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To cite this article: Sugiyarto *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **590** 012007

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The suburban forest as a habitat of eagles (Accipitridae): a case study in Gunung Bromo University Forest, Karanganyar, Central Java, Indonesia

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Abstract. Eagles (Accipitridae) are sensitive to environmental disturbance such as fragmented environment. This study was aimed to describe the forest in Gunung Bromo as a habitat of the eagles. The research method used was the case study, habitat observation, monitoring presence of eagles, and literature review. Gunung Bromo University Forest is totally fragmented suburban forest with four types of habitat such as oligoculture forest, mixed forest, cropland and riverstream. Two species of eagles were found in the area namely *Nisaetus cirrhatus* and *Spilornis cheela*. Potential prey for the eagles found in the area was six species of snakes, eight species of amphibians, five species of lizards, 32 species of birds, and three species of small mammals. Inactive eagle's nest was also found, and the shape of nest is a big circle with neat plaits created from branches placed in the upper canopy of *Bombax ceiba* tree. The nest presumed to be used by *N. cirrhatus*. The study also noted the competitor namely *Artamus leucorhynchus* which often aggressively mobbing the eagles when soaring. Gunung Bromo University Forest was a good habitat for eagles, although it was fragmented. It provided four different habitats, diverse preys, and nesting site. Threats for conservation of eagles in the forest were illegal hunter and noise from visitors' motocross.

1. Introduction

Diurnal raptor also called birds of prey, is group of birds widely known as daytime hunter in order Ciconiiformes, Accipitriformes, Sagittariiformes and Falconiformes exclude nocturnal raptor (Strigiformes) [1]. Raptor is avian top predator in mainland ecosystem that has key role in controlling prey population and regulating natural communities [2]. Its presence as bioindicator of good ecosystem in stabilizing food chain [3]. Raptor might reduce rodent or avian agricultural pest [4]. Raptor can be primary and secondary seed disperser [5]. Total species of raptor is 557 (321 species of diurnal raptor and 236 species of nocturnal raptor) in the world [6]. In Asia, there is 127 species of raptor [7] and especially Indonesia has 81 species raptors [8]. In term of richness and endemism of diurnal raptors, Indonesia is the highest [6] endemism of species diurnal raptor, 10-17 out of 81 species are known to be endemic to the country [8]. Because of its important function, all species of raptors in Indonesia are protected by law [3].



In fact, Indonesia has most declining species of raptor in the world [6]. Raptors in Indonesia are threatened by illegal trade and habitat destruction [8,9,10]. Based on online survey held in 2015, there were 4,748 individuals [9] and 2,471 individuals of diurnal raptor [10] were offered in Facebook group. On the other hand, the main threat to Indonesian raptor is the incredibly rapid habitat destruction [8]. Especially, all natural forests are fragmented left only found in montane areas covered 10% from all areas in Java. Lowland forest only in conservation forests such as nature reserve and national park. Many forest areas have been changed to agricultural land and monoculture production forest [11].

Accipitridae is large and diverse family of bird of prey, among members of this group are kites, hawks, eagles and allies [12]. It has big size of body, hooked bill, sharp claw to killing and tearing their prey (vertebrates) [11]. Its diet varies from mammals, birds, reptiles, fish, frogs [13]. The habitat range is diverse from forest to open country [12]. The human-modified landscape is also suitable for the habitat of eagles [13,14]. The research of eagle's habitat has been concentrated in West Java [3,14]. Meanwhile, the research of eagle in other part of island like Central Java is still focussing in species diversity. Four species of eagle was recorded in totally fragmented forest in border of Central Java-Yogyakarta, namely Javan Hawk-eagle *Nisaetus bartelsi*, Crested Serpent-eagle *Spilornis cheela*, Black Eagle *Ictineatus malaiensis*, and Changeable Hawk-eagle *Nisaetus cirrhatus* [15]. Nine species of eagle was also recorded in suburban forest in Semarang, Central Java [16]. This research will provide information on a fragmented suburban forest as eagle's habitat in Central Java. The information includes its condition, potential of prey, and conservation.

