Distribution and Ecology of the Central America River Turtle (*Dermatemys mawii: Dermatemidae*) in the Lowland Maya Forest, Guatemala*

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INTRODUCTION

The Central American River Turtle (*Dermatemys mawii*) is the most threatened turtle in the lowland Maya Forest (i.e. "Selva Maya") of Guatemala, Mexico, and Belize. The lowland Maya Forest is an important region for the conservation of this turtle, a highly threatened species, mainly due to its exploitation by local people who use it as a gastronomical delicacy in the region (Arriola 2005, Campbell J. 1998, Lee J. 1996, Mittermeier R. 1970). Although it was very abundant in the past (Campbell J. 1996, Lee R. 1969, Vogt & Flores-Villela, 1992), its distribution is becoming more and more restricted due to habitat destruction and human predation, and its status in Guatemala is unclear (Polisar & Horwich, 1994).

We used Trammel Nets and standardized statistical methodology (Mark-recapture models) to determine the abundance of *D. mawii* in different lagoons and rivers in the Lowland Maya Forest in Guatemala. In this report, we present a new distribution map for the species in the region using data from this study and literature data.

BACKGROUND

Maya Forest Corridor

The Selva Maya is the second largest tropical rainforest portion in the Americas after the Amazonian forest. The Selva Maya corridor goes from the southeast of México (Chiapas, Tabasco, Campeche, Yucatán and Quintana Roo states), to the El Petén department of Guatemala and Belize. It is covered with montane tropical rainforest (Selva Lacandona in Chiapas, Chiquibul and Mayas Mountains in the South of Belize) and lowland tropical rainforest (Marqués de Comillas in Chiapas, Yucatán Peninsula, Petén in Guatemala and North of Belize). The Selva Maya includes the middle and lower parts of the Usumacinta river basin which, together with the Grijalva River Basin, form the most important waterway systems in Mesoamérica (Rodríguez C. & N. Asquith. 2004, Figure 1).

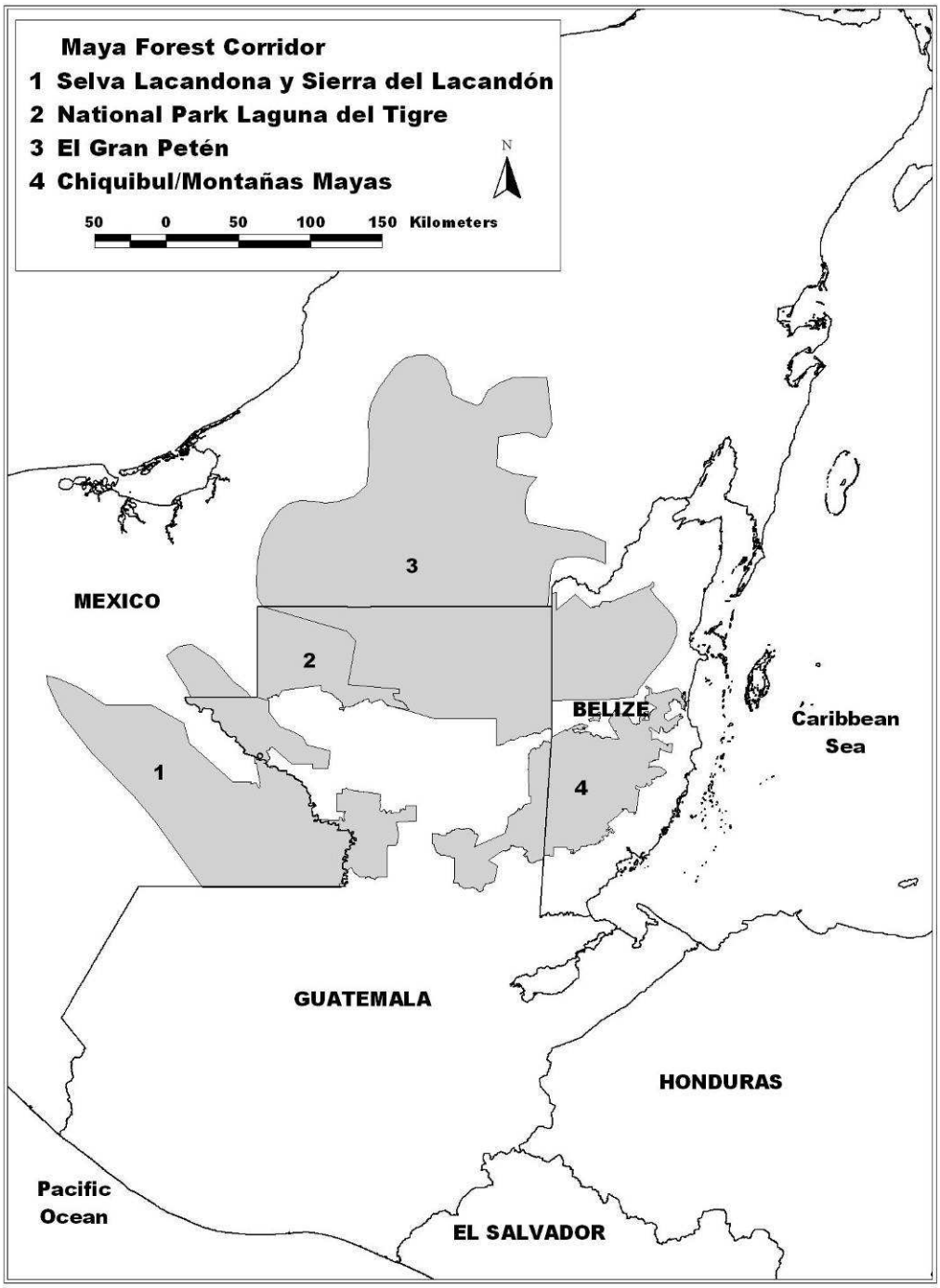

Figure 1. Maya Forest Corridor (Based in Rodriguez C. & N. Asquith. 2004)

Maya Biosphere Reserve

During the past thirty years, human populations in the Petén region of northern Guatemala have increased nine percent each year due to socio-economic factors and political changes (Fort & Grandia 1999). Before it was designated as a reserve, uncontrolled logging and burning of lowland tropical forest threatened to destroy all of the forest in what is now the Maya Biosphere Reserve (MBR) in less than thirty years (Sader 1999). Due to this alarming rate of forest loss, the Guatemalan government established in 1990 the 2.11 million hectare Maya Biosphere Reserve with the goal of conserving this unique tropical forest habitat while promoting sustainable economic activities and social participation.

