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Site selection for captive habitat of *Cervus unicolor* case study: Area suitability for captive *C. unicolor* in district of Tanah Laut South Kalimantan, Indonesia

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Abstract. *Cervus unicolor* is an animal with a protected status under government regulations in Kalimantan. Conservation efforts for this species can be done through captivity. This study aims to analyze the suitability of the area for captive *C. unicolor* with additional functions as educational tourism. The research location that will determine the feasibility of captive *C. unicolor* in Tanah Laut Regency, South Kalimantan consists of 3 selected locations. Data was collected by direct field observation and interviews. Secondary data collected in the form of thematic layers and other land characteristics data. Environmental characteristics that became the main study points in captivity of *C. unicolor* were analyzed descriptively. The feasibility of the location for captivity was analyzed by weighting several parameters approach. Some of the feasibility parameters assessed are accessibility, topography, grazing area, shade, water sources, and safety aspects. The mapping of the assessed captive locations was analyzed using Arc Gis Software. The results of the analysis show that the location of the Gunung Kayangan tourist area is the most recommended area for captive *C. unicolor*. The disadvantage of this area compared to the other 2 options is the limited water source which can be overcome by optimizing existing water bodies as reservoirs for water supply for captive *C. unicolor*.

1. Introduction

Indonesia as a country with the highest animal diversity in the world has 515 species of mammals and habitats > 1539 species of aves. Endemic fauna was also found as many as 259 species of mammals, 384 species of birds and 173 species of amphibians. Despite having high diversity. Indonesia had a declining trend in animal diversity leading to extinction. Recorded 184 species of mammals, 119 species of birds, 32 species of reptiles, 32 species of amphibians that are threatened with extinction [1]. The total number of Indonesian animal species that are threatened with extinction in the critically endangered category is 69 species, the endangered category is 197 species and the vulnerable category is 539 species [1].

The phenomenon of decreasing animal diversity must be addressed with conservation actions. Conservation can be carried out in an in situ approach by protecting animals and improving the original habitats where animals breed or using an ex situ approach through animal management activities outside their natural habitats.



One of the areas in Indonesia that has implemented conservation measures for animals is Tanah Laut Regency, South Kalimantan. Pelaihari Tanah Laut Wildlife Reserve is one of seven conservation areas in South Kalimantan. The appointment of this Wildlife Sanctuary aims to protect various types of wildlife, especially the sambar deer (*Cervus unicolor*) and the yellow deer (*Muntiacus atheroides*). The area of the Pelaihari Tanah Laut Nature Reserve is $\pm 6,000$ ha (SK Minister of Forestry No. 695/Kpts/II/1991, 11 October 1991 concerning Changes in the Functions of Part of the Tanah Laut Pelaihari Wildlife Reserve).

This description illustrates that the Tanah Laut area has been conserving animals for a long time. In situ management has not shown significant results. The presence of *C.unicolor* and *M.atheroides* are increasingly difficult to find. This phenomenon has made the Tanah Laut Regency government take the initiative to carry out ex situ conservation in the form of captivity. The focus of fauna that will be conserved in captivity is *C. unicolor*.

C.unicolor is one of seven sub-species of sambar deer in the world which is distributed in Kalimantan [2]. The sambar deer is a protected species because its population is threatened [3,4]. The threat to its existence is due to habitat destruction and illegal hunting [5,6].

Various considerations such as choosing the right location, the main design of the captive of *C.unicolor* area must be carefully considered. The success of the captive breeding process is largely determined from the initial design of the planning for the creation of the captive area. This study aims to analyze the choice of area to be made as a breeding place for *C.unicolor* in Tanah Laut district, South Kalimantan.

