically. Behaviours of dholes such as hunting strategy, time of hunting and the minimum pack size needed for killing banteng were described. The number of banteng killed by dholes was noted. The data include sex of killed banteng, age class and other remarks. Change of habitat selection by banteng caused by the high frequent of dhole in feeding ground was also analyzed. We assumed that banteng would avoid open habitat when predation pressure was high. The Mann-Whitney U-test was applied to test the statistical different of the number of banteng group visiting feeding ground in 2002 and 2003.

RESULTS

In November 2002, the total number of banteng observed in 13 waterholes was 126 individuals. Among the waterholes, four were very highly preferred (always visited), two were preferred (visited three times), three were moderately preferred (visited twice), one low preferred (visited once) and three avoided (never visited). The number of cows observed was 61 animals, while of bulls 55 and of sub-adult 10 animals. No calves could be seen by the observations. We estimated the minimum number of banteng in BNP was 126 animals composed of 55 males, 61 females and 10 sub-adult banteng. The total number of banteng observed in November 2006 was extremely fewer than those in 2002. Only 15 individuals were observed including two cows, nine bulls, two sub adults and five banteng could not be identified (Table 1). One waterhole was always visited, three twice, three once and four never visited by banteng. Estimate population decline within four years was 111 banteng (88%), from 126 in 2002 to only 15 individuals in 2006. The estimate of rate per capita of population growth (r) was -0.53 year^{-1} that indicated a rapid decline of banteng population in BNP.

The number of banteng seen daily through regular observation from the tower in Bekol varied from 0-101 individuals. In total 67 herds of banteng were observed. The median of herd size was 5 individuals. A maximum of 101 animals established on July 10, 2002 was at the same time the maximum ever observed as far as different individuals were concerned. It was composed of 63 cows and 38 bulls. At that time no single calf and sub-adult could be seen. During the research, seven different individuals of sub adult consisting of 5 females and 2 males could be identified. Eighteen calves were encountered, but it was very difficult to determine how many could be considered with certainty as different individuals.

During the survey, in total 90 packs of dhole were observed. The most packs composed of one to five individuals and the biggest pack was 52 animals (Table 2). Among the observed groups, 30% were solitary animals. Total population size of dholes estimated in BNP was 150 individuals. Around the feeding ground occurred at least 100 individuals.

Dholes were coursing pack hunters and actively searched for prey. At least three animals were needed to capable to kill adult rusa. It was frequently observed that a single or a pair of dholes was pursued by some adult rusa. However, dholes might hunt alone or in pairs, taking smaller prey such as jungle fowl or peacock. The frequency of hunting on banteng by dholes was high. Observed predation between April 2002 and April 2003 was shown in Table 3. The true number of banteng killed by dholes have to be much higher than that our observation. Most killing sites were near Bekol feeding

Table 1: Total number of bulls, cows, sub-adult and unidentified banteng in 13 waterholes in November 2002 and in 11 waterholes in November 2006

Date	Bull	Cow	Sub-Adult	Unidentified	Total
Nov. 12, 2002	34	61	2	25	122
Nov. 17, 2002	40	18	4	13	75
Nov. 18, 2002	55	39	10	13	117
Nov. 19, 2002	38	22	7	9	77
Average	41.8	35.0	5.8	15	97.8
Nov. 7, 2006	9	0	0	0	9
Nov. 8, 2006	6	2	2	5	15
Nov. 9, 2006	4	1	0	0	5
Average	6.3	1.0	0.67	1.67	9.67

Table 2: The frequency of pack size of dholes in BNP. The total number of individuals in this table did not represent the total number of dholes in BNP because a dhole could be recorded for twice or more in different days

	Class of pack size (Individuals)						
	1-5	6-10	11-15	16-20	21-25	>25	Total
No. of groups	64	9	4	5	4	4	90
	(71)	(10)	(4.4)	(5.6)	(4.4)	(4.4)	
No. of individuals	140	70	59	99	99	182	649

Value in parenthesis show percentage

Table 3: Events of predation on banteng by dholes in BNP

Date	Preys	Time of predation	Location
April, 06, 2002	A pregnant cow	Early morning	Edge between monsoon forest and road
May, 12, 2002	A pregnant cow	Early morning	Edge between monsoon forest and road
June, 05, 2002	A cow	Unidentified	Edge between monsoon forest and grassland
June, 12, 2002	A cow and a calf	Early morning	Near the coastal line
June, 30, 2002	A calf	Night	Artificial waterhole in Bekol feeding ground
November, 19, 2002	A cow	Night	Grassland in Bekol
	A male sub-adult	Night	Grassland in Bekol
April, 10, 2003	A pregnant cow	Early morning	Grassland in Bekol

Table 4: Comparison of the number of banteng group visiting feeding ground in Bekol during April to July 2002 and 2003. Observation was conducted in ten consecutive days

Year	April	May	June	July	Total	Mean±SD
2002	6	22	38	76	142	35.50±29.99
2003	12	2	4	4	22	5.50±04.43

ground. The victim of dholes possessed a typical characteristic that was preys have to die from several injuries, rather than from a single killing bite.

