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BEKANTAN (*Nasalis larvatus*) HABITAT SUITABILITY IN TABUNIO WATERSHED IN SOUTH KALIMANTAN

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ABSTRACT

*The transfer of forest land to non-forests is increasingly massively carried out by humans, including in riparian forest areas (left-right forests of rivers). The study aimed to identify determining factors that affect the suitability of bekantan (*Nasalis larvatus* Wurm, 1781) in the riparian habitat of the Tabunio watershed in South Kalimantan through spatial modeling. Habitat suitability is analyzed using Sentinel-2 imagery and cellular automata and integrated with geographic information systems. The encounter with bekantan in Tabunio watershed as many as 443 bekantan individuals spread across 43 meeting points and consists of five main groups of bekantan with the number of group members for each of the main groups ranging from 20 - 68 individuals, With the average number of individuals grouped is 10.3 individuals The total area suitable for settlement habitat in the Tabunio watershed is 2.1113,84 hectares, or 3.38% of the entire Tabunio watershed area which totals 62.516,24 hectares. The model of the results of this study explains that the distribution of bekantan habitat suitability is influenced by the disturbance factor.*

Keywords: Bekantan (*Nasalis larvatus*), vegetation, population, habitat suitability

INTRODUCTION

Bekantan (*Nasalis larvatus*) is an endemic primate of Borneo whose population is increasingly threatened. In the Redlist Data Book of Endangered Species-IUCN [1], bekantan is categorized as endangered species, while in CITES it is categorized into Appendix I [2]. Bekantan includes animals protected under PP No. 7 of 1999 [3] which has been revised to The Minister of Environment and Forestry Regulation of the Republic of Indonesia Number P.20/ MENLHK / SETJEN / KUM.1 / 6/2018[4] on Preservation of Plant and Animal Species. Bekantan cannot be traded. Forest destruction, especially mangrove forests, is getting massive. This can be a serious problem with the existence of Bekantan. Indonesia has experienced significant forest loss [5]; [6], and this problem is particularly severe in South Kalimantan where lowland forests (wetlands) located within a network of protected areas have experienced significant declines [7]. This long-nosed animal can be found in several types of habitats including mangrove forests, peat swamp forests, riverside forests, dipterocarpacea forests, kerangas forests [8]; [9]). Habitat is a factor that determines the sustainability of a type of animal because the habitat provides the living needs of animals as a breeding ground, feed and water provider, as well as a place to rest and shelter. One component of habitat that is very important for bekantan is the tree, this is because bekantan is an arboreal animal where bekantan spends its life on a tree. Therefore, research was conducted on forest structure and how different aspects of forest canopy can affect the

performance of bekantan activities such as sleeping and foraging. Habitat damage that affects the presence of bekantan populations in Tabunio watershed needs to get serious attention in mangrove forest management, especially. This research aims to analyze the suitability of bekantan habitats in the Tabunio watershed in South Kalimantan. The benefits of this study provide recommendations for the parties in an effort to maintain the bekantan population in Tabunio watershed.

METHOD

The research was conducted in the period May - October 2021 in Tabunio watershed of Tanah Laut Regency of South Kalimantan Province. The objects in this study were the tree that bekantan selected as the feed source tree, its night bed and a place for its daily activities. This study uses equipment in the form of research site maps, GPS, roll meters, binoculars, measuring tape to measure diameter, haga to measure the height of trees, compasses to measure the degree of position of the presence of diamonds during research, cameras to document research activities, flashlights or headlamps, writing equipment and *kelotok* (small ships to conduct surveys). This study uses the spot observation method, which is a recording method that is done when encountering objects [10]; [9]. Data collection for local distribution of bekantan, including interview activities with the surrounding population, determining the coordinates of the habitat site where the bekantan was found using GPS, then interpreted with SIG data [11] and analyzed using geostatistic analysis [12]; [13]. Qualitative identification of habitats and record habitat status. The observations made in this study were ship-based surveys by observing the entire edge of the Tabunio watershed to identify trees that bekantan uses as a place of daily activity. Direct field observation for the collection of bekantan encounter data is carried out by concentration count method. The observation time of the distribution of bekantan is carried out at 05:30 to 18:00 WITA.