The reserve is divided into three zones. The Core Zone, which consists of National Parks and Biotopes, covers 36 percent of the reserve. According to law, this area is designated solely for scientific investigations and low impact tourism. The Multiple Use Zone functions as the *de facto* heart of the reserve, connecting the National Parks and Biotopes while spanning 40 percent of the reserve. This zone is an extractive reserve covering 848,440 hectares, and use of the reserve must be sustainable and cause little damage. The Buffer Zone of the MBR covers 24 percent of the reserve, and consists of a 15 kilometer-wide band along the southern border of the reserve (Figure 2).

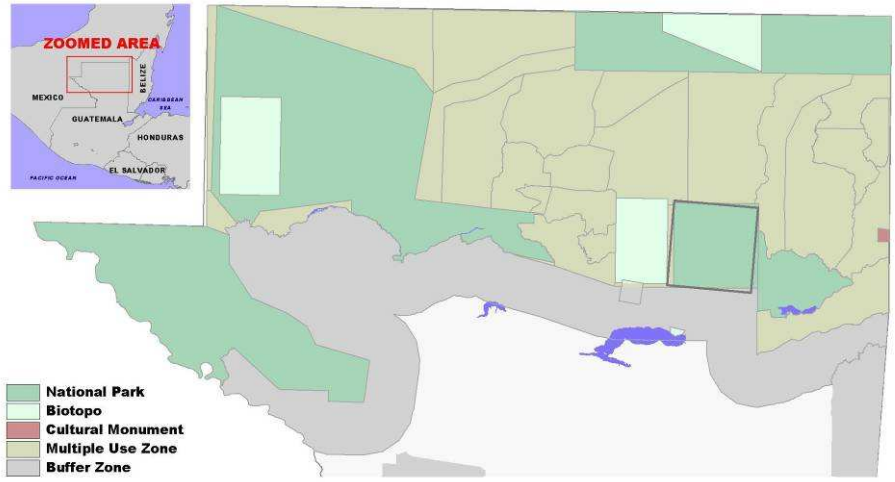

Figure 2. Maya Biosphere Reserve, Guatemala, C.A.

The Core Zone (i.e. National Parks and Biotopes) of the MBR is distributed principally around the perimeter of the Reserve, contrary to what might be expected to be the ideal design for a biosphere reserve.

The Central American River Turtle (D. mawii)

The Central American River Turtle, the only living species of the family *Dermatemydidae* (Köhler G. 2003, Campbell J. 1998, Lee J. 1996), is listed under CITES Appendix II, as a high priority species in the World Conservation Union (IUCN) Species Survival Commission Action Plan for the Conservation of Tortoises and Freshwater Turtles (Polisar J. 1995) and in the Guatemalan Red List of endangered species (Campbell J. 1998, Lee J. 1996, Solís V. & A. Jiménez 1999). *D. mawii* is also included in the list of the world's top 25 most endangered tortoises and freshwater turtles compiled by the Turtle Conservation Fund (2003). Despite the species' importance and its highly threatened status, there is very little information available on its population parameters, and practically none on its distribution or the genetic variability between wild populations in Guatemala. Existing information is scarce and non-representative of the entire population, and there is no reliable estimate of population size. In order to effectively conserve and propose science-based recommendations for the successful management of the species, we must describe the species' population tendencies through time and space, measure the effects of determined threats on its populations, and document its genetic variability.

It is safe to say there is an information gap on the distribution and ecology of the *D. mawii* in the Selva Maya Corridor in Guatemala. Conservationists and park managers lack information on its actual distribution, and we lack information on how various factors, like type of water body, surface area of water bodies, and distance to human settlements, among others, may affect its distribution and abundance in the region. The results obtained through this study may be used as baseline information to guide management plans and conservation strategies for *D. mawii*.

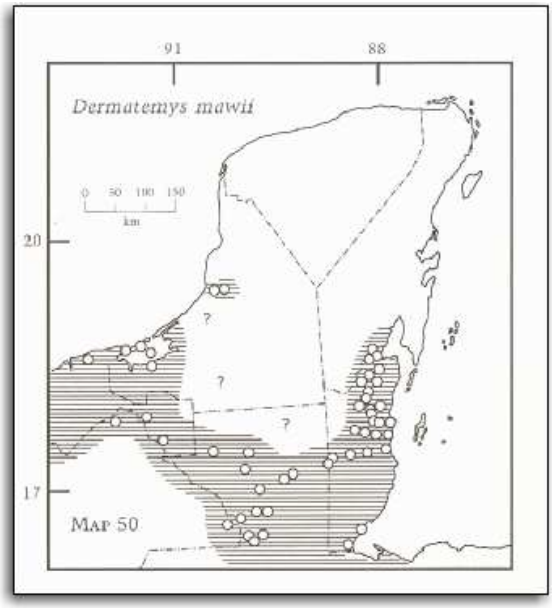

Figure 3. Distribution of *D. mawii* (Source: Lee J. 1996)

OBJECTIVES OF THE STUDY

Our main objective was to obtain baseline information on the distribution and abundance of *D. mawii* in different bodies of water in the lowland Selva Maya of Guatemala. We came up with a list of variables, characterizing the bodies of water, perceived to be potentially important in determining the distribution and abundance of the species. The information generated by this study will be used to develop the CA River Turtle Conservation Strategy for the lowland Selva Maya of Guatemala.

Information generated will also be incorporated into the CA River Turtle Conservation Model, which the WCS Maya Forest Living Landscapes Program (LLP) is currently developing. *D. mawii* is one of six key species selected for the Maya Biosphere Reserve LLP in the development of landscape conservation models, which will provide guidance for where conservation investment should be focused in order to reduce the major threats facing the selected species and the rest of the biodiversity associated with these key species.

METHODS

Trammel nets

The trammel nets which were used measure 50 meters long by 2 meters wide and are made of No. 30 fishing line with a mesh size of 8 x 8 centimeters. These nets were installed in deep sites (4-6 meters) and secured using wooden stakes. We had to be sure that the entire trammel net remained fixed so that neither wind, turtles neither wind, turtles nor crocodiles could move it. We had to figure out where the turtles would be passing and install the trammel in order to maximize capture probabilities.