2. Methods

2.1. Research location and objects

The research location is in the administrative area of Tanah Laut district, South Kalimantan. Astronomically, Tanah Laut Regency is located between $114^{\circ}30'20'' - 115^{\circ} 23'31''$ East Longitude, and between $3^{\circ} 30'33'' - 4^{\circ} 11'38''$ South Latitude. Area of Tanah Laut is $3,631.35 \text{ km}^2$ or only 9.71% of South Kalimantan Province area. Tanah Laut Regency has 11 Subdistricts. The research object used is the biophysical characteristics of 3 areas, 2 subdistricts consisting of Pelaihari subdistrict (2 locations), Bajuin subdistrict Information on the location that will be selected as a *C. unicolor* breeding area is a City Forest Area with an area of $7,0271 \text{ m}^2$ (± 7 ha), the Mount Khayangan Tourism Area with an area of $170,000 \text{ m}^2$ (± 17 ha), and the Bajuin Waterfall Tourism Object with an area of $20,000 \text{ m}^2$ (± 20 ha).

2.2. Research equipment and materials

The equipment used is a GPS, camera, a set of computers, Arc-Gis software and writing equipment. The material used is a tally sheet about the biophysical characteristics of the area and a list of questions.

2.3. Data collection

Data was collected by direct observation of the results of field observations and interviews. The data collected in field observations in the form of land form, distribution and population density, the presence of water bodies and vegetation cover. Interviews were conducted in a semi-structured manner, where interviews were conducted directly and freely but still referred to a list of questions that had been made previously. Secondary data collection in the form of thematic layers and population data and other regional characters area.

2.4. Data analysis

Data analysis was carried out with the following various approaches:

1. The identification of environmental characteristics that became the research point was analyzed descriptively.

2. The suitability of the area for captive deer is analyzed by using a weighting approach of several parameters. The parameters used in the assessment are: i) Animal accessibility; ii) topography; iii) Shade; iv) Water sources; v) grazing areas; vi) proximity to settlements. The weighting in this study uses three classes for order S (appropriate) and one class for order N (not suitable). The details of the suitability weighting used are as follows ([7] combined):

Class S1: highly suitable = the area has no boundaries for a particular use (score 3)

Class S2: moderately suitable = the area has few restrictions for a particular use. This barrier will affect the plans and activities in management (score 2)

Class S3: suitable conditional = the area has a barrier with a heavier level, but can still be improved by using a higher technological treatment (Score 1)

Class N: not suitable = the area has very heavy boundaries so it is not possible. Management can be applied with high technology but there must be high maintenance with very large funding and the potential impact of biophysical and social problems (score 0)

The implementation of the weighting for the feasibility of the area as a captive area was analyzed using Arc Gis Software.

3. Result and discussion

3.1. *Environmental characteristics of alternative captive sites*

The original habitat of the sambar deer is more towards dense forests and savanna, so a selection is made to choose several alternative locations that are possible to be used as captive locations. Only selection directs decisions on 3 locations whose conditions resemble the original habitat of the sambar deer. The locations in question are the Kayangan Mountain area, the City Forest Park area and the Bajuin Waterfall area. The characteristics of each alternative breeding location are described below:

Alternative 1: Mount Kayangan Area

Mount Kayangan is located in Ambungan Village, Pelaihari District, which is a hilly area. This area is one of the tourist destinations of Tanah Laut Regency. The location of the Mount Kayangan area is very strategic because it is located at a road crossing from Banjarmasin to Pelaihari and various cities in the east of South Kalimantan (Batulicin, Pagatan, Kotabaru). The journey can be continued to Penajam, Balikpapan, Samarinda, and various other cities in East Kalimantan Province. An area gate as an area marker has been built at this location. The markers are the Kijang Mas Monument and the Adipura Monument and the Cow Cart statue.

Based on geospatial analysis, this area is located at an altitude ranging from 20 m above sea level to 50 m above sea level with a land slope of 2-3%, sloping to wavy contours. The top part of the area which has several rest building facilities and towers, is at an elevation of 68 - 78 m above sea level with a land slope of about 8-10%. The rest area available for visitors facilitates the needs of visitors with several food and beverage canteens (18 canteens). Toilet facilities, prayer room and monitoring tower are available at this location. There is a large meadow for grazing, there are also some shade trees (cover), this condition is ideal for captive sambar deer with a pedok system. There are no major rivers but only mountains for water reserves. The choice of area to be developed as a breeding area is relatively far from settlements with relatively sparse population density. The description of the landscape of the Mount Kayangan area is shown in the following figure:



Figure 1. Landscape of Mount Kayangan Kawasan

Alternative 2: Pelaihari City Forest Park Area

Pelaihari City Forest Park is located in the center of Pelaihari City. This City Forest Park is integrated with Mina Tirta Park and Orchid Park as well as the Orchid House which are located close by. This area is one of the tourist destinations in Tanah Laut district. There are gates to the City Forest Park area, the Orchid Park marker, and the Mina Tirta Park marker. This area is located at an altitude between 20 m above sea level to 25 m above sea level with a gentle-plate. Several improvements were made for the development of this area as a tourist destination.