Gunung Bromo University Forest (hereafter GBUF) is suburban Pines and timber production forest managed by Perum Perhutani Surakarta Region (Figure 1). GBUF is located only seven km from center of city on Subdistrict of Karanganyar, Central Java. GBUF is bordered by rubber plantations, sugar cane fields, residential settlements and Tirtomarto Reservoir. In 2018, management forest was transferred to Universitas Sebelas Maret as forest area in Indonesia with special purpose for education and forestry training. There are two species of diurnal raptor found in there, namely Changeable Hawk-eagle *Nisaetus cirrhatus* and Crested Serpent-eagle *Spilornis cheela*. This paper described GBUF as habitat of these eagles, especially about its condition, potential of prey, and conservation.

2. Methods

2.1. Survey area

This research was conducted on GBUF located in Karanganyar Subdistrict, Karanganyar District, Central Java Province covering an area of 120 ha (Figure 1).



Figure 1. Map of GBUF covering an area of 120 ha.

2.2. Procedures

Raptor monitoring was conducted by exploration methods with point count and transect [17]. Point count was conducted in higher place for clearly viewing when raptor soaring. Transect was conducted by following pathways in forest and cropland. The research was held in 2017–2019, with intensive monitoring lasted on May to August 2019. Binocular Celestron 10x25 was used to observe the raptors. Canon Powershot SX430 Camera was used to taking picture. Time and date, species and individuals, and activities were noted in monitoring presence of raptors. Observation was used to describe condition of habitat in GBUF. The description of habitat covered type of habitat, dominating plant and other conditions. We also reviewed relevant literatures in relation to potential of prey for raptor. Descriptive analysis was used to explain condition of habitat, potential preys, and conservation of raptors in GBUF.

3. Results and Discussion

A habitat of bird will provide place to feed, drink, play, protection, and breed [18]. Habitat selection of bird causes different resource usage and food viability [19]. The habitat of raptor is diverse from forest to open country [12]. Indonesian raptor is mostly forest dwellers, only part of is presumed to be dependent on forest, none can survive without woodland [20]. It is because the main components of raptor habitat must contain large tree for perching, roosting and nesting [20]. In fact, many forests change into human-modified habitats like agricultural sites and industrial plant monocultures, but it is still able to provide habitat for adaptable raptor like Crested Serpent-eagle and Changeable Hawk-eagle [13]. In the case of GBUF, this human-modified habitat was still be able to provide the place for eagles to feed, breed, and for protection.

3.1. Condition

GBUF is northward and eastward bordered by rubber plantations, southward bordered by sugar cane fields, westward bordered by residential settlements, and south-westward bordered by Tirtomarto Reservoir. GBUF has 4 type of land covers or habitats such as production forest, mixed forest, cropland, and river stream. Production forest dominated about 80% in GBUF. Main production plant was Merku's pine *Pinus merkusii* with intercropped plants such as Siamese cassia *Senna siamea*, Indonesian Rosewood *Dalbergia latifolia*, and Mahogany *Swietenia* spp.. Mixed forest was inactive production forest in GBUF. This area was dominated by Mahogany *Swietenia* spp., other plants found in this area were Laban *Vitex pinnata*, *Dilennia* sp., Cotton tree *Bombax ceiba*, Merku's pine *Pinus merkusii*, *Flacourtia* sp., *Ficus* sp., *Pterocarpus indica*, *Adenanthera pavonina*, *Dalbergia latifolia*, *Guazuma ulmifolia*, *Schleichera oleosa*, and *Sterculia foetida*. Cropland was logged-over forest which planted by annual crop like corn and cassava. The river in GBUF flows from the east area with a rock substrate.

3.2. Observation of eagles

The monitoring result found two species of eagles in the area namely Crested Serpent-eagle (hereafter CSE) and Changeable Hawk-eagle (hereafter CHE) (figure 2). CSE is a medium-sized raptor (50 cm) while CHE is a big-sized raptor (70 cm) on Sundaland forest areas [11]. Conservation status for both species as it is suggested by IUCN is Least Concern, in which CSE has a stable populations trend while CHE has a decreasing populations trend [21, 22].

