PROJECT REPORT

The status of the Saltwater crocodile (*Crocodylus porosus*) inhabiting the Nilwala River, Matara District and its impact on the community

Anslem de Silva

Herpetologist
Member, Crocodile Specialists Group
IUCN, World Conservation Union, Species Survival Commission.

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PROJECT SUMMARY & ACKNOWLEDGEMENTS

PROJECT TITLE: The status of the saltwater crocodile (*Crocodylus porosus*) inhabiting the Nilwala River, Matara District and its impact on the community.

RESEARCHER / CONSULTANT: Anslem de Silva, Herpetologist, Member Crocodile Specialists Group IUCN/SSC. **TECHNICAL ADVICE:** Romulus and Nik Whitaker, Madras Crocodile Bank, India.

OBJECTIVE: Conduct a preliminary assessment on the status of the saltwater crocodile (*C. porosus*) inhabiting the Nilwala River, Matara, the status of its habitats and investigate the human-crocodile conflict situation in Matara and propose actions that should be taken to minimize this conflict as well as to conserve the crocodiles and their mangrove habitats.

RESULTS (SUMMARY):

- Observed fourteen *C. porosus* yearlings (under 600 cm) and 13 adults including a large (approximately 4.5 m) specimen.
- Encountered 31 and 39 pairs of eye-shines respectively during the night 'eye-shine' technique, which was conducted on two nights.
- Observed about 25 species of riverine mangrove plants and mangrove associate plants
- Investigated eight people who were attacked and killed by crocodiles.
- Investigated ten people who sustained minor injuries from crocodile attacks.
- Investigated 70 abandoned and in use 'crocodile pens' and 3 crocodile 'fences' that have been installed along Nilwala River.

BENEFITS OF THE PROJECT:

1. This is the first comprehensive study on the status of the saltwater crocodile and their habitats conducted along the Nilwala River, to understand the human-crocodile conflict and assess the knowledge and attitude towards crocodiles.
2. Discovery of yearlings, sub adults and adults which suggests that there is a healthy breeding population of the saltwater crocodile inhabiting the Nilwala River in Matara.
3. To understand the composition and the status of riverine mangroves, a major habitat of the saltwater crocodile.
4. Devise proper and secure crocodile pens and fences to protect people from crocodile attacks.
5. Educate the vulnerable people of the precautions they should take to prevent crocodile attacks and why they should conserve crocodiles and their habitats.

ACKNOWLEDGMENTS

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INTRODUCTION

Two species of crocodiles: the Mugger or Marsh crocodile (*Crocodylus paluster* Lesson 1831) and the Saltwater or Estuarine crocodile (*Crocodylus porosus* Schneider 1801) are reported from Sri Lanka (Deraniyagala 1939; Whitaker & Whitaker, 1979; Das & de Silva, 2005; de Silva 2007). References to crocodiles are found in the early literature of the country such as Buddhist Jataka stories (written around 5-8th century AC) e.g. *Vanara Sumsumara Jataka*, *kumbila*. The ancient chronicle *Culavamsa* (1: 70.4) also records that during the reign of king Gajabahu 1132-1153 AC, King Parakkramabahu's men could not pass the deep waters at Yatthikanda and Dumbara due to man-eating crocodiles (Geiger, 1929).

From the 17th to the 21st century there have been many observations on crocodiles of the island by early Western writers in their works pertaining to Ceylon (= Sri Lanka) on the existence of numerous and large-sized crocodiles on the island. More notable are: Baldaeus (1671) who states "...is very frequent here, some of which are 18 ft long", Knox (1681) states "Towards the Mahaweli ganga is full of alligators but non in the mountains", Heydt in 1744 record: "Among these the crocodiles comes before all other, since it is very great both in numbers and size", Tennent (1859) a foremost naturalist on Sri Lanka in the 19th century, records: "… remarkable for the numbers and prodigious size of the crocodiles which infest them …".

In the early part of the 20th century, crocodiles were extensively hunted for their skins. However, with the introduction of the Fauna and Flora Protection Ordinance in 1937, these large-scale killings for their skins stopped. A major reason for this decline was that there were very few crocodiles left to shoot. According to Hennessy (1949), crocodile skin tanning factories had to be closed down after ten years, as there were no crocodiles left to tan. Presently however, the skin trade has completely stopped. Nevertheless, killing of crocodiles does continue as there is still some demand for its flesh and local fishermen occasionally kill sub adult crocks when it gets trapped in their nets. Also, shooting 'supposed to be nuisance crocodiles', destruction of crocodile nests and eggs, clearing and alterations of nesting habitats and mangroves along the river for agriculture and development work yet continue and is on the increase.

Regarding observations of crocodiles in Sri Lanka, it was Deraniyagala (1930, 1939) who conducted some of the pioneering studies of both species of crocodiles. However, the first status and census survey of crocodiles of the island was carried out by Rom Whitaker & Zai Whitaker in 1977 (1979). This was followed by brief studies by Porej (1999) and Santiapillai and de Silva (2001). However, the present study could be mentioned as the first detailed investigation of the saltwater crocodile inhabiting the Nilwala River. The present study also investigated several other related aspects of the saltwater crocodile, such as approximate numbers, status of their habitats, including nesting, human conflict and the knowledge and attitude of the people living in crocodile habitats along the Nilwala River. Educate and specific recommendations to vulnerable people of the precautions that they need to take to avoid attacks by crocodiles are also outlined.

Estuarine crocodile

Paradoxically, the numbers of the Saltwater or Estuarine crocodiles has been greatly reduced in Sri Lanka whereas it is more abundant in other parts of its range. This reduction

is mainly due to killing by humans for its skin, and threats to its nesting habitats. The present study indicates that outside of protected areas, the Nilwala River could be one of the best remaining habitats of the saltwater crocodile on the island. However, presently it too is under pressure of a reduction in population due to human activities.

SPECIFIC OBJECTIVES

1. Physical verification and identification of the crocodile species inhabiting the Nilwala river from Modara or Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5") up to Paraduwa (North 06º 04' 09.3" and East 080º 30' 55.0"). Check also for other evidence such as the presence of crocodile tracts, nest mounds etc.

2. Assess the status of the habitat of the riverine mangroves and mangrove associate plants in the study area.

3. Assess threats faced by crocodiles during all stages of its life history (eggs, yearlings, sub adults and adults) and to their nesting and foraging habitats.

4. Propose conservation strategies for crocodiles and their habitats.

5. Conduct a survey among the vulnerable people at Fort and Piladuwa, Matara to assess their Knowledge, Attitude and Practice (KAP) regarding crocodiles.

6. Investigate localities where 'Human Crocodile' conflicts occur along the study area in the Nilwala River in Matara.

7. To investigate the reasons for 'Human/Crocodile' conflicts, and propose methods on how to minimize this among the vulnerable communities in Matara District where Sri Lanka Red Cross (SLCRCS) Disaster Preparedness (DP) team are currently working with.

8. Recommend locations to install protective fences and pens from crocodiles at Fort and Piladuwa.

9. Identify places to install 'Crocodile-Warning' signboards.

10. Conduct awareness programs for the people living in high-risk crocodile areas on the importance of crocodiles and precautions that they should take to prevent crocodile attacks.

BACKGROUND and JUSTIFICATIONS

During Vulnerability Capacity Assessments (VCAs) undertaken by SLRCS DP team, one of the major concerns raised by some of the local communities is the presence of potentially dangerous crocodiles. It was thought the best way to assist these communities, using the American Red Cross and the World Wildlife Fund Partnership, was to undertake a study of the crocodiles in affected areas to determine how best to deal with problems, and raise public awareness.

Crocodylus porosus is highly a threatended reptile in Sri Lanka. It has only a few favoured natural habitats left, and presently most of these habitats are cleared, altered and under pressure by human activites. Thus, this proposed study will give a clear idea of the situation of the species, the status of the mangrove habitats and the knowledge and attitude of the people who live in crocodiel habtats.

it is important to get an overall perspective on where crocodile concentrations still occur (especially outside the Wildlife Protected Areas) and identify places where crocodiles are likely to continue to survive given some assistance with awareness and protection to the community in these areas.

Human-crocodile conflict mitigation is a prime concern and this involves both awareness and the building of some expertise in controlling 'nuisance' crocodiles as well as strategy for translocation when found necessary. However, we should be extremely careful of such translocations as the ‘homing’ instinct of this species is now well established (see below under Management and Conservation). Saltwater crocodiles are especially in need of conservation actions in Sri Lanka, as there are so few remaining suitable habitats left for them. In addition, the recent IUCN Red List records the saltwater crocodile under ‘Near Threatened’ category (IUCN, 2007).

