

Population and Habitat Characteristics of the Saltwater Crocodile (*Crocodylus porosus*, Schneider 1801) in the Antan River, Jebus-Parittiga District, West Bangka
[Populasi dan Karakteristik Habitat Buaya Muara (*Crocodylus porosus*, Schneider 1801) di Sungai Antan, Kecamatan Jebus-Parittiga, Bangka Barat]

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ABSTRACT

Saltwater crocodile (*Crocodylus porosus*) is the largest and longest crocodylian species in the world. The increasing human activities along river have been caused habitat degradation in watersheds. On the other hand, the crocodile population may have increased after decades of protection. Rivers that are habitat for crocodiles and have increased human occupancy have led to increase conflicts with crocodiles. This increasing cases requires the management authorities to immediately issue policies based on scientific data. Population data and habitat characteristics of saltwater crocodiles in the Bangka Belitung Islands are not yet available. The research with the aim to know the population condition and habitat characteristics of the saltwater crocodile in the Antan River, Bangka Belitung Islands, was conducted using visual encounter survey method along 5 km. Observations were made in three time periods, namely morning, afternoon, and evening with 8 repetitions per period. Population were analyzed using the encounter rate formula, while the habitat characteristics were described descriptively. During the research, we only found one adult and this individual was sighted in the morning, afternoon and evening. This study also confirms that crocodile surveys should be conducted at night. The encounter rate at the study site was 1.13 individu/km. This value indicates that the population is small. The habitat type in the Antan river is a mangrove ecosystem with a depth of around 2.55 meters, water brightness 38.6%, water temperature 29.18°C, salt content 0.89%, and water pH 6.09. Although only one adult individual is found, it requires attention because in general conflict cases occur in adult individuals.

Keywords: antan river, habitat, population, Saltwater crocodile

ABSTRAK

Buaya muara (*Crocodylus porosus*) merupakan jenis buaya yang terbesar dan terpanjang di dunia. Peningkatan aktivitas manusia di sepanjang sungai telah mengakibatkan degradasi habitat di daerah aliran sungai. Di sisi lain, populasi buaya kemungkinan telah meningkat setelah puluhan tahun dilindungi. Sungai yang menjadi habitat buaya dan mengalami peningkatan okupansi manusia telah menimbulkan peningkatan konflik-konflik dengan buaya. Peningkatan kasus ini menuntut pihak otoritas manajemen untuk segera mengeluarkan kebijakan yang berbasis pada data ilmiah. Data populasi dan karakteristik habitat Buaya muara di Kepulauan Bangka Belitung belum tersedia. Penelitian dengan tujuan untuk mengetahui kondisi populasi dan karakteristik habitat Buaya muara di Sungai Antan kepulauan Bangka Belitung ini dilakukan dengan menggunakan metode visual encounter survei sepanjang 5 km. Pengamatan dilakukan dalam tiga periode waktu yaitu pagi, sore, dan malam dengan ulangan sebanyak 8 kali per periode. Data populasi dianalisis dengan rumus tingkat perjumpaan, adapun karakteristik habitat digambarkan secara deskriptif. Selama penelitian dilakukan hanya dijumpai satu individu dewasa dan individu ini dijumpai baik pagi, sore maupun malam. Penelitian ini juga memperkuat bahwa survei buaya sebaiknya dilakukan pada malam hari. Tingkat perjumpaan populasi buaya di lokasi penelitian adalah 1,13 individu/km. Nilai ini mengindikasikan bahwa populasi buaya kecil. Tipe habitat buaya di Sungai Antan merupakan ekosistem mangrove dengan kedalaman berkisar 2,55 meter, kecerahan air 38,6%, suhu air 29,18°C, kadar garam 0,89%, and pH air 6,09.

Kata Kunci: buaya muara, habitat, populasi, Sungai Antan

INTRODUCTION

Crocodiles are a group of reptiles that use two habitats, land and water, breathe with lungs and are cold-blooded (Saputro *et al.* 2020). In Indonesia, there are five species belong to Crocodylian species (*Crocodylidae* family) *Tomistoma schlegelii*, *Crocodylus porosus*, *Crocodylus siamensis*, *Crocodylus novaeguineae* and *Crocodylus halli* (Stuebing *et al.* 2006; Saputro *et al.* 2020; Uetz *et al.* 2022). Based on the Minister of Environment and Forestry Regulation Number P.20/MENLHK/SETJEN/KUM.1/6/2018, all these species are protected by law in Indonesia, so that their use must be authorized by the Indonesian Minister of Forestry (Kurniati 2018; Murray *et al.* 2019). Adult male of Saltwater crocodile can grow to a length of up to 6 m, while females rarely surpass 3 m (Webb *et al.* 2010; Britton *et al.* 2012).

