

The potential of Mesangat Lake, East Kutai, Indonesia as an essential ecological area for habitat conservation of critically endangered *Crocodylus siamensis*

SUDRAJAT^{1,*}, HIKMA AMALIA SALEH^{2,3}

¹Laboratory of Ecology and Biodiversity, Faculty of Mathematics and Natural Sciences, Universitas Mulawarman. Jl. Barong Tongkok, Gunung Kelua, Samarinda 75242, East Kalimantan, Indonesia. Tel.: +62-541-749140, *email: sudrajat.fmipa@gmail.com

²Department of Environmental Science, School of Graduates, Universitas Mulawarman. Gunung Kelua, Samarinda 75242, East Kalimantan, Indonesia

³The Office of Environmental Service, East Kutai District Government in Sangatta. Jl. Pertanian, Teluk Lingga, Sangatta Utara, East Kutai 75683, East Kalimantan, Indonesia

Manuscript received: 20 September 2019. Revision accepted: 7 October 2019.

Abstract. Sudrajat, Saleh HA. 2019. The potential of Mesangat Lake, East Kutai, Indonesia as an essential ecological area for habitat conservation of critically endangered *Crocodylus siamensis*. *Biodiversitas* 20: 3126-3133. The Siamese crocodile, *Crocodylus siamensis*, is one of the most threatened reptile species in the world with IUCN Red List status of Critically Endangered. This study aims to investigate and assess the biogeophysical conditions of Mesangat Lake area, East Kutai District, East Kalimantan Province, Indonesia as an essential ecological area for *C. siamensis* conservation outside biodiversity conservation areas. Data was collected through direct survey using spotlight technique at night, tracking, observation and interviews with local fishermen. The results showed that the biogeophysical conditions of Mesangat Lake habitat in Long Balau, Loah Toh and Abang areas still support *C. siamensis* population which was marked by the presence of its nests and the occurrence of 17 individuals with sizes between 30 and 50 cm in length. Habitat conditions in the form of lake waters had depths between 30-110 cm, low currents, and covered with aquatic plant species for resting, nesting and basking, as well as contained sufficient diversity of fish and other prey. A nest was also found in the form of mound of plants measuring ± 45 cm high and ± 75 cm wide which contained 20 eggs with an average length of ± 8.45 cm, an average width of ± 4.9 cm. Potential factors that threaten *C. siamensis* habitat included siltation of water bodies caused by invasive weeds, over-exploitation of fishes and conversion of lake land into plantations and/or agriculture lands. Based on the results of this study, it can be stated that Mesangat Lake has the potential to be designated as an essential ecological area of *C. siamensis* habitat. Through this strategy, it is hoped that there will be good collaboration between local government and concession rights holders, NGOs and local communities to participate in the conservation of *C. siamensis*. In the area of the lake, zoning can be classified into areas of nesting, closed areas, playing and sunbathing, limited fishing, recreation.

Keywords: Essential ecological areas, *Crocodylus siamensis*, East Kalimantan, habitat, Mesangat Lake, utilization zones

INTRODUCTION

Siamese crocodile, *Crocodylus siamensis*, is a medium-sized freshwater crocodile with the males usually measuring of 3.5 m long and females of 2.5 m (Crocodile Specialist Group 2013). *C. siamensis* is one of the most threatened crocodile species in the world. In 1992, Thorbjarnarson reported that this animal was declared as endangered in the wild and since 1996 it was listed under the International Union for Conservation of Nature and Natural Resources (IUCN) Red List Status as 'Critically Endangered' (Simpson and Bezuijen 2010). At present, significant wild populations are known to exist in Cambodia and Kalimantan. In small number, there are scattered remnant populations found in several parts of Laos. In Vietnam and Thailand, *C. siamensis* is considered extinct in the wild. In Cambodia, Platt et al (2006) reported that *C. siamensis* still exists and remains in fragmented locations. Siamese crocodiles are found in a variety of freshwater habitats, including rivers, lakes, swamps. In Indonesia, the conjoined species of *C. siamensis* spread at first in the islands of Java and Kalimantan. According to

Thorbjarnarson (1992), its existence in Indonesia is stated as being almost extinct. Cox et al.(1993), conducted a study and found that *C. siamensis* still exists in Mesangat Lake, Muara Ancalong Sub-district, East Kutai District, East Kalimantan Province, Indonesia. Since Cox's discovery, Mesangat Lake was later included in the IUCN map as a habitat for Siamese crocodiles. In 1996, the Siamese crocodile species (*C. siamensis*) was declared as Critically Endangered category by IUCN.

