

Status Assessment of Tomistoma in Peninsular Malaysia: Peat Swamp Forests of Selangor & Pahang



By
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For the
Tomistoma Task Force of the IUCN/SSC Crocodile Specialist Group
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Project Report

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Cover Photo: Peat swamp forest along the Chini River in Lake Chini, Pahang, 2013.

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ABSTRACT

This report documents the results of field assessments undertaken to determine the distribution and status of the globally threatened crocodilian, *Tomistoma schlegelii*, in peat swamp areas of Peninsular Malaysia. The study was focused in, and around, Peninsular Malaysia's two largest peat swamp forests; the North Selangor peat swamp forest and the Southeast Pahang peat swamp forest. Surveys were conducted over several weeks and coincided with the drier (low water) times of the year at the different sites. Very few crocodile surveys have been undertaken in Peninsular Malaysia, and as a result, little is known of the distribution and conservation status of the *Tomistoma*, although populations are considered to be extremely low.

Spotlight surveys were carried out over 153km of waterways in and around peat swamp areas. No crocodiles were seen during any of the survey legs. Numerous semi-structured interviews were also undertaken with residents in these areas. Informants indicated that *Tomistoma* were historically more abundant at all sites, but that numbers had declined over the past decades, and in some areas, *Tomistoma* had been extirpated.

In the North Selangor peat swamp forest, *Tomistoma* are still occasionally seen or caught, with nesting reported during the past few years. The riverine habitat, although degraded in part, continues to provide suitable crocodile habitat, especially along the upper Tenggi River, within the swamp forest. In the Southeast Pahang peat swamp forest, the major rivers are degraded, with significant agriculture along the lower reaches. The upper reaches are said to be devoid of crocodiles, although the habitat, in parts, remains in relatively good condition. Past logging, hunting, agriculture and fishing have severely affected *Tomistoma* populations at this site, and it is likely that *Tomistoma* have been extirpated. The Chini Lake has also been severely affected by development in the area, and probably no longer has a *Tomistoma* population. Nearby tributaries of Lake Chini and surrounding areas of the Pahang River, still hold suitable habitat, with local residents reporting that *Tomistoma* and *Crocodylus porosus* are occasionally seen. It is likely that *Tomistoma* continue to inhabit areas of the Pahang river basin in the vicinity of the Chini Lake.

While we were unable to confirm *Tomistoma* from any of the surveyed areas, it is likely that the species continues to survive in the North Selangor peat swamp forest, and probably in the Pahang River, albeit in very low numbers. Although *Tomistoma* are believed to live in naturally low densities, the lack of confirmed sites, from anywhere in the peninsula, is a cause for serious concern. With continuing development within the country, remaining *Tomistoma* are under continued threat, and are in danger of further declines. Further work is urgently needed to identify *Tomistoma* sites, assess threats, and provide mitigating measures to conserve the *Tomistoma* of Peninsular Malaysia.

BACKGROUND

The Tomistoma, *Tomistoma schlegelii*, is a large slender-snouted crocodylian listed as *Vulnerable* by the IUCN (2014). The current distribution includes freshwater and peat swamp habitats in Indonesia, Malaysia and Brunei (Stuebing *et al.* 2006). It is one of the least studied crocodylians, and subsequently relatively little is known of its ecology in the wild. Detailed information on the distribution and status throughout its range is also lacking (Bezuijen *et al.* 2010). The largest threats to the species are considered to be the continued regional degradation and loss of its wetland habitats for development and agriculture. As conservation and management planning for the species is generally in its infancy, further work on the distribution and status of Tomistoma is required.

Distribution surveys and status assessments have been carried out across parts of the known Tomistoma range (Borneo, Sumatra), however, fieldwork in Peninsular Malaysia is generally lacking. This work documents surveys conducted in and around Peninsular Malaysia's largest peat swamp forests, specifically the North Selangor peat swamp forest and the Southeast Pahang peat swamp forest. This fieldwork forms part of the conservation initiatives of the Tomistoma Task Force of the IUCN/SSC Crocodile Specialist Group.

INTRODUCTION

The Tomistoma has received very little attention in Peninsular Malaysia, even though it was first described here in 1896 (Boulenger 1896). Since then, very little biological work has been carried out, which contrasts to the work conducted in other range states. Boulenger (1896) noted that Tomistoma could be found in the Perak and Pahang rivers, but since this time, few other areas have been added to the list.

The first status review was carried out by Sebastian in 1993, which consolidated much of the scattered information on the species, and set conservation priorities across all range states (Sebastian 1993a,b, 1994). For Peninsular Malaysia, this information was mainly obtained from data on captures, killings, confiscations and unconfirmed reports. Sebastian identified areas in the States of Pahang (the Pahang basin) and Selangor (North Selangor peat swamp forest) as having Tomistoma, and suggested other sites where Tomistoma may possibly be found; the Beriah swamp forest in Perak and the Jemaluang swamp forest in Johor. In 1997, Simpson *et al.* (1998) undertook the first dedicated Tomistoma surveys in the Lake Bera wetland, Pahang State; they however failed to find any sign of crocodiles despite reports that Tomistoma were still occasionally seen in the lake. Simpson *et al.* noted several rivers in the Pahang basin where Tomistoma had been reported. Stuebing *et al.* (2004) provided additional location records for Tomistoma in Peninsular Malaysia, specifically Lake Kenyir in

Terengganu State (but see Bezuijen *et al.* 2012), and several tributaries in the Perak and Pahang river systems. In 2006, Stuebing *et al.* provided a comprehensive overview of the historic and current distribution of *Tomistoma* throughout its range (Stuebing *et al.* 2006). For Peninsular Malaysia, they noted that scattered populations of *Tomistoma* still exist. More recently in 2008, students from the Science University of Malaysia (USM) have conducted surveys in the Setiu wetlands in Trengganu State, with photographs being obtained of small *Tomistoma* (Shahrul Anwar pers. comm.). Johor State may also harbour *Tomistoma* (Mohd. Sanusi pers. comm.), while the States of Kedah and Kelantan may also warrant investigation.

Although numerous areas have already been identified, or proposed, as *Tomistoma* sites, such areas have yet to undergo systematic crocodile surveys or assessments. The current status of *Tomistoma* in Peninsular Malaysia is largely unknown, although numbers are considered to be in extremely low. The current (and historic) distribution is poorly understood, with most records so far reported, being of single animals gathered from incidental sightings, captures, or occasional local reports. There have been very few systematic surveys for *Tomistoma*, and none of which indicate preferred habitat or population locations. Neither has there been a systematic assessment via questionnaires or interviews with local residents to gain a broad understanding of status or distribution. There has been no assessment of abundance, nor any attempt to estimate numbers within any of the reported *Tomistoma* sites. Breeding sites have yet to be identified, although the occasional reports of smaller animals indicate that breeding does take place in some areas, ie. Trengganu State. Populations or status have yet to be confirmed from within any of the reported crocodile sites in Peninsular Malaysia, with majority of sites never subjected to formal surveys or assessments.

