

**Preliminary Assessment of False Gharial (*Tomistoma schlegelii*)
Populations in Sumatra**



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1.0 Introduction	1
2.0 Methods	3
2.1 Study Areas	3
2.2 Habitat Quantification and Description	5
2.3 Spotlight Surveys	6
2.4 Interviews	7
2.5 Mapping	8
3.0 Study Area and Habitat Descriptions	9
3.1 Kampar River System (Riau Province)	9
3.2 Serkap River (Kampar Tributary)	12
3.3 Turip River (Kampar Tributary)	15
3.4 Kerumutan River (Kampar Tributary)	17
3.5 Simpang Kanan River (Riau Province)	21
3.6 Merang River (Sumatra Selatan Province)	24
3.7 Berbak National Park (Jambi Province)	27
3.8 Bukit Batu and Giam Siak Kecil Rivers (Riau Province)	29
4.0 Survey and Interview Results	31
4.1 Serkap River	32
4.2 Turip River	34
4.3 Kerumutan River	35
4.4 Simpang Kanan River	37
4.5 Merang River	39
4.6 Berbak National Park	40
4.7 Bukit Batu and Giam Siak Kecil	41
5.0 Discussion	42
6.0 Conclusions	44
Literature Cited	45
Appendices	47

1.0 Introduction

Tomistoma schlegelii (*Tomistoma*; Muller 1838) is a unique species of crocodylian, inhabiting lowland rivers and peat swamp forests of the Greater Sunda Region. The species is one of the largest crocodylians in the world, with documentation of individuals over five meters in length. A few studies have explored basic ecology and biology of *Tomistoma*, but overall there is little information about the species.

Tomistoma was previously listed as endangered on the IUCN Red List, but was recently assessed as Vulnerable in 2014 (<http://www.iucnredlist.org/details/21981/0>). Although the IUCN species status has changed, there is little information regarding the status of many populations across its remaining range.

Historically, *Tomistoma* was widespread throughout the Sunda Region (Stuebing et al. 2004). However, habitat fragmentation and hunting pressure has left the species concentrated in a few isolated river systems, mainly on the islands of Borneo and Sumatra (Auliya et al. 2006; Bezuijen et al. 2003; Stuebing et al. 2006). Research on *Tomistoma* in Sumatra has been sparse, particularly regarding population size and distribution across various river systems. Stuebing et al. (2006) summarized *Tomistoma* research throughout Sumatra and shows that documentation is limited to a few select river systems. Only recent surveys over the last several decades have uncovered information regarding their abundance and nesting ecology and the majority of this data comes from South Sumatra and Jambi Provinces (Bezuijen et al. 1995; Bezuijen et al 1997; Bezuijen et al 2001; Bezuijen et al. 2002a). There have been no recent population surveys conducted in those locations. Population data is vital, because conservation efforts cannot be taken without determining occurrence, persistence or trends in population size.

Aside from survey efforts in Jambi and South Sumatra provinces, few surveys have been carried out across other provinces of Sumatra. Only select river systems in Riau and Lampung Provinces have been surveyed for crocodylian activity. Riau province is of particular interest, because it still holds multiple patches of intact peat swamp forest. Although habitat seems favorable for *Tomistoma*, only 10 confirmed historical records of *Tomistoma* have been documented in Riau (Stuebing et al. 2006). This number is low, but it is likely more of a reflection of minimal survey effort, rather than a lack of crocodylian activity. Previous surveys consisted only of short term assessments on the Kubu, Siak and Teso Rivers of Riau province in the late 1990's (Bezuijen et al. 1997). The majority of rivers in Riau have never been surveyed, including those that pass through some largest tracts of intact primary forest. To the best of our knowledge the Bukit Batu/Giam Siak Kecil area, Simpang Kanan River (and neighboring area) and lower Kampar River System have never been surveyed, but all still hold large tracts of intact primary forest. These three areas are ideal candidate locations for *Tomistoma* population assessments.

Our objectives are to determine *Tomistoma* presence, persistence and density in previously surveyed and un-surveyed river systems of Sumatra. Therefore, this preliminary assessment was aimed at gathering logistical information, before a thorough assessment starts in 2015. With historical information and current forest cover data in mind we chose five study areas, consisting of two previously surveyed areas and three un-surveyed areas: the Merang River and Berbak National Park (South Sumatra and Jambi Provinces respectively, previously surveyed); Simpang Kanan River (and surrounding rivers), the lower Kampar River System and the Bukit Batu/Giam Siak Kecil River systems, (All in Riau Province, previously un-surveyed).

To gather information about all study areas, we conducted an 18 day rapid assessment across study locations in Sumatra during June of 2014. Because research permits were not yet obtained, only visits to study areas, interviews with locals and brief spotlight surveys were permitted by the forestry department during this assessment. We were able to conduct baseline spotlight surveys in three of our five proposed study areas. Of the three locations where surveys were conducted, we spent one day at each of two river systems (Simpang Kanan and Merang Rivers) and spent three days at a single river system (Kampar River System).

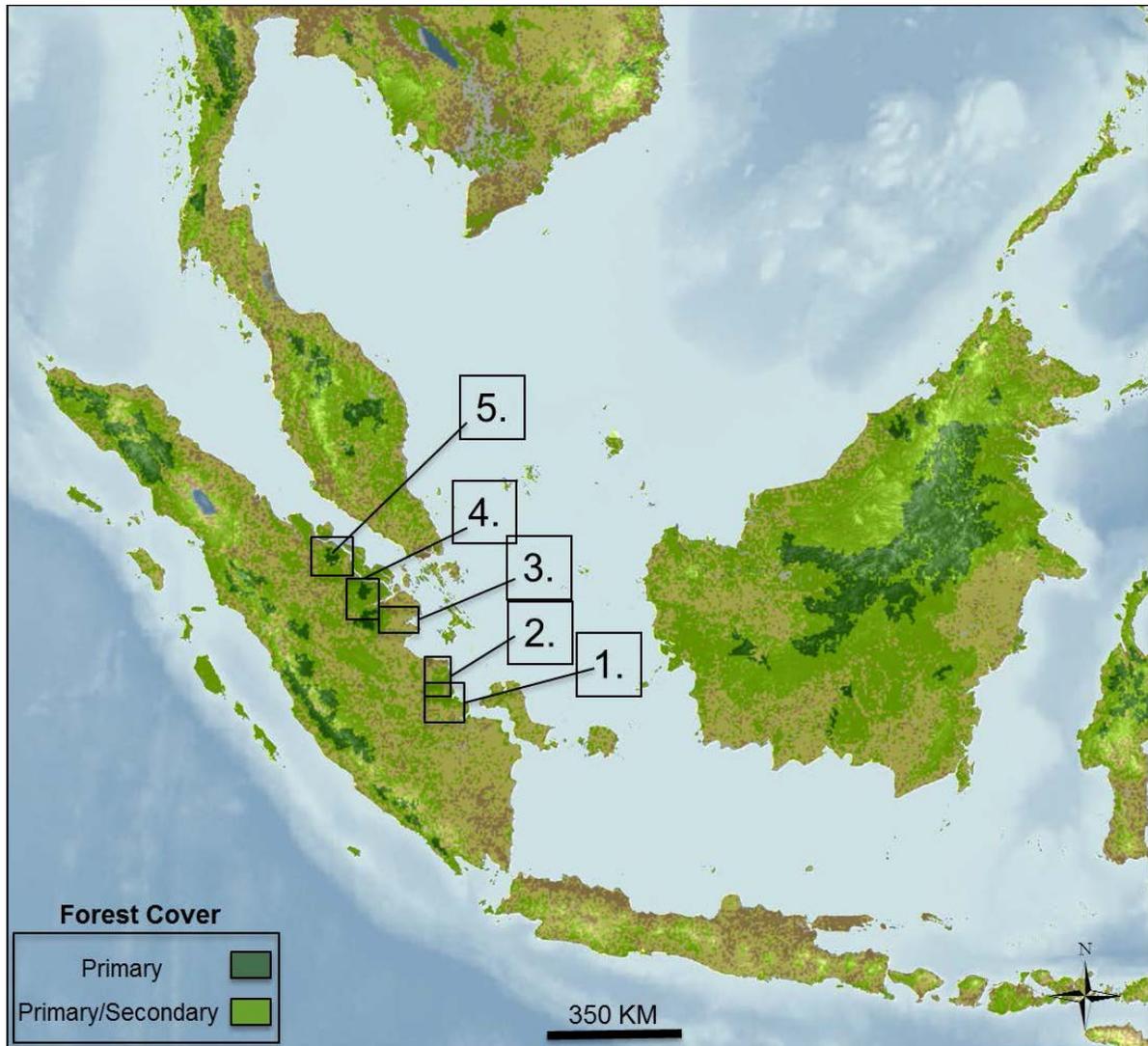
Over the course of the survey period we documented the presence of crocodiles in three rivers. In two tributaries of the Kampar River system we confirmed *C. porosus* populations and in a third tributary of the Kampar River we recorded a single eye shine (species unconfirmed). The latter single eye shine was recorded far upriver, within pristine peat swamp forest and in an area where locals stated *Tomistoma* were relatively common. This suggests the eye shine was possibly a *Tomistoma*, but only future surveys will allow us to confirm this. Based on interviews with locals and forestry officials, it seems that *Tomistoma* may still be found in four of our five study areas, including Berbak National Park, the Kampar River System, the Merang River and the greater Giam Siak Kecil/Bukit Batu area, but this is yet to be confirmed.

