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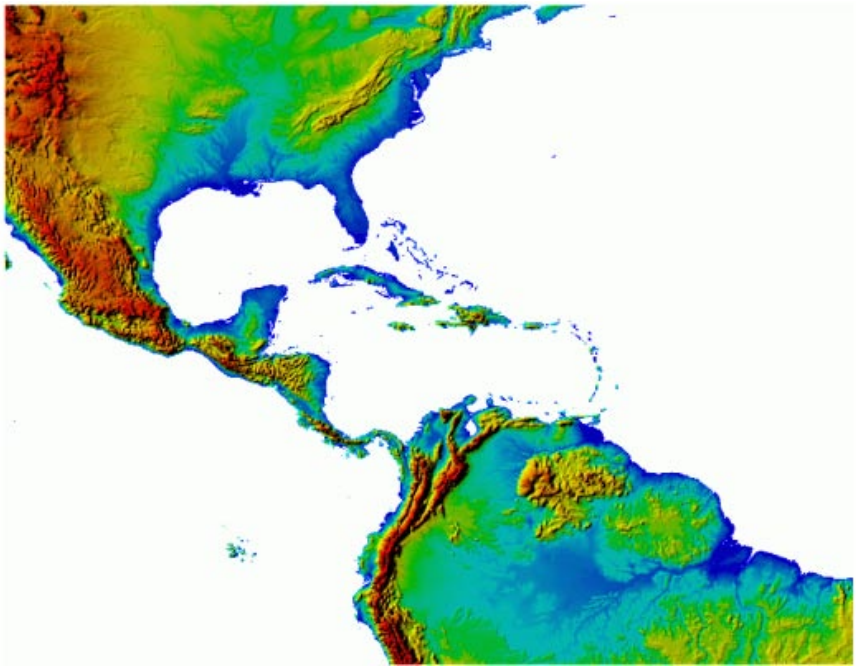
Regional Coordinating Unit

Regional Management Plan for the West Indian Manatee (*Trichechus manatus*)



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Caribbean Environment Programme
United Nations Environment Programme

REGIONAL MANAGEMENT PLAN FOR THE WEST INDIAN MANATEE

(*Trichechus manatus*)

Compiled by:

Dr. Ester Quintana-Rizzo

Dr. John E. Reynolds III

Manatee (*Trichechus manatus*)
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Mote Marine Laboratory

Prepared in collaboration with:

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PREFACE

The Caribbean Environment Programme (CEP) is one of several Regional Seas Programmes administered by the United Nations Environment Programme (UNEP). The CEP is based in Kingston, Jamaica, and forms the programmatic framework for the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean (Cartagena Convention) adopted in 1983 by governments of the Wider Caribbean Region.

The Cartagena Convention is the only comprehensive environmental umbrella treaty for the region, promoting regional cooperation to protect the economic and environmental sustainability of the region through improved management of coastal and marine resources. To achieve its objectives, the Convention has established three Protocols for environmental management: the Protocol Concerning Cooperation in Combating Oil Spills, the Protocol Concerning Specially Protected Areas and Wildlife (SPAW), and the Protocol Concerning Land-Based Sources and Activities of Marine Pollution (LBS).

The purpose of the SPAW Protocol is to protect rare and fragile ecosystems and habitats, thereby protecting the endangered and threatened species residing therein. This Protocol was adopted in 1990 and, in 1991, the participating governments adopted three Annexes to the SPAW Protocol listing species of flora and fauna of regional concern requiring protection under the Protocol. The SPAW Protocol became international law in 2000.

This document was prepared following Articles 11 and 21 of the SPAW Protocol, which call for the development of general guidelines and criteria for the management and recovery of endangered and threatened species of regional concern. This document also updates UNEP-CEP Technical Report Number 35 published in 1995 and entitled "Regional Management Plan for the West Indian manatee, *Trichechus manatus*," to promote more effective research and conservation.

The marine mammal fauna of the Wider Caribbean Region is diverse and adds significant ecological, aesthetic and economic value to Caribbean countries and territories. Success in managing and conserving marine mammals in this region ultimately will depend largely on the commitment of participating countries to build their internal capacities and to work cooperatively by establishing conservation priorities, standards and strategies for marine mammal conservation and education.

Since 1995 governments participating in the SPAW Protocol have considered conservation of the Antillean subspecies of the West Indian manatee (*Trichechus manatus manatus*) as a regional priority. The subspecies is found in waters of nearly 20 countries or territories, but its distribution is patchy, abundance is very low in most countries, and adverse impacts of humans are or may be considerable.

This report is based on in-depth consultation with scientists and managers from the various States and Territories of the Wider Caribbean Region; including both Parties and non-Parties of the SPAW Protocol. All comments and recommendations were considered in preparation of the final document, which was submitted for approval and on 8 September 2008, endorsed by the SPAW Parties at their Fifth Conference of the Parties in Antigua.