Data estimating the density of the number of individuals glutinous around the location of the sample point is extracted using the Kernel Density Analysis (KDA) method. Based on the data of the points found bekantan and the number of individuals bekantan from the field. The KDA tool is integrated into ArcGIS Desktop software. Spatial data estimating the density of the number of bekantan individuals is extracted to provide an overview of the distribution of the bekantan population around observation points in the field. At the same time later as input parameters in the measurement of the estimated distance found bekantan from settlement objects, roads, and rivers. Based on data on the points of discovery of bekantan in the field, the entire location of the discovery of bekantan is in the thicket. Of course, it is assumed that bekantan will also be found, potentially even more of its population in the forest. So that in modeling the suitability of bekantan habitats, it is assumed that bekantan habitats are only suitable in forests or shrubs.

Theoretically, bekantan would be away from humans, so the suitability of the bekantan habitat would be as far away from human activity centers as possible, such as settlements and roads. So that in modeling the suitability of bekantan habitat, the distance from the settlement and the distance from the road taken is the minimum distance or the closest distance as a barrier to habitat suitability. That is, the longer the distance of a place from the minimum distance of settlements and roads, the more suitable for the habitat of bekantan. On the other hand, bekantan requires river water to drink and clean itself. So that in modeling the suitability of bekantan habitats, for the distance from the river taken is the maximum distance or the furthest distance as a barrier to habitat suitability. So that the closer a place from the river, it will be more suitable for bekantan habitat. And if the distance has exceeded the maximum distance from this river, it is assumed that it is no longer viable for the habitat of the bekantan.

In this study, measurements of the distance of bekantan from settlements, roads, and rivers, were carried out based on data on the estimated density of the number of diamond individuals around the location of the sample point extracted using the previous KDA. This is because the sample points in the field are accidental sampling and coupled with limited survey time. So it may be a lot of bekantan that is not found or not seen at the time of the survey in the field. So that the overall location of the bekantan population is estimated using the KDA method as described in the previous section.

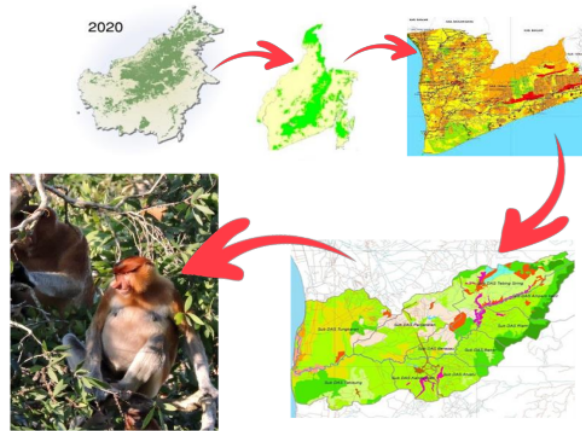


Figure 1. Location of Researcher Habitat Suitability Bekantan (*Nasalis larvatus*) in Tabunio Watershed in South Kalimantan

RESULTS AND DISCUSSIONS

Most of the forests in Tanah Laut Regency are along the river stream, especially those near the Tabunio River are riparian forests. This area has the potential of flora with a type that is quite diverse as found in the habitat area of the Tabunio watershed. In general, vegetation found in riparian forests include the families Combretaceae, Mimosaceae, Myrtaceae, Moraceae, Euphorbiaceae, Anacardiaceae, Melastomataceae, Apocynaceae, Annonaceae, Rubiaceae, and Fabaceae [14]. Flora in the area is partly a potential feed for bekantan such as galam, kabuau, and piai. The results of inventory in the field showed that the type of vegetation found along the river that became the habitat of the diamond in the Tabunio watershed amounted to 37 types of vegetation. Here is the results of an inventory of vegetation types in Tabunio watershed habitats with several types based on their local names as in Table 1.

