RESEARCH ARTICLE

MEDIA KONSERVASI
SCIENTIFIC JOURNAL IN CONSERVATION OF NATURAL RESOURCES AND ENVIRONMENT



# Potential Habitats of Siamese Crocodiles and False Gharials in East Kalimantan for Conflict Resolution

Firda Larasati [a], Yudi Setiawan [b] and Mirza Dikari Kusrini [b]

[a]Tropical Biodiversity Study Program, Graduate School, IPB University, Bogor 16680, Indonesia
[b]Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry and Environment, IPB University, Bogor, 16680, Indonesia

**Article Info:**
Received 18 May 2024
Revised 27 November 2024
Accepted 03 December 2024

**Corresponding Author:**
Firda Larasati
Tropical Biodiversity Conservation Study Program, Graduate School, IPB University, Bogor, 16680, Indonesia
E-mail:
firdalarasati@apps.ipb.ac.id



**Abstract**

Concerns in crocodiles sustainability have long been overlooked, due to humans fear of its ferocity and unresolved human-crocodile conflicts. The siamese crocodile (*Crocodylus siamensis*) and false gharial (*Tomistoma schlegelii*) are considered threatened by the IUCN red list because of their limited range and declining populations. In this study we developed habitat suitability model for both species and overlaid with anthropogenic factors to mitigate conflict between crocodiles and human in Mesangat-Suwi Wetland, East Kalimantan, Indonesia. We collected species presence from 2018–2023, measured environmental variables, interviewed 100 respondents, and mapped all information with Maximum Enthropy program (MaxEnt). Results showed that different factors influenced the habitat distribution for each species. Specifically, distance from swamps was affected the most for both crocodiles. Our model found that the potential habitat was much smaller than the non-potential ones due to humans' intrusion. Much of the Mesangat-Suwi area was covered in high-conflict zones between humans and crocodiles, endangering both species even more. Hence, serious actions were urgently needed to resolve the conflict, either by prevention and mitigation actions, to ensure human-crocodile coexistence in East Kalimantan.

Keywords: coexistence, false gharial, human-crocodile conflict, mitigation, siamese crocodile

## 1. Introduction

Although crocodiles have long been known to be one of the most dangerous animals to humans, there is no justification for hunting them freely. They are regarded as important species with ecological roles in protecting the variety and productivity of wetland habitats [1,2]. On the IUCN red list of threatened species, *C. siamensis* is listed as endangered [3], whereas *T. schlegelii* is listed as critically endangered [4] due to its limited distribution and population reduction. This leads to their inclusion in CITES Appendix I [5] and protection under Indonesian law, The Mesangat-Suwi Wetland, which has been identified as an important ecosystem area by the East Kutai Regent's Decision No. 660/K.391 in 2023, is home to several species, including both species. This area consists of rivers, swamps, swamp forests, and lakes, which are vital for the survival of humans, animals, and plants. Conflicts are also likely to arise because these areas are close to community settlements where agriculture and fishing are the main sources of income.

Conflict between humans and wildlife can lead to changes in the resource niche and prey partitioning [6,7]. Wildlife relies heavily on specific ecological niches for survival and reproduction, and crocodiles, being freshwater habitat dependent, are no exception. Unfortunately, crocodiles are among the wildlife species that frequently negatively interact with humans worldwide [8]. However, global attention towards human-crocodile conflicts is relatively scarce [9], and declines in natural crocodile habitats, depletion of prey populations, and increased human activities around crocodile habitats have led to human attack incidents [10]. Crocodile attacks on humans and hunting of crocodiles represent the most common human-crocodile conflicts [11,12]. Such negative interactions are among the biggest challenges in crocodile conservation, as their presence only leads to conflicts with local communities. Long-term crocodile conservation necessitates intact habitat availability, effective protection practices, and societal tolerance towards crocodile populations in their vicinity [10].

Coexistence between humans and wildlife is vital globally, but it is difficult to achieve when wildlife only negatively impacts human lives, and local people do not reciprocate. Such actions can lead to a passive acceptance of the existence of wildlife populations, with the risk of actions that harm or even exterminate these populations [13,14]. However, evaluating tolerance levels across a large area is a complex challenge.

The purpose of this research is to determine potential habitat of both *C. siamensis* and *T. schlegelii* in Mesangat-Suwi and identify areas with high probability of human activities to mitigate crocodile-human conflict. The outcome of this study is to provide recommendations for policymakers in managing the habitat of *C. siamensis* and *T. schlegelii* and the community to achieve harmonious coexistence with wildlife, especially Siamese crocodiles and false gharials. Policies pertaining to wildlife-human conflict, in particular crocodile mitigation planning and conservation initiatives in East Kalimantan, are anticipated to benefit from this study as well.

## 2. Materials and Methods

### 2.1. Study Area

The study area is situated within the boundaries of East Kalimantan province, Indonesia, with fieldwork focusing on the important ecosystem area of the Mesangat-Suwi wetland. The area is classified as an Other Use Area (in bahasa Indonesia is considered as Area Penggunaan Lain or APL), a landscape categorized as non-forest or protection area. The area of the Mesangat-Suwi wetland is 14,165.50 ha, divided into two parts, namely, the Mesangat wetland, which are 7,377.49 ha and Suwi wetland of 6,788.01 ha (Figure 1).

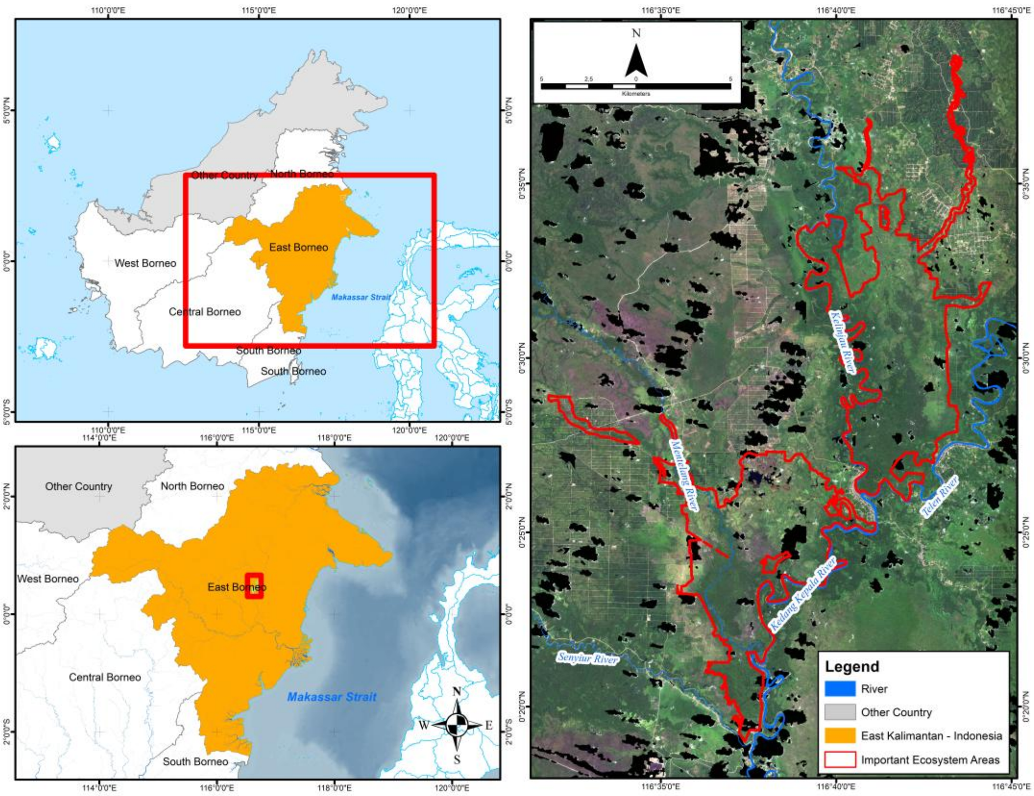


**Figure 1.** The map delineating the study area depicts the location of the Mesangat-Suwi wetlands, Kutai Timur, East Kalimantan.

### 2.2. Data Collection

The potential habitat of crocodile was modelled using the distribution data of siamese crocodiles (*Crocodylus siamensis*), false gharials (*Tomistoma schlegelii*), and predicted environmental variables that might affect the distribution of both species. The distribution of both species in this study was obtained from both primary (direct encounters during field research in July–September 2023) and secondary sources, which were acquired from monitoring by the Ulin Foundation and the Yasiwa-Ulin Consortium. We only considered data from 2018 to 2023 owing to its unavailability prior to 2018. In total, we obtained 130 and 43 presence points for *C. siamensis* and *T. schlegelii*, respectively, in East Kalimantan.