During the last decade, the results of studies on the ecology of *C. siamensis* have begun to be widely publicized although this crocodile is less widely known. Ihlow et al. (2014) reported that the number of *C. siamensis* was estimated to the global population be less than 1,000 adult individuals in the wild. Crocodile skin trading activities and the search for crocodile tillers to be farmed in the mid and the late 20th century were considered as the main cause of its population decline. At present the threats still exist, including illegal egg collection, land conversion so that the habitat is lost or narrowed, incidental capture by the community and the vulnerability of the remaining population due to the small numbers, indicating that

without intervention in conservation efforts, the crocodile population conjoined will continue to decline.

Staniewicz et al. (2018) reported that in Mesangat Lake region, there are two types of crocodiles protected and their life is sympatric, namely *C. siamensis* and *C. tomistoma* in their juvenile stage. This sympatric nature is characterized by different ecological niches to minimize competition between species. Based on the comparison of habitats and the analysis of the contents of stomach, it suggested that *C. tomistoma* Schlegelii was found mostly in flooded forest areas, while *C. siamensis* mainly lived in open areas.

All the remaining small and fragmented subpopulations are threatened by illegal collection, conversion of lakes into plantations, mining and other activities, and overfishing by local communities. Without conservation intervention, the remaining population will continue to decline. Lack of information regarding this species has an impact on determining the right conservation strategy. On the other hand, the rapid expansion of plantations, settlements, mining, and other activities and the ignorance of conservation principles increasingly threatens the preservation of the habitats of Siamese crocodiles. Therefore, there is a need for study on conservation areas

outside the nature protection areas determined by the government. Until now, information regarding the habitat of *C. siamensis* is still not widely known.

The purpose of this study is to investigate the biogeophysical conditions of Mesangat Lake as a habitat for *in situ* conservation of *C. siamensis*, population distribution, supporting factors and activities that can threaten its survival. The results are expected as a reference and consideration for management actions of Mesangat Lake as an ecological essential area that can support the sustainability of the *C. siamensis* in their habitat in collaboration with the society.

MATERIALS AND METHODS

Study location

Mesangat Lake is located in Long Mesangat Sub-district, East Kutai District, East Kalimantan Province located between 00°30'07" North and 116°41'54" East (Figure 1). The lake covers an area of 18,500 hectares, located between the Kelinjau River and Telen River.

