"Distribution, habitat characterization and natural history of the Central American river turtle (*Dermatemys mawii*) in Sarstún River, Guatemala"

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Abstract

The Central American river turtles (*Dermatemys mawii*) are fully aquatic herbivorous. They range from southern Mexico to the north-east of Guatemala and Belize. Unfortunately wild populations have declined greatly due to over-exploitation, harvesting and habitat loss. The population at Sarstún River is genetically very different from all the other populations of this species. The main objective was to obtain information of the current status of this population, its distribution, and the status of the available habitat for this turtles at Sarstún River. Trammel nets were used to capture and mark them along the study area, and a GPS was used to mark the exact point of the capture. In total 53 individuals were captured, of which 16 were adults (9 males, 7 females), 35 juveniles and 2 hatchlings. Males and females presented sexual dimorphism according to their coloration and the morphometric measurements taken. To characterize the habitat physical and chemical water analysis were made along with microclimatic data, taken using data logers, characterization of vegetation from the shore and a written and photographic description of the underwater habitat. Seven different microhabitats were found in Sarstún River, where the "flooded forest" was the one with more captures. Feces composition was also obtained and the major components found were stems, small leave pieces and seeds that could belong to *Ficus glabrata*, commonly known as "higuero" (fig tree). With this information a map was generated which shows that the area where there was a greater number of captures is outside of the core zone of the protected area. This is why it is expected that the information in this study will serve to start a conservation strategy for the Central American river turtles at Sarstún River, and also benefit local people.

Main Findings

A. Captures, distribution and habitat preference

Although trammel nets were set among the entire river, most captures occurred outside of the protected area of Sarstún River, in sections 5, 6 and 7. No *Dermatemys* were captured in sectors 1, 2, 3 and 4. See figures 1 and 2. This result is both interesting and worrying, because by being outside the protected area *Dermatemys* is exposed to many types of exploitation, habitat loss and hunting.

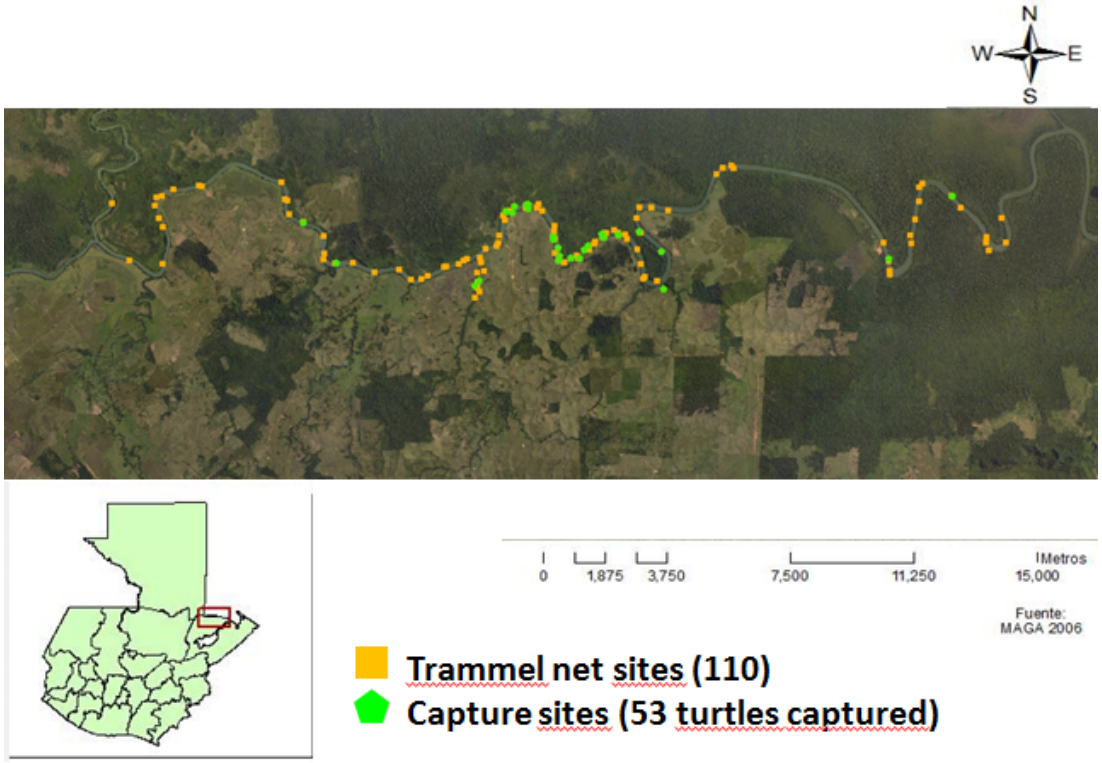

Figure 1. Sarstún River map with captures.

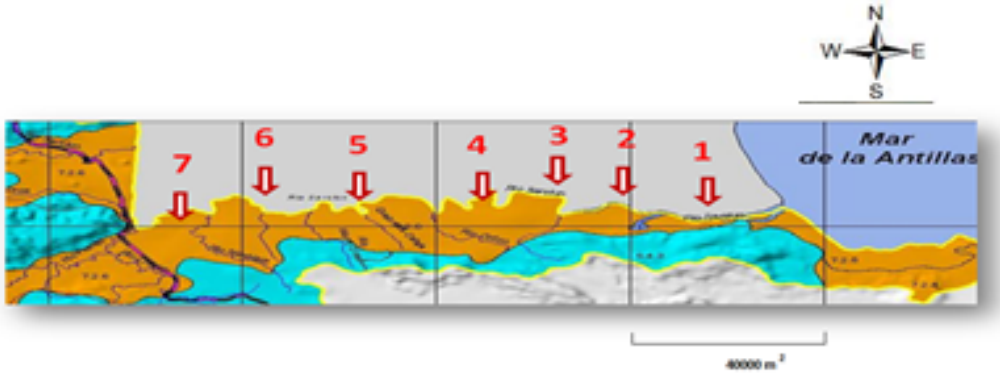

Figure 2. Sarstún River map divided by sections.

Knowing this, we began to search for possible explanations. Most captures occurred in section 6 (36/53), followed by section 7 (10/53) and finally section 5 (7/53). See figure 3.