This project will focus on two main areas which have been previously identified as potential *Tomistoma* sites, and fall within freshwater and peat swamp forests habitats. The project will concentrate fieldwork activities on the large forest blocks of the North Selangor peat swamp forest in Selangor State, and areas in and around the South east Pahang peat swamp forest in Pahang, including the nearby Lake Chini area.

The overall goal of the field surveys will be to provide an assessment of the conservation status of *Tomistoma*; including information on habitat quality, nesting, abundance and threats at these sites.

METHODS

Survey Areas

Field surveys for *Tomistoma* focused on the areas in and around Peninsular Malaysia's two largest peat swamp forest blocks; the North Selangor Peat swamp forest and the Southeast Pahang peat swamp forest, within the states of Selangor and Pahang respectively (Figure 1).



Figure 1. Main survey sites. 1 = North Selangor peat swamp forest, 2 = Southeast Pahang peat swamp forest, 3 = Lake Chini

The North Selangor Peat Swamp Forest

The North Selangor peat swamp forest (NSPSF) is situated on the northwestern part of Selangor state on the west coast of Peninsular Malaysia at 3.56469° N latitude, 101.28032° E longitude. It is a large contiguous peat swamp forest covering some 74,000ha. The area is low-lying with a mean elevation of approximately 20m, and situated about 10km from the Straits of Malacca. Rainfall approximates 2500mm per year, with a drier period during the months of May to August (DIDM 2014). The vast bulk of the swamp forest complex fall

within the jurisdiction of the Selangor State Forestry Department, under two Forest Reserves (FR); the Sungai Karang Forest Reserve (50,106ha) in the North, and the Raja Musa Forest Reserve (23,486ha) in the South (Figure 3) (FD/MNS 2013). The forest complex also extends into neighbouring areas including agricultural lands, State lands and some of the Protected Area of the Sungai Dusun Wildlife Reserve.

The NSPSF complex was originally more extensive than it is at present, with considerable peripheral land being converted to palm oil plantations decades ago. The area has also been intensively logged since the 1950's, and as a consequence, the remaining swamp forest (both the Raja Musa FR and Sungai Karang RF) is highly disturbed and degraded (Figure 4). Drainage canals crisscross the forest and served to drain the swamp, enable transport of cut logs to be floated out, and provide additional irrigation water for downstream rice cultivation.

Although the remaining NSPSF is largely contiguous, it has undergone considerable disturbance, modification and clearance over the decades, which continues to-date. Recently, 400ha of State land in the northeast was cleared and planted with palm oil (Figure 2). Approximately 6,500ha of the Raja Musa Forest Reserve has been severely degraded by a combination of continued drainage and forest fires. Approximately 3,500ha of this burnt area is now covered in lalang or baldy grass, *imperata cylindrical* (Parish 2002). The clearing and burning of forest has also allowed encroachment, settlement and agriculture in the forest reserve. Drainage canals continue to drain water from the NSPSF and feed water into the Tenggi River which contributes to the irrigation of 20,000ha of lowland rice grown downstream in the Tanjung Karang Rice Scheme.



Figure 2. Peat swamp clearing (~400ha) for oil palm plantation in part of the North Selangor peat swamp forest.

Whilst the Raja Musa and Karang River are forest reserves, they are primarily production forests for timber production via rotational selective logging. The decades of (often unmanaged) logging in the swamp forest have left the forest heavily degraded (Parish 2002). Under the 'Integrated Management Plan of the NSPSF (2001 - 2010)' however, 70% of Raja Musa FR was classified as production forest, while about 30% is classified as a sanctuary. There has been no logging within the production forest of the NSPSF since 2007.

Although Tomistoma are generally associated with peat swamp and freshwater swamp forest (Stuebing *et al.* 2006), they are essentially restricted to the rivers and waterways within these forest types – especially at the drier times of the year. The main rivers (or sungai) of the NSPSF are now the Tenggi River and the associated artificial irrigation canals; the Ban canal and the lower feeder canal, and, to a lesser extent, the Dusun River which also flows along the northern edge of the swamp forest border (Figure 3, Figure 5). The Dusun River, no longer flows into the Bernam River as it once did. Its lower reaches were converted to palm oil decades ago, while the upper reaches are narrow, shallow and flow through mostly agricultural lands into the Ban canal.



Figure 3. Map of the North Selangor peat swamp area, and various associated Reserves. Green area along coast is the Tanjung Karang Rice Scheme.

The Ban canal extends almost 20km from the headwater at Bernam River weir to the confluence with the Tenggi River. It was constructed during Colonial times to increase water flows into the Tenggi River for downstream rice irrigation in the coastal area at Tanjung Karang rice scheme. The Tenggi River runs for approximately 25km, starting in the alluvial hills in the west and running through the swamp forest to the weir gate at the Tanjung Karang rice scheme. The water then flows along almost 20km of the lower irrigation feeder channel. The majority of the Tenggi River is navigable by boat, except for the upper 3-4km, which are narrow, and overgrown by trees, and run through swamp forest. The uppermost reaches run through agricultural areas. The Ban canal and Tenggi River are approximately 20-25m wide, with 15-20m of trees and shrubs cleared along each bank. The banks are now grass covered. Both the Tenggi River and the Ben canal are occasionally dredged to allow adequate water flow, and banks are regularly sprayed to reduce vegetation growth (Figure 6, Figure 7).

Areas of the Raja Musa Forest Reserve are now the focus of a restoration project, particularly in 1000ha which have been severely burnt. Drainage canals in the area have been blocked in an attempt to increase water levels within the area, and reduce the risk of further fires. Reforestation has been underway with community support for the past several years.



Figure 4. Peat swamp forest in the North Selangor peat swamp forest. Considerable logging has occurred here over the decades, but no logging since 2007.



Figure 5. The Dusun River upstream (left) and its downstream confluence with the Ban canal (right).



Figure 6. The Lower Feeder Canal (left) and the upper Ban Canal (right), man-made irrigation channels to provide water to the Tanjung Karang Rice Scheme near the coast.



Figure 7. The Tengi River flows for more than 20km through the North Selangor peat swamp forest. Despite the banks being cleared of forest, the river still provides good habitat for Tomistoma. Cows graze the banks in the lower sections (right).



Figure 8. The Bernam River flows through palm oil estates, with the habitat generally degraded. Nests of a crocodile species (*C. porosus?*) have been occasionally reported from the grassy banks bordering oil palm trees.