STUDY AREA AND METHODOLOGY

STUDY AREA:

Nilwala River, Matara, from Modara (Lands End) (North 5º 56' 42.7" and E 80º 32' 26.0") to Paraduwa (North 06º 04' 09.3" and East 080º 30' 55.0"), land water interface area, riverine mangroves and vulnerable people at Fort and Piladuwa, Matara (See Figures 1, 2 and 3).

METHODOLOGY USED:

- A structured questionnaire (annexure 1) was administered to 53 householders in Fort and Piladuwa, Matara (Figure 4) by the chief investigator and a survey team of six people from Sri Lanka Red Cross (DP) team.

- Conducted boat cruises in the Nilwala River in the study area from 0800 to 1300 hours on three days for physical verification of the presence of crocodiles, assess the status of their habitats and discuss possible plans of action with people residing along the riverbank within crocodile locations (Figure 5).

- The same river route was cruised at night (2000 to 2400 hours) to conduct the night "eye-shine" sampling technique using powerful spotlights. The survey team was dressed in dark clothes so they were not conspicuous to the crocodiles.

- Interviewed fishermen to estimate the number of crocodiles accidentally trapped and killed in their nets.

- Interviewed family members of victims who were killed by crocodile attacks as well as people who sustained minor injuries due to attacks.

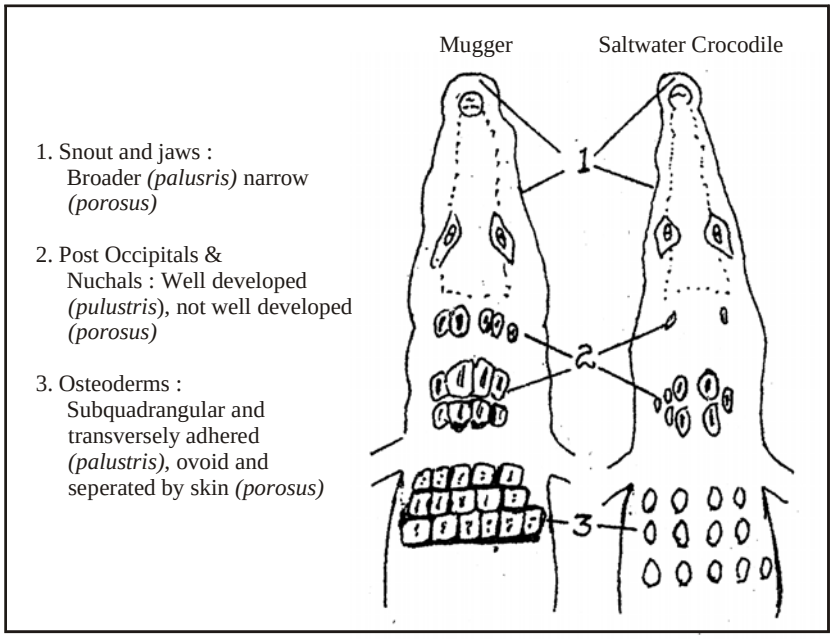
- Collected samples of mangrove plants and mangrove associate plants along the riverbank. These were immediately placed into separate plastic bags, and secured with rubber bands. These plants were subsequently taken to the National Herbarium, Botanical Gardens, in Peradeniya for identification.

- For identification of the crocodile species the key (below) was used as well as confirmation by technical advisors and experts.

RESULTS and DISCUSSION

IDENTIFICATION OF THE SPECIES

The following key was used to differentiate *C. porosus* from *C. paluster*. In addition, specific information of the mound nest of the species was ascertained from individuals interviewed to confirm the identity of the species.



KAP (KNOWLEDGE, ATTITUDE AND PRACTICES) SURVEY

Fifty-three household families were interviewed and their responses are given in the following tables. All those whom we interviewed have seen crocodiles in the Nilwala River.

Localities where crocodiles had been observed:

Seventy seven percent of the people interviewed have seen the crocodiles in the river (Table 1). Of the 13 adult crocodiles that we observed, 10 were in water and 3 were on the river bank. Additionally, two fishermen stated that they have seen crocks in the sea. In fact, a large crocodile we observed (Figure 6) was about a half kilometer from the Nilwala river mouth.

Table 1 - Localities where crocodiles were observed

Locality	Number	%
River	24	77.4
Land	05	16.1
Both	02	6.4
Total	31	100.0

Number not recorded = 22

Approximate length of the crocodiles observed:

Regarding the approximate length of the crocodiles seen by the respondents, 76% stated that they have seen specimens possibly measuring over 3 meters in length (Table 2). In fact, we observed during the boat cruises three large crocodiles, which may have exceeded 3 m, and one that may have measured 4.5 m long.

Table 2 - Distribution of the approximate length of crocodiles observed

Approximate length (in meters)	Number	%
< 02	06	12.2
02 – 03	06	12.2
≥ 03	37	75.6
Total	49	100.0

Number not recorded = 04

Hours of crocodile observations:

Nearly 46 % of respondents have observed crocodiles between 1000 to 1300 hours (Table 3). When questioning people who live along the riverbank they informed us that they have seen crocodiles entering their compounds at night. During boat cruses on three mornings (0830–1300) we observed three crocodiles basking on riverbanks at different locations with one adult on land during the night eye-shine survey. Some villagers along the river also informed us that they have seen solitary large crocodiles basking at midday either clinging on to dead trees in water or on the riverbank.

Table 3 - Distribution of hours of crocodile observations

Time	Number	%
1000 to 1300 hours	11	22.9
1300 to 16 hours	22	45.8
Both	15	31.3
Total	48	100.0

Number not recorded = 05

Predators of crocodile hatchlings observed:

Six people have seen large water monitors (*Varanus salvator*) swallowing crocodile yearlings (Table 4). Similarly, few informed us of seeing large crocodiles swallowing adult water monitors.

Table 4 - Predators of crocodile hatchlings observed

Predators observed	Number	%
Observed	06	14.3
Not observed	36	85.7
Total	42	100.0

Number not recorded = 11

Reasons for eating crocodile flesh:

Sixteen people stated the curative properties (e.g. for asthma) of eating crocodile flesh including that it improves eyesight (Table 5). Inquiries also revealed that wearing shoes or slippers made from crocodile skin develops improved eyesight. Some people stated that crocodile flesh tastes good.

Table 5 - Reasons for eating crocodile flesh

Categories	Number	%
Eat for curative properties	16	35.6
Not eat	29	64.4
Total	45	100.0

Number not recorded = 08

Are crocodiles useful animals:
Ninety five percent of respondents considered that crocodiles were not useful or rather did know the ecological roles played by the crocodiles (Table 6).

Table 6 - Are crocodiles useful animals

Categories	Number	%
Useful	02	4.7
Not useful	41	95.3
Total	43	100.0

Number not recorded = 08

How to escape when a crocodile holds on to someone:
Forty-seven percent informed that they have heard that when a crocodile holds on to its victim, the stomach or the belly of the crocodile should be stroked or tickled, then it will release its bite (Table 7). Whilst 53 % did not know any methods to escape from a crocodile's grip. There is a report of a prawn fisherman who was dragged into the water while catching prawns in the Chilaw Lagoon (North West, Sri Lanka), that had touched the crocodiles belly while struggling, and immediately the animals' jaws had been loosened. Hence the victim continued stroking the crocks' belly and it had subsequently released the victim (Anonymous, 1964). The author, as a young boy lived in his ancestral house in Fort, Matara near the Nilwala River during the 1950's. He kept a yearling saltwater crocodile which was collected from Nilwala River for about 4 years. During this period, in order to verify this popular belief, he stroked the belly of the captive crocodile, which responded immediately by becoming passive and did not struggle. Several repetitions of this method produced the same results. In addition, the yearling crocodile observed during the present study also exhibited the same behaviour.

Table 7 - How to escape when a crocodile holds

Categories	Number	%
Escape by tickling	23	46.9
No knowledge	26	53.1
Total	49	100.0

Number not recorded = 04

Dumping of refuse:
Twelve householders informed that they discard their domestic refuse into the river (Table 8). During the survey, we found out that several slaughterhouses and fish stalls discard their refuse into the river, and in two such places crocodiles are attracted when fish and beef by-products are thrown into the river.

Table 8 - Dumping of refuse

Categories	Number	%
Dumping refuse	12	35.3
Not dumping	22	64.7
Total	34	100.0

Number not recorded = 19

SURVEY OF CROCODILES

Physical verification of adult, sub-adult and yearling crocodiles inhabiting the Nilwala River in the study area (see under methodology) was conducted while cruising in a motor boat from 0830 to 1330 hours and the same route was covered on two nights from 2100 to 0030 hours using the 'eye-shine' technique. In addition, physical verification of tracts left by crocodiles in places where crocodiles had attacked and killed humans were also investigated.