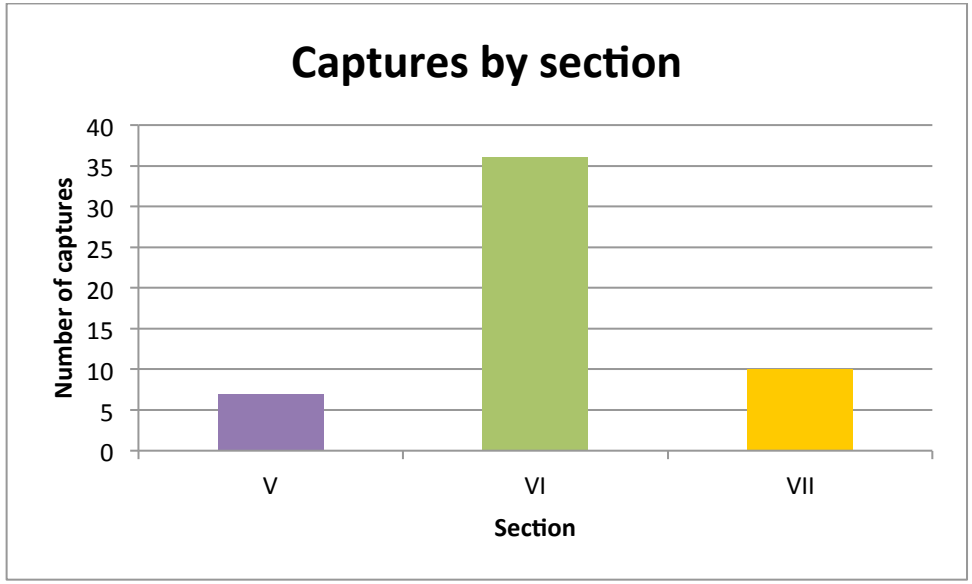

Figure 3. *Dermatemys* captures by section.

As for the microhabitat preference, most captures were made in microhabitat "Flooded forest" (21/53), followed by microhabitat "Secondary association" (16), then microhabitat "Paddock" (13/53) and finally microhabitat "Creek" (3/53). See Figure 4. There were no captures in the other microhabitats. It is important to mention that even do only 3 individuals were captured in the microhabitat "Creek", most visual encounters took place in this microhabitat. Apparently this microhabitats have characteristics that make them more suitable and habitable for *Dermatemys*, that the ones that are being preserved in the protected area. This could be because they have more places to hide and lots of more sources of food.

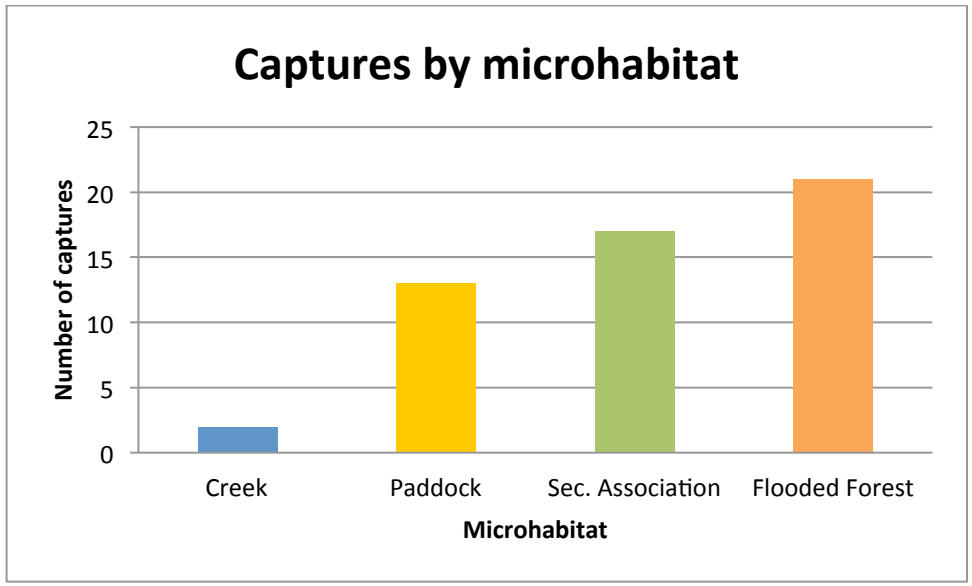

Figure 4. *Dermatemys* captures by microhabitat.

Most of the North side of Sarstún River is composed by "Flooded forest" or by "Secondary association", which explains why there were more captures here than in the South side of the river. See figure 5.

Regarding the captures by season, the dry season had a clear advantage because in the rainy season it was really hard to set the trammel nets with success. See figure 6.

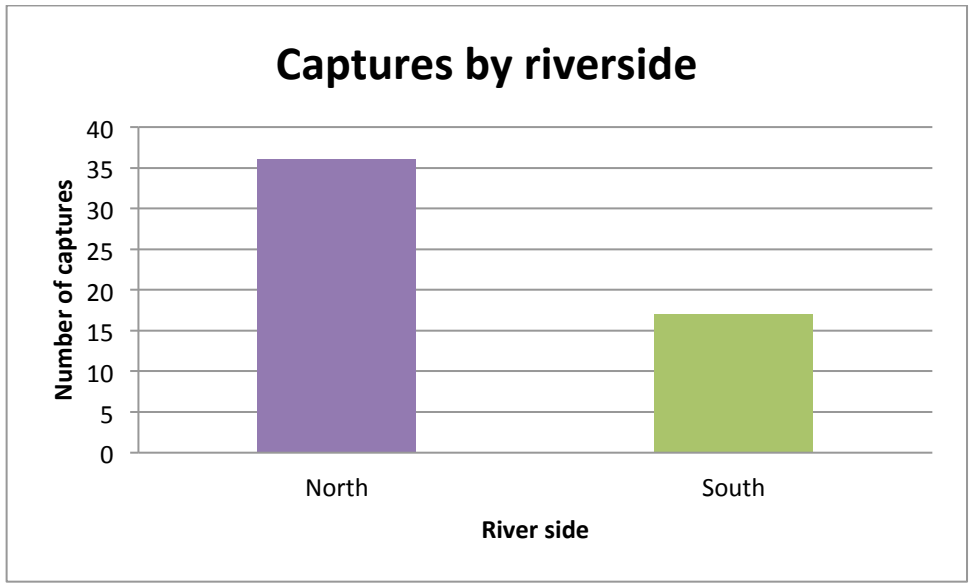

Figure 5. *Dermatemys* captures by riverside.