The Southeast Pahang Peat Swamp Forest

The southeast Pahang peat swamp forest (SEPPSF) is believed to be the largest peat swamp forest complex remaining in mainland Southeast Asia (UNDP 2006). Situated along the east coast of central Peninsular Malaysia, the peatlands extend for some 70km along the coast in a north/south orientation, at approximately 3.2000° N latitude, 103.3000° E longitude. The elevation is typically about 30m. The weather on the eastern coast of Malaysia (and the SEPPSF) is heavily influenced by the northeast monsoon, which brings heavy rainfall in October-January, often with extensive local flooding. The annual rainfall is typically 2,000-3,500 mm, with the monthly rainfall reaching a maximum of over 500 mm in December, and a minimum of about 100 mm in April

The SEPPSF complex is discontinuous and covers a total of some 200,000ha in three or four major forest blocks, which are dissected by the major rivers in the area; the Pahang River, the Bebar River and the Merchong River. Swamp forest has been cleared along these rivers, sometimes for several kilometers on each bank (UNDP 2006).

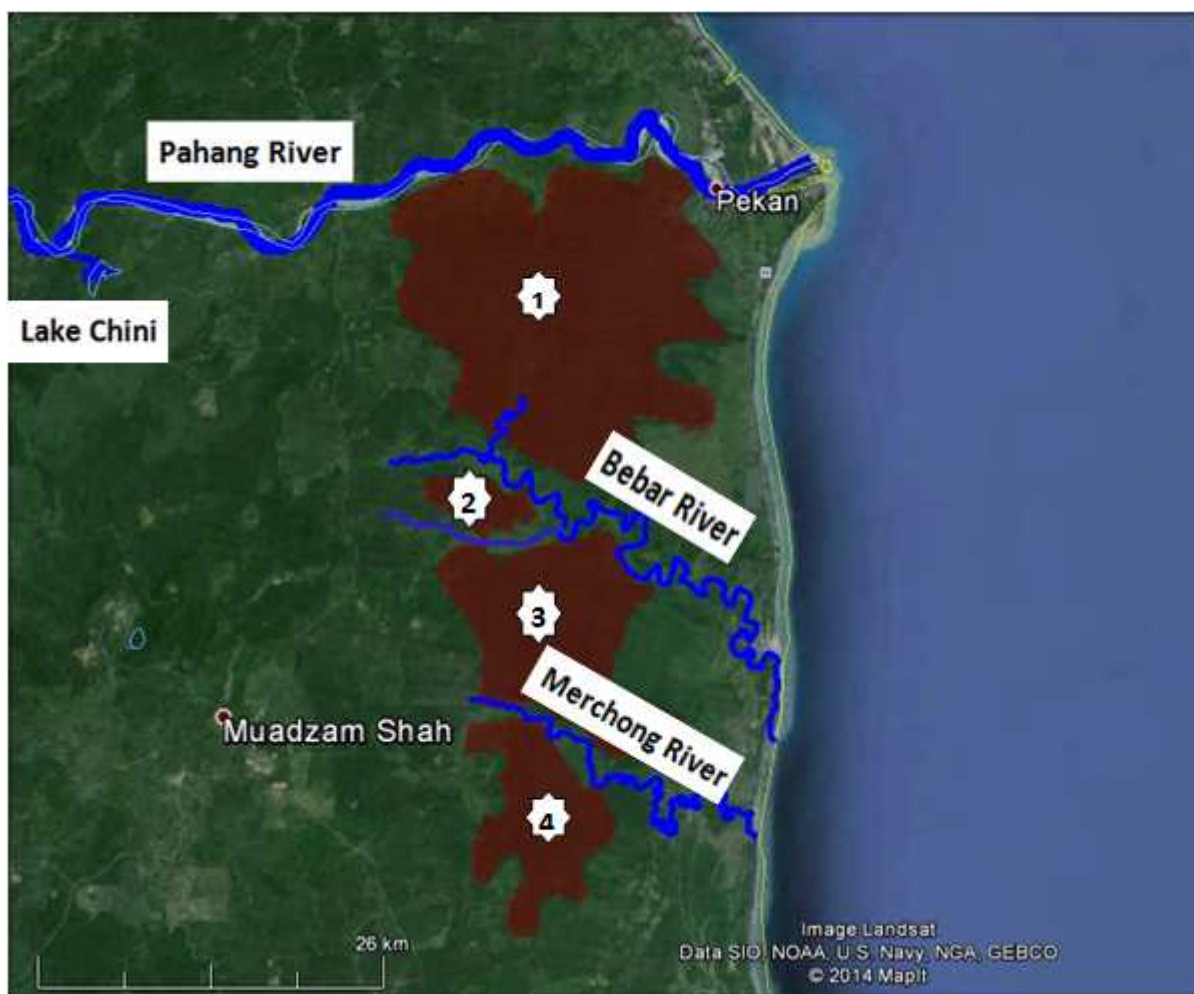


Figure 9. Map of the Southeast Pahang peat swamp forest and surrounding area. Red patches represent peat swamp forest. Numbered stars refer to Forest Reserves; 1= Pekan FR, 2 = Kedongdong FR, 3 = Nenasi FR, 4 = Resak FR.

The SEPPSF comprises of a mix of land-use types, including Forest Reserves, Stateland and agricultural areas. This general area experienced logging in the 1980-1990s. Now approximately 87,000ha (or 40% of the forest complex) fall under the State Forestry Department for the management of four (4) Permanent Forest Reserves (FR); Pekan, Kedongdong, Nenasi and Resak (Figure 9). Within these Forest Reserves timber extraction has been initiated. Selective logging of 4,500ha within Nanasi FR was reported during the mid 2000s (UNDP 2006), however much of the SEPPSF is undergoing rapid conversion to agriculture on Statelands (to oil palm) and continued selective logging within FRs since that time. Malaysia saw a great deal of land conversion and forest loss for the period 2000-2012, ranking as the world's top country in terms of deforestation rate (Butler 2013). Some of this "deforestation" is noted as old oil palm plantations being knocked down and replanted, however much has been the loss of natural forest in the SEPPFS area. More recently, during the six month period from October 2013 to March 2014, high levels of deforestation have occurred in the Pekan area of the SEPPFS, according to Global Forest Disturbance Alert System (Mongabay 2014). Much of the area in State and agricultural lands has undergone conversion to oil palm plantations, including old plantations being re-planted with new.

Agricultural areas border the banks along much of the rivers (particularly the Merchong River and lower reaches of the Bebar River) in the SEPPFS, with considerable areas being burnt in some places. Burning allows better access and conditions for the hunting, and prepares the area for agricultural activities. The natural peat swamp forests of the area are diminishing and being replaced with agriculture.