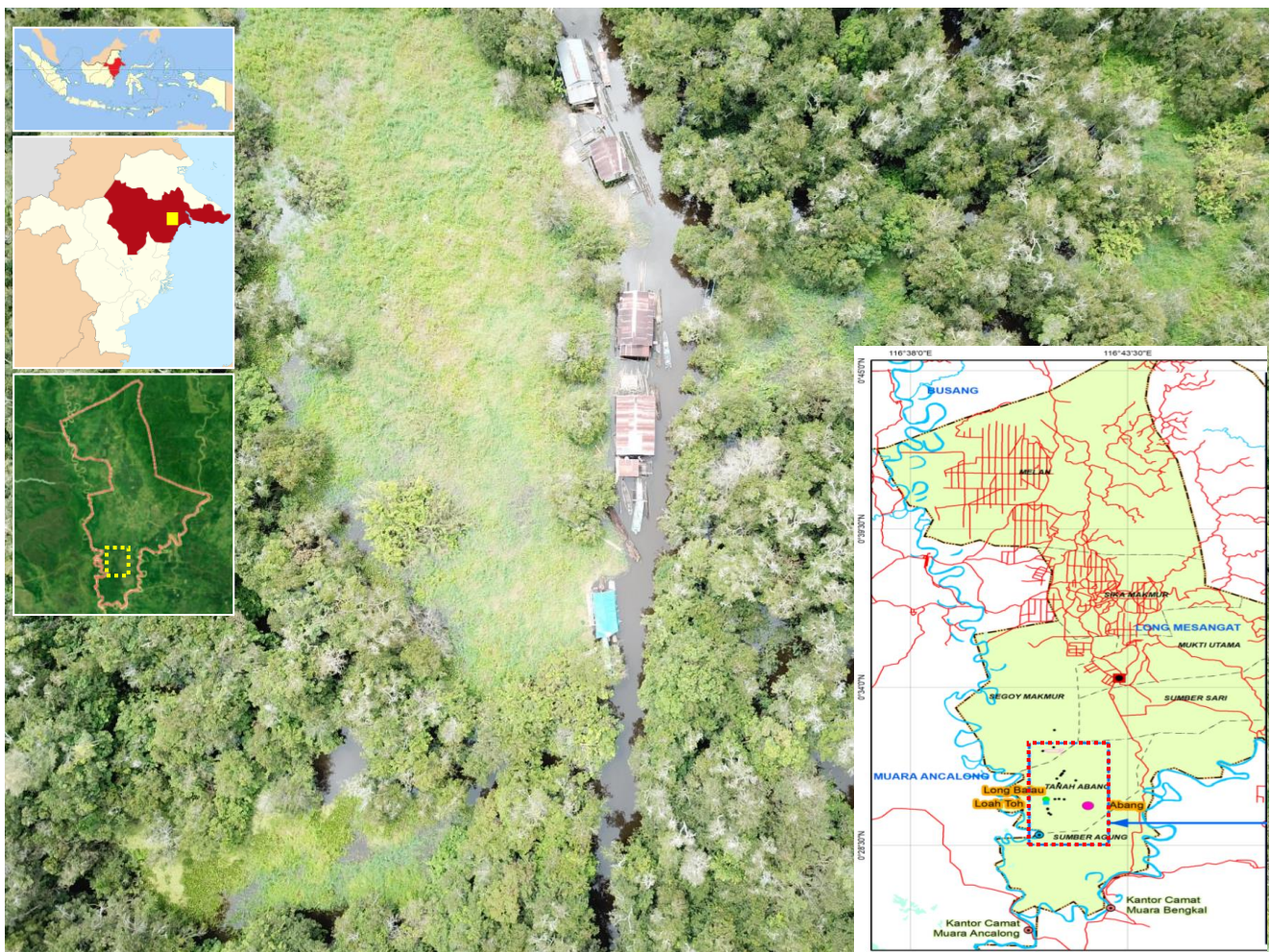


Figure 1. Location of study sites in the Mesangat Lake, Subdistrict of Long Mesangat, East Kutai District, East Kalimantan Province, Indonesia. Aerial photograph of Mesangat Wetland Area taken from Ulin Foundation, Samarinda, Indonesia

Field survey

The survey to investigate crocodile habitats was conducted between October and December 2018 during the day by walking and on boats. The survey to seek the presence of crocodiles was carried out using night spotlight technique on wooden boat equipped with a diesel outboard motor. Following the method carried out by Savini et al. (2012), the crocodiles that were caught were measured and released again. Data on the existence of crocodiles, plant species and geographical coordinate locations were recorded to create distribution maps. Environmental data of the habitat were collected from related institutions, including geological, climate, land cover, hydrological and land use data.

RESULTS AND DISCUSSION

Biogeophysical characteristics of *Crocodylus siamensis* habitat

Mesangat Lake is a lake or basin of swamp waters, in local languages, it is called *Kenohan* or *Long*. The lake is connected by small rivers to the main river, the Kelinjau River and the Kedang Kepala River. This lake is made up of riparian, lowland forests, swamps, swamps and lakes that form one unit. There are 3 (three) rivers namely the Mesangat, Senyun, and Sekgoy Rivers. The river on the left is the Sekgoy River, in the middle is the Mesangat River and on the right the Senyun River. To the left and right upstream of the Mesangat River are lowland forests dominated by Rattan and other shrubs and there are streams such as Long Putu, Long Saka.

