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Site assessment for a small-scale Javan rusa (*Rusa timorensis*) captive breeding in East Java, Indonesia

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Abstract. *Subeno, Pudyatmoko S, Imron MA, Widi TSM. 2023. Site assessment for a small-scale Javan rusa* (Rusa timorensis) *captive breeding in East Java, Indonesia. Biodiversitas 24: 4568-4576.* Javan deer (*Rusa timorensis* Blainville, 1822) is a protected wild animal with high potential economic value; captive breeding can be done to avoid extinction and sustainably utilize it. Most land ownership by rural communities in Indonesia is less than 5 ha; therefore, it is essential to design small-scale captive breeding, which local people can adopt to meet economic isxadwnterests and species conservation. We assessed a site part of the Perum Perhutani area in East Java dedicated to developing captive breeding models. Assessment is an essential consideration in exploring location feasibility and designing optimal allocation of available space; data collection on bio-physical conditions used nested sampling, circular plots, and profile diagrams. Feed availability is obtained by identifying the grass type and calculating its productivity. The collected data were then analyzed and compared with the needs of the Javan deer. The selected location was then made a captive design for space allocation based on the management and basic needs of the Javan deer. The results showed that the location at RPH (Resort Pemangkuan Hutan=Forest Management Resorts) Malo (Bojonegoro District, East Java, Indonesia) could be declared feasible to be developed as a Javan deer breeding area. The captive site design is mini ranching; this captive design consists of the breeding/management and office blocks.

Keywords: Biophysical, captive breeding, Javan deer, mini ranching, site assessment

INTRODUCTION

Captive breeding has been recognized as one of the important ex-situ conservation measures, which goes hand in hand with in-situ conservation (Braverman 2014). Captive breeding recognizes people's need for protein and other products (Kuba et al. 2015). It becomes an alternative for both protection and economic support of rural people in tropical countries (Krisna et al. 2020). Captive breeding, sometimes called wildlife farming, can have various aims of products including meat, velvet, fur, and others (Kuba et al. 2015).

Captive breeding has been applied on various scales, from small to large. Small-scale wildlife breeding, which accounts for 90% of wildlife farming, has been carried out by various countries (Nogueira-Filho and Nogueira 2018). For example, Brazil uses a semi-intensive production system, using fenced areas ranging from 0.5 to 4 ha surrounded by arboreal vegetation (Nogueira-Filho and Nogueira 2018). Meanwhile, in Oklahoma, small-scale deer farming uses an area of about 1 ha consisting of paddocks arranged in one block with an alley in the middle (De Vuyst 2013).

The Javan rusa (*Rusa timorensis* Blainville, 1822) is among the native deer species of Indonesia (Ali et al. 2021), which is also protected by national law (Semiadi and Jamal 2015). Despite being legally protected by the Indonesian government by stipulates as a protected animal and prohibits hunting in nature, the perspective of local communities on Javan rusa has been playing an important role in their faith in nature, affecting population numbers that continue to decrease due to illegal hunting and increasing habitat degradation (Krisna et al. 2020). Therefore, to avoid extinction and accommodate sustainable utilization, this species was proposed to be under a captive breeding program (Rasyidi et al. 2022).

Despite the Javan rusa being promoted for captive breeding, current research is limited to assessing the spatial distribution of habitat (Hedges et al. 2015; Rahman et al. 2020) and studies on captive breeding of this species on their roles to climate change mitigation (Krisna et al. 2020). However, we have imperfect knowledge of any studies to explore various sizes and site conditions affecting captive breeding management. In Indonesia, land ownership for agricultural activities is relatively low, less than 5 ha (Susilowati and Maulana 2012; Liu and Yamauchi 2014). On Java Island, the world's most highly populated island, the land ownership is 0.25 ha on average (Antriyandarti 2018; Prasada et al. 2022). One of the important aims of captive breeding is to balance the captive population and locals' economics to reduce illegal activities. Therefore, to ensure the adaptation of captive breeding by the wider communities to support economic and conservation, captive units in Java Island should be carried out through semi-intensive breeding systems (Khan et al. 2016), which can later be a model for a small-scale area.

Captive breeding generally tries to mimic natural conditions brought into confines to provide various needs of the captive species (Braverman 2014). The smaller the scale of captive breeding, the more intensive animal care (Rizzolo 2020). It is important to assess local conditions to establish a good captive breeding site available for breeding. This stage is very crucial to identifying gaps in resources in captive areas and possible intervention for captive breeding designing optimal allocation of available space to ensemble the function and site requirements of the captive deer unit (Janiszewski et al. 2016; Urošević et al. 2018). This process is essential because it affects the management design needed to achieve captive success. We aim to assess two potential areas for the captive breeding of Javan rusa in East Java of Indonesia. The assessment involves evaluating the areas' bio and physical aspects and developing suitable designs for captive breeding.

