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INTEGRATED WATERSHED RESOURCES MANAGEMENT

RESULT 2: PROTECTED AREAS MANAGED
REQUIREMENT 2.2: NATURAL RESOURCES IDENTIFIED, CHARACTERIZED AND MADE AVAILABLE

DISTRIBUTION, HABITAT USAGE AND RELATIVE ABUNDANCE OF ANTILLEAN MANATEE (*TRICHECHUS MANATUS MANATUS*) ON THE NORTH COAST OF HONDURAS

June 30, 2006

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COVER PHOTO

Two Antillean Manatee (*Trichechus manatus manatus*)
in Cuero y Salado Wildlife Refuge.
By Daniel Gonzalez-Socoloske.

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INTRODUCTION

WEST INDIAN MANATEE

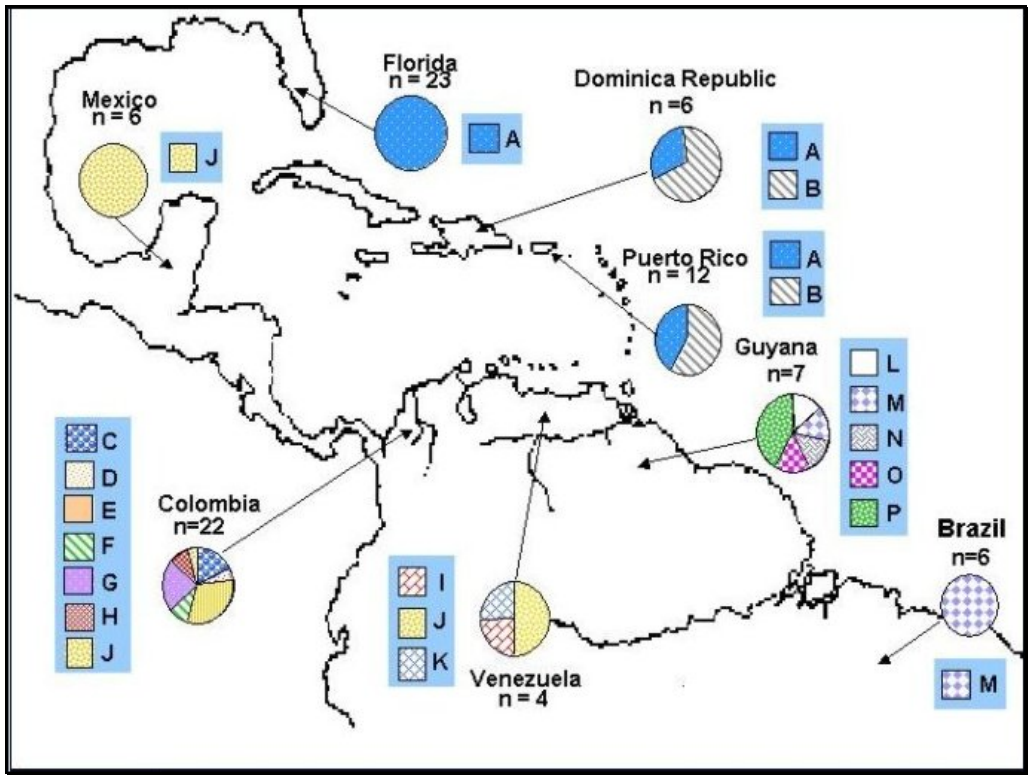
The West Indian manatee (*Trichechus manatus*) is one of the three species in the family Trichechidae (Reynolds and Powell, 2002). The other two manatees, which are also in the genus *Trichechus* are the Amazonian manatee (*Trichechus inunguis*) and the West African manatee (*Trichechus senegalensis*) (Reynolds and Powell, 2002) See Figure 1.

Figure 1. Sirenians of the world.

Two subspecies of the West Indian manatee have been described, Trichechus manatus latirostris (Florida manatee), found in Florida and the Gulf of Mexico, and Trichechus manatus manatus (Antillean manatee), found in the West Indies and along the coast of central and South America (Reynolds and Powell, 2002). The distinction of these two subspecies has been disputed (Moore, 1951). Hartman (1979) predicted that the behavior and ecology between subspecies range (with the exception of the cold-water congregations in Florida) is uniform. Garcia-Rodriguez et al. (1998) found that mtDNA of West Indian manatees from 86 individuals from Mexico, Columbia, Venezuela, Guyana, and Brazil constituted 15 distinct haplotypes. From these haplotypes three distinct mtDNA lineages were identified within the species, corresponding to (a) Florida and the West Indies (b) the Gulf of Mexico and Caribbean mainland coasts and rivers; and (c) the Atlantic Coast of South America (Figure 2.)

Adult West Indian manatees can weigh as much as 1500kg and reach 4 meters in length (Reynolds and Powell, 2002; Hartman, 1979). There skin color is varied shades of slate grey to brown. Algae or barnacle growth on the backs of adults often obscures their skin color. Scar tissue appears pale in color. They lack external ears only having the presence of small ear opening. The West Indian manatee is the largest of the living Sirenians (Reynolds and Powell, 2002).

Figure 2. Distribution of haplotypes of West Indian manatee



(From Garcia-Rodriguez et al., 1998).

STATUS AND DISTRIBUTION

Both subspecies of West Indian manatee are listed as vulnerable by the IUCN (Hilton-Taylor, 2000). Antillean manatees are also protected under Honduran national law (Ley de Pesca, 1959).

West Indian manatees are found in both fresh and sea water habitats of the tropical and subtropical regions of the New World Atlantic (Reynolds and Powell, 2002). The Amazonian manatee is restricted to rivers in Brazil, Peru and Ecuador, while the West African manatee is found coastally in a small range in the central region of Western Africa. The exact numbers of West Indian manatees in the Caribbean regions and along the coast of Central America is unknown. (UNEP, 1995; Lefebvre et al., 2001).

In the United States the cold season range of the Florida subspecies is confined to Florida and the coast of Georgia. During warmer months they disperse east and west along the coastline, with reports from Louisiana, Virginia, and the Carolinas (Husar, 1978; Gunter and Perry, 1983; Reynolds and Wilcox, 1986; Reid et al., 1991; Schwartz, 1995; Koelsch, 1997; Lefebvre et al., 2001). West Indian manatees are also found along the coasts of Mexico, Belize, Honduras, Guatemala, Nicaragua, Costa Rica, Panama, Venezuela, Columbia, Surinam, French Guyana, and Brazil (Husar, 1978; Klein, 1979; Oshea et al., 1988; Lazcanobarrero and Packard, 1989; Sue et al., 1990; Borobia and Lodi, 1992; Arriaga Weiss and Contreras Sanchez, 1993; Axis-Arroyo et al., 1998; Smethurst and Nietschmann, 1999; Morales-Vela et al., 2000; Lefebvre et al., 2001; Montoya-Ospina et al., 2001; de Thoisy et al., 2003; Morales-Vela et al., 2003; Olivera-Gomez and Mellink, 2005).