Based on the wide range of opinions considered, this report recommends both traditional measures for manatee conservation (e.g., improved education and awareness; enforcement) and novel ones (e.g., re-

introduction into historic habitat) that have proven effective for conserving other endangered species and, if based on sound scientific guidance, may prove useful for manatees. Not all scientific experts (including the authors) necessarily agree with every recommendation or its relative priority. This report does not reflect full scientific consensus, as the issues involved are too complex. Rather, it presents a synthesis of issues and approaches that Parties of the SPAW Protocol should consider and, if deemed appropriate, implement.

The UNEP-CEP thanks everyone who contributed in any way to the development of this document. In particular, UNEP-CEP thanks the Government of France for providing funding through the SPAW Regional Activity Centre in Guadeloupe, and Drs. Ester Quintana-Rizzo and John Reynolds, of Mote Marine Laboratory (Sarasota, Florida) for their dedication to this effort and technical expertise. We hope that it will facilitate more effective conservation of manatees in the Wider Caribbean.

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TABLE OF CONTENTS

PREFACE ..... **iii**
LIST OF FIGURES ..... **ix**
LIST OF TABLES ..... **xi**
ACKNOWLEDGMENTS ..... **xii**
EXECUTIVE SUMMARY ..... **xiii**

1. INTRODUCTION **1**
1.1. Review of Taxonomy and General Biology 1
1.1.1. Common Names 1
1.1.2. Classification and Taxonomy 1
1.1.3. Geographic Range and Distribution 2
1.1.4. Biology 3
1.1.5. Life History 4
1.1.6. Social Structure 5
1.1.7. Mating Patterns 5
1.1.8. Foraging Behaviour 6
1.1.9. Thermoregulation and Movement 8
1.1.10. Communication 10

1.2. General Status in the Region 11
1.2.1. Species Population Information 11
1.2.2. General Threats Throughout the Distribution Range of the Species 12
1.2.3. Legal Status 14

1.3. Ecological Importance 15

2. NATIONAL STATUS **17**
2.1. Redefining “Status” of Marine Mammal Stocks 17
2.2. Bahamas 18
2.3. Belize 20
2.4. Brazil 25
2.5. Colombia 29
2.6. Costa Rica 33
2.7. Cuba 36
2.8. Dominican Republic 39
2.9. French Guiana (France) 42
2.10. Guatemala 44
2.11. Guyana 48
2.12. Haiti 50
2.13. Honduras 51
2.14. Jamaica 54
2.15. Mexico 57
2.16. Nicaragua 62
2.17. Panama 65
2.18. Puerto Rico (U.S.A.) 69

2.19. Suriname 73
2.20. Trinidad & Tobago 75
2.21. United States 78
2.22. Venezuela 81

3. SUGGESTED SHORT- AND LONG-TERM RECOMMENDATIONS 84
3.1. Short-Term or Priority Recommendations 85
3.1.1. Assess Current Status and Distribution of Manatees 85
3.1.2. Define Guidelines for Data Collection/Censusing 85
3.1.3. Provide Protection for Manatees and Manatee Habitat 86
3.1.3.1 Improve Manatee Awareness 86
3.1.3.2. Protected Areas 88
3.1.3.3. Enforce Relevant Laws 89
3.1.3.4. Reduce Human-Related Injuries and Mortality 90
3.1.4. Promote Co-operation and Exchange of Information on Manatee Conservation at the National and Regional Levels 91
3.1.4.1. Prepare/Update National Recovery Plans and Organise Recovery Teams 92
3.1.4.2. Establish an Information and Co-operation Network 93
3.1.4.2.1. Regional Manatee Network 93
3.1.4.2.2. Manatee Regional Network Co-ordinator 93

3.2. Long-Term Research And Conservation Measures 94
3.2.1. Research on Manatees 94
3.2.1.1. Status and Distribution 94
3.2.1.2. Biological Information Leading to Major Aspects of Population Dynamics 96
3.2.1.3. Regionally Co-ordinated Efforts 97
3.2.1.4. Monitor Climate Change and its Effect on Manatee Distribution and Survival 98
3.2.2. Monitor Habitat Condition 99
3.2.2.1. Identify Habitat Requirements and Protected Areas of Special Significance to Manatees 99
3.2.2.2. Promote Restoration of Degraded Manatee Preferred Areas 100
3.2.2.3. Habitat Pollution 100
3.2.2.4. Acoustic Disturbance 100
3.2.3. Monitor and Modify Accordingly Manatee Awareness Programmes and Law Enforcement Measures 101
3.2.3.1. Manatee Awareness 101
3.2.3.2. Assess and Improve the Effectiveness of Existing Laws 102
3.2.4. Reduce and Monitor Activities that may be Detrimental to Manatees 102
3.2.5. Develop Guidelines for Manatee Watching in the Wild and Associated Activities 102
3.2.6. Develop Guidelines for Manatees in Captivity 104
3.2.7. Provide Training for Local Personnel and Biologists in the Area of Coastal Zone Management and Conservation 105