MATERIALS AND METHODS

Study area

We assess a site in East Java Province of Indonesia under the management of PERUM PERHUTANI, the state-owned forest enterprise on Java Island. The research was carried out in two locations that had been prepared by KPH (*Kesatuan Pemangkuan Hutan*=Forest Management Units) (Forest management area according to its main function and designation, which manager can manage efficiently and sustainably) Parengan based on a letter from Adm/KKPH Parengan No. 554/045.1/PRG/II. The two locations are (i) RPH/*Resort Pemangkuan Hutan*=Forest Management Resorts (the smallest forest area management unit) Malo, and (ii) RPH Parengan Utara. The prospective location in the RPH Malo (or Malo) has an area of 0.425 ha, and the prospective location in the RPH Parengan Utara (or Parengan Utara) has an area of 0.35 ha. The reason for choosing the two locations is because Perum Perhutani's working area is one of the areas that is the habitat of Javan deer and is dedicated to model development of captive breeding. The two areas are adjacent to the Forest Management Resorts office area to ensure the area's security because there are always officers on guard every day.

Data collection

Biophysical condition

We collected physical conditions of the locations, such as rainfall, temperature, humidity, topography, water sources, and accessibility through secondary data from the Meteorology and Geophysics Agency for the Bojonegoro and Tuban Regions and direct observations in the field. In contrast, we collected biological data on the location, including the type and number of vegetation (seedlings, saplings, poles, and trees), covers of understorey and canopy, understory foliage volume, and the vertical structure of vegetation. We employed the nested sampling method, commonly used to collect data on vegetation (Prayoga and Imron 2022). The sample plot is 50% of the total area analyzed (<0.5 ha), with 5 or 6 sample plots for each location. The data are the type and number of individuals of each vegetation (seedlings, saplings, poles, and trees). 6 nested samplings were used to collect vegetation data at Malo, and 5 nested samples at Parengan Utara.

The circular plot method (Prayoga and Imron 2022) measured other habitat characteristics, including canopy and understory cover, leaf volume closure, temperature and humidity, and slope. The circular plot is placed overlapping the nested sampling plot. A profile diagram method (Kastuari et al. 2020) assessed the vertical structure of the vegetation in each of the selected locations. The data taken includes species name, diameter breast height (dbh), height, width of canopy, height of the crown, and spatial position of trees.

Feed productivity

Feed productivity was collected by measuring vegetation productivity in a systematic 1x1 m sampling plot (Stendardi and Karlsen 2016); 5 measuring plots were placed in each nested sampling plot. In total, 30 plots were laid in Malo, and 25 plots were in Parengan Utara. In each plot, we cut all potential feed vegetation above ground. The removed feed grass in the sample plots grew for 20 days without intervention. After that, we cut the vegetation again and weighed the gross weight (mass) to calculate the feed's growth.

Data analysis

Physical and biological condition location

We calculated the relative density of each vegetation stage. The formula for calculating relative density is as follows (Nguyen et al. 2014):

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Density} = \frac{\text{Number of a species}}{\text{Total area sampled}}$$

We computed canopy and understory covers following Noon (1981) as follows:

$$C = \frac{p}{n}\ x\ 100\%$$

Where,
C: Canopy and understory cover
P: Number of green vegetation at the intersection point of the cross hairs (+)
n: Total of 20 (10 each transect) plus or minus readings

Understory foliage volume closure is calculated using the formula according to Noon (1981) as follows:

PVD (*Penutupan Volume Daun*) =

$$\frac{\textit{the number of squares within each height interval at least 50 percent obscured}}{\textit{Total number of squares per height interval}}\ x\ 100\%$$

PVD = Understory foliage volume closure

The profile diagram to determine the vertical structure of the vegetation at the site was analyzed using the Sexi-FS program (Kastuari et al. 2020). The Sexi-FS program allows the researcher to simulate a plot's horizontal and vertical structure visually.

Forage productivity

Forage productivity can be calculated using the formula (Setiawan and Haryanto 2018):

$$P = \frac{L}{B} \times l$$

Where,
P: Forage productivity
L: Grass area (m^2)
B: Sample average natural grass biomass production (kg/day)
l : Sample area (m^2)

Feasibility analysis

The description of the locations' bio-physical conditions was compared with the Javan rusa's life requirements. Furthermore, to find out the deer's life needs, including food, water, and habitat for Javan deer, literature studies from various sources.

Site plan

From the location that has been selected, a site design is carried out for the division of space based on the needs for management and captive breeding of Javan deer by taking into account aspects of the basic needs of Javan deer.

