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## Conservation of the Sunda gharial *Tomistoma schlegelii* in Lake Mesangat, Indonesia

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Although featured in many international zoo collections for decades, little was known about the natural history of Sunda gharial *Tomistoma schlegelii* until recently. Zoos rarely keep large individuals and breeding success has been low. As late as 1998, even though most conservationists regarded the conservation status of the species as Endangered, the reality was that over most of the range the actual status of the Sunda gharial was Data Deficient. Beginning with surveys of the species by international and local scientists in Indonesian Sumatra and, later, in Kalimantan, Indonesian Borneo, supported by the International Union for Conservation of Nature/Species Survival Commission Crocodile Specialist Group, more details on the broad distribution of this crocodylian came to light. Ironically, rediscovery of a large and healthy population of *T. schlegelii* in East Kalimantan arose from an oil-palm company accessing the area to develop a site called Danau Mesangat. Subsequently through a cooperation agreement with the oil-palm company's conservation department and a local foundation, a group of dedicated zoos in Europe and America, and the Tomistoma Task Force set up by the Crocodile Specialist Group, provided funding for three consecutive years of field studies by a research group. These studies investigated the ecology of *T. schlegelii* and of a sympatric population of the Critically Endangered Siamese crocodile *Crocodylus siamensis*. The role of the zoos, including their role in the development of the research programme, is described. Accounts are given of the characteristics of the Mesangat habitat, some new details about the distribution and abundance of Sunda gharial and Siamese crocodiles in the habitat, and information about reproduction in *T. schlegelii*. In summary, an overview of threats and suggestions for conservation actions needed at the Mesangat site are provided.

**Key-words:** endangered species; habitat threats; Indonesia; invasive species; Kalimantan; Siamese crocodile; Sunda gharial; wetlands.

### INTRODUCTION

East Kalimantan, Borneo, remains one of the most forested Provinces in Indonesia, possessing not only dryland dipterocarp biomes but also extensive wetlands under mature kerangas (heath forest) and peat-swamp vegetation. Most of these disturbed wetland habitats occupy a crescent-shaped expanse extending south-westwards from c. 0·5° latitude north and south of the equator across the middle of the Province of East Kalimantan (Kalimantan Timur). The Danau Mesangat–Kenohan Suhuwi sites in the Muara Anca-long District form a major portion of this connected basin, within a depression extending from the Kelinjau and Kedang Kepala Rivers to as far as the Mahakam River at Muara Kaman (Fig. 1). Plantation agriculture generates mixed-use landscapes that contain a wide variety of habitats resulting from forest regrowth as well as various anthropogenic regimes, such as subsistence farms, large plantations, agroforestry projects, subsistence fishermen using small-mesh gillnets and electrofishing equipment, commercial fish farming, industrial development and a plethora of other uses.

Kalimantan Timur has been an import focus for expansion of oil-palm plantations since the late 1980s. Despite some obvious limitations (palms may not grow or produce fruit, or may be killed by annual flooding), a