Spilornis cheela is found in Java and Bali [12]. The characteristics of this raptor is yellow featherless skin between eyes and bill, white line on tail, and white line on edge back of wings [6]. Based on field record, this eagle was often seen soaring in a group with loud voice [11]. The highest count for CSE record was five individuals (Table 1). CSEs found mostly on eastern area of Merku's pine forest GBUF.



Figure 2. Pictures of raptor in GBUF, (a) CHE light morph, (b) CHE dark morph, (c) CSE.

CHE is unique eagle that has varied color of feather such as dark morph, light morph, and intermediate morph. Two morph was recorded in GBUF which identified as race *limnaeetus* (Figure 2). Its characteristic is polymorphic and nearly crestless of race CHE [1]. The dark morph has dark brown color on all body with black bill to distinguish it from Black Eagle *Ictinaetus malaiensis*. The light morph has brown ashy upper body, white with dark brown streaks on lower body [11]. This race is spread on South Asia, Southeast Asia, Greater Sundas and Philippines [12]. Population of CHE in GBUF is estimated to be two individuals as a pair. It was proved with record of two morphs CHE which perching on *Bombax ceiba* (Table 1). The record for common activity of CHE was perching on Cotton tree *Bombax ceiba* (Table 1). CHE has habit ambushing prey from deciduous tree on open country and over-logged forest [11]. The mixed habitat like cropland, production forest, and mixed forest was available that could support the survival of CHE.

Table 1. Record of eagles in GBUF from 2017-2019.

Time	Date	Species	Individual(s)	Morph	Activities
10h15	28 May 2017	CSE	1	-	Mobbed by White-breasted Woodswallow
-	29 April 2019	CHE	1	Dark morph	Perching in <i>Bombax ceiba</i>
11h00	25 May 2017	CSE	2	-	Mobbed by White-breasted Woodswallow, Soaring
17h00	23 June 2019	CHE	2	Light morph and dark morph	Perching in <i>Bombax ceiba</i>
8h29	7 July 2019	CHE	1	Light morph	Perching in <i>Bombax ceiba</i>
8h00	18 July 2019	CHE	1	Light morph	Soaring, Perching in <i>Bombax ceiba</i>
8h25	18 July 2019	CHE	1	Dark morph	Perching in <i>Bombax ceiba</i>
9h36	19 July 2019	CHE	1	Light morph	Perching in <i>Bombax ceiba</i>
9h44	19 July 2019	CHE	1	Dark morph	Soaring, Perching in <i>Bombax ceiba</i> , Mobbed by White-breasted Swallow
11h25	19 July 2019	CHE	1	Dark morph	Perching in <i>Bombax ceiba</i>
14h28	19 July 2019	CHE	1	Dark morph	Perching in <i>Bombax ceiba</i> with the nest
8h10	20 July 2019	CHE	1	Light morph	Perching in <i>Bombax ceiba</i>
9h27	20 July 2019	CSE	1	-	Perching in <i>Parkia speciosa</i>
9h51	20 July 2019	CSE	5	-	Soaring
9h00	21 July 2019	CSE	1	-	Perching in <i>Parkia speciosa</i> , Flying away

3.3. Potential of preys

The monitoring result did not find feeding activities of eagles. Based on literature review, there were six species of snakes, eight species of amphibians, five species of lizards, 32 species of birds, and three species of small mammals as potential prey of raptors in GBUF (Table 2). CSE is specialist raptor, their main preys are snakes and lizards [1,13], some frogs [1], occasionally small rodents [13]. CHE is typical generalist raptor with range prey from small rodents to large mammals as well as small monkeys and hares [13]. Other preys hunted by CHE including lizards, small and large birds, snakes, and frogs [22].

The abundance of prey on GBUF was high and it could support the survival of these raptors. The most common snakes species found on riverstream were Asian Vine Snake *Ahaetulla prasina* and Painted Bronzeback *Dendrelaphis pictus* [23]. The highest abundance of lizard species was Maned Forest Lizard *Bronchocela jubata* [23]. Those herpetofauna species were potential preys for CSE. The small mammal, Plain Squirrel *Callosciurus notatus* was also abundant in GBUF [23]. That species was often seen on upper part of Cotton Tree *Bombax ceiba*. This species was presumed as the main prey of CHE in GBUF.

