The Habitat Characteristics of Banteng (*Bos Javanicus* D'alton, 1832) in Pringtali Feeding Ground, Meru Betiri National Park, East Java

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Abstract. Banteng (*Bos javanicus*) is an endangered native species found in Meru Betiri National Park (MBNP), East Java, Indonesia. This research is aimed to identify the habitat characteristics of banteng at Pringtali feeding ground, Bandealit Resort, MBNP, which is one of the most important habitats for this species. This habitat was studied using the line transects with multiplot, evidence of banteng activity, vegetation composition and other habitat characteristics study. This was conducted from June to November 2018. The results show that the Pringtali feeding ground contains a habitat which has a good potential to support the banteng population, and there were signs of banteng activity in the 147 plots which have the size of one square meter. Twenty understorey plant species were recorded, including four important banteng food plants (*Mikania scandens, Desmodium pulchellum, Panicum muticum,* and *Eulalia amaura*). We found significant positive associations between the relative abundance of two particular food plants (*P. muticum* and *E. amaura*) with the presence of banteng. Tree canopies, including species of *Chydenanthus excelsus, Ficus hispida, Lagerstromea speciosa, Annona muricat*a, and *Bambusa* sp. Are used by banteng to cover. The coverage area of Banteng is 57.77 m^2, while grazing ranges from 9,994.23 m^2. The presence of the potentially invasive plant *Lantana camara* in this location represents a serious threat to the banteng habitat. This may help to explain why banteng have been reported to enter the plantation areas which border the Pringtali feeding ground. Our study results provide a baseline reference for future studies of banteng habitat use and can inform conservation efforts to maximize the value of habitat for banteng in MBNP.

Keywords: Bos javanicus · Habitat · Pringtali Feeding Ground · Meru Betiri National Park

1 Introduction

Banteng (*Bos javanicus*) is a species of wild cattle native to Southeast Asia. The banteng population is declining [1–3], mainly due to poaching and habitat degradation [4–6].

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As a result, the banteng is listed as endangered on the IUCN Red List of Threatened Species [7], and the Indonesian government has included it as a priority species in its policy on the preservation of flora and fauna [8, 9].

In Indonesia, banteng is only found in Kalimantan, Bali, and Java [10]. In Java, banteng is mostly restricted to natural conservation areas, such as Ujung Kulon National Park, Baluran National Park, Alas Purwo National Park, and Meru Betiri National Park (MBNP) [11], although some populations have been reported from non-conservation areas [5]. Based on information from the MBNP Forest Ecosystem Controller, the population of banteng in the MBNP has decreased in recent years. In 2013, only 80 individuals were recorded, while in 2016, it was estimated to be only 60 individuals. They are found in three locations: Sarongan Sector, Ambulu Sector, and Kalibaru Sector. Direct encounters with banteng occur mostly in the Ambulu Sector, where around 43 individuals occupy four areas or observation blocks of the Balsa, Kedungwatu, Banyuputih, and Pringtali feeding ground.

Pringtali is located at Bandealit Resort, where the habitat is intentionally formed for feeding ground or wildlife habitat, especially for banteng [12]. In addition, banteng is often found in the adjacent plantation areas, where their presence is resisted by residents and plantation staff, as the species is considered to threaten crops. The presence of banteng in the plantation areas occurs as a result of a shortage of suitable habitats in the MBNP. However, we have only limited knowledge of the habitat preferences of the species in Java, and other locations in general. This paper aims to answer this question by evaluating the ecological characteristics of the habitat that is suitable for banteng in the Pringtali feeding ground and identifying predictors of banteng activity. The goal is to inform the habitat management in MBNP about the conservation of this endangered species.

2 Materials and methods

2.1 Study Sites

The study was conducted from June – November 2018 at Pringtali feeding ground, Bandealit Resort, MBNP, East Java, Indonesia (Fig. 1). Pringtali has an area of about 5 ha, in which 1.8 ha is used as a sampling in this study. The determination of this study area is based on information on the existence of banteng from the officer's report. Data were collected including the composition of vegetation, as well as the availability of food plants and shelter characteristics of banteng.