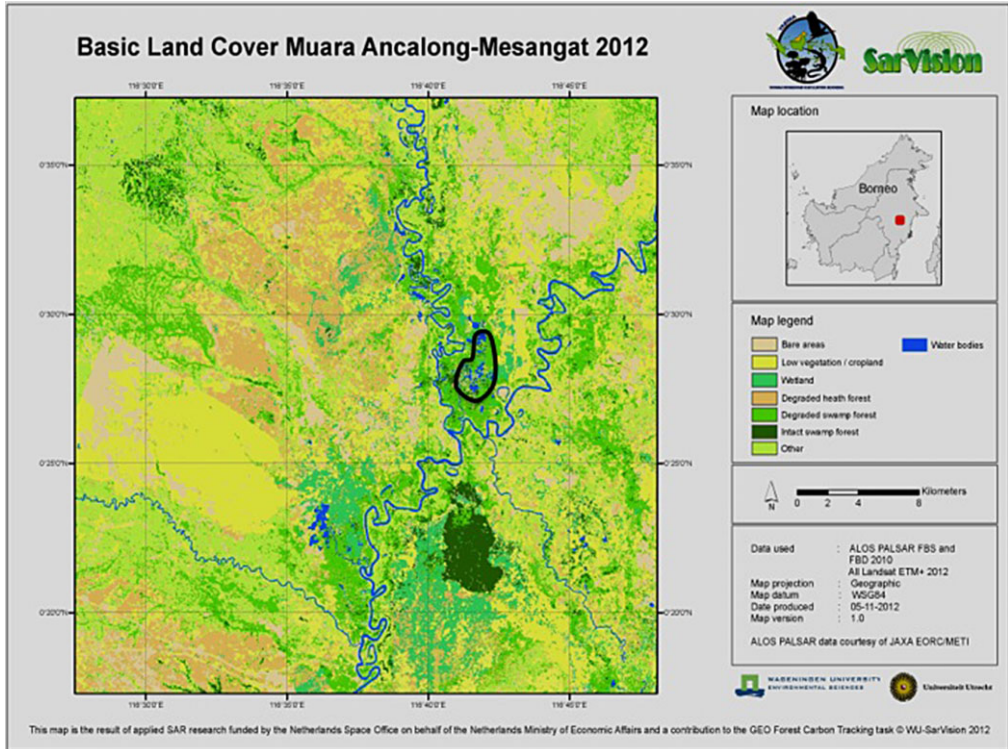


Fig. 1. Map of basic land cover for Mesangat–Kenohan Suhuwi wetland, Indonesia. Study area boundary indicated in black. SarVision for Yayasan Ulin.

substantial number of the wetland areas are still earmarked for plantation development. More important for conservation, many of these areas contain populations of threatened species that appear on the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2014). However, on lands set aside for plantations or mining (or a combination of these), threatened species – many of them as yet unidentified – face a high probability of local extinction and possibly extinctions in the wider landscape. The areas currently allocated as national parks and nature reserves cannot support adequately the range of species diversity that exists. This fact has been demonstrated both within and at the periphery of oil-palm estates, where threatened and previously unknown species

have been documented by local and international scientists (Wahyudi & Stuebing, 2013).

The Sunda gharial *Tomistoma schlegelii* was an enigma for decades, without any significant understanding of its ecology, distribution and abundance even within the IUCN/Species Survival Commission (SSC) Crocodile Specialist Group. Furthermore, because of the osteoderms in its ventral scales, *T. schlegelii* was rarely if ever exploited commercially as a source of crocodile leather, so that support of research by the crocodile-leather industry was limited, or incidental to studies of other species. However, by the mid-1990s more information had come to light, primarily related to surveys of other crocodile species, especially

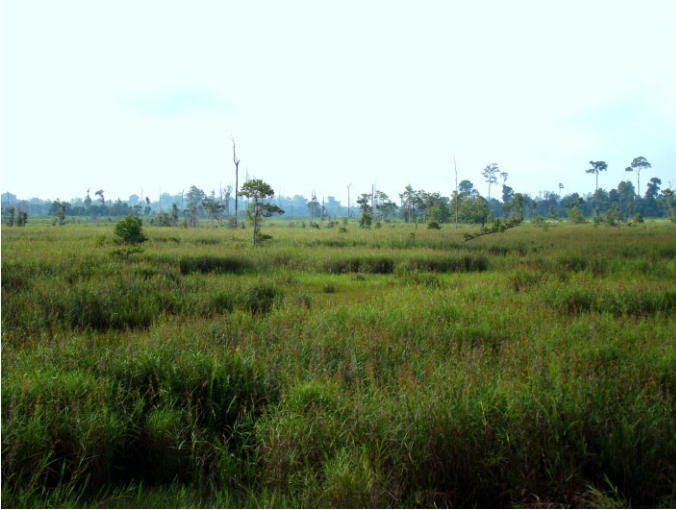
the Salt-water crocodile *Crocodylus porosus* in Borneo and Sumatra (Cox *et al.*, 1993; Bezuijen *et al.*, 2002, 2003). In 1997, a research report from the Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia: LIPI), Jakarta, and the Smithsonian Institution, Washington, DC, USA, on surveys of Siamese crocodile *Crocodylus siamensis* in Kalimantan, hinted that the Sunda gharial was much more widespread than had been previously thought (Bezuijen *et al.*, 2013). This was in stark contrast to the reports from Sumatra, where scientists inferred that the species was on the verge of extinction as a result of the impacts of logging, illegal land clearing and plantation development (Bezuijen *et al.*, 2002, 2003). The latter findings stimulated the preparation of several papers about the Sunda gharial that were presented at the IUCN/SSC Crocodile Specialist Group Working Meeting in Singapore in 1998 (Crocodile Specialist Group, 1998). Subsequently, an informal discussion group was formed to plan more systematic research on the species. The urgency for field research into the status of the Sunda gharial was revived at the 2002 Conservation Specialist Group meeting in Gainesville, FL, USA, and the Tomistoma Task Force was set up in 2003, chaired by Grahame Webb. The group was formed from a broad array of crocodile field biologists, husbandry specialists, and several members of government wildlife agencies from the main range states of Indonesia, Malaysia and Thailand.

