

## Study of Suitability and Carrying Capacity on Ecotourism of Turtle Conservation in The Tikus Island Bengkulu City

Dede Hartono<sup>1\*</sup>, Zamdial<sup>1</sup>, Musriyadi Nabiu<sup>2</sup>, Ari Anggoro<sup>1</sup>, Ridka Rizki Novanda<sup>2</sup> & Dwi Bulan Dari Julian Putri<sup>1</sup>

<sup>1</sup>Marine Departement Agriculture Faculty The Bengkulu University, Bengkulu City 38371, Indonesia

<sup>2</sup>Agribusiness Departement Agriculture Faculty The Bengkulu University, Bengkulu City 38371, Indonesia

\*Corresponding author: [dhartono@unib.ac.id](mailto:dhartono@unib.ac.id)

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### ABSTRACT

Tikus Island is the only small island located very close to Bengkulu City. Tikus island has long been known by the Bengkulu people as a turtle nesting area. The types of turtles found were hawksbill and green turtles. In recent years, research has shown that the turtle population has decreased, which is thought to be caused by the degradation of environmental conditions. Recently, environmentalists have plans to revitalize Tikus Island. Tikus Island has a very vital economic function and environmental function for the people of Bengkulu City. The Marine Edu-park development plan is one of the efforts to revitalize Tikus Island with an integrated development concept. Integration between environmental and economic sectors, as well as regional development integration between Tikus Island and the surrounding tourism locations in Panjang Beach, Bengkulu City. In this study, the plan for the development of turtle conservation ecotourism on Tikus Island, will be analyzed based on the environmental conditions of the island and in the surrounding Water Conservation Area (KKPD P Tikus). The purpose of this study was to determine the suitability value and carrying capacity of turtle ecotourism in the Tikus Island area, Bengkulu City. This study uses a survey method to data collection with using observation and interviews. The types of data used are primary data and secondary data. Suitability analysis is the determination of the value of Tikus island that is suitable for ecotourism activities. Carrying capacity functions as a limitation of activities carried out by humans in an environment. The results of this study indicate that the Turtle Ecotourism Conformity Index (IKEP) of Tikus island is in the very appropriate category (S1). The carrying capacity is 60 people/day with 5 visits every day.

**Keywords** : Suitability, carrying capacity, ecotourism, turtles

### INTRODUCTION

Tikus Island is one of the islands in Bengkulu Province which is located in Bengkulu. Tikus Island about a 40-minute by boat from downtown Bengkulu. Many people go to the beaches and reefs to fish and earn money. Tikus Island is one of the islands with a comfortable environment for turtles to live and breed. The most common types of turtles, found around this water area, are the hawksbill and green turtles. The shrinkage of the Tikus Island area is one of the factors that reduces the number of turtles eggs. Not only destroying the natural environment, there are still many people who consume turtle eggs and turtle meat. Physically, the turtle habitat is a reflection of the existence of the turtle itself. Ecologically, the reduced number of turtle nests that can be found is one of the factors causing the decline in the turtle population.

Present time, turtles rare to be found in this area, due to damaged or changed environmental conditions. Some of the activities that affect the turtle population are human activities such as pollution of coastal and marine waters, destruction of nesting sites, destruction of feeding grounds, disruption of migration routes, catching of mother turtles and transfer of mother turtles, and illegal eggs collection. Turtles are protected animals because their populations are threatened with extinction. One of the things that can be done to prevent the extinction of turtles is conservation. Conservation is an effort that can prevent the destruction of turtle habitat and prevent turtles from being used commercially. In an effort to support conservation activities, ecotourism is needed. Coastal ecosystems have great potential and can be managed and utilized for tourism activities. One type of beach tourism in

Indonesia is beach tourism. Beach tourism is a form of beach tourism that generally utilizes coastal resources (Putera et al., 2013).

Marine tourism is a special type of tourism. That is, the management and utilization of marine and coastal landscapes that are managed directly such as swimming, boating, and snorkeling. Like diving, or indirectly picnics and beach sports. One form of tourism product that is part of the concept of sustainable tourism is the concept of ecotourism development (Yulianda et al., 2010). Sustainable tourism in its development must pay attention to environmental aspects in order to maintain the sustainability of tourism development Domo et al. (2017). The development of turtle ecotourism still needs to pay attention to the function of conservation areas. Visitors waiting for turtles to come ashore can also lay their eggs on disturbed turtles.