The topography of the lake is flat with an altitude of 0-20 m above sea level (m asl.). The dry season lasts from June to October and the rainy season occurs from November to May. The average daily temperature is 26.3°C, with the highest average temperature of 32.5°C and the lowest average temperature of 23.0°C (Table 1). The water level varies throughout the year, ranging from 31 to 381 cm depending on the season. The lake's geological formation consists of quarterly alluvium deposits on the edge of the lake and the surrounding large river. The rock structure is composed of clay, silt, sand, and gravel, which are not yet integrated.

The pattern of river flow is dendritic and water flows at a slow speed because the river's body is meandering, causing inundation to occur in low areas. Lake water level is influenced by river inlet water discharge and direct rainfall to the surface of the lake does not result in rising water levels. This area has the highest tide and tide area of almost 4 meters and is highly dependent on the waters upstream of the lake (i.e. Sekgoy, Mesangat, and Senyun Rivers).

The land cover in Mesangat Lake consists of swamp forests, swamp shrubs, oil palm plantations and aquatic floating vegetation (Figure 2). Based on land use, the entire Mesangat Lake area is in the status of other use areas (*area penggunaan lain*) and most of them are within the concession of PT. Cipta Davia Mandiri (CDM), a subsidiary of PT. REA Kaltim Oil Palm Plantations Group.

Assessment of the existence of *Crocodylus siamensis* and its habitat preferences

From all observations of crocodiles in Mesangat Lake, 19 objects were found, consisting of 31% identified as *C. siamensis* measuring between 30 to 50 cm in length, 15% as *Tomistoma schlegelii* and the rest could not be identified or only the eyes, "Eyes Only" (EO). Siamese crocodiles like a lot of bright areas, on the edge of a stretch of water hyacinth, *Eichhornia crassipes* (eceng gondok). The results of the study are presented in Table 2 and Figure 3.

Based on the data in Table 2, it can be seen that *C. siamensis* found were in the level of hatchlings (adolescents) with size of 30-60 cm in length. Adult crocodiles were not found which is likely caused by a narrow and shallow range of movement in the lake. *C. siamensis* hatchlings preferred to hide under aquatic plants such as *E. crassipes*, *Salvinia molesta* (kiyambang, water spikes) and *Ipomoea* sp. (kangkung). In terrestrial vegetation environment, hatchlings were found predominantly among *Hanguana malayana* (bakung), sometimes were also found between *Hypolytrum nemorum* (selingsing) and *Scleria sumatrensis* (predang, Sumatran scleria). The location of habitat with the presence of *C. siamensis* was in Long Balau, Loah Toh and Abang. *C. siamensis* likes open areas full of direct sunlight, with dense floating plant communities.

Table 1. Climatic conditions in the area around Mesangat Lake, East Kalimantan, Indonesia in the period of 2008-2018

Month	Intensity rainy (mm)	Day rainy (day)	Temperature (°C)			Humidity (%)	Wind speed (Knot)	Wind rose
			Max	Min	Mean			
January	220	13	34.5	21.5	26.6	86.0	4.0	NW
February	263	11	33.3	22.5	24.4	94.0	4.0	NE
March	272	12	33.9	20.9	26.0	89.0	3.0	SW
April	312	14	32.8	23.2	25.8	85.0	4.0	E
May	275	15	33.0	23.3	27.0	87.0	3.0	SW
June	275	11	32.1	23.4	26.9	83.0	3.0	SW
July	106	10	32.8	23.3	26.5	84.0	3.0	SW
August	105	10	31.5	23.4	26.2	86.0	3.0	SW
September	137	11	31.9	23.8	26.9	83.0	3.0	S
October	156	10	31.5	23.4	26.2	86.0	3.0	SW
November	283	12	32.2	23.6	26.8	85.0	3.0	W
December	274	11	30.0	23.6	26.0	85.0	5.0	W
Total	2678	140	-	-	-	-	-	-
Mean	223	12	32.5	23	26.3	85.8	3.4	-

Note: The Office of Agriculture Service, East Kutai District Government in Sangatta 2018