2.0 Methods Overview

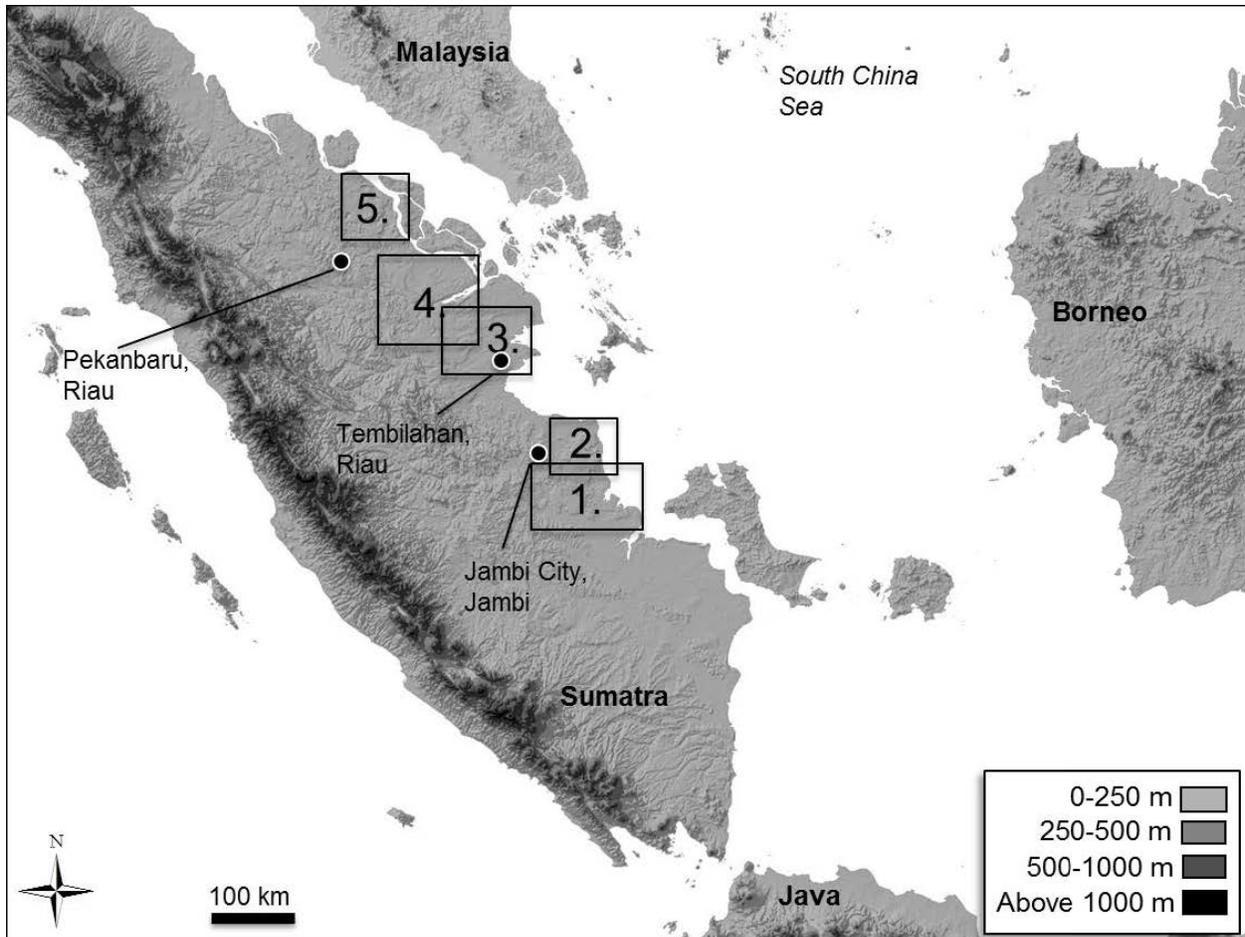
Over the course of 18 days travelling in the lowlands of Eastern Sumatra (June, 2014), we travelled to study locations (or areas nearby), conducted interviews with locals and conducted spotlight surveys when possible. In total, we spent five days and five nights conducting spotlight surveys, four days meeting with national park and forestry officials, four days meeting with locals and conducting interviews outside of study areas and five days were spent driving between field sites (including the drive and ferry taken from Java to Sumatra).

2.1 Study Areas

Study areas were chosen based on previous *Tomistoma* documentations and the current understanding of *Tomistoma* ecology, which suggests they prefer and commonly nest in Peat Swamp Forests. Based on current forest map estimates in Sumatra and areas with previous *Tomistoma* sightings we selected five areas for study locations (Maps 1 and 2).



Map 1. The island of Sumatra and the five areas visited over the course of our assessment. Each area numbered on the map, is shown in more detail throughout the report. Dark and Light green indicate intact primary and fragmented primary forest respectively. Tan and Brown coloration indicate areas where forest has been logged or did not occur historically (respectively). Study areas are as follows (1.) Merang River; (2.) Berbak National Park; (3.) Simpang Kanan River System; (4.) Kampar River System; (5.) Giam Siak Kecil and Bukit Batu Rivers, Greater Area.



Map 2. Provides a detailed terrain and elevation map for the region of Sumatra where our survey efforts will be focused. Our five study areas are numbered and relevant city names are provided on the map. Study areas are as follows (1.) Merang River; (2.) Berbak National Park; (3.) Simpang Kanan River System; (4.) Kampar River System; (5.) Giam Siak Kecil and Bukit Batu.

2.2 Habitat Quantification and Description

We provide as much detail on survey areas as possible. Rivers that were spotlight surveyed are divided into sections based upon habitat around the river being discussed. We describe transitions in habitat based mainly upon forest conditions we encountered and satellite imagery analysis of areas we have not visited. We recorded at which point forest transitioned from palm oil to secondary forest, or secondary forest to primary forest (or any combination in between). We identified structural characteristics of each river and approximate extent of tidal influence when possible.

We recorded GPS coordinates for starting (mouth of river) and ending points (furthest we could travel upriver) on each river surveyed. We recorded notes on human and other wildlife activity on each river. When we refer to a point along the river (e.g. 20 km), we are referring to how far that point is from the mouth of the river. We provide descriptions of study areas in Section 3 (Study Area and Habitat Descriptions).

2.3 Spotlight Surveys

Methods for spotlight surveys followed previous work (Bayliss 1987; Bezuijen et al. 1995; 1997). The only difference in survey techniques between areas, depended on our time line and which direction we travelled throughout the day (before night time surveys). We would typically travel upriver during the day, to meet with locals, conduct interviews and then survey moving down river at night. Night-time spotlight surveys always began at approximately 30 minutes after sunset, aside from one occasion where we travelled to more than one location in the same night. The majority of surveys were conducted from a four to five meter speedboat with a 30 to 45 hp engine, travelling at low speeds. Only brief surveys were conducted from a canoe in one location.

Various forms of spotlight were used, but consisted of a strong battery powered torch (~2 million candle power) or sometimes headlamps when surveys were on smaller sections of river. In areas where swamp forest receded far from the main channel, multiple people shined lights simultaneously to try and cover areas more thoroughly. All crocodile sightings were recorded with an E-Trex GPS system in decimal degrees. All start and end points, as well as locations with important land features were recorded. Crocodile size was estimated to the nearest foot measurement (e.g. 1 – 2 ft, 3 – 4 ft) when possible. If we were unable to approach close enough to determine species, crocodiles were recorded as an “eye shine”. We did not assume any eye shines to be *Tomistoma* or *C. porosus*. We only counted a sighting as a specific species, if identification could be confirmed by the author.

Counts were transformed to crocodiles counted per km of river surveyed, which provides a crocodilian density count. We also grouped counts in to five km blocks, to examine patterns in crocodile density between different sections of rivers. As discussed in other recent reports (Simpson 2014), the crocodilian density is described as an index for variation in population size between sections of river, between rivers and between species. Counts conducted on the same section of river on separate nights were treated as separate density counts. Counts were only done while travelling in one direction (e.g. we did not include sightings while returning from survey). This was to ensure that we did not count the

same individual twice. On some evenings we only travelled one direction during the survey; therefore double counting was not always a concern.

We spent three days and nights on the Kampar River System, one day and night on the Merang River System and one day and night on the Simpang Kanan River System (and neighboring area).

2.4 Interviews

We conducted interviews with park officials, villagers, fisherman and loggers whenever possible. Surveys were informal, but typically consisted of the same series of questions. Photos of crocodiles were shown in situations where appropriate, to help in determining the local's ability to differentiate between crocodile species. Photos of both *Tomistoma* and *C. porosus* were shown. All local names for crocodile species were written down and are included in Appendix II. When photos were not shown to locals, we asked them to describe physical features of crocodiles, to determine how well they could distinguish between species. Interviews were only carried out with locals who seemed to have a realistic knowledge of crocodiles in the area. It was apparent that some people based their answers only on indirect evidence, while others had personal experience with crocodiles. Therefore, care was taken which interviews to include in the final results.

Interview questions were based on the same series of questions, although not all questions were always asked during each interview. Questions asked typically came from the following list, although other questions were also asked depending upon the conversation:

Questions

- Have you or anyone you know seen crocodiles in the area?
- How often do you see crocodiles in the area?
- What size crocodiles have you seen?
- Do people hunt or kill crocodiles in the area?
- Have you seen *Tomistoma* or *C. porosus* (See local names Appendix II)?
- Are people afraid of crocodiles here?
- Do you know anyone who has been attacked by a crocodile?
- Do you know of other areas where there may be crocodiles?
- Are crocodiles more or less common than in the past?
- Do you know of areas where crocodiles nest?

Translated to Indonesian

- Apakah Anda atau siapa pun yang Anda tahu buaya di daerah terlihat?
- Seberapa sering Anda melihat buaya di daerah?
- Apa ukuran buaya yang telah Anda lihat?
- Apakah orang-orang berburu atau membunuh buaya di daerah?
- Pernahkah Anda melihat *Tomistoma* atau *C. porosus* (Buaya Mancang Panjang atau Buaya katak)?
- Apakah orang takut buaya di sini?
- Apakah Anda tahu siapa saja yang telah diserang oleh seekor buaya?
- Apakah Anda mengetahui daerah-daerah lain di mana mungkin ada buaya?
- Apakah buaya lebih atau kurang umum daripada di masa lalu?
- Apakah Anda tahu daerah mana sarang buaya?

2.5 Mapping

A lack of available map information makes travel arrangements difficult in unstudied areas. Rivers and creeks are often unable to be identified until a researcher travels to the area and identifies the tributary name on site. This is typically done by asking locals on site and talking with park officials. We have provided maps for all areas surveyed during this assessment and areas which will be surveyed in the future. Names of rivers or other notable locations were collected from literature or from experience during our travel.