Table 1. List of Types of Vegetation Found in Bekantan Habitat of Tabunio Watershed

No.	Family	Scientific Name	Regional Name
1	<i>Pteridaceae</i>	<i>Acrostichum aureum</i>	Piai
2	<i>Rhizophoraceae</i>	<i>Rhizophora mucronata</i>	Bakau
3	<i>Arecaceae</i>	<i>Metroxylon sagu</i>	Rumbia
4	<i>Combretaceae</i>	<i>Terminalia catappa</i>	Ketapang
5	<i>Fabaceae</i>	<i>Acacia aulicoliformis</i>	Akasia
6	<i>Rhizophoraceae</i>	<i>Laguncularia racemosa</i>	Bakau Putih
7	<i>Myrtaceae</i>	<i>Melaleuca cajuputi</i>	Galam
8	<i>Apocynaceae</i>	<i>Alstonia scholaris</i>	Pulai
9	<i>Asteraceae</i>	<i>Chromolaena odorata</i>	Kerinyuh
10	<i>Rubiaceae</i>	<i>Nauclea orientalis</i>	Bangkal
11	<i>Malvaceae</i>	<i>Ceiba pentandra</i>	Kapuk
12	<i>Anacardiaceae</i>	<i>Mangifera indica</i>	Mangga
13	<i>Musaceae</i>	<i>Musa paradisiaca</i>	Pisang
14	<i>Calophyllaceae</i>	<i>Calophyllum sp</i>	Kabuau
15	<i>Moraceae</i>	<i>Ficus benjamina</i>	Panggang
16	<i>Nepenthaceae</i>	<i>Nepenthes sp</i>	Kantong semar
17	<i>Malvaceae</i>	<i>Thespesia populnea</i>	Waru
18	<i>Rhizophoraceae</i>	<i>Rhizophora apiculata</i>	Mangrove
19	<i>Anacardiaceae</i>	<i>Gluta reinghas</i>	Jingah
20	<i>Anacardiaceae</i>	<i>Gluta velutina</i>	Jingah habang
21	<i>Lythraceae</i>	<i>Duabanga moluccana</i>	Binuang laki
22	<i>Rubiaceae</i>	<i>Morinda citrifolia</i>	Mangkudu
23	<i>Sapindaceae</i>	<i>Pometia correae</i>	Matoa
24	<i>Myrtaceae</i>	<i>Syzygium polyanthum</i>	Daun salam
25	<i>Phyllanthaceae</i>	<i>Phyllanthus acidus</i>	Cermai
26	<i>Acanthaceae</i>	<i>Acanthus illicifolius</i>	Jaraju
27	<i>Liliaceae</i>	<i>Crinum asiaticum</i>	Bakung
28	<i>Arecaceae</i>	<i>Elaeis guineensis Jacq</i>	Sawit
29	<i>Myrtaceae</i>	<i>Rhodomyrtus tomentosa</i>	Karamunting
30	<i>Anacardiaceae</i>	<i>Mangifera caesia</i>	Binjai
31	<i>Verbenaceae</i>	<i>Vitex pubescens</i>	Laban
32	<i>Celastraceae</i>	<i>Laphopelatum javanicum</i>	Perupuk
33	<i>Lythraceae</i>	<i>Lagerstroemia</i>	Bungur
34	<i>Salicaceae</i>	<i>Flacourtia rukam</i>	Rukam
35	<i>Apocynaceae</i>	<i>Cerbera manghas</i>	Bintaro/Mangas
36	<i>Arecaceae</i>	<i>Calamus sp</i>	Rotan/Pekat
37	<i>Arecaceae</i>	<i>Areca sp</i>	Pinang

Source: Field observation data, 2021

Research at the Tabunio watershed found 443 bekantan individuals spread across 43 meeting points and consisted of five main groups of bekantan with the number of group members for each of the main groups ranging from 20 - 68 individuals, with the average number of individuals grouped is 10.3 individuals. The number of members of this group is small when compared to the average number of members of the bekantan group in Samboja Koala (East Kalimantan) amounting to an average of 32.7 individuals [15], or the number of members of the bekantan group in Kutai National Park which is 17- 25 individuals [16]. Bekantan behavior during meetings with researchers, including eating, drinking, jumping, and

clustering. Research at the Tabunio watershed found 443 bekantan individuals spread across 43 meeting points and consisted of five main groups of bekantan with the number of group members for each of the main groups ranging from 20 - 68 individuals, with the average number of individuals grouped is 10.3 individuals. The number of members of this group is small when compared to the average number of members of the bekantan group in Samboja Koala (East Kalimantan) amounting to an average of 32.7 individuals [15], or the number of members of the bekantan group in Kutai National Park which is 17- 25 individuals [16] or other research results that are 11 - 56 individuals [17]. Bekantan behavior during meetings with researchers, including eating, drinking, jumping, and clustering.