Saltwater crocodile spread throughout Indonesian waters from Sumatra Island to Irian Jaya Island (Webb *et al.* 2010; Ripai & Kamarubayana 2016; Winarno & Harianto 2018). Saltwater crocodiles have inhabits coastal areas, especially in mangrove forests, rivers, lakes, wetlands (swamps) and other types of waters (Webb *et al.* 2010; Das 2015; Winarno & Harianto 2018). This species has a high adaptation to water salinity, so they can live in high salinity water such as sea water to fresh water in the upstream part of the river (Kurniati 2008). This adaptation ability plays an important role for its survival (October 2019).

Based on the IUCN red list, the conservation status of the Saltwater crocodile is included in the category of Least Concern (LC) and listed in Appendix II of CITES for Indonesia, Malaysia, Australia, Papua New Guinea population (Setio *et al.* 2010). The existence of Saltwater crocodile populations in nature can be threatened by continuous habitat destruction, reduced natural food, illegal hunting and crocodile conflicts (Ripai & Kamarubayana 2016; Oktaberi 2019). Damaged habitats are the cause of Crocodile conflicts with humans that often occur in the Bangka Belitung Islands, such as opening new land for tin mining in watersheds. West Bangka

Regency is a tin producing area in the Bangka Belitung Islands. One of the areas where tin mining centers are located in West Bangka Regency is the Antan river.

As is the case with mangrove habitat which is inhabited by various marine fauna (Heryanto & Radjab 2014; Heryanto 2018), the Antan area is a tidal brackish river as well as a mangrove area which is one of habitat of various land and marine faunas, including Saltwater crocodile (*Crocodylus porosus*). The Antan river itself circled by a forest area of 8,575 hectares. The records about relative density of the Saltwater crocodile population in the Bangka Belitung Islands is not available. Therefore, it is necessary to conduct continuous research to determine the relative density of the population and the characteristics of the Saltwater crocodile habitat so that it can be used to support for decision making in the context of wildlife management.

MATERIALS AND METHODS

This research was conducted in January – February 2022 along 5 km of Antan river, Jebus - Parittiga District, West Bangka, Bangka Belitung Islands Province (Figure 1). We conducted the surveys using visual encounter survey method, the sampling were conducted every once a week during January - February. Observations were started from the upstream to the downstream of the river and observation time is divided into morning (07.00 - 10.00), afternoon (13.00-16.00), and night (20.00-23.00).

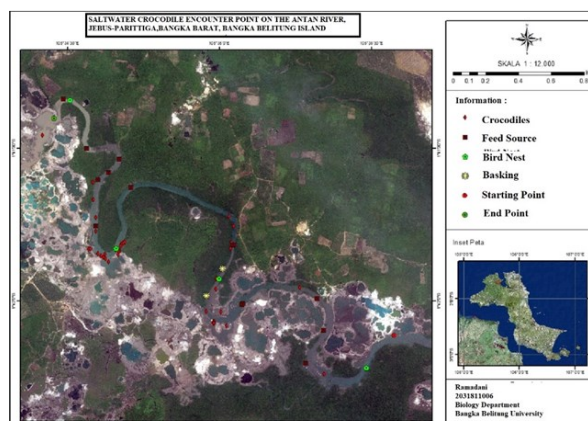


Figure 1. Saltwater crocodile encounter point on the Antan river, Jebus-Parittiga, Bangka Barat, Bangka Belitung island.

We estimated Crocodiles size by photograph documentation, and categorized into hatchlings (H) (estimated size are less than 50 cm, juveniles (J) (estimated sized between 50 cm to 150 cm, and adults (A) (more than 150 cm) (Kurniati 2018). We recorded the nests, footprints, basking areas and habitat characteristics. The microclimate data of river waters (water depth, water brightness, water temperature, pH, salinity, weather at the time of observation) were recorded in the field. We also recorded animals found in the habitat that potentially become prey for Crocodile (Fukuda *et al.* 2013).