We utilized raster layers available from ArcMap 10.0. to visualize land cover and terrain in Sumatra. We used a landscape cover raster layer to visualize the remaining forest cover across Sumatra (Map 1), as well as a second layer in order to visualize terrain and elevation (Map 2). For more detailed maps of each study area, we used nearly up to date Land Satellite imagery (<http://landsat.usgs.gov/> ; 2013), which can be seen in the following section (3.0). This provided maps with a clear picture of remaining forest cover, as well as changes to forest since previous surveys were conducted in the past. The comparison between current and previous forest cover was only estimated visually, we did not quantify the forest loss over time.

3.0 Study Area and Habitat Descriptions

Although only three out of five study sites were surveyed during this preliminary assessment, we attempted to collect as much landscape and habitat information as possible in and around each study area. Because we spent more time in some areas than in others, we were able to collect more data in certain locations. We estimate major transitions and changes in habitat along sections of rivers which we surveyed, but also use satellite imagery to estimate transitions in areas not visited. Detailed information on the habitat encountered in each study area is separated by river name below.

3.1 Kampar River System (Riau Province)

The Kampar River is a major waterway that runs west to east across Riau province Sumatra. The upper reaches of the river originate in the Barisan mountain range west of the city of Pekanbaru. Based on satellite imagery, the majority of its tributaries appear to have been logged heavily across the upper reaches of the river system. A few select tributaries of the upper Kampar River were briefly surveyed in the past. These rivers are the Kubu and Teso Rivers, which were surveyed by Bezuijen et al. (1997). No crocodiles were encountered during those surveys, although evidence based on local reports suggests that *Tomistoma* were present in both rivers during the time surveys were conducted.

Despite the lack of intact forest in the upper reaches of the Kampar River, the far eastern reaches of the river system are fed by a number of small black water tributaries, which empty out of primary peat swamp forest. These sections of forest represent some of the largest remaining sections of peat forest in Sumatra. A section of forest can be found immediately north of the Kampar River near the coast and another section immediately to the South. To the best of our knowledge these patches of forest have never previously been surveyed for the presence of crocodylians. The intact peat swamp and adjacent sections of remote coastal swamp lands suggest it is an important area for both *C. porosus* and *T. schlegelii* populations.

The far eastern stretch of river is massive and is approximately eight km wide near the mouth and three km wide near our study area (Photo 1). Only one main village is found along this section of River, Teluk Meranti. Teluk Meranti is home to around 3,000 people, with a number of small satellite villages spread out in multiple directions (<50 people in each). The region surrounding Teluk Meranti is remote and the majority of the river systems in the area can only be accessed by boat. The small black water tributaries around the area are home to very few people and stretches of these rivers are completely uninhabited (10 to 20 km sections).

The Kampar River is known for massive waves, which are forced up the mouth of the river system from the Indian Ocean to the East. This event is known locally as “Bono”. Due to the language barrier, it is still unclear exactly how often this phenomenon occurs, however it was obvious that this was a major concern on a daily basis for the villagers who guided us along the waterways in the area. It was made apparent that this was a dangerous event and care needed to be taken to stay off of the main river (Kampar) when this was going to occur. There is a significant tidal influence which affects the first five to 10 km of each tributary near the village of Teluk Meranti.

Teluk Meranti is centered between multiple black water tributaries and is an important location for making guide, boat, food and other arrangements. There is one main road which deviates due East from the Sumatra East highway (main highway running North and South across East Sumatra) which can be used to travel to Teluk Meranti. This road is paved for approximately 30 to 40 km (one hour’s drive, depending upon road conditions) before turning in to a dirt track. The dirt track persists for approximately another 40 km (one to two hours’ drive). The dirt section is not well suited for two wheel drive vehicles. The other option for travel to Teluk Meranti is by boat. The Kampar River runs far inland, near the city of Pekanbaru and boats can be hired to travel to Teluk Meranti a short distance south of the city. This has not yet been done, however it was suggested by our boat guide that it would take between two to three hours to travel from Pekanbaru (Kampar River South of city) to Teluk Meranti by boat. The cost is likely to be between one and two million rupiah (~\$100 to 200 US dollars) for the trip, depending upon the situation and time of year.

The main Kampar river channel did not seem favorable for *Tomistoma*, but we surveyed three tributaries in the area. These are discussed in more detail below (The Serkap River Section 3.2, Turip River Section 3.3 and Kerumutan River Section 3.4). The Kampar River System can be seen in (Map 3) below.



Map 3. Detailed map of the Kampar River System, near our study area. Reserve boundaries (orange dotted lines) are our best approximations. Primary Forest is represented by dark green coloration.



Photo 1. Shows an image looking out across the Kampar River (~ three km wide at this location).

3.2 Serkap River (Kampar Tributary)

The Serkap River has never previously been surveyed for crocodylian activity. It is located along the far Eastern portion of the Kampar river system. It originates from a medium sized inland peat swamp lake and flows south for approximately 65 km before entering the Kampar River. We describe various sections of the river below, based on our observations during surveys.

Habitat Description

River Mouth – 5 km—Travel time from Teluk Meranti to the mouth of the Serkap river was approximately 45 minutes by speed boat due East of the village (30 km, located on opposing river bank). The mouth of the river is characterized by scattered log jams and stretches of sandy beaches for the first three km. The entrance to the river can be quite difficult for a speedboat to navigate because it is shallow during low tide. Those entering the river may have to wait at the mouth until the water begins to rise with high tide. The mouth of the river is situated in a location where the Bono wave system impacts, so anyone waiting in the area should wait in a nearby secluded cove, if they are unsure of the timeline for Bono. The first five kilometers of river bank are characterized by secondary forest, which appears to have been undisturbed for many years (trees 10 to 15 meters tall). The river itself is between 20 to 40 meters wide in this section. The river current is relatively strong and changes with fluctuations in tide.

5 – 20 km— The river banks along this section consist of undisturbed swamp forest. Based on satellite photos of the area (Figure remote sensing photos), there are a few roads that have been cut through the forest and intersect various points along this stretch of river. It also appears that there is primary forest for many miles to the East, West and North of this section of river based on satellite imagery (<http://landsat.usgs.gov/>). This section of river is approximately 20 meters wide in most places, but often bottlenecks to between three to four meters wide. Truncated sections narrow to a point where plants may brush along both sides of the boat, before opening up again. Although narrow these sections are deep enough to be travelled by speedboat.

20 – 25 km—This stretch of river opens up into a small lake. The lake is shallow and wide open with only grasses, *Pandanus* and dead trees. The lake is approximately 400 to 500 meters wide for most of its length before narrowing at the North end. At the North end of the lake there are five huts and it is unknown if there are any permanent residents.

Above 25 km — Above the first lake, the river becomes quite narrow and is covered in *Pandanus*. After one to two km it becomes impassable by speedboat, however a canoe will allow for travel much further. Based on satellite imagery the river seems to continue for approximately 35 to 40 km further, with at least two more lakes along the way. At the end of the 60 to 65 km long river, there is a large lake which appears to be intact swamp forest habitat based on satellite photos, but travel appears to be quite difficult.



Photo 2. The mouth of the Serkap River, which is characterized by debris and sandy shoreline.



Photo 3. The Serkap River (~five km upriver). By this point the river has transitioned to primary swamp forest, with a small amount of tidal influence.



Photo 4. Around 20 km upriver, the Serkap opens up in to a small lake.



Photo 5. Immediately after the lake (~25 km mark), the river narrows to a point where it can only be travelled by canoe.

3.3 Turip River (Kampar Tributary)

The Turip River is located near the village of Teluk Meranti, but on the opposing river bank. The river originates in the same patch of primary swamp forest that the Serkap River originates within. Similar to the Serkap and other black waters tributaries, the headwaters of the river consist of what appears to be a series of small lakes and swamp forest (Based on satellite imagery). The river then transitions to a narrow river network, before entering in to the Kampar River. The Turip River is located approximately 20 km north-east from Teluk Meranti. It is near the Serkap River and similar in composition as well. The Turip is smaller than the Serkap River.

Habitat Description

River Mouth – 5km— The river is approximately 30 meters wide at the mouth and narrows quickly as you travel upstream. The first five kilometers are tidally influenced and characterized by sporadic sand bars, sunken logs and secondary forest. The Turip was said to have been fished less often than the Serkap River. It was stated that in the past the river was fished more heavily, but due to declines in fish catch fisherman transitioned to other locations.

5 – 10 km—The river is quite narrow and surrounded by primary forest throughout this section. There is only evidence of small amounts of logging activity. After the 10 km mark the river becomes quite narrow and is only navigable by canoe or small motor boat. Unfortunately we were unable to acquire a canoe and reach the lakes further upriver.

Above 10 km— It appears that the river channel might continue another 15 to 20 km upriver, with the majority of that distance characterized by a series of small lakes. It also seems the river is surrounded by primary forest until it reaches its origin. This knowledge is based only on satellite photos and the status of the habitat further upriver is currently unknown.



Photo 6. A photo of the mouth of the Turip River, looking out toward the Kampar River.



Photo 7. Shows the Turip River five km upriver. From five to 10 km, the river maintains this width and is surrounded by primary forest.

3.4 Kerumutan River (Kampar Tributary)

The Kerumutan River flows from south to north and enters the Kampar River system immediately adjacent to the village of Teluk Meranti (five km due west, same side of river). The entire Kerumutan river system appears to be between 50 to 60 km in length, depending upon the definition of the starting point. The headwaters of the river consist of a unique peat swamp forest system, which differs from other rivers we have surveyed. The swamp forest is surrounded by primary rainforest and part of the river falls within the boundaries of the Kerumutan Game Reserve. However, it is unclear exactly where these boundaries start and stop along the river, as there are no signs or markers which indicate this if travelling by boat. Despite being protected, the area is still under heavy illegal logging activities (based on personal observations).