West Indian manatees are also found in Caribbean islands such as Cuba, Dominican Republic, Haiti, and Jamaica, with rare occurrences in Puerto Rico and the Bahamas (Husar, 1978; Belitsky and Belitsky, 1980; Powell et al., 1981; Hurst, 1987; Reynolds et al., 1995; UNEP, 1995; Mignucci-Giannoni and Beck, 1998; Lefebvre et al., 2001). See Figure 3.

Figure 3. Distribution of West Indian manatee

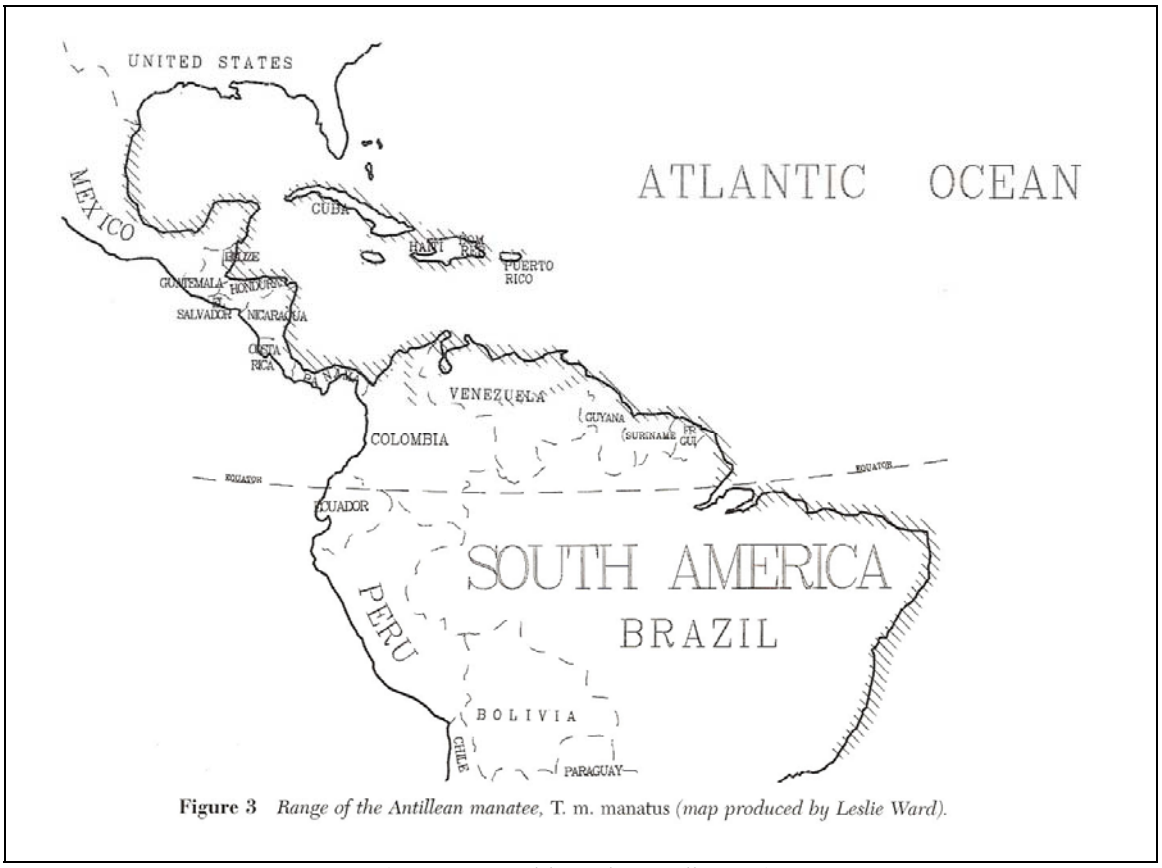


Figure 3 *Range of the Antillean manatee,* T. m. manatus *(map produced by Leslie Ward).*

(From Reynolds and Powell, 2002).

HABITAT AND ECOLOGY

West Indian manatees live in both fresh and salt water with neither salinity nor turbidity effecting their movement (Hartman, 1979). In Florida, manatees move to warm water springs and man-made warm water sources during the winter (Reynolds and Powell, 2002; Hartman, 1979). There is a lack of documentation of detailed movements of manatees in their southern range (Husar, 1978). They are commonly found in estuaries, rivers and streams, although they have been reported to stay in coastal salt water for extended periods of time (Husar, 1978; Hartman, 1979).

West Indian manatees are entirely herbivorous consuming both submersed vegetation as well as vegetation overhanging from river shores (Reynolds and Powell, 2002). They consume true aquatic plants (sea grasses), such as *Myriophyllum spicatum*, *Hydrilla verticillata*, and *Ceratophyllum demersum*; as well as marine algae such as *Enteromorpha*, *Spirogyra*, and *Cladophora* (Husar, 1977). In addition they have been observed to incidentally ingest quantities of insect larvae, mollusks, shrimp, amphipods and other invertebrates that live within the algae and sea grasses (Reynolds and Powell, 2002). Hartman (1979) suggests that this may provide substantial amounts of protein.

REPRODUCTION BIOLOGY

Breeding occurs year round. Gestation lasts up to 400 days and usually one calf is born. Newborns weigh from 11 to 27 kg and measure over 1m in length. Twins have been reported and cases of foster parenthood have also been observed. Calves may nurse for a period of one to two years. Transition to adulthood is slow and sexual maturity is not reached until four to six years of age, or a body length of 2.5m to 2.7m (Hartman, 1979; Reynolds and Powell, 2002). Population traits of the Florida manatee based on long term life history are summarized in Table 1 by Reynolds and Powell (2002).