Distribution

We reviewed the site records in the existing literature, conducted interview with local people and fishermen, and visited sites where the species' presence was uncertain in order to determine its distribution in the Selva Maya Corridor. To verify the species' presence in any given area, we relied on the trammel nets for site captures. We also used GIS/remote sensing to perform remote analyses of the connectivity between bodies of water in order to better understand how the seasonal connectivity of the *D. mawii's* habitat may be relevant to the conservation of the species.

Abundance

Through mark-recapture methodology we estimated densities in the main bodies of water in different water basins in Guatemala's lowland Selva Maya. We used trammel nets to capture and recapture individuals. We analyzed the potential for correlation between the turtle abundance gradient and the gradient for distance from human settlements.

El Perú Lagoon

The best-known water body in the eastern side of Laguna del Tigre National Park, El Perú Lagoon, has an area of 0.63 km² during the dry season (Figures 4, 5). At this site, we only sampled points 1, 2, 3, 14 and 15, while the other points depicted in Figure 5 were separated by a division caused by an absence of water between sample points 13

and 4. Due to a drop in water level during dry season sampling, the lagoon was effectively divided into two smaller lagoons.

Figure 4. El Perú Lagoon, Laguna del Tigre National Park (Roan B. McNab)

In each sample point (1, 2, 3, 14 and 15) we placed one trammel net for 24 hours (Figure 5). Each 24-hour period was considered one sampling event. In total, we sampled in three capture events (May 5-6, May 17-18 and May 23-24, 2006). After the third capture event, the return of the rainy season filled the lagoon, reconnecting the two sections of the lagoon and reconnecting the lagoon to the Rio San Pedro and Rio San Juan.

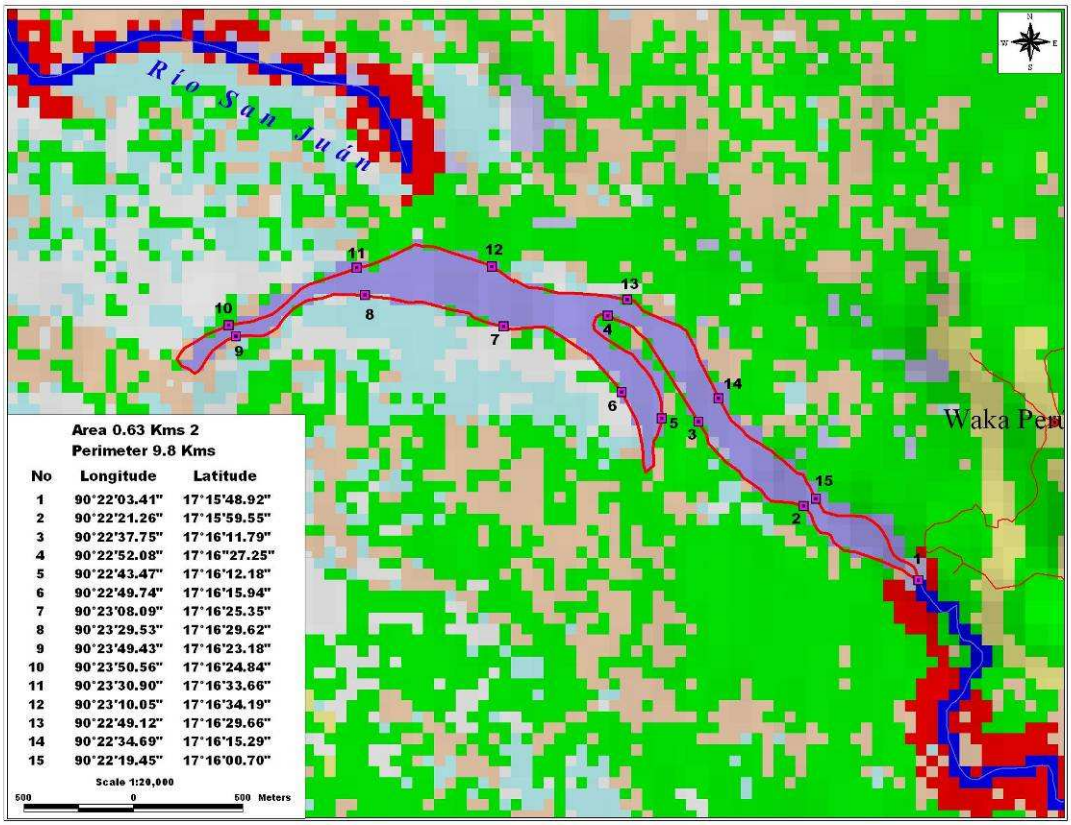

Figure 5. Sampling points in El Perú Lagoon, Laguna del Tigre National Park, Maya Biosphere Reserve

Sacnab & Yaxha Lagoons

Sacnab and Yaxha Lagoons are located at the southern edge of Yaxha-Nakun-Naranjo National Park and represent areas of 8.8 km² and 5.3 km² respectively (Figures 6, 7). In each lagoon, we used three sample points (1, 2 and 3).

Figure 6. Yaxha Lagoon, Yaxha-Nakun-Naranjo National Park, Maya Biosphere Reserve

In each sample point (1, 2 & 3) we placed five trammel nets for 24 hours. Again, this was considered one capture/recapture event. In total, we coordinated three capture events in Sacnab Lagoon (September 11-14, October 4-7 and October 25-28, 2006) and three capture events in Yaxha Lagoon (July 5-8, June 4-7 and September 6-8, 2006).