Partnerships are required between social groups, government, private sector or organizations interested in environment and protected area management. Activities that often occur in the Tikus island area are: coral reef of Tikus island used as fishing ground, the place to stop, rest and hide from strong winds for fishermen, coral reef objects become diving and snorkeling spots.

Increase community participation in management organizations as a form of acknowledgment of joint efforts in conserving nature, preserving the environment, and optimizing protected areas. Efforts to achieve the goals of ecotourism development, there is a need for ecotourism planning that considers ecotourism market demand, impacts on the environment, and location design that considers tourist comfort, but does not cause side effects on the environment (Mirsanjari, 2012). Analysis of ecotourism development is one way to determine the suitability of the attractiveness of an area for the development of certain ecotourism. Ecotourism development is based on several criteria of landscape beauty and its limiting factors, such as soil vulnerability, dynamics of the Indonesian environment, climate, biodiversity and accessibility. While attractiveness is the main factor, several limiting factors also need to be balanced in ecotourism development (Bunruamkaew and Murayama, 2011) and (Bali et al., 2015). For the appropriate type of land, the manager considers the duration of activity and changes in tourists, as well as the number of tourists who can come to the place so as not to exceed the carrying capacity of the area.

This study aims to determine the suitability and carrying capacity of turtle ecotourism in the Tikus Island, Bengkulu City. The benefits of the research can be important information in the preparation of an integrated sustainable ecotourism plan regarding the development *Marine Edupark* based on turtle ecotourism on Pulau Tikus area.

## MATERIALS AND METHODS

This study used a survey method and was carried out in November 2021 – April 2022 on Pulau Tikus, Bengkulu City, Bengkulu Province (Figure 1). The tools and materials used during the research are: stationery, Global Positioning System (GPS), camera, laptop, roll meter, scale pole, spirit level.

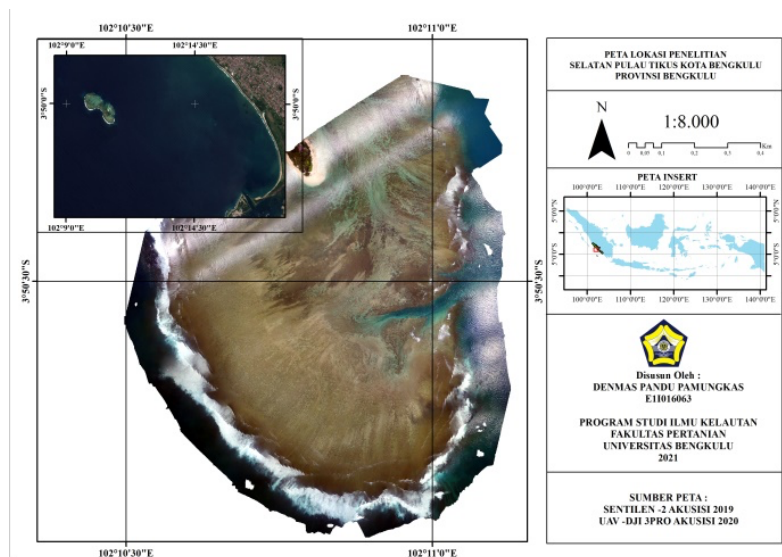


Figure 1. Map of Tikus Island as Research Site

Methods of data collection using the method of observation and interviews. The types of data used are primary data and secondary data. Primary data is obtained from direct measurements and observations at the research site, while secondary data comes from government agencies, previous research related institutions, and literature such as the Geographic Information Agency (BIG).