Figure 10. Peat swamp in the upper Bebar River, Southeast Pahang peat swamp forest. The upper reaches of the rivers are in good condition.

Lake Chini and Surrounds

Tasik Chini, or Lake Chini, is situated in southeast Pahang state, and is Malaysia's second largest natural lake covering an area of some 200ha. The lake displays a dendritic and convoluted shoreline produced from numerous rivers flowing into it, which form 12 interconnected smaller sublakes. It is surrounded in part by the 5,000ha of forest, known as the Tasik Chini forest reserve. The reserve comprises peat swamp, lowland and hill dipterocarp forest, some of which is secondary forest (Toriman *et al.* 2010). Much of the reserve is now bordered by oil palm, rubber plantations and other development. Lake Chini is situated approximately 30km west of the Southeast Pahang peat swamp forest, and about 3 km from the Pahang River, into which it drains.

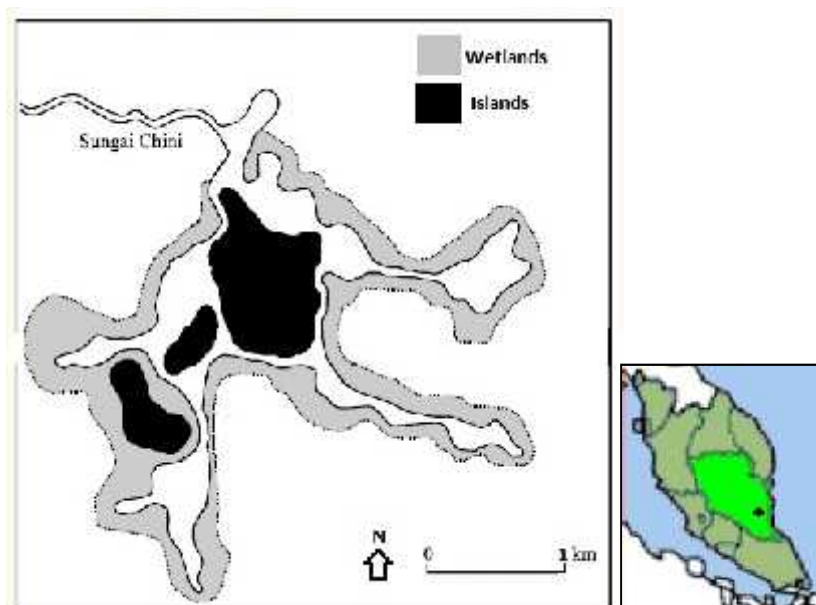


Figure 11. Map of Lake Chini.

Over the past decades, the lake and surrounds have undergone considerable development, alteration and more significantly, degradation. A weir in the main river, the river Chini, which drains the lake, was designed to maintain water levels throughout the year, however this has resulted in drowning some trees on the margins of the lake, and restricting water flow. Oil palm plantations bordering the lake and reserve may have resulted in increased levels of fertilizer entering the lake system which have been implicated in increased growth of particular macrophytes. The submergent macrophyte, *Cabomba furcata*, is now the dominant water plant in the lake covering more than 95% of sample plots in a recent study (Wan Juliana *et al.* 2010). This plant was not evident during studies of the lake in 1980s. High levels of sulphates and phosphates are evident in the lake now, which is thought to have promoted the macrophyte growth (Wan Juliana *et al.* 2010). Boat surveys were made much more difficult by the extensive macrophyte coverage, which continually choked the engine. Low water flows and higher levels of sediments have also reduced water quality in Lake Chini.



Figure 12. Lake Chini is surrounded by peat and lowland forest.

The timing of surveys was carried out to provide a preliminary appraisal and rapid assessment of the status of crocodylians in the area, and as such fieldwork was conducted during the drier times of the year when water levels were relatively low. In the North Selangor peat swamp forest, on the west coast of Peninsular Malaysia, surveys were conducted during June 2013. Surveys of the waters in the Southeast Pahang peat swamp forest on the east of the peninsula were conducted in November 2013, while surveys in central Pahang state were undertaken in April 2013.

Crocodile surveys (whether using night spotlight or track counts) are usually undertaken during the drier months of the year or when water levels are lower, as such conditions help facilitate the detection of crocodiles. The survey conditions for this work were generally good; often with clear or overcast skies, and only occasional light rains. Only twice did we delay a planned survey due to heavy rain.

Spotlight Surveys

Spotlight surveys are usually carried out when water levels are low (at low tide or during the dry season) as such circumstantiates usually provide better conditions to detect crocodiles. Crocodiles can be detected by their red coloured 'eyeshine', reflecting back from the torch-light beam, and can often be approached to determine size and species. Sizes are usually estimated in 1 foot categories. Spotlight surveys provide an index of abundance, rather than a total population count, however, such an *observation index* allows a comparison to be made between different observers, rivers or species. The observation index is usually

described as a density, that is, the number of crocodiles seen per kilometer of river (or lake shoreline) traveled (crocodiles/km).

Standard spotlight techniques were used to carry out surveys during this survey régime (see Messel *et al.* 1981, Bayliss 1987 for details). Surveys were conducted from small (2.8-3.5m) fiberglass boats (powered with a 5, 10, 15 or 30hp engine) using a hand-held narrow beam LED torches (LED Lenser P14, Nebo Redline SE, Rike RE-7305). When working in smaller or narrower creeks or waterways, the less powerful torch lights were used. Surveys usually started about 30 minutes after sunset, typically about 8pm. All start and finish locations, and crocodile locations were recorded with a *Garmin 60CSx* Global Positioning System, which was also used to determine distance traveled.

Interviews

Semi-structured interviews were conducted with local villagers and other inhabitants in the survey areas. Interviews were undertaken in an informal manner to gather information on *Tomistoma* or other crocodile species of the area. Photographs of various crocodile species were also shown during interviews to help instigate discussions and assist in species identification. Interview information can provide an insight into local sightings, threats, history and the general status pertaining to the crocodiles of the area. Interviews can also provide important background information but this information should be clearly recorded as 'reports' or otherwise separated from actual data recorded during survey work.

The information provided during interviews is often anecdotal, sometimes inaccurate, and even intertwined with spiritual beliefs, so all information must be assessed on its merit. The informants, can however, provide important information of past events and current activities, all of which can allude to prior/current status and distribution, and provide a focal point to undertake current activities or future work. Interviews are especially important when the timeframe for the assessment is short.