Environmental data was collected from the Ministry of Environment and Forestry's land cover data for 2021, which comprised of distances to thicket swamps, distance to swamps, distance to shrubs, distance to primary swamp forests, distance to secondary swamp forests, distance to plantations, and distance to settlements. The classification of shrubs is divided into two categories, both of which have low vegetation but differ from their previous land conditions. Shrubs were previously dryland forests, whereas thicket swamps were previously swamp forest [15]. Additionally, water presence data were sourced from the Global Surface Water dataset downloaded from global-surface-water.appspot.com. Distance from rivers data were extracted from the Indonesian Soil Research Institute's database downloaded from https://tanahair.indonesia.go.id/. Land surface temperature data were obtained from Terra-Modis 1B, and elevation data were processed using the Digital Elevation Model downloaded from https://portal.opentopography.org/. The collected environmental data were then converted into GeoTIFF raster format.

Data on potential conflicts were collected through semi-structured interviews with 100 respondents representing the study area, taken during field research from July to September 2023. Respondents were drawn from communities active in and around Mesangat-Suwi wetlands who could identify *C. siamensis* and *T. schlegelii*. Respondents were selected using the snowball technique to obtain additional respondents based on suggestions from key respondents [16]. Key respondents included the head of the local village and leaders of the fishermen's group. We also interviewed respondents who had conducted activities at the research site and were willing to be interviewed. The questions were divided into two categories: general questions for the surrounding local community and specific questions for fishermen. The questions asked of respondents included information on the location of encounters, frequency of encounters, information regarding the victim, time of attack, form of attack, activities before the attack, and losses after the attack. Meanwhile, additional questions for fishermen included fishing location, type of fishing gear, amount of fishing gear, bait used, depth of bait, length of gear set, information on crocodile entanglement, type of entangling gear, post entanglement impact, and frequency of entanglement were divided into three categories: rarely (1 per month), occasionally (2 per months), and frequently (>3 per months). In addition, secondary data on *C. siamensis* and *T. schlegelii* attacks were obtained from CrocAttack, the world's crocodile attack database (http://www.crocodile-attack.info/), which produced only one case of *C. siamensis* attack on humans on the website.

### 2.3. Data Analysis

The data analysis process in this research can be seen in the following flowchart (Figure 2).

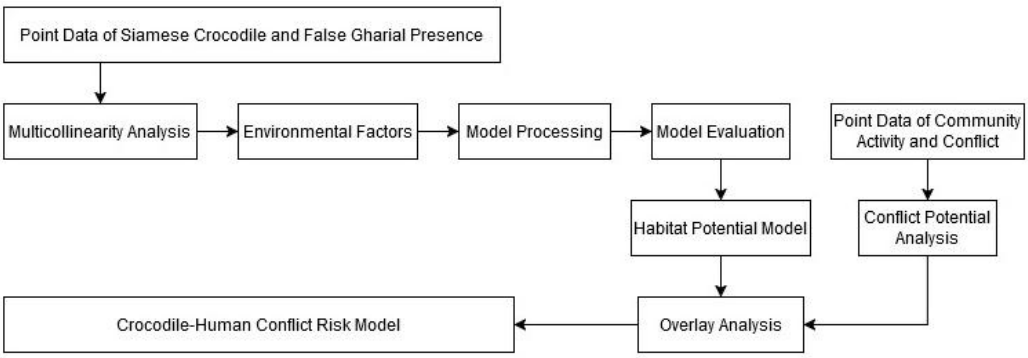


**Figure 2.** Workflow for the research methodology.

The first step in using data for habitat potential modelling is preprocessing. The spatial resolution of each variable was standardized by resampling before they were integrated as processing variables in the model. Not all data points of siamese crocodiles and false gharials presences were used as we conducted data selection procedures to ensure that each presence points have accurate coordinates and eliminating duplicate encounter data. Thus, from a total of 130 presence points, the data for *C. siamensis* were reduced to 85 points, while the *T. schlegelii* presence points decreased from 43 to 30.

Potential habitat modelling was conducted using the Maximum Entropy (MaxEnt) algorithm, which identifies the spatial distribution of a species based on presence data and environmental variables influencing its presence [17]. A multicollinearity analysis of all environmental variables was conducted to assess the correlation between the environmental variables used. If multicollinearity arises, it can negatively affect the model's outcomes [18]. If the Variance Inflation Factor (VIF) exceeds ten (>10), one of the variables must be removed or reduced [19].

The habitat potential model was validated by examining the Area Under the Curve (AUC) value from the Receiver Operating Characteristic (ROC) curve, which provides overall accuracy information unaffected by the threshold values. Additionally, AUC is a standard method for identifying the model distribution prediction accuracy [20]. Based on [20], the obtained AUC test values are categorized into three categories: a value of 0.9 indicates excellent accuracy; values between 0.800 and 0.900 indicate good accuracy; and values below 0.800 indicate fair accuracy. The results were analyzed using jackknife analysis, which provided a more detailed explanation of the obtained results.

The siamese crocodile and false gharial habitat potential classes were divided into four categories: no potential (0–0.2), low potential (0.2–0.4), moderate (0.4–0.6), and high (0.6–1.0) [21]. Furthermore, mapping of crocodile-human conflict risks was conducted by performing overlay analysis and weighting between human activity points around the research location and the siamese crocodile and false gharial habitat potential maps. The human activity map is a combination of community activity points and conflict points, which then underwent buffer analysis with the rule t1 km distance weights 3, 2 km distance weights 2, and 3 km distance weights 1. Weighting was also applied to the habitat potential map, with high potential (weight 3), moderate potential (weight 2), and low potential (weight 1). From each weight, the distance weight from community activities + habitat potential weight was calculated and classified into three categories and scores: high risk (5–6), moderate (3–4), and low (1–2).

## 3. Results

### 3.1. Variable Selection instead of Multicollinearity Analysis

The VIF test revealed that only the distance to the thicket swamp resulted in VIF values above 10. This indicates the presence of multicollinearity based on the VIF test findings. Variables with multicollinearity may have estimated parameter variances that are higher than necessary, which would reduce the accuracy of the estimation values [18,22]. As a result, the Maxent program processed habitat potential model data using only 10 variables (Table 1).

**Table 1.** Multicollinearity test result

| No | Environmental variables | VIF |
|---|---|---|
| 1 | Distance from thicket swamp | 15.83* |
| 2 | Distance from swamp | 1.07 |
| 3 | Distance from shrubs | 2.01 |
| 4 | Distance from primary swamp forest | 1.28 |
| 5 | Distance from secondary swamp forest | 5.30 |
| 6 | Distance from plantation | 6.75 |
| 7 | Distance from settlement | 2.77 |
| 8 | Presence of water | 1.27 |
| 9 | Distance from river | 1.68 |

| No | Environmental variables | VIF |
|---|---|---|
| 10 | Land surface temperature | 1.30 |
| 11 | Elevation | 3.24 |

*Notes: Asterisk in the table indicates the highest correlation between variables

### 3.2. Model Validation

The assessment findings for the models in this study revealed no significant variations in accuracy values among the created models. Model performance evaluation is a critical stage that should be performed technically [23]. Model performance is a measure of how effectively a model can describe the ecological circumstances of a species. The habitat potential model for siamese crocodiles in East Kalimantan had an AUC value of 0.991, and the false gharial model had an AUC value of 0.996, both with a standard deviation of 0.003 (Figure 3A and Figure 3B). When the standard deviation is reduced significantly, the model evaluation is considered ideal [24]. This indicated that the prospective models in this investigation performed remarkably well.

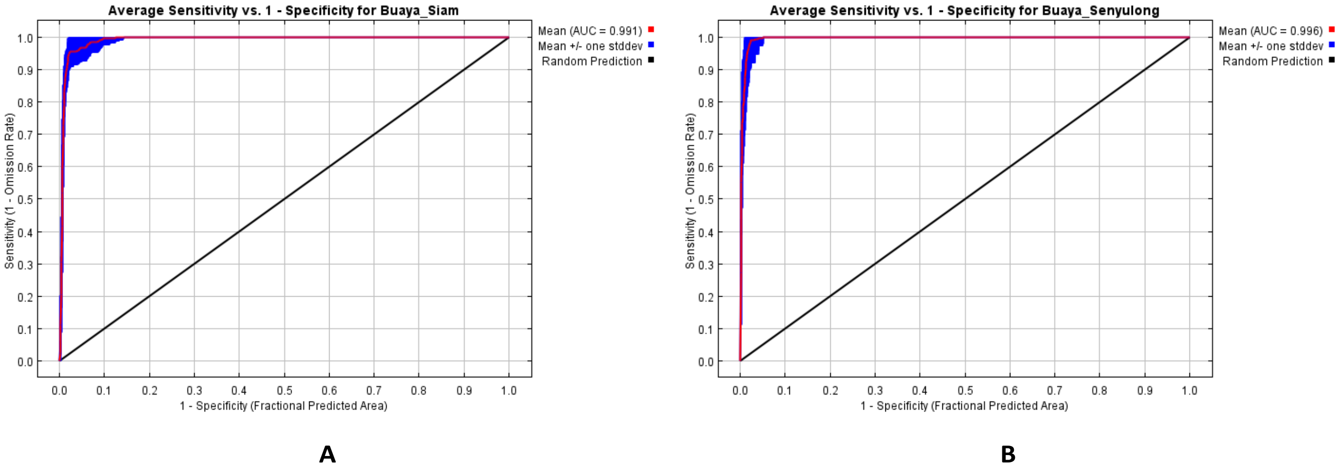


**Figure 3.** The mean value of AUC (Area Under Curve) (A) siamese crocodile (B) false gharial.

### 3.3. Contribution of Environmental Variable

The determination of important variables for the siamese crocodile and false gharial habitat potential model can be identified using percent contribution [25]. This was done to observe the estimated contribution of environmental variables to the model results, where the higher the percent contribution value, the greater the contribution of that variable to the habitat potential model. Overall, the environmental variables consider a set of environmental variables covering various aspects of habitat characteristics for both species. The environmental variables with the highest contribution percentage to the siamese crocodile habitat potential model were the distance from the swamp (45.6%), distance from secondary swamp forest (26.4%), distance from plantations (9.9%), and distance from shrubs (9.3%) (Table 2).