The beach slope is carried out to determine the type of beach and the cause of the formation of the beach (Lestari, 2013). The formula for calculating the slope of the beach is:

$$a = \arctan \frac{Y}{X}$$

$a$  : Angle formed (°)

$Y$  : The distance between the perpendicular formed horizontally with the surface of the sand below it

$X$  : Depth (m)

The analysis of the suitability of the area as a turtle ecotourism area is a scoring analysis to determine the suitability and ability of the area for all ecotourism activities (Muflih 2019). The turtle ecotourism suitability index is seen from several aspects including beach slope, beach type, water base material, coastal vegetation, beach width, tides, water depth, fresh water availability. According to (Yulianda, 2007) the formula for calculating the turtle ecotourism suitability index :

$$\text{IKEP} = \sum [\text{NI}/\text{N maxs}] \times 100\%$$

Carrying capacity functions as a limitation of activities carried out by humans in an environment. The carrying capacity of the area can be calculated using the formula (Yulianda, 2007):

## RESULTS AND DISCUSSION

Tikus Island in general is an island in Bengkulu Province which is directly opposite the Indian Ocean. Tikus Island is located in the west of Bengkulu City with a distance of 10 Km from the center of Bengkulu City. Geographically, it is located at the coordinates of 30 50'17.55" South Latitude and 102010'50.59" East Longitude. Rat Island is a small coral island located in the administrative area of Bengkulu City, Teluk Segara Subdistrict, Marlborough Village which is surrounded by coral and rich in resources. The inhabitants are fishermen who rest and maintain lanterns. Tikus Island has rocky white sand, and is a strategic place for turtles to lay their eggs. The journey from Bengkulu to Tikus Island takes approximately 60 minutes by boat from Marlborough Village Beach. Using Speed Boot, Tapak Paderi Beach only takes about 40 minutes from Bengkulu city. The existence of Tikus Island is increasingly worrying because it continues to be eroded by abrasion. Based on the results of the study, the parameter values for turtle ecotourism can be presented in Table 1.

**Table 1.** Parameters Composing Turtle Ecotourism

Parameter	Station 1	Station 2	Station 3	Station 4
Beach Width (m)	15,7	19,2	17,9	19,1
Beach Slope (°)	5	6	5	4
Water Depth	0,8	0,5	0,7	0,8
Beach Type	White Sand Slightly Coral	White Sand Slightly Coral	White Sand Slightly Coral	White Sand Slightly Coral
Bentic Material	Sandy Coral	Sandy Coral	Sandy Coral	Sandy Coral
Coastal Vegetation	Coconut tree (Cocos Nucifera)	Keben (Barringtonia Asiatica)	Beach Sweets (Ipomoea Pescaprae)	Fir (Casuarina Equisetifolia)
Fresh Water Availability (km)	0,150	0,60	0,200	0,230
Tides (cm)	154,1	154,1	154,1	154,1
Turtle Ecotourism Suitability Index (%)	79,16	80,55	80,55	86,11
Category	Very Appropriate Category	Very Appropriate Category	Very Appropriate Category	Very Appropriate Category

Administratively right next to the Indian Ocean ± 0.6 ha. The width of the beach is measured from the distance of the highest tide to the outermost vegetation with a roll meter for supratidal width. The intertidal width is measured from the distance of the highest tide to the limit of low tide. The length of the beach is measured following the shoreline.

The result of measuring the width of the beach at observation point 1 is 11.4 m at observation point 2, which is 14.7 m, while at observation point 3 it is 13.6 m and at observation point 4 is 13.4 m. The

width of the beach affects when turtles will lay their eggs, the longer the intertidal area the farther the turtle goes to the supratidal area, because turtles will not lay their eggs in the intertidal area because of high humidity which is influenced by tides.

Based on the results of measurements of the beach slope at observation point 1 is 5 at observation point 2 which is 6, while at observation point 3 is 5 and at observation point 4 is 4. The level of slope of observation point 1 to observation point 4 has a slope category value, namely Sloping with magnitude high or wavy.

Slope  $<1^\circ$  with 0-2% in the flat-almost flat category,  $1-3^\circ$  with 3-7% in the very gentle category,  $3-6^\circ$  with 8-13% in the sloping category,  $6-9^\circ$  with 14-20% in the the category is rather steep,  $9-25^\circ$  with 21-55% is in the steep category,  $25-65^\circ$  with 56-140% is in the very steep category and  $>65^\circ$  with  $>140\%$  is in the steep category (Tutupary, 2018). Meanwhile, according to Darmawijaya (1997), the slope is very steep, namely between 16% to 30%, the slope class is 8%-16%, the slope class is 3%-8%. The height of the slope did not change significantly from observation point 1 to observation point 4. Turtles prefer gentle slopes and wide beaches not far away. The slope of the beach has a significant effect on the number of turtles laying eggs on the beach. The steeper the coast, the harder it is for turtles to see distant objects.