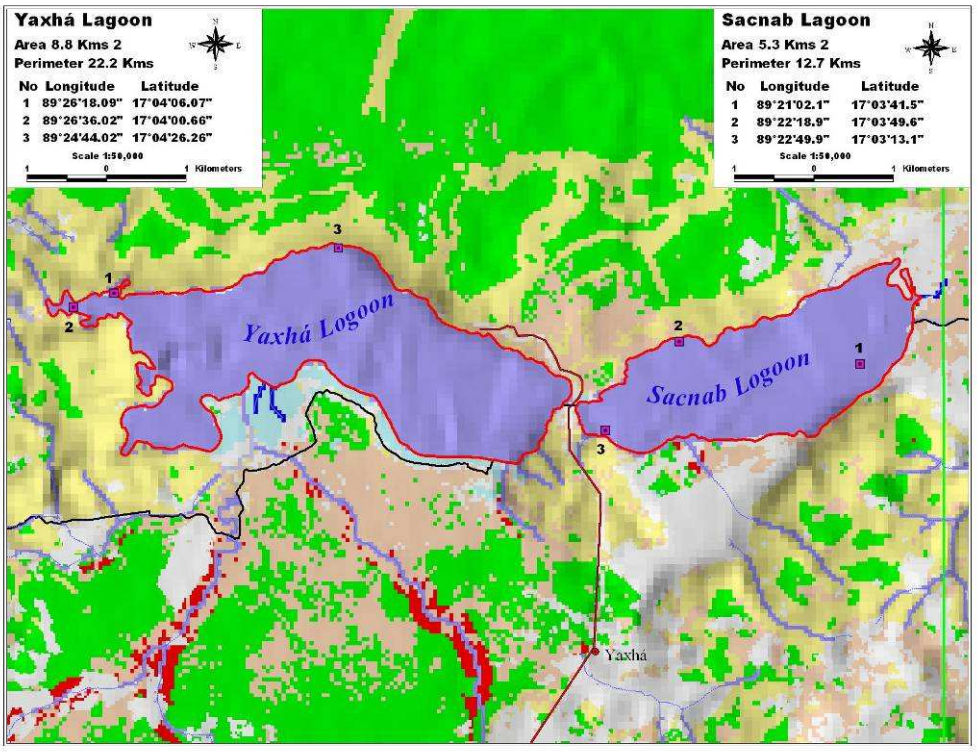

Figure 7. Sacnab & Yaxha Lagoons, Yaxha-Nakun-Naranjo National Park, Maya Biosphere Reserve

Salpetén Lagoon

Salpetén Lagoon is located within the Maya Biosphere Reserve Buffer Zone and has an area of 2.95 km² (Figure 8). In this lagoon, we sampled three points (1, 2 and 3). At each sample point, we placed five trammel nets for 24 hours. In total, we sampled in three capture events (September 26-29, October 11-14, and November 2-5, all during 2006).

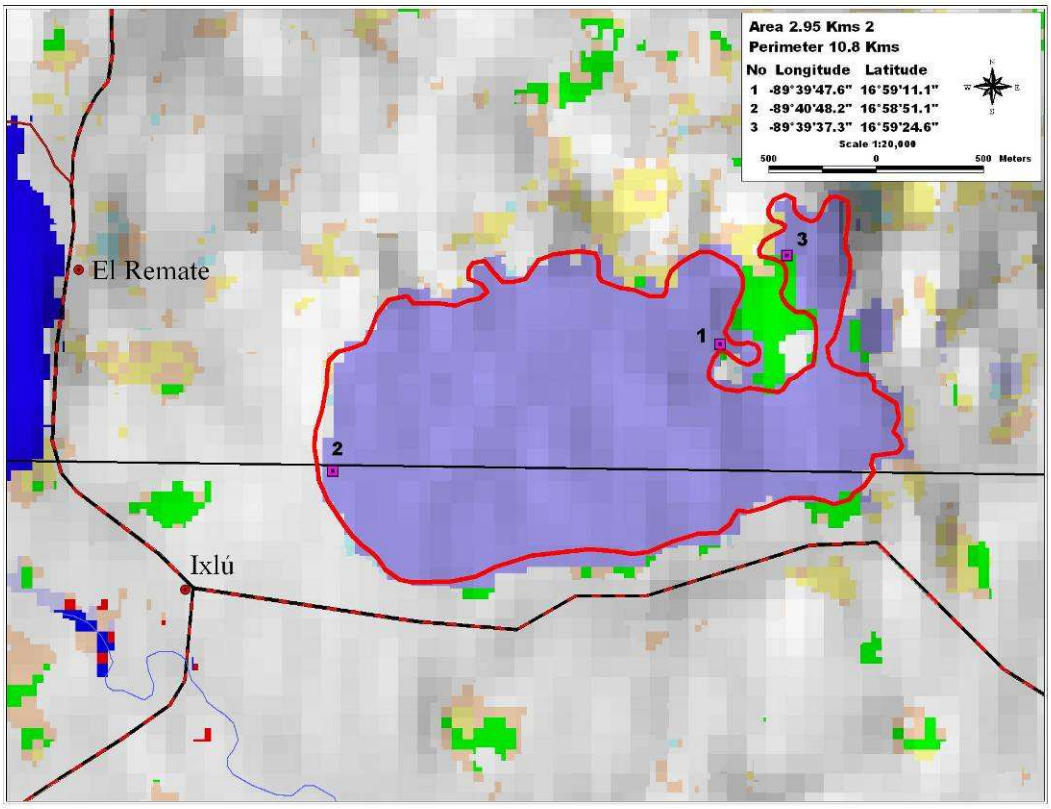

Figure 8. Salpetén Lagoon, in the Buffer Zone of the Maya Biosphere Reserve, Guatemala

El Picú Lagoon

El Picú Lagoon is located within the Maya Biosphere Reserve Buffer Zone and has an area of 0.45 km² (Figure 9). In this lagoon, we used three sample points. At each sample point, we placed five trammel nets for 24 hours. We only sampled in one capture event (November 13-16, 2006).

Figure 9. El Picú Lagoon, in the Buffer Zone of the Maya Biosphere Reserve, Guatemala

Ixcoche Lagoon

Ixcoche Lagoon is in the Maya Biosphere Reserve Buffer Zone and has an area of 0.90 km² (Figure 10). In this lagoon, we used three sample points. In each sample point, we placed five trammel nets for 24 hours. In total, we sampled in only one capture event (February 7-10, 2007).