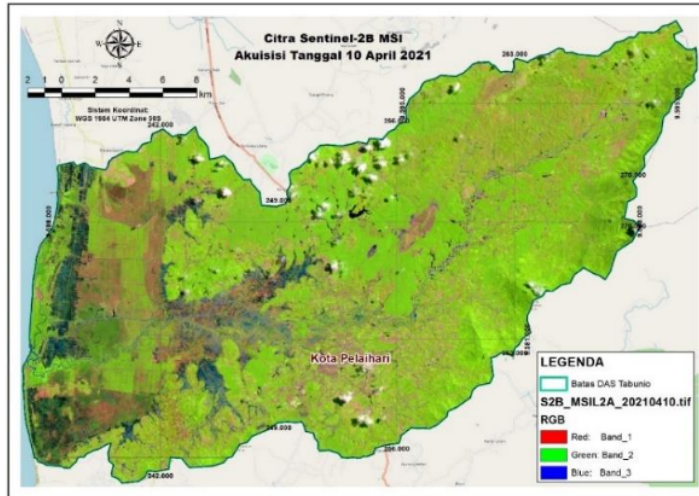


Figure 2. Sentinel-2B MSI image recorded April 10, 2021

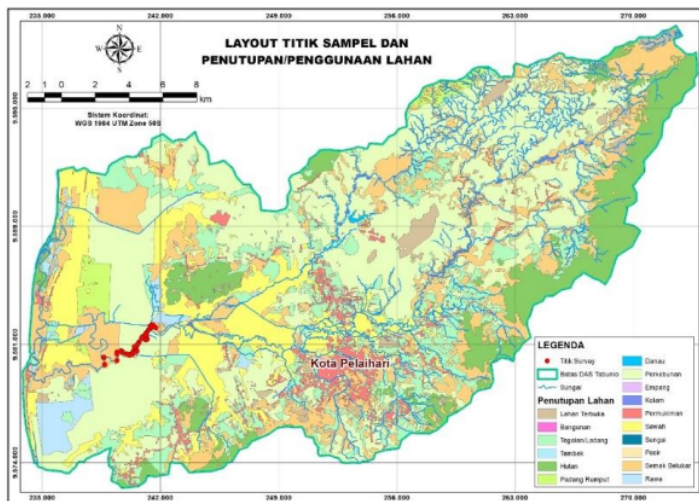


Figure 3. Closure / land use and meeting point with bekantan in Tabunio watershed

Table 2. Land Closure Area in Tabunio Watershed in South Kalimantan

No	Land Closure/Use	Wide (hektare)	Percent (%)
1	Open Land	1.702,44	2,72%
2	Building	6,32	0,01%
3	field	7.221,15	11,55%
4	fishpond	204,86	0,33%
5	Forest	6.489,10	10,38%
6	Meadow	856,88	1,37%
7	Lake	47,36	0,08%
8	Plantation	23.301,00	37,27%
9	embankment	27,54	0,04%
10	Pool	168,01	0,27%
11	Settlement	2.107,83	3,37%
12	field	7.407,97	11,85%
13	river	97,61	0,16%
14	Sand	1,29	0,00%
15	Shrubs	11.809,40	18,89%
16	Swamp	1.067,49	1,71%
Total		62.516,24	

Description:

Spatial closure/land use data is visually interpreted and digitized from the Sentinel-2B MSI Image recording dated April 10, 2021. The date of recording this image is adjusted to the time of the field survey.