Habitat Description

River Mouth – 10 km— The mouth of the river is very close to the village of Teluk Meranti and is quite large. The mouth is approximately one to two km wide and the river depth is quite shallow across the majority of the river channel. Our speedboat was only able to drive part of the way up river before it became too shallow to continue driving. We then had to get out and walk the speedboat across sand bars. It was necessary to walk between 200 and 300 meters of shallow water in order to get the boat

to a spot where we could continue. The river becomes narrower after travelling three to five km upriver and stays consistently between 100 to 200 meters wide for approximately five to 10 km. The first five km is mostly palm oil and secondary forest, but between five to seven km upriver, the river transitions in to pristine lowland forest.

Between 10 – 15 km—The river is between 50 and 100 meters wide and the forest is in good condition. The banks of the river are lined with what appears to be primary rainforest and the trees were much larger than other patches of primary forest along other rivers. There is some evidence of logging sporadically throughout this section. Along the river, *Hanguana* and *Pandanus* were the two plants most commonly encountered.

15 – 30 km—At approximately the 15 km mark, the river transitions in to unique swamp forest habitat, between 100 and 300 meters wide. At the edge of the main river channel, the water recedes in to the swamp forest. Trees are spaced tightly together (one to two meters apart) making travel in to the swamp forest unfeasible without a small canoe. However, travel down the main channel is typically free of obstacles and can be travelled at high speeds during the day. Visibility in the swamp forest is approximately 40 meters in most places. After asking locals how far the water receded in to the forest, they suggested it went over 300 meters from the main river channel. This swamp forest makes it difficult to survey, because detection of *Tomistoma* away from the main channel is unlikely. Although survey conditions are difficult, the habitat seems quite favorable for *Tomistoma*. There are only a few small floating huts found along this stretch of river and most appear uninhabited. Beyond ~30 km upriver the conditions are unknown, but based on satellite imagery it appears that some of the areas near the headwaters are heavily deforested and there is a small village near the origin of the river.

Over the stretch of river surveyed, interviews were conducted with four different people, but only a single interview yielded reliable information (Results: Kerumutan: Interview 1).



Photo 8. The mouth of the Kerumutan River, which is near one km in width at this point.



Photo 9. Photo taken approximately one km from the mouth of the Kerumutan River (looking upriver). Shows how shallow and wide this section is and requires walking and dragging the boat before continuing upriver.



Photo 10. Taken between five to 10 km mark of the Kerumutan River. Shows the river at its narrowest point.



Photo 11. Taken between 15 to 20 km mark of the Kerumutan River. Shows where the river has transitioned in to unique peat swamp forest habitat.



Photo 12. Looking in to the peat swamp forest. The flooded forest is too narrow to navigate with speedboat. Visibility only about 40 meters, but locals say it recedes up to 300 meters away from main channel before dry land starts.

3.5 Simpang Kanan River (Riau Province)

The Simpang Kanan River is located approximately 100 km due North of the village of Tembilahan, in Riau province (Map 4). The river originates in what appears to be intact primary rainforest; however the majority of the forest surrounding the river has been logged. The river flows from West to East before meeting a larger river system near the coastline (larger river name unknown).

To reach the river, it seems the best route may be from the village of Tembilahan. Travelling from the main Sumatra East Highway, a single main road leads to the village. Tembilahan is large enough that there are many people who own speedboats and hiring options are numerous. Another potential route to the river, could be from the village of Teluk Meranti, where our Kampar River study area is located. It appears that multiple logging roads near Teluk Meranti have been cut through the forest and terminate near the headwaters of the Simpang Kanan. However, it is unclear based on satellite photos if the logging roads extend far enough to connect the two study areas. If they are connected this would be ideal, as it would save a large amount of time to travel and survey the area.

There is also another unknown river located to the South of the Simpang Kanan, which appears to have intact forest habitat as well. This river could not be visited due to time constraints however; its

headwaters originate within intact primary forest, near our Kampar River study area (See “unknown river” Map 4). The headwaters of the unknown river are a good candidate area for *Tomistoma* surveys.

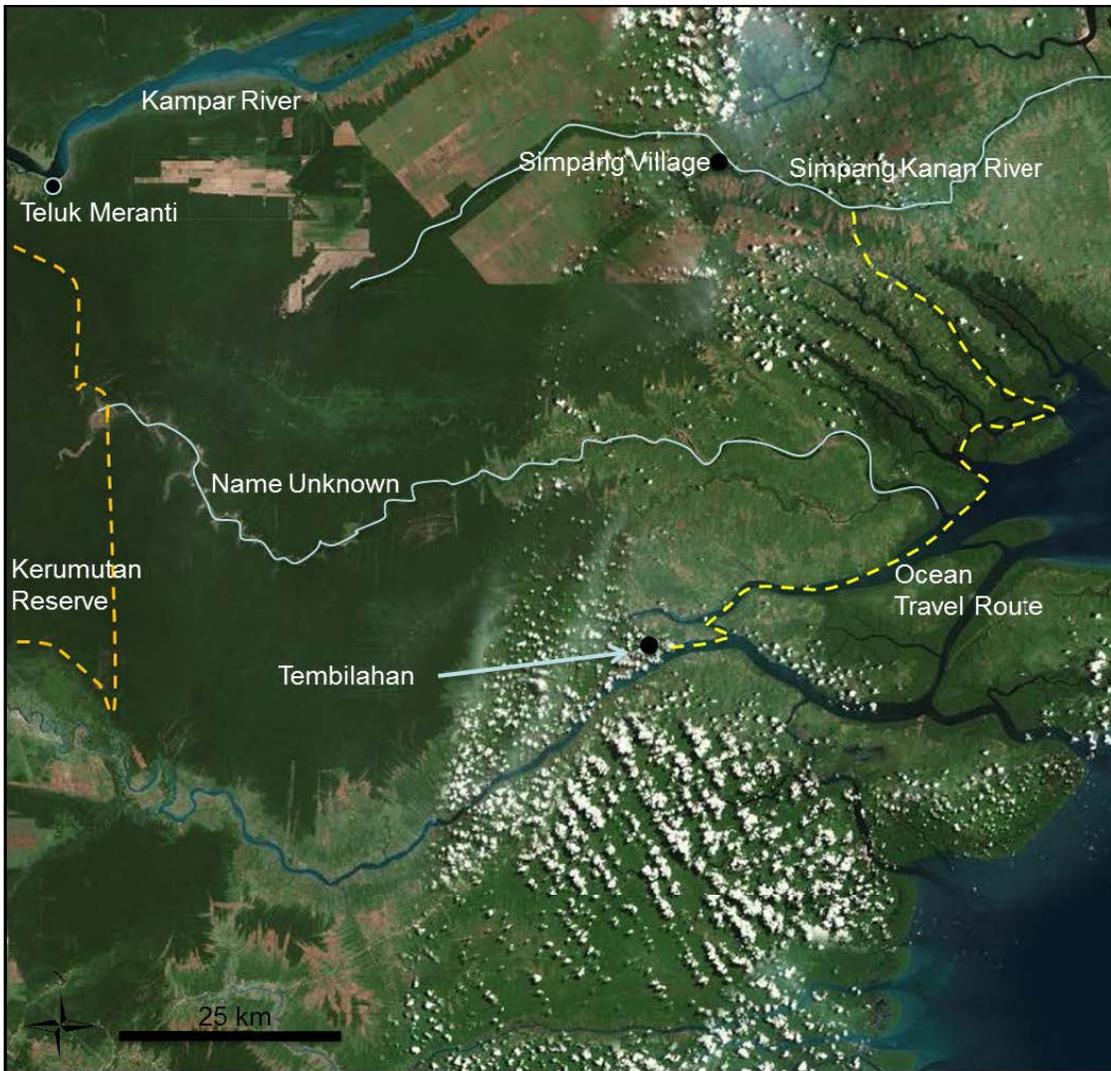
Habitat Description

Tembilahan – Mouth Simpang Kanan River—There are approximately 95 km of mangrove and ocean between Tembilahan and the Simpang Kanan River. The majority of this travel was through remote areas, across sections of ocean channels and inlets. Much of the travel was across rough water and care should be taken to bring extra supplies if others intend to make this trip in the future. There are only a few small villages along this 95 km stretch and the trip took us between three to four hours, travelling mostly at high speeds. The area is surrounded by mangrove forest on all sides and it appeared to be in healthy condition as wildlife was abundant along the shore. Many wild pigs and monkeys were seen feeding along the shoreline and the mangrove forest appeared to be intact.

Lower Simpang Kanan River – Simpang Village— There is a man-made channel that cuts through the mangroves and leads to the Simpang Kanan River and it is approximately 25 km from this point to the village of Simpang. The length of this section is surrounded by almost entirely palm oil forest. There are a few small villages and what appears to be heavy logging pressure along the river, as barges filled with lumber could be seen travelling downriver. The river is approximately 500 to 800 meters wide along this section.

Simpang Village – 30 km further upriver— From the village of Simpang the river forks to the left and right (looking upriver). Only the fork to the right was travelled. The right fork of the river is heavily deforested up until around 20 to 25 km upriver from the village of Simpang. From that point there are many patches of primary forest, secondary forest and palm oil plantation scattered around the river. The river appears to be progressively changing towards primary forest from that point.

Above 30 km point (Upriver from Simpang)— We did not travel past this point upriver, however it appears that there may be another 15 to 25 km of river and a small series of lakes which could be travelled in a small speedboat or canoe. These upper sections appear to have primary forest remaining, based on satellite images. However, due to logging pressure, it is difficult to say whether or not these patches will remain for much longer.



Map 4. Shows the greater Simpang Kanan survey area. Our starting point was from the village of Tembilahan. Ocean travel route highlighted in yellow. Part of the Kampar River survey area can be seen to the North-West. Primary Forest is represented by dark green coloration.



Photo 13. Shows the upper reaches of the Simpang Kanan River. Taken approximately 20 km upriver from the village of Simpang.

3.6 Merang River (Sumatra Selatan Province)

The Merang River is located on the northern end of South Sumatra province. The river is one of the main tributaries to the Lalan River System. Other tributaries of the Lalan River were surveyed in the past as well; particularly the Medak and Kepahiang Rivers (spelled Kepahyang by Bezuijen et al. 1995). However, only a few *Tomistoma* were recorded on the Medak River and none along the Kepahiang in 1995. This may have been because both rivers had less suitable habitat than the Merang River.