The data were analyzed using the encounter rate formula:

$$Encounter\ rate = \frac{Number\ of\ crocodiles\ counted}{Survey\ distance\ (km)}$$

The final density of crocodilian was obtained from the average of encounter rate in every observation.

RESULTS

Population

The result from the observations in the morning, afternoon, and evening (8 repetitions per period) show that only one adult individual was encountered during the survey (Figure 2). However, from the night survey, 3-10 individuals were found (Table 1). The average of encounter rate f all observations during January-February 2022 is 1.13 individuals/km. This indicates a low density value.

Linear regression of the relationship of three different times with the emergence of Crocodiles that continues to increase, where the

Table 1. Number of individual stages detected in three different observation time during January to February 2022.

Observation date	Observation time												Total individual	Average observed	Mileage (km)	Encounter rate
	(replication)															
	Morning				Afternoon				Night							
H	J	A	EO	H	J	A	EO	H	J	A	EO					
09 January 2022	0	0	1	0	0	0	0	0	2	1	0	6	10	03:33	5	0,296528
16-Jan-22	0	0	0	0	0	0	0	0	0	1	0	3	4	01:33	5	00:27
23 January 2022	0	0	0	0	0	0	0	0	0	1	0	4	5	0,088194	5	00:33
30 January 2022	0	0	1	0	0	0	1	0	1	4	0	2	9	3	5	00:06
06 February 2022	0	0	0	0	0	0	1	0	1	0	0	2	4	01:33	5	00:27
13 February 2022	0	0	0	0	0	0	0	0	0	0	1	2	3	1	5	00:02
20 February 2022	0	0	0	0	0	0	0	0	1	3	0	4	8	0,129861	5	00:53
27 February 2022	0	0	0	0	0	0	0	0	1	0	0	2	3	1	5	00:02

Remarks: H: Hatchling, J: Juvenile, A: Adult, and EO: Eyeshine only

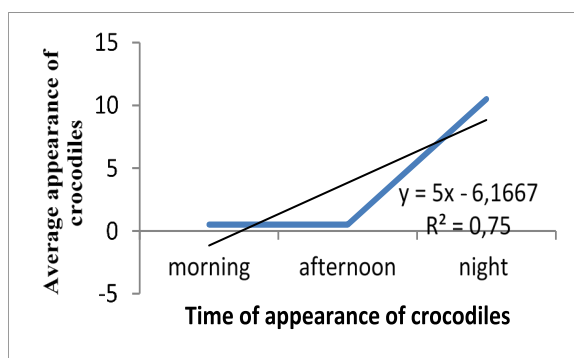


Figure 2. Linear regression of the average appearance of Saltwater crocodiles in different observation time.

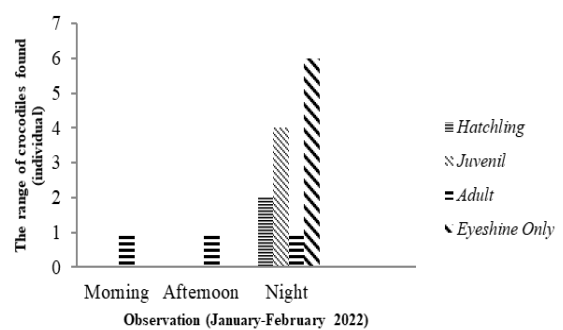


Figure 3. Appearance of Saltwater Crocodiles in the Antan river in Januari to February 2022

Table 2. The Average value of microclimate measurements in the Antan River in Januari-February 2022

Time	Water depth (m)		Water brightness (%)	Water temperature (°C)	Salinity (%)	pH	Weather
	Hight tide	Low tide					
Morning	2.55	-	43.87	29.5	1.35	5.98	Rain
Afternoon	-	1.31	33.33	29.5	0.74	6.22	
Night	-	1.20	-	28.5	0.57	6.08	
Average	2.55	1.25	38.6	29.16	0.88	6.09	

value of $y = 5x - 6.1667$ is obtained. This graph has represented 75% of the data as evidenced by the R2 value which reached 0.75. Crocodile emergence is more dominant at night (Figure 3).

Microclimate

The results of the average measurement of microclimate conditions in the Antan river from each parameter measured in observations from January to February 2022, the depth of river water at high tide is 2.55 m and at low tide 1.25 m, water brightness is 38.6 %, water temperature 29.16°C, water salinity 0.88%, and water pH 6.09 (Table 2). The weather at the time of observation are raining.