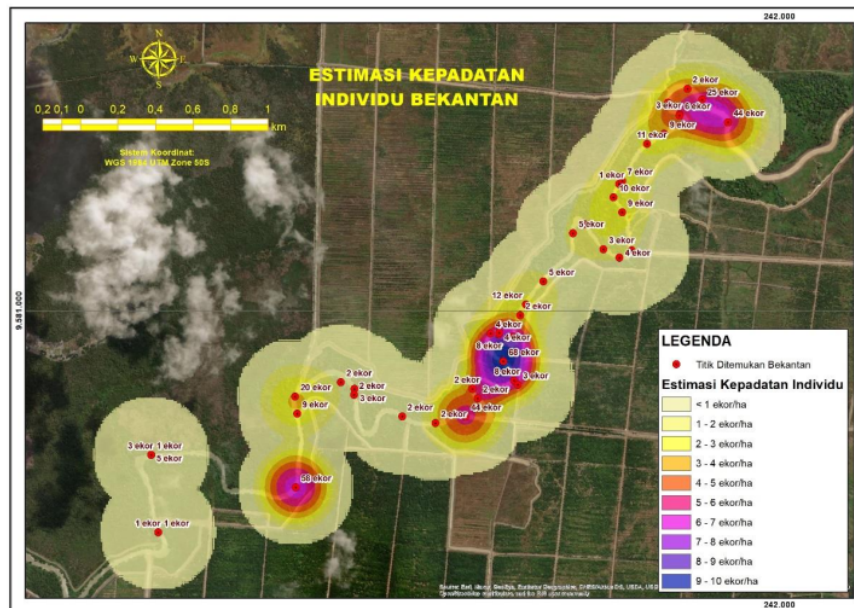


Figure 4. Estimated density of the number of bekantan individuals around the location of the Meeting point with the bekantan

As seen in Figure 4, the estimated density of the number of individuals or the distribution of bekantans looks uneven along the Tabunio River. And in general there are three or four clusters of bekantan distribution, where in each cluster there is a kind of central point of distribution. The points that become the centers of distribution are likely the safest and most comfortable points for bekantan to live and move there. This is an opportunity for future research, to examine further comprehensively in the field, why these locations can become a kind of central presence of diamonds along the Tabunio river. Whether because there is abundant feed, the best and most preferred quality of feed bekantan, or because the quality of river water there is the best. Of course, this will be a separate research later, and beyond the scope of this research.

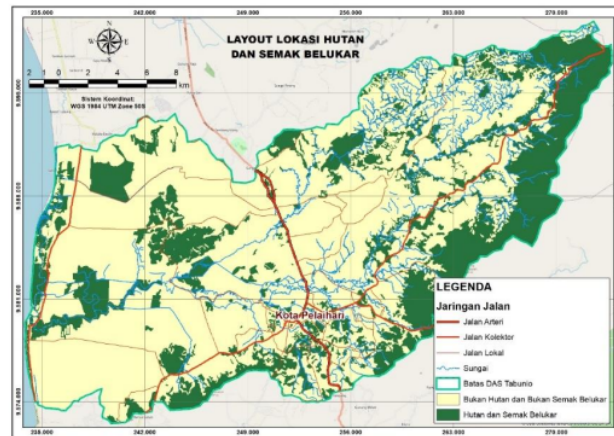


Figure 5. Location of forests and shrubs

The existence of settlement, plantation, and agricultural activities that are quite massive in the Tabunio watershed, has caused the remnants of forest and shrubs in the Tabunio watershed to become scattered in several locations, some of which are far from each other. This causes potential areas to become habitats for bekantan to be blocked, where between barriers separated by land uses loaded with human activities, such as settlements and highways. This can be seen in Figures 5, 6, 7, and 8.

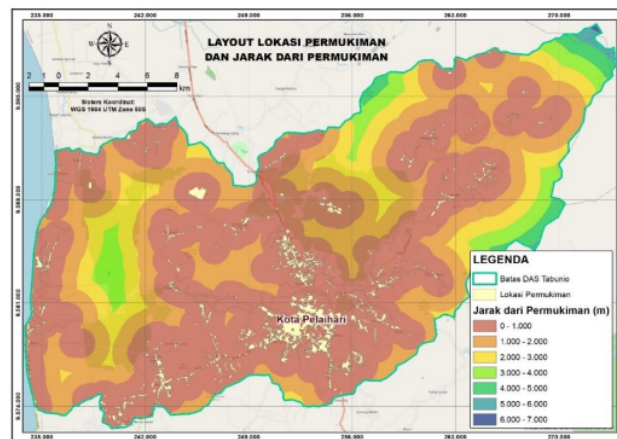


Figure 6. The location of the settlement and the distance of each meeting location with bekantan in Tabunio watershed from the nearest settlement