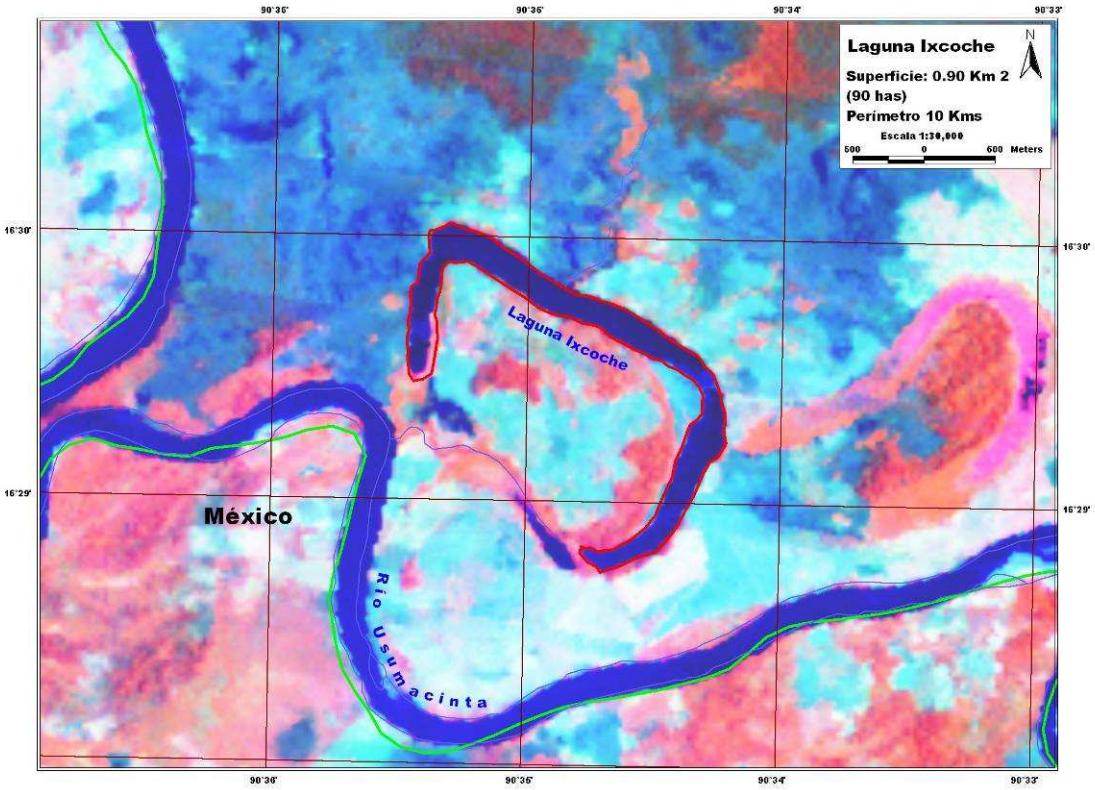

Figure 10. Ixcoche Lagoon, in the Buffer Zone of the Maya Biosphere Reserve, Guatemala

San Pedro & Sacluc River

San Pedro is the principal river drainage for the northwestern region of the Maya Biosphere Reserve, including a majority of Laguna del Tigre National Park and the RAMSAR Wetland Site. The San Pedro eventually flows into the Usumacinta River, the largest river in Mesoamerica. Sampling at this site was conducted to determine if *D. mawii* abundance within the river is related to distance from a village located at the headwater of the river. The village in question was Paso Caballos, a village of

approximately 1,500 inhabitants primarily dedicated to subsistence agriculture and fishing. In order to evaluate the effect of distance from the village, we sampled in three points (1, 2, and 3 in Figure 12) at varying distances from Paso Caballos village (1 km, 5 kms, and 9 kms respectively) December 2-11, 2006.

Sacluc River is an affluent of San Pedro (Figures 11 and 12) and we sampled in two points of this river: in the Sacluc-San Pedro mouth and three kilometers upstream (July 5-8, 2007).

Figure 11. San Pedro & Sacluc Rivers (Roan B. McNab)

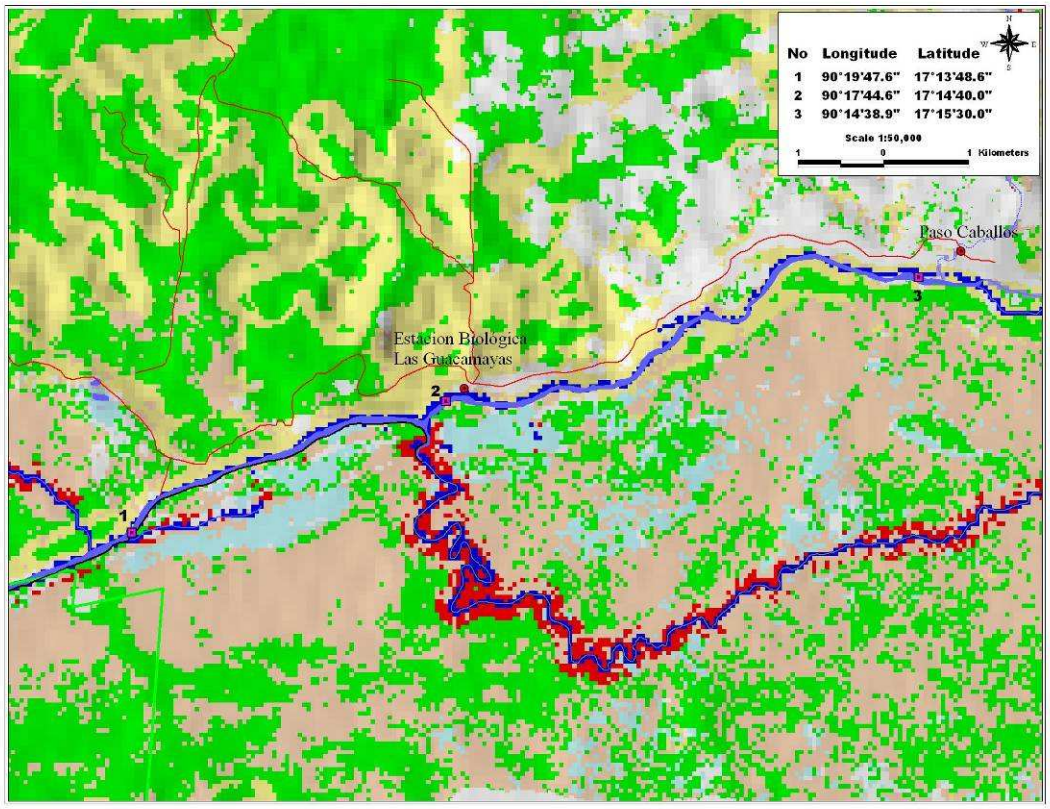

Figure 12. San Pedro River, Laguna del Tigre National Park, Maya Biosphere Reserve

RESULTS

Distribution

Interview with Families of Paso Caballos

Paso Caballos is a rural village with approximately 1,500 inhabitants (Figure 13), all of them migrant *Q'eqchí* families. Twenty-five families of Paso Caballos Village were interviewed in August 2006, with the majority of these families having lived for ten or more years in the village. Only thirty percent were familiar with *D. mawii*, known across the Petén as the *Tortuga Blanca*, and only four families admitted that they capture Tortuga Blanca (to eat). The majority of the families interviewed that were familiar with the turtle indicated having seen *D. mawii* in the San Pedro River or Sacluc (an affluent of

San Pedro). Only two families indicated that they had seen *D. mawii* in other places like Playa Grande-Ixcán, Quiche, and Chinajá in Poptún (Petén).