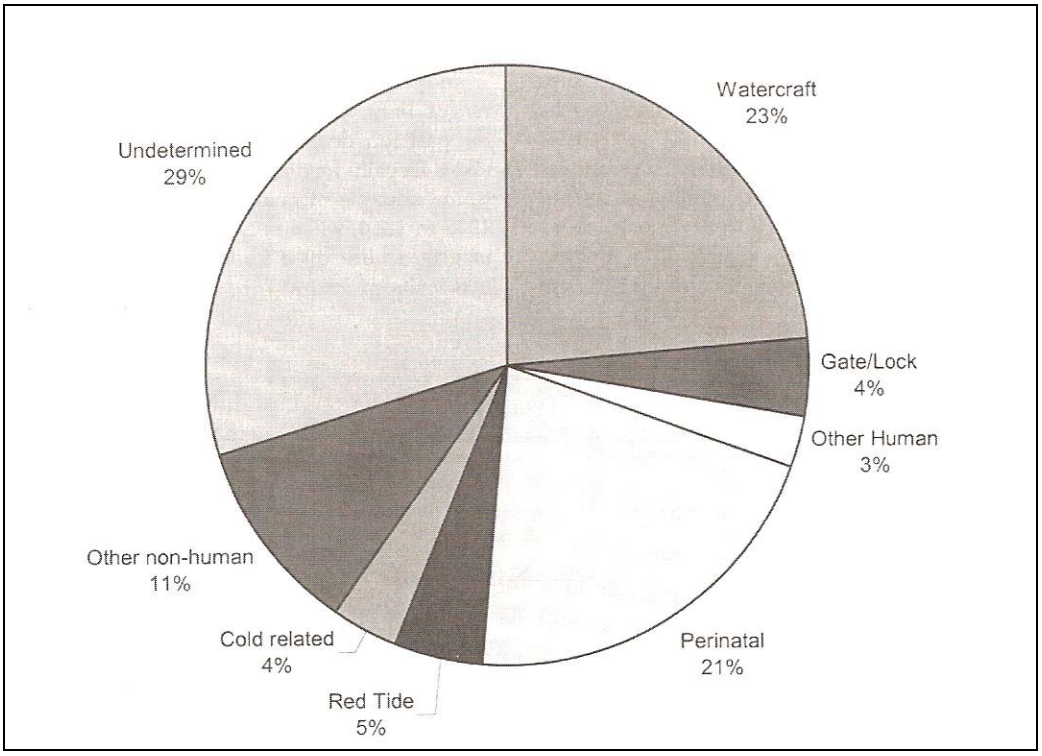
Table 1. Population traits of the Florida manatee based on long-term life history research

Trait	Description
Maximum life expectancy	60 years
Gestation period	11-13 months
Litter size	1
Percentage of twins	1.79% at Blue Spring; 1.4% at Crystal River
Sex ratio at birth	1:1
Calf survival to year 1	0.60 at Blue Spring; 0.67 at Crystal River
Annual adult survival	90% on Atlantic coast; 96% at Crystal River and Blue Springs
Earliest age of first reproduction: female	3-4 years
Mean age of first reproduction: female	5 years
Earliest onset of spermatogenesis	2 years
Proportion of adult females pregnant	0.33 of salvaged carcasses; 0.41 of living animals at Blue Spring
Proportion of nursing first-year calves during winter season	0.36 (mean)
Mean period of calf dependency	1.2 years
Mean interbirth interval	2.5 years
Period of highest number of births	May-September
Period of highest frequency of mating herds	February-July

(From Reynolds and Powell, 2002)

Threats Manatees have been hunted both historically and recently throughout their range. Husar (1978) suggested that current diminished numbers are a result of hunting pressures by individual fisherman. Due to their slow rate of reproduction any disturbance in the population can have fatal effects. In the United States manatees are protected but still suffer from habitat loss and pollution from coastal development. The highest cause of manatee mortality in the U.S. is boat-manatee collisions. Reynolds and Powell (2002) summarized the cause of manatee mortalities in Florida based on 3501 carcasses recovered from 1974-1998 (Figure 4).

Figure 4. Category of manatee mortality in Florida.



(From Reynolds and Powell, 2002).

Rathbun et al. (1983) observed that manatees were still being hunted in La Mosquitia opportunistically. They also noted that fishing nets pose a hazard to manatees along the coast of Honduras. They mention an animal that was caught and killed in February 1979.

ANTILLEAN MANATEE IN HONDURAS

The exact number of West Indian manatees (*Trichechus manatus*) in the Caribbean regions and along the coast of Central America is relatively unknown (UNEP, 1995; Lefebvre et al., 2001). The characterization of the local and regional habitat of the Antillean manatee (*Trichechus manatus manatus*) was determined to be a top priority in order to protect and preserve the remaining populations. Recent studies have been focusing on this in Mexico, Costa Rica, and Nicaragua (Olivera-Gomez and Mellink, 2005; Jimenez, 2005).

Historical manatee populations in Honduras are unknown, with the exception of infrequent records of continuing existence (Lefebvre et al., 2001). Cerrato (1993) guessed the manatee population in Honduras at 120-140, in a report to the United Nations, mainly based on anecdotal information and two brief studies done a decade before (Klein, 1979; Rathbun et al., 1983).

Rathbun et al. (1983) sighted 11 manatees during a 13-hour aerial survey of the entire Atlantic coast of Honduras. They subsequently surveyed the coast, rivers and lagoons between El Porvenir and Zambuco five more times sighting manatees 40 more times. They averaged 13.3 manatees per survey hour for the six flights over El Porvenir- Zambuco area. They conducted those surveys on March (2nd, 4th, and 12th, 1979) and May (8th and 20th, 1980) (Table 2 & Figure 5).

Table 2. Review of primary literature of status and distribution of manatees in Honduras

Date of collection	Locations	Manatees Seen	Survey Method	Category	Source
1979/80	Coast of Zambuco	3*	Aerial	Sighting	Rathbun et al, 1983
1979/80	Laguna de Tansin (La Mosquitia)	4	Aerial	Sighting	Rathbun et al, 1983
1979/80	Rio Salado	18*	Aerial	Sighting	Rathbun et al, 1983
1979/80	Rio Cuero	2*	Aerial	Sighting	Rathbun et al, 1983
1979/80	Laguna de Boca Cerada (Thompson)	17*	Aerial	Sighting	Rathbun et al, 1983
1979/80	Rio Lean	2	Aerial	Sighting	Rathbun et al, 1983
1976	Laguna de Tansin	1	Interview	Remains	Klein, 1979
1977	Laguana Caratasca (La Mosquitia)	1	Interview	Sighting	Klein, 1979
1975	Laguna Ibans	9	Interview	Sighting	Klein, 1979
1977	Laguna Siksa (North of Laguna Biltamaira)	3	Boat Survey	Sighting	Klein, 1979
1976	Rio Cangrejal	1	Interview	Hunted	Klein, 1979
1977	Rio Cangrejal	1	Interview	Hunted	Klein, 1979
1977	Laguna de Brus	U (O)†	Interview	Sighting	Klein, 1979
1977	Laguna Ibans	U (O)	Interview	Sighting	Klein, 1979
1977	Laguna Rapa (west of Rio Patuca)	U (F)	Interview	Sighting	Klein, 1979
1977	Laguna Guarunta	U (F)	Interview	Sighting	Klein, 1979
1977	Laguna Biltamaira	U (F)	Interview	Sighting	Klein, 1979
1977	Laguna Tilbalaca	U (O)	Interview	Sighting	Klein, 1979