The GPS (Global Positioning Satellite) reading of some locations where crocodiles were observed during the morning boat cruise are given in the GIS mapping (Figure 3). However, in some instances, especially at night the GPS readings were not taken.

17th March, 2008

Kiralapana Island (N 05 º 56' 34.8" and E 080 º 32' 22.5") is a small island (approximately 150 m long and 100 m wide) with a dense cover of riverine mangrove plants with few grassy patches in the sandy and muddy soil (Figure 7). Around 0845 hours we observed footprints as well as marks left by the dragging tail (Figure 8) on the wet, sandy soil in the Kiralapana Island. These tracks were considered fresh as it rained heavily that morning and there was no sign of washout due to rain. In addition, we observed heavy impressions on the grass in two places probably made by a crocodile resting on the grass (Figure 9), however, it would have most likely moved away due to our presence. The impression in the grass measured 2 m x 36 cm wide, suggesting that it could have been a large crocodile, possibly 3.5 m in length. Three water monitors (*Varanus salvator*), sea birds, crabs and other invertebrates were also on the island. We did not however locate a crocodile nest.

While cruising from the island and passing the Matara main bridge, hospital and dumping grounds, (Figure 10) we observed 11 water monitors. Four of which were hatchlings and the rest adults (Figure 11). A few hundred meters before approaching the Piladuwa south canal (N 05 º 56' 52.9" and E 080 º 33' 34.9") one crocodile was observed on the riverbank around 1015 hours and it jumped into the river with a huge splash. Cruising about 250 meters further upriver from Piladuwa canal (Figure 2 and 12), we observed another crocodile (N 05º 57' 17.4" and E 080º 33' 51.5") on the riverbank, which also jumped into the river. Each would have been about 2 m long.

Passing the Piladuwa North canal (N 05 º 57' 30.3" and E 080 º 33' 44.2") a large crocodile was observed (N 05º 57' 52.3" and E 080º 33' 06.5") around 1130 am clinging with its forelimbs to *Sonneratia caseolaris* (Sinhala – *Kirala*) branches that were touching the water (Figure 13). On 19 March around 0855 hours possibly the same crocodile was observed clinging on to the same *kirala* branches. Inquiries made from nearby villagers informed us of a crocodile, which frequents this vicinity, but had not caused any problems.

Mr. B. H. Dharmadasa, a 50 year-old bookbinder was visited during the river cruise. He had been attacked by a crocodile while bathing in the river near their house (N 05 º 58' 13.4" and E 080 º 33' 10.9"), and sustained minor injuries. Subsequently, he had built a traditional crocodile pen for bathing and washing purposes (Figure 14).

We observed five crocodile yearlings, possibly 60 cm in length, resting / hiding on the branches of a mangrove associate plant (*Dolichandrone spathacea,* Sinhala – *Diya danga*)

between Piladuwa south canal (N 05 º 56' 52.9" and E 080 º 33' 34.9") and (N 05 º 58' 13.4" and E 080 º 33' 10.9") on the Piladuwa side of the River. These branches form ideal resting / hiding cover for yearlings from possible avian and/or other predators. Of the five juveniles, three were photographed (Figure 15) and the remaining two disappeared under water.

We investigated the exact location (N 05 º 57' 17.4" and E 080 º 33' 49.7") where a 22 year-old man, was attacked and killed by a large crocodile in September 1999 while swimming. His friends and brother had all witnessed the episode from the riverbank (Figure 16). One week later, this crocodile (approximately 3.5 m long) had been caught by his friends at the same spot using a bait, and the animal was subsequently killed. The specimen is presently exhibited at Bundala National Park Museum.

While cruising in the middle of the river a large adult, one of the largest wild crocodiles that I have ever seen, (probably 4 m in length) literally dashed towards our boat with its body visible above water and came very close (about 30 cm) towards our boat and then abruptly dove down. We were also informed by some of the locals of instances of crocodiles jumping onto canoes. This occurred near the uncompleted bridge / roadway and ferry. We stopped our boat and inquired from some people in the vicinity who informed us that this large crocodile frequents this area and basks on a nearby dead tree trunk in the river.

On completion of the morning boat cruise, around 1320, our boat was anchored in the boat yard, at which time we observed a large crocodile floating with its body and head distinctly visible above the water level (Figure 6). This specimen was probably just over 3 m in length, and was approximately 250 m from the mouth of the river (N 05º 56' 34.8" and E 080º 32' 22.5"). This observation occurred between the Kiralpana Island (Figure 7) and the Modara boatyard. It appeared to be quite acclimated to the presence of people.

Night 'eye-shine' survey – 17th March 2008

The night 'eye-shine' survey began at approximately 2100 hours and ended around 0030 hours. The outing began at Modara or Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5") and continued up to N 05 º 57' 17.4" and E 080 º 33' 49.7". Using flashlights, we checked the left bank of the river for crocodiles and the right bank during the return trip. A total of 39 'eye-shines' were observed. However, it is possible that due to the sound of the engine of our motorboat several crocodiles will have hidden or disappeared under water. We not observe any 'eye-shine' in the Kiralapana Island despite our search around the island.

19th March, 2008

A longer boat cruise was done from Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5") up to Paraduwa (N 06 º 04' 09.3" and E 080 º 30' 55.0") along river Nilwala river from 0800 and returned to Modara around 1400 hours.

Possibly the same large crocodile that we observed on 17th March was observed at 0845 hours (N 05º 57' 52.3" and E 080º 33' 06.5") clinging to the same *Sonneratia caseolaris* branches that were touching the water (Figure 13).

Around 0855 hours, after passing the unfinished bridge, we observed a yearling crocodile resting on branches of *Excoecaria agallorha* (Sinhala – *Thala or Thel kiriya*) which was in contact with the water.

At 0925 hours we spotted a large crocodile (N 05º 58' 23.0" and E 080º 33' 09.3") basking on a small river bank mound opposite *Acrostichum aureum* (Sinhala – *Kerang koku)* which are also used in nest building. It dove into the river producing a large splash as we approached it (Figure 17).

We also investigated the location (N 06º 04' 09.3" and E 080º 30' 55.0") where one woman (Seetha) was taken and killed by a large crocodile on 25th July 2007. Recently, two bathing pens have been constructed on both sides of the river at this spot (Figure 18).

21st April, 2008

We began at approximately 0800 am from Modara or Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5") up to (N 05 º 57' 17.4" and E 080 º 33' 49.7") and returned back at 1300 hours. One sub adult crock about 1.5 m long (N 05 º 56' 46.7" and E 080 º 32' 49.2") was observed virtually behind the Bank of Ceylon building, in Matara or close to the main bridge in Matara town and was resting / basking on some fallen coconut branches at the waters edge.

This day was spent checking the riverine mangrove vegetation and collecting samples for identification. However, on our return journey we did observe another sub-adult (N 05 º 56' 53.2" and E 080 º 33' 19.6") resting on dead vegetation.

Night 'eye-shine' survey – 21st April, 2008

The night cruise began around 2100 hours at Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5") up to (N 05 º 57' 17.4" and E 080 º 33' 49.7") and ended around 2400 hours. During this time, observations were made on both sides of the river at infrequent intervals. Thirty-one pairs of eye shines were observed using flashlights. We were also able to physically verify eight yearlings of which two were measured (SVL – 290 mm, tail 310 mm and SVL 285 mm and tail 295 mm) (Figure 19, 20). Of the remaining six yearlings, two were small and would have measured about 400 mm while the other four juveniles were about 600 mm in length. We also observed an adult possibly 3 m in length jump into the water when we approached. It is also possible that due to the sound of the motorboat a few would have hidden or gone under water. On this night we observed a total of 4 'eye-shines' in the Kiralapana Island region. It is interesting to note here that this night cruise was conducted the day following a full moon, and it was a cloudless night.

22nd April, 2008

We observed 2 adults around 0800 at Modoara or Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5"). In addition, numerous crocodile tracts on the sand dune formed during the December 2004 tsunami, and presently this is now covered with mangrove vegetation.

We investigated a 32 year old man that was attacked by a crocodile on his left leg (Figure 21) while bathing in the Kirama oya, a tributary of Nilwala River. Also nearby was a juvenile saltwater crocodile 860 mm long that was trapped in a fishing net a few months prior. The animal was killed and skinned by locals (Figure 22) (N 06 º 01' 36.3" and E 080 º 33' 23.4").

Regarding the above observations, we have personally verified 13 adult crocodiles, 14 yearlings, several crocodile tracks and 31 and 39 night 'eye-shines' (in two nights of boating). Considering that some specimens may have hidden or retreated under water it is possible to assume that a total 50-60 crocodiles of all age classes are inhabiting the

Nilwala River, Matara from Paraduwa (North 06º 04' 09.3" and East 080º 30' 55.0") to Modara or Lands-End (N 05º 56' 34.8" and E 080º 32' 22.5").