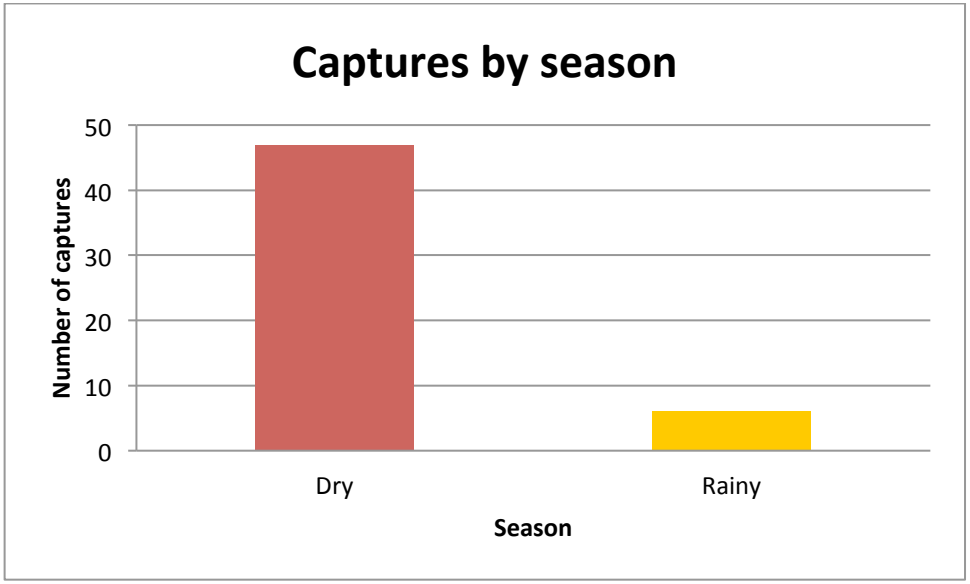

Figure 6. *Dermatemys* captures by season.

Table 1. Individuals of *D. mawii* captured by area.

The obtained capture of *Dermatemys* by area (ha) is really low, but this needs further studies to be fully understood.

Section	Area (ha)	Captures	Captures/ha
1	170.81	0	0/ha
2	127.03	0	0/ha
3	61.26	0	0/ha
4	94.84	0	0/ha
5	103.55	7	0.07/ha
6	61.65	36	0.58/ha
7	37.02	10	0.27/ha

Total	656.16	53
Captures/ha	0.08/ha	

B. Population characterization

Most individual captured were juveniles. See table 2. This may be due to several reasons. One of them could be that the harvesting is affecting only fully developed adults (males and females), and because there is less adults there is also less newborns. Also a population composed mostly by juveniles could be normal in a lotic environment. It is known that in lentic environments, such as lakes and lagoons turtles tend to develop to the adult stage more rapidly than turtles in lotic environments such as rivers (Polisar 1992). This makes sense when comparing the mean size of the plastron lenghtof Sarstún´s *Dermatemys* to others in rivers and lagoons on the north side of Guatemala, El Petén. The range size of the plastron in river *Dermatemys* (from Río Azul and Sarstún River) is 20.01-30 centimeters, while in lagoon *Dermatemys* (from "El Perú" and"Yaxha" lagoons) is 30.01-40 centimeters (Juárez 2008).

Table 2. Number of captures by sex and age.

	Sex			
Age	Unknown	Female	Male	Total
Adult	0	7	9	16
Juvenile	35	-	-	35
Newborn	2	-	-	2
General Total	37	7	9	53

Morphometric measurements were also taken to every individual captured. This could be useful to make further comparisons on the morphological differences among *Dermatemys* populations. Adult females were found significantly larger than adult males.

Adults Morphometric means (centimeters, weight in pounds)

Head lenght	**Head width**	**Carapace lenght**	**Carapace width**	**Plastron lenght**	**Left bridge width**	**Right bridge width**	**Tail lenght**	**Shell hight**	**Weight**
8.975	5.362	45.187	42.112	33.437	3.643	3.618	14.413	11.799	24.511

Males vrs. Females morphometric means (centimeters, weight in pounds)

Sex	Head lenght	Head width	Carapace lenght	Carapace width	Plastron lenght	Left bridge width	Right bridge width	Tail lenght	Shell hight	Weight
Female	9.257	5.771	47.485	44.257	36.014	3.728	3.785	12.616	11.842	26.379
Male	8.755	5.044	43.4	40.444	31.433	3.577	3.488	15.811	11.765	23.058

Juveniles morphometric means (centimeters, weight in pounds)

Head lenght	Head width	Carapace lenght	Carapace width	Plastron lenght	Left bridge width	Right bridge width	Tail lenght	Shell hight	Weight
7.368	4.257	35.78	32.605	26.965	2.825	2.788	11.189	11.386	15.046

C. Habitat characterization

1. Water analysis

Sarstún River has very similar water characteristics among all its length because of the strong currents and the occasional rains. The water analysis showed that both, the nitrates and the phosphates levels where lower than 5mg/l, which is the limit that indicates eutrophication in a water body. The salinity was always higher during dry season, and it increases with depth. Water clarity during dry season was 3.5 meters of visibility, while in rainy season it was less than 2 meters of visibility. The water temperature stayed the same during dry and rainy season, and it always increased with depth. Finally the oxygen levels decreased with depth, getting to 0.1% in the bottom.

2. Forest profiles

Transects of 10x2 meters were made to collect vegetation samples that would help us characterize the different microhabitats found at Sarstún River. We identified 48 plants. See table 2.

Table 2. Identified plants from the river shore.