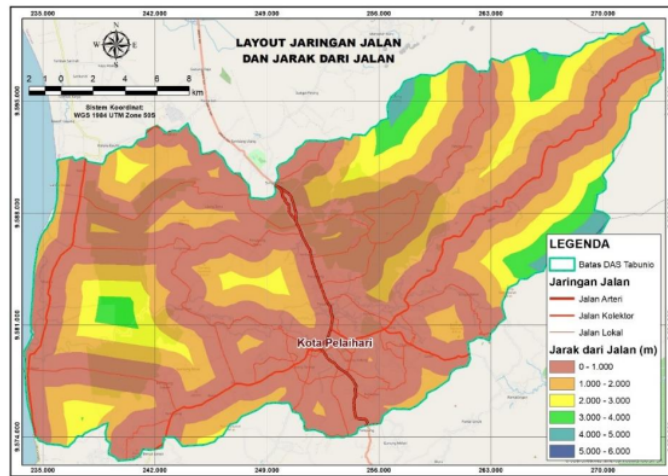


Figure 7. The road network and distance of each meeting place with bekantan in Tabunio watershed from the nearest road

Due to the barrier of forest and shrubs by settlements and roads, the areas estimated as suitable locations for bekantan habitats become very far-flung clusters. There are at least five main clusters or large groups of locations suitable for bekantan habitat, as seen in Figure 5. In addition to small clusters that are likely in the field are actually not suitable for bekantan habitats, because they are too small and far from the main clusters. The scattered conditions or separation of these bekantan habitats certainly describe Tabunio watershed conditions that are no longer ideal as wildlife habitats, especially wildlife that require special privacy such as bekantan. If there is no conservation of the remnants of existing habitats, it is not impossible that in the next few decades bekantan will leave this region, because of its displaced habitat. And locations of scattered habitat suitability like this will cause difficulties for bekantan when one day it will have to exodus or evacuate from where it is now, when the place of residence is now displaced or disturbed by human activities around it.

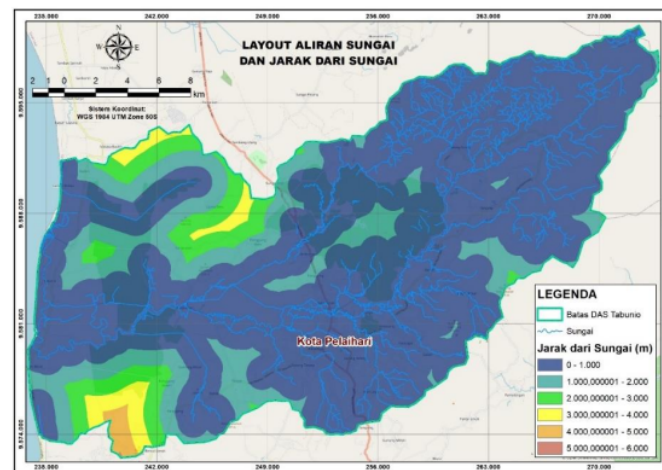
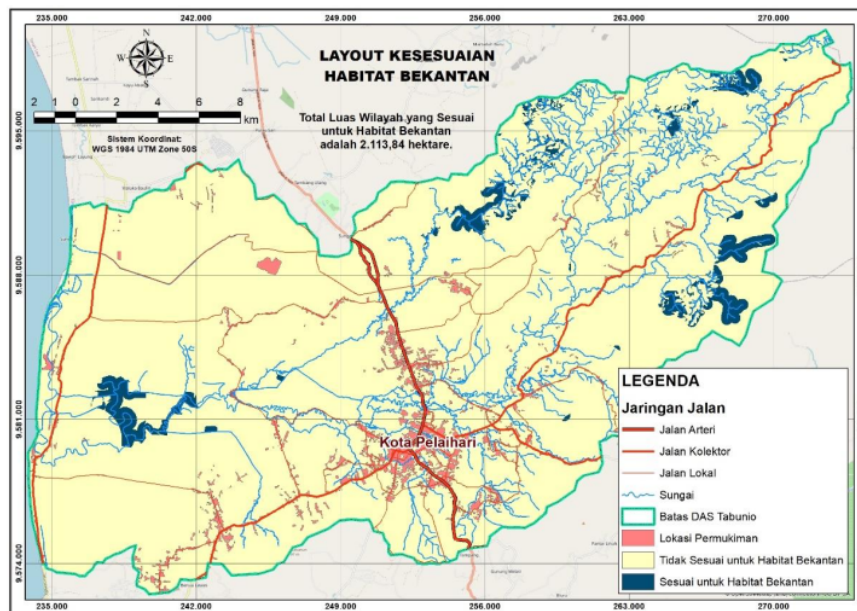