In 2008, a special Tomistoma Task Force workshop in Pattaya, Thailand, targeted the development of a strategy for expanding field research on the ecology of the Sunda gharial. Later in that same year, a site called Lake Mesangat in the District of Kutai Timur, East Kalimantan, was identified as an important location where studies could begin. Originally <12 000 ha of wetland forests, the area is important to the livelihoods of traditional Kutai fishermen. Because there was easy river access through a tributary of the Mahakam River to the timber port of Samarinda, in the 1970s the District of Muara Ancalong witnessed a

rapid expansion of intensive forest exploitation. At the time of writing all that remains of the original forest are some small wooded 'islands' or domes lying in deeper, flooded basins. Generally <10 m above sea level, the Mesangat Lake now forms a landscape of patchy shrubs and sedges, interspersed with irregular groves or lines of trees (Plate 1). During the El Niño Southern Oscillation events of 1982–1983 and 1997–1998 (Chokkalingam *et al.*, 2005) vast areas experienced cycles of intensive burning by local farmers or immigrants from other parts of Indonesia. Grasses and shrubs permanently colonized the flat landscape. Habitat disturbance opened the door to a wide range of invasive exotic species, such as Water hyacinth *Eichornia crassipes*, Floating fern or Giant salvinia *Salvinia molesta*, apple snails *Pomacea* spp, Amazon sailfin catfish *Liposarcus (Pterygoplichthys) pardalis*, Giant snakehead *Channa micropeltes* and many others (Plate 2). Despite the loss of much of the natural vegetation over many decades, visits by local and international scientists have confirmed the presence of *T. schlegelii* and *C. siamensis* (Ross *et al.*, 1998; Kurniati *et al.*, 2005) (Plates 3 and 4). Mesangat remains home to at least six threatened species that have survived or even thrived in the mosaic of damaged habitats, including two species of freshwater crocodiles, a stork, a river turtle and at least two species of mammals (Table 1).

By 2007, most of the Mesangat wetland had been surveyed and sold for the development of oil-palm plantations. After two planting failures, and discussions with the PT.REA Kaltim Conservation (REA KON) staff, the company decided to restrict its development of the site and to investigate permanent allocation of specific areas for conservation management and sustainable use.

To date four field reports have been written on the Mesangat population of Sunda gharial, and two MSc projects have been completed. In due course the results of these studies, including the bulk of the ecological data, will be published.



**Plate 1.** The landscape around Mesangat Lake, Indonesia, today is made up of patchy shrubs and sedges, interspersed with irregular lines of trees. *Rob Stuebing, Yayasan Ulin.*



**Plate 2.** Habitat disturbance in the Mesangat Lake region, Indonesia, made way for a wide range of invasive exotic species, such as (left) the Water hyacinth *Eichornia crassipes* in the Abang area and (right) the Water fern *Salvinia molesta* in the Kenohan Suhuwi wetlands area. *Yayasan Ulin.*

## SUPPORT FOR MESANGAT CONSERVATION

In 2009, the Danau Mesangat–Kenohan Suhuwi area became a logical choice for implementation of long-term field studies of both the Sunda gharial and the Siamese crocodile (Stuebing & Sommerlad, 2010). The site was the only known location in South East Asia where healthy natural popu-

lations of both species occurred in relative abundance. The early work of the conservation staff of REA KON, and its associated conservation foundation, the Ironwood Foundation (Yayasan Ulin), drew the attention of the IUCN Crocodile Specialist Group’s Tomistoma Task Force. These somewhat disparate bodies began collaborative ecological studies of the crocodiles and their habitat. The initial challenge was to find



**Plate 3.** Head of a Sunda gharial *Tomistoma schlegelii* at Lake Mesangat, Indonesia. Agata Staniewicz, Bristol University.

sources of funding for this relatively unknown, isolated and degraded habitat.