2.2 Data Collection

The method was combined with a multiply plot of vegetation analysis for Herbaceous = $1m^2$, Scrub = $25m^2$, and Tree = $100m^2$ systematically on each transect [13]. Every transect had a distance of 20 m. The total number of vegetation plots (Herbaceous, n = 147; Scrub, n = 98; Tree, N = 49) used were in a 1.8 ha area of feeding ground. We recorded all types of vegetation found. We also counted the percentage of herbs and shrubs covered, and the number of individuals of trees. The study also identified the

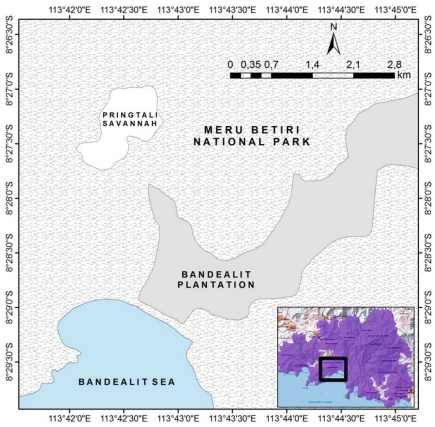

Fig. 1. Map of the study site at MBNP (constructed from google earth 2018 and MBNP administration map).

type of vegetation using an identification book [14–16] and the food plants of Banteng [17–19].

The presence of banteng was evaluated indirectly by recording traces of footprints and faecal [20, 21] in the vegetation survey plots. In each plot, we simply recorded the presence or absence of any signs. In this study, we also took aerial photos of the research area using the DJI Phantom version 4 drone to analyse the tree cover used as a shelter for banteng.

2.3 Data Analysis

We calculated Relative Density (RD) and Relative Frequency (RF) on understorey vegetation (herbs and shrubs). Furthermore, to ensure that the understorey vegetation is a source of banteng feed, we also conduct a reference study using several scientific articles [17-19]. Understorey plant diversity was characterized using the Shannon-Wiener Index (H') and Species Richness (D) [22]. We tested for an association between understorey plant diversity and the presence of banteng using a Wilcoxon test in R version 3.2.1 [23]. This analysis is presented in the form of a boxplot about the correlation between the presence of banteng and the ecology of foodplants (species richness and the Shannon understorey foodplants).

Furthermore, we calculated the density and area of tree covering used by banteng for activity. A map of habitat characteristics present in the study area was created. Aerial photography, taken from a drone (DJI Phantom 4), was used to provide a base map. The final map was constructed using Agisoft (http://www.agisoft.com) and ArcMAP 10.0 (http://www.esri.com).

3 Results and discussion

3.1 Understorey Vegetation and Availability of Food Plants

The vegetation survey revealed 20 understorey plant species (Table 1) and 17 tree species (Table 3). The understorey included two scrub species and 18 herbaceous species. The dominant understorey plant was the potentially invasive shrub *Lantana camara.* Four known food plants of banteng were found (*Mikania scandens, Desmodium pulchellum, Panicum muticum*, and *Eulalia amaura*). These species had the largest relative density after *L. camara* and *Chromolaena odorata.*

The presence of four food plant species in this area suggests that the habitat is favourable for banteng since food plant distribution will affect the distribution of large mammalian herbivores [24]. Our finding is supported by [25], who stated that the Banteng in Alas Purwo National Park (APNP) is more commonly found in Sadengan Savannah, a habitat which supported several preferred banteng food plant species (i.e. *Arundinella setosa* and *Andropogon contortus*). The domination of grasses in savannah vegetation is thought to create this ecosystem as a favourite feeding ground for banteng [26].

Banteng in Java Island is preferred to open areas such as feeding ground, and savanna [27, 28] and also some are found in the highland forests up to 2000 m above sea levels [29]. Savanna or feeding grounds tends to have open space and provide opportunities for herb groups to grow well. The 18 species of herbs found at the Pringtali hence give the banteng a choice of the food plant. However, this endangered species is also found eating fairly high vegetation (browsers) in some places. In Sadengan APNP, banteng prefers the 25 types of food consisting of 18 types of non-grass and 7 types of grass [30].

The existence of understorey vegetation is indicated by the RD and RF values. Relative density is the ratio of the density of a type of vegetation to the density of all vegetation in an area. While the relative frequency is the percentage ratio between the frequency of a type of vegetation with the frequency of all vegetation in the area. Shrub groups in Pringtali were found with high RD values, namely *L. camara* (64.17) and *C. odorata* (21.21). Both of these species are introduced species and have the potential to become invasive species in the MBNP area [31].

The highest RF value was found in *M. scandens* (22.06). This indicates that the banteng species are more abundant in the observation plot. It also gives hope that the availability of feed that banteng can grow at each observation plot. Availability of feed is a guarantee for the existence of banteng in a habitat [32].

A comparison of survey plots with and without signs of banteng activity revealed that banteng activity is associated with higher herbaceous plant diversity in the understorey (Fig. 2). The pattern is the same, regardless of whether plant species richness or the Shannon Index is used to measure diversity. Based on this, it indicates that banteng prefers high diversity of species including herbaceous plants. This allows banteng to explore more food plant options.

The species richness of herbaceous (18 species) in Pringtali is lower than the Bekol, Keramat, and Balanan savannas at Baluran National Park which has 63 species [33]. The more diverse herbs species in a habitat, the more food resource options for banteng. The diversity of herbaceous species in Sadengan also creates this feeding ground a preferred habitat type for banteng in APNP [25].