Figure 8. The flow of the river and the distance of each meeting place with bekantan in the Tabunio watershed from the nearest river

Table 3. Data parameters of the location of the bekantan from several land use/closing objects

No	Distance From	Minimum Distance (meter)	Maximum Distance (meter)	Average Distance (meter)	Standard Deviation
1	Settlement	1.583,84*	3.235,72	2.496,39	409,98
2	Road	1.549,05*	3.351,38	2.471,39	398,88
3	River	0,00877	270,17*	82,07	62,38

Description: *Parameters limiting the suitability of bekantan habitats

**Figure 9. Suitability of habitats resulting from spatial modeling**

The total area suitable for bonded habitat in Tabunio watershed is 2.1113,84 hectares, or 3.38% of the entire Tabunio watershed area which totals 62.516,24 hectares. The spread of bekantan for high conformity classes based on the results of projections and map treatment shows that its presence is close to feed sources, water sources, but far from interference factors. The condition of the spread is thought to be strongly influenced by the disruption factor in the form of settlements, ponds and roads. Based on the thematic map of land closures that bekantan with a high suitability class has an undisturbed habitat pretension and is far from the disorder factor in the form of human activities. Based on the suitability class of bekantan habitat conditions in the riparian ecosystem of Tabunio watershed is in a condition threatened by human activities with settlements, ponds, oil palm plantations and roads. This form of pressure and disruption impacts the number of individuals, although the availability of water sources and feed sources needed is very supportive. The impact of the disturbance causes the spread of bekantan which tends to cluster, the population is threatened and critical. Bekantan is a primate that does not like proximity to various access to human activities, so that with the disruption factors that appear to have an impact on population decline, distribution patterns that tend to cluster in certain habitats and limited movement of bekantan.

Various environmental factors that influence the pattern of distribution and selection of habitat by bekantan in Tabunio watershed as presented by Table 7. All of these factors are complexly associated and affect the characteristics of bekantan habitats either directly or indirectly. From the various descriptions that have been conveyed that there are major factors that have a direct and very large influence on the selection and use of habitat by bekantan. The main factor is the cover of land and vegetation. As has been explained that land cover is a very important factor for bekantan life to be able to carry out all forms of life activities. With good land cover bekantan tends to be able to survive and develop the number of individuals and groups well. In addition, habitats with good land cover will provide abundant vegetation variations and ensure the availability of diverse feed. In this study found 37 types of vegetation that makes up habitats in riparian forests of Tabunio watershed. This is the main reason that good habitat is a leading indicator that characterizes the characteristics of habitats used by bekantan in the Tabunio watershed. But it should be underlined that these factors collaborate in complement with various other biotic and abiotic factors such as temperature, humidity, and distance from settlements, distance from roads and distance from bodies of water (rivers).

Adaptive behavior is indicated in diet and movement. Bekantan diet that tends to dominantly eat young leaves will be more accustomed to the source of feed that is above ground on open land or ponds. Bekantan as an arboreal primate that utilizes the header strata for its movement, with the disruption factor of human activity will tend to behave as terrestrial wildlife. Behavior itself has the meaning of the attitude and motion of organisms in responding and adapting to environmental changes [18]. Adaptive behavior in living things is also shown in the process of learning about danger and the behavioral efforts he avoids danger. Adaptive behavior can occur under any environmental condition and anywhere [18]. Environmental changes to the habitat of the bekantan will affect behavior, which will lead to dependence and even the nature of tolerance. Bekantan has the ability to respond to changes that occur in its habitat to survive and breed.

The spread of bekantan for high conformity classes based on the results of projections and map treatment shows that its presence is close to the source of feed, water source, but far from the interference factor. The condition of the spread is thought to be strongly influenced by the disruption factor in the form of settlements, ponds and roads. Based on the thematic map of land closures that bekantan with a high suitability class has an undisturbed habitat pretension and is far from the disorder factor in the form of human activities. Based on the suitability class of bekantan habitat bekantan conditions in the riparian ecosystem of Tabunio watershed is in a condition threatened by human activities with the existence of settlements, ponds, oil palm plantations and roads. This form of pressure and disruption impacts the number of individuals, although the availability of water sources and feed sources needed is very supportive. The impact of the disturbance causes the spread of bekantan which tends to cluster, the population is threatened and critical. Bekantan is a primate that does not like proximity to various access to human activities, so that with the disruption factors that arise to have an impact on population decline, distribution patterns that tend to cluster in certain habitats and limited movement of bekantan.