Support was found from abroad such as the Mohamed Bin Zayed Species Conservation Fund (Project no. 0925309), Abu Dhabi, United Arab Emirates, and the generosity of public and private zoos and aquariums in Europe and the United States, which provided a well-timed opportunity to initiate in-depth ecological studies of both the threatened crocodile species in Mesangat. An unusual partnership developed between conservation biologists, the zoological facilities and an oil-palm plantation company, and was unique in providing the means for developing a detailed picture of the autecology of both *T. schlegelii* and *C. siamensis*.

Even though the Sunda gharial has long been reared in crocodile ‘tourist’ farms and zoos throughout South East Asia, most holdings were of single animals, pairs or small groups that were kept in enclosures of limited size with the sole purpose of keeping the crocodiles conspicuously on view for visitors. These conditions virtually guaranteed that little understanding about the natural ecology and behaviour of the Sunda gharial would ever be achieved. Furthermore, the lack of any commercial value of the skins or meat of *T. schlegelii* generated minimal commercial interest. Nevertheless, the novel appearance of this crocodylian and its secretive habits in the wild made the species an excellent attraction for zoo exhibits and

tourist parks, few of which made any real attempts to breed the species.

Only a few farms made concerted efforts to breed this iconic crocodylian, especially Utairatch Crocodile Farm in Samutprakarn, Thailand (owner Uthen Youngpapakorn), and Jong’s Crocodile Farm in Kuching, Sarawak, Malaysia (owned by Johnson Jong and family), both of which successfully established sustainable breeding stocks (Plate 5).

The Sunda gharial was a common species in European zoological facilities in the 20th century. Most specimens were obtained from international animal dealers, such as Carl Hagenbeck, who founded his company in 1848 and became one of the largest wildlife dealers worldwide (Hanson, 2004). Hagenbeck and others kept in close contact with dealers and hunters in Malaysia and Indonesia. Singapore developed as the principal hotspot for the international wildlife trade, so that most of the *T. schlegelii* that came to Europe in the second half of the 20th century originated from dealers based there. The provenance of these traded animals remained essentially unknown (Trutnau & Sommerlad, 2006).

Until the early 1970s, crocodiles were mostly kept in multi-species groups and for that reason often did not do well, although there were individuals that survived for several decades under these suboptimal conditions (Sommerlad *et al.*, 2011). When modern zoos sought to transform their image and practices from that of menageries to ‘cageless’ exhibits to promote wildlife conservation, several crocodylian species gradually disappeared from European collections and the number of facilities keeping the Sunda gharial also declined.

Because of the scarcity of empirical data concerning the conservation status of *T. schlegelii* in the wild, and their Endangered Red List status at that time (IUCN, 2014), the European Association of Zoos and Aquaria (EAZA) was urged by the then Chair of the Crocodile Specialist Group Tomistoma Task Force, Ralf Sommerlad, at the 2004 EAZA conference in Kolmarden, to establish a captive-breeding programme for the Sunda



**Plate 4. Female Siamese crocodile *Crocodylus siamensis* basking on an old nest in the Mesangat wetland, Indonesia. Camera-trap photograph. Agata Staniewicz, Bristol University/Yayasan Ulin.**

SPECIES	IUCN STATUS	CITES	CURRENT THREAT LEVEL IN MESANGAT
Sunda gharial <i>Tomistoma schlegelii</i>	VU	I	Moderate
Siamese crocodile <i>Crocodylus siamensis</i>	CR	I	Moderate
Malaysian giant turtle <i>Orlitia borneensis</i>	EN	II	High
Southeast Asian softshell turtle <i>Amyda cartilaginea</i>	VU	II	Moderate
Storm's stork <i>Ciconia stormi</i>	EN		High
Leopard cat <i>Prionailurus bengalensis</i>	LC	I	Moderate
Proboscis monkey <i>Nasalis larvatus</i>	EN	I	Moderate