Figure 13. Community of Paso Caballos, Laguna del Tigre National Park, Maya Biosphere Reserve

Literature Records and Field Personnel Surveys

We encountered all 12 locations recorded in the literature (Lee 1996) and added 18 new locations to the map distribution for *D. mawii* in lowland Selva Maya of Guatemala (Table 1). Of these, records of *D. mawii* in Rio Azul in Mirador-Rio Azul National Park and Playa Grande, Quiche are the only two records outside Lee's distribution.

Locality	Coordinates	Reference
Chinaja	16 04' N / 90 15' W	Lee J. (1996)
Altar de Sacrifios	16 28' N / 90 32' W	Lee J. (1996)
16 Kms NNW Chinaja		Lee J. (1996)
Laguna Perdida	17 05' N / 90 13' W	Lee J. (1996)
Laguna Petenxil	16 55' N / 89 50' W	Lee J. (1996)
near La Libertad	16 47' N / 90 07' W	Lee J. (1996)
Paso Caballos	17 15' N / 90 16' W	Lee J. (1996)
Remate	17 00' N / 89 42' W	Lee J. (1996)
Rio San Pedro, 60 mi below El Paso		Lee J. (1996)
Rio de La Pasion above mouth of Rio Santa Amelia	16 28' N / 90 33' W	Lee J. (1996)
Sayaxche	16 31' N / 90 10' W	Lee J. (1996)
Ceibal	16 33' N / 90 03' W	Lee J. (1996)
El Peru	17 16' N / 90 23' W	This Survey
Parque Nacional Mirador-Rio Azul	17 46' N / 89 12' W	This Survey
Jabali, cruce del rio	17 16' N / 90 23' W	This Survey
Laguna Ixcoche	16 29' N / 90 33' W	This Survey
Laguna Salpeten	16 59' N / 89 40' W	This Survey
Laguna Sacnab	17 03' N / 89 21' W	This Survey
Laguna Yaxha	17 03' N / 89 24' W	This Survey
Laguna Sacpuy	16 59' N / 90 01' W	This Survey
Rio San Pedro	17 14' N / 90 17' W	This Survey
Rio Azul, PNMRA	17 46' N / 89 12' W	This Survey
Rio Sacluc	17 15' N / 90 13' W	This Survey
Lago Peten Itza	16 59' N / 89 48' W	This Survey
Laguna Macanche	16 58' N / 89 37' W	This Survey
Rio Usumacinta	16 52' N / 91 00' W	This Survey
Laguneta Lacandon	17 04' N / 91 10' W	This Survey
Laguna Petexbatun	16 27' N / 90 13' W	This Survey
Rio Chinaja, Poptun	16 04' N / 89 24' W	This Survey
Rio Sarstun	15 53' N / 89 17' W	This Survey

Table 1. Locations of *D. mawii* in lowland Selva Maya of Guatemala based on literature review, field surveys, and interviews

Map Distribution of *D. mawii* in the lowland Selva Maya of Guatemala

With the help of Victor Hugo Ramos (CEMEC/CONAP/WCS GIS expert), we constructed a map distribution using the following criteria:

1. Inclusion of all site locations reported in Lee (1996) and this survey (Table 1).
2. Inclusion of all water bodies connected to sites mentioned above, using a Maya Forest Connection Model based on micro basins.
3. Inclusion of all water bodies close (< 1km) to the sites identified in criterion 2, above.