CROCODILE ATTACKS (HUMANS)

Mortality data due to crocodile attacks are available for the past century (Registrar Generals Reports). However, during the past several decades a fair amount of media publicity on the 'man eating' crocodiles of the Nilwala River, Matara were published. In fact, Deraniyagala (1930) also reported that the Nilwala River is one of the more well-known habitats for the occurrence of man-eating crocodiles (*C. porosus*). During the present survey, we collected data on eight human deaths due to crocodile attacks and ten cases of attacks resulting in minor injuries (Table 9 & 10). However, it is felt that most of these accidents might have been prevented if the victims knew some of the basic safety measures.

Table 9
Deaths due to crocodile attacks in Nilwala River, Matara

Date	Gender	Age	Circumstance	Time of attack	Body recovered after
6.9.07	M	19	Bathing	6 pm	2 days
20.7.06	F	46	Bathing	615 am	1 day
5 years ago	M	45	Bathing	-	1 day
10 years ago	F	45	Bathing	11 am	1 day
27.7.03	M	59	Bathing	630 pm	2 days
20.2.98	M	47	Face washing	5 am	1 day
25.7.07	F	51	Bathing	5 am	1 day
22.9.99	M	22	Bathing	130 pm	1 day

Table 10
Minor injuries due to crocodile attacks in Nilwala River, Matara

Gender	Age	Circumstance	Body site of bite
Male	Not recorded	Bathing	Not recorded
Male	Not recorded	Bathing	Leg
Male	Not recorded	Breaking leaves	Hand
Female	75	Breaking leaves	Leg
Female	Not recorded	Walking on river bank	Leg
Male	38	Walking on river bank	Leg
Male	35	Walking on river bank	Leg
Male	70	Washing hands	Hand
Male	50	Bathing	Hand
Male	32	Bathing	Leg

SURVEY OF MANGROVE HABITATS

Mangrove habitats

Remnants of once luxuriant riverine mangrove vegetation and mangrove associate plants fringed the Nilwala River. The mangrove vegetation had an interesting pattern of patches of between two to five species of mangrove plants together covering most parts of the river route we cruised by boat up to Paraduwa (North 06º 04' 09.3" and East 080º 30' 55.0"). This mangrove vegetation offers ideal hiding and resting habitats for adult and yearling crocodiles as well as forming optimal nesting habitats.

The following mangrove plants and mangrove associated vegetation were identified. Apparently one of the best natural population of *Hanguana malayana* (Sinhala - *Induru*) (Figure 23) plants on the island are found near Nawimana (North 05º 58' 09.1" and East 080º 33' 01.7").

Small populations of the shrubs *Hernandia nymphaefolia* (Sinhala – *Palatu*) were observed in a few places along the river. However, thick growths of these shrubs were observed in Kadduwa. Nevertheless, an individual from Kadduwa informed us that earlier that there had been thick growths of these plants, but they were cut down for firewood over the years.

Isolated populations of *Acanthus illicifolius* (Sinhala – *Katu Ikili*) were observed at several places along riverbanks. Dense growths were common in many open places where the shade have been removed (Figure 24). These plants are considered to be 'mangrove weed species' which grow in open spaces where the forest canopy is removed or not present. Several patches of *Cerbera manghas* (Sinhala – *Gon kaduru*) (Figure 25) fringed the riverbanks with small branches touching the water. These formed ideal hiding / resting habitats of crocodile yearlings (Figure 15).

Large patches of *Typha angustifolia* (Sinhala – *Hambu pan*, English – Bull rush) are present in some parts along the river (Figure 26). *Excoecaria agallorha* (Sinhala – *Thala or Thel kiriya*) braches of these trees droop towards the river. These tresses grow about 7 to 10 m tall. These tress and branches are harvested as fuel wood. Large populations of *Pandanus* species were also observed. *Phragmitis karka* (Sinhala – *Thala bata*) fringe the riverbank at some places.

Earlier large tracts of *Acrostichum aureum* (Sinhala – *Kerang koku)* (see Figure 17) plants had dominated along the riverbanks and the adjacent marshes. These were now widely cleared in many localities including the riverbanks around town limits. The tender shoots of this plant is considered a delicious dish. It is harvested for sale as well. Dense growths of these plants are the favored nesting habitat of the saltwater crocodile.

Sonneratia caseolaris (Sinhala – *Kirala*) (10-17 m tall) trees were found from Modara (including the island) up river in many locations along the riverbanks. The drooping branches of this and other mangrove plants offer 'resting' or 'holding' platforms for crocodiles (Figure 13). The ripe fruit can be made into a delicious drink. The braches and tress are used for firewood.

Nypa fruticans (Sinhala - *Gin pol*, English – water coconut) thick concentrations fringe the Nilwala River in many places (Figure 27). Including Matara town limits (behind the Matara Police Station and Bank of Ceylon). This is the only palm species found in mangroves of the country and not only adds to the esthetic beauty of the river, but it also protects the riverbanks from erosion. The fruit can also be used to prepare a pleasant drink.

Other riverine mangrove plants and mangrove associates observed along the Nilwala River are:
Hibiscus tiliaceus (Sinhala – *Belipatta*) (Figure 28), *Ipomoea carnea* (Convolvulaceae), *Derris carensis* (Sinhala – *Diya kalawel*), *Premna* species (Sinhala – *Maha midi), Dolichandrone spthacen* (Sinhala - *Diya danga*) and *Mezomeuron* species (Sinhala – *Goda wavuletiya*). In addition to these, several species of *Colacacia*, *Ipomoea*, and aquatic sedges and grasses are found in open spaces where the canopy has been removed.

THREATS

The major threats faced by the crocodiles in Nilwala River that we identified during the survey are:

Direct threats to crocodiles due to human activities:
Direct threats to crocodiles by human activities are: killing of supposed 'man-eaters', destroying eggs to control the growth of the species, killing of yearlings and sub adults which get trapped in fishing nets, (some drown in the fishing nets). In fact, one fisherman informed the author of killing five sub-adult crocodiles that had got trapped in his fishing nets in the past. Evidence of similar instances of fishery related mortality was revealed while interviewing several fishermen. Furthermore, there is an increase in the fishing industry in Matara. Occasional attacks on humans give crocodiles a bad reputation. Just a single confirmed man-eater inevitably leads to many of the crocodilians in the vicinity being killed.

Direct threats to crocodile habitats due to human activities:
Vast extents of the riverine mangroves and mangrove associated plants along the Nilwala River have been cut down for firewood, cleared for agricultural purposes as well as other development projects over the years (Figure 29). Some of these plants are:
Hernandia nymphaefolia (Sinhala – *Palatu*) harvested for firewood over the years.
Excoecaria agallorha (Sinhala – *Thala or Thel kiriya*) tress and branches harvested.
Acrostichum aureum (Sinhala – *Kerang koku)* large tracts cleared for development work. One favored nesting habitat of the estuarine crocodile.
Sonneratia caseolaris (Sinhala – *Kirala*) trees (10-17 m tall) tress and branches are harvested as firewood and used to make fences.
Cerbera manghas (Sinhala – *Gon kaduru*) tress and branches used as firewood and used to make fences.
Concerning *Lagenandra* species, that have been reported in the earlier literature (Deraniyagala, 1939; de Silva, 2001, Whitaker & Whitaker 1979; Santiapillair & de Silva 2001) as nesting habitats of the saltwater crocodiles in the south and west of the island, we did not observed this plant species. Deraniyagala reported in his paper in 1939 that vast tracts of these plants had been cleared away.

Predators
The water monitor (*Varanus salvator*) (Figure 11) attacks and feeds on large number of animals, including other reptiles, such as venomous and non-venomous snakes and crocodile yearlings and crocodile eggs. Deraniyagala (1939) also reports water monitors feeding on crocodile eggs. In addition, eagles, hawks and mongoose have all been observed to prey on yearlings.

MANAGEMENT AND CONSERVATION

During early part of the 20th century, thousands of crocodiles had been killed annually for their skins. When the species was threatened with extinction, it was initially protected under the Fauna & Flora Protection Ordinance in 1937. Presently there is no management plan for crocodilians of Sri Lanka, except for a small section in the main Action Plan for the world crocodilians (Thorbjarnarson, 1992). Although the crocodile is a protected animal, it is illegally hunted mainly for its flesh, and due to its reduction of local fish populations. Unfortunately, the destruction of its eggs and clearing its natural habitats still continue. In addition, occasionally a 'man-eater' is killed with the appropriate, Government sanctioned permits. However, shooting or capturing any specific 'man-eater' is still questionable. Australian studies (Caldidicott et al., 2005) also indicate that there is no guarantee that the crocodile responsible for the attack could be captured. In addition, incidents of translocation of supposed 'man-eaters' into wildlife sanctuaries is known in the country (N. Atapattu, personal communication, 2008). However, it is now well known of the 'homing' capability of crocodiles (Read et al., 2007).