**Table 1. Threatened vertebrate species in Mesangat, Indonesia: CITES. Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES, 2014); I. CITES Appendix I; II. CITES Appendix II; International Union for Conservation of Nature (IUCN): Red List categories: CR, Critically Endangered; EN, Endangered; LC, Least Concern; VU, Vulnerable (IUCN, 2014).**

gharial in European zoological facilities (Shwedick, 2006). The EAZA Reptile Taxon Advisory Group promptly agreed and set up the European studbook with Gonzalo Fernandez-Hoyo at Fuengirola Zoo, Spain, as studbook keeper. In 2006, Fuengirola Zoo was the first zoo in Europe to successfully breed *T. schlegelii*, and more were hatched in 2010 (Fernandez-Hoyo, 2012). As more zoos became interested in exhibiting this large, narrow-snouted crocodylian, several built new, spacious and modern exhibits (e.g. Leipzig Zoo, Germany; Dvur Kralove Zoo, Czech Republic). ARTIS Amsterdam, The Netherlands, recently constructed a new exhibit to house their large old pair of *T. schlegelii*, formerly displayed in the reptile house (W. Spencer, pers. comm., 2013).

At the time of writing, the European studbook for *T. schlegelii* lists 43 individuals at ten European facilities (Fernandez-Hoyo, 2012; G. Fernandez-Hoyo, pers. comm., 2013). Protivin Crocodile Zoo in the Czech Republic now holds the largest group of Sunda gharial in Europe. Outside Europe, the São Paulo Zoo, Brazil, and Taipei Zoo, Taiwan, also joined the European studbook population and the number of



**Plate 5.** Sunda gharial *Tomistoma schlegelii* on a nest at Jong Crocodile Farm, Kuching, Sarawak, Malaysia. *Rob Stuebing*.

captive-bred individuals continues to grow. The first *T. schlegelii* to hatch in the USA occurred at both the Bronx Zoo, NY, and Miami Zoo, FL, in 1985; since 2008 San Antonio Zoo, TX, USA, has also been successfully breeding the Sunda gharial (Shwedick *et al.*, 2013).

This growing interest in *T. schlegelii* and its conservation was well timed to assist the Mesangat Conservation Project, set up in early 2009 by REA-KON.

Confirmation of the presence of the Critically Endangered (CR) Siamese crocodile *C. siamensis* at Lake Mesangat led to growing support for this *in situ* project by the Zoologische Gesellschaft für Arten- und Populationsschutz (ZGAP), the Deutsche Gesellschaft für Herpetologie und Terrarienkunde (DGHT), and several European and American zoos. Without the financial, scientific or organizational support of institutions in Germany, including Cologne Zoo, Dortmund Zoo, Erfurt Zoo, Frankfurt Zoo and Neunkirchen Zoo, Protivin Crocodile Zoo in the Czech Republic and institutions in the USA, including the Virginia Aquarium, VA, and the Crocodylian Advisory Group of the Association of Zoos &

Aquariums, field research and conservation activities at Mesangat would not have been possible (Sommerlad, 2012). The Mohamed Bin Zayed Species Conservation Fund donated significantly to Mesangat conservation, and assistance was also received from the IUCN-SSC Crocodile Specialist Group and its *Tomistoma* Task Force.

Through the Cologne Zoo and Dortmund Zoo, the Mesangat Crocodile Conservation Project became a partner project for the World Association of Zoos and Aquariums, providing funding and articles for publication (Sommerlad *et al.*, 2010). When the EAZA–IUCN/SSC South East Asia Campaign launched in 2011, the Mesangat project was selected as one of the flagship projects and received support from many EAZA (and non-EAZA) institutions (Marseille, 2011).

From 2009 to 2012 European zoos donated more than 20 000 Euros to support the field research of two research students (A. Staniewicz and N. Behler). These funds were also used to obtain a suitable boat and outboard motor, and for the renovation of the raft-station facilities. Most of the funds given by zoos were collected from visitors, either via a donation funnel for coins beside

posters explaining the conservation project (in the rainforest house at Dortmund Zoo) or by selling information booklets (Protivin Crocodile Zoo). Cologne Zoo also collected funds and provided additional support, including the supervision of the work on Siamese crocodiles by Associate Professor Dr Thomas Ziegler, who also had some input into the Sunda gharial field research.

#### FIELD RESEARCH 2009–2012

With financial support by European zoos, conservation funds and Yayasan Ulin, from 2009 to 2012 Agata Staniewicz of Bristol University, UK, conducted extensive field studies into the ecology and population structure of *T. schlegelii*. From 2010 to 2012, Natascha Behler of Bonn University, Germany, concurrently implemented a study into the ecology and taxonomy of the sympatric and CR Siamese crocodile *C. siamensis*. Other studies carried out in Mesangat included that of aquatic life (Wowor & Hadiaty, 2010), a preliminary camera-trapping inventory of the mammal fauna and studies of Asiatic softshell turtle *Amyda cartilaginea* and Malaysian giant turtle *Orlitia borneensis* (REA Kaltim Conservation and Yayasan Ulin), and botanical surveys of wetland forests (Leong, 2011), all of which were implemented concurrently.