The landscape of the City Forest Park Area has a very sloping topography. There are some shade trees (cover), but no large pasture land for grazing. This of course will make it difficult for managers to provide feed. The availability of water reserves is relatively quite a lot. The location of the area is relatively close to offices and settlements with a higher population density than the other 2 options. The description of the landscape in the City Forest Park area is shown in the following figure:



Figure 2. Landscape of the City Forest Park area

Alternative 3: Bajuin Waterfall Area

Bajuin Waterfall is located in Sungai Bakar Village, Bajuin District, with a distance of about 10 km from the city of Pelaihari. The land cover around the waterfall is lowland secondary forest. This area is one of the tourist destinations in Tanah Laut Regency. There are 3 waterfalls in the Bajuin area. The facilities of

this tourist attraction have been equipped with prayer rooms, rest areas, toilets, stalls. Grazing meadows are also available, but cover trees grow too dense.

This area has a fairly varied elevation and slope. The slope of the area in the visitor parking area is about 7% with an altitude between 56 m above sea level to 75 m above sea level, while the area around the location of the waterfall has an elevation of 102 – 122 m above sea level and a slope of about 65% (steep), although near the parking location there are few the land is quite sloping with a slope of about 2-3%. The dam construction plan will be carried out at the location of the Bajuin waterfall area. The description of the landscape in the Bajuin Waterfall area is shown in the following figure:



Figure 3. Landscapes in the Bajuin Waterfall Area.

3.2. Area suitability for captive *C.unicolor*

Based on the analysis of several ways of captive *C.unicolor*, the planned form of maintenance is the pedok method. Determination of the location of the pedok plays an important role for the smooth running of all activities related to deer farming itself. Based on the results of the habitat suitability analysis above, consideration can be made for site selection as shown in the table 1 and figure 4.

Table 1. Habitat suitability for *C.unicolor*.

Location/Parameters	Access	Topograhly	Shade	Water source	Grazing Area	Settlement	Total score
Mount Kayangan Area	3	3	3	1	3	3	16
City Forest Park Area	3	3	1	3	1	0	11
Bajuin Waterfall Area	2	0	1	2	2	3	10