The relationship between nest slope and nest humidity, namely on beaches with a slope of less than  $30^\circ$  and nest humidity of 30–40%. Slopes range from 20-28%. The humidity of the nest is high when the slope is less than 30 degrees, due to the entry of sea water into the nest. The relationship between humidity and plants is that the wider the shade of the nest, the more humid the nest, because the shade will evaporate. The beach slope favored by turtles is in the gentle category because it is very impactful for turtles to reach areas suitable for laying eggs. Tikus Island beach depth is very diverse, influenced by tidal activity and topographic conditions. The location of depth data collection is 10 meters from the shoreline. This is based on Masita et al. (2013) The location of depth data collection is 10 meters from the shoreline. Meanwhile, to measure the depth of the waters using a scale pole with a length of 2 meters.

The results of the measurement of the depth of the Tikus Island waters are at observation point 1 with a depth of 0.8 m, at observation point 2, a depth of 0.7 m at observation point 3 and a depth of 0.8 m at observation point 4. According to Bennett (1999), tides at low tide with a depth of 1-1.5 meters makes it easier for turtles to find food. According to Juliono (2017), turtles prefer relatively shallow areas. Sand is an environment where turtles lay their eggs, and the type of sand greatly affects the success of the hatching process. There are several types of sand, such as coarse sand, medium sand, fine sand, and very fine sand. According to Yustina et al. (2004) medium size can be classified Coarse sand  $> 0.4$  mm, Medium sand (medium sand)  $0.25$  mm  $< x <$  fine, (3) Fine sand with dimensions  $0.1$  mm  $< x <$   $0.24$  mm and (4) Size  $< 0.1$ mm.

Sand The type of beach is determined by visual observation by observing the type and color of the sand. The beach sand on Tikus Island is medium-sized white sand that turtles love. The determination of the type of beach is carried out by visual observation, namely by observing the type and color of the sand. The beach sand on Tikus Island is a medium-sized stretch of white sand which is the preferred place for turtles to lay their eggs. The high sand content makes it easier for turtles to build nests than mud. Turtles like sandy beaches to lay their eggs. The quality of the nest substrate depends on the level of ease of digging the nest.

The substrate is an egg-laying environment for spawning turtles, which are generally sandy. Meanwhile, according to Abdurahman (2018) Substrate is a nest medium for laying turtle eggs which are generally sandy. The basic material of the waters on the Tikus Island beach is at observation points 1, 2 and 3, namely rocky sand. According to Abdurahman (2018), he revealed that the proportion of sand in turtle nesting sites is moderate, the rest is above 90% with the rest being coarse rock, coral debris, dust and clay. This storage capacity keeps the sand from being too dry or too wet. This storage capacity makes the sand conditions neither too dry nor too wet. Mortimer (1990) in Chess et al. (2011), adding dry coarse sand makes it difficult for female turtles to build nests. The existence of vegetation on the beach is very important for turtle nesting nests, especially for egg incubation. Hawksbill turtle nesting nests are often found under the shade of coastal vegetation. The presence of vegetation is able to maintain the temperature in the incubation process of scale eggs and instinctively vegetation is considered to increase safety for laying eggs to avoid predators. According to Bakhtiar and Zamdial (2015) in Elbet (2018), there is almost no native vegetation on the mainland of Pulau Tikus. Most of the existing vegetation is intentionally planted by lighthouse keepers and rehabilitation activities by various parties.

The types of plants found on Tikus Island are sea pine (*Casuarina equisetifolia*), ketapang (*Terminalia catappa*), deep coconut (*Cocos nucifera*), and sea hibiscus (*Threspesia. populnea*), mangroves (*Scaevola taccada*), batatang (*Ipomoea pes-caprae*), noni (*Morinda citrilia*) and papaya

(*Carica papaya*). The presence of coastal vegetation is a biological feature that affects the location of turtle laying eggs. Plants maintain a stable temperature so as not to overheat from the sun. Plants also function as protection of turtle eggs from predators (wildlife) (Hermawan et al., 1993). Based on the results of the study, the coastal vegetation of Tikus Island At observation point 1 was covered by coconut trees (*Cocos nucifera*) and 2 coastal vegetation was covered by keben (*Barringtonia asiatica*), at the observation point 3 coastal vegetation was covered by coastal sweet potatoes (*Ipomoea pescaprae*), and at observation point 4 covered with fir (*Casuarina equisetifolia*).