The Lalan River itself flows from west to east, due south of Berbak National Park. The Lalan has been deforested since previous surveys were done in the mid 1990's (Bezuijen et al. 1995). The Merang River flows north to south and intercepts the Lalan River between the Medak and Kepahiang Rivers. The Merang has served as an important survey site for *Tomistoma* in the past, as the majority of all *Tomistoma* documented in Sumatra have been from the Merang River. However, the river has not been surveyed for over a decade and the status of *Tomistoma* populations in the river system is currently unknown.

Travel to the river was historically done by travelling along the Lalan River and then up the Mouth of the Merang. The starting point by Bezuijen et al. (1995) had previously been from the city of Palembang, which required four and a half hours by boat to reach the Merang. We travelled from a village off of the Sumatra East Highway, which required about a two hour ride to the Merang River mouth by boat. The

name of the village is Bayung Lencir. Despite the previous travel along the Lalan River being most common (as mentioned above), new information suggests it may be easier to travel along recently built logging roads that intercept the Merang River around the 40 km mark and there may be even more roads that intercept further upriver. This is further discussed in our results section.

Habitat Description

0 – 45 km— This section of river has been considerably deforested and has almost no remaining primary forest. The river banks along this section of river are mostly surrounded by palm oil plantations and some patches of secondary forest. There are a few small villages along this section of river and the Merang is a major pathway for transporting lumber downstream.

45 – 65 km— We were unable to travel this section of river, however previous information from (Bezuijen et al. 1995) suggests this section held the best *Tomistoma* habitat and highest density of *Tomistoma* in the past. The upper sections historically held intact peat swamp forest and the majority of *Tomistoma* sightings and nests were documented along this section. Although we did not travel this section, locals suggested the upper reaches have been under heavy logging pressure. Satellite photos suggest this as well. Despite the logging activity, satellite photos show that there is still intact primary forest along much of this upper section.



Map 5. The Greater Lalan River area. The Merang River seen on the middle-left hand side of the map. National Parks are circled in orange. The Merang River and Other notable rivers that have been surveyed previously are labeled. Discordance in spelling of Kepahiang River (Bezuijen et al. Kepahyang River). Primary Forest is represented by dark green coloration.



Photo 14. Photo taken approximately 25 km up the Merang River. Highlights the continuous chain of logs being ferried downriver.



Photo 15. Photo taken approximately 25 to 30 km upriver and shows the clear cut forest along the river banks.

3.7 Berbak National Park Overview (Jambi Province)

Berbak National Park is situated in the South-East corner of Jambi province and located due east of Jambi City. The park is known to hold one of the largest remaining chunks of intact peat swamp forest in the world and is still currently home to multiple endangered species, including Sumatran Tigers,

Sumatran Rhino, Sumatran Elephant and the False Gharial. Crocodile surveys have been carried out in the past (Cox et al. 1990; Bezuijen et al. 1997) and both *Tomistoma* and *C. porosus* have been documented there. The main river system that runs through the park is the Air Hitam Laut River and the river's upper reaches seem to still hold favorable *Tomistoma* habitat.

In the past, *Tomistoma* were recorded in the Air Hitam Laut River, as well as a small tributary named Simpang Malaka Creek (Cox 1990; Bezuijen et al. 1996). Nests have also been found along Gajah Creek, another small tributary of the Air Hitam Laut River. The Alai River has been surveyed, but no *Tomistoma* were recorded (Bezuijen et al. 1996). Another tributary only recently mentioned is the Simpang Kubu creek (Also tributary to Air Hitam Laut). This should not be confused with the Kubu River in Riau province (Tributary to Kampar River). The Simpang Kubu was only mentioned briefly through personal communication with a turtle researcher who conducted research on the creek in 2014. The researcher mentioned that two *Tomistoma* were seen.

Travel to the river has been done in the past, by means of speedboat. The trip first requires a long boat trip from Jambi City along the Batanghari River, towards the ocean. Then one must head directly south hugging the shoreline, before meeting the Air Hitam Laut River. From there, it is possible to enter the river and travel upstream in to the boundaries of Berbak National Park. It appears that a series of logging roads may also lead in to the park as well (originating near Jambi City), but there is currently no information available on whether or not travel by vehicle is feasible and whether a boat would be available where logging roads enter in to the park.

During our preliminary trip in 2014, we were unable to conduct research in the park, because the majority of the park is closed to visitors without research permits. However, we were able to meet local people and identify guides for hire in 2015. We were also able to ask some basic interview questions with park staff at the Berbak National Park headquarters in Jambi City, as well as the turtle researcher mentioned above (See Results: Berbak National Park: Interviews).



Map 6. Shows the greater Berbak National Park area. Berbak National Park is circled in orange. The main target survey river is shown in the middle of Berbak National Park. Jambi City is just out of picture, due west of the park (See blue arrow on left side of image). Primary Forest is represented by dark green coloration.

3.8 Bukit Batu and Giam Siak Kecil Rivers (Riau Province)

Giam Siak Kecil Reserve is located immediately to the north-east of Pekanbaru, Riau. Giam Siak Kecil River runs through the center of the reserve. To the best of our knowledge the river has never been officially surveyed for crocodylian activity, however a report from 1994 indicated that locals stated *Tomistoma* were present in the river (Muin and Ramono 1994). The authors suggested the river as a study location and anecdotal evidence suggests that *Tomistoma* are still present. The upper sections of the river (~75 to 100 km from mouth) seem to be heavily deforested based on satellite maps, but the middle sections of the river (~40 to 75 km) are surrounded by intact primary rainforest. The middle

reaches also have a series of large lakes which branch off of the main river channel and create large patches of swamp forest habitat. Therefore, there appears to be large chunks of habitat still available for *Tomistoma* throughout the middle section of river. The lower section of the river (~0 to 40 km) is heavily fragmented and little or no primary forest is found along the majority of that section. The area makes up part of what has been pronounced a world biosphere reserve. Based on discussions with forestry officials in Pekanbaru, the park still has a population of Tigers and potentially Elephants and Rhinos. We also conducted interviews related to crocodiles, which can be found in the results section. The best way to travel to the Giam Siak Kecil River is still unknown; but we did attempt to access the upper section of the river from a dirt road north of Pekanbaru. This attempt was unsuccessful, as roads that appeared on the map, were not passible by two-wheel drive vehicle. However, we did cross the lower section of the river, during travel to Bukit Batu Reserve (mentioned below) and it appeared that there were speed boats near the river crossing as we passed (near the coast). It is likely that a speedboat could be hired near this river crossing on the lower section and then travel upriver to the reserve from there would be possible.

Bukit Batu River is situated further north-east from Pekanbaru than the Giam Siak Kecil River (Map 7). Although the river is relatively small, it appears to be at least 40 km in length and passes through intact peat swamp forest. The upper reaches are characterized by a few small lakes. The river is surrounded by Bukit Batu Reserve, which has successfully maintained primary rainforest around the majority of the river (other than the first five km near the sea). Travel to Bukit Batu requires six hours of driving due east from the city of Pekanbaru. The drive consists of many rough roads and gravel roads, but there are multiple villages to stop in along the way for supplies. Along the drive, one must cross over a lower section of the Giam Siak Kecil, as mentioned above. No interviews were conducted on site, but we were able to conduct an interview over the phone with the husband of a forestry official (Results: Giam Siak Kecil and Bukit Batu Rivers: Interview 2).

Although no surveys were conducted on the Giam Siak Kecil or Bukit Batu Rivers, both rivers appear to be promising areas for *Tomistoma* populations. It was also mentioned that during the wet season, the upper reaches of the Bukit Batu River, may become interconnected with the Giam Siak Kecil River, due to flooding in the forests. This is unclear based on satellite photos, but if this is true it could allow for *Tomistoma* to migrate between the two waterways.



Map 7. Shows the Giam Siak Kecil and Bukit Batu study area. Reserves are highlighted in orange. The city of Pekanbaru is out of the photo, but is situated immediately to the South-West of Giam Siak Kecil (See blue arrow). Primary Forest is represented by dark green coloration.

4.0 Survey and Interview Results

We were able to conduct river surveys in three of the five areas discussed; the Merang River (one day and one night), the Simpang Kanan River (one day and one night) and the lower Kampar River System (three days and three nights). During the three days on the Kampar River System we documented crocodiles (only *C. porosus* confirmed) on the Serkap River, Turip River and Kerumutan River. Interviews were conducted at each study area surveyed. We also conducted interviews with forestry officials and locals near the other two study areas where we were unable to conduct spotlight surveys. Detailed results for each study area are discussed below. We did not see any crocodiles during the day. Therefore

survey results refer only to our night time spotlight surveys. For an overview of crocodiles seen, see appendix I. For a list of local names for crocodiles see Appendix II.

4.1 Serkap River

Survey Results, Night 1—We covered 25 km of river during the day and waited for nightfall before spotlight surveying the entire section that night. We stopped near the beginning of Tasik Besar Game Reserve, but the border is not clearly marked and it is difficult to say exactly where it starts and where it stops. We began surveys immediately after dark (8:30 pm) and floated downstream from the lake, using only the current of the river for the majority of the survey. Our starting point was in the middle of the first lake, which we reached earlier in the day and our ending point was at the mouth of the river. We saw one hatchling eight km upriver (Appendix 1). The species was unknown. This first sighting occurred at approximately 11:30 pm. No other sightings occurred until we reached the mouth of the river. At the end of the survey there was one other hatchling directly at the mouth of the river, between large log jams. This sighting occurred at approximately 1:00 am (See Table 1).