Crocodiles are protected under the following legislations in the country:

Legislation

1. Fifth Amendment in 1964 of the Fauna and Flora Protection Act (Amendment No. 44 of 1964)

2. Total protection by the 7th amendment to the Act (No. 49 of 1993). The Department of Wild Life Conservation is empowered to enforce the provisions to protect crocodiles.

3. Legal protection afforded under the Fisheries and Aquatic Resources Act, No. 2 of 1996. The Department of Fisheries and Aquatic Resources can act to protect crocodiles under the above Act.

4. The Police are empowered by the Fauna & Flora Protection Ordinance to enforce the provisions to protect crocodiles.

5. Act 1 of the Customs Gazette of 1969 prohibits the export of crocodile skins.

6. This species is listed in Appendix I of CITES (Convention In Trade of Endangered Species)

IUCN Red listing status of *Crocodylus porosus*

1. Vulnerable in 1990 IUCN Red List of Threatened Animals.
2. Threatened in IUCN Sri Lanka (2000), 1999 List of threatened fauna and flora (National List).
3. Near Threatened in 2007 Red List of threatened Fauna and Flora of Sri Lanka.

Conservation

A brief account of crocodiles of Sri Lanka is included in the ***Conservation Action Plan*** for crocodiles of the world complied by Thorbjarnarson (1992). However, it is felt that a Conservation Action Plan should be initiated in the country which addresses the specific issues of the country. Nearly 13% of the land is protected under the Department of Wildlife Conservation. The major natural habitats of the mugger (*C. paluster*) are in some of these wildlife reserves, such as Yala and Wilpattu National Parks. However, some of the major and known habitats of estuarine crocodile (*C. porosus*) do not come under wildlife or forest department protected areas. Thus, it is felt that immediate steps should be taken to protect the remaining saltwater crocodile population and the riverine mangroves of the Nilwala River.

Other constrains to conservation

- No serious attempt has been made to either plan or implement any crocodile conservation programs in Sri Lanka.

- The Dept of Wildlife Conservation, who implements the Fauna & Flora Protection Ordinance under which crocodile conservation falls, does not have the conservation of Sri Lanka crocodiles as a priority.

- Lack of awareness of crocodiles, their biology, and behavior, etc amongst the Sri Lankans, especially those who live in crocodile areas, is also a serious constraint to crocodile conservation. See the section on the KAP study above.

- The increase in tourist arrivals and Southeast and East Asian repatriates living in Sri Lanka has brought in its wake an increase in demand for exotic flesh including that of crocodiles.

- Increase in the fishing industry and development project does not take appropriate action to protect crocodiles or their habitats.

Public Awareness programs on crocodiles

The author conducted three awareness programs on crocodiles on 21st, 22nd and 23rd April, 2008 at Fort, Piladuwa and at St. Mary's Convent, Matara respectively (Figures 30, 31). The later was for advance level students from St. Servatius College and St. Mary's Convent, Matara.

The Power Point presentation covered the following aspects:

1. Introduction to crocodiles of the world and those of Sri Lanka
2. Details of the Nilwala River crocodile survey
3. Facts about crocodile attacks
4. Safety measures one should take from possible crocodile attacks
5. Importance of crocodiles in aquatic ecosystems and their conservation

DISCUSSION AND CONCLUSIONS

The present study is the first comprehensive study on the status of the saltwater crocodile (*C. porosus*) inhabiting the Nilwala River, Matara. This study is considered comprehensive as it includes assessments of the habitats of the crocodiles, status of prey species, predators, human impact, human-crocodile conflict situation in Matara, assessment of the Knowledge and Attitude of the vulnerable people towards crocodiles, and the investigation of deaths due to crocodile attacks. In addition to the study, awareness program to the people who are vulnerable in Fort and Piladuwa, Matara and on methods for protection from crocodile attacks as well as the importance of conserving these reptiles was conducted.

Following are some conclusions that could be derived from the above study.

The KAP (Knowledge, Attitude and Practice) survey indicated that vulnerable people were unaware of most of the general facts about crocodiles. Similar KAP studies conducted in other parts of country [Nilgala Fire Savannah and the Knuckles (de Silva et al 2004, de Silva et al 2005)] on the knowledge and attitudes of the inhabitants of these two ecosystems towards wildlife also indicated similar responses. However, many important and interesting observations can be learned about the activities of crocodiles from these people as they observe them daily.

Regarding the human-crocodile conflict and attacks, investigations revealed that in all cases studied the fault was on the part of human beings. Yet many use insecure crocodile pens for bathing and washing (Figures 32, 33). Thus, an intensive awareness program coupled with protective measures like installing 'crocodile-pens', 'crocodile-fences' and installing warning sign boards in risk areas should be carried out (see annexure 2, 3, & 4). As far as crocodile attacks on pet and farm animals is concerned, most of these attacks have taken place in the river-land interface, pointing to the negligence of the respective owners of these animals. During our survey of residents living near the river we observed that some tie their dogs in the backyard of their homes adjoining the river, which prompts the dog to bark at the slightest disturbance. This unfortunately helps to attract crocodiles. During the survey, we encountered five such cases.

Most of the riverine mangroves have been depleted mainly due to human activities. Here it is felt that the people living along the river should be informed of the legal aspects of the river reservation area, such as the 20 m riverbank reservation that belongs to the government, thus any destruction of the mangroves may be liable for legal action. In addition, local residents should be educated in the importance of these mangroves as they protect the land during floods and tsunamis, and they provide important ecosystems for fish breeding and the resultant fingerlings.

Regarding the direct threat to crocodiles by humans, such as killing of supposed 'man-eaters', destroying eggs and yearlings and sub-adults that get trapped in fishing nets could be minimized by educating the relevant people. In addition, killing crocs for its flesh is an additional threat. In areas where crocodile flesh is eaten, we surveyed people who related

that the flesh tastes good and is of high medicinal value. In her paper on Ceylonese beliefs, Simon (1954), documents that in Sri Lanka people who consume crocodile flesh believe that the crocodile fat is of medicinal value and the meat is an aphrodisiac.

RECOMMENDATIONS

The following recommendations will help to minimize the human-crocodile conflict situation in Matara, as well as help to conserve *Crocodylus porosus* and its habitats, which are among the best remaining natural habitats of the saltwater crocodile in the country.

Steps to minimize Human-Crocodile conflicts

NOTE: First, obtain official permission from the relevant authorities before erecting any structures in the river or riverbanks.

- Conduct awareness programs to the vulnerable people, such as those who live by the side of the Nilwala River, fishermen, and those who use the river for fishing, bathing and washing clothes.
- Install proper “crocodile pens” in places where it is need by the community. The ideal pen should be fenced from all four sides, with a door to enter the pen (see Annexure 2 and Figure 34). It is possible that when crocodiles wonder on land at night they could enter the pen accidentally. Inquiries made from people who used crocodile pens for many years also informed of incidents where crocodiles have been found inside these pens.
- Installing a crocodile “fence” where crocodiles frequent into compounds during the night. These fences should be installed so that it will leave some land space for the crocodiles to prowl at night where they are used to doing so (Annexure 3).
- Install “Crocodile warning sign Boards” in places where crocodiles have attacked and killed humans, bitten humans and in places where crocodiles are frequently seen (Annexure 4).

Steps that should be taken to conserve the remaining mangrove habitats

- Soil erosion was observed in some places along the Nilwala River. A recommendation to plant these areas with mangrove plants found close to these regions to help arrest further erosion.

- Several alien invasive plants were observed in places where the mangrove vegetation has been removed, It is recommended that the invasive plants be removed and replaced with native species
- Encroachment into the river using artificial material can be replaced by mangrove vegetation (Figure 35).

Steps that should be taken to conserve the Crocodiles

Crocodiles are regarded as “keystone species” that maintain ecosystem structure and function through selective predation on fish species, recycling of nutrients and maintenance of wetlands in drought. Thus, it is important that we conserve these reptiles and their natural habitats. The following actions are recommended:

- Identify threats to nesting habitats.
- Investigate fishing related mortality and by-catch as well as killing crocodiles for flesh.

- Initiate a crocodile park similar to Madras Crocodile Bank, South India and other countries. Thus 'man-eaters' and nuisances crocodiles could be housed in such a park. This could be a tourist's attraction as well as an income-generating venture.