Assisted by local fishermen and Yayasan Ulin staff, Agata Staniewicz was stationed for weeks at a time on a simple raft anchored in the Mesangat wetland. At least 2 months were spent mapping and assessing habitat characteristics, and conducting spotlight surveys, mark–recapture studies and investigations into the diet of the Sunda gharial. In order to account for seasonal differences in water level and access to the wetlands, observations took place over three separate field seasons: during the rainy season of October–December 2010, the dry season of June–September 2011 and a transitional period from May to July 2012. There is a series of field reports on the recent crocodile studies in Mesangat (Indraswari & Staniewicz, 2009; Behler, 2011; Staniewicz, 2011b). In addition,

an informational poster on Mesangat Conservation was prepared for a working meeting of the IUCN Crocodile Specialist Group in 2010 (Staniewicz, 2011a) (Fig. 2).

Wild juvenile *T. schlegelii* were found to inhabit predominantly flooded forest areas of Mesangat (A. Staniewicz, unpubl. data) (Plate 6). In total, 30 Sunda gharial were captured over the three field seasons. The apparent preference of habitat largely inaccessible to people, combined with highly secretive lifestyle and low capture-and-recapture rates, made it difficult to assess accurately the population size of *T. schlegelii* in the area. The studies thus focused on juveniles, which were easier to approach, and habitat partitioning with the sympatric *C. siamensis*. The Siamese crocodile was found predominantly in the open water areas of Mesangat (A. Staniewicz, unpubl. data; N. Behler, unpubl. data). Juvenile *T. schlegelii* are apparently generalist, opportunistic feeders with a diet consisting of invertebrates and small vertebrates, similar to that seen in other crocodylians (Taylor, 1979; Platt *et al.*, 2006; A. Staniewicz, unpubl. data). Nesting season was confirmed to occur during the dry season (June–September) with mound nests built on land at the base of a tree in close proximity to water, similar to earlier observations, both published (Ross *et al.*, 1998; Bezuijen *et al.*, 2002, 2010) and unpublished (R. Stuebing, unpubl. field data, Sarawak and East Kalimantan) (Plate 7). Preliminary investigations into physiological colour-change ability in *T. schlegelii* were also carried out (A. Staniewicz, pers. comm). For additional early field results, see the poster in Fig. 2.

#### SUSTAINING SUNDA GHARIAL WITHIN DEGRADED ECOSYSTEMS

Work in Mesangat was activated in 2008 and increased in intensity until 2012. Beginning in mid-2013, fieldwork temporarily ceased and is currently on hold. It is the hope that the project will be reactivated in the future, once human and financial resources are available, including work on a more effective radio-tracking technique and more





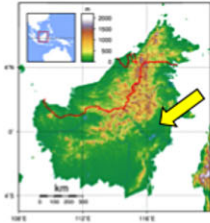
# Crocodiles in Mesangat Lake East Kalimantan, Indonesia

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## Mesangat Lake

Mesangat Lake is located in the Lower Mahakam river area in East Kalimantan. It is connected to several rivers and expands into a large freshwater swamp during the wet season, with its surface covered by floating natural and exotic vegetation.

The area, under threat from Oil Palm development is home to two crocodile species: *Crocodylus siamensis* and *Tomistoma schlegelii*.

## *Crocodylus siamensis* *Tomistoma schlegelii*



IUCN Red List: 'Critically Endangered'

IUCN Red List: 'Endangered'

## Objectives

1. Assess the population size and distribution of both species in the area.
2. Obtain data on crocodile location in the rainy season for further studies of seasonal movements.
3. Obtain information on general biology and feeding ecology of both species.

## Crocodile distribution and demography

A total of 155 eye shines was recorded, including 30 *C. siamensis*, and 58 *T. schlegelii*. Both species occur together in most locations, however there is also some evidence for space partitioning (Fig. 1). More *T. schlegelii* were seen in the land and flooded forest area in the North, while in the South, a large open area covered in floating vegetation, only large *C. siamensis* were spotted. Both species were frequently seen in other parts of Mesangat, in open areas covered with floating vegetation.