Table 1. Criteria for eligibility assessment of Javan rusa captive breeding for each aspect

Aspects	Criteria for eligible	Reference
Accessibility	Relatively easy to reach from the road or main road have the higher eligibility of the area.	Pierce et al. (2015)
Climate	Low to high, according to Schmidt and Fergusson	Kissinger et al. (2021); Saputra et al. (2021)
Temperature	24-32°C	Pairah et al. (2014)
Humidity	65-92%	Pairah et al. (2014)
Topography	Relatively sloping to slightly hilly so that the area's development does not damage the site	Pairah et al. (2014); Pierce et al. (2015)
Slope	0-45°	Kissinger et al. (2021); Saputra et al. (2021)
Water Source	Always available, both quality and quantity	Pierce et al. (2015); Khattak et al. (2019)
Vegetasi	Tend not to be close	Saputra et al. (2021)
Shelter	Medium canopy closure for shelter. There are some shade trees (cover)	Khattak et al. (2019); Kissinger et al. (2021); Saputra et al. (2021)
Food	Have sufficient types of forage plants (>8 species)	Saputra et al. (2021)

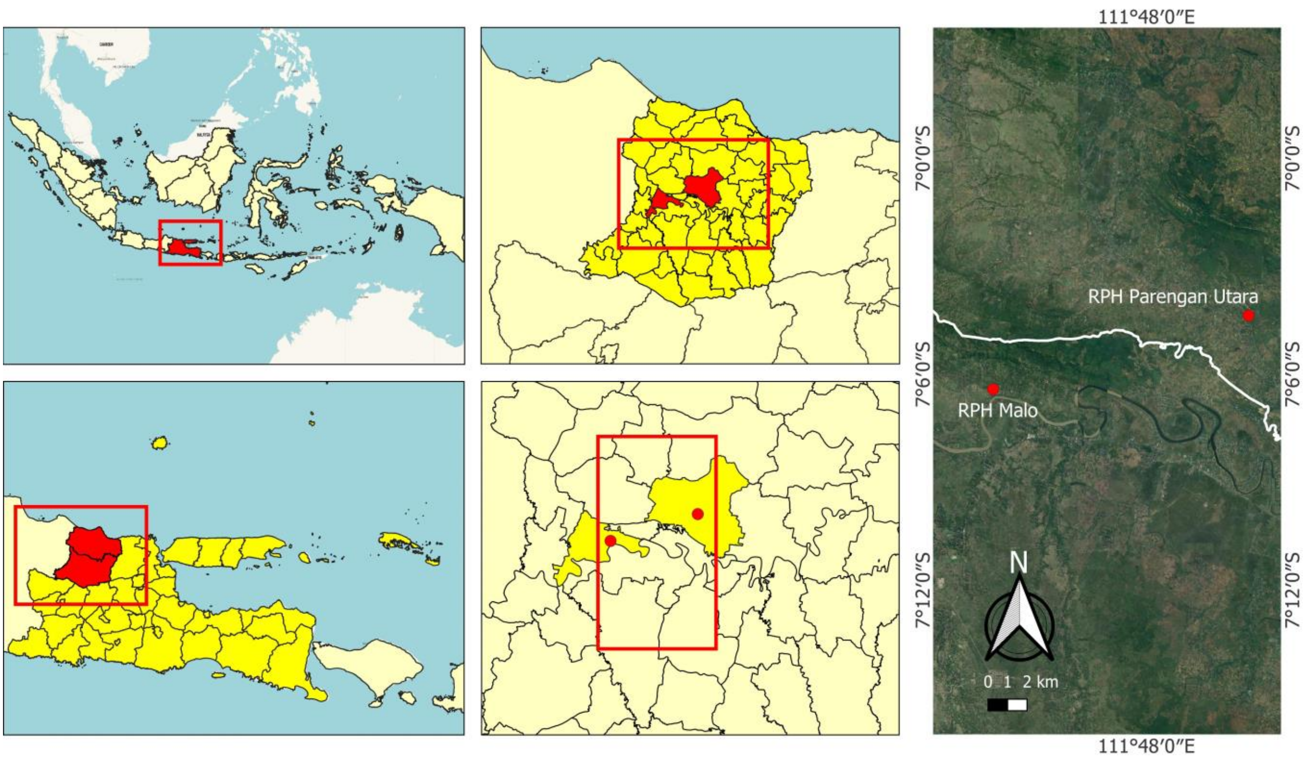

Figure 1. Map of the study area in RPH Malo, Bojonegoro District and RPH Parengan Utara of KPH Parengan, Tuban District of East Java Province, Indonesia

RESULTS AND DISCUSSION

Bio-ecological condition of Malo location

The observations obtained five species at the seedling level, three species at the sapling level, three types at the pole level, five species at tree level, and 20 species of understorey. The highest relative density at the seedling level is teak (*Tectona grandis*), with a value of 48%. The relative density at the sapling level is teak (75%), banana (*Musa acuminata*) (12.5%), and chinaberry (*Melia azedarach*) (12.5%). The relative density at the pole level is teak (81.25%), johar/kassod tree (*Senna siamea*) (12.5%) and mango (*Mangifera indica*) (6.25%). The relative density at the highest tree level is teak (*Tectona grandis*) (57.9%) and kassod tree (*Senna siamea*) (15.7%). Of the 20 types of grass and understorey found at Malo, 14 are plants eaten by Javan deer (*Rusa timorensis*).