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Figure 1

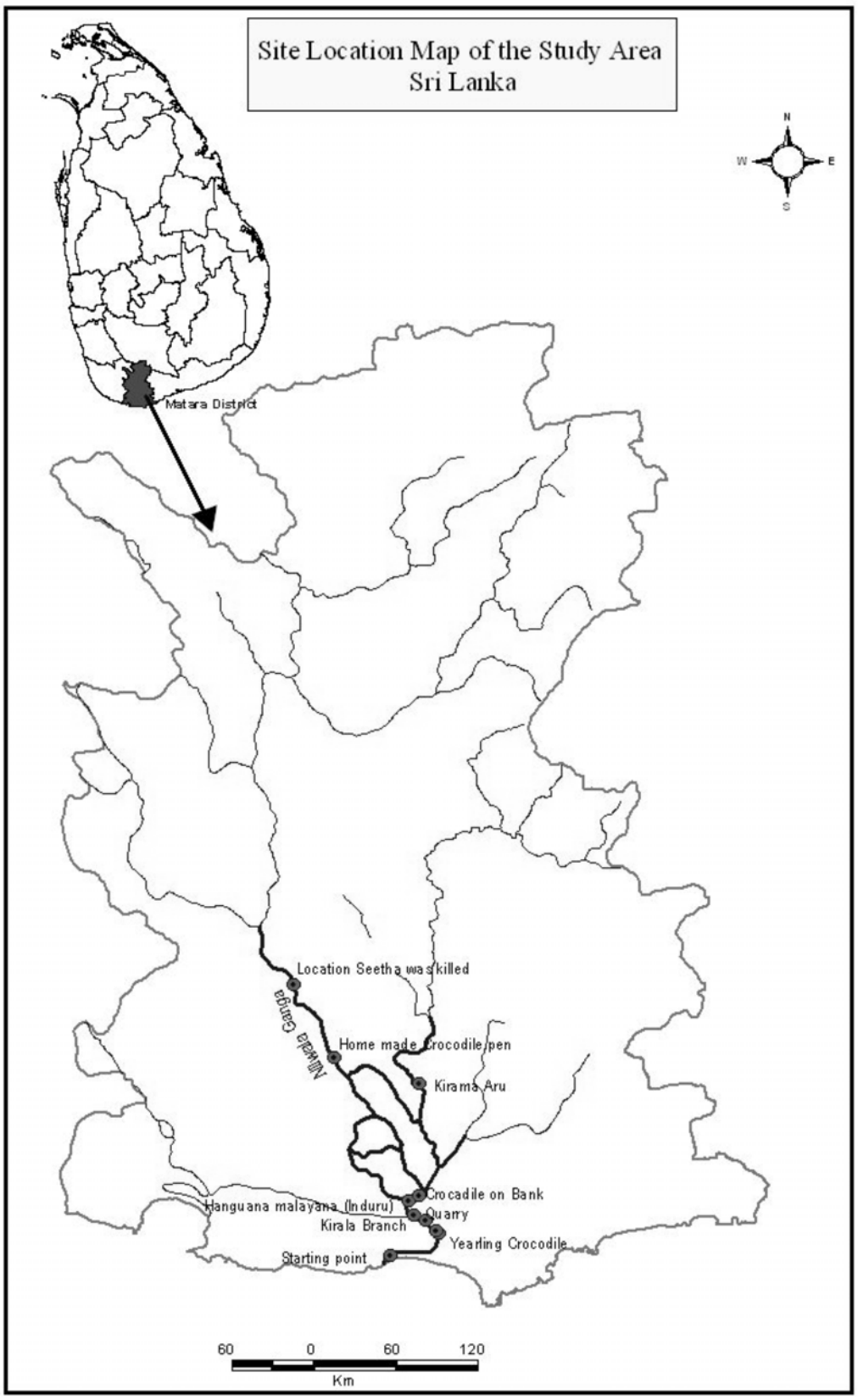

Site Location Map of the Study Area
Sri Lanka
N
W
E
S
Matara District
Nilwala Ganga
Location Seetha was killed
Home made Crocodile pen
Kirama Aru
Crocadile on Bank
Hanguana malayana (Induru)
Quarry
Kirala Branch
Yearling Crocodile
Starting point
60
0
60
120
Km

Figure 2
Map of Matara Town area showing the Nilwala River
(Source: Survey Department, 1994)