4. POSSIBLE REINTRODUCTION OF MANATEES: A CONSIDERATION FOR ENHANCED CONSERVATION AND RESEARCH 107
4.1. Background 107

4.2. Issues To Consider Before Proceeding 107
4.2.1. Legal Status and Transparency 108
4.2.2. Lessons to be Learned from Reintroductions of Other Species 108
4.2.3. Systematics of Manatees in the Wider Caribbean 108
4.2.4. How Many Manatees Would be Needed for a Successful Reintroduction Effort? 108
4.2.5. Status of the Manatees that Would be Used for the Reintroduction 108

4.3. Questions That Should Be Answered Prior To Captures/Removals Of Manatees From Any Location 110
4.3.1. What is the size of the manatee population from which captures are proposed (assuming that manatees held in captivity are either unavailable or inappropriate for the reintroduction)? 110
4.3.2. What are the current threats to that population? 110
4.3.3. What effect do those threats currently have on manatee health and survival, and are steps being taken to bring those threats under control? 110
4.3.4. Are the manatees proposed for removals Antillean manatees? 111
4.3.5. Do the manatees proposed for removals exhibit genetic variability in genes undergoing ..... active selection? 111
4.3.6. Are the animals healthy? 111

4.4. Promoting A Healthy Manatee Population In Guadeloupe, FWI 111

4.5. Conclusions 113
4.5.1. Overall Impressions of the Guadeloupe Proposal to Reintroduce Manatees (from Reynolds and Wetzel 2008) 113
4.5.2. The Bigger Picture: Conclusions with Regard to the General Question of Reintroducing Manatees into Former Habitats in the Wider Caribbean 113

5. SUGGESTED COUNTRY-SPECIFIC ACTIONS 114
5.1. Bahamas 114
5.2. Belize 114
5.3. Colombia 116
5.4. Costa Rica 116
5.5. Cuba 117
5.6. Dominican Republic 117
5.7. French Guiana 117
5.8. Guatemala 118
5.9. Guyana 118
5.10. Haiti 119
5.11. Honduras 119
5.12. Jamaica 120
5.13. Mexico 120
5.14. Nicaragua 121
5.15. Panama 121
5.16. Puerto Rico 122
5.17. Suriname 124
5.18. Trinidad & Tobago 124

5.19. United States 125
5.20. Venezuela 126

6. LITERATURE CITED 129

7. APPENDICES 143
APPENDIX I 144
APPENDIX II 149
APPENDIX III 152
APPENDIX IV 166

LIST OF FIGURES

Figure 1.	General distribution of the West Indian manatee, *Trichechus manatus*	2
Figure 2.	Manatees underwater	4
Figure 3.	A mating heard of 11 manatees was sighted along the beach of Longboat Key, Florida	6
Figure 4.	Manatee feeding on seagrasses	17
Figure 5.	Distribution of manatees, *Trichechus manatus,* in the Bahamas based on best available data from documented sightings	18
Figure 6.	Distribution of West Indian manatees, *Trichechus manatus,* in Belize according to recent aerial surveys	20
Figure 7.	Distribution of West Indian manatees, *Trichechus manatus,* in Brazil according to best available data from reported sightings	25
Figure 8.	Distribution of West Indian manatees, *Trichechus manatus,* in Colombia according to interviews and reports from published and unpublished documents	29
Figure 9.	Distribution of West Indian manatees, *Trichechus manatus,* in Costa Rica according to interviews and boat and land-based observations	33
Figure 10.	Distribution of West Indian manatees, *Trichechus manatus,* in Cuba according to results from aerial surveys, documented sightings, and interviews of local residents	36
Figure 11.	Distribution of West Indian manatees, *Trichechus manatus,* in Dominican Republic according to results of interviews of local residents and sighting reports	39
Figure 12.	Distribution of the West Indian manatee, *Trichechus manatus,* in French Guiana based on best available data from documented sightings and interviews of local residents	42
Figure 13.	Distribution of the West Indian manatee, *Trichechus manatus,* in Guatemala based on best available data from aerial surveys and sighting reports	44
Figure 14.	Distribution of the West Indian manatee, *Trichechus manatus,* in Guyana based on best available data from distribution studies conducted in 1963 and reported sightings	48
Figure 15.	Distribution of the West Indian manatee, *Trichechus manatus,* in Haiti based on best available data from aerial surveys and interviews of local residents conducted in the 1980s	50
Figure 16.	Distribution of the West Indian manatee, *Trichechus manatus,* in Honduras based on best available data from aerial surveys and reported sightings	51
Figure 17.	Distribution of the West Indian manatee, *Trichechus manatus,* in Jamaica based on best available data from aerial surveys and reported sightings	54
Figure 18.	Distribution of the West Indian manatee, *Trichechus manatus,* in Mexico based on best available data from boat surveys, aerial surveys, and interviews	57