The canopy cover at Malo was quite open, ranging from 8.33 to 50%, while the understorey cover ranged from 16.67 to 83.33%. The observations of bush cover ranged from 0 to 5.83%, while the cover of saplings, poles, and trees was 0. Meanwhile, the complete condition of the vegetation structure in Malo can be seen in the profile diagram presented in Figure 2.

The forage productivity calculation of all types of grass and understorey that has been carried out is 253.6 kg. At the same time, the forage productivity of understorey and grass species eaten by deer was 174.51 kg. The highest forage productivity was arrowleaf sida (*Sida rhombifolia*) at 49.42 kg, cogon grass (*Imperata cylindrica*) at 19.36 kg, and bermuda grass (*Cynodon dactylon*) at 16.40 kg.

Bio-ecological condition of Parengan Utara

Based on the observations at the Parengan Utara, 48 types of grass and understorey were obtained, and 1 type of tree, namely Teak (*Tectona grandis*). Of the 48 types of grass and understorey found, eight are plant species that feed deer. Two individual teak trees were found from observing seedlings, saplings, and trees. The canopy cover in the observation area shows that the cover condition ranges from 0-8.33%, while the understorey cover is between 8.33-6.66%. The range of bush cover in the observation area is 0-10%. Meanwhile, the complete condition of the vegetation structure in the Parengan Utara can be seen in the profile diagram presented in Figure 3.

The forage productivity calculation of all types of grass and understorey that has been carried out is 186.5 kg. At the same time, the forage productivity of understorey and grass species eaten by deer was 64.47 kg. The highest forage productivity was carpet sedge (*Carex jackiana*) at 19.96 kg, tick weed (*Cleome viscosa*) at 13.61 kg, and bermuda grass (*Cynodon Dactylon*) at 12.51 kg.

Physical components of Malo and Parengan Utara

The results of the physical condition of the location at the Malo and Parengan Utara can be seen in Table 5.

Location feasibility analysis

Several requirements that must be considered in determining the location of deer captive breeding, among others, are outside the nature reserve area, located in a quiet place, safe from interference, easily accessible in the rainy and dry seasons, and plenty of water available all year round for drinking.

Site plan of captive breeding

Deer breeding site design should be reviewed from the technical aspects of deer breeding. Considering the bio-physical conditions and considerations of limiting factors and management efficiency, the area that needs to be developed in the Javan deer captive breeding consists of 2 zones: the office zone and a captive breeding zone. The site design for Javan deer captive breeding is shown in Figure 4.

Table 2. Types of grass and understorey in Malo, Bojonegoro District, East Java Province, Indonesia

Local name	English name	Scientific name	Type of deer feed	Reference
Alang-alang	Cogongrass	*Imperata cylindrica*	Yes	Firdaus et al. (2023)
Otok	Arrowleaf sida	*Sida rhombifolia*	No	
Rumput Grinting	*Bermuda grass*	*Cynodon Dactylon*	Yes	Firdaus et al. (2023)
Rumput kabek-kabekan merah	Centipede grass	*Ischaemum timorense*	Yes	Pattiselanno (2012)
Rumput kabek-kabekan putih	Bowgrass	*Cyrtococcum patens*	Yes	Tewari and Rawat (2013)
Kacang-kacangan	Wild grout nut	*Calopogonium mucronata*	Yes	Suarna et al. (2019)
Lamuran	Nadi blue grass	*Dichanthium caricosum*	Yes	Azwar et al. (2019)
Patikan putih	Garden spurge	*Euphorbia hirta*	No	
Rawadan	*Cape gooseberry*	*Physalis peruviana*	No	
Rondo moprol	Tridax daisy	*Tridax procumbens*	No	
Rumput jarum	*Golden false beard grass*	*Chrysopogon aciculatus*	Yes	Pattiselanno (2012)
Rumput lulangan	Crowfoot grass	*Eleusine indica*	Yes	Sudibyo (2015)
Sogok telik	Rosary pea	*Abrus precatorius*	No	
Rumput teki	Coco grass	*Cyperus rotundus*	Yes	Firdaus et al. (2023)
Wedusan	Billy goat weed	*Ageratum conyzoides*	Yes	Suarna et al. (2019)
Saruni laut	Beach sunflower	*Wedelia biflora*	No	
Rumput udang	Chinese love grass	*Eragrostis unioloides*	Yes	Suarna et al. (2019)
Rumput jejarongan	Swollen Finger Grass	*Chloris barbata*	Yes	Suarna et al. (2019)
Waderan	Swamp millet	*Isachne globosa*	Yes	Sudibyo (2015)
Putihan	Sweet pitted grass	*Bothriochloa pertusa*	Yes	Suarna et al. (2019)