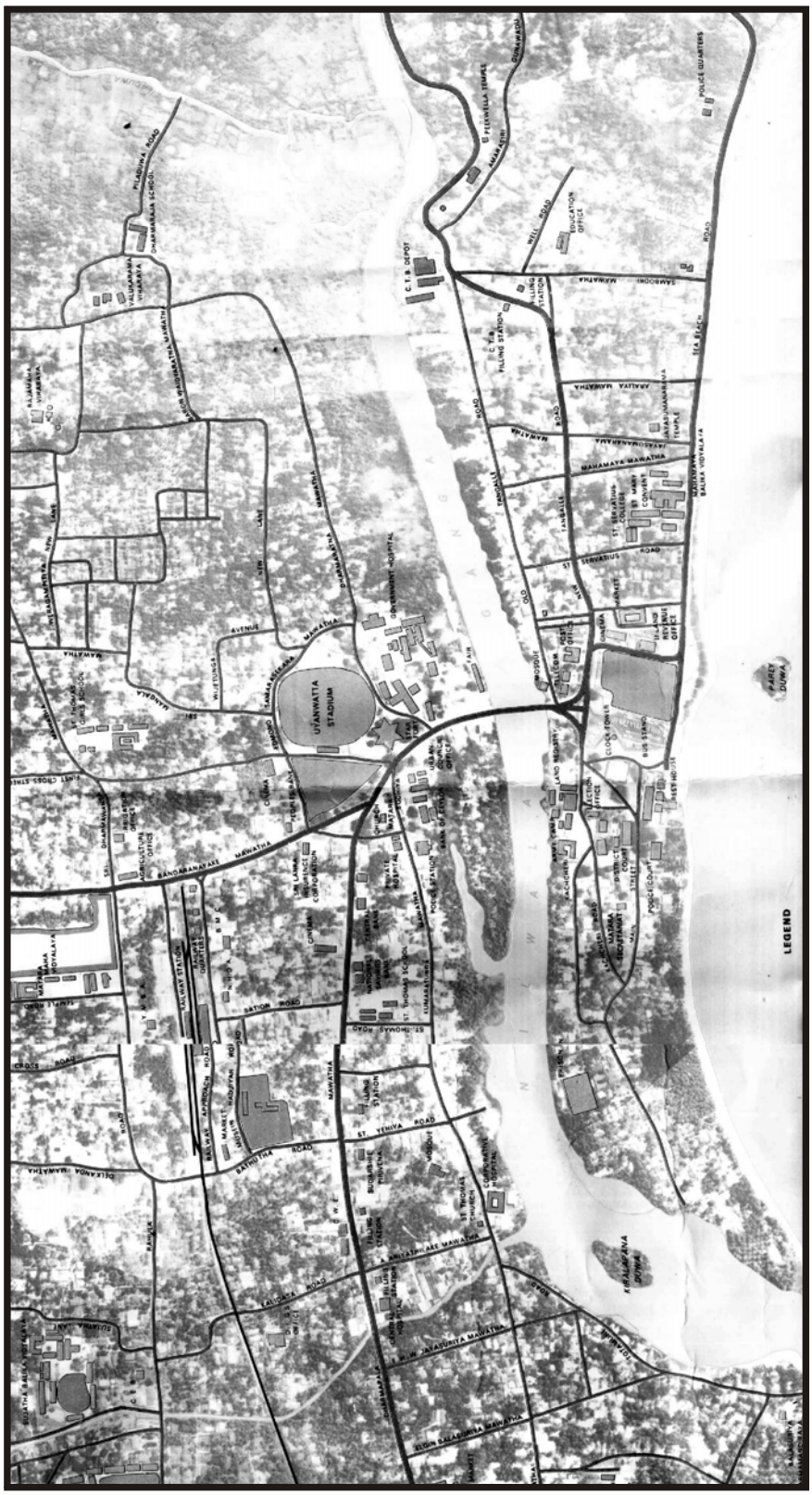


Figure 3

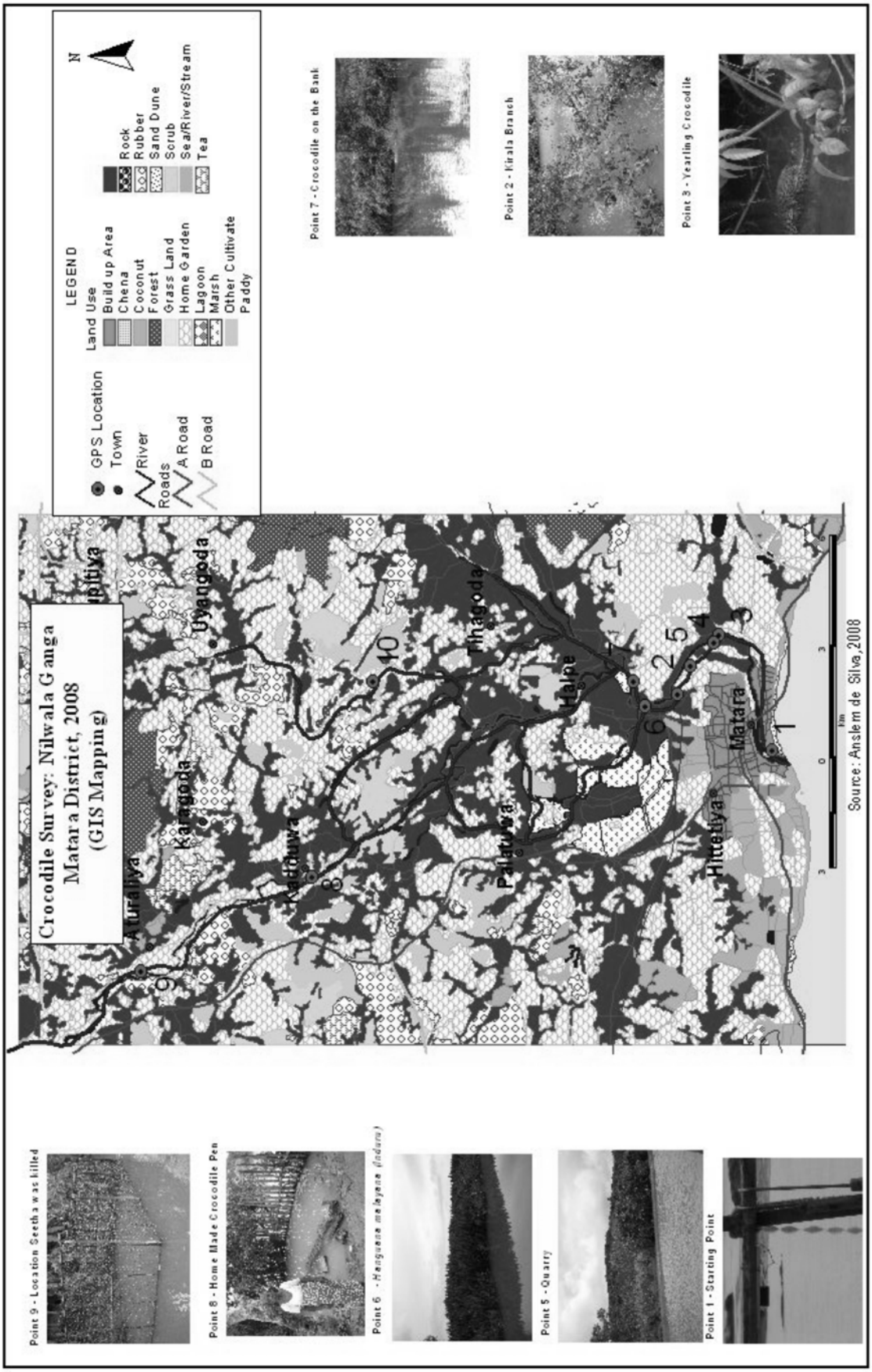

Crocodile Survey: Nilwala Ganga
Matara District, 2008
(GIS Mapping)
LEGEND
GPS Location
Town
River
Roads
A Road
B Road
Land Use
Build up Area
Chena
Coconut
Forest
Grass Land
Home Garden
Lagoon
Marsh
Other Cultivate
Paddy
Rock
Rubber
Sand Dune
Scrub
Sea/River/Stream
Tea
N
Aturaliya
Karagoda
Uyangoda
Kadduwa
Pallatura
Hittetiya
Matara
Halpe
Thiaggoda
Source: Anslem de Silva,2008
Point 7 - Crocodile on the Bank
Point 2 - Kirala Branch
Point 3 - Yearling Crocodile
Point 9 - Location Seetha was killed
Point 8 - Home Made Crocodile Pen
Point 6 - Hanguana malayana (Jinduru)
Point 5 - Quarry
Point 1 - Starting Point

Figure 4
Survey team at Fort, Matara

Figure 5
Survey team - Boat cruise

Figure 6
Large crocodile at Modara

Figure 7
Kiralapana Duwa, Lands End, Fort, Matara

Figure 8
Crocodile tracks: Kiralapana Duwa

Figure 9
Crocodile tracks: Kiralapana Duwa

Figure 10
Dumping grounds, Nilwala River Bank - 2008

Figure 11
Water monitor on Nilwala River Bank

Photographs : Anslem de Silva

Figure 12.
Piladuwa cannal

Figure 13
Sonneratia caseolaris branches

Figure 14
Traditional crocodile pen

Figure 15
Yearling *C. porosus* on *D. spathacea* branch

Figure 16
Location a man was killed by a crocodile

Figure 17
Crocodile dove into water

Figure 18
Location where Seetha was killed by a crocodile

Figure 19
Yearling, total length of 600 mm

Photographs : Anslem de Silva

Figure 20
Yearling, total length of 580 mm

Figure 21
A minor crocodile attack

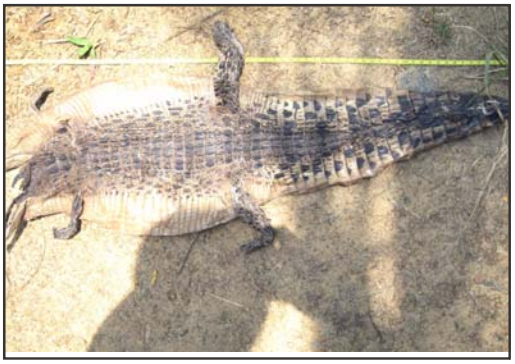


Figure 22
Skin of a saltwater crocodile 860 mm long

Figure 23
Hanguana malayana (Sinhala - *Induru*)

Figure 24
Acanthus illicifolius (Sinhala *Katu Ikili*)

Figure 25
Cerbera manghas (Sinhala *Gon kaduru*)

Figure 26
Typha angustifolia (Sinhala *Hambu pan*)

Figure 27
Nypa fruticans (Sinhala - *Gin pol*)l

Photographs : Anslem de Silva

Figure 28
Hibiscus tiliaceus (Sinhala *Belipatta*)

Figure 29
Recent clearing along Nilwala River bank

Figure 30
Awareness program at Piladuwa

Figure 31
Awareness program at Matara Convent

Figure 32
Current insecure bathing pen

Figure 33
Current insecure bathing pen

Figure 34
Recent traditional crocodile pen

Figure 35
Encroachment into the river

Photographs : Anslem de Silva

ANNEXURE 1
SURVEY FORM USED

HUMAN CROCODILE CONFLICT SURVEY: KAP SURVEY

(Please return this form to Anslem de Silva, 15/1 Dolosbage road, Gampola)