Bird species were also potential prey for the raptor and they were highly diverse. The large-sized bird (>3,9 kg) like Green Junglefowl *Gallus varius* was often seen on Cropland [23]. Medium-sized bird as potential prey for raptor included Barred buttonquail *Turnix suscitator* and Eastern Spotted Dove *Spilopelia chinensis* were abundant in all areas of GBUF [24].

3.4. Nest

The monitoring results also found an inactive eagle's nest on Cotton Tree *Bombax ceiba*, located on the edge of riverstream (Figure 3). It was placed on upper canopy of tree with circle shape. This nest presumed to be used by CHE. CHE was often seen perching on *Bombax ceiba* near the nesting tree, especially dark morph of CHE once perched on nesting tree. *Bombax ceiba* was nesting tree of CHE on lowland area [25]. The similar species, Kapok *Ceiba pentandra* was used to nest by CHE on Gunung Halimun Salak National Park [26]. However, it was confirmed by more field monitorings on the nest during the breeding season.



Figure 3. An inactive nest in *Bombax ceiba*.

3.5. Competitor

Competitor did not compete for prey in this study. The competitor we observed in field was White-breasted Woodswallow *Artamus leucorhyn*. The Woodswallow was seen mobbing both eagle species when soaring (Table 1). This species was a brave bird, mobbed large bird especially raptor when soaring in its territory. The results of monitoring did not find mobbing between the eagles. It seems that different types of hunting did not cause competition to occur. It often happened at the same time in the field where CHE was perching on tree to monitor prey while CSE was soaring to find prey [11].

Table 2. Potential of preys hunted by CSE and CHE in GBUF.

Type of Preys	Scientific Name	English Name	Source	Potential of Prey	
				CSE	CHE
Snakes	<i>Ahaetulla prasina</i>	Asian Vine Snake	[23,24]	√	√
	<i>Dendrelaphis pictus</i>	Painted Bronzeback		√	√
	<i>Cryptelytrops albolabris</i>	White-lipped Pitviper		√	√
	<i>Xenochrophis triangulierus</i>	Red-sided Keelback Water Snake		√	√
	<i>Gonyosoma oxycephalum</i>	Red-Tailed Racer		√	√
	<i>Pareas carinatus</i>	Keeled Slug-eating Snake		√	√
Amphibians	<i>Phrynoidis aspera</i>	Java Toad	[23,24]	√	√
	<i>Fejervarya limnocharis</i>	Marsh Frog		√	√
	<i>Chalcorana chalconota</i>	Brown-streamed Frog		√	√
	<i>Polypedates leucomystax</i>	Four-lined Tree Frog		√	√
	<i>Ingerophrynus biporcatus</i>	Indonesian Toad		√	√
	<i>Duttaphrynus melanostictus</i>	Asian Common Toad		√	√
	<i>Occidozyga sumatrana</i>	Sumatran Puddle Frog		√	√
	<i>Fejervarya cancrivora</i>	Crab-eating Frog		√	√
Lizards	<i>Bronchocela jubata</i>	Maned Forest Lizard	[23,24]	√	√
	<i>Bronchocela cristatella</i>	Green crested Lizard		√	√
	<i>Gekko gecko</i>	Tokay Gecko		√	√
	<i>Draco volans</i>	Common Flying Lizard		√	√
	<i>Eutropis multifasciata</i>	Many-line Sun Skink		√	√
Birds	<i>Aegithina tiphia</i>	Common Iora	[23]		√
	<i>Todiramphus chloris</i>	Collared Kingfisher			√
	<i>Halcyon cyanoventris</i>	Javan Kingfisher			√
	<i>Alcedo meninting</i>	Blue-eared Kingfisher			√
	<i>Pericrocotus cinnamomeus</i>	Small Minivet			√
	<i>Orthotomus sepium</i>	Olive-backed Tailorbird			√
	<i>Orthotomus sutorius</i>	Common Tailorbird			√
	<i>Prinia inornata</i>	Plain Prinia			√
	<i>Spilopelia chinensis</i>	Eastern Spotted Dove			√
	<i>Chalcophaps indica</i>	Grey-capped Emerald Dove			√
	<i>Geopelia striata</i>	Zebra Dove			√
	<i>Crypsirina temia</i>	Racquet-tailed Treepie			√
	<i>Cacomantis variolosus</i>	Brush Cuckoo			√
	<i>Centropus bengalensis</i>	Lesser Coucal			√
	<i>Lonchura leucogastroides</i>	Javan Munia			√
	<i>Hirundo tahitica</i>	Tahiti Swallow			√
	<i>Lanius schach</i>	Long-tailed Shrike			√
	<i>Psilopogon haemacephalus</i>	Coppersmith Barbet			√
	<i>Cinnyris jugularis</i>	Olive-backed Sunbird			√
	<i>Malacocincla sepiaria</i>	Horsfield's Babbler			√
	<i>Gallus varius</i>	Green Junglefowl			√
	<i>Dendrocopos macei</i>	Fulvous-breasted Woodpecker			√
	<i>Dinopium javanense</i>	Common Flameback			√
	<i>Dendrocopos analis</i>	Freckle-breasted Woodpecker			√
	<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul			√
	<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul			√
	<i>Pycnonotus melanicterus</i>	Black-capped Bulbul			√
	<i>Acridotheres javanicus</i>	Javan Myna			√
	<i>Turnix suscitator</i>	Barred Buttonquail			√
	<i>Gerygone sulphurea</i>	Golden-bellied Gerygone			√
	<i>Hypothymis azurea</i>	Black-naped Monarch			√
	<i>Centropus nigrofusus</i>	Javan Coucal			√
Small Mammals	<i>Cynopterus</i> sp.	Bats	[23]		√
	<i>Callosciurus notatus</i>	Plaintain Squirrel		√	√
	<i>Rattus</i> sp.	Mouse		√	√