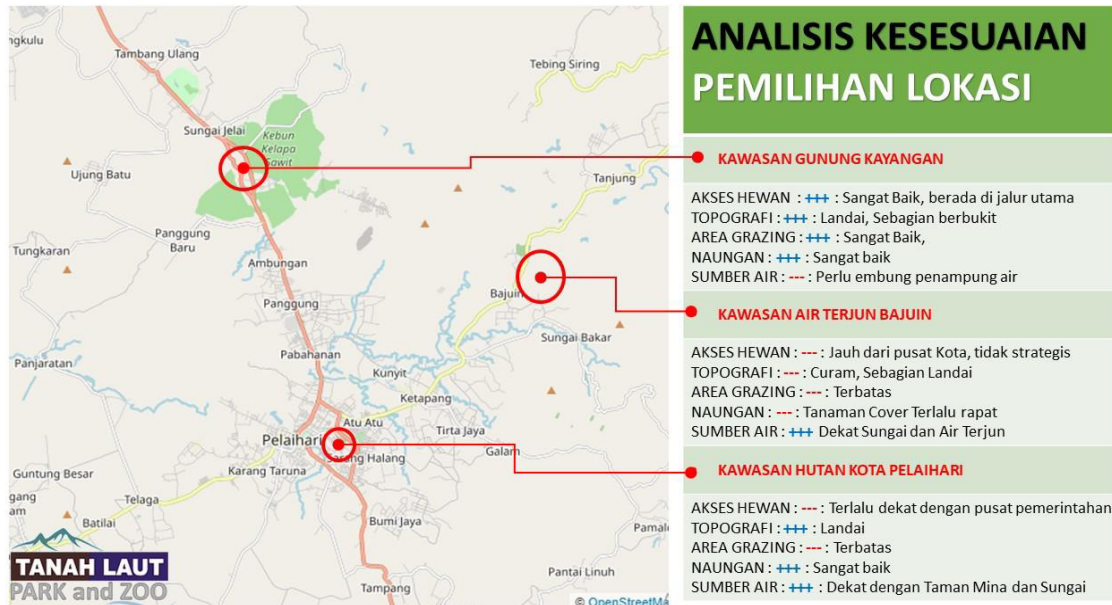


Figure 4. Habitat suitability analysis results for *C.unicolor*.

Based on the recapitulation of the analysis of the selection of a conducive location from various perspectives, it indicates that the most suitable location is the Gunung Kayangan area. The Gunung Kayangan area has easy accessibility because it is located on the main road that connects Pelaihari City with other cities. The location is not too far from the city center. The captive area can also be developed into a tourist area, because it has complete infrastructure and is located close to various other tourist attractions. The availability of water is also predicted to be sufficient if a reservoir is made from the potential water contained in the mountains (water bodies). The presence of water is very important for *C.unicolor*, because its natural habitat is an area that has water bodies [8].

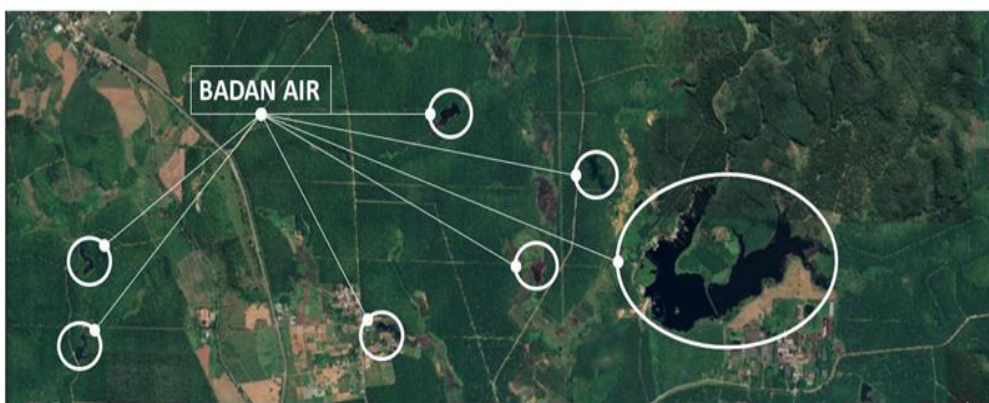


Figure 5. Water bodies around the Mount Kayangan area.

The least suitable area for captivity is the Bajuin Waterfall area. Grasslands for grazing are actually available in this area, but the shade trees (cover) grow too dense so that it is not ideal for captive sambar deer with a pedok system. The potential for solid and liquid waste from captivity is expected to disrupt the quality of river water in the Bajuin Waterfall area which is the main water source for Local Government Drinking Water Company (PDAM) in Tanah Laut district. The City Forest area is biophysically ideal to be developed as a breeding place, but the problem of a limited grazing area will complicate the captive process. The location which is very close to the district office/government center, hospitals and settlements causes the area to be negatively affected by the breeding development of *C.unicolor*. The potential for solid, liquid and air pollution is an important problem in the development of *C.unicolor* breeding in areas near settlements and offices.

4. Conclusion

The Gunung Kayangan tourist area is most recommended as a choice of *C.unicolor* breeding area. However, there are shortcomings that must be met in this area compared to the other 2 options, namely limited water resources. The problem of limited water can be overcome by optimizing the mountain (body of water) that exists as a reservoir for water supply for captive *C.unicolor*. The problem of solid and liquid waste from captivity has a negative impact on river pollution and air pollution in areas close to settlements so that it becomes an obstacle factor for the other 2 areas.

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