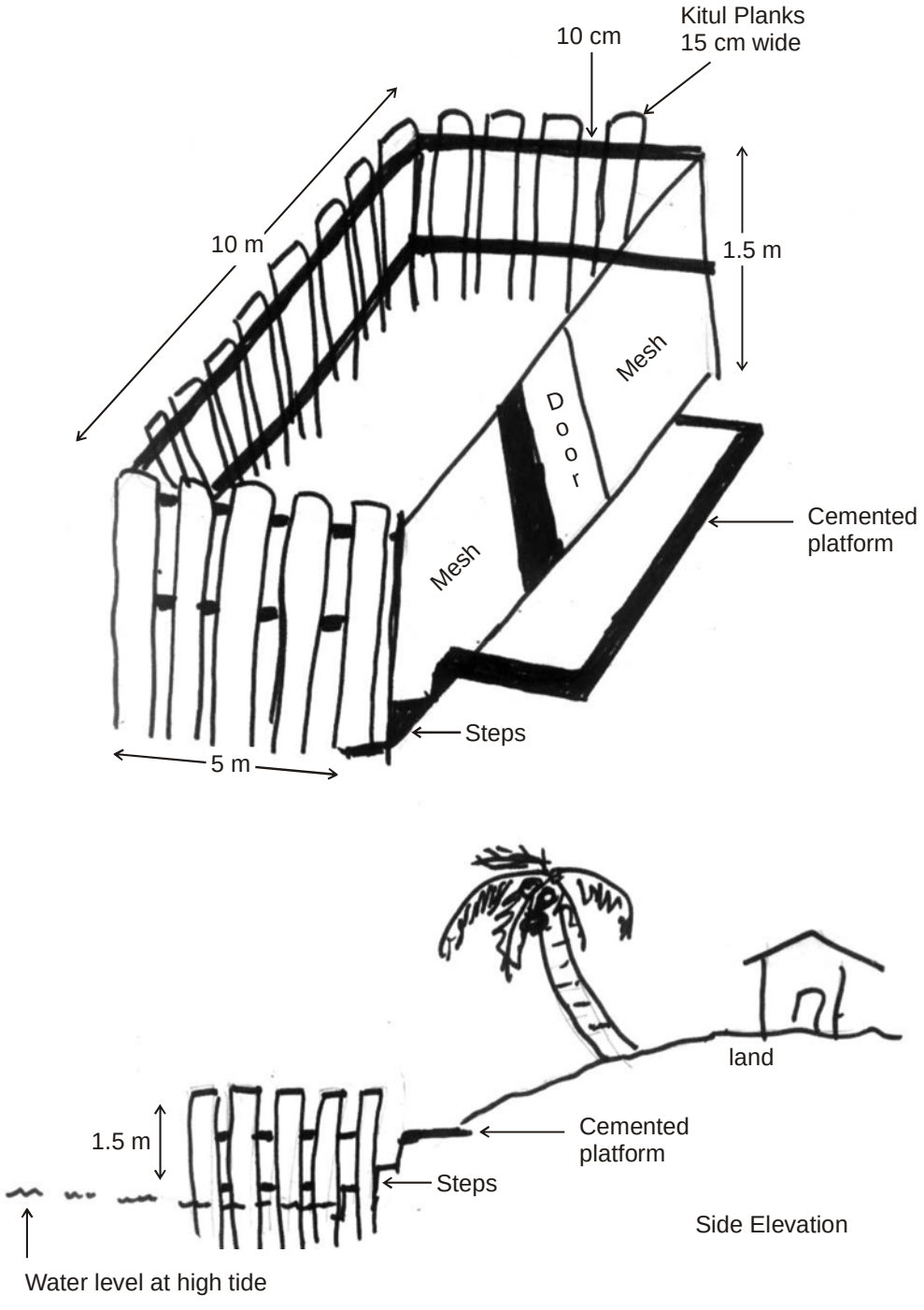
Form No……..
District: Grama Niladari Division……
Village Name
Name of the tank/oya/river/etc
Date Form no.
Name of respondent …….
Age……..M/F……Address …….
Employed……Telephone …… --------
---

1. Have you observed any crocodiles in your area Yes/No
2. Were there any crocodiles in your area earlier Yes/No
3. How long ago ?
4. Have the elders in your area observed crocodiles earlier
5. Where have you seen the crocodiles:
6. tank/vila/oya/river/other water source
7. Approximately how many crocodiles have you seen
8. Size of the largest crocodile you have seen.
9. Have you seen specimens below two feet in your area.
10. Have you observed any crocodile nests in your area
11. Have you seen crocodile eggs.
12. Do people destroy the crocodile nests / eggs
13. Have you seen other animals feeding on crocodile eggs / hatchlings
14. What are these animals
15. Do people clear the crocodile nesting habitats
16. For what purpose
17. How many humans have died from crocodile attacks within past three years?
18. How many survived from crocodile attacks within past three years?
19. Are there any crocodile attacks on farm and pet animals?
20. What are the pet species that were attacked by the crocodiles?
21. Are there any crocodiles killed in your area?
22. How many crocodiles are killed annually in your area.
23. How are they killed: shooting, harpooning, others specify
24. Is the crocodile flesh eaten
25. Is the crocodile skin taken for leather. What are the other threats to crocodiles you have observed
26. At what time do crocodiles come out from water
27. Have you seen them on land.
28. Are crocodiles useful animals
29. What are the uses of crocodiles
30. Record popular beliefs about crocodiles from your area
31. Is there any dumping place of waste from slaughter houses?

ANNEXURE 2

SKETCH FOR A SECURE CROCODILE PEN

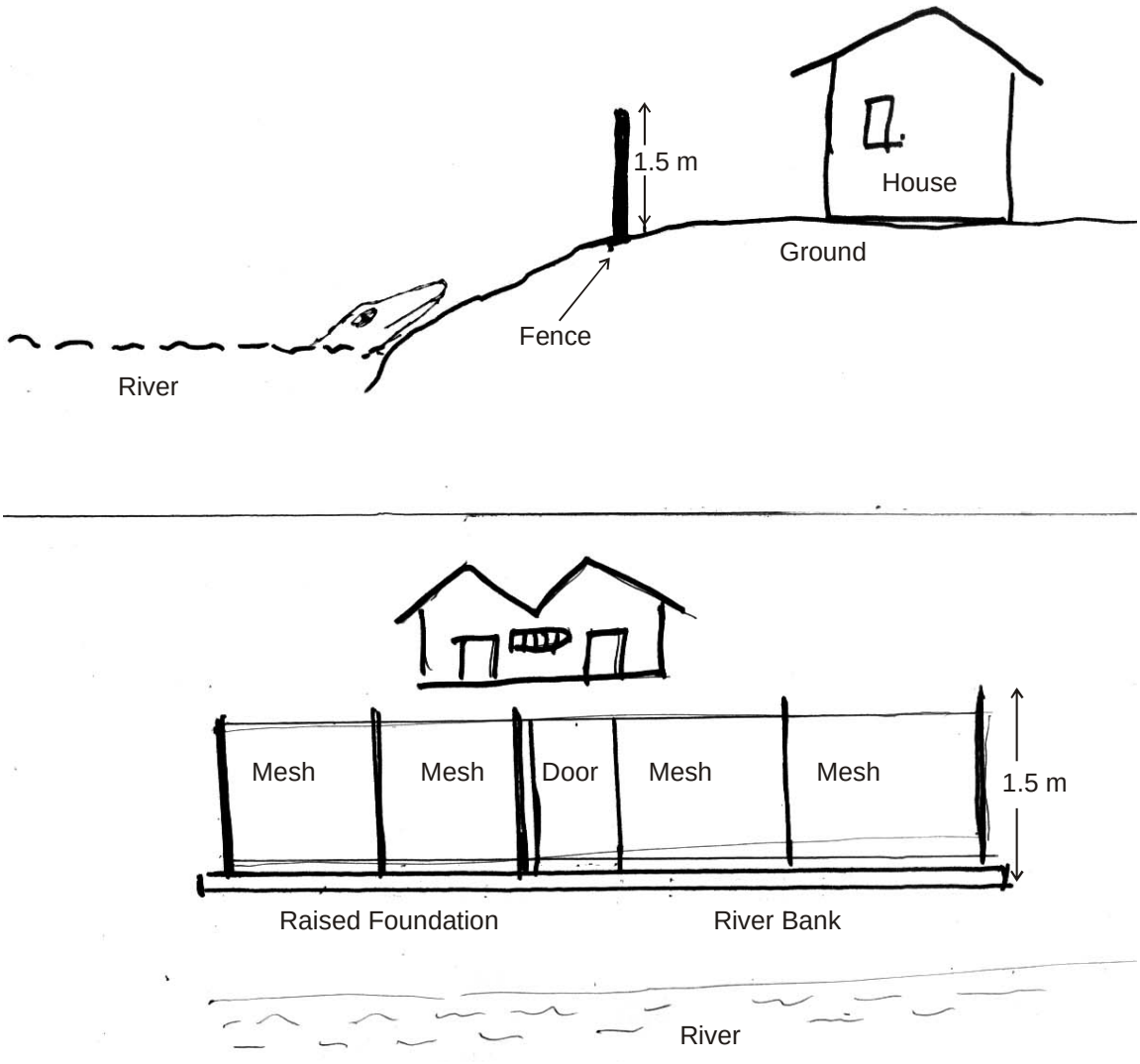
To enhance aesthetic and traditional beauty (also durability) I recommend building a pen using Kitul planks on 3 sides, 10 m x 5 m (Figure 34) but to make it secure the front should have a strong wire mesh with a door. The kitul planks should be 15 cm wide and when installed in water they should be approximately 1.5 m above the river water level during high tide. The space between 2 planks should be 10 cm. There should be a rough concrete platform and steps leading up to the water.



ANNEXURE 3

SKETCH FOR A SECURE CROCODILE FENCE

Erect the fence on a secure foundation and should be constructed so that half the land area is for the occupants and the other half for the river or rather for the crocodiles to prowl at night. Thus, we create land area for the crocodile, as well as protect the people and their pet animals. This technique has never been attempted anywhere in the world. In addition, a door should be fixed to this fence so that people could use both land spaces during the day.



ANNEXURE 4
ROUGH SKETCH FOR A WARNING SIGN BOARD

It would be a good idea to initiate a competition among schoolchildren of the area to come up with sketches for warning signboards.