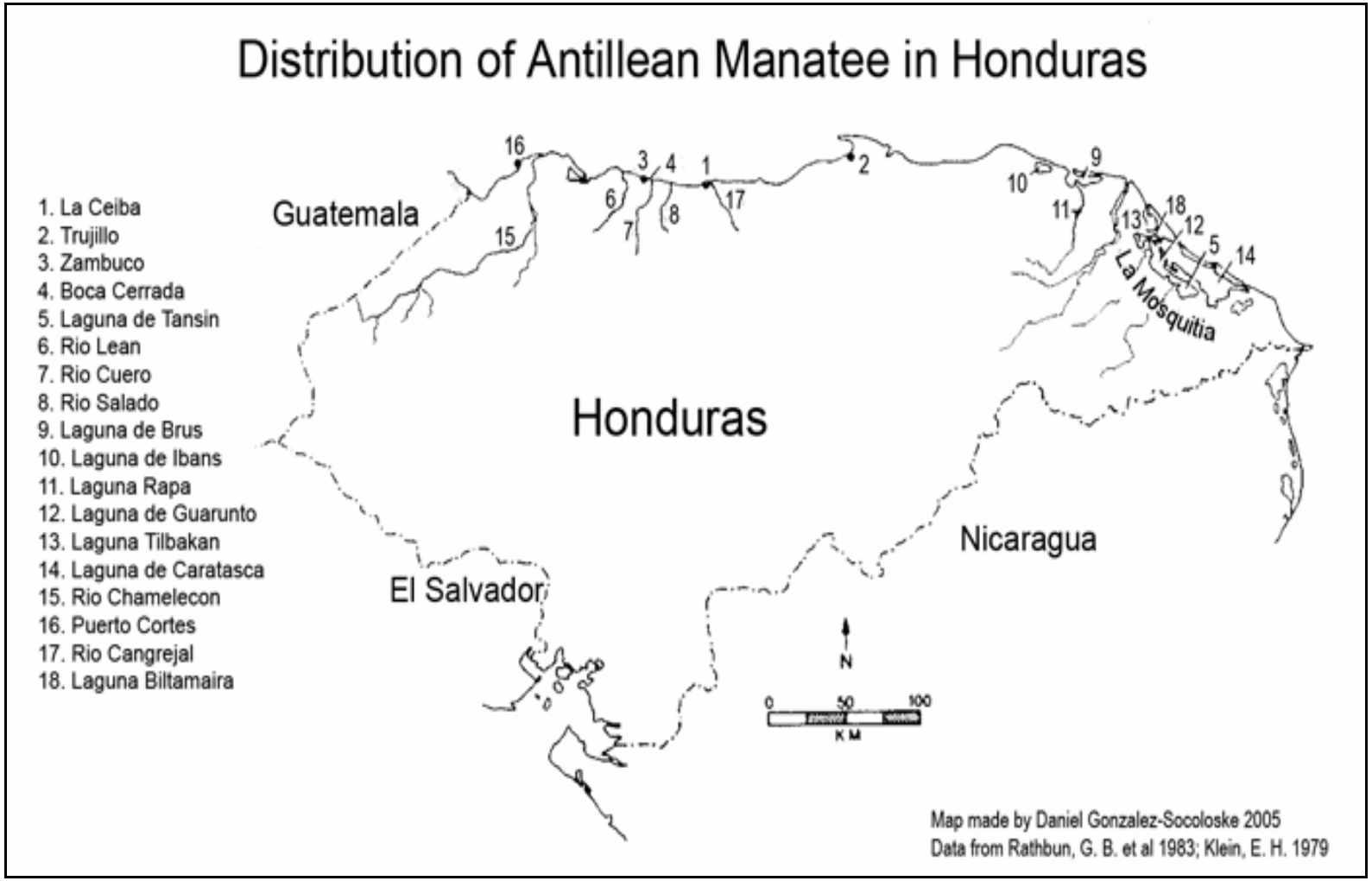
*Total manatees seen in that location from multiple surveys by given source.

†U = Unknown number seen (F = seen frequently; O= seen occasionally; and R = seen rarely

While conducting night surveys for crocodiles, Klein (1979) sighted three manatees in Laguna Siksa (Figure 5). He then conducted interviews of local fishermen to determine relative abundances along the coast (Table 2).

We propose to conduct a systematic manatee population survey along the North Coast of Honduras. Our overall objectives are to (1) determine manatee occupancy rate, (2) determine habitat use and important habitat variables for manatee presence, and (3) determine relative abundance of manatees within the survey area on the north coast of Honduras.

Figure 5. Historic distribution of antillean manatee in Honduras



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METHODS

On March 29, 30, 31 and April 2,3, and 4, 2006 aerial surveys were conducted on the North Coast of Honduras from the Rio Aguan (west of Trujillo) to the Laguna El Diamante (east of Tela) (Figure 7). Six identical surveys of this area were conducted, with the exception that the first three surveys did not include the Rio Aguan. On those flights our western most limit was the Rio Chapagua (which we mistakenly thought was the Rio Aguan). Flights were flown at 700ft (213m) and at an airspeed of 80kt (150km/hr) in a Cessna 206 (Figure 6), which is the typical altitude and speed used on manatee surveys (Ackerman, 1995; Lefebvre, 1995). Flight path was recorded with an onboard GPS (Figure 8). Three observers were located on the right side of the aircraft (front right – data recorder, middle right – secondary observer, and back right – primary observer). Surveys were flown with the doors removed to improve visibility. I led the team of three biologists as part of my Master's program at Loma Linda University. The rest of the team included Saul Flores (Museum curator and professor of biology at the National University of Honduras, Tegucigalpa) and Cyndi Taylor (Senior Research Scientist with Wildlife Trust, FL). Manatee observations were noted on data sheets (see Appendix I). In addition, the location of boats and nets seen were also recorded.

Figure 6. The 2006 aerial survey Team.

Right to left, Cyndi Taylor, Chuck Schroll, Daniel Gonzalez-Socoloske, and Saul Flores

Marsh and Sinclair (1989) identified two types of biases from aerial surveys, visibility bias and perception bias. Ideally, independent observers can deal with perception bias but since the rate of manatee encounter was low, the observers were not independent and were in constant communication during the flights.

According to Packard et al. (1985) the proportion of total manatees sighted during aerial flights in Florida ranged from 0.33 to 0.57 with a mean of 0.47 based on radio tagged animals. I suspect that our visibility bias was much greater then 0.47 (based on the dark tannin-stained water conditions), so we looped several times over river mouths and lagoons to deal with this visibility bias.

We chose the end of March 2006 to conduct our aerial surveys so that we could directly compare them with the surveys done by Rathbun et al. (1983) (Table 4). Additionally, March represents the dry season and the water conditions are most favorable for aerial surveys.