The presence of vegetation is an indicator of protection for turtle eggs from sea water runoff, predators and slows the spread of the process of transmitting heat from sunlight to the surface of the sand. The propagation and absorption of sunlight becomes slower because the sunlight is absorbed first by the shade of the vegetation before it reaches the surface of the sand. Anshary et al. (2014) stated that environmental factors determine turtle landing activities to lay eggs and coastal vegetation also supports being used as green turtle nesting habitats.

One of the criteria for assessing priority for the development of coastal tourism is the presence of fresh water. According to Yulianda (2007) in Muflih (2019), beach tourism is very suitable if the availability of fresh water is less than 0.5 km, the distance of fresh water is 0.5-1 km, the category is not suitable and the distance to fresh water is not suitable. suitable. More than 1-2 Km. There is no direct spring on Tikus Island but there is a rainwater reservoir and the nearest spring is 10 Km away. The type of tidal sea water in Bengkulu is a mixed type of double skew. Tikus Island is an island that has two high tides and two low tides or semi diurnal. The ebb and flow of coastal sea water affects the frequency of turtle landings and also affects the number of green turtles and hawksbill turtles that land. Based on the graph above, it is found that the average tide in Central Bengkulu is -0.00061 cm, the highest tide occurs at an altitude of 0.894 cm and the lowest tide is at an altitude of -0.647 cm. the distance between the highest and lowest tides is 154.1 cm. According to Mansula and Agus (2020) Tidal waves are one of the most important factors in turtle landing on the beach when laying eggs. The tides also affect the mother turtles, as they open their nests to lay their eggs on the beach and let the eggs hatch. Once the turtles go down, the tide helps, and usually begins to grow an hour or two before and after the highest waves of the night, which the mother turtles use to supply energy (Mukminin, 2002). Anshary et al., (2014) reported that the inflow and outflow of coastal seawater affects the frequency of turtle landings and the number of green turtles (*Chelonia mydas*) that land on the beach. Based on the results of the combination of several turtle ecotourism variables studied, in Table 2.

**Table 2.** Analysis value of turtle ecotourism suitability index

No	Research sites	Turtle Ecotourism Suitability Index	Category
1	Station 1	79,16%	very appropriate
2	Station 2	80,55%	very appropriate
3	Station 3	80,55%	very appropriate
4	Station 4	86,11%	very appropriate

At Station 1, based on the results of the research conducted, the value of the turtle ecotourism suitability index (IKEP) was 79.16%. Beach width, beach depth and distance to fresh water availability were assessed with three scores. The size of the beach slope, the type of beach and the bottom material of the waters got 2 scores. Measurements of coastal and tidal vegetation get two scores of 1.

At station 2, based on the results of the research conducted, the value of the turtle ecotourism suitability index (IKEP) was 80.55%. Beach width, beach depth and distance to fresh water availability were assessed with three scores. The slope of the coast, type of beach, coastal vegetation, and basic water materials get 2 scores. The magnitude of the ups and downs receives 1 score. This suitability value is the same for Stations 2 and Stations 3.

At Station 4 based on the results of the research conducted, the value of the turtle ecotourism suitability index (IKEP) was 86.11%. Measurement of beach width, beach depth, beach slope, and distance of fresh water availability obtained 3 scores. While the measurement of the type of beach and the bottom material of the waters obtained 2 scores. Measurement of coastal vegetation and tides was obtained 1 score.

Based on the results of the analysis of the suitability of turtle ecotourism, it was found that the Turtle Ecotourism Conformity Index (IKEP) at station 1 was 79.16% at stations 2 and 3, which was 80.55%, while at station 4 it was 86.11%. The value of the Turtle Ecotourism Conformity Index (IKEP) on Tikus Island which is included in the very appropriate category (S1). The suitability of turtle ecotourism, namely >75-100% is said (very suitable), 50-75% is (appropriate), <50% (not suitable).

So that the suitability index of turtle ecotourism on Tikus Island turtle conservation at stations 1 to 4 is in the very appropriate category.

Based on the results of the analysis of the carrying capacity of the turtle ecotourism area on Tikus Island, Bengkulu City, it can be seen in Table 3.