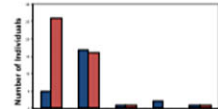


Fig. 2: Estimated sizes of 26 identified *C. siamensis* (blue) and 44 *T. schlegelii* (red) observed or captured throughout survey period.

Most of the *T. schlegelii*, both seen and captured, were smaller than the *C. siamensis* (Fig. 2). This is probably due to different nesting periodicity.

**North: flooded forest**  
mostly *T. schlegelii*

**Other areas: open with floating vegetation**  
both species present

**South: open with floating vegetation**  
mostly *C. siamensis*

## Methods

52 spotlight surveys were carried out during the rainy season from 28<sup>th</sup> October to 4<sup>th</sup> December 2010. Crocodiles were identified to species or classified as 'eye shine' and their position marked on GPS. Captured crocodiles were measured, weighted and individually tagged with PIT tags (*C. siamensis*) or external bead tags (*T. schlegelii*). One tail scute was also clipped from each animal. Stomach contents was obtained from live crocodiles by stomach flushing.

## Diet

Table 1: Preliminary analysis of stomach contents of captured crocodiles.

Species	No.	TL (cm)	BM (kg)	Stomach contents				
				Aquatic invertebr.	Land invertebr.	Aquatic vertebr.	Land vertebr.	Plant material
<i>T. schlegelii</i>	1	43	127		x			
	2	44.5	127	x				
	3	42.4	115		x			
<i>C. siamensis</i>	4	61.9	366			x	x	
	5	95	2370			x	x	x
	6	59	430			x	x	x
	7	76.6	1230			x	x	x
	8	87.3	1730			x	x	x
	9	88.1	1800			x	x	x
	10	80	1350			x	x	x

*T. schlegelii* individuals (No. 1-4) and *C. siamensis* (No. 5-10): Total length (TL), Body Mass (BM), presence of aquatic invertebrates, land invertebrates (insects and arachnids), aquatic vertebrates (fish), land vertebrates and plant material denoted as 'x'.

Stomachs of *T. schlegelii* contained mostly invertebrates, mainly insects and spiders and only the largest individual contained vertebrate remains (frog). All but one *C. siamensis* had both invertebrate and vertebrate remains, generally identifiable as fish. This difference in stomach contents is probably related to body size difference of captured individuals.

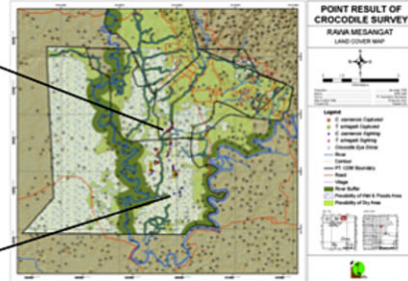


Fig. 1: General distribution of crocodiles in Mesangat Lake (figure prepared by Yayasan IAIN)



Fig. 2. A poster describing early work carried out in the Mesangat Lake area, Indonesia, on population size and distribution, seasonal movements, and general biology and feeding ecology for Sunda gharial *Tomistoma schlegelii* and Siamese crocodile *Crocodylus siamensis*.



**Plate 6. Wild juvenile Sunda gharial *Tomistoma schlegelii* inhabit the flooded forest area around Mesangat, Indonesia.** *Agata Staniewicz, Bristol University/Yayasan Ulin.*



**Plate 7. Sunda gharial *Tomistoma schlegelii* build mound nests on land at a base of a tree in close proximity to water around the Mesangat Lake area, Indonesia.** *Agata Staniewicz, Bristol University/Yayasan Ulin.*

extensive involvement of the village communities in Muara Ancalong. A head-starting effort is also planned for *T. schlegelii*, *C. siamensis* and at least one species of threatened terrapin, although all the details are not yet finalized. A stepwise assessment of the commercial value of any local or exotic species occur-

ring in Mesangat will be undertaken next to initiate long-term management for sustainable consumptive or non-consumptive (e.g. recreation and nature tourism) use of aquatic resources. Active or passive habitat restoration will also be implemented at the same time, with efforts to remove at least some invasive species.

Meanwhile the development of oil-palm plantations has continued in the Mesangat area, and the threats to the wetland and its threatened species remain.