Interviews were carried out in villages we visited, with local fishermen, and government or local authorities. Interviews were conducted around general topics; however questions were dependant on the respondents' answers, and often not all questions were asked. Interviews were based around the following topics and questions:

- Ñ Where can crocodiles be seen in this area; name of rivers / lakes / areas?
- Ñ When were the last time crocodiles were seen in these areas?
- Ñ When is best time to see crocodiles (wet/dry/special time of year)?
- Ñ What size crocodiles have been seen; estimate size; adult, juvenile, young, hatchling?
- Ñ How often do you see crocodiles, every year, wet, dry, every time out fishing?
- Ñ Have you ever heard any stories of crocodiles being seen, caught, killed by some-one else. What area was this, dates, details?

- Ñ Any nests or babies seen - or any stories of young crocodiles (description, nest habitat, clutch size, nest type)
- Ñ Do you know of anyone with a captive crocodile, skulls, skins, teeth, eggs, etc?
- Ñ How many species or types of crocodiles live here?
- Ñ What is the difference between the species?
- Ñ Has there been any commercial hunting - now or previously? Were crocodiles taken dead or alive, what for, what crocodile parts, prices, what years?
- Ñ Is there any local consumption or trade in crocodiles, what parts, prices?
- Ñ Current & historic threats – any reasons for decline/increase in crocodile numbers?
- Ñ Any beliefs or superstitions regarding crocodiles?
- Ñ Do these crocodiles use burrows (description, size, types, habitats)?
- Ñ Have crocodiles ever threatened or attacked anyone, or livestock?
- Ñ Would people like to have crocodiles back in this area?

RESULTS

A total of 153.8km of waterways were surveyed in and around Peninsular Malaysia's largest peat swamp forests; the North Selangor peat swamp forest and the Southeast Pahang peat swamp forest, including part of the Chini Lake. The habitat type beside the surveyed rivers varied in quality and quantity and included peat swamp, oil palm plantations, irrigation canals, cleared riverine forest and lowland forests. No crocodiles were seen for the entire survey régime. See appendix I for specific location data of surveys.

North Selangor Peat Swamp Forest (NSPSF)

Spotlight surveys were carried out over five nights covering a total of 75.2km in and around the North Selangor peat swamp forest. No *Tomistoma* were seen during any of the survey legs (Table 1). Surveyed areas proceeded through various habitat types including peat swamp, oil palm and rice paddy areas.

Table 1. Spotlight surveys units conducted in and around the NSPSF

Survey Unit	Date	Distance	Crocs seen
Ban canal (Sg Bernam weir to Sg Tinggi)	4 June 2013	18.4 km	0
Sg Bernam (from weir going upstream)	6 June 2013	14.0 km	0
Sg Bernam (from weir going downstream)	17 June 2013	9.4 km	0
Sg Tinggi (from Ban canal to lower feeder canal)	26 June 2013	24.4 km	0
Lower feeder canal (from Sg Tinggi confluence)	29 June 2013	9.0 km	0

Bernam River

The Bernam River (Sungai Bernam) was surveyed upstream and downstream of the Ban canal weir for a total of 23.4km. No crocodiles were seen. This large river runs through oil palm estates, and although once bordered with peat swamp and lowland forest, has since been converted to agriculture. The area is generally unsuitable for *Tomistoma* with the banks bordered by palm oil trees, little forest, some scrubby areas and grassy banks. Fishing seems to be of low intensity with some nets and set hooks seen. Moderate levels of boat traffic were observed, and with the sea ~60km downstream, there was some tidal influence below the weir.

Local Reports

Interviews carried out with numerous local villagers and fishermen indicate that crocodiles are occasionally seen in the Bernam River, both upstream and downstream of the weir. It is generally considered that the majority of crocodiles seen were **buaya tembaga** (*Crocodylus porosus*), but that **buaya jenjulong** (*Tomistoma schlegelii*) were also still present and occasionally seen. A large Tomistoma was reportedly seen swimming ~20km downstream from the weir early in 2013. Reports indicate that both species were more prevalent 15-20 years ago. *C. porosus* are more often seen in the mangrove areas closer to the sea, 50-60km further downstream.

Nesting is said to still occur in areas upstream of the weir, and that a few nests have been seen over the years. Nests are left undisturbed by locals, while the species responsible for nesting is unknown. Nesting (for both species) is said to start at the drier part of the year (mid-year), with hatching occurring in October-December, at the start of the rainy season. Tomistoma hatchlings were also reported from a swampy area 15-20km downstream of the weir. The area has now been converted into a pineapple farm and hatchlings haven't been seen there for ~10 years or so.

According to interviews, hunting was undertaken for both species by one group of hunters around 1985-1990. Crocodiles were caught with baited hooks and then shot. Skin and meat were sold to Chinese middlemen. It was possible to catch ~one crocodile per week. One respondent also reported catching a few small (1m total length) Tomistoma in a fishing net 15-20km downstream from the weir in a swampy area in ~2000. He later sold them for Rm25 (~US\$8) each. The area has now been converted into a pineapple farm.

Ban Canal and the Tenggi River

Surveys were undertaken along the artificial Ban canal which runs for about 18km from the river Bernam (at the weir) into the Tenggi River, and also along the 24km length of the navigable part of the Tenggi River. Surveys were also conducted along part (9km) of the lower irrigation feeder canal servicing the rice paddy areas. No crocodiles were seen.

The canal cuts through about 6km of oil palm (near the river Bernam) and then 12km of peat swamp forest, while the Tenggi River runs entirely through the middle of the North Selangor peat swamp complex. The canal and Tenggi River see moderate small boat traffic and some net and set hook fishing. Within the swamp forest, the habitat for Tomistoma is generally good, although the occasional dredging of the waterways (canal and Tenggi River) and clearing of bank trees and vegetation is far from ideal. Banks are said to be sprayed to

kill grass every 6 months. The lower irrigation feeder canal incorporates a number of weirs and directly provides water to large areas of low land rice fields. The feeder canal is generally devoid of larger vegetation (short grass only), has higher levels of disturbance, and is generally unsuitable for Tomistoma.

Local Reports

Although the Ban canal was constructed during Colonial times, it was only more recently (20 years) that dredging and bank clearing has occurred. Prior to this, the canal would cut a narrower path through the forest with trees sometimes over-arching the canal. Tomistoma were more common in the peat swamp at those times, while *C. porosus* could be found in the lower river reaches and coastal areas.

Tomistoma are still reported from the peat swamp within the NSPSF, but are more likely to be seen in the upper reaches of the Tenggi River, in the region of the confluence with the Ban canal. Tomistoma were previously reported (10 years ago) from the confluence of the Ban canal and Dusun River, but no longer use this area. Tomistoma were said to move around more during higher water levels (September – January).