Figure 2. Vegetation types in Mesangat Lake, East Kalimantan, Indonesia. A. *Lophopetalum javanicum* (perupuk), B. *Hanguana malayana* (bakung), C. *Eichhornia crassipes* (eceng gondok), D. *Leersia hexandra* grass

Tabel 2. The distribution of *Crocodylus siamensis* in Mesang Lake, East Kalimantan, Indonesia in 2018

Code	Time	Body length (cm)	Coordinate		Location	Water depth (cm)	Aquatic plants that dominate
			East	North			
TS001	19.50	30	116°41'45.77"	0°30'05.55"	Border to Abang	30	<i>Hanguana malayana</i> , <i>Ipomoea</i> sp., <i>Salvinia molesta</i> , <i>Scleria sumatrensis</i>
TS 002	20.05	30	116°41'42.57"	0°30'49.05"	Long Balau (Folden)	100	<i>Gluta renghas</i> , <i>Lophopetalum javanicum</i>
CRO001	21.12	36	116°41'42.28"	0°30'45.37"	Long Balau (Bakungan)	100	<i>L. javanicum</i> , <i>H. malayana</i> , <i>S. molesta</i>
ES 001	19.35	36	116°41'49.62"	0°30'58.07"	Long Balau (Kepala Segoi)	85	<i>L. javanicum</i> , <i>S. sumatrensis</i>
CRO002	21.00	36	116°41'51.44"	0°31'00.03"	Long Balau (Kepala Segoi)	75	<i>L. javanicum</i> , <i>Gluta renghas</i> , <i>S. sumatrensis</i>
CS 001	22.15	40	116°41'53.47"	0°31'04.95"	Long Balau	75	<i>H. malayana</i> , <i>Eichhornia crassipes</i> , <i>S. molesta</i>
ES 002	20.00	40	116°41'53.21"	0°31'04.52"	Long Balau	90	<i>H. malayana</i> , <i>S. molesta</i> , <i>E. crassipes</i> , <i>Cyclosorus interruptus</i>
CS 002	22.05	40	116°41'28.72"	0°29'46.39"	Loah Toh	75	<i>C. interruptus</i> , <i>S. sumatrensis</i> , <i>E. crassipes</i>
CS 003	24.30	45	116°41'39.59"	0°31'43.96"	Loah Toh	90	<i>E. crassipes</i> , <i>C. interruptus</i> , <i>Ipomoea</i> sp.
TS 003	00.55	40	116°41'45.77"	0°30'39.12"	Long Balau (Batangan)	90	<i>L. javanicum</i> , <i>G. renghas</i>
CS 004	01.15	40	116°41'32.87"	0°29'34.24"	Loah Toh	120	<i>H. malayana</i> , <i>S. sumatrensis</i> , <i>E. crassipes</i>
Es 003	19.55	36	116°41'30.27"	0°30'06.15"	Loah Toh	120	<i>H. malayana</i> , <i>E. crassipes</i> , <i>S. sumatrensis</i>
Es 004	22.00	50	116°41'53.57"	0°30'05.96"	Long Balau (bakung)	105	<i>S. sumatrensis</i> , <i>E. crassipes</i>
Es 005	23.05	36	116°41'38.82"	0°30'05.96"	Long Balau	100	<i>S. sumatrensis</i> , <i>E. crassipes</i>
Nest	17.00		116°41'48.13"	0°30'55.76"	Long Balau	140	<i>S. sumatrensis</i> , <i>C. interruptus</i> , <i>Lersia hexandra</i> (kelementa), <i>E. crassipes</i>
CS005	21.05	40	116°41'28.56"	0°29'46.48"	Loah Toh	140	<i>S. sumatrensis</i> , <i>C. interruptus</i> , <i>S. molesta</i> , <i>E. crassipes</i>
Nest	17.05		116°41'21.05"	0°31'46.76"	Long Balau (Border to Kelindimut)	150	Predang <i>S. sumatrensis</i> , <i>C. interruptus</i> , <i>L. hexandra</i> , <i>E. crassipes</i>
CS006	22.05	50	116°41'37.61"	0°31'54.26"	Long Balau (Border to Kelandimut)	110	<i>Hypolytrum nemorum</i> , <i>S. molesta</i>