### THREATS TO *T. SCHLEGELII*

#### Habitat destruction by plantation companies as well as the local government

Efforts continue towards the completion of large-scale conversion of the greater Mesangat–Kenohan Suhuwi wetlands into plantation agriculture (oil palm or fast-growing timber, such as *Acacia* spp). The most serious threat lies with clearing and draining of extensive wetland sites for plantation agriculture. Repeated attempts continue to drain flooded sites of the Mesangat–Kenohan Suhuwi wetland.

#### Disturbance, harvest and sale of threatened species in Lake Mesangat

Crocodile nesting sites continue to be raided by local people who collect and sell eggs of both *T. schlegelii* and *C. siamensis*, and the occasional crocodile is killed when it drowns in a fishing net. In addition, the harvest and sale of riverine/wetland turtles and their eggs, and the hunting of Proboscis monkeys *Nasalis larvatus* as food continues.

#### Use of toxic, persistent chemicals in agriculture or control of invasive water weeds

A whole range of invasive exotic aquatic plants continues to spread into the degraded areas of the wetland, dominated by Water hyacinth *E. crassipes* and Floating fern *S. molesta*. These species and others have already colonized vast areas in thick masses, forming floating mats that hamper use of the waterways by local fishermen. The senescent mass then decomposes, creating anoxic conditions in large areas of the Lake. Periodically – and only temporarily –

the weeds are attacked by the local fisherman by spraying non-selective contact herbicides, such as Gramoxone and Paracol, available from oil-palm plantation suppliers. Substantial levels of fertilizer run-off continue to be diverted into the wetland, further enhancing the growth of *E. crassipes* and *S. molesta*.

### PROPOSED FUTURE ACTION

- Extend research to discover the true geographic distribution of *T. schlegelii* in East Kalimantan (and elsewhere in Borneo) because most current information is still inadequate or out of date.
- Determine the specific nest requirements, characteristics (temperature, depth, tolerated level of disturbance) and the real-time distribution of reproductive adult *T. schlegelii* in the appropriate Mesangat habitat.
- Determine differences in behaviour in disturbed versus relatively pristine areas. For example, compare the very differently behaved *T. schlegelii* in Tanjung Putting in Central Kalimantan (where the species openly basks), with the shyness of the animals observed in Mesangat.
- Initiate a financially robust, long-term radio-tracking study using tower and cell-phone technology. For more extensive areas satellite-tracking technologies can be used.
- Investigate underwater behaviour of *T. schlegelii*, which is a species that appears to spend extensive periods submerged compared with other crocodile species in Asia. A permanent network of hydrophones should be set in place to record the acoustic behaviour of the *T. schlegelii* population, as well as the background sound characteristics (including boat traffic) of the surrounding underwater environment.
- Establish the Mesangat–Kenohan Suhuwi wetlands (extending to more than 1000 km<sup>2</sup>) as a formally protected Conservation Reserve based on sustainable use – ensuring the livelihoods of the local

people with traditional means of making a living.

## CONCLUSION

Despite widespread and sometime drastic levels of disturbance over several decades, Lake Mesangat and the vast surrounding wetland of Kenohan Suhuwi, have quite remarkably still retained healthy populations of several threatened species. Because most funding for *in situ* conservation is usually directed towards pristine protected areas, this situation presents conservationists with a dilemma: why save a degraded habitat? This situation could in fact be a unique opportunity to establish a permanent conservation presence within an area that we know has the potential to provide a safe haven for several threatened vertebrates (Bezuijen *et al.*, 2010). This is especially true, for the area around the Mesangat Lake as much of the Kenohan Suhuwi wetlands will eventually be abandoned by commercial interests (e.g. plantation agriculture) because of its inherent unsuitability. The Sunda gharial and Siamese crocodile have already withstood some of the worst kinds of disturbance possible: overharvesting of timber, savage fires, introduced invasive species and even potentially toxic chemical run-off. Mesangat could be one of the most dramatic conservation successes, not only because of the opportunity to conserve a large resident population of *T. schlegelii* for long-term studies but also as a world-class example of ecological restoration in the tropics, where such renewal is rare. With *T. schlegelii* and *C. siamensis* as flagship species, many other threatened species (turtles, wild cats, monkeys, plants) can be restored through sustainable use of the living resources of the area, conserving traditional livelihoods of the fishermen and farmers of this unique, and despite the damage wrought by humans, remarkably beautiful part of Kalimantan.

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