**Table 2.** Effect of environment variables on the habitat potential of siamese crocodile

| Environmental variables | Contribution percentage (%) |
|---|---|
| Distance from swamp | 45.6 |
| Distance from secondary swamp forest | 26.4 |
| Distance from plantation | 9.9 |
| Distance from shrubs | 9.3 |
| Distance from primary swamp forest | 3.4 |
| Elevation | 3.2 |
| Distance from river | 0.9 |
| Distance from settlement | 0.7 |

| Environmental variables | Contribution percentage (%) |
|---|---|
| Presence of water | 0.5 |
| Land surface temperature | 0.0 |

The important environmental variables for the false gharial habitat potential were distance from the swamp (50%), distance from the secondary forest (32.6%), distance from shrubs (7%), and distance from rivers (5.9%) (Table 3). This indicates that these variables are important for building the model. If not used, they will affect the accuracy of the model of potential *T. schlegelii* habitat in the East Kalimantan province.

**Table 3.** Effect of environment variables on habitat potential of false gharial

| Environmental variables | Contribution percentage (%) |
|---|---|
| Distance from swamp | 50.0 |
| Distance from secondary swamp forest | 32.6 |
| Distance from shrubs | 7.0 |
| Distance from river | 5.9 |
| Distance from primary swamp forest | 3.5 |
| Distance from settlement | 0.7 |
| Distance from plantation | 0.2 |
| Presence of water | 0.1 |
| Land surface temperature | 0.1 |
| Elevation | 0.0 |

### 3.4. Potential Habitat of Siamese Crocodile and False Gharial

The results of the habitat potential analysis for siamese crocodiles and false gharials in East Kalimantan were divided into potential and non-potential areas. The potential classes for siamese crocodiles show that the suitable habitat area is 1,075,832.69 ha (9%) out of 12,576,319.59 ha, divided into three classes: low with an area of 447,867.91 ha (4%), moderate with an area of 255,108.32 ha (2%), and high with an area of 372,856.47 ha (3%) (Figure 4A). Meanwhile, the potential habitat for false gharials indicates that the suitable habitat area is 880,712.82 ha (7%). In the low class, it covers an area of 401,428.47 ha (3%), moderate with 227,551.30 ha (2%), and high with 251,733.06 ha (2%) (Figure 4B).

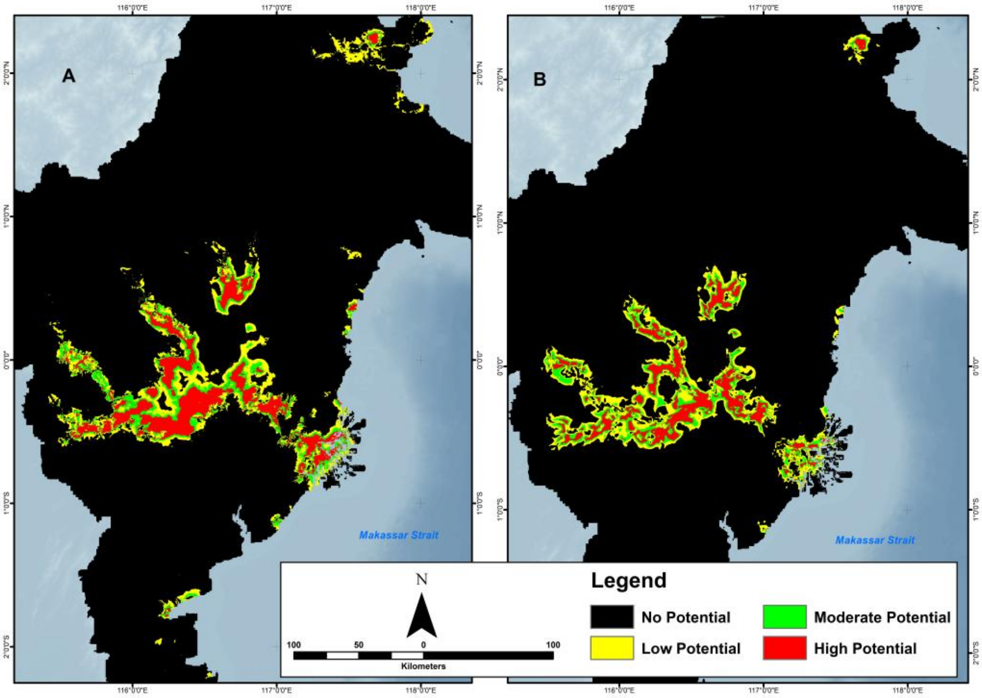


**Figure 4.** The map of habitat potential (A) siamese crocodile (B) false gharial.

### 3.5. Crocodile-Human Interaction Risk Areas

Areas with high or moderate levels of potential crocodile habitat as well as habitat for human activities pose an important challenge in managing potential human-crocodile conflict. Local community activities in the Mesangat-Suwi wetland and surrounding areas include fishing, farming, and cattle farming. These activities are in accordance with the geographical conditions of the research location, which is a wetland ecosystem classified as an area with other uses (APL) that is commonly utilized for agricultural and settlement purposes. This study provides evidence of crocodile attacks in humans. There were 54 cases or crocodile-human conflict points involving siamese and false gharials in the Mesangat-Suwi wetlands. These were categorized into four types: crocodiles entangled in traditional fishing gear, crocodile attacks on humans, crocodile predation on livestock, and crocodiles found in settlements and plantations.

Observational findings indicate that the frequency of conflicts involving *C. siamensis* and humans is higher compared to *T. schlegelii*. This finding is based on 44 cases of *C. siamensis* entangled in traditional fishing rods or *rawai* and fishing nets or *ringgi* by the Dayak and Kutai communities (Figure 5). Through interviews with 71 fishers, it was found that 44 of them had experienced siamese crocodile entanglement incidents while they were fishing. The frequency of crocodile entanglement incidents was calculated based on the number of responses from the respondents. It was found that 34% of them said that the occurrence of such incidents was often or occasionally, while 32% stated that such incidents rarely occurred (Figure 6).

**Figure 5.** Crocodiles entangled in rawai, a traditional fishing gear (November 30th, 2022 in Mesangat wetland).

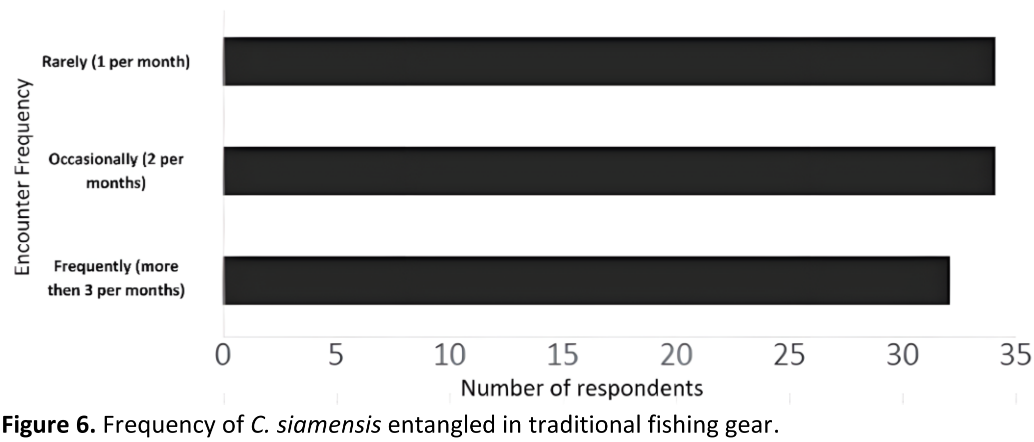


**Figure 6.** Frequency of *C. siamensis* entangled in traditional fishing gear.

The number of occurrences was also related to the depth of the bait, type of bait, and installation location of the fishing gear used. Bait on fishing gear such as longlines or longlines is usually placed at a depth of 10–20 cm, often using live fish bait that is believed to attract siamese crocodiles as prey. In addition, the location of fishing gear is believed to influence the level of conflict. These fishing gears are usually placed in the middle of open swamps, close to floating vegetation, which is a favorite haunt for *C. siamensis* [26,27]. Although nets and *ringgi* are not used as much as longlines, they also contribute to entanglement. They are 5–6 cm wide and small enough to cause the entanglement of hatchlings and death. This gear is set lengthwise and follows the water current, which will only damage the fishing gear if it entangles juvenile crocodiles.