Figure 7. Geographic features of the North Coast of Honduras

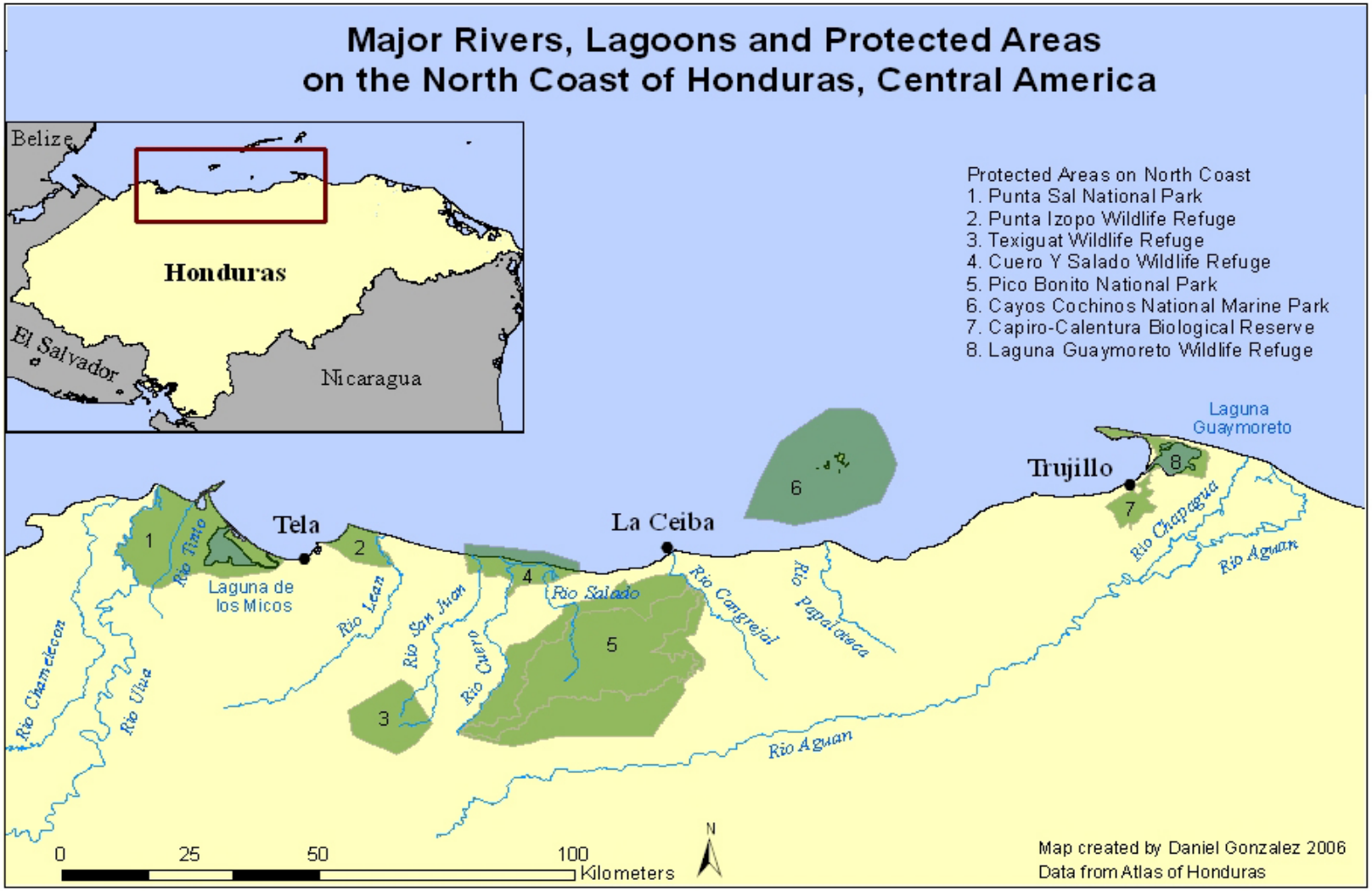
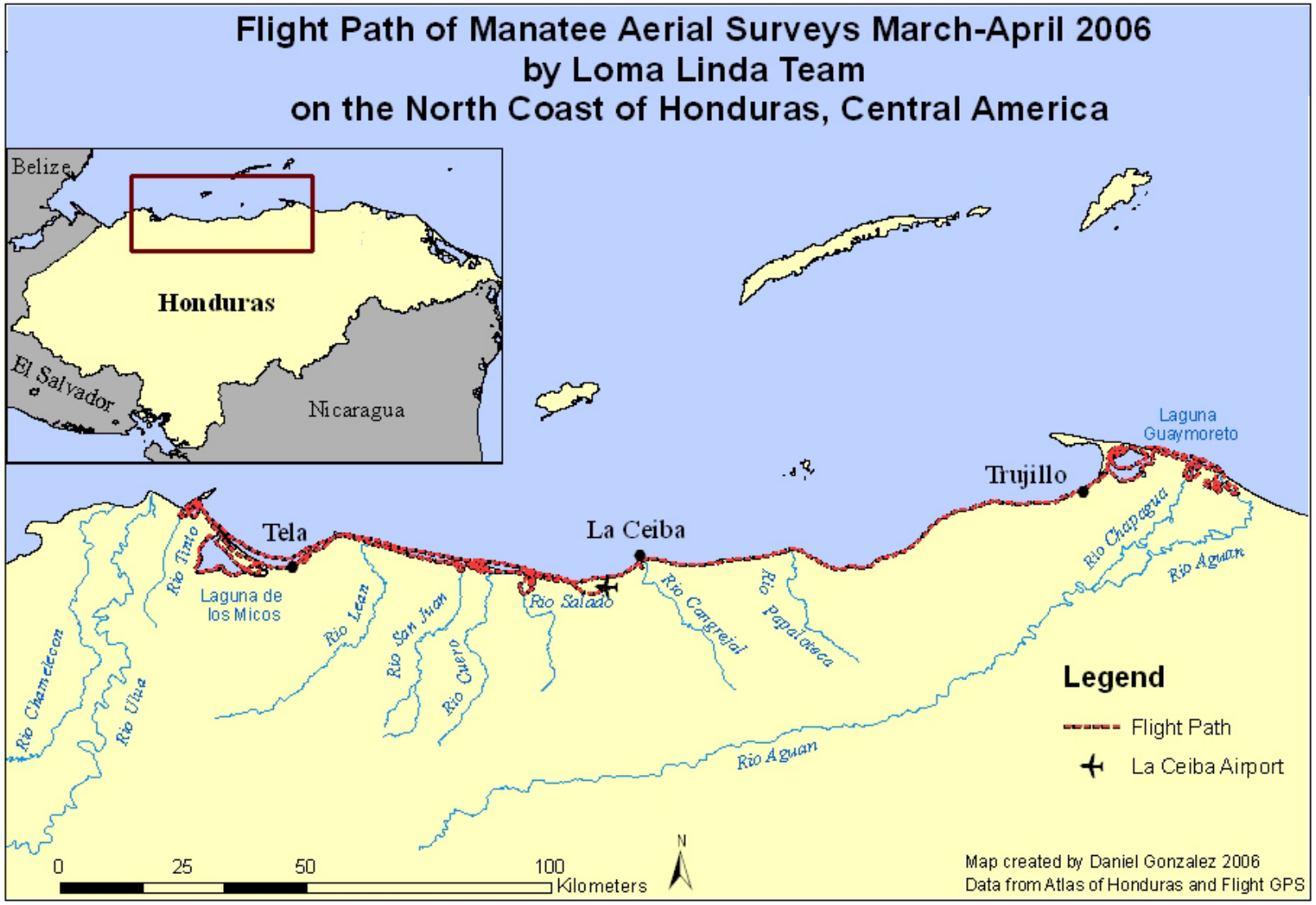


Figure 8. Flight path for aerial surveys 2006



RESULTS

We averaged three animals per survey with a detection rate of 1.23 manatees per survey hour for the whole North Coast. Our survey time ranged from 2 hours and 10 min to 2 hours and 40 minutes per survey. In all we sighted manatees 18 times during a total of 14 hours and 8 minutes of survey time (Table 3). We never observed a manatee along the coast, but rather always saw them within the rivers and lagoons. In addition, we only observed adults. The distribution of the sightings is summarized in Figure 9. No manatees were seen west of the Thompson lagoon.