**Table 3.** Value of area carrying capacity

No	Carrying capacity (people/day)
1	60

Based on the analysis of the carrying capacity of the turtle ecotourism area on Pulau Tikus, it is known that the carrying capacity value is 12 people/trip. The area used at this conservation location is 6,000 m<sup>2</sup> and the area of a certain unit (Turtle Ecotourism) is 500 m<sup>2</sup>. The conservation party gives 10 hours to do activities in the conservation area with each visit trip given a maximum of 2 hours, if it is calculated, it means that in a day the ecotourism manager gets 60 people/day or 5 visits per day.

The Regional Carrying Capacity (DDK) concept is the maximum number of visitors that can be physically placed in a certain time zone without compromising the ecotourism zone. Yulianda (2007) in Muflih (2019). This means that the maximum number of visitors that can be visited per day is only 60 people with a display of 12 people / 2 hours. Meanwhile, in its implementation, the conservation manager for Tikus Island has not set limits for visiting tourists. This results in if the tourists who visit exceed the capacity, it will have an impact on conservation itself.

### Impact of Ecotourism Development in Conservation Areas

Conservation can be defined as maintaining or preserving the carrying capacity, quality, function and capacity of the environment in a balanced way (Harnino et al., 2021). The historical context and contribution of nature conservation are discussed as closely as possible to increase revenue for tourist sites without disrupting conservation programs (Wanda, 2016). Turtle conservation includes considerable efforts to protect turtles from extinction from various threat factors such as hunting). According to Effendi (2019), efforts to protect turtles must be carried out to minimize the decline in turtle populations, especially in the waters of Pulau Tikus.

Turtle conservation aims to keep the turtle regeneration process running normally. Turtles that live in Indonesian waters are protected by Law Number 5 of 1990 concerning Protection of Biological Natural Resources and Their Ecosystems, Government Regulation Number 7 (PP) of 1999 concerning Protection of Plant and Animal Species, Government Decree Number 8 of 1999 (PP) concerning use of wild plants and animals.

The development of turtle ecotourism still needs to pay attention to the function of conservation areas. Visitors waiting for turtles to come ashore can also lay their eggs on disturbed turtles. Partnerships are required between social groups, government, private sector or organizations interested in environment and protected area management.

Increase community participation in management organizations as a form of acknowledgment of joint efforts in conserving nature, preserving the environment, and optimizing protected areas. Efforts to achieve the goals of ecotourism development, there is a need for ecotourism planning that considers ecotourism market demand, impacts on the environment, and location design that considers tourist comfort, but does not cause side effects on the environment (Mirsanjari, 2012).

The development of nature-based tourism (ecotourism) has also been regulated in Permendagri No. 33 of 2009 concerning Guidelines for Regional Ecotourism Development. Permendagri No. 33 of 2009 has the principle that ecotourism development can occur in a conservation process, to encourage people to become drivers of economic development, raise public awareness of the environment, increase community satisfaction, increase community roles in planning, use and control ecotourism, and accommodate local wisdom.

Ecotourism can be viewed from three perspectives, namely: ecotourism as a product, ecotourism as a market, and ecotourism as a development approach (Arida, 2017). Based on the results of research that has been carried out by (Muhiddin, 2010) it is found that population structure, social institutions, norms and customs as well as cooperation between communities do not have an impact, marine ecotourism activities have a positive impact on the economic conditions of local communities in the form of increasing employment, income expenditure and the production and development assets of marine ecotourism do not have an impact on the condition of the house and household assets.

Ecotourism also means involving local communities in the process and they can derive socio-economic benefits from the process. In the development of ecotourism, coral reef ecosystems are one of the priorities for the development of turtle ecotourism. Tourists who come are expected to be interested in the process or life cycle of turtles, for example how to lay eggs, how to clean the shells to how the hatching process is and in the final stage tourists will enjoy releasing hatchlings or turtle chicks.

## CONCLUSIONS

Based on the results of the research conducted, it was found that Tikus Island has the potential to be used as turtle ecotourism, with a value range of the Turtle Ecotourism Conformity Index 79.16% - 86.11%. The turtle ecotourism suitability index (IKEP) on Tikus Island is included in the very appropriate category. The calculation results for the carrying capacity of the area can produce a maximum of 60 people per day.

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