Note: TS: *Tomistoma schlegelii*; Cs: *Crocodylus siamensis*; CRO: Object Cannot be captured, but according to fishermen information is Crocodile, it can be TS or Cs based on shape, skin color, and movement. ES: Eye Shine, object cannot be captured but can be identified as a crocodile based on the look in its eyes

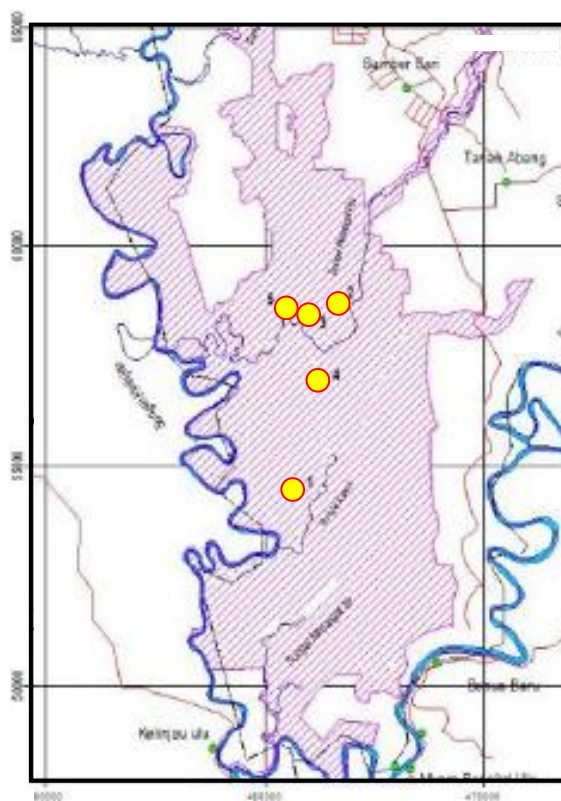


Figure 3. Map of *Crocodylus siamensis* distribution in Mesangat Lake, Long Mesangat Subdistrict, East Kutai District, East Kalimantan Province, Indonesia

Biological conditions of Mesangat Lake

The vegetation in Mesangat Lake was dominated by water hyacinth (*E. crassipes*), water spikes (*Salvinia molesta*) and several types of swamp grass which resulted in the closure of most of the lake's waters. Particular areas were dominated by shame princess plant (*Mimosa pigra*) while the upstream area in the Kelinjau Ulu River was dominated by water rattan (*Calamus* sp.), perupuk (*Lophopetalum javanicum*), rengas (*Gluta renghas*), *Ficus microcarpa* and *Asplenium nidus*.

Sources of food for *C. siamensis*, in general, are fish and snake (Han et al. 2015). There are at least 37 possible species in the Mesangat swamp including 29 fish species that are also found in the Suwi lake (Nugroho et al. 2016). Other natural food sources are based on reference to feed composition which can be an alternative choice that has the potential as food for *C. siamensis*. Based on analysis of food samples from the crocodile's stomach, which averaged 86 cm (59-113 cm), the remaining prey components were found, including insects, snails, clams, fish bones, bird feathers, snakeskin scales and hair of small mammals (Behler et al. 2018). Based on the results of this analysis, it appears that the source of feed *C. siamensis* is fish, insects, snails, birds, snakes, small mammals

Habitat preferred by *Crocodylus siamensis*

Habitat characteristics favored by *C. siamensis* are presented in Table 3. According to information from several fishermen, *C. siamensis* were often seen resting on

floating vegetation, such as *Lersia hexandra* and *Eichhornia crassipes*, *S. molesta* and grass species such as *H. malayana*. All of these plant species are known as invasive plants and have been invading the Mesangat Lake area.

Nest of *Crocodylus siamensis*

The nests of *C. siamensis* were found in Long Balau at coordinates 116°41'48.13" E; 0°30'55.76"N and 116°41'21.05" E; 0°31'46.76 "N during floodwaters with water level of ± 150 cm. Nests were marked with plants on the nest with mounds measuring about 45 cm high and 75 cm wide (Figure 4). The nesting habitats are consistent with the species preferred habitats in Mesangat Lake, even though *C. siamensis* in Laos have been reported nesting on land as well as on floating vegetation (Bezuijen et al. 2006, 2012).