No.	Scientific name
1	*Cocos nucifera*
2	*Attalea cohune*
3	*Acoelorraphe wrightii*
4	*Roseodendron donell-smithii*
5	*Calophyllum brasiliense*
6	*Bursera simaruba*
7	*Cecropia peltata*
8	*Bactris balanoidea*
9	*Ficus glabrata*
10	*Ficus pertusa*
11	*Ficus maxima*
12	*Ficus glaucescens*
13	*Guettarda combsii*
14	*Terminalia catappa*
15	*Inga vera*
16	*Pachira acuatica*
17	*Pouteria sapota*
18	*Chrysobalanus icaco*
19	*Anona glabra*
20	*Grias integrifolia*
21	*Nectandra coriacea*
22	*Psidium guineense*
23	*Plumeria rubra*
24	*Gliricidia sepium*
25	*Vitex gaumeri*
26	*Manihot esculenta*
27	*Erythrina folkersii*
28	*Cassia sp.*
29	*Psychotria limonensis*
30	*Malouetia guatemalensis*
31	*Hampea stipitata*
32	*Chrysophyllum cainito*
33	*Pithecellobium dulce*
34	*Nectandra ambigens*

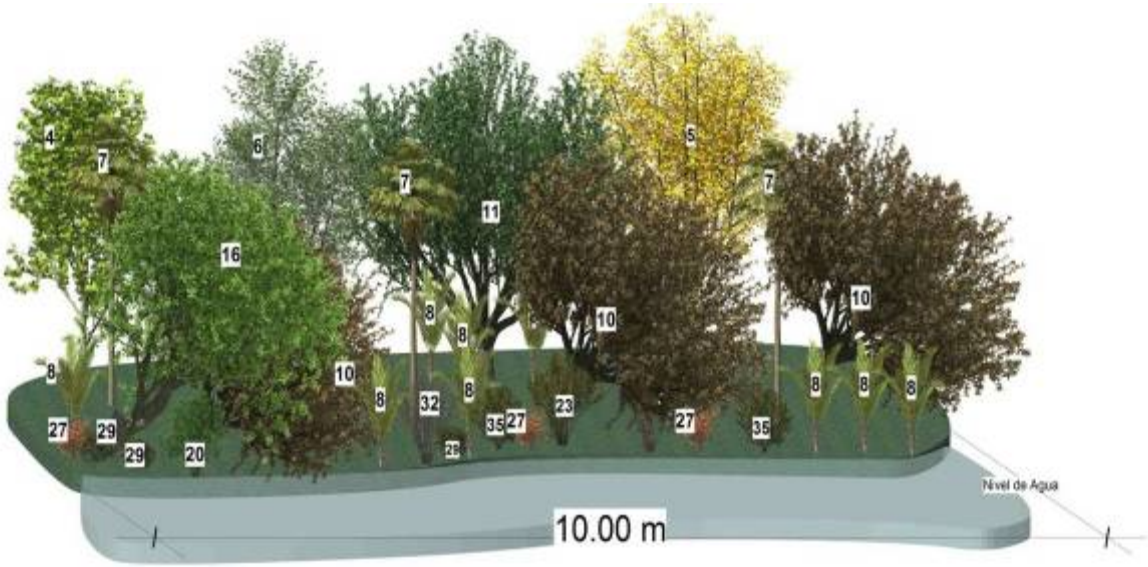

Figure 7. Microhabitat profile “Belize Forest”.

One of the microhabitat found in Sarstún River was named “Forest”, because it is composed mainly by tall trees and it is not very dense. This type of microhabitat can be found within sections 3, 4 and 5. And it is still inside of the protected area. The Belize forest (Figure 7) is the one found in the north side of the river, and the Guatemala forest (Figure 8) is the one found in the south side.

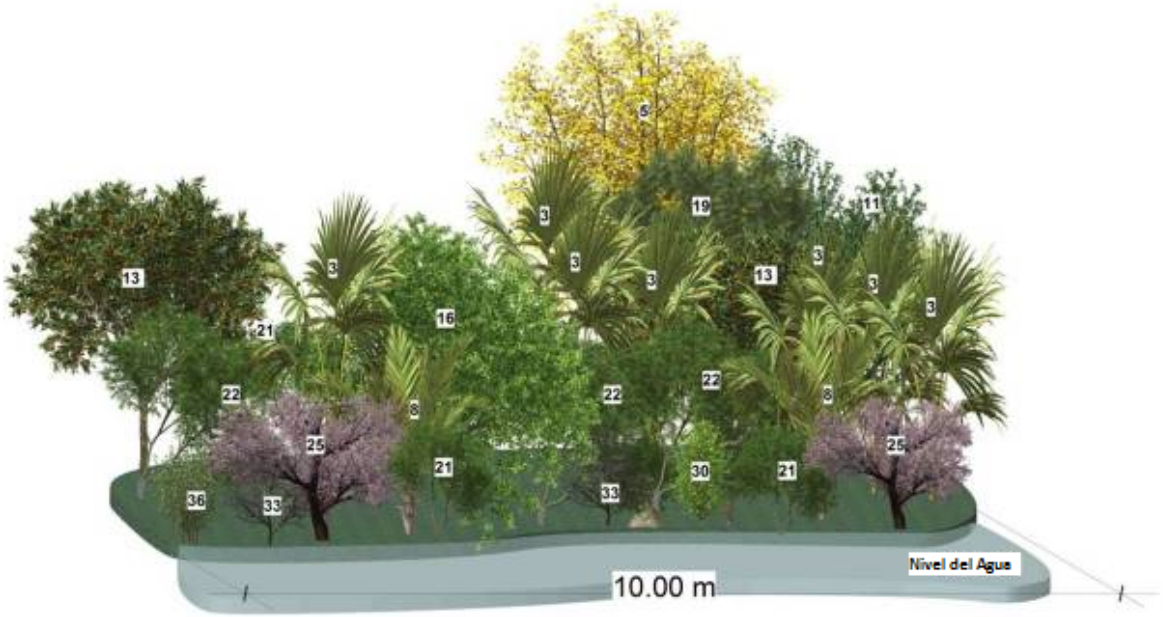

Figure 8. Microhabitat profile “Guatemala Forest”.

The Paddock microhabitat is almost plain. See figure 9. It´s conformed mainly by grasses, palm trees, cultivated fruit trees although it also has some leaning “Fig trees” that touch the water. This microhabitat can be found in the south side of sections 6 and 7.