Field monitoring revealed that *T. schlegelii* tended to be found at the edge of swamps close to tree roots. This finding is also reinforced by the analysis of ESRI imagery satellite image data, which show the distribution of *T. schlegelii* at the edge of swamps. This is related to the breeding habitat tendency of *T. schlegelii* [28,29], which generally builds nests in swamp forests, whereas *C. siamensis* tends to roam among the grasses [30,31].

The overlap of habitat potential and community activities resulted in areas of potential conflict (Figure 7). The classification of potential crocodile-human conflicts between *C. siamensis* and *T. schlegelii* showed that most of the Mesangat-Suwi wetland area was included in the high conflict potential area. This situation has resulted in an increasing number of conflicts involving fishers, although there are few records of direct attacks on humans. Attacks on humans by crocodiles was present for both *C. siamensis* (2 incidents) and *T. schlegelii* (2 incidents). Both were non-mortal and only caused bite wounds, consistent with the findings of the CrocAttack site survey conducted in June 2023, which found one case of *C. siamensis* attack on a human in the Mesangat wetlands.

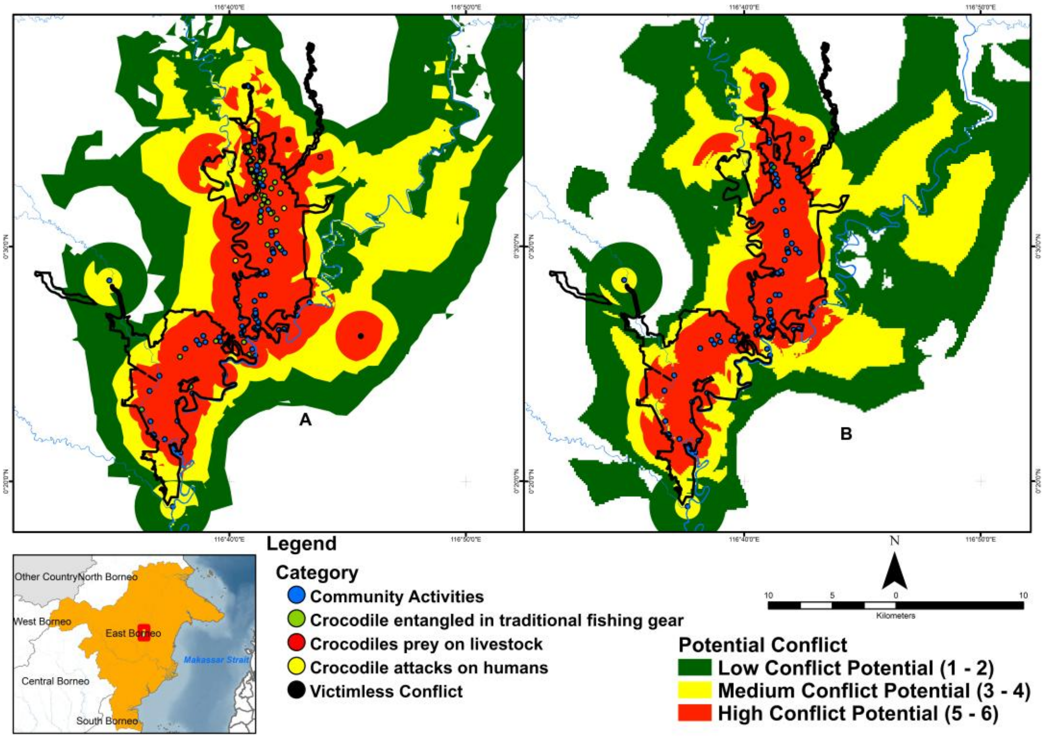


**Figure 7**. Risk map of conflict (A) siamese crocodile (B) false gharial.

The surrounding residential areas also have high potential for conflict, especially settlements located on the banks of the Kelinjau and Telen Rivers. Interviews with local communities revealed confirmed cases of *C. siamensis* and *T. schlegelii* entering settlements during floods.

Furthermore, potential conflicts between crocodiles and humans were also identified in plantation areas. Based on the analysis of the potential habitats of these two crocodile species, most of their habitats are adjacent to oil palm plantations. This situation also increases the potential for conflict in plantation areas due to the association of crocodile habitat with plantations. Interviews with local communities revealed confirmed cases of *C. siamensis* and *T. schlegelii* entering settlements during floods. Several findings of crocodiles entangled in fishing gear and isolated crocodiles were also found in the irrigation area of oil palm plantations. The presence of isolated siamese crocodiles indicates a threat to habitat and potential conflict with humans. As opportunistic predators, crocodiles do not rule out the possibility for humans to become alternative prey when their natural prey declines or is depleted [32]. This finding is supported by two cases of siamese crocodile attacks on livestock.

**Figure 8**. Siamese crocodile isolated in oil palm plantation (August 15th, 2023 in oil palm plantation, Muara Bengkal Hulu).

## 4. Discussion

### 4.1. Ecological Specialization and Potential Habitat

The habitat models developed in this study underscore the ecological specialization of *Crocodylus siamensis* and *Tomistoma schlegelii*, both of which exhibit a strong dependence on wetland ecosystems. Specifically, swamps emerged habitats, significantly contributing to the habitat potential models in East Kalimantan. Swamps are the primary habitat for *C. siamensis* and *T. schlegelii*, as they provide abundant food sources, such as invertebrates, vertebrates, and fish, which are the main food sources [26]. The probability of finding *C. siamensis* and *T. schlegelii* is high when they are in the swamp and decreases at subsequent distances. This finding is supported by observations in the research area showing that *C. siamensis* hatchlings are often found on the edge of open expanses, under invasive floating vegetation such as *Salvinia molesta* and *Leersia hexandra*, which grow densely on the water the water surface. This finding is consistent with previous research regarding *C. siamensis* findings in swamp areas near floating vegetation [26,27,33].

*C. siamensis* hatchlings were also found in swamp forest types, specifically among plants named locally as bakung (*Hanguana malayana*), selingsing (*Hypolytrum nemorum*), and predang (*Scleria sumatrensis*) [34]. Meanwhile, *T. schlegelii* are commonly found amidst dense vegetation submerged in water, such as *Lophopetalum javanicum* and *Planchonia valida* trees. These findings align with previous research in 2010 [28], which found that *T. schlegelii* are frequently located among tree stands. Tree vegetation is preferred by fish for breeding [26], while its leaves and dry branches are used for nesting, which is necessary for stabilizing egg temperature and accelerating the hatching process [35].

However, the alarming reality presented in this study indicates that potential habitat areas are smaller than non-potential areas. This may illustrate that the threat to the existence of these species remains relatively high. This study showed that potential areas for the conservation of siamese crocodiles and false gharials are scattered in wetland areas, including peat swamp forests, swamps, mangroves, rivers, and coastal areas. These findings are in line with previous studies that have shown that siamese and false gharials inhabit lowlands up to 730 meters in elevation [26]. *C. siamensis* were found in swamps, wetlands, and slow-moving small rivers [26,27,31,33,36]. Meanwhile, *T. schlegelii* is also often found in peat swamp forests and large rivers [26,35,37–40]. Although there are few records regarding the distribution of these two species in East Kalimantan, [30] mentioned that *C. siamensis* was found in the Bongan area, West Kutai, and [41] also stated that *T. schlegelii* was found in the Mahakam River. Both areas were included in the potential habitats identified in this study.

The magnitude of the threat to the existence of the population comes not only from habitat unsuitability, but also from the large amount of conversion of the area. One of the threats to the survival of freshwater crocodiles is habitat loss, especially through the expansion of primary forests [42] and the draining of peat swamp forests for plantation purposes, especially oil palm plantations [29,38,43]. As a result of potential habitat modeling, the area of high potential area included in oil palm plantation areas is 61,489.54 ha for *C. siamensis* and 50,704.46 ha for *T. schlegelii*. However, this is thought to be influenced by the location of the data collection, which is in an area adjacent to palm oil plantations. Such disturbances disrupt animal distribution [44] and lead to residual fragmentation, which in turn can trigger the local extinction of species [45–49]. Limitations in home range and declining nest quality lead crocodiles to seek alternative prey [50,51], which in turn can trigger conflicts with communities.