Several smaller Tomistoma have been caught near the Wildlife Department's Sungai Dusun Conservation Center over the past years. In 2010, a fisherman hand caught 2 young Tomistoma (2-3 feet long) at night and gave them to the Sungai Dusun Conservation Center nearby, "so they would not get caught on fishing hooks". A 3 foot Tomistoma was caught on a set hook in 2010 and sent to the above mentioned Conservation Center. Also a number of 1 meter Tomistoma were seen on the bank of the Ban canal several kilometers downstream from the Conservation Center during the high water season. In 2010 Mr Hamzah caught 2 young Tomistoma (2 foot long) in a net near the confluence of the Tenggi River and Ban canal. Both were released. It should be noted that these juvenile Tomistoma may have escaped from the nearby Conservation Center, which did originally have about 20 similar-sized captive juveniles at the time.

An 8 foot Tomistoma was reportedly caught in a net several years ago near the river Tenggi/Ban canal confluence, while a larger 12 foot Tomistoma was said to have been caught in a net in a similar area and sent to the Malacca zoo in Melaka State.

Nests have been reported from the peat swamp along the Ban canal / Tenggi River area. A nest was reportedly seen 10-15 years ago on the bank, 5m from the water. A small mound was made from an emergent water grass (terberau grass) in a swampy area near the canal. An old fisherman said that he saw a Tomistoma nest in a similar area in 2012 with 2 large crocodiles nearby. The nest was seen during low water levels (mid-year). Several years ago the same fisherman collected 7 eggs from a 40cm grass mound nest in this area. He boiled

the eggs for half an hour before eating. He considered this would help heal scratches and improve general health. This belief is generally not shared with others in the area however.

Crocodiles and nests are generally left alone, and residents tend not to disturb crocodiles if they see them. There are no taboos regarding crocodiles in the area, but it was best to leave them alone according to the locals.

Southeast Pahang Peat Swamp Forest (SEPPSF)

Surveys were carried out over six nights covering 78.6km of riverine and lake habitats along the main rivers of the SEPPSF, parts of Lake Chini and surrounding lowland rivers. No crocodiles were seen (Table 2).

Table 2. Spotlight surveys units conducted in and around the SEPPSF

Survey Unit	Date	Distance	Crocs seen
Bebar River (upstream section)	6 April 2013	16.8 km	0
Mercong River (downstream section)	7 April 2013	20.0 km	0
Bebar River (downstream section)	8 April 2013	23.5 km	0
Luit River	15 November 2013	6.4 km	0
Kemak River	16 November 2013	2.0 km	0
Lake Chini	17 November 2013	9.9 km	0

Bebar River and Merchong River

The Bebar River runs through the heart of the SEPPSF, with the majority (40km) of the navigable sections surveyed. It was not possible to survey the furthest reaches of the Bebar River due to the narrow and tree strewn nature of the river here. The river was said to continue for many kilometers. The small and narrow Merba River (running into the river Bebar) was also excluded as it was also not navigable. The site was accessed from the western edge of the swamp forest to one of the fishing camps at about 38km upstream. At this distance the river was still under tidal influence. Considerable fishing occurs here with hooks used during the drier times (April) and nets used with high water (October). No crocodiles were seen during the surveys.

There were large sections of intact peat swamp with *pandanus* bordering the river in the upper sections which looked good and would be suitable for *Tomistoma*. These upper reaches seems in good condition (with dark peat water), and this would also be expected of the un-navigable sections as well. However, the majority of riverine habitat was degraded,

with much of the forest being cleared, burnt, logged or farmed, especially along the lower sections.

The Merchong River runs from Muadzam Shah town to the coast, a distance of maybe some 80km. Much of this distance may once have been peat swamp forest, yet now the land bordering this river has been cleared and converted to paddy and oil palm for some 1-2km either side of the river. The upper reaches are said to be shallow and narrow. There are still, however, many areas where patches of reasonable forest still remain beside the river. In these areas the river and habitat looks good and suitable for *Tomistoma*. Surveys were undertaken for 20km in the lower reaches. No crocodiles were seen.

Local Reports

Bebar River

Local residents from the upper Bebar River area report that the river previously had both *Tomistoma* and *Crocodylus porosus*, but that crocodiles had not been caught (in either nets or hooks) or even seen for the past 25 years. Some fishermen noted that crocodiles had declined after logging in the area some 30 years ago. Residents from the lower reaches note that it is possible to see *C. porosus* (both large and small) on occasions, as they may swim in from the sea, or possibly live in the lower reaches. Only the older villagers along the river reported seeing *Tomistoma* from years gone by.

Logging occurred around the Bebar River in the 1980-1990s, with logs floated out along the Bebar River. Some logging also occurred in 2003 (also noted in UNDP 2006 report). The habitat in the upper reaches is still in very nice condition along the Bebar River, however.

Hunting of crocodiles (both species) in the Bebar River was said to have occurred more than 30 years ago. At that time, smaller *Tomistoma* were caught in the upper reaches. Teams of men would use a spotlight and nooses to catch small crocodiles. Many hunters would frequent the area catching the small (~2 feet long) crocodiles to sell alive. Hunters may come up river for couple of nights collecting 20-40 juveniles. Trips could be made every week or so.

Merchong River

Reports from the Merchong River indicate that *C. porosus* have been seen in recent times, but that *Tomistoma* are rarely seen. There also seemed some confusion in differentiating between *C. porosus* and *Tomistoma* and this can sometimes be the case in areas where crocodiles are rarely seen. Reports of large and small crocodiles being seen 10-15km upstream from the river mouth in recent years, where the river is ~25m wide, were considered to be *C. porosus*.

A number of reports record that ~20-40 small *C. porosus* were captured and taken from the Soi River (near Kuantan town, see below) for sale to a crocodile farm (or dealer?) near the Merchong River in 2011/12. After the sale did not go ahead, the small crocodiles were released into the Merchong River upstream of the bridge (~5-10km upstream from river mouth). Reports of small crocodiles being seen recently in this area may be those of reportedly released crocodiles.

There were a considerable numbers of people fishing in this river with various hooks (rods, setlines, string lines), although the river did not seem overly fished. Fishermen were actually farming the riverside land, and fishing for subsistence and sale.

We received little information regarding nesting in the area. A crocodile nest was said to have been found 30 years ago in a small swampy area on the Reung River, off the main Merchong river, about 10km upstream from the main river mouth. The nest had eggs with a female beside it. This was considered to probably be a *C. porosus* given the proximity to the sea, but the species was not known.

There were a number of names for crocodiles in this area, some of which probably refer to the same species (buaya refers to crocodile).