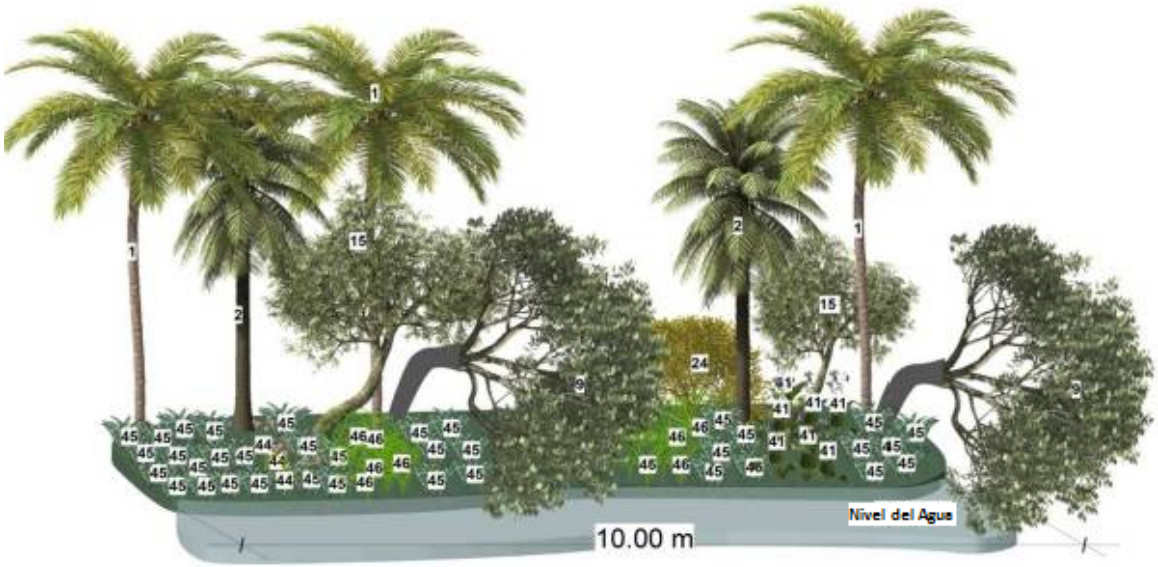

Figure 9. Microhabitat profile “Paddock”.

The microhabitat “Creek” is similar to the Paddok, it also has lots of grasses and leaning fig trees but it is more dense than the paddock and can only be found in section 6. See figure 10.

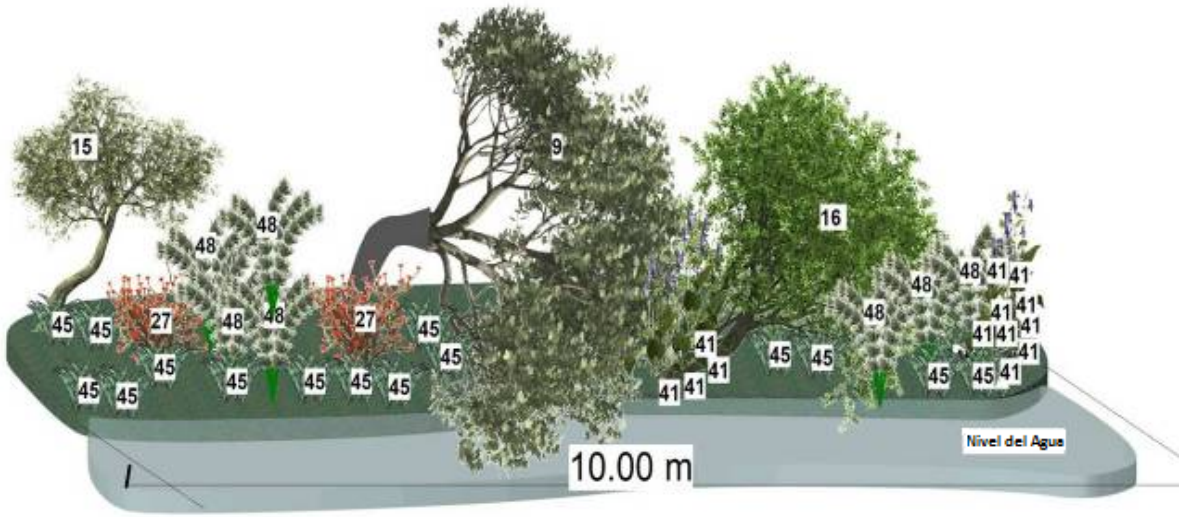

Figure 10. Microhabitat profile “Creek”.

The microhabitat “secondary association” is formed mainly by tall grasses and vines that make it almost impenetrable. It is the densest of all Sarstún´s microhabitat and it can be found in both river sides at sections 6 and 7. See figure 11. All these vegetation could provide of hiding places for *Dermatemys* and other species.

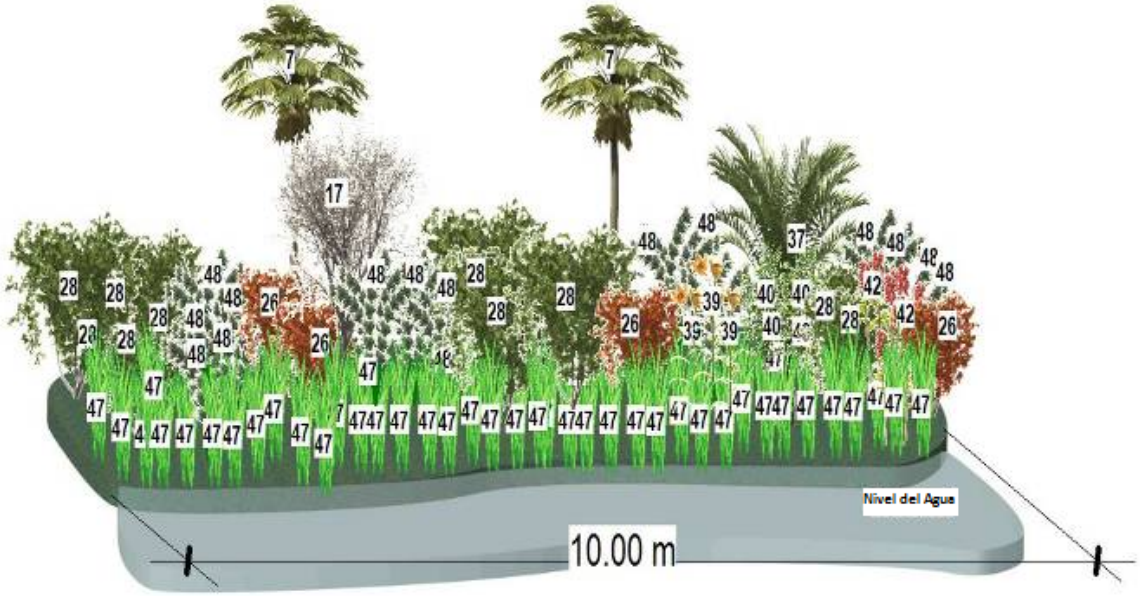

Figure 11. Microhabitat profile “Secondary association”.