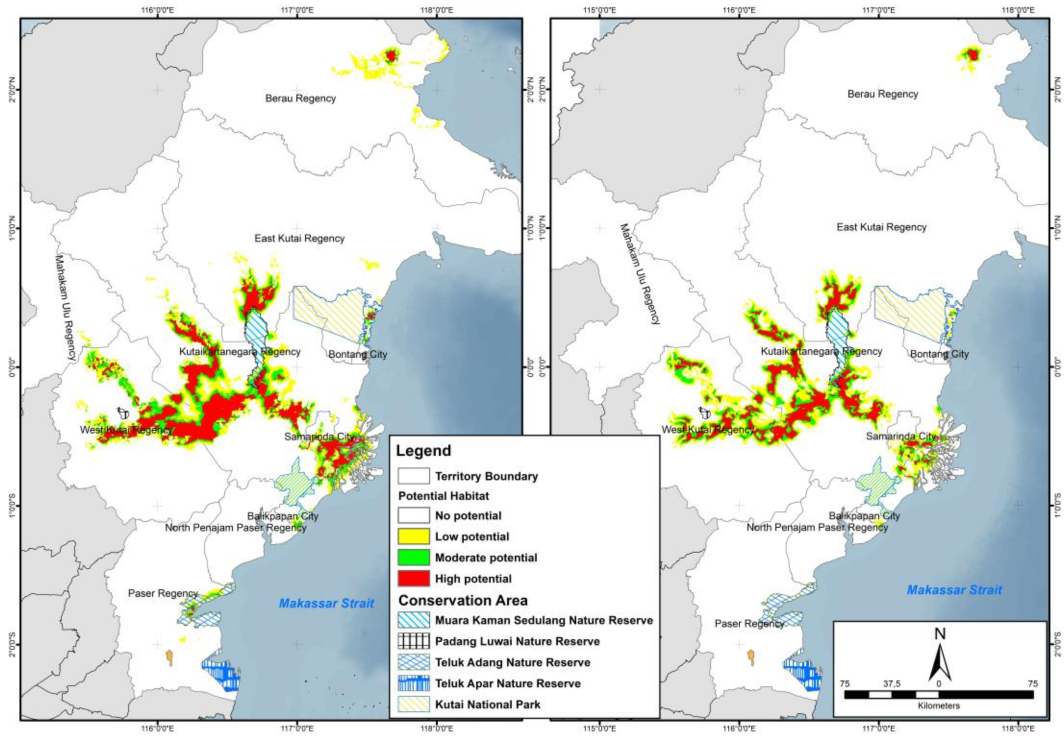


**Figure 9.** Overlaid map of conservation areas with administrative boundaries in East Kalimantan.

A conservation area is a landscape with administrative boundaries designated for specific conservation purposes. The designation of conservation areas in East Kalimantan is regulated in the Decree of the Minister of Environment and Forestry Number SK.6628/MENLHK-PKTL/KUH/PLA.2/10/2021 concerning the Map of Forest Area Stipulation Progress in East Kalimantan Province, with a total area of 435,313.06 ha. Of this area, only 39,959.10 ha or about 9% is potential habitat for *C. siamensis*, while potential habitat for *T. schlegelii* covers 20,027.19 ha or about 5% of the total conservation area in East Kalimantan. These conservation areas are spread across several areas, including parts of the Kutai National Park, Muara Kaman Sedulang Nature Reserve, Teluk Adang Nature Reserve, Teluk Apar Nature Reserve, and Bukit Soeharto Grand Forest Park (Figure 9). However, more potential habitats are located outside of conservation areas; therefore, the government needs to consider protecting important ecosystems, especially for *C. siamensis* and *T. schlegelii* outside of conservation areas.

The existence of several potential habitats outside conservation areas underscores the importance of prioritizing and monitoring the remaining forest areas, given the potential risk of land change in East Kalimantan. Prioritization of conservation areas aims to determine the form of crocodile management within these conservation areas in the future. East Kalimantan is an important ecosystem area of the Mesangat-Suwi Wetland located outside the conservation area. This area was established with the aim of maintaining ecological functions and protecting the biodiversity within it, the habitat for several protected species, including siamese crocodile (*Crocodylus siamensis*), false gharial (*Tomistoma schlegelii*), proboscis monkey (*Nasalis larvatus*), lesser adjutant (*Leptoptilos javanicus*), flat-headed cat (*Prionailurus planiceps*), and belida fish (*Chitala* sp.). In the long term, the conservation of *C. siamensis* and *T. schlegelii* requires the implementation of measures in accordance with the protection system to monitor threats to both species, especially in the Mesangat-Suwi wetland area, which is a top priority project. After being recognized as an important ecosystem area, the Yasiwa-YU Consortium collaborated with local government organizations, as well as oil palm plantation parties to manage and protect animal habitats and populations through the Mesangat-Suwi wetland important ecosystem area management forum.

### 4.2. Human-Crocodile Conflicts: Drivers and Patterns

The study documented 54 cases of human-crocodile conflict in the Mesangat-Suwi wetland, highlighting the pervasive impact of anthropogenic pressures. Fishing practices, particularly the use of longlines, were identified as the primary cause of crocodile entanglement, resulting in wounds and injuries that impact survival, reproduction, and even mortality of the species [52]. This phenomenon is also linked to the nesting season of *C. siamensis,* which occurs during the rainy season [53], along with seasonal fluctuations in water levels, known as the flood season. During the rainy season, water discharge from the main river flows into the Mesangat-Suwi wetland, causing water levels to rise by up to 500 cm [54]. These changes affect human activities within the area, increasing the potential for human-crocodile conflict. This observation is consistent with findings from other regions, where human-wildlife conflicts are often driven by overlapping resource use [55].

The density of community activities is the main trigger for conflict [10,51]. This situation has resulted in an increasing number of conflicts involving fishers, although there are few records of direct attacks on humans. The absence of reports of *T. schlegelii* entanglement in fishing gear is thought to be due to its shyness and tendency to habitat away from human activity [28,43,56]. However, this does not guarantee that *T. schlegelii* will not come into conflict with humans, as evidenced by the record of crocodile attacks on humans, most of which have occurred in western Indonesia [57].

Although *C. siamensis* is known as a shy crocodile [58] and *T. schlegelii* is traditionally considered harmless to humans [56]. Human presence might trigger behavioral change in this species [59–62], thus making it more aggressive. These behavioral changes are influenced by anthopogenic factors [57], such as illegal fishing practices. Findings also confirm that fishermen using electrofishing devices have caused the death of crocodile hatchlings. This is believed to increase crocodiles' aggression levels towards humans. Although crocodiles typically prefer fish as prey, over time, humans have also begun exploiting fish populations, resulting in a decrease in food availability for crocodiles. This shortage of food sources may stimulate high levels of aggression in crocodiles [11]. Habitat loss, fragmentation and degradation due to deforestation, urbanization and agricultural expansion are also major threats to wildlife and lead to conflicts between crocodiles and humans [63–66].

### 4.3. Mitigation of Crocodile-Human Conflict

Spatial modeling is not a definitive attempt to predict the presence or absence of animals in a habitat, but rather an attempt to identify areas that need to be prioritized for management [67]. The Mesangat-Suwi wetland is one of the few *C. siamensis* and *T. schlegelii* habitats in the world, and there is no record of these two crocodiles in other parts of East Kalimantan. Resource competition, both direct and indirect, is a major cause of conflict. As conflicts are complex interactions, the integration of social and ecological information is essential to elucidate the causes and dynamics of crocodile-human interactions in order to prioritize areas of intervention [68,69]. Addressing conflicts between *C. siamensis* and *T. schlegelii* and humans and reducing conflict levels requires an integrated and holistic set of actions.

The public safety program for crocodile-human conflict consists of two main programs, namely the education component for safety awareness and evacuation of crocodiles in conflict [70]. Ulin Foundation has been actively counseling and educating local communities on the importance of maintaining a balanced ecosystem and sustainable ways of doing activities in crocodile habitats. This approach can involve direct outreach, socialization through local mass media, as well as educational programs in local schools. Raising public awareness regarding the presence of crocodiles can also be implemented through interpretation boards. While interpretation boards have been implemented, most are located only within the company's oil palm plantation area. Therefore, implementation by the village government is required to make these boards accessible to the entire community.

Conflict mitigation strategies include prevention and management. Modifying fishing gear or changing gear types to reduce the risk of contact is the primary strategy known to reduce the risk of crocodile entanglement [71]. The most promising solution is to develop alternative fishing gear to replace current fishing methods, such as using artificial bait instead of live fish bait and adding floats to fishing lines to maintain the bait above the water surface, thereby reducing the likelihood of crocodile entanglement. Using a net size (*ringgi*) with a larger hole size (7–9 cm), as well as replacing fishing rods (*rawai*) with other methods such as *bubu* or traps that do not use live bait.

Training and distribution of hook release equipment to fishermen is also crucial so that they can respond quickly to handling and minimize injury to animals. In addition, the establishment of specialized animal rescue teams and the implementation of reporting procedures are important for handling conflicts with communities. Evacuations are conducted when there are reports of crocodiles around settlements or plantations as well as when crocodiles are caught in fishing gear. Evacuation of *C. siamensis* was carried out by the Ulin Foundation team together with the Natural Resources Conservation Center (BKSDA) in March 2021 in Mesangat sub-district. A total of 8 individuals were recorded in this area, but only 5 individuals were successfully evacuated and then released in the Mesangat river. A camera trap installed at the same location in August 2023 successfully observed one individual.