Table 1. The composition of understorey vegetation in the Pringtali feeding ground. Relative Density (RD); Relative Frequency (RF)

Species	Percentage (100%)		Habitus
	RD	RF	
Lantana camara	64.17	16.48	Shrub
Chromolaena odorata	21.21	8.65	Shrub
*Mikania scandens**	21.43	23.92	Herb
*Desmodium pulchellum**	20.29	18.32	Herb
*Panicum muticum**	22.06	16.28	Herb
*Eulalia amaura**	13.29	9.41	Herb
Centrosema pubescens	12.63	8.65	Herb
Synedrella nodiflora	6.71	9.92	Herb
Piper sarmentosum	6.36	3.82	Herb
Ageratum conyzoides	3.25	1.53	Herb
Momordica charantia	1.18	1.52	Herb
Salvia hispanica	1.32	1.02	Herb
Alternanthera sessilis	0.87	1.28	Herb
Cyathula prostrata	1.32	0.76	Herb
Pueraria javanica	0.82	0.51	Herb
Ipomoea triloba	0.58	0.51	Herb
Phyllanthus sp.	0.55	1.27	Herb
Gomphrena celosioides	0.53	0.51	Herb
Hemidiodia ocymifolia	0.21	0.50	Herb
Pseudelephant opus	0.39	0.25	Herb

Note: * Known food plants of banteng

The analysis of the correlation between banteng and food plants showed that the presence of signs of banteng activity was significantly associated with two of four known food plant species (Table 2). Species *P. muticum* and *E. amaura* (0.2439) were both positively associated with banteng activity. These results suggest that habitat use by banteng in the study area is influenced by the availability of suitable food plants and in particular grasses. Species *P. muticum* is a member of the Poaceae which is also food for Sumatran elephants [34] in North Bengkulu and barking deer (*Muntiacus muntjak*) in Mount Halimun National Park [35]. Banteng in the tropical rainforests of Borneo is known as a favourite plant from the families Graminae and Poaceae. This was proven by the presence of Paspalum conjugatum seeds inside banteng faeces [36].

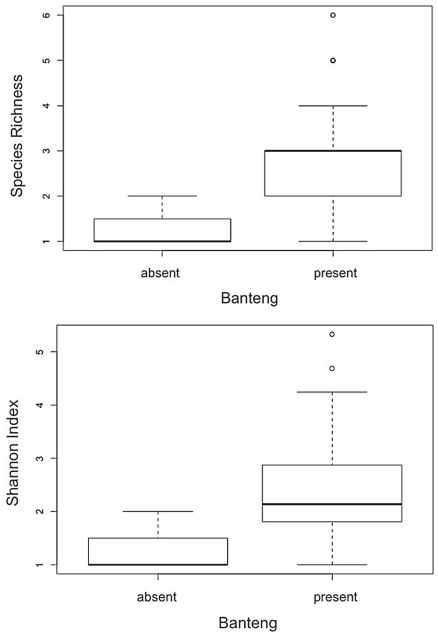

Fig. 2. Boxplot showing two measures of herbaceous understorey plant diversity in plots with and without. Signs of banteng activity. Left: species richness. Right: Shannon index.

Table 2. The results of Wilcoxon tests of the association between the presence of signs of banteng activity and the relative density of four known food plants

Species	Wilcoxon-test	
	w	p-value
Panicum muticum	1175.5	2.209e-05
Eulalia amaura	1483.5	0.00124
Desmodium pulchellum	1909.5	0.54870
Mikania scandens	2398.5	0.09267

3.2 Availability of Cover Characteristics

Habitat suitability for banteng is also thought to be determined by tree cover because they provide important shelter as well as grazing [11]. Seventeen species of trees belonging to 14 families and 14 genera were found in this study (Table 3).

The cover characteristics of banteng that were found in the Pringtali feeding ground are scattered in several locations that have fairly tight canopy cover (Fig. 3). Some types of covers used by Banteng in the area are tree canopies and bamboo clumps. This estimation was recorded based on the presence of traces, faecal, and interviews with

Table 3. The densities of tree species in Pringtali savannah

Tree Species	Number of Individuals	Density (ind/m^2)
Ficus hispida	49	0.0098
Ficus septica	33	0.0066
Kleinhovia hospita	32	0.0064
Lagerstromea speciosa	28	0.0056
Leea indica	13	0.0026
Croton glabiescens	8	0.0016
Bischofia javanica	9	0.0018
Ficus benjamina	5	0.0010
Erioglossum rubiginosum	5	0.0012
Toona sureni	5	0.0011
Chydenanthus excelsus	4	0.0008
Terminalia ballirica	4	0.0008
Spathodea sp.	4	0.0008
Ficus sp.	2	0.0004
Trema orientalis	1	0.0002
Parkia roxburghi G. Dan	1	0.0002
Annona muricata	1	0.0002
Total	**204**	**0.0411**