According to information from local fishermen that *C. siamensis* nesting season in Mesangat Lake, occurred in March and hatchlings emerged in June 2018. Observation of the nest at the time of the study was experiencing major constraints due to very shallow water conditions in October and November 2018 namely the average depth averaging 40 cm to 100 cm and dense aquatic vegetation from the swamp that prevents access to the nest. In December 2018 the presence of the nest was found based on information from fishermen and Ulin Foundation staff. Nest position is far from human activities and rarely passed by fishermen because the area to the location is covered by water plants and swamp grass with an average water level between 60-80cm.

Based on the Ulin Foundation documentation (2018), the characteristics of active Siamese crocodiles are characterized by mounds made of grass around and the grass has sturdy branches and is not washed away and has a dense density so it is not brittle; around the nest are usually free of grass and sometimes surrounded by floating water plants and there is no sand in the mound because it is always cleaned by the female parent.

Observation results from the nests found, types of plants used as nests by *C. siamensis* are types of *Scleria sumatrana* grass, *Leersia hexandra* grass and *Cyclosorus interruptus* (pakis rawa, swamp fern) (Figure 5). *S. sumatrana* and *L. hexandra* grasses have stiff and rough nature so in large amounts of density makes the mound sturdy, strong and not easily washed away. Meanwhile, *C. interruptus* (swamp fern) has brown fiber roots. Nest material is more dominated by twigs, leaves and grass.

Potential threats to *Crocodylus siamensis* in Mesangat Lake

Invasive plant species

Siltation due to the boom of aquatic invasive plants floating in Mesangat Lake became a threat to *C. siamensis* habitat. At some locations, *E. crassipes* and *S. molesta* invaded vast open water areas and blocked the waterways of fishing boats. Besides, this weed after blooming will rotten which causes bad smell. This smell is originated from poisonous hydrogen sulfide compound as a result of anaerobic decomposition of these weeds.

Habitat fragmentation

Crocodylus siamensis population occurred in fragmented habitats, sometimes only two or three individuals or even only a group of males without females in one location (Bezuijen et al. 2012). The adults of *C. siamensis* live in a remote place, sometimes in isolated swamp which is not supported by sufficient food. Habitat fragmentation in this area has occurred due to the establishment of oil palm plantations and large forest fires in the 2000s. Fragmentation increases isolation of the remaining population thereby increasing the likelihood of greater extinction.

Overfishing

Mesangat Lake waters are open access for local fishermen to catch fish, so there is a tendency to compete between fishermen and at the same time with crocodiles. This is supported by the report of Daltry et al. (2003) stated that adult crocodiles have feed preference of particular fishes, although they have a broad diet, including reptiles, birds and even other carcasses.

Discussion

Wetland areas of Mesangat Lake are not classified as protected or conservation areas. The status of the area is oil palm plantation concession. This situation becomes obstacle for the management of the area, because it must coordinate with the permit holders. Currently, areas of Mesangat Lake have been pressured by human activities namely logging and forest conversion into oil palm plantations, mining and other land uses. Staniewicz et al. (2018) reported that in the region around the lake, there are two threatened crocodile species namely *C. siamensis* and *Tomistoma schlegelii*.

Table 3. Habitat characteristics favored by *Crocodylus siamensis* in Mesangat Lake, East Kutai, Indonesia

Characteristics	Condition
Type vegetation	Open water near vegetation
Closure of vegetation	Dense with plants or under the clumps
Availability of feed sources	Abundant fishes or insects
Distance from settlement	Far from human activities
Water flow	Stagnant
Basking	On top of floating vegetation or between submerged water vegetation under open conditions



Figure 4. Nests of *Crocodylus siamensis*



Figure 5. Types of plants making up Siamese crocodile (*Crocodylus siamensis*) nests in Mesangat Lake, East Kalimantan, Indonesia. A. *Scleria sumatrensis* (predang), B. *Cyclosorus interruptus* (swamp fern), C. *Leersia hexandra* (swamp grass)