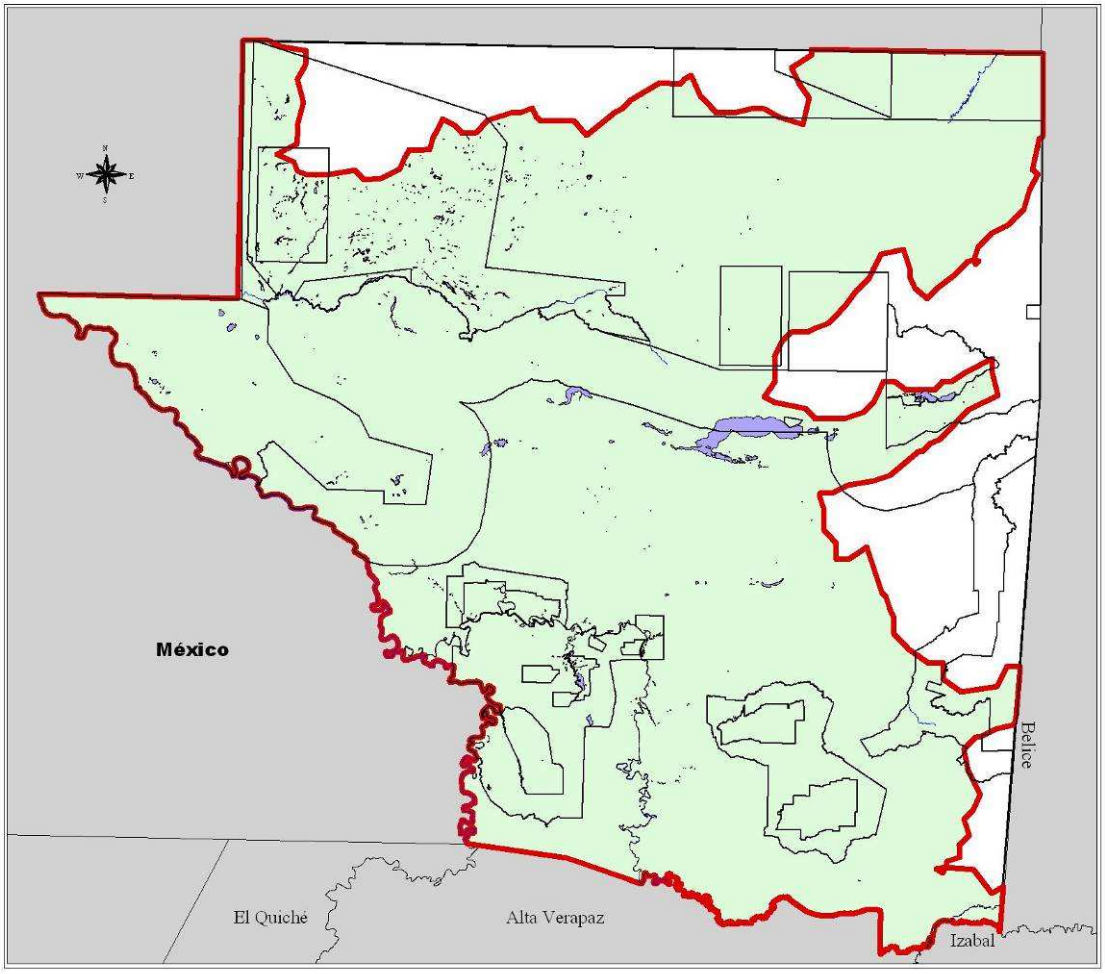

Figure 14. Distribution of *D. mawii* in Maya Forest Corridor in Guatemala

Figure 14 details the probable distribution of *D. mawii* within the lowland Selva Maya of Guatemala. Based on an extrapolation of the densities obtained in this survey, 4,081 turtles are estimated to currently exist within this area. This estimate includes all the lagoons greater than 30 ha (inside the probable distribution obtained and presented in Fig. 15) with a density of 9.81 turtles/km^2 (the lower density observed in this survey, in order to be conservative) and the principals rivers with a density of 2.11 turtles/km^2 (the conservative density obtained in San Pedro River was 19 turtles in 9 kms of the river).

Survey Effort

Table 2 shows the survey effort for each sampled site and each site capture rate[1]. El Peru and Yala showed the highest site capture rate (Figure 15).

Site	Date	Survey Effort (trap-days)	Turtles captured (*)	Session capture rate	Site capture rate
El Peru	May-06	20	123	6.15	6.13
	May-07	20	122	6.10	
Yala	Abr-07	12	62	5.17	6.05
	May-07	12	90	7.50	
	Jun-07	12	66	5.50	
Sacluc	Jul-07	8	18	2.25	2.25
Salpeten	Sep-06	15	13	0.87	1.02
	Oct-06	15	21	1.40	
	Nov-06	15	12	0.80	
Sacnab	Sep-06	15	9	0.60	0.90
	Oct-06	30	35	1.17	
	Nov-06	15	10	0.67	
San Pedro	Ago-06	17.7	14	0.79	0.49
	Dic-06	50	19	0.38	
Yaxha	Abr-06	10	2	0.20	0.17
	Jul-06	10	3	0.30	
	Sep-06	15	1	0.07	
Ixcoch	Feb-07	15	1	0.07	0.07
Penion de BV	Mar-07	10	0	0.00	0.00
El Picu	Nov-06	15	0	0.00	0.00
Total		331.7	621	1.87	

Table 2. Sampling Effort for *D. mawii* in the Lowland Maya Forest Survey

(*) "Turtles captured" includes individuals that were captured in other events

Even though San Pedro showed a low capture rate, most sites related to this system showed high capture rates except for Peñón de Buena Vista well, where no turtles were found during field sampling. In the rainy season, when all of the system is connected (even sporadically) with San Pedro, turtles could be found in the site.

[1] Including the trammel net testing events.

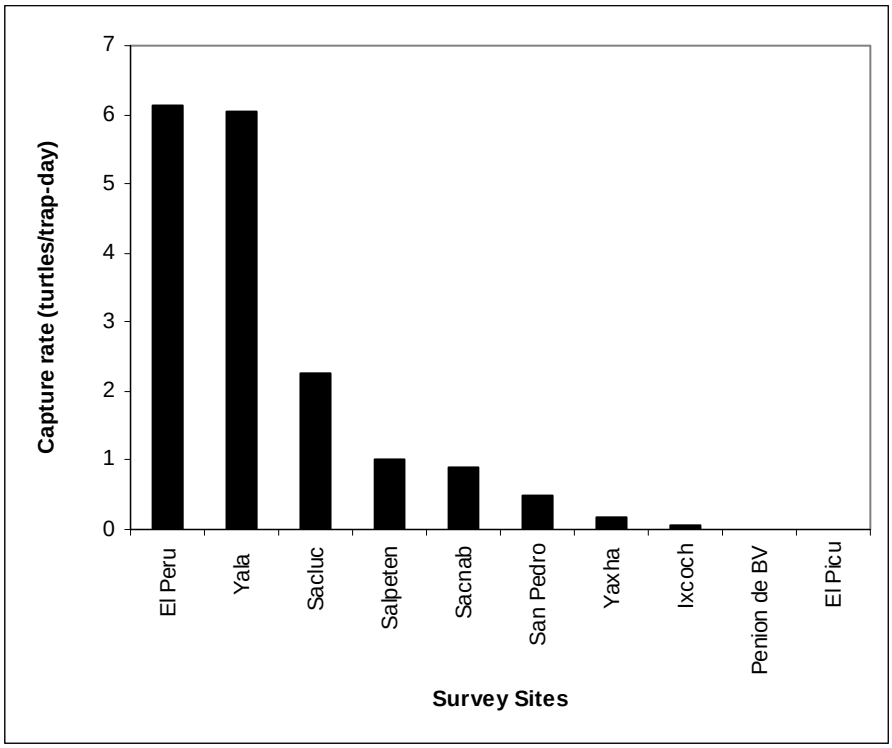

Figure 15. Capture Rate of *D. mawii* in the Lowland Maya Forest Survey

Dermatemys Density Estimations

El Peru Lagoon

We captured and marked 113 individuals of *D. mawii* in El Peru Lagoon during this survey. Only 13 of these were recaptured. Using CAPTURE© statistical software, we estimated a population of 202 turtles (Standard Error 13.79, approximately 95 percent confidence interval 179-232 turtles) in the section of the lagoon that we surveyed. The density estimate for this fragment is 841.6 turtles/km². If we assume that the non-sampled sections of the lagoon harbored the same density of *D. mawii*, the total population for El Peru during the low water sampling period would be 530 turtles.