Tomistoma = **buaya jenjulong**

C. porosus = **tembaga** (in sea and lower river reaches)

C. porosus ? = **buaya katak** (found in the upper river reaches)

C. porosus ? = **buaya kerbau** (buffalo crocodile) noted by one fisherman from the lower reaches of the Merchong River

Soi River (near Kuantan town)

After receiving information of crocodiles being captured from the river Soi, we spoke to fishermen in this area. The Soy River lies some 75km north of Nenas, near Kuantan town, Pahang. The Soi River runs through agricultural lands in the upper reaches, although is bordered by some large patches of riparian forest in the middle/lower reaches. Fishermen suggest that only *C. porosus* (buaya katak) live in this river, and can be seen during low water levels further upstream (~40-50km from river mouth). It was suggested that although Tomistoma could not be found in the Soi River, it may be possible to find them far upstream in swampy areas in Kelantan State further to the north.

Lake Chini and Surrounds

A survey undertaken in Lake Chini covered about 9.9km, including approximately 3km of river Chini, which connects to Peninsular Malaysia largest river, the Pahang River. Although the circumference of the lake is larger than we surveyed, survey conditions were difficult

due to the abundance of submergent macrophytes covering the lake. Boating off the established “roadways” resulted in the engine becoming clogged and overheating. No crocodiles were seen on this survey leg.

The Luit River was surveyed for about 6km, from the confluence of the Pahang River, going upstream. Further progress was stopped by an abundance of trees and logs in the river. The river may continue for a further 2-3km or so according to the map. The riverine habitat is still intact, and the river looks like it would support crocodiles. Considerable nets were seen throughout this river, including bubu fish traps. No crocodiles were seen during the surveys.

We surveyed 2km of the narrow Kemak River, off the river Luit. This was a very small river with over-arching forest in parts, but also oil palm plantations along some bank sections. The habitat looked good. No crocodiles were seen.

Local Reports

Lake Chini villagers report that there have not been any *Tomistoma* seen in this lake for some 20-30 years. Although *Tomistoma* used to be seen in the lake, they were said not to nest here, but in the adjoining rivers which feed into the lake. Young *Tomistoma* were sometimes seen. There had not previously been any crocodile hunting in the lake, although logging did occur in the past in the surrounding forest. The water quality has declined over the decades, and the lake has also seen an increase in tourists visiting, and a decrease in fish numbers. These factors, and others, such as oil palm plantations and nearby developments in the area, may have had detrimental impacts on the crocodile populations which had lived here.

Local fishermen from the Luit River report that both *C. porosus* (buaya katak) and *Tomistoma* (buaya jenulong) can sometimes be seen in this small river. Crocodiles were seen twice during 2012, although the species could not be identified. Fishermen also suggest that young crocodiles are sometimes heard, and that crocodile slides marks were sometimes seen on the banks. This river has been reported previously as containing crocodiles (Simpson *et al.* 1998).

DISCUSSION

Research, conservation and management actions or opportunities for *Tomistoma* in Peninsular Malaysia are hampered by the lack of known population sites. This contrasts with various conservation initiatives conducted in other parts of the *Tomistoma*'s range (Borneo, Sumatra), where numerous activities are taking place (Bezuijen *et al.* 2010, Bonke *et al.* 2014, Simpson and Mediyansyah 2009, Staniewicz 2011). Identifying and confirming *Tomistoma* sites are first required in Peninsular Malaysia, before further actions can be implemented.

Given the large tracts of peat swamp forest habitat surveyed during this project, it was disappointing that *Tomistoma* were not recorded from any of the assessed sites. This is not unusual for *Tomistoma* surveys however, and even at the time of discovery in Peninsular Malaysia, Boulenger (1896) noted that *Tomistoma* were rarely seen. Previous surveys from Kalimantan and Sumatra also recorded very low densities, with generally few individuals detected, or nothing at all, over many hundreds of kilometers. Bezuijen *et al.* (1998) compiled data from numerous studies covering 1965km, with a resultant density of 0.041 *Tomistoma*/km. A more recent survey from Kalimantan showed a density of just 0.016 *Tomistoma*/km (Simpson and Mediyansyah 2009). The lack of *Tomistoma* sightings from this study does not necessarily equate to an absence of crocodiles from the study areas (as *Tomistoma* are also very cryptic), however, it does show that if *Tomistoma* are present, they probably occur in very low numbers. This can also be supported by local reports which indicate that *Tomistoma* are 'occasionally seen' at some of the sites, yet were never said to be 'common' or 'often seen'.

The North Selangor Peat Swamp Forest

The North Selangor peat swamp forest was identified by Sebastian (1993a) as a site for *Tomistoma*, with reports from 1982 near the Bernam River, and 1988 in the Tenggi River. Sporadic reports of sightings, captures or nesting have been made periodically since that time. The waterways and forest of the North Selangor peat swamp have undergone considerable transformation over the past 30-50 years or so. Logging within the forest has not only led to a degradation of forest quality, but has severely impacted the swamp through the creation of numerous drainage canals used to lower water levels. The heavily modified irrigation canals, and Tenggi River itself, are now less suitable for *Tomistoma* than they were previously. The river dredging, and particularly the clearing of bankside vegetation, has reduced the suitability of this swamp forest habitat. This has opened up the canopy over the waterways and may have also destroyed swampy nesting sites along the riverbanks. The waterways are still suitable for *Tomistoma* however.

The Tenggi River, running for more than 20km through the heart of the peat swamp forest, still has great potential as a Tomistoma waterway. The upper reaches of the river system remain relatively undisturbed through several kilometers of overgrown forest, and with boat access restricted (due to the overgrown nature) other disturbance activities are also reduced (eg fishing). The more natural state of the river here affords better conditions for any remaining Tomistoma and may allow relative seclusion, and the possibility of more suitable breeding areas. As Tomistoma are still reported from confluence of the Tenggi River and the Ban canal, it is possible that this upper Tenggi River area still harbours Tomistoma which venture out to into the Ban canal and main Tenggi River proper.

Given that smaller Tomistoma are still reported from the upper Tenggi river (near the confluence with the Ban canal), this may indicate that a small breeding population is still exists in the area. However, the presence of smaller Tomistoma originating from escaped captive individuals cannot be discounted, as the Sungai Dusun Conservation Center is nearby and houses Tomistoma. The occasional reports of larger Tomistoma from the Tenggi River indicate, however, that a small population is likely to exist, and may even be breeding.

It is evident that if Tomistoma initiatives are to be successful in the North Selangor peat swamp forest, the Tenggi River would provide the best site for population protection/recovery. This site is in relatively good condition and well protected, surrounded by the Raja Musa and Sungai Kerang Forestry Reserves, and the Sungai Dusun Wildlife Reserve. The remaining Tomistoma population there would also benefit from population augmentation, with the introduction of additional animals. The modification of the swamp forest may also be required to provide wetlands more suitable for Tomistoma. This could include the blocking and expanding (width and depth) of existing drainage canals, and the provisions of small ponds (dry season refuges) within the peat swamp forest itself. Fishing regulations may also be warranted.