Table 3. Forage productivity of all types of grass and understorey in Malo, Bojonegoro District, East Java Province, Indonesia

English name	Scientific name	Forage productivity (kg)	Forage productivity for type of deer feed (kg)	References
Cogongrass	*Imperata cylindrica*	19.36	19.36	Firdaus et al. (2023)
Arrowleaf sida	*Sida rhombifolia*	49.42	-	
Bermuda grass	*Cynodon Dactylon*	16.40	16.40	Firdaus et al. (2023)
Centipede grass	*Ischaemum timorense*	13.26	13.26	Pattiselanno (2012)
Bowgrass	*Cyrtococcum patens*	14.15	14.15	Tewari and Rawat (2013)
Wild grout nut	*Calopogonium mucronata*	11.60	11.60	Suarna et al. (2019)
Nadi blue grass	*Dichanthium caricosum*	3.62	3.62	Azwar et al. (2019)
Garden spurge	*Euphorbia hirta*	9.93	-	
Cape gooseberry	*Physalis peruviana*	3.19	-	
Tridax daisy	*Tridax procumbens*	3.30	-	
Golden false beard_grass	*Chrysopogon aciculatus*	14.82	14.82	Pattiselanno (2012)
Crow-foot grass	*Eleusine indica*	13.55	13.55	Sudibyo (2015)
Rosary pea	*Abrus precatorius*	2.13	-	
Coco grass	*Cyperus rotundus*	10.28	10.28	Firdaus et al. (2023)
Billy goat weed	*Ageratum conyzoides*	9.38	9.38	Suarna et al. (2019)
Beach sunflower	*Wedelia biflora*	11.13	-	
Chinese love grass	*Eragrostis unioloides*	12.48	12.48	Suarna et al. (2019)
Swollen Finger Grass	*Chloris barbata*	10.64	10.64	Suarna et al. (2019)
Swamp millet	*Isachne globosa*	9.38	9.38	Sudibyo (2015)
Sweet pitted grass	*Bothriochloa pertusa*	15.60	15.60	Suarna et al. (2019)
Total		253.60	174.51	

Table 4. Forage productivity of all types of grass and understorey in Parengan Utara, Tuban District, East Java Province, Indonesia

English name	Scientific name	Forage productivity (kg)	Forage productivity for type of deer feed (kg)	Type of deer feed	References
Billy goat weed	*Ageratum conyzoides*	5.10	5.10	Yes	Suarna et al. (2019)
Musk basil	*Basilicum polystachyon*	6.50	-	No	
Purple amaranth	*Amaranthus blitum*	7.06	-	No	
Erect spiderling	*Boerhavia erecta*	8.29	-	No	
Creeping panic grass	*Brachiaria reptans*	6.19	6.19	Yes	Suarna et al. (2019)
Carpet sedge	*Carex jackiana*	19.96	-	No	
Tick weed	*Cleome viscosa*	13.61	-	No	
Coco grass	*Cyperus rotundus*	2.83	2.83	Yes	Firdaus et al. (2023)
Cane grass	*Eragrostis* sp.	4.68	-	No	
Chinese love grass	*Eragrostis unioloides*	5.19	-	No	
Bermuda grass	*Cynodon dactylon*	12.51	12.51	Yes	Firdaus et al. (2023)
Madras carpet	*Grangea maderaspatana*	5.40	-	No	
Centipede grass	*Ischaemum timorense*	7.36	7.36	Yes	Pattiselanno (2012)
Tropical kudzu	*Pueraria phaseoloides*	7.67	-	No	
Soybeans	*Dolichos soja*	9.68	-	No	
Sweet potato	*Ipomoea batatas*	5.67	-	No	
Little hogweed	*Portulaca oleracea*	4.53	-	No	
Nadi blue grass	*Dichanthium caricosum*	3.40	3.4	Yes	Azwar et al. (2019)
Water pimrose	*Ludwigia adscendens*	9.44	-	No	
Indian goosegrass	*Eleusine indica*	3.40	3.4	Yes	Sudibyo (2015)
Rice	*Oryza sativa*	5.67	-	No	
Knotgrass	*Paspalum distichum*	8.68	8.68	Yes	Suarna et al. (2019)
King begonia	*Begonia rex-cultorum*	7.64	-	No	
English ivy	*Hedera helix*	6.23	-	No	
Purple needlegrass	*Stipa pulchra*	9.25	-	No	
Ironweed	*Vernonia* sp.	0.57	-	No	
Total		186.50	64.47		