Bekantan habitat in the riparian ecosystem of Tabunio watershed is located in mangrove forests. Mangrove forest ecosystem provides a good habitat suitability for bekantan with the availability of biotic and abiotic elements needed by bekantan. But the condition of mangrove habitat for bekantan in the riparian ecosystem of Tabunio watershed has undergone many changes due to damage and reduction of habitat area. Damage and reduced area of mangrove area is heavily affected by human activities. Habitat destruction has an impact on the decline of the bekantan population. As a result of the decline in habitat area, bekantan populations

tend to decrease because these primates are less tolerant to habitat destruction [19]; [20]. From the interpretation of the image manually, that damage occurred within the mangrove area of the Tabunio watershed riparian ecosystem for conversion into oil palm plantations. Road access provides the facilities of the surrounding community to take advantage of it to the sea, gardens and ponds. Settlements that are relatively increasingly dense with the development of administrative areas increasingly affect the existence of bekantan in riparian forests of Tabunio watershed. Bekantan is very sensitive to habitat damage so that the large or small population of bekantan in a habitat can be used as an indication of the extent of damage to mangrove forests and riverside forests. Damage to mangrove habitat of Tabunio watershed riparian ecosystem arises and occurs due to settlements close to mangrove habitat, tree felling and land clearing for oil palm plantations and ponds, opening road access, and utilization of rivers for transportation routes.

The nature of bekantan adaptation will have a limited movement impact by utilizing feed sources around the place of rest or sleep. This fact occurs in watersheds whose areas are opened for ponds and road access. Bekantan better utilize feed to survive as the terrestrial and arboreal animals on the type of feed that is on the banks of the river and animals in ponds. Bekantan at the site of this study can still survive and the population increases although not optimally. Some of the strategies that be used by bekantan to survive in this isolated and fragmented habitat are to (i) optimize existing resources within its narrow roaming area, including by using other sources of feed not unusually eaten in other places, (ii) saving energy by reducing agonistic behavior towards other types of sympatric primates and human presence, (iii) use most of the time of his daytime activities for rest or sleep, and (iv) make daily movements that are not too far away [21].

The occupation of people into the wetland forest area starts from the river as the main means of transportation in the region. The increase in the frequency of the use of rivers as a means of transportation leads to increased settlement growth and the use of riparian forests in the form of forest products and the use of forest land for the expansion of fields or gardens. Whereas the forest area of the 100 m wide river border belongs to the category of protected areas. In Kalimantan, swamp forests along the banks of rivers and riverine mangroves on the coast, are potential areas as wildlife habitats. Bekantan is one type of leaf-eating primate endemic to Kalimantan, whose population depends heavily on the quality of wetland ecosystems, particularly mangrove forests and riparian forests, and is intolerant to habitat disturbances [19]; [20]. The emergence of road access, the existence of settlements, land clearing for ponds and plantations, the utilization of rivers for transportation lines from spatial analysis of habitat suitability modeling need attention to prevent and control habitat destruction. Areas identified as disturbed areas but become bekantan habitats need to be a priority in increasing bekantan population. Law enforcement efforts, habitat improvement or habitat restoration on ponds and river borders with the type of bekantan feed source trees such as *Bruguiera* and *Sonneratia* are the implications of habitat damage that must be done for the preservation of bekantan. The role of the manager of the Tabunio watershed (essential area) in this case the Forest Service of South Kalimantan Province and the Regional Government of Tanah Laut Regency is needed to control the damage and increase the reduction of suitable habitat for bekantan.

CONCLUSION

The encounter with bekantan in Tabunio watershed as many as 443 bekantan individuals spread across 43 meeting points and consists of five main groups of bekantan with the number of group members for each of the main groups ranges from 20 - 68 individuals, with the average number of individuals grouped is 10.3 individuals The total area suitable for the

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