√ = Potential as a prey

3.6. Conservation threats

The threats to raptor in GBUF were incidental as seen by third author (A). Illegal hunter was once seen on GBUF, he brought airgun to shoot the bird or small mammals like plantain squirell. When he saw large bird like an eagle, the eagle was most likely to be shot. The motocross visitor in GBUF was often seen. Noise from visitor's motocross also disturbed the eagles. The period of highest motocross visitors each week was on weekends. Noise was one of disturbances when the eagle was breeding [27]. In addition, the condition of fragmented forest could cause a decrease in genetic quality, especially for raptor [28].

4. Conclusion

GBUF was a good habitat for the two eagles namely Changeable Hawk-eagle *Nisaetus cirrhatus* and Crested Serpent-eagle *Spilornis cheela*. It could be seen from the diverse potential prey for the eagles found in GBUF: snakes, frogs, lizards, birds, and small mammals. Inactive eagle's nest was also found in the area, presumably it had been used by Changeable Hawk-eagle. However, there was conservation threats to the eagles in the forest such as illegal hunter and noise from visitors's motocross. Accordingly, bird protection efforts in GBUF need regulations, as well as in-situ and ex-situ preservation by Universitas Sebelas Maret.

Acknowledgments

We thank Universitas Sebelas Maret (UNS) for the grant PNPB-Penelitian Unggul Terapan with contract number 516/UN27.21/PP/2019 by LPPM UNS. We also thank UPT Pendidikan dan Pelatihan Kehutanan UNS and Biodiversitas Research Group FMIPA UNS. Our thanks also go to Ministry of Environmental and Forestry. Thanks to all member of the fauna research in Gunung Bromo University Forest: Galuh Masyithoh, Ayu Astuti, Nur C. Merdekawati, Rizqi Adanti P. P., and Uki P. Nugraheni. Thanks also go to Yoshe Rahmad Al Karim, Gilang D. Nugroho, Yusuf 'Ucup' Prasetyo, and Avandi Latrianto for helping us during our field works. We are very grateful to all anonymous reviewers for helpful comments and suggestions that improve this manuscript.

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