Table 5. Physical components of the candidate for Javan rusa captive breeding in Malo and Parengan Utara, East Java, Indonesia

Aspects	Malo	Parengan Utara
Accessibility	very easy to reach both in the dry season and the rainy season	Easy to reach, bordering the highway and village roads
Climate	Dry tropics, rainfall 1670 mm/year	Dry tropics, rainfall 1483 mm/year
Temperature	26.5-30℃	27.5-30.5℃
Humidity	51-71%	54-65%
Topography	Relatively flat	Relatively flat
Slope	0.5-7.75	3.75-6.75
Water source	Ground well	Seasonal well

Table 6. Location feasibility analysis of the candidate for Javan rusa captive breeding in Malo and Parengan Utara, East Java, Indonesia

Aspects	Malo		Parengan Utara	
	Site condition	**Remarks**	**Site condition**	**Remarks**
Accessibility	very easy to reach both in the dry season and the rainy season. (only there is one main road from location and the distance is enough far so that the location remains convenient for deer in captivity	Eligible	Easy to reach, bordering the highway and village roads. (it will cause the location to become busy and noisy and this will make the deer in captivity uncomfortable).	Not eligible
Climate	Dry tropics, rainfall 1,670 mm/year	Eligible	Dry tropics, rainfall 1,483 mm/year	Eligible
Temperature	26.5-30℃	Eligible	27.5-30.5℃	Eligible
Humidity	51-71%	Eligible	54-65%	Eligible
Topography	Relatively flat	Eligible	Relatively flat	Eligible
Slope	0.5-7.75	Eligible	3.75-6.75	Eligible
Water source	Ground well	Eligible	Seasonal well	Not eligible
Vegetasi	Tend not to be close	Eligible	Tend to be open	Not eligible
Shelter	Medium canopy closure for shelter. There are some shade trees (cover)	Eligible	Low canopy closure for shelter. There are little shade trees (cover)	Not eligible
Food	Have sufficient types of forage plants (> 8 species)	Eligible	Have little types of forage plants (< 8 species)	Not eligible

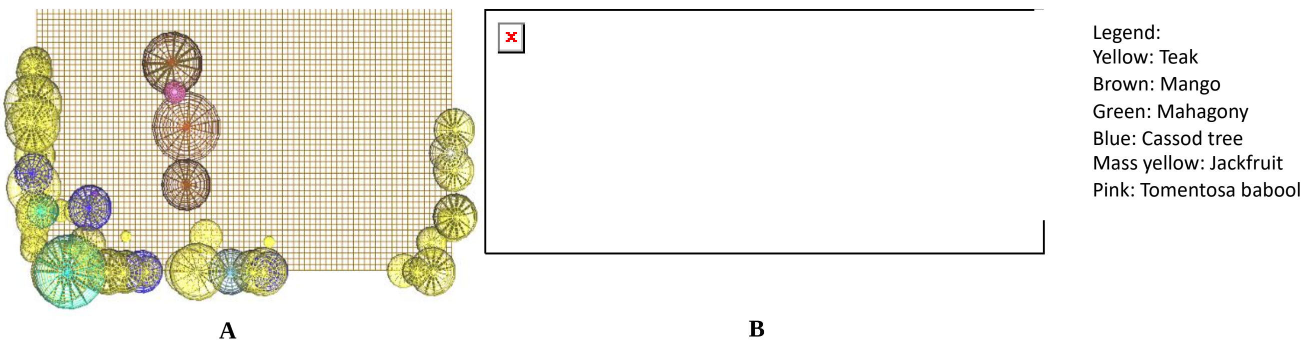

Figure 2. Tree profile diagram at Malo, East Java, Indonesia seen from above (A) and viewed from behind (B)

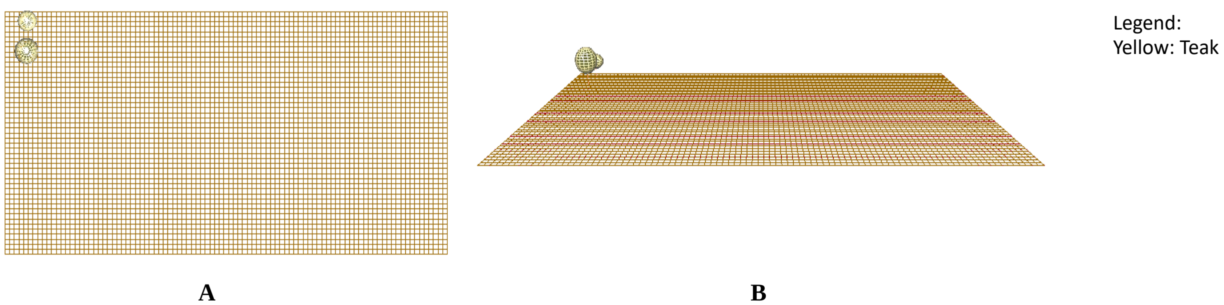

Figure 3. Tree profile diagram in the Parengan Utara, East Java, Indonesia, seen from above (A) and from the front (B)