**Figure 10.** Siamese crocodile monitoring (August 10, 2023 in community pond, Mesangat sub-district).

Translocation should be carefully considered with a minimum release distance of ≥110 km [72,73] to avoid the possibility of crocodiles returning to conflict areas. However, this is a measure of last resort as it is considered ineffective [51] and may increase the risk of crocodile mortality [73]. Therefore, careful monitoring and management are required. The application of technology, such as GPS tracking, can help identify the location of crocodiles that have been involved in previous conflicts and analyze their movement patterns. This will help reduce the potential for future conflicts to recur.

It is also important to strengthen crocodile habitat conservation efforts by developing a land use plan for each buffer village. Land use planning aims to map the function of the area in more depth. It is expected that each village with potential crocodile habitat can utilize the map of potential habitat in their land use planning. Areas with habitat potential can be identified as protected areas, but still allow for sustainable use. We also recommend the provision of alternative land-based livelihoods that are expected to minimize the density of community activities.

An integrated set of mitigation measures is expected to reduce human-crocodile conflict and protect the crocodile population in East Kalimantan from harmful threats. This mitigation not only considers potential habitat outcomes, but also involves active participation from various stakeholders to achieve sustainable conservation goals.

## 5. Conclusions

Anthropogenic activities had driven crocodile populations into a decline. In this study, the habitat potential of *C. siamensis* was affected by the distance from swamps, secondary swamp forests, plantations, and shrubs. Meanwhile, for *T. schlegelii*, it was influenced by the distance from swamps, secondary forests, shrubs, and rivers. Our mapping revealed that potential habitats for both species only covered 9% (*C. siamensis*) and 7% (*T. schlegelii*) of East Kalimantan. Moreover, the presence of human activities in areas with higher crocodile probability, particularly in freshwater swamp and riverine ecosystems, escalated the risk of human-crocodile conflict. Settlements and plantations surrounding the Mesangat-Suwi wetland were identified as high-risk areas for human-crocodile conflict. Activities that triggered adverse interactions included intensive fishing and electrofishing in fishing. The

Yasiwa-YU consortium, in collaboration with the local government and oil palm plantations, has undertaken management and protection efforts through the Mesangat-Suwi swamp critical ecosystem area management forum.

## Author Contributions

**FL**: Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original draft; **YS**: Writing - Review & Editing, **MDK**: Writing - Review & Editing.

## Conflicts of interest

There are no conflicts to declare.

## Acknowledgments

We want to thank Suimah, Chairperson of the Ulin Foundation, for the permission granted for this research, recorded in letter No. 008.07/YU/2023. We would also like to thank the Ulin Foundation, Yayasan Konservasi Khatulistiwa Indonesia, and PT Davia Mandiri for the financial support provided for this research.

## References

1. Nifong, J.C.; Silliman, B.R. Impacts of a Large-Bodied, Apex Predator (Alligator Mississippiensis Daudin 1801) on Salt Marsh Food Webs. *J. Exp. Mar. Bio. Ecol.* **2013**, *440*, 185–191, doi:10.1016/j.jembe.2013.01.002.
2. Somaweera, R.; Nifong, J.; Rosenblatt, A.; Brien, M.L.; Combrink, X.; Elsey, R.M.; Grigg, G.; Magnusson, W.E.; Mazzotti, F.J.; Pearcy, A.; et al. The Ecological Importance of Crocodylians: Towards Evidence-Based Justification for Their Conservation. *Biol. Rev.* **2020**, *95*, 936–959, doi:10.1111/brv.12594.
3. Bezuijen, M.R.; Simpson, B.; Behler, N.; Daltry, J.; Tempsiripong, Y. Crocodylus Siamensis. *IUCN Red List Threat. Species* **2012**, *8235*, 19.
4. Shaney, K.; Shwedick, B.; Simpson, B..; Pine, A.; Sideleau, B.; Stevenson, C. Tomistoma Schlegelii (False Gharial). *IUCN Red List Threat. Species 2023* **2023**, *43*, 608–609, doi:10.2305/IUCN.UK.2023-1.RLTS.T21981A214287051.en.
5. CITES Appendices I, II and III Valid from 25 November 2023. *Conv. Int. Trade Endanger. Species Wild Fauna Flora* **2023**, 3–80.
6. Thompson, R.M.; Brose, U.; Dunne, J.A.; Hall, R.O.; Hladyz, S.; Kitching, R.L.; Martinez, N.D.; Rantala, H.; Romanuk, T.N.; Stouffer, D.B.; et al. Food Webs: Reconciling the Structure and Function of Biodiversity. *Trends Ecol. Evol.* **2012**, *27*, 689–697, doi:10.1016/j.tree.2012.08.005.
7. Magioli, M.; Moreira, M.Z.; Fonseca, R.C.B.; Ribeiro, M.C.; Rodrigues, M.G.; De Barros Ferraz, K.M.P.M. Human-Modified Landscapes Alter Mammal Resource and Habitat Use and Trophic Structure. *Proc. Natl. Acad. Sci. U. S. A.* **2019**, *116*, 18466–18472, doi:10.1073/pnas.1904384116.
8. González-Desales, G.A.; Sigler, L.; García-Grajales, J.; Charruau, P.; Zarco-González, M.M.; Balbuena-Serrano, Á.; Monroy-Vilchis, O. Factors Influencing the Occurrence of Negative Interactions between People and Crocodilians in Mexico. *Oryx* **2021**, *55*, 791–799, doi:10.1017/S0030605319000668.
9. Torres, D.F.; Oliveira, E.S.; Alves, R.R.N. Conflicts Between Humans and Terrestrial Vertebrates: A Global Review. *Trop. Conserv. Sci.* **2018**, *11*, doi:10.1177/1940082918794084.
10. Webb, G.J.W.; Manolis, S.C.; Brien, M.L. Saltwater Crocodile Crocodylus Porosus. *Crocodiles.* **2010**, *3*, 99–113.
11. Caldicott, D..; Croser, D.; Manolis, C.; Webb, G.; Britto Crocodile Attack in Australia: An Analysis of Its Incidence and Review of the Pathology and Management of Crocodilian Attacks in General. *Wilderness Environ. Med.* **2005**, *16*, 172–173, doi:10.1580/1080-6032(2005)16[172:AMSVCF]2.0.CO;2.
12. Britton, A.; Campbell, A. Croc Attacks: A New Website with Bite. *Ecos* **2014**, doi:10.1071/ec14001.
13. Bruskotter, J.T.; Wilson, R.S. Determining Where the Wild Things Will Be: Using Psychological Theory to Find Tolerance for Large Carnivores. *Conserv. Lett.* **2014**, *7*, 158–165, doi:10.1111/conl.12072.

 