Table 3. Summary of results from aerial surveys of mayor rivers and lagoons on the North Coast of Honduras

Flight #	Date	Survey duration	*Rio Aguan*	*Rio Chapagua*	*Laguna Gaumoreto*	*Rio Salado*	*Rio Cuero*	*Laguan Thompson*	*Laguna del los Micos*	*Rio Tinto*	Total sightings per survey	Manatees per survey hour
1	03/29/06	2hrs 40min	--	0	0	1	2	0	0	--	3	1.1
2	03/30/06	2hrs 40min	--	1	2	0	0	1	0	0	4	1.5
3	03/31/06	2hrs 23min	--	1	0	2	0	0	0	0	3	1.3
4	04/02/06	2hrs 15min	1	0	0	2	0	0	--	0	3	1.3
5	04/03/06	2hrs 15min	0	2	0	0	1	0	--	0	3	1.3
6	04/04/06	2hrs 10min	0	0	0	2	0	0	--	0	2	0.9
Total		**14hrs 8min**	**1**	**4**	**2**	**7**	**3**	**1**	**0**	**0**	**18**	**1.3**
Average		**2hrs 21min**	**0.33**	**0.67**	**0.33**	**1.17**	**0.50**	**0.17**	**0**	**0**	**3.0**	**1.23**

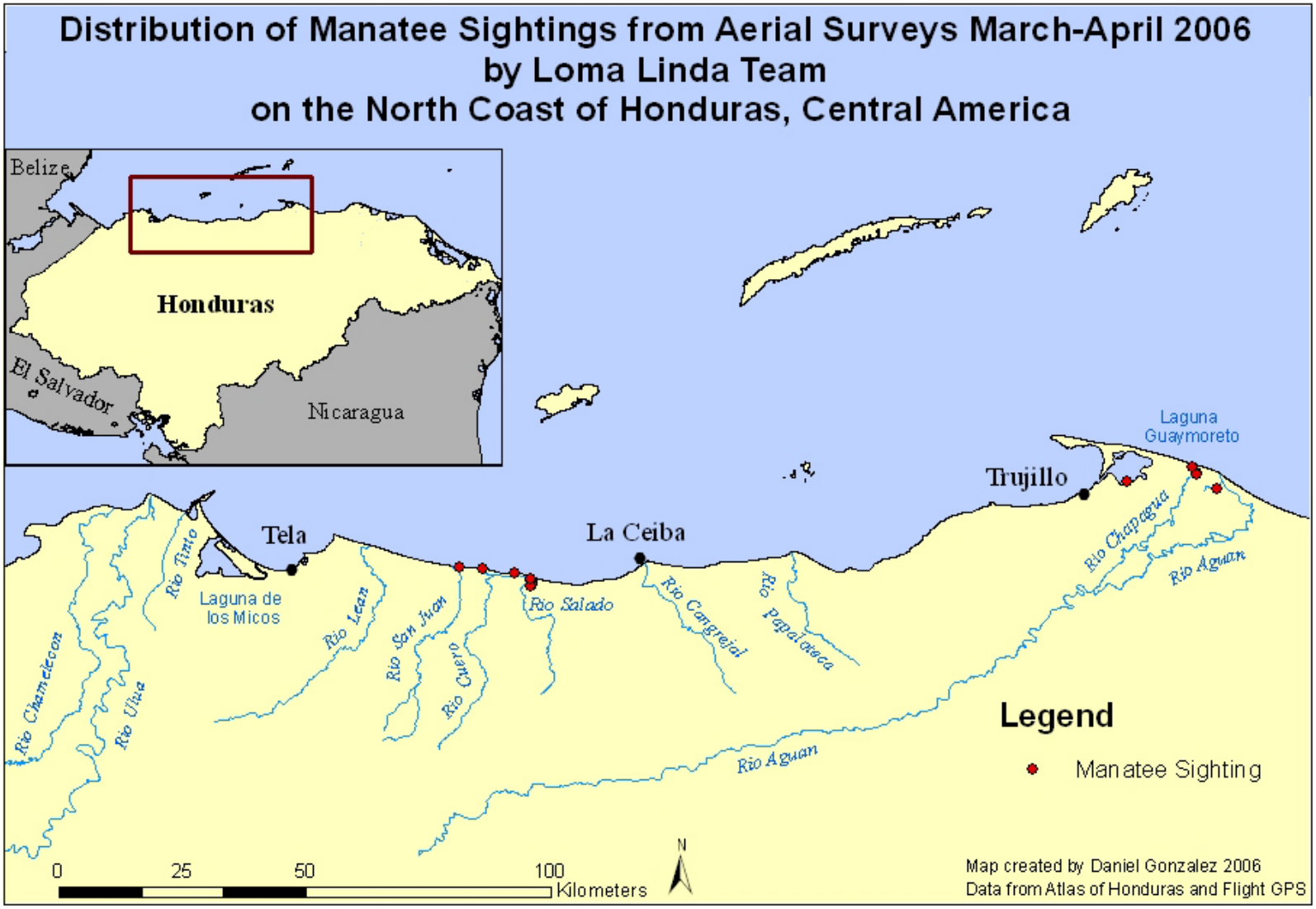
To directly compare our flights with the flights conducted in 1979/80, values for survey durations, average number of manatees, and manatees per survey hour were adjusted for the area between El Porvenir and Zambuco (the area within data sheet 3, see Appendix I). This could be accurately done because time was noted at the beginning of every new data sheet. Thus total survey time for data sheet 3 was calculated by subtracting the start time of data sheet 4 with the start time of data sheet 3.