The microhabitat “Flooded forest” can also be found in both sides of the river in sections 6 and 7. It is conformed mainly by leaning trees and fruit bushes that touch the water. Most of its leaning trees are “Figs” (*Ficus glabrata*). It is less dense than the “Secondary association” but denser than the “Forest”. It has very soft soil, and in appearance it looks like a good nesting and foraging site for *Dermatemys*. See figure 12.

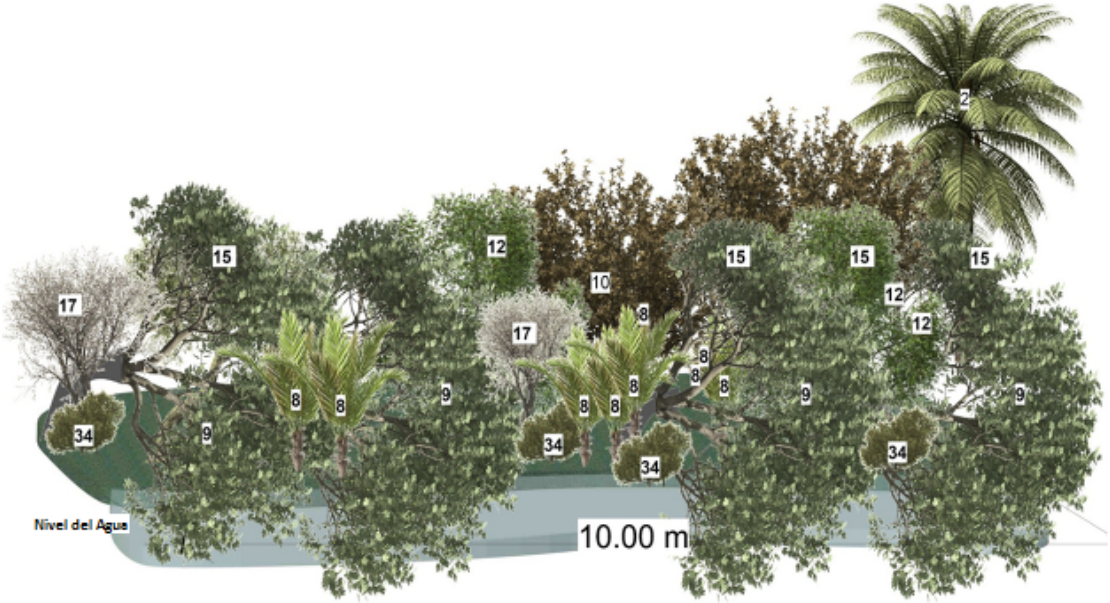

Figure 12. Microhabitat profile “Flooded forest”.

The mangrove microhabitat can only be found in sections 1 and 2, both north and south. These sections are nearest to the ocean. It is conformed mainly by red mangrove, some palm trees and lily pads. See figure 13.

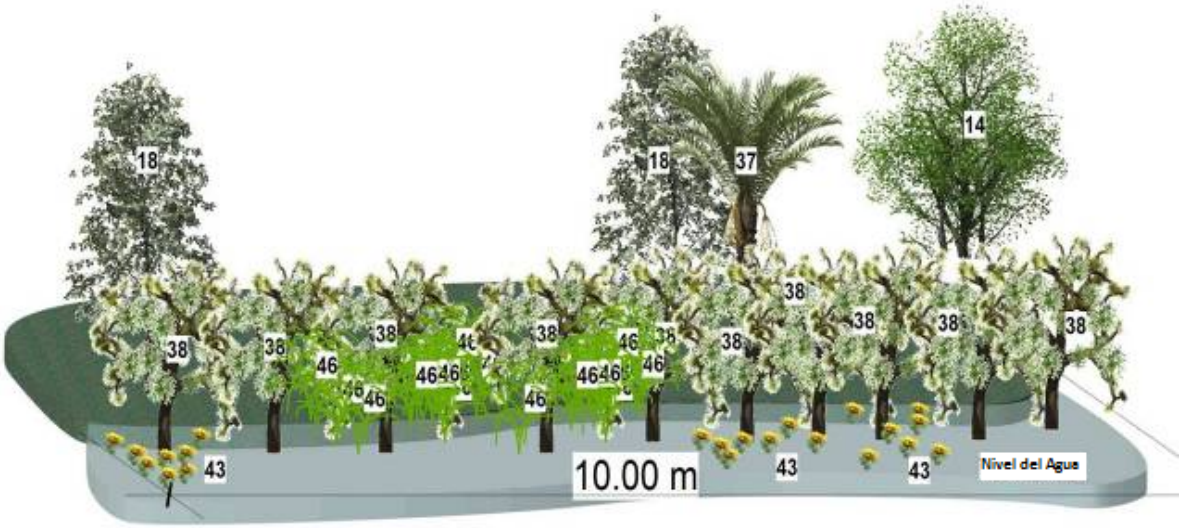

Figure 13. Microhabitat profile “Mangrove”.

3. Microclimatic data

Using 4 USB data loggers we collected microclimatic data of the microhabitats where *Dermatemys* individuals were captured. The humidity and temperatures varies little between microhabitats. It didn´t vary much between seasons either, rainy season is a little bit more humid and hot than dry season but it is not significant. See figures 14 y 15.