14. Kansky, R.; Kidd, M.; Knight, A.T. A Wildlife Tolerance Model and Case Study for Understanding Human Wildlife Conflicts. *Biol. Conserv.* **2016**, *201*, 137–145, doi:10.1016/j.biocon.2016.07.002.
15. KLHK Peraturan Direktur Jenderal Dan Planologi Kehutanan Nomor: P.1/VII-IPSDH/2015 Tentang Pedoman Pemantauan Penutupan Lahan. *Kementeri. Lingkung. Hidup dan Kehutan. Direktorat Jenderal Planol. Kehutan.* 2015, 1–17.
16. Hardani; H, A.; J, U.; EF, U.; RR, I.; RA, F.; DJ, S.; NH, A. *Metode Penelitian Kualitatif & Kuantitatif*; H, A., Ed.; 2020; ISBN 9786237066330.
17. Rahman, D.A.; Gonzalez, G.; Haryono, M.; Muhtarom, A.; Firdaus, A.Y.; Aulagnier, S. Factors Affecting Seasonal Habitat Use, and Predicted Range of Two Tropical Deer in Indonesian Rainforest. *Acta Oecologica* **2017**, *82*, 41–51, doi:10.1016/j.actao.2017.05.008.
18. Pearson, R.G.; Raxworthy, C.J.; Nakamura, M.; Townsend Peterson, A. Predicting Species Distributions from Small Numbers of Occurrence Records: A Test Case Using Cryptic Geckos in Madagascar. *J. Biogeogr.* **2007**, *34*, 102–117, doi:10.1111/j.1365-2699.2006.01594.x.
19. Sunaryo, S.; Setiawan; Siagian, T.H. Mengatasi Masalah Multikolinearitas Dan Outlier Dengan Pendekatan Robpca (Studi Kasus Analisis Regresi Angka Kematian Bayi Di Jawa Timur). *Mat. Sains, dan Teknol.* **2015**, *2015;12(1)*, 1–10.
20. Çoban, H.O.; Örücü, Ö.K.; Arslan, E.S. Maxent Modeling for Predicting the Current and Future Potential Geographical Distribution of Quercus Libani Olivier. *Sustain.* **2020**, *12*, 1–17, doi:10.3390/su12072671.
21. Yan, H.; Feng, L.; Zhao, Y.; Feng, L.; Wu, D.; Zhu, C. Prediction of the Spatial Distribution of Alternanthera Philoxeroides in China Based on ArcGIS and MaxEnt. *Glob. Ecol. Conserv.* **2020**, *21*, 1–15, doi:10.1016/j.gecco.2019.e00856.
22. Sukmono, A.; Subiyanto, S. Penggunaan Partial Least Square Regression (Plsr) Untuk Mengatasi Multikolinearitas Dalam Estimasi Klorofil Daun Tanaman Padi Dengan Citra Hiperspektral. *Geoid* **2014**, *10*, 93, doi:10.12962/j24423998.v10i1.702.
23. Condro, A.A. Dinamika Distribusi Spasial Primata: Perubahan Iklim Dan Implikasinya Terhadap Pengelolaan Kawasan Konservasi [Tesis], Institut Pertanian Bogor, 2020.
24. Rusman, D. Prediksi Kehadiran Badak Sumatera (Dicerorhinus Sumatrensis) Dan Analisis Struktur Lanskap Habitatnya Di Taman Nasional Bukit Barisan Selatan, Universitas Gadjah Mada, 2016.
25. Phillips, S.J.; Anderson, R.P.; Schapire, R.E. Maximum Entropy Modeling of Species Geographic Distribution. *Ecol. Modell.* **2006**, *190*, 231–259, doi:10.1016/j.ecolmodel.2005.03.026.
26. Staniewicz, A.; Behler, N.; Dharmasyah, S.; Jones, G. Niche Partitioning between Juvenile Sympatric Crocodilians in Mesangat. *Raffles Bull. Zool.* **2018**, *7600*, 528–537.
27. Bezuijen, M.R.; Cox, J.H.; Thorbjarnarson, J.B.; Phothitay, C.; Hedemark, M.; Rasphone, A. Status of Siamese Crocodile (Crocodylus Siamensis) Schneider, 1801 (Reptilia: Crocodylia) in Laos. *J. Herpetol.* **2013**, *47*, 41–65, doi:10.1670/11-157.
28. Lariman; Desyana, M.; Trimurti, S. Study of False Gharial (Tomistoma Schlegelii) Habitat Characteristics in Mesangat Wetlands, East Kutai, East Kalimantan. *Int. J. Sci. Res.* **2020**, *10*, 649–653, doi:10.21275/SR211208061717.
29. Stuebing, R.; Sommerlad, R.; Staniewicz, A. Conservation of the Sunda Gharial Tomistoma Schlegelii in Lake Mesangat, Indonesia. *Int. Zoo Yearb.* **2015**, *49*, 137–149, doi:10.1111/izy.12068.
30. Kurniati, H.; Widodo, T. Surveys of Siamese Crocodile (Crocodylus Siamensis) Habitat in the Mahakam River, East Kalimantan. *Zoo Indones.* **2005**, *16*, 51–62.
31. Sam, H.; Hor, L.; Nhek, R.; Sorn, P.; Heng, S.; Simpson, B.; Starr, A.; Brook, S.; Frechette, J.L.; Daltry, J.C. Status, Distribution and Ecology of the Siamese Crocodile Crocodylus Siamensis in Cambodia. *Cambodian J. Nat. Hist.* **2015**, 153–164.
32. Morpurgo, B.; Gvaryahu, G.; Robinzon, B. Aggressive Behaviour in Immature Captive Nile Crocodiles, Crocodylus Niloticus, in Relation to Feeding. *Physiol. Behav.* **1993**, *53*, 1157–1161, doi:10.1016/0031-9384(93)90373-N.
33. Behler, N.; Kopsieker, L.; Staniewicz, A.; Darmansyah, S.; Stuebing, R.; Ziegler, T. Population Size, Demography and Diet of the Siamese Crocodile, Crocodylus Siamensis (Schneider, 1801) in the Mesangat Swamp in Kalimantan, Indonesia. *Raffles Bull. Zool.* **2018**, *66*, 506–516.


 

34. Sudrajat, H.A.S. The Potential of Mesangat Lake , East Kutai , Indonesia as an Essential Ecological Area for Habitat Conservation of Critically Endangered Crocodylus Siamensis. *Biodiversitas* **2019**, *20*, 3126–3133, doi:10.13057/biodiv/d201104.

35. Saputro, M.; Rifanjani, S.; Siahaan, S. Studi Habitat Buaya Senyulong (Tomistoma Schlegelii) Di Sungai Sekonyer Taman Nasional Tanjung Puting Kalimantan Tengah. *J. Hutan Lestari* **2020**, *8*, 145–155.

36. Ratanakorn, P.; Chamsai, T.; Sedwisai, P.; Sujittosakul, T.; Lapjatuporn, T.; Wongluechai, P.; Tiyanun, E.; Kunsorn, A.; Puangdee, S.; Chooma, T.; et al. Population Assessment of Crocodiles in Bueng Boraphet, Thailand. *J. Appl. Anim. Sci.* **2021**, *14*, 21–32.

37. Bezuijen, M.R.; Webb, G.J.W.; Hartoyo, P.; Samedi Peat Swamp Forest and the False Gharial Tomistoma Schlegelii (Crocodilia, Reptilia) in the Merang River, Eastern Sumatra, Indonesia. *Oryx* **2001**, *35*, 301–307, doi:10.1046/j.1365-3008.2001.00195.x.

38. Stuebing, R.B.; Bezuijen, M.R.; Auliya, M.; Voris, H.K. The Current and Historic Distribution of Tomistoma Schlegelii (The False Gharial ) (Müller , 1838) (Crocodylia , Reptilia ). *RAFFLES Bull. Zool.* **2006**, *54*, 181–197.

39. Setiawan, A.; Safri, A.; Prima, B.; Kadarisman, R.; Indrianti, W.; Oktaberi, R. Recent Observation of False Gharial (Tomistoma Schlegelii) in the Sembilang Natonal Park (TNS) Area, Banyuasin Regency, South Sumatera Province. *BIOVALENTIA Biol. Res. J.* **2019**, *5*, 8–13, doi:10.24233/biov.5.1.2019.133.

40. Shaney, K.J.; Hamidy, A.; Walsh, M.; Arida, E.; Arimbi, A.; Smith, E.N. Impacts of Anthropogenic Pressures on the Contemporary Biogeography of Threatened Crocodilians in Indonesia. *Oryx* **2019**, *53*, 570–581, doi:10.1017/S0030605317000977.

41. Stuebing, R.B.; Bezuijen, M.R.; Auliya, M.; Voris, H.K. The Current and Historic Distribution of Tomistoma Schlegelii (the False Gharial) (Müller, 1838) (Crocodylia, Reptilia). *Raffles Bull. Zool.* **2006**, *54*, 181–197.

42. Wicke, B.; Sikkema, R.; Dornburg, V.; Faaij, A. Exploring Land Use Changes and the Role of Palm Oil Production in Indonesia and Malaysia. *Land use policy* **2011**, *28*, 193–206, doi:10.1016/j.landusepol.2010.06.001.

43. Stuebing, R.; Anuar, S.; Sah, M.; Lading, E.; Jong, J. The Status of Tomistoma Schlegelii ( Mueller ) in Malaysia. *Group* **2004**, 136–140.

44. Morrison, J.C.; Sechrest, W.; Dinerstein, E.; Wilcove, D.S.; Lamoreux, J.F. Persistence of Large Mammal Faunas as Indicators of Global Human Impacts. *J. Mammal.* **2007**, *88*, 1363–1380, doi:10.1644/06-MAMM-A-124R2.1.

45. Karanth, K.K.; Naughton-Treves, L.; Defries, R.; Gopalaswamy, A.M. Living with Wildlife and Mitigating Conflicts around Three Indian Protected Areas. *Environ. Manage.* **2013**, *52*, 1320–1332, doi:10.1007/s00267-013-0162-1.

46. Sawyer, H.; Kauffman, M.J.; Middleton, A.D.; Morrison, T.A.; Nielson, R.M.; Wyckoff, T.B. A Framework for Understanding Semi-Permeable Barrier Effects on Migratory Ungulates. *J. Appl. Ecol.* **2013**, *50*, 68–78, doi:10.1111/1365-2664.12013.

47. Martinuzzi, S.; Withey, J.C.; Pidgeon, A.M.; Plantinga, A.J.; McKerrow, A.J.; Williams, S.G.; Helmers, D.P.; Radeloff, V.C. Future Land-Use Scenarios and the Loss of Wildlife Habitats in the Southeastern United States. *Ecol. Appl.* **2015**, *25*, 160–171, doi:10.1890/13-2078.1.

48. Numata, I.; Silva, S.S.; Cochrane, M.A.; d'Oliveira, M. V. Fire and Edge Effects in a Fragmented Tropical Forest Landscape in the Southwestern Amazon. *For. Ecol. Manage.* **2017**, *401*, 135–146, doi:10.1016/j.foreco.2017.07.010.