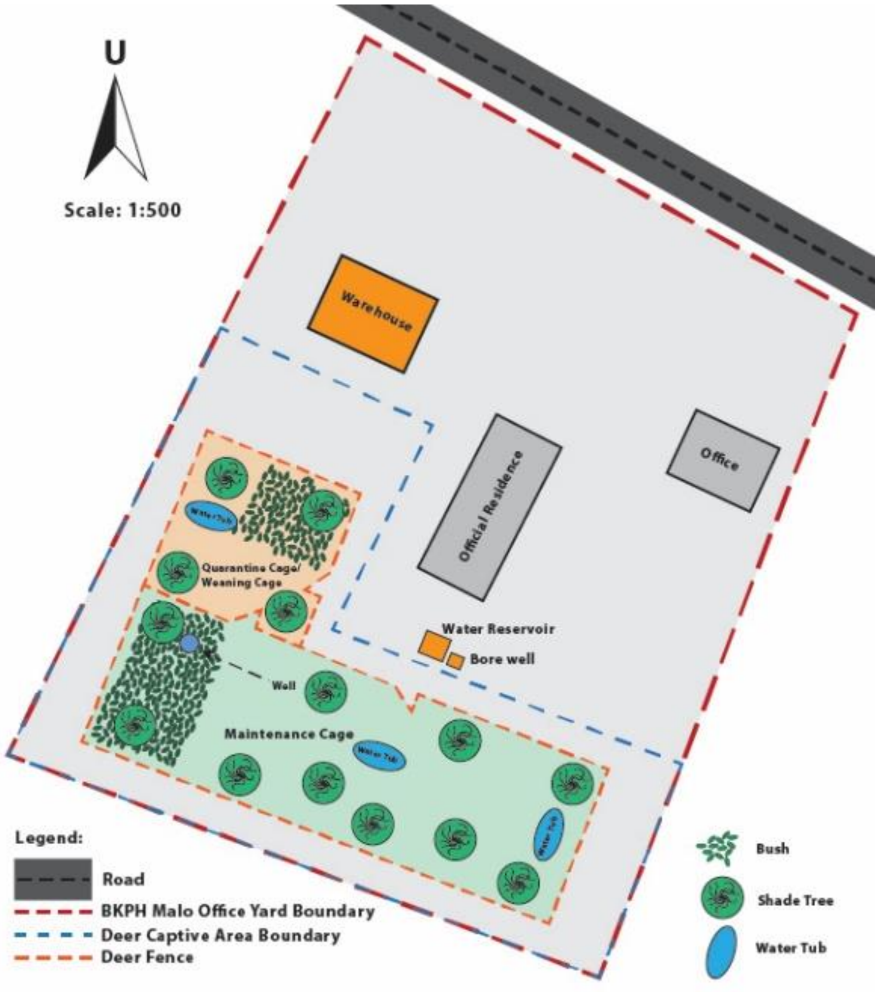

Figure 4. Design of the Javan deer breeding site at Malo, East Java, Indonesia

Discussion

The Bio-Ecological condition in Malo showed that the vegetation cover in the area is quite open, and only a few areas are covered by vegetation. The vegetation condition in the existing location illustrates that the area is not too covered by vegetation so that the growth and development of the understorey, a food source, is not hampered. The condition of trees, poles, and stakes for cover and shelter functions as a place of shelter/hiding, is quite good and safe, especially during childbirth and breastfeeding fawn.

During rut, the stag always rubs the antlers on the trees, so the captive area needs trees (Charco et al. 2016). If sufficient trees are in the breeding area, the male deer will tend to rub their antlers against the fence posts. In addition, in terms of animal movement and access to management, the condition of dense trees can cause limited deer movement, which can reduce access and affect the layout. Therefore, it is necessary to manage and regulate to achieve optimal tree conditions.

The Bio-Ecological condition in Parengan Utara showed that the vegetation cover in the area is open, and the minimal area is covered by vegetation. The vegetation condition in the existing location illustrates that vegetation does not cover the area. Likewise, the condition of trees, poles, and stakes for cover and shelter functions as a place of hiding is very lacking, so it is not a safe and comfortable place, especially when giving birth and breastfeeding fawn.