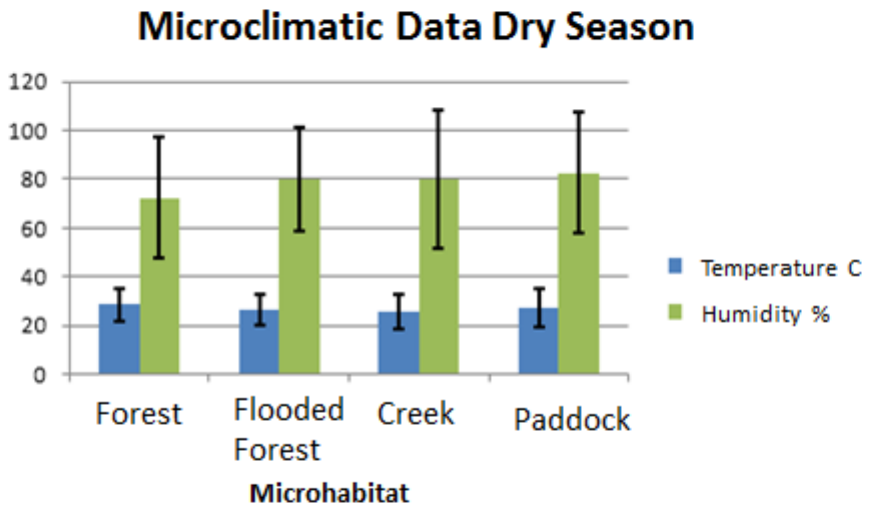

Figure 14. Microclimate data, dry season.

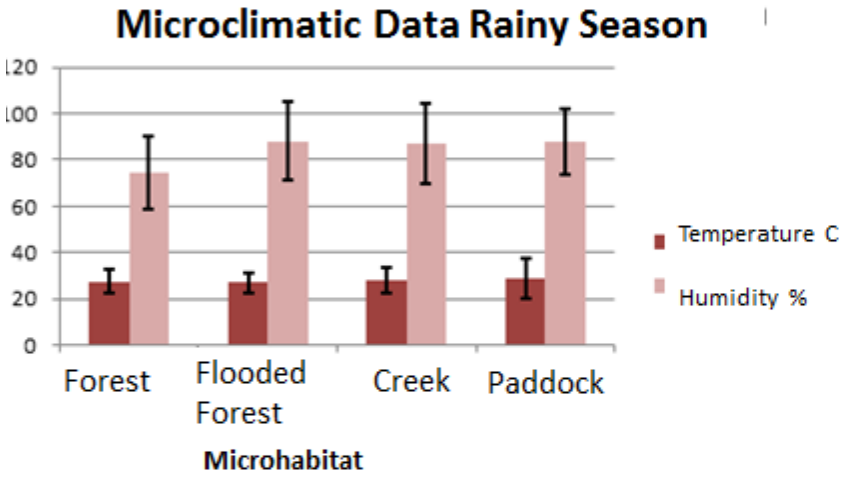

Figure 15. Microclimate data, rainy season.

4. Underwater habitat

Dives were conducted in sections 5, 6 and 7. Sections 1 and 2 were shallow and had poor visibility, and sections 3 and 4 had risk of crocodiles.

Contrary to popular belief, the underwater habitat of Sarstún River is very complex. Underwater habitat was divided into: surface, intermediate and bottom floor. On the surface you can see the leaves of all the leaning trees submerged into the water, many with fish bites. The intermediate part has fallen trees, bushes and even submerged huge palm leaves. There is a vast diversity of organisms that hide among them, so this could be a potentially good place for *Dermatemys* to find refuge too. The bottom floor has the less clarity. It has many suspended substrates and the temperature increases significantly. The bottom soil is smooth and has a lot of decaying plant matter. See figure 16.

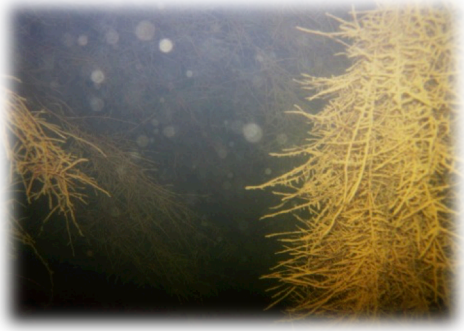




Figure 16. Underwater habitat photographs.

D. Observations on Diet

Dermatemys feces samples were separated to extract identifiable components. Most of the samples were composed of unidentifiable plant matter, but there were also found stems, incomplete leaf, seeds, grass, rocks and small fruits. See figure 17. To identify the source of these components, they were compared to the already identified plants, used for the forest profiles. Most of the stems, incomplete leaves and seeds corresponded to "Fig tree" (*Ficus glabrata*). See figures 18, 19 and 20.

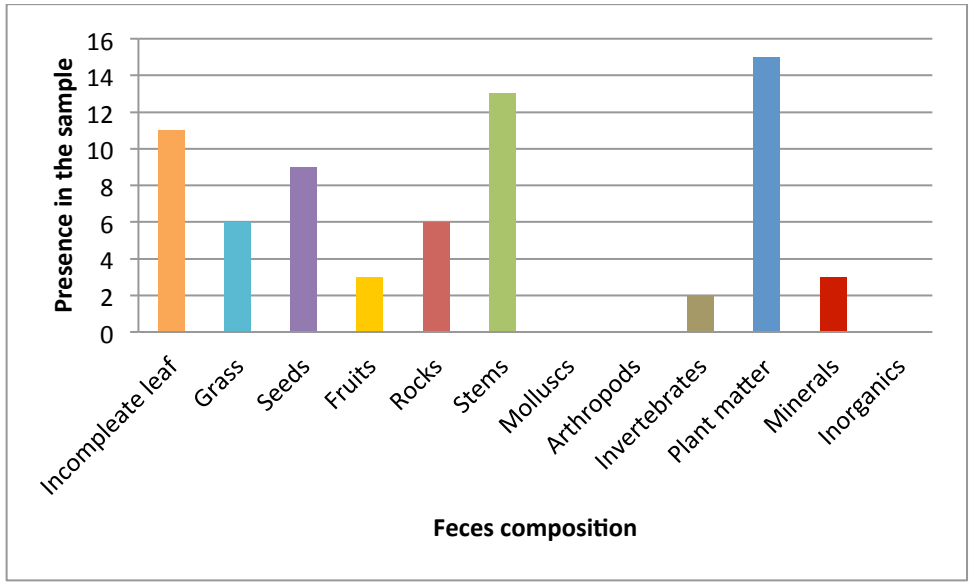

Figure 17. *Dermatemys* feces composition.