The Southeast Pahang Peat Swamp Forest, Lake Chini and Surrounds

Although the Southeast Pahang peat swamp forest is Peninsular Malaysia's largest peat forest complex, we received no credible information of Tomistoma from the area in recent times. Tomistoma were reported from the area many decades ago, but logging, agriculture and hunting may have impacted heavily on the population. And, although the swamp forest itself is large, the rivers themselves are not, and thus dry season refuges are restricted. The riverine habitat seems in relatively good condition in the upper Bebar River, however, the lower reaches of the river Bebar, and most of the Merchong River, are heavily degraded, with agricultural activities (paddy and oil palm) following these water courses.

The continued degradation of the peat swamp, through logging within the Forest Reserves, and agricultural development outside the Reserves, results in fewer options for Tomistoma conservation in this area. This is particularly the case when these relatively narrow waterways are constantly fished, and impacted by agricultural development along the banks. Considerable work and resources would be required for Tomistoma conservation initiatives (ie. re-introductions) in the upper Bebar River area to be successful. The Southeast Pahang peat swamp forest is not considered a priority for Tomistoma conservation under the current conditions.

Lake Chini is a relatively small and shallow lake, with a resort and two villages situated on the shoreline. We did not see any crocodiles during our surveys and the local inhabitants informed us that there haven't been Tomistoma in the lake for some decades. Given this information, and the condition of the lake, the number of fishermen and other lake users, it would be surprising if Tomistoma could live in the area and go undetected. It is most probable that the lake itself does not have a crocodile population, and probably has not had for many years. We did receive reports, while in the Southeast Pahang peat swamp forest, that rivers in the vicinity of Lake Chini, or tributaries of Lake Chini itself, still held Tomistoma. It was noted that some of the small rivers flowing into Lake Chini provided excellent habitat, although they were generally narrow in size. Further work would be needed to assess these areas.

We did not detect any crocodiles during the limited surveys on the Luit and Kemak Rivers, near Lake Chini. The rivers looked suitable for Tomistoma, and locals suggested that both Tomistoma and *C. porosus* were occasionally seen here. These rivers are fairly short, measuring less than 10km, and it may be that crocodiles move in and out of these smaller Pahang River tributaries from time to time. The Pahang river basin was noted by Sebastian (1994) as a site for Tomistoma, while Simpson *et al.* (1998) listed a number of tributaries of the Pahang River, in the vicinity of Lake Chini, as reported Tomistoma sites. During the current surveys, the Mentiga River was also mentioned as an area in which to search for Tomistoma. This river also lies close to the Chini Lake, and flows into the Pahang River. The numerous rivers in the vicinity of Lake Chini would warrant further investigation.

Status of Tomistoma in Peninsular Malaysia

The current status of Tomistoma in Peninsular Malaysia is largely unknown. It can, however, be assumed that remaining populations are extremely low, and that the continued development in wetland areas are invariably contributing to a decline in the species. Although these current surveys covered more than 150km of potential Tomistoma waterways, we failed to detect any Tomistoma. It is thus, still unfortunate, that significant Tomistoma sites have yet to be confirmed, assessed and quantified, from anywhere in

Peninsular Malaysia. While a breeding population may be inferred, from the two young *Tomistoma* recorded in the Setiu wetlands 6 years ago (Shahrul Anuar pers. comm. 2008), the current situation there is still uncertain, and assessments are required in this rapidly developing wetland habitat. The situation in Peninsular Malaysia contrasts sharply to other *Tomistoma* range states where specific sites are known and work has/is being carried out; ie. Mesangat wetlands, Tanjung Putting National Park, Danau Sentarum National Park and surrounds, Merang River and Berbak National Park (see Stuebing *et al.* 2006, for an overview of locations).

The comments by Stuebing *et al.* (2006) are still a fair appraisal of the current situation in Peninsular Malaysia. Stuebing *et al.* noted that “scattered populations of *T. schlegelii* still exist, and small numbers are seen in any given year in Perak State and possibly also in Pahang State”. With the addition of Selangor and Terengganu States, this sums up the distribution and status of *Tomistoma* in the Peninsula. *Tomistoma* locations are relegated to vague generalizations, with occasional sightings, and are short on specific details and quantitative data.

Future Actions

It is unfortunate that so few crocodile surveys have been undertaken in Peninsular Malaysia, and that the distribution and status of *Tomistoma* is still largely unknown – other than to note that the species is extremely rare. Follow-up work is urgently required, and the rivers and wetlands previously identified as potential *Tomistoma* sites need to be assessed. Without the identification of specific *Tomistoma* sites, conservation actions will be severely hampered. Such is the slow pace of progress in Peninsular Malaysia, that comments made by Sebastian 20 years ago, still ring true. Sebastian (1993) noted that the lack of dedicated assessments for *Tomistoma* had been a major obstacle for the formulation of any conservation plan, and that dedicated surveys were needed to fully understand the distribution and status in Peninsular Malaysia. Much work remains to be done.

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APPENDICES

Appendix I. Locations of areas surveyed and noted rivers. All locations are displayed in decimal degrees, North latitude and East longitude.

Survey Unit	Start Location	Finish Location
Ban canal (Sg Bernam weir to Sg Tinggi)	3.6914 / 101.3442	3.5730 /101.3523
Sg Bernam (from weir going upstream)	3.6914 / 101.3442	3.6637 / 101.3486
Sg Bernam (from weir going downstream)	3.6914 / 101.3442	3.6765 101.2922
Sg Tinggi (Ban canal to lower feeder canal)	3.5730 /101.3523	3.4814 / 101.2213
Lower feeder canal	3.4814 / 101.2213	3.5312 / 101.1583
Sg Bebar (going upstream)	3.2253 / 103.2953	3.2843 / 103.2458
Sg Mercong (downstream section)	3.0298 / 103.2872	3.0227 /103.4274
Sg Bebar (downstream section)	3.2424 / 103.3138	3.1352 / 103.4436
Sg Luit	3.4988 / 102.8412	
Sg Kemak	3.5064 / 102.8299	
Tasik Chini	3.4325 / 102.9145	
Sg Soi	3.7286 /103.2926	
Sg Mentiga	3.4126 / 103.0254	

Appendix II. Tomistoma skulls from the Sungai Dusun Conservation Centre, Selangor. The Conservation Centre currently has 8 captive Tomistoma. It is not known if these skulls are from captive or wild specimens.