Survey Results, Night 2— We started our survey immediately after dark (8:30 pm) and motored upriver rather than downriver. Because of low tide, we were unable to get the speedboat past the mouth of the river during the day and we waited near the mouth of the river for approximately three hours. High tide came in just after sunset and we began our survey upriver. We immediately sighted three hatchlings, which were seen in the first two km of river (8:30 pm). One was confirmed to be a *C. porosus*, two were unknown. We then located one adult *C. porosus*, estimated between 10 and 11 feet, approximately two km up river (9:00 pm). Further up river another *C. porosus* hatchling was found at approximately five km (9:30). At approximately the 10 km mark, we had difficulties navigating the boat against the current and around sunken debris. This was not an issue the previous night because we had the current in our favor, travelling downriver. Therefore, on this occasion we turned the boat around and went back down river in order to survey another river in the same evening (Turip River). Travelling down river we encountered what we assumed to be the same adult *C. porosus*. As the boat drifted down river with the current, the individual swam near the bank and allowed the boat to travel within 15 feet. The animal raised its head out of the water, as if it was posturing and then slowly turned and swam downstream before submerging (See Table 1).

In total there were seven crocodiles counted over the course of two nights, along the 25 km section we surveyed. The first night we counted two crocodiles across the 25 km section of river surveyed, which

gave us a total density of 0.08 crocodiles per km, however both crocodiles were seen within the first five km of river. Therefore, if that section is split apart from other sections, the crocodile density was 0.2 crocodiles per km in the zero to five km section, 0.2 crocodiles per km in the section between 5 to 10 km and zero crocodiles per km across the remaining 15 km of river surveyed.

On the second night we located five crocodiles in the 10 km of river surveyed, making for a total density of 0.24 crocodiles per km of river. However, all crocodiles were seen in the first five km of river, therefore if that section is split out separately, then the crocodile density was ~1 crocodile per km in the zero to five km section and zero crocodiles per km in the five to 10 km section. More variables should be collected, to determine the significance of this variation in densities between each five km block of river, however it is notable that all crocodile sightings were within the zero to 10 km section of river over two survey nights. All individuals that were observed well enough to identify, were *C. porosus*.

Table 1. Provides a breakdown of crocodiles seen over two days of surveys on the Serkap River.

River Section	Times Surveyed	<i>C. porosus</i>	<i>Tomistoma</i>	Eye Shines	Size Classes (Feet)
0 – 5 km	2	4	0	2	5 (1 – 2 ft), 1 (10 – 11 ft)
5 – 10 km	2	0	0	1	1 (1 – 2 ft)
10 – 15 km	1	0	0	0	NA
15 – 20 km	1	0	0	0	NA
20 – 25 km	1	0	0	0	NA

Interview 1— We met an older man who was fishing from a small motor propelled canoe approximately 10 km upriver. The man said he checked fish traps daily and although he had seen many crocodiles in the past, there were few he had seen recently. He stated that he remembered seeing a very large *Tomistoma* that had been killed and left on the river two years prior. He estimated it to be between four and five meters in length. He said that people were afraid of crocodiles in the area and that people would commonly shoot or poison them. He had no knowledge of nests in the area and did not know of anyone who had been attacked in the area.

Interview 2— At the end of the first large lake in the area (~20 km mark), there were a few small huts on stilts. Near this location, an older man who appeared to be in his 50’s, arrived late one evening after a day of fishing from his canoe. He invited us in to his hut and we interviewed him about his experience with crocodiles in the area. He stated that he had seen both species in the area although he did not see

them often. He said he was not afraid of the crocodiles and that he believed they were less common than they were 10 to 20 years prior. He did not know of any nests in the area. He was unsure if there were more crocodiles further upriver, because he did not travel far from the lake to fish and the river extended far from where he lived.

Interview 3—The man who guided us through the area was a villager who lived in Teluk Meranti his whole life. The man was young and said he was only 23 years of age. He was the only villager from the area with a speedboat and said he had seen many crocodiles along both the main river (Kampar River) as well as the mouth of the Serkap River. He said there were many more crocodiles near the mouth of the river, then far upriver. He insisted that both species of crocodile could be found near the mouth of the river. He also said he knew of a man who lived on an island a short distance away (in the middle of the Kampar River) and the man would commonly go and collect hatchling crocodiles from the mouth of the Serkap River. He stated that the man would shock the river using jumper cables connected to a car battery. The hatchlings would float to the surface and he would collect them. The hatchlings would recover later on and he would sell the live animals to other villagers. He said that both *Tomistoma* and *C. porosus* were shocked and captured near the mouth of the Serkap River. He said the island where he lived was 20 km directly east of the mouth of the Serkap River. He said there was a second island adjacent to where he lived and *C. porosus* commonly nested there (Notated in Kampar River System Map 3 above).

4.2 Turip River

Survey Results—We travelled from the Serkap River at around 11:00 pm and began our survey at the mouth of the Turip River at 11:30 pm. We immediately detected the eye shines of two crocodiles, which were identified as hatchling *C. porosus*, between 200 and 500 meters upriver. We then spotted a single juvenile animal from an eye shine (species no confirmed), approximately 800 meters up river (~11:45 pm). The juvenile appeared to be between four and five feet in length. We travelled approximately five km upriver but no other eye shines were seen. Because of the danger of sunken logs in the rest of the river (experienced during the day), we did not travel any further upriver and turned the boat around. We left the river at approximately 12:30 am. A total of three crocodiles were counted during this single survey, making for a density of 0.3 crocodiles per km over the 10 km stretch which was surveyed. However, because all crocodiles were counted in the first five km stretch, we calculate density over the first five km separately for comparison. Three crocodiles over the first five km, is a 0.6 crocodile per km density and 0 crocodiles per km between the five to 10 km section. This is similar to the Serkap River

where the majority of crocodiles were found in the first five km of river. As mentioned in the Serkap River Results, more variables should be collected to test the significance of variation in crocodile densities between sections.

Table 2. Provides a breakdown of crocodiles seen over in one day and night on the Turip River.

River Section	Times Surveyed	<i>C. porosus</i>	<i>Tomistoma</i>	Eye Shines	Size Classes (Feet)
0 – 5 km	1	2	0	1	2 (1 – 2 ft), 1 (4 – 5 ft)
5 – 10 km	1	0	0	0	NA

Interview 1— We were invited to sit and eat with four loggers who paddled the Turip River daily and had a small logging camp set up approximately eight km upriver from the mouth. The four men agreed that crocodiles were common in the lower sections of the river (one to five km) and that they had seen both species in the area (*C. porosus* and *Tomistoma*). They said they did not know anyone who had been attacked by a crocodile in the area. They said they believed crocodiles were less common than they were in the past (10 to 20 years ago), however on any given day it was common to see crocodiles basking during the morning when they paddled upriver to fish. They did not have any information on crocodile nests in the area.

4.3 Kerumutan River

Survey Results— We entered the mouth of the river at 8:00 am the local guides took the boat approximately 33 km upriver, to where the speedboat could go no further. It was unclear where the borders of the Kerumutan Reserve start or stop. Near the stopping point, interviews were conducted and we waited for nightfall, before travelling downriver. We started travelling at 8:30 pm and noticed one eye shine around the 18 km mark at 9:30 pm. There was potential it could have been a *Tomistoma*, because the location was in an intact section of peat swamp forest, but the species identity could not be confirmed. This finding was also unique because of the eye shine’s distance from the main Kampar River channel. No other crocodiles were sighted more than 10 km upriver from the Kampar River, when surveys were conducted on the Serkap and Turip Rivers. This sighting was located much further upstream and did not follow the pattern that was associated with the *C. porosus* sightings being in the

lower sections of other rivers. However, this certainly does not preclude the potential that the sighting was a *C. porosus*. We did not encounter any other crocodiles for the remainder of the survey and finished at the main Kampar River around 12:30 am. Because we only sighted a single eye shine on this river, the overall density comes out to be 0.03 crocodiles per km of river surveyed. We did not calculate crocodile density results in five km blocks because there was only a single sighting.

Table 3. Provides a breakdown of crocodiles seen over in one day and night on the Kerumutan River.

River Section	Times Surveyed	<i>C. porosus</i>	<i>Tomistoma</i>	Eye Shines	Size Classes (Feet)
0 – 5 km	1	0	0	0	NA
5 – 10 km	1	0	0	0	NA
10 – 15 km	1	0	0	0	NA
15 – 20 km	1	0	0	1	1 (4 – 5 ft)
20 – 25 km	1	0	0	0	NA
25 – 30 km	1	0	0	0	NA
30 – 33 km	1	0	0	0	NA

Interview 1— We met a family that owned three huts, which were built to float along with changes in the river depth throughout the year (~25 km upriver). There were no roads leading to their huts and they lived in and out of canoes on a daily basis. The family invited us in to their small hut and interviews were conducted. They stated they saw many crocodiles along this section of river and that both species were present. However, they stated that *Tomistoma* was more common, which was the first we had heard during interviews in the area. They said they were very fearful of crocodiles, although no one in their family had been attacked. They did not provide any information on potential nests in the area. They also insisted that people did not hunt or kill crocodiles in the area.

4.4 Simpang Kanan River

Survey Results— On this survey, only Kyle Shaney (KJS) travelled along with a guide. No crocodiles were recorded along any of the mangrove forest shoreline, which was travelled in order to reach the Simpang Kanan River. In all they travelled approximately 95 km of ocean and mangrove forest before reaching

the Simpang Kanan River. They travelled approximately 25 km upriver before reaching Simpang Village. KJS met with the village leader in Simpang and discussed his knowledge of crocodiles in the area (Interview 1), before departing up the right branch of the river (looking upstream from Simpang there was a left and right fork). They proceeded for another hour before any primary forest could be seen, approximately 25 km up that branch of the river. However, at this point the river narrowed from 100 meters wide to only 30 meters wide and became shallower. Sunken logs were hazardous and the boat driver insisted on turning around. Before leaving, KJS was able to conduct an interview with two workers who were living in a small hut next to a section of palm oil plantation (Interview 2). They waited nearby until nightfall and conducted a spotlight survey on their way down the river. There were no crocodiles recorded along the 50 km branch. Only sporadic spotlight surveys were conducted along the 95 km stretch of Mangrove on the way back to the village of Tembilahan that evening. No crocodiles were recorded.

Table 4. Provides a breakdown of crocodiles seen in one day and night on the Simpang Kanan River, as well as the ~95 km of which was rapidly surveyed as well (in areas where we approached close enough to shore while travelling).