Mesangat Lake, in a natural landscape, forms swamp ecosystem connected to the Suwi Lake wetlands in the south. Both areas have high conservation value and become important habitats for various protected flora and fauna, such as proboscis monkey (*Nasalis larvatus*), Siamese crocodiles (*C. siamensis*) as well as various species of water birds, fish, etc. These lakes are integral part of supporting ecological function on the provision of abundant fish resources. However, our study suggested that there is competition between fishermen and *C. siamensis* in finding fishes. This condition is in line with the results of the study by Han et al. (2015) and Behler et al. (2018) which reported that *C. siamensis* preys include fishes, insects, frogs, snails, birds, snakes, small mammals, and carcasses. Nonkrang (2017) reported in detail about the natural diet of siamensis crocodiles which consists of 52.63% of fish species, 21.05% of mammalian species, 5.26 reptile species, and 2.63% of bird species. Among mammal species, the crocodile diets are mice, crab-eating macaques, and silvery langurs. Based on data from Wahyudi et al. (2017), the research and information from fishermen, there are 63 species of bird, 38 species of fish, 4 species of shrimp, 12 species of mammal and 9 species of reptile in this area. Some fish species with economic value include haruan (*Channa striata*), toman (*Channa micropeltes*), biawan (*Helostoma temminckii*), repang (*Cyclocheilichthys enoplos*), pepuyu (*Anabas testudineus*), baung (*Mystus micracanthus*), sepat (*Trichogaster pectoralis*), belida (*Notopterus* sp.), and patin (*Pangasius hypophthalmus*).

This study indicate that Mesangat Lake has an important role, both from the aspect of biodiversity conservation and economic potential. However, the pressure from overfishing in Mesangat Lake, which is the habitat of *C. siamensis*, is increasing and crocodile adolescents are also caught due to fishing activities. This will threaten the survival of the crocodile. Some fishermen catch *C. siamensis* because there are orders from outside the Mesangat Village.

Various types of swamp plants support *C. siamensis*. The information of plant occurred in the habitat of *C. siamensis* is important to ensure the protection strategy of *C. siamensis* by taking into account the potential availability of food sources, nesting, and basking which should be maintained to support the survival of the crocodile in their habitat. However, on the other hand, some invasive aquatic plants pose a threat to *C. siamensis* habitat. The same thing was reported by CAWA (2017), in which two main invasive plant species, namely water hyacinth (*E. crassipes*) and giant mimosa (*M. pigra*) have caused a decrease in water quality and siltation of siam crocodile habitat in Laos. Kim et al. (2016) reported that poor environmental conditions have the potential to disrupt the health of siamensis crocodiles by attacking liver and lungs due to necrosis caused by *Aspergillus fumigatus*.

Various kinds of threat to *C. siamensis* habitat in Mesangat Lake require collaborative conservation efforts to prevent extinction by preserving their habitat. Ecosystem sustainability and *C. siamensis* conservation must involve

cooperation with fishing communities. This collaboration is necessary to reduce the impact of dangerous fishing methods as there are many cases of *C. siamensis* trapped by fishing gear or killed by electric shock method used by fishermen. One of the new approaches of conservation outside protected areas is to establish Mesangat Lake wetland as essential ecological areas. Using this approach, an area can be managed for social, economic and cultural uses but still maintain ecological values that play important role in the conservation process. This has been initiated by the Government of Indonesia by closing down several legal logging companies upstream of the Mahakam River to preserve habitat and create partnerships with companies, NGOs, local communities to jointly manage habitats for the survival of *C. siamensis*.

ACKNOWLEDGEMENTS

The authors would like to thank the Head of Department of Environmental Science, Post Graduate School of Environmental Science, Mulawarman University, Samarinda, Indonesia; The Head of Office of Environmental Service, East Kutai District Government in Sangatta; Suimah from the Indonesian Equatorial Conservation Foundation in Samarinda and fisherman in Mesangat who have supported data this research, as well as the field team for sampling and analysis data. The authors declare that there are no conflicts of interest regarding the publication of this article.

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