Vegetation

Based on our observations of vegetation along the river bank was dominated by *Rhizophora apiculata* and *Sonneratia alba*. The other vegetation associated to this ecosystem was recorded i.e. *Acrostichum aureum*, *Nypa fruticans*, *Pandanus* sp. and *Melaleuca cajuputi*.

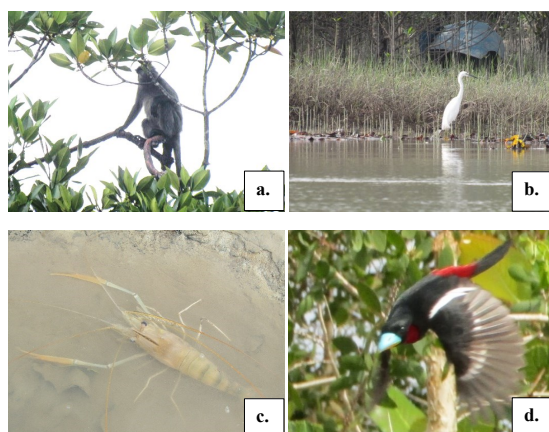


Figure 4. a) Silvered Leaf Monkey (*Trachypithecus cristatus*), b) Great egret (*Egretta alba*), c) The Giant River Prawn (*Macrobrachium rosenbergii*), and d) Black-and-red Broadbill (*Cymbirhynchus macrorhynchos*)

Potential Preys

Several animals were observed during observation and mapped in Figure 1. These animals are Crab-eating macaque (*Macaca fascicularis*), Silvered Leaf Monkey (*Trachypithecus cristatus*), Great egret (*Egretta alba*), Black-and-red broadbill (*Cymbirhynchus macrorhynchos*), Black-capped king-fisher (*Halcyon pileata*), The giant river prawn (*Macrobrachium rosenbergii*) (Table 3) and (Figure 4).

DISCUSSION

Relative Density of Saltwater Crocodile Population

Based on observations that have been made during the morning, afternoon, and evening survey periods with eight repetitions per period. the results in (Table 1) show that only one adult individual was encountered during the survey. However, from the night survey, 3-10 individuals were found, namely hatchling crocodiles, juveniles and eyesshine only. The average relative population density of all observations during January-February 2022 is 1.13 individuals/km. This indicates a low density value and also not much different from the research of Oktaberi (2019) which total number of Saltwater crocodiles encountered is 27 individuals, while the average value of the

Table 3. River species and frequency detected as potential prey for Saltwater Crocodiles in the Antan River during January to February 2022.

<i>Macaca fascicularis</i>	8	Often found
<i>Trachypithecus cristatus</i>	5	Often found
<i>Egretta alba</i>	14	Often found
<i>Cymbirhynchus macrorhynchos</i>	2	Rarely found
<i>Halcyon pileata</i>	3	Rarely found
<i>Macrobrachium rosenbergii</i>	-	Often found

relative density of Saltwater crocodiles is 1.08 individuals/km. The difference in the number of individual Saltwater crocodiles in each observation is due to differences in the times of tidal river water (Oktaber 2019).

According to Fukuda *et al.* (2013) the influence of the rainy season, minimum temperature, and the availability of wetlands with good vegetation can have a strong influence on the presence of Saltwater crocodiles. Several other factors also affect the appearance of Saltwater crocodiles including the level of fear of Saltwater crocodiles against human presence, community tin mine (TI) machine activities that cause noise around the river area so that Saltwater crocodiles will enter the water if the sound of boat engines is heard during the day, while at night observations the crocodile is relatively calm but hides in the bushes along the riverbank. Aziz & Islam (2018) stated that the continuous transportation of large cargo ships on the river route can interfere with the presence of Saltwater crocodiles.

Saltwater crocodiles are animals that are active at night (Majid 2009; Webb *et al.* 2010) so crocodiles are often found at night when the moon is dark. However, this also makes it difficult to predict the size because the crocodiles usually can be seen only show the head and eyes. Adult crocodiles were oftenly observed during the morning and afternoon (Figure 5), while hatchlings and juveniles were more common at night. Aziz & Islam (2018) stated that adult individuals are common observed during the day (93%) than at the night. This is likely related to foraging behaviour of adult crocodile where most of potential prey active during the day along the river bank. Most hatchlings and juvenile individuals are oftenly observed at the night to avoid predator. Based on Figure 5, linear regression of the relationship of three different times with the emergence of crocodiles which continues to increase, which is obtained by the value of $y = 5x - 6.1667$. This graph has represented 75% of the data as evidenced by the R2 value which reached 0.75.