River Section	Times Surveyed	<i>C. porosus</i>	<i>Tomistoma</i>	Eye Shines	Size Classes (Feet)
	-	-	-	-	-
0 – 5 km	1	0	0	0	NA
5 – 10 km	1	0	0	0	NA
10 – 15 km	1	0	0	0	NA
15 – 20 km	1	0	0	0	NA
20 – 25 km	1	0	0	0	NA
25 – 30 km	1	0	0	0	NA
30 – 35 km	1	0	0	0	NA
35 – 40 km	1	0	0	0	NA
40 – 45 km	1	0	0	0	NA
45 – 50 km	1	0	0	0	NA
Mangrove	-	-	-	-	-
0 – 95 km	1	0	0	0	NA

Interview 1— A single interview with the village head of Simpang was conducted. The man said *C. porosus* was common but *Tomistoma* was not. He said no villagers had been attacked in recent years and they did not fear the crocodiles. He did not know of any nests in the area. Without a translator, no information could be gathered beyond that.

Interview 2— KJS spoke with two men who worked at an oil palm plantation near the river. They said they did not see crocodiles on a common basis however they thought they may be more *Tomistoma* in a small lake further upriver. They were not afraid of crocodiles, because they were rare and they did not know anyone who had been attacked. They did not know of any nests in the area. Without a translator, no information could be gathered beyond that.

4.5 Merang River

Survey Results— KJS and a guide started at what they believed to be Bayung Lencir Village (GPS coordinates—2.054469, 103.685063) and travelled down the Lalan River during the day, until reaching the mouth of the Merang River. They travelled up the Merang over the course of the afternoon before reaching a stopping point around 40 km upriver, where the river narrowed to the point that travel was no longer feasible by speedboat. There was high very high human activity along the river. Two interviews were conducted and then they waited until nightfall and surveyed the 40 km section of river (started around 8:30 pm), travelling toward the confluence of the Merang and Lalan Rivers. No eye shines were recorded during the survey on the Merang River. They reached the Lalan River confluence at approximately 12:30 am.

During interviews, it was stated that crocodiles had been seen farther upstream (Both species). Based on previous work (Bezuijen et al. 2001), *Tomistoma* was historically more common between the 45 and 65 km section, than the zero to 45 km section, so this information was not surprising. Time constraints and heavy logging (log clusters being moved impeded progress) did not allow them to survey the upper section of river between 45 and 65 km.

After reaching the confluence of the Merang and Lalan Rivers, rapid spotlight surveys were conducted on their way back toward the village of Bayung Lencir. No eye shines were recorded along the length of the Lalan River.

Table 5. Provides a breakdown of a single night’s river survey on the Merang River.

River Section	Times Surveyed	<i>C. porosus</i>	<i>Tomistoma</i>	Eye Shines	Size Classes (Feet)
Merang					
0 – 5 km	1	0	0	0	NA
5 – 10 km	1	0	0	0	NA
10 – 15 km	1	0	0	0	NA
15 – 20 km	1	0	0	0	NA
20 – 25 km	1	0	0	0	NA
25 – 30 km	1	0	0	0	NA
30 – 35 km	1	0	0	0	NA
35 – 40 km	1	0	0	0	NA
Lalan Riv.	1	0	0	0	NA

Interview 1— The first interview was conducted with a family who lived near the start of the spotlight survey (40 km upriver from mouth). They said they had only lived in the area for a short time; however they had seen crocodiles before. They said they believed both species lived in the area and that *Tomistoma* would be more common further upriver. Due to the language barrier (no translator available), KJS was unable to gather any more information beyond that.

Interview 2— One of the loggers who was floating down river on a series of logs, came aboard the speedboat and was asked basic survey questions. He said he had been working upriver (exact location unknown) for a long period of time and that he occasionally saw *Tomistoma*. However he said he thought they were less common now than in the past. Beyond that there was no specific information that could be taken from the conversation.

4.6 Berbak National Park

The national park office was closed when we arrived in Jambi City, Jambi. Therefore, we made the decision to travel to a small village outside of Jambi, where we met with local villagers. The village was referred to as “Tanjung”, although this simply translates to “promontory” in English. While there, the head of village met with us and discussed potential arrangements and prices for hiring a guide to take us

in to Berbak National Park. Prices were negotiated to be about 3.5 million rupiah (~\$350.00 US) for six days. This would include four villagers to guide through the park, conducting night surveys, cooking and other necessities.

However, after meeting we travelled to meet with park staff at the Berbak office and discussed the possibility of travel in to the park. Unfortunately 95 percent of the park is off limits without a research permit. Therefore we could not justify hiring guides to travel to the park, as we would be unable to survey the most suitable habitat for *Tomistoma*. However, we were able to gather logistical information for our surveys in 2015 (See Section: Future Work), as well as conduct interviews with park staff about *Tomistoma* and *C. porosus* sightings.

Interview 1— We considered an interview with two of the lead park staff at the Berbak National Park office, to be a single interview. They indicated that *Tomistoma* was still relatively common in the park. They also indicated that they knew of a large *Tomistoma* that had recently been trapped in an irrigation area near Berbak National Park, after it had moved there during a flooded period. They stated they would be glad to work with us on crocodile survey work in 2015.

Interview 2—We also spoke with an American turtle researcher who was in the office preparing to start his research in Berbak National Park during our visit. We took note of his contact information and contacted him two months later, after his work was completed. He said he saw two *Tomistoma* on a small tributary of the Air Hitam Laut River, known as Simpang Kubu Creek. He said they also saw multiple *C. porosus*.

4.7 Bukit Batu and Giam Siak Kecil Rivers

We were unable to conduct river surveys on either Bukit Batu or Giam Siak Kecil Rivers. However we did travel to the starting location of the Bukit Batu Reserve (near the mouth of the river). We were unable to speak with anyone that lived on the river at this location, but did identify the best travel route (Map 7). We were also able to gather logistical information regarding boat rentals from locals in the area. The only interview conducted was with the husband of a forestry staff official, but this interview provided valuable information (Interview 1).

Interview 1— Before travelling to Bukit Batu, we asked the staff in the Riau Forestry office if they had any information about crocodiles on the river. They said they knew of sightings from locals but had very little information. However, a woman who worked in the office allowed us to speak with her husband

over the phone and conduct an interview. Her husband was a lecturer at Riau University and spoke fluent English. He said he had conducted water and soil research on the Bukit Batu River as part of a Master's Thesis project about five years prior (~2010). He stated that while he was there he was positive he saw *Tomistoma* in the upper reaches of the River and that they were relatively common. He also said he still occasionally spoke with fisherman who worked on the river and stated they still see *Tomistoma* as well.

5.0 Discussion

We gathered important information from locals and park officials that suggests *Tomistoma* is still present in many rivers, including within rivers which have not previously been surveyed. We also collected valuable logistical information, which will allow us to work more efficiently in 2015. Connections were made with park officials in both Jambi and Riau provinces of Sumatra. We discuss our results for each river system below.

Kampar River System— We have enough data to indicate *C. porosus* populations are present in the tidally influenced sections of the Kampar river tributaries. Despite no confirmed *Tomistoma* sightings in three days of river surveys, there was one eye shine approximately 18 km upriver in the Kerumutan River which was potentially a *Tomistoma*. Based on local information and this single sighting, the Kerumutan should be surveyed more thoroughly in 2015. The locals along all tributaries said they believe *T. schlegelii* is still common throughout most rivers in the area, as well as *C. porosus* in lower sections of all tributaries. With this in mind the Serkap River and Turip River should be surveyed again as well. Another river which was not surveyed, but may be visited in the future, is the Kutup River. The Kutup River is located approximately 50 km due West of the village of Teluk Meranti and holds a number of characteristics which may be favorable for *Tomistoma*. There are a small set of islands on the far eastern stretch of the Kampar River, which were mentioned by locals to be yearly nesting locations for *C. porosus*. A local who lives on one of the islands is said to capture both *C. porosus* and *Tomistoma* occasionally and hold them at his home before selling them. Based on these factors, it may be a good location to travel to for a short time in 2015 as well.

Simpang Kanan River— The Simpang Kanan River yielded no recorded crocodiles and although the villagers stated crocodiles could be found along the river, the habitat does not seem favorable for *Tomistoma*. There is a series of intact mangrove forests in the area, that may hold populations of *C. porosus*, but that is still unknown as well. Although the Simpang Kanan River had very little primary

forest remaining, there is an “Unknown River” due South of Simpang Kanan River, which appears to still have intact primary forest (based on satellite imagery). Logistically it is still unclear of the best route by which to travel to the unknown river. The river can be visited from the village of Tembilihan, but there may be other possible routes. It is possible that there are small logging roads from the village of Teluk Meranti which can be used to travel to the river through the forest, but this question will remain unanswered until we can visit those roads and assess the situation in person. If this is possible then a few days may be spent travelling the upper reaches of the unknown river in 2015.

Merang River— The status of *Tomistoma* populations in the Merang River is still unknown at this point, however logging and agricultural development since previous survey work is concerning. Although villagers claim to still see *Tomistoma*, the habitat in the area has been seriously altered and it is questionable whether the river will hold viable populations in the future. The upper reaches appear to be best reached by travelling dirt roads. We are yet to determine whether the Merang will be a point of focus for the 2015 survey season. However, if time permits, new survey information would provide much needed updates on the *Tomistoma* populations of the area. If we are able to survey the Merang River in 2015, our time will be spent in the upper stretches of the river, between 45 and 65 km.

Berbak National Park—Berbak National Park may still be a stronghold for *Tomistoma* and will likely be our first survey location in 2015. We plan to survey the Air Hitam Laut River and its tributaries for two to three weeks (which have been surveyed previously; Bezuijen et al. 1997), while conducting interviews with locals in the area. The turtle researcher that we interviewed stated that during his time there (2014), he did see at least two *Tomistoma* on what he called the Simpang Kubu Creek. It is important to note that two separate Kubu Rivers have been mentioned at this point in the literature. One in Riau province by Bezuijen et al. (1997) and one in Berbak National Park, Jambi Province mentioned from personal communication with the turtle researcher. The Simpang Kubu mentioned by this researcher is supposedly located two to three hours upstream (boat ride) from Air Hitam Village in Berbak National Park and the researcher did show photos of what appeared to be two *Tomistoma* seen at night (Personal Communications).