The physical components in Malo has higher rainfall than Parengan Utara. It is very beneficial for the growth and development of forage. Hu et al. (2021) said that information about rainfall and the number of rainy days affect the direction of land use. Such climatic conditions cause surface water and groundwater to always be available, as well as better soil productivity so that the growth and development of vegetation and forage are not hampered. Javan deer can adapt to various environmental conditions, where deer can live and breed at altitudes ranging from 200-500 m above sea level (Pairah et al. 2014). There is even a claim that the Javan deer can live up to an altitude of 2600 m above sea level (Widjaja and Utomo 2021).

The physical components in the Parengan Utara have lower rainfall than Malo location. It is less favorable for the growth and development of forage. Zhao and Wu (2018) and Martins et al. (2016) said that information about rainfall and the number of rainy days affect the direction of land use. Existing climatic conditions cause surface water and groundwater to not always be available in sufficient quantities so that soil productivity becomes less good, which causes the growth and development of vegetation and forage to be hampered.

The analysis results of the area's bio-physical components indicate that Malo can be declared feasible to be developed as a Javan deer breeding area. Bio-ecological conditions showed that the location of Malo has better potential than Parengan Utara. Malo location had 20 types of grass and undergrowth found, of which 14 species were eaten by Javan deer (*Rusa timorensis*). Five plant species can function as shelters, and the productivity data of all types of grass and understorey that have been carried out was obtained at 253.6 Kg. In contrast, the productivity of understorey and grass species eaten by deer was 174.51 Kg. In addition, from the aspect of other wildlife in the captivity location, there were also no domestic animal species that could interfere with the presence of deer.

The determination of development zones in captive locations is based on considerations: (a) management intensity; (b) utilization intensity; and (c) the feasibility of the available area. These considerations are crucial so captive deer management's objectives can be achieved effectively and efficiently. First, the Office Zone is an area that functions as a regional administration and management services center. The determination of the office zone is carried out considering the following requirements of location: (1) The topography is relatively flat to light hilly so that the construction of the building will not damage the site; (2) Availability of easy-to-use water sources to meet water needs for daily management activities; and (3) The road accessibility must be easy to reach (Krisna et al. 2020; Kissinger et al. 2021). Types of buildings in the office zone are facilities and infrastructure to support deer breeding activities. These buildings include offices, guard posts, feed or medicine warehouses, control roads, water towers, signage, and information.

Second, the Captive Zone is an area for breeding, rearing, and maintaining animals to develop their population. The location determination is based on the following requirements of location: (1) Flat topography, sloping to mild hilly so that deer can explore well; (2) It provides the availability of food, water, and cover as the main components of the needs of the deer's life; (3) The ecosystem must provide the minor possible technical intervention options to change the existing physical and vegetation conditions to become a suitable habitat for deer; and (4) The allocation of the area is adjusted to the projected development of deer captive breeding that will be developed in the future (Krisna et al. 2020; Kissinger et al. 2021). The facilities and infrastructure in this captivity zone are the maintenance area, enlargement area, transit area, water tank, water tower, shade building, and inspection road.

The captive/management block is the core of the captive activity, which has facilities such as a location for giving birth, weaning, clip-on cages, shelters, places to eat/drink, and waterways. Pierce et al. (2015) said that determining deer breeding zones needs to consider technical, economic, and environmental requirements. The breeding block that has been established is very strategic and follows its designation so that it can function as a center for the development of deer breeding technology to produce deer breeds, utilize deer, and provide educational and training facilities.

Captivity has many facilities, so the primary consideration in building design is to provide facilities that can be used effectively (Khattak et al. 2019). The design of deer breeding facilities must consider the type of deer to be bred, the budget, and the available resources (bio-ecological and physical location). Janiszewski et al. (2016) said that the principles that must be considered in designing deer breeding facilities include (1) deer like to move around outer circles or corners; (2) the site should be well-drained; and (3) Avoid visual contact with other animals outside of captivity.

Facilities should be considered, enabling easy access to deer transport, feed, equipment, and medicines. Deer breeding should also consider avoiding low trees that interfere with road access in transportation (Janiszewski et al. 2016). The facilities and infrastructure contained in the captive breeding location are as follows: cage, fence, drinking place or water tub, road control/inspection, waterways, water tower, warehouse and equipment, guardhouse, and deer feed location. In addition, it is also necessary to support captive breeding facilities and infrastructure in the form of harmonica bulkheads, portable bulkheads, clip cages, and electrical installations. In Conclusion, the bio-ecological conditions in the Malo area showed this location has better potential than Parengan Utara. The physical condition of the two areas showed that all physical components in the Malo area were more eligible than Parengan Utara. Based on the results of the bio-physical components analysis of two areas, it is shown that the location in the Malo can be declared feasible to be developed as a Javan deer captive breeding area. The captive breeding site design is mini ranching, consisting of the breeding/management and office blocks.

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