Figure 18. “Fig tree” (*Ficus glabrata*) leaf, and leaf apex found in the feces samples.

Figure 19. “Fig tree” (*Ficus glabrata*) fruit and seeds compared with the seeds found in the feces sample.

Figure 20. “Fig tree” (*Ficus glabrata*) leaning into the river.

And because this “Fig tree” was also found leaning into the water in sections 6 and 7, and in microhabitat “Flooded forest”, “Paddock” and “Creek” it could be related to the majority of captures in this sites.

Conclusions

1. None specimens of *D. mawii* were captured in the nuclear zone of the Protected Area of Sarstún River.
2. Seven different microhabitats were found along the riverbank in Sarstún River.
3. No significant difference was found between individuals captured in different sections of the river.
4. According to the morphometric data, in Sarstún River adult females of *D. mawii* (LCA 47.49 ± 3.4 cm, 3.4 cm ± WCA 44.26 and 11.03 ± 2.07 kg W) are larger than adult males (43.4 ± 3.5 cm LCA, WCA 40.4 ± 3.6 cm and 19.8 ± 1.94 kg W) when F= 6.13, P= 0.02.
5. Most turtles were captured in section six, corresponding to microhabitat “Flooded forest”.
6. Individuals of *D. mawii* were only captured in microhabitats “Paddock”, “Secondary association forest” and “Flooded forest”.
7. No turtles were captured in microhabitats “Mangrove” and “Forest”.
8. The estimated population density for *D. mawii* at Sarstún River was 0.08 individuals/ha.
9. Fecal samples were mostly composed of broad leaves, stems and seeds of “fig tree” (*Ficus glabrata*).

Recommendations

- It is important to take into account the occasional storms that occur in Sarstún River, as in all the rest of Izabal (in both dry and rainy season). Predicting these events and the strength of them is virtually impossible so using life jackets at all times is highly recommended. Also it is not recommended to work or camp near old trees because in case of a storm branches and even trees could fall on the boat or the camping tent.
- It is not advisable to dive in aquatic areas where: crocodiles have been seen, the visibility isn´t good and underwater currents are unpredictable. Diving is not recommended immediately after a storm because the currents bring pieces of trees at high speed and it could be dangerous.
- Remove the trammel as soon as possible when there is a storm or when one is coming. Trapped animals could get injured or even die in the trammel net during storms. It is also likely that the currents bring trunks that could break the trammel nets.
- If you observe iguanas basking on a specific site by the river, trammel nets should be placed diagonally to prevent these of getting stuck in them if they jump overboard and swim to another place. The trammel should be directed about 75 ° towards the center of the river from the shore.
- To avoid catching fish is important that the mesh in the trammel net is No. 5 or larger. This way even if one falls easily these may be released without harm.
- If a crocodile is accidentally captured the best thing to do is to cut the trammel net to release it and avoid harm to both, the crocodile and people who try to release it.
- It is recommended to use green nylon trammel nets to capture *D. mawii* in Sarstún River. Silk trammel nets are also effective, however they are easily tangled, they capture a lot of leaves and hindering the release of the turtle or other organism.
- Environmental education at the villages of sections No. 5, 6 and 7 is highly recommended. It is important to highlight the importance of the conservation of streamside vegetation, the importance of the river itself and of course the importance of *D. mawii* (especially within fishermen, hunters, and children). This is vital to help preserve this species at Sarstún River.
- It is recommended to do some telemetry studies with *D. mawii* to understand better the species and to get more information about their distribution in Sarstún River. This way it will be easier to make decisions about what sites to preserve.
- Make an agreement with landowners in section No. 6 and 7 to keep intact at least a few meters from the river bank, preventing soil erosion and loss of wealth in the river.
- Get to an agreement with the managers of the protected area in Belize, in which both FUNDAECO (managers of the protected area of Sarstún River) work to ensure the protection of microhabitat "flooded forest" of both riversides in Sarstún River.
- To conduct a detailed study of *Dermatemys* genotype is important to understand the genetic differences between the *Dermatemys* populations and be able to design a conservation strategy according to the genetic diversity.
- It is important that experts working with *D. mawii* in other countries (Mexico and Belize) as Guatemala hold a meeting where they discussed the measures to be taken to preserve the existing populations of the species throughout its range

Financial Report

	Amount Needed	Unitary Cost	TCF		Zootropic		Researcher		UVG		WCS		Idea Wild	
			Amount	Total Cost	Amount	Total Cost	Amount	Total Cost	Amount	Total Cost	Amount	Total Cost	Amount	Total Cost
EQUIPMENT	Amount													
Trammel Net	4	$110.00	2	$220.00							2	$220.00		
Measuring Tape	2	$6.95			2	$13.90								
Ruler	2	$1.00			2	$2.00								
Electronic Vernier	2	$14.60	2	$29.20										
Weighing scale	1	$55.00					1	$55.00						
GPS Garmin	1	$249.00											1	$249.00
Water Quality Test Kit	1	$195.80							1	$195.80				
Waterproof Camera	1	$319.00											1	$319.00
Data loggers	4	$17.50											4	$70.00
Netbook	1	$495.00					1	$495.00						
Diving Equipment	1	$1,399.00					1	$1,399.00						
FIELD TRIPS	Trip/day													
Car Gas	20 trips	$30.10	20	$602.00										
Boat Gas	20 trips	$102.00	20	$2,040.00										
Food for three people	141 days	$22.50					141	$3,172.50						
Boat Rental	141 days	$18.85	66	$1,244.10			75	$1,413.75						
Lodging	141 days	$15.00					141	$2,115.00						
SALARY	Days													
Two field assistants	141	$12.50	33	$825.00			108	$1,350.00						
TOTAL				$4,960.30		$15.90		$10,000.25		$195.80		$220.00		$638.00