Giam Siak Kecil and Bukit Batu Rivers— Another area which is of high interest for research in 2015, is the greater Giam Siak Kecil and Bukit Batu Area. An interview with a lecturer from a local University in Riau, said he personally had seen *Tomistoma* in the Bukit Batu River and knows locals who still see them. There is virtually no information on Giam Siak Kecil, however based on maps, the area holds promising habitat for *Tomistoma*, as it still has high quality Peat Swamp Forest.

Other Locality Information— Since this preliminary assessment took place, another area was mentioned through personal communication with a researcher who conducted environmental research in Riau, Sumatra during the early 2000's. He stated in his message that he had seen a single nest around the confluence of the Paku and Siak Rivers during his reptile and amphibian surveys. He said locals believed *Tomistoma* were common in those areas and that locals had also seen *Tomistoma* on the Tapung River in Riau. The exact location of these areas is yet to be confirmed, as there is little detailed map information available on Riau Province Rivers. Based on satellite images, it appears these rivers may be located south-west and west (Respectively) of the city of Pekanbaru. Satellite imagery suggests that forest cover is very low in these areas and it seems that there is little intact habitat currently available.

6.0 Conclusions

It appears multiple locations may still hold *Tomistoma* and *C. porosus* populations. Interviews with locals and park officials yielded promising information and river surveys allowed us to gather new confirmed information on *C. porosus* populations.

We were able to identify four areas, where *Tomistoma* are still likely to occur, however we plan to focus our efforts on two locations during 2015. This will allow us to thoroughly survey each area, rather than short surveys in multiple locations. We plan to focus our efforts on Berbak National Park and the lower Kampar River System (e.g. Serkap, Turip, Kerumutan and Kutup rivers) in the coming field season. Based on our preliminary work, these areas seemed to provide the best chance for locating healthy *Tomistoma* populations. The Merang River system has been important in the past, but the amount of deforestation in the area is troubling. However, if time permits, we will attempt to visit the Merang for a short period during 2015 as well. If this happens, we will focus our efforts on the upper reaches of the river (~45 to 65 km), due to heavy human activity in the lower stretches. Another area that may hold viable *Tomistoma* populations is the greater Giam Siak Kecil/Bukit Batu area. It is unlikely time will allow us to survey this location in 2015, but it will remain a target area for future surveys.

We have also made significant progress acquiring permits for 2015 and our research proposal has been approved by RISTEK for 2015. Research Visa's will likely be acquired between March and April of 2015 and travel to Indonesia is currently planned for June of 2015. The permits include the approval of *Tomistoma* and *C. porosus* tissue collection and survey work in Sumatra. However, due to *Tomistoma*'s status, *Tomistoma* tissue samples must remain at the LIPI museum and any genetic research will have to be done in Indonesia.

Literature Cited

Auliya M, Shwedick B, Sommerlad R, Brend S, Samedi. 2006. A short-term assessment of the conservation status of *Tomistoma Schlegelii* (Crocodylia: Crocodylidae) in Tanjung Putting National Park (Central Kalimantan, Indonesia). A cooperative survey by the Orangutan Foundation (UK) and the *Tomistoma* Task Force, of the IUCN/SSC Crocodile Specialist Group, 36 pp.

Bayliss P. 1987. Survey methods and Monitoring within crocodile management programmes. In: Wildlife Management: Crocodiles and Alligators. Webb, G.J. W., S. C. Manolis & P. J. Whitehead (eds.). – Surrey Beatty & Sons Pty Ltd, Chipping Norton, Australia.

Bezuijen MR, Cannucciar P, Manolis SC, Samedi, Kadarisman R, Simpson BK. 1995. Project *Tomistoma*. Field Expedition to the Lalan River and its tributaries, South Sumatra, Indonesia, August-October 1995: Assessment of the Distribution, Abundance, Status and Nesting Biology of the False Gharial (*Tomistoma schlegelii*). Unpublished Report, Wildlife Management International Pty Limited, Darwin.

Bezuijen MR, Hartoyo P, Elliott M, Baker BA, 1997. Project *Tomistoma*. Second Report on the Ecology of the False Gharial (*Tomistoma schlegelii*) in Sumatera. Unpublished Report, Wildlife Management International Pty Limited, Darwin.

Bezuijen MR, Webb GJW, Hartoyo P, Samedi. 2001. Peat swamp forest and the false Gharial *Tomistoma schlegelii* (Crocodylia, Reptilia) in the Merang River, eastern Sumatra, Indonesia. *Oryx*. 35(4):301-307.

Bezuijen MR, Hasudungan F, Kadarisman R, Wardoyo S, Webb GJW, Samedi, Manolis SC. 2002a. False Gharial (*Tomistoma schlegelii*) surveys in southeast Sumatra, Indonesia (1995-2002). Unpublished Report, Wildlife Management International Pty Limited, Darwin.

Bezuijen MR, Wibowo P, Wirawijaya H, 2002b (eds). Prosiding Workshop Buaya Senyulong (2002b). Pengkajian Rencana Pengelolaan dan Konservasi Wilayah River Merang sebagai Habitat Buaya Senyulong (*Tomistoma schlegelii*). (Proceedings of the 2002 False Gharial Workshop: Assessment of the Management and Conservation of the Merang River as habitat for the False Gharial (*Tomistoma schlegelii*)). Wildlife Management International Pty Limited, Darwin & Wetlands International-Indonesia Program, Palembang.

Bezuijen MR, Stuebing RB, Auliya M, Manolis SC. 2003. False Gharial (*Tomistoma schlegelii*) conservation: priorities for action. Unpublished report, vers. 2 (June 2004). IUCN *Tomistoma* Task Force www.Tomistoma.org.

Bezuijen MR. 2004. Preliminary assessment of the status of the False Gharial (*Tomistoma schlegelii*) in the Mayeng Sarang River, Grand Perfect SDN. BHD. Planted Forest Area, Bintulu Division, Sarawak. Internal report for Grand Perfect SDN. BHD, Kuching.

Bezuijen MR, Suryansyah B, Huda I, Pratjihno PS, Andriyono S, Potess, LF, Sommerlad R. 2005. False Gharial (*Tomistoma Schlegelii*) surveys in West Kalimantan, Indonesia in 2004. A co-operative project of the KSDA-West Kalimantan, CSG-TTF and PRCF. Crocodile Specialist Group – *Tomistoma* Task Force and the People, Resources, and Conservation Foundation, Frankfurt and Pontianak.

Cox J. 1990. Crocodile surveys of Sumatra. Unpublished Report.

Muin, A., Ramono, W. 1994. Preliminary survey of Buaya sumpit (*Tomistoma schlegelii*) and Buaya Kodok (*Crocodylus siamensis*) in East Kalimantan. Report.

Simpson, BK. 2014. Status Assessment of *Tomistoma* in Peninsular Malaysia: Peat Swamp Forests of Selangor and Pahang. IUCN Crocodile Specialist Group, *Tomistoma* Task Force. Report.

Stuebing RB, Lading R and Jong I. (1998). The status of the False Gharial (*Tomistoma schlegelii*) in Sarawak. Pp. 1-9 in Crocodiles. Proceedings of the 14th Working Meeting of the mCN-SSC Crocodile Specialist Group. Singapore, 13-17 July 1998. mCN: Gland, Switzerland.

Stuebing RB, Mohd S, Lading E, Jong J. 2004. The Status of the False Gharial (*Tomistoma schlegelii* Mueller) in Malaysia. In: Proceedings of the 16th Working Meeting of the Crocodile Specialist Group, Darwin, NT, Australia. IUCN/SSC Crocodile Specialist Group, Gland.

Stuebing RB, Bezuijen MR, Auliya M, Voris HK. 2006. The current and historic distribution of *Tomistoma schlegelii* (The False Gharial) (Muller, 1838) (Crocodylia, Reptilia). The Raffles Bulletin of Zoology. 54(1): 181-197.

The IUCN Red List of Threatened Species. 2013. <http://www.iucnredlist.org/details/21981/0>

Appendices

Appendix I. GPS coordinates of Crocodile Sightings.

Latitude	Longitude	Sighting	Size Class	River Name
0.330561	102.712308	Hatchling Eye Shine	1 – 2 ft	Serkap
0.28712	102.722074	Hatchling Eye Shine	1 – 2 ft	Serkap
0.301231	102.7123	Hatchling <i>C. porosus</i>	1 – 2 ft	Serkap
0.303892	102.712946	Hatchling Eye Shine	1 – 2 ft	Serkap
0.286943	102.721675	Hatchling Eye Shine	1 – 2 ft	Serkap
0.29051	102.7227	Hatchling <i>C. porosus</i>	1 – 2 ft	Serkap
0.290473	102.722503	Adult <i>C. porosus</i>	10 – 11 ft	Serkap
0.258338	102.672269	Hatchling <i>C. porosus</i>	1 – 2 ft	Turip
0.2632445	102.671269	Hatchling <i>C. porosus</i>	1 – 2 ft	Turip
0.26042	102.668098	Juvenile Eye Shine	4 – 5 ft	Turip
NA	NA	Juvenile Eye Shine	4 – 5 ft	Kerumutan

Appendix II. Local names for crocodiles, which were mentioned during our time in Sumatra.

Local Names	English Translation	Species
Senyulong	False Crocodile	<i>Tomistoma</i>
Buaya Mancang Panjang	Long Nosed Crocodile	<i>Tomistoma</i>
Buaya Putih	White Crocodile	<i>Tomistoma</i>
Buaya Lentik	Tapering Crocodile	<i>Tomistoma</i>
Buaya Sempit	Narrow Snout Crocodile	<i>Tomistoma</i>
Buaya Muara	Estuarine Crocodile	<i>C. porosus</i>
Buaya Katak	Frog Crocodile	<i>C. porosus</i>