Banteng normally formed large congregations in feeding ground from April to September yearly. Outside this period, banteng spend more time in the lowland forest and was very difficult to see. The change of habitat use of banteng was obvious, when predator pressure was high. Frequent activities of dholes in grassland forced banteng to avoid feeding ground and preferred closed habitats. The median of number of banteng group visiting feeding ground Bekol in April to July 2003 was clearly lower than those in 2002, except in April ($U = 2.03$, $p = 0.021$) as shown in Table 4. Banteng apparently changed also their activity pattern from a diurnal to be almost nocturnal animal.

DISCUSSION

Comparison between population data in 2002 and in 2006 indicated a dramatic decline of banteng in BNP. The value of $r = -0.53$ year^{-1} was greater than those estimated by the population viability model that was -0.23 year^{-1} (Pudyatmoko, 2005a). A sharp decline of banteng was once reported in Alas Purwo National Park, due to predation by dholes. The number of banteng from 1992 to 1995 diminished from 323-119 animals ($r = -0.33$). Under the assumption of one banteng killed per five days, Hedges and Tyson (unpublished data) predicted that the population would be extinct in March 1997.

A clear tendency of banteng decline in BNP was indicated by the age structure of population in 2002. The number of sub-adults in population with only 10 (8%) among 126 total individuals was under represented. Similarly, the number of juveniles in calving season was also very low, as shown in observation of July 10, 2002. Low proportion of calves and sub adults was the result of a high mortality rate of immature animals. Choquenot (1993) reported that 26% of banteng calves on Couburg Peninsula, northern Australia, died in their first six months of life. In BNP, however, the high predation rate by dhole strongly diminished the survival rate of young banteng. In the presence of predator the mortality rate can be very high that only 1% of calves can survive (Gaillard *et al*., 2000).

In a diverse prey and predator community, small herbivores were exposed to more predators, owing to opportunistic predation, than are larger ungulates. They also suffer greater predation rates and experience strong predation pressure. A threshold occurs at prey body sizes of 150 kg above, which ungulate species have few natural predators and exhibit food limitation (Sinclair *et al*., 2003). Bull and a non pregnant cow might not be a primary prey of dhole at a high abundance of medium prey, such as rusa deer and muntjak. In Nagarahole, India, dhole preferentially killed medium- sized prey of 31-171 kg, although it preyed gaur (*Bos frontalis* Lambert, 1804) too (Karandt and Sunquist, 2000). Present study suggested that dholes preferred pregnant cows, cows with young, sub-adults and calves than bulls. Pudyatmoko and Djuwantoko (2006) reported that sex ratio of banteng changed from female bias in year 1999-2001, to more equal ratio in 2002.

The fact that the proportion of young banteng was very low and clear decrease of female in population were indicator that predation played more important role in decline of banteng population than the environmental factors. Although much extinction resulted from habitat changes, habitat fragmentation and loss of dispersal area (Kinnaird *et al*., 2003; Ottichilo *et al*., 2000; Sinclair *et al*., 2006), present study showed that the role predator on survival of prey should not be underestimated. Predation by dholes affected not only the survival of young banteng but also the foraging behaviour of adult banteng. Generally, animal selected optimal areas with interspersion of habitat components in order for successful of reproduction and survival (Stephens and Krebs 1986). Banteng showed to utilize foraging strategies that responded to special habitat features and spatial reference information, namely distance to water resources (Lewison and Carter, 2004). In Bekol and its surrounding, all of habitat components essentials for banteng were available in proximity to each other. The mixed of different habitat types such as grassland, monsoon forests, pure acacia stand and waterholes provided a complete requirement of banteng namely, food, water, mineral, cover and mating arena. Animals here were seldom poached, because rangers were always in attendance. However, when water was available everywhere in Park, banteng tend to have wider range. Few number of banteng visiting feeding ground in 2003 was unlikely the consequence of population decline. High risk of predation inhibited banteng from using Bekol feeding ground. However, banteng did not change the preferences suddenly after the high frequency of occurrence of dholes. The animals required time to learn where to find food resources and how best to avoid predator (Owen-Smith, 2003). The suitable habitat for banteng depended not only on adequacy of food availability, but also shelter and security from predation. Change of habitat preference

from optimal to sub optimal habitat might be a further factor that diminished the survival ability of banteng.

To avoid banteng from extinction, the reduction of mortality of young animals due to predation is the key factor. The long-term survival of banteng can only be assured if the minimum viable population can be maintained. If the population of banteng fall into a very small, the extinction risk become higher because aside predation additional factors like genetic, demographic and environmental stochasticity would accerelate the extinction process (Reed, 2004). A small rise of predation risk may greatly diminish the likelihood of the persistence of a small isolated population (McLoughlin and Owen-Smith, 2003). Banteng population could not sustain the high rate of predation by dholes. However, an action to reduce dholes in BNP was an agony of choice. Dholes and banteng have the same level of conservation status. Both are considered as endangered species based on IUCN Red List 2006. A reduction of pack size of dholes was a possible measure. If the pack size of dholes was small enough, they would switch to prey the smaller animals such as rusa deer. But the pack size must be above the critical minimum threshold, in which the probability of extinction was low (Courchamp and McDonald, 2001). We have identified why banteng was decline and clarified what measures have to do to prevent banteng from extinction. The highest priority of banteng conservation was the regulation of dhole. Although, the population size of banteng in BNP clearly under the minimum viable population, it does not mean that banteng has no chance of survival (Storch, 2003). We learned from Alas Purwo National Park that banteng recovered rapidly after the disappear of dhole.

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