49. Nde, S.C.; Bett, S.K.; Mathuthu, M.; Palamuleni, L. Anthropogenic Land Use and Land Cover Change as Potential Drivers of Sediment Sources in the Upper Crocodile River, North West Province, South Africa. *Int. J. Environ. Res. Public Health* **2022**, *19*, doi:10.3390/ijerph192013313.

50. Saragih, G.S.; Kayat; Hidayatullah, M.; Hadi, D.S. A Preliminary Study on the Population and Habitat of Saltwater Crocodile (Crocodylus Porosus) in Timor Island, East Nusa Tenggara. *IOP Conf. Ser. Earth Environ. Sci.* **2020**, *591*, doi:10.1088/1755-1315/591/1/012044.

51. Amarasinghe, A.A.T.; Madawala, M.B.; Karunarathna, D.M.S.S.; Manolis, S.C.; de Silva, A.; Sommerlad, R. Human-Crocodile Conflict and Conservation Implications of Saltwater Crocodiles Crocodylus Porosus (Reptilia: Crocodylia: Crocodylidae) in Sri Lanka. *J. Threat. Taxa* **2015**, *7*, 7111–7130, doi:10.11609/jott.o4159.7111-30.

52. Knowlton, A.R.; Clark, J.S.; Hamilton, P.K.; Kraus, S.D.; Pettis, H.M.; Rolland, R.M.; Schick, R.S. Fishing Gear Entanglement Threatens Recovery of Critically Endangered North Atlantic Right Whales. *Conserv. Sci. Pract.* **2022**, *4*, 1–14, doi:10.1111/csp2.12736.


 

53. Platt, S.G.; Monyrath, V.; Sovannara, H.; Kheng, L.; Rainwater, T.R. Nesting Phenology and Clutch Characteristics of Captive Siamese Crocodiles (Crocodylus Siamensis) in Cambodia. *Zoo Biol.* **2012**, *31*, 534–545, doi:10.1002/zoo.20418.

54. Suryanto; Sumanbowo, H.; Tresina; Noor, A.; Muslim, T.; Suimah; Kusneti, M.; Isa, N. *Rencana Aksi Perlindungan Dan Konservasi Kawasan Ekosistem Esensial Lahan Basah Mesangat-Suwi (2019-2023)*; 2019; ISBN 9786239024802.

55. Rodríguez-Caro, R.C.; Graciá, E.; Blomberg, S.P.; Cayuela, H.; Grace, M.K.; Carmona, C.P.; Pérez-Mendoza, H.A.; Gimenez, A.; Salguero-Gómez, R. Anthropogenic Impacts on Threatened Species Erode Functional Diversity in Turtles and Crocodilians. **2022**, doi:10.1101/2022.03.11.483822.

56. Hassan, R.; Ahmad, R.; Md Adzhar, M.A.A.; Gani, M.I.Z.A.; Ayob, A.; Zainudin, R. Notes on the Wild Tomistoma Populations in Western Sarawak, Malaysian Borneo. *Int. J. Ecol.* **2016**, *2016*, doi:10.1155/2016/4357623.

57. Sideleau, B.; Staniewicz, A.; Syah, M.; Shaney, K.J. An Analysis of Tomistoma (Tomistoma Schlegelii) Attacks on Humans. *Mar. Freshw. Res.* **2022**, *73*, 1331–1338, doi:10.1071/MF22015.

58. Cox, J.J.H.; Phothitay, C. *Survey of the Siamese Crocodile Crocodylus Simensis in Savannkakhet Province , Lao PDR, 6 May - 4 June 2008*; OZ Minerals Ltd. & Wildlife Conservation Society, 2008;

59. Bolaños, J.R. Manejo de Cocodrilos (Crocodylus Acutus) En Estanques de Cultivo de Tilapia En Cañas, Guanacaste. *Rev. Ciencias Ambient.* **2012**, *43*, 63, doi:10.15359/rca.43-1.6.

60. Valdelomar, V.; Ramírez-Vargas, M.A.; Quesada-Acuña, S.G.; Arrieta, C.; Carranza, I.; Ruiz-Morales, G.; Espinoza-Bolaños, S.; Mena-Villalobos, J.M.; Brizuela, C.; Miranda- Fonseca, L.; et al. Percepción y Conocimiento Popular Sobre El Cocodrilo <em>Crocodylus Acutus</Em> (Reptilia:Crocodylidae) En Zonas Aledañas Al Río Tempisque, Guanacaste, Costa Rica. *UNED Res. J.* **2012**, *4*, 191–202, doi:10.22458/urj.v4i2.8.

61. Sandoval-Hernández, I.; Duran-Apuy, A.; Quirós-Valerio, J. Activities That May Influence the Risk of Crocodile (Crocodylus Acutus: Reptilia: Crocodilidae) Attack to Humans in the Tempisque River Area, Guanacaste, Costa Rica. *Uniciencia* **2017**, *31*, 13, doi:10.15359/ru.31-1.2.

62. Sandoval Murillo, L.F.; Morera Beita, C.; Sandoval Hernández, I. Zonificación de Las Áreas Propensas a Incidentes Por Ataques de Crocodylus Acutus En El Pacífico Central de Costa Rica Utilizando Un Sistema de Información Geográfico. *Rev. Cart.* **2019**, 259–279, doi:10.35424/rcar.v5i98.150.

63. Manurung, R.; Kusrini, M.D.; Prasetyo, L.B. Mapping the Distribution of Saltwater Crocodile (Crocodylus Porosus) and Risks of Human-Crocodile Conflicts in Settlements Around Kutai National Parl, East Kalimantan. *Media Konserv.* **2021**, *26*, 52–62, doi:10.29244/medkon.26.1.52-62.

64. Mascarenhas, P.B.; Maffei, F.; Muniz, F.; Freitas-Filho, R.F.; Portelinha, T.C.G.; Campos, Z.; Bassetti, L.A.B. Conflicts between Humans and Crocodilians in Urban Areas across Brazil: A New Approach to Support Management and Conservation. *Ethnobiol. Conserv.* **2022**, *10*, doi:10.15451/ec2021-12-10.37-1-19.

65. Ardiantiono; Henkanaththegedara, S.M.; Sideleau, B.; Anwar, Y.; Haidir, I.A.; Amarasinghe, A.A.T. Integrating Social and Ecological Information to Identify High-Risk Areas of Human-Crocodile Conflict in the Indonesian Archipelago. *Biol. Conserv.* **2023**, *280*, 109965, doi:10.1016/j.biocon.2023.109965.

66. Syafutra, R.; Apriyani, R.; Heri; Karsina, L.; Wulan, N.A.N. Mitigasi Konflik Manusia-Buaya Muara Di Desa Kayu Besi Dan Bukit Layang, Kabupaten Bangka. *J. Pengabdi. Kpd. Masy. Nusant.* **2023**, *4*, 565–572.

67. Rahmat, U.M.; Santosa, Y.; Prasetyo, L.B.; Kartono, A.P. Pemodelan Kesesuaian Habitat Badak Jawa (Rhinoceros Sondaicus Desmarest 1822) Di Taman Nasional Ujung Kulon, 2012, Vol. 18.

68. Gálvez, N.; Guillera-Arroita, G.; St. John, F.A.V.; Schüttler, E.; Macdonald, D.W.; Davies, Z.G. A Spatially Integrated Framework for Assessing Socioecological Drivers of Carnivore Decline. *J. Appl. Ecol.* **2018**, *55*, 1393–1405, doi:10.1111/1365-2664.13072.

69. Struebig, M.J.; Linkie, M.; Deere, N.J.; Martyr, D.J.; Millyanawati, B.; Faulkner, S.C.; Le Comber, S.C.; Mangunjaya, F.M.; Leader-Williams, N.; McKay, J.E.; et al. Addressing Human-Tiger Conflict Using Socio-Ecological Information on Tolerance and Risk. *Nat. Commun.* **2018**, *9*, doi:10.1038/s41467-018-05983-y.

70. Fukuda, Y.; Manolis, C.; Appel, K. Featured Article: Management of Human-Crocodile Conflict in the Northern Territory, Australia: Review of Crocodile Attacks and Removal of Problem Crocodiles. *J. Wildl. Manage.* **2014**, *78*, 1239–1249, doi:10.1002/jwmg.767.

71. Leaper, R.; Calderan, S. *Published by the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals*; 2018; ISBN 9783937429267.


 

72. Cherkiss, M.S.; Mazzotti, F.J.; Hord, L.; Aldecoa, M. Remarkable Movements of an American Crocodile (Crocodylus Acutus) in Florida. *Southeast. Nat.* **2014**, *13*, N52–N56, doi:10.1656/058.013.0407.

73. Brunell, A.M.; Deem, V.; Bankovich, B.; Bled, F.; Mazzotti, F.J. Effects of Translocation on American Crocodile Movements and Habitat Use in South Florida*. J. Wildl. Manage.* **2023**, *87*, 1–20, doi:10.1002/jwmg.22427.