Table 4. Covering types in Pringtali feeding ground

Species	Cover Type	Function
F. hispida	Tree Canopy	Rest, Eat
L. speciosa	Tree Canopy	Refuge, Rest, Eat
C. excelsus	Tree Canopy	Refuge, Rest, Eat
A. muricata	Tree Canopy	Eat
Bambusa sp.	Bamboo Clump	Refuge, Rest, Eat

officers. Observation data regarding the shape and function of the cover are presented in Table 4.

The map (Fig. 3), showed that the Pringtali feeding ground has several areas of suitable habitat to support the banteng population ranging from 1.8 ha. The coverage area of Banteng is 57.77 m^2, while grazing ranges from 9,994.23 m^2. Banteng is known to spend a greater proportion of time foraging in open canopy areas [37]. The distribution

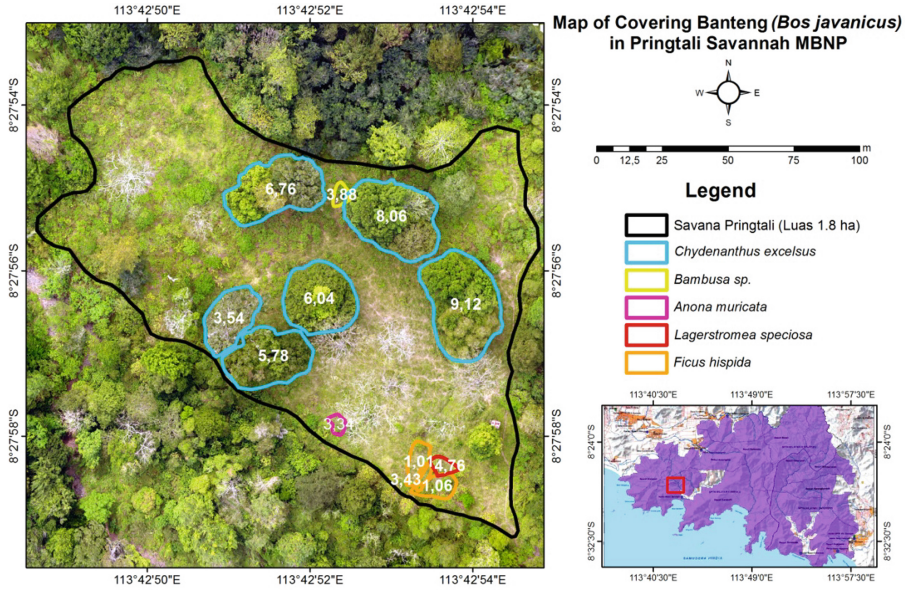

Fig. 3. Map of habitat types in Pringtali feeding ground (based on an aerial photograph of our research).

of some large herbivores found in Gonarezhou National Park is affected by the density and distribution of the vegetation [38]. Further research is required to find out the carrying capacity to the productivity of food plant species and to determine the population size of the banteng that can occupy the Pringtali feeding ground.

3.3 Habitat Threat of Banteng

The main concern about the suitability of habitat in the Pringtali feeding ground for banteng is the dominance of *L. camara* and *C. odorata* in this site. These two species have the highest relative density (Table 1) and they dominate throughout the area. Species *L. camara* is capable to grow up to two meters above ground level [39] and forms dense scrub. The species, which is a known invasive weed in several grassland areas which are wildlife habitats [40], is not a preferred food plant for banteng. Therefore, it is difficult for banteng to find food, drink, shelter, play and breed, to find shelter and cover [11]. In this study, we found an *L. camara* that had a height of up to 1.8 m above ground level. If the invasion of this species at our study site continues, the habitat may become less suitable for banteng. In Udawalawe National Park, *L. camara* is threatening the Asian elephant habitat, as it is widespread in the forest, scrub, and grassland plots [41].

The results suggest that it may be possible to improve the quality of the banteng habitat in the Pringtali feeding ground by controlling the growth of invasive species (notably *L. camara*). If the invasive species is not properly controlled, the native habitat of the banteng will potentially be destroyed. The study from [42] and [43] reported that nearly 50% of the savannah in Baluran National Park was invaded by *Acacia nilotica.*

After three years, out of 10,000 ha of savannah, only 150 ha is free from invasive *A. nilotica plants*, and this is thought to have caused the banteng population to decrease significantly [3]. In Meru Betiri National Park, it is possible to anticipate a similar problem caused by the presence of *L. camara*, and hence we suggest conservation intervention to prevent the problem.

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