Seventy-six percent of the turtles captured were male (86) and twenty-four percent (27) were female. Only one of the 13 turtles recaptured was a female. Captured females were significantly heavier (16.44 pounds Standard Deviation = 4.28) than the males (14.98 pounds Standard Deviation = 2.01, ANOVA: $F_{1,111} = 5.95$ $p=0.016$).

Sacnab & Yaxha Lagoons

We captured and marked 52 *D. mawii* individuals in Sacnab Lagoon during this survey. None of these were recaptured. Due to the absence of recaptures, we were not able to use CAPTURE to estimate the size of Sacnab population. The area of the lagoon is 5.3 km², and if we use the 52 turtles like a minimal population, we obtain a minimal density estimated of 9.81 turtles/km². We captured only one turtle in Yaxha Lagoon during the survey. If we use the minimal density estimated for Sacnab, we obtain an abundance of 86 turtles living in this lagoon.

Fifty-eight percent of the turtles captured were male (30) and forty-two percent (22) were female. No significant difference in weight was detected between males (14.1 pounds Standard Deviation = 2.2) and females (14.6 pounds Standard Deviation = 3.12; ANOVA: $F_{1, 48}$=0.497 p=0.497).

Salpetén Lagoon

We captured and marked 41 *D. mawii* individuals in Salpetén Lagoon during this survey. Only three of these were recaptured. Using CAPTURE, we estimated a population of 78 turtles (Standard Error 8.69, approximately 95% confidence interval 65-99 turtles) in the lagoon. The density estimated for Salpetén lagoon was 26 turtles/km².

Twenty-four percent of the turtles captured were male (10) and seventy-six percent (31) were female. Two of the three turtles recaptured were females. Captured females were significantly heavier (14.04 pounds Standard Deviation = 3.5) than the males (11.85 pounds Standard Deviation = 1.67, ANOVA: $F_{1, 39}$ =5.53 p=0.024).

El Picú Lagoon

No turtles were captured in El Picú Lagoon, and we detected no sign of the presence of *D. mawii*. It is important to note that this lagoon is inside the property of a cattle ranch, making the poaching of wildlife and fishing in the area unlikely without the authorization

of the ranch manager. We suspect that in the past all *D. mawii* in the lagoon were extirpated.

Ixcoche Lagoon

We captured only one turtle in Ixcoche in the beginning of the survey, but we observed that the lagoon at this moment was reconnected to the Usumacinta River. We will thus wait until the dry season enters into force to sample the lagoon when it becomes isolated from Usumacinta.

San Pedro & Sacluc Rivers

We captured and marked 19 *D. mawii* individuals in San Pedro River. None of these were recaptured during this survey. While there was no replication in the samples, there is a gradient observed (relationship) between the captures rate and the distance to Paso Caballos Village (r=0.3074). See Figure 16.

We calculate a minimal density for San Pedro River using the 19 individuals captured in 9 kilometers of the river that was sampled.

18 turtles were captured in Sacluc, six in San Pedro and Sacluc joint, and 12 turtles three kilometers upstream.

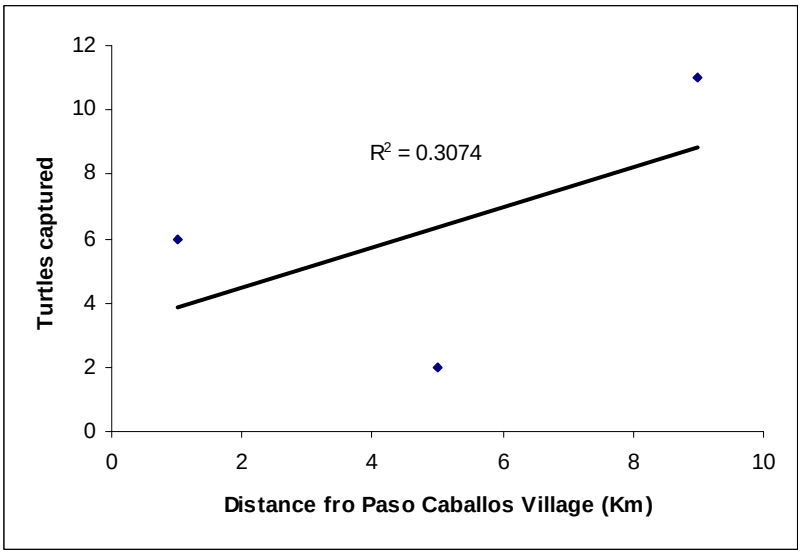

Figure 16. Relationship between the Number of *D. mawii* captured and the Distance to Paso Caballos Village

DISCUSSION

There is not a great difference between the distribution of *D. mawii* reported by Lee (1996) and the distribution resulting from our initial surveys. Nevertheless, our field work and interviews did provide some evidence of new distribution records that help to answer doubts of the presence of *D. mawii* in the headwaters of the Rio Azul in extreme northeastern Guatemala. Our extremely conservative estimate of 4,081 *D. mawii* is certain an underestimation due to the fact that we only used the sites within our distribution map and the minimal density estimated.

El Peru Lagoon was the body of water with the greatest density estimated in the lowland Maya Forest. We suspect that during the low-water dry seasons, lagoons such as El Peru function as nesting and feeding refuges. If the other lagoons close to San Pedro River have the same condition, they probably function as sources of *D. mawii* replenishment to San Pedro River watershed and will have to get special management conditions in order to conserve the species in the future. It is obvious that *D. mawii* are hunted in this region (there is an abundance gradient and some interviewed families admitted it). In Paso Caballos (and in the majority of El Petén), although there are no *D. mawii* hunting

specialists, their captures are opportunistic when they are fishing and the turtles are caught on their fish-hooks (no-one would pass up the opportunity to eat turtle soup).

The Lowland Maya Forest of Guatemala is a *D. mawii*-rich site. It seems that the existence of the turtle in other sites depends on the production of the relatively protected sites within Maya Biosphere Reserve (i.e. Yala and Perú). Nevertheless, the risk of losing these populations in bodies of water close to sites with a high chance of new human settlements exists, and this has to be taken into account when designing conservation actions.

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