Table 4. Comparison of aerial surveys from El Porvenir to Zambuco on the North Coast of Honduras in 1979/80 and 2006

Year	No. of Flights	Area	Ave. time/ survey (min)	Ave. Speed (km/hr)	Ave. Altitude (m)	No. of Observers	Time of Year	Type of Plane
1979-80	6	El Porvenir - Zambuco	30.1*	150	175	2	March, May	Cessna 180
2006	6	El Porvenir - Zambuco	32.8	148	212	3	March, April	Cessna 206

*Average from 6 flights calculated from the total number of manatee sightings (40) divided by the known rate of manatees per survey hour (13.3) during the flights (Rathbun et al., 1983)

Figure 9. Distribution of manatee sightings on North Coast of Honduras



Our surveys of this area averaged 32.8 min per survey, in which we saw an average of 1.67 manatees per survey (Table 4 and 5). Our average number of manatees per survey hour was 3.3 (Table 5). The average number of manatee sightings per survey was significantly less in 2006 then in 1979-80, $t(10) = 5.41$, $p < 0.001$ (Figure 10). In addition, the average number of manatees per survey hour was also significantly less for 2006 then in 1979-80, $t(10) = 5.03$, $p < 0.001$ (Figure 11).

Table 5. Summary of results from aerial surveys from El Porvenir to Zambuco on the North Coast of Honduras from 1979/80† and 2006

Year	# of Flights	Total # of manatee sightings	Ave. manatees/ survey hr	Ave. manatees/ survey	# Calf sightings	# Sightings Offshore
1979-80†	6	40	13.3	6.7	4	17
2006	6	18	3.3	1.67	0	0

†Data from unpublished trip report by Rathbun and Powell to Fish and Wildlife 1979. 13p.

We ran an ANOVA to compare year and location of manatee sightings between 2006 and 1979. We divided locations into the four areas that had at least one sighting. These were Rio Salado, Rio Cuero, Laguna Thompson, and Zambuco (Table 6).

Table 6. Descriptive statistics for number of manatee observed in 2006 and 1979-80.

	N	Mean	SE
Year			
2006	24	0.46	0.159
1979-80	24	1.67	0.424
Location 2006			
Rio Salado	6	1.17	0.401
Rio Cuero	6	0.50	0.342
L. Thompson	6	0.17	0.167
Zambuco	6	0.00	0.000
Location 1979-80			
Rio Salado	6	3.00	1.150
Rio Cuero	6	0.33	0.211
L. Thompson	6	2.83	0.654
Zambuco	6	0.50	0.500

Figure 10. Average manatee sightings per survey

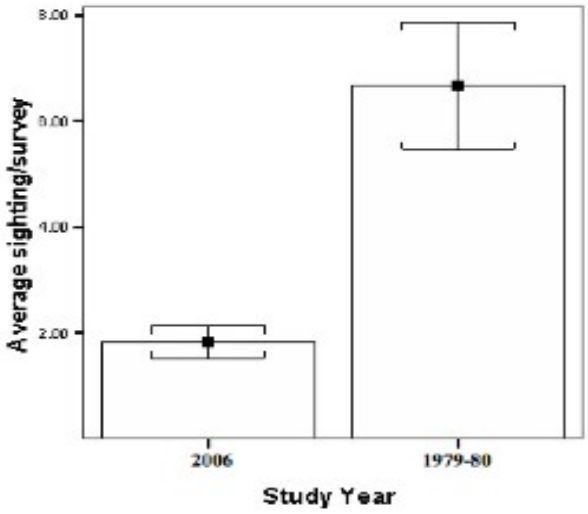
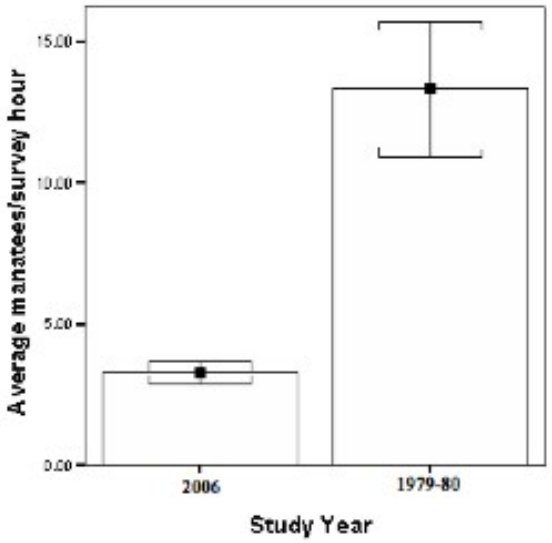


Figure 11. Average number of manatee sightings per survey hour

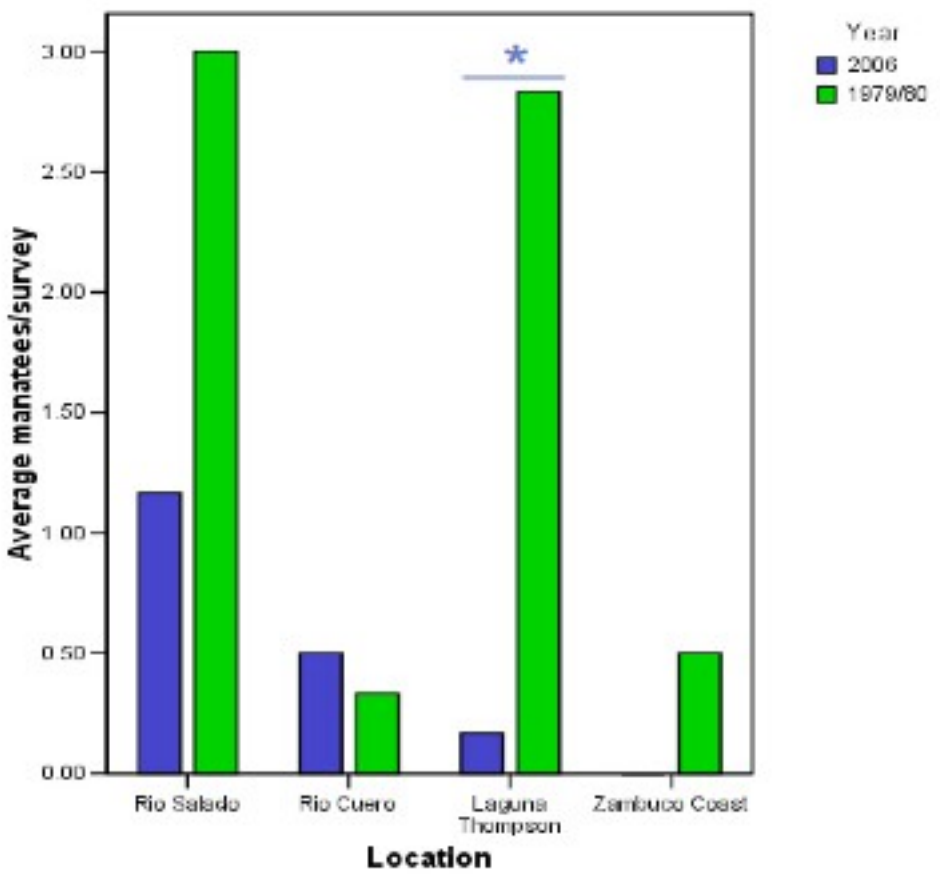


Data were rank transformed to correct for skewness of distribution. Both year and location were found to be significant $F(1) = 7.91$, $p = 0.008$ and $F(3) = 5.98$, $p = 0.002$ respectively (Table 7). To test what locations were significantly different in manatee sightings between years, post hoc independent t-test were run for the four locations between both years. Alpha was adjusted to prevent type II error. The average number of manatee sightings was significantly lower in 2006 then in 1979-80 for Laguna Thompson (Figure 12). No other significant difference was found between the other locations.