Habitat Characteristics

The description of crocodile habitat was

carried out by measuring the microclimate, the condition of the river bank vegetation, and observing wildlife as a potential source of food (prey). Environmental and anthropogenic factors (temperature, vegetation structure, altitude, rainfall, salinity, land use composition, prey availability, human population density and human settlement) can influence saltwater crocodile habitat use (Fukuda *et al.* 2008; Rich *et al.* 2016; Mazzotti *et al.* 2019).

Based on the average microclimate measurements (Table 2), the water depth of the Antan River at high tide is 2.55 meters and at low tide is 1.25 meters. This low depth level is possibly related to the accumulation of *tailing* (excavated material in the form of sand or gravel) in the river. The water brightness of the Antan river is only 38.6%, factors that affect the brightness of the water in the Antan river are tin mining activities in the river so that the water becomes cloudy. The temperature of the river water is relative stable 29.16°C (Majid 2002). The water salinity of the Antan River has a value of 0.88‰ and this value is low, because the starting point of the observation path is a point close to a freshwater resource. The Saltwater crocodiles are often found in a narrow river with low salinity. According to Aziz & Islam (2018), there is no significant relationship between the presence of crocodiles and the level of water salinity. However, there are records that low water salinity levels and proximity to human settlements have a major impact on the activity and population density of more Saltwater crocodiles (Gramentz 2008; Aziz &

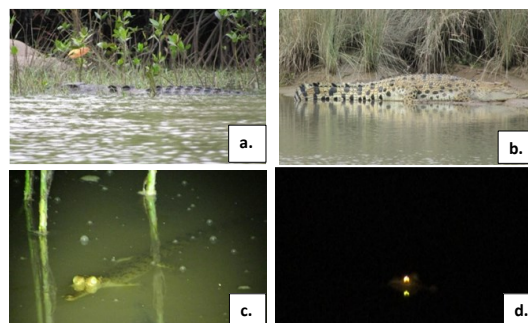


Figure 5. Types of individual sizes of Saltwater crocodiles: (a) adult, (b) juvenile, (c) hatchling, and (d) eyesshine only.

Islam 2018). The pH value recorded in the Antan river is 6.09. This pH level of the Antan river water is acidic. Affresia *et al.* (2017) stated that a neutral pH value can support the life of aquatic biota, but only some aquatic animals are sensitive to changes in water pH. The presence of saltwater crocodile here can be assumed that this animal has well adapted for decades to changes in the pH of river water due to tin mining activities.

Vegetation structure is an important component for the survival of animals, including Saltwater crocodiles. Mangrove vegetation is considered a poor nesting habitat for Saltwater crocodiles (Evans *et al.* 2017). However, we found an interesting phenomenon that contradicts to that statement. We encountered non-active nests located on riverbanks with mangrove vegetation. The inventory on the potential prey was presented in (Table 3). These species (Figure 4) a source of food for Saltwater crocodiles in the Antan river. According to Majid (2009), prey of saltwater crocodiles are in fishes, turtles, and other animals that live in rivers. Crocodiles are known as carnivores, meat eaters, so the crocodiles are not too picky to type of prey (Majid 2009), but the type of crocodile prey depends on the size of the crocodile itself. Hatchlings depend on the availability of invertebrates and small fish, juveniles eat crabs and shrimps, while adults eat large animals such as mammals and birds including livestock and humans (Grigg & Krishner 2015; Sivaperuman 2015; Adame *et al.* 2018). Based our observation above, the mangrove habitat of Antan river is a place that important for Saltwater crocodiles to foraging, build nest, and shelter from other threats and dangers.

CONCLUSION

Saltwater crocodile in Antan river are low in population, whereas only single adult individual was found in all observation periods. The mostly observed individuals are from hatchling, juvenile, and eyeshine only. The encounter rate during observations in January - February 2022 is 1.13 individuals/km. The habitat type is a mangrove ecosystem with a

microclimate and abundant food sources that still suitable for Saltwater crocodiles.

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