Table 7. Results of analysis of variance for location and year

Source	SS	df	MS	F	*p*	Partial Eta Squared
Model	3377.42	7	482.49	4.87	< 0.001	0.46
Year	784.08	1	784.08	7.91	0.008	0.17
Location	1776.62	3	592.21	5.98	0.002	0.31
Interaction	816.71	3	272.24	2.75	0.055	0.17
Error	3962.58	40	99.07			
Corrected Total	7340	47				

Figure 12. Average manatee sightings per survey by location for 2006 and 1979-80



DISCUSSION

While we can't state definitively that the population of manatees has decreased on the north coast (because we can't account for loss by migration or visibility bias due to change in water conditions) we can say that the number of sightings for the north coast in 2006 was significantly lower then the numbers obtained in 1979-80. The overall distribution has not changed. Most of our sightings occurred in Cuero y Salado Wildlife Refuge (11), although a significant amount were clustered in both the Rio Aguan and Rio Chapagua (5), which may represent a new important area for the remaining manatees of the North Coast of Honduras. While Rathbun, et al. 1983 mentioned that the rivers east of Trujillo were a potential manatee hotspot, they never observed manatees in that location. In our flights we observed manatees in both the Rio Chapagua and Rio Aguan. In addition, we observed two manatees on one occupation in the Laguna Guaimoreto. This observation represents the first time that manatees have been reported to be in this lagoon.

It is important to note that we never sighted calves or shore animals. In the 1979-80 flights both calves and shore animals were reported in significant percentages. This may signify a low reproductive population. Interviews of fishermen on the north coast indicate that manatees are still occasionally killed by gill nets such as an adult animal that was eventually eaten in 2000 in Cuero y Salado Wildlife Refuge. In addition, reports of young manatees found dead have been reported in Cuero y Salado Wildlife Refuge such as one found in January of 2005 (Figure 13). We are not certain of the cause of death, but locals report that it drowned by entanglement in a gill net.

Figure 13. Young manatee found dead in Rio Salado in January 2005

(Photo provided by FUCSA).

Based on the observation estimates mentioned in the methods section by Packard et al. (1985), the proportion of total manatees sighted during aerial flights in Florida ranged from 0.33 to 0.57 with a mean of 0.47 based on radio tagged animals. It is important to note that because we don't know the detection rate for this area, estimates can be very crude. If we count the maximum number of manatees seen in each area at one time (survey) we can estimate the relative abundance by adding the corresponding number of "unseen" animals.

We estimate that the relative abundance of animals in Cuero y Salado Wildlife Refuge to be between 6-15 (based on predicted observation rates of 0.5 and 0.2 respectively). We estimate that for Rio Aguan and Rio Chapagua there are 4-10 animals (based on the same observation rates). Finally, we estimate that relative abundance for the North Coast (Rio Tinto to Rio Aguan) to be between 10-25 animals.

Interestingly, the only statistically significant difference in average manatee sightings was in Laguna Thompson for 2006 and 1979-80. Although numbers have dropped for all locations since 1979-80, the greatest change has occurred in Laguna Thompson. This may be due to the increased sedimentation reported between Cuero and Laguna Thompson. More research into habitat change might shed more light on this

RECOMMENDATIONS

- We recommend that the responsibilities of coordinating and developing manatee research should be assigned to one person. We recommend that it be someone near the North Coast so that they can have immediate access to sites where manatees are found dead. We recommend this person be in charge of collecting manatee sightings data as well as coordinating yearly flights over key areas.

- We recommend that when a manatee is found dead it should be necrotized to determine cause of death and salvaged for museum specimens. If the carcass is not fresh, pictures of the body and anecdotal information should be noted as well as standard measurements and information on possible cause of death. If the carcass is fresh, we recommend that skin tissue be preserved for DNA. In addition, the bones should be recovered for study whenever possible. All this data should be given to the manatee research coordinator.

- We recommend that "hot spots" identified on the North Coast (i.e. Cuero y Salado Wildlife Refuge, Rio Aguan and Rio Chapagua) be surveyed once a year or once every two years in late March through early May to determine any changes in distribution and relative population abundance. These flights should be coordinated by the manatee research coordinator and we recommend collaboration with an external party such as Wildlife Trust Belize.

- We Recommend that La Mosquitia coast be surveyed to determine the status and distribution of manatees in that area of Honduras. For completion of the initial survey we recommend assembling a small team such as the one organized for the North Coast surveys.

- To better understand the movements and behavioral ecology of manatees in Honduras, we recommend that some animals be radio and satellite tagged. We suggest that the best location for such tagging is Cuero y Salado Wildlife Refuge, both because of its accessibility and its population of manatees. This represents the next step in protecting manatees in Honduras and should be considered after several years of population surveys. We recommend establishing a relationship with the USGS Sirenia Project team and or the Wildlife Trust team working in Honduras for this.

- We highly recommend the continued protection of Cuero y Salado Wildlife Refuge. Because of our results, we recommend that more ecological studies be carried out in Laguna Thompson to determine if excess sedimentation or other factors are changing the ecosystem.

- Finally, we recommend that local education about manatees should be prioritized. This increased awareness will help in the generation of manatee sightings and will increase the reporting of dead animals. We recommend that the local people of the North Coast be informed that the relative abundance is decreasing.

CONCLUSIONS

The number of manatees on the north coast appears to have decreased since 1979-80. Cuero y Salado Wildlife Refuge is still the major "hot spot" for manatees in this area, although we sighted a significant number of animals in Rio Chapagua and Rio Aguan. We recommend that more surveys be conducted in this area to determine if there is a resident population. There appears to be ample habitat for manatees and the limiting factor may be a low starting population and an increase of human disturbance along the coast. We highly encourage that the rest of the Honduran coast be surveyed as soon as possible as well as yearly surveys of both Cuero y Salado Wildlife Refuge and the Rios Aguan and Chapagua. Based on the numbers that we sighted in our aerial surveys in March and April of 2006 we estimate the abundance of the whole north coast at 10-25 animals. Of those we estimate 6-15 are found in Cuero y Salado Wildlife Refuge.

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APPENDIX

Figure 14: Landsat images of the North Coast of Honduras used in the aerial surveys of March-April 2006.