Figure 19.	Distribution of the West Indian manatee, *Trichechus manatus*, in Nicaragua determined from best available data gathered by boat surveys, interviews, and reported sightings	62
Figure 20.	Distribution of the West Indian manatee, *Trichechus manatus*, in Panama from best available data from aerial surveys and interviews	65
Figure 21.	Distribution of the West Indian manatee, *Trichechus manatus*, in Puerto Rico based on best available data from aerial surveys and reported sightings	69
Figure 22.	Distribution of the West Indian manatee, *Trichechus manatus*, in Suriname based on best available data from reported sightings	73
Figure 23.	Distribution of the West Indian manatee, *Trichechus manatus*, in Trinidad and Tobago based on best available data from aerial surveys, boat surveys, and interviews	75
Figure 24.	Distribution of the West Indian manatee, *Trichechus manatus*, in United States based on aerial surveys, boat surveys, interviews, and documented sightings	78
Figure 25.	Distribution of the West Indian manatee, *Trichechus manatus*, in Venezuela based on best available data from aerial surveys and interviews of local residents	81
Figure 26.	A manatee showing permanent scars from boat strikes	91
Figure 27.	Aerial and boat surveys are instrumental techniques for studying different aspects of manatee biology	95
Figure 28.	Research biologists tracking tagged manatees in Chetumal Bay, Mexico	96

LIST OF TABLES

Table 1.	Freshwater and estuarine plants and grasses consumed by West Indian manatees, *Trichechus manatus*, in different parts of their range	9
Table 2.	Some marine plants consumed by West Indian manatees, *Trichechus manatus*, in different parts of their range	10
Table 3.	Population estimates of West Indian manatees, *Trichechus manatus*	11
Table 4.	Legal status of the West Indian manatee, *Trichechus manatus*, throughout its distribution range	16
Table 5.	National legislation and conservation measures taken to protect manatees in Brazil	27
Table 6.	Conservation areas for manatees in Brazil	28
Table 7.	Summary of suggested short-term and long-term recommendations	106
Table 8.	Summary of suggested country-specific recommendations	127

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EXECUTIVE SUMMARY

People over the world believe that marine mammals represent important resources of aesthetic, recreational, ecological, and economic significance. Considered in this way, people and governments have wisely encouraged sound management and conservation of marine mammals. Certainly, this is the case for manatees in the Wider Caribbean. This report recognizes the good work being done to study and conserve manatees in this region, but notes where efforts could be improved and makes suggestions about ways to move forward in the short and long terms.

The West Indian manatee (*Trichechus manatus*) ranges from the southeastern United States to northeastern South America, including Brazil, Trinidad and Tobago, and the Greater Antilles. West Indian manatees are present in twenty countries of the Wider Caribbean. As aquatic herbivores, they occupy a specialized niche in the ecosystem. This factor, along with their life history attributes (e.g., long lifespan, slow reproductive rate) make manatees susceptible to over-exploitation and environmental changes. Heavily hunted in the past, they have always played an important role in the folklore and traditions of indigenous people. Ecologically, manatees may serve as cultivation grazers, thus stimulating new growth and nutritional value of sea grasses and other aquatic vegetation.

The West Indian manatee has been identified by government and experts from the region as one of the priority protected species of the Wider Caribbean Region. Globally manatees have also received protected status under the IUCN Red List where they have been placed as vulnerable. With the adoption in 1990 of the Cartagena's Convention Protocol Concerning Specially Protected Areas and Wildlife (SPAW) and in 1991 its lists of protected species, manatees and the rest of marine mammals in the region, were identified as requiring total protection. In 1995 and under the framework of SPAW, the first Regional Management Plan for the species was developed by the Caribbean Environment Programme (CEP) of the United Nations Environment Programme (UNEP). The overall objective of the Plan was to serve as a framework for the conservation of manatees and their habitat in the region. However, to be optimally effective, such plans require regular updating to reflect the current status of and threats to the species. To achieve this end, this, the second version of the plan, was generated.

Objectives and Structure of the Report

The primary objectives of this document are to (a) present an overview of the status of scientific knowledge, legislation, and conservation efforts in each country where West Indian manatees are found throughout the Caribbean, and (b) provide short- and long-term recommendations for management and conservation. The document is divided into four major sections:

1. An introduction that includes a review of taxonomy, general biology, and general status of manatees in the region
2. A review of the status of manatees in each range country (including Puerto Rico) where they are found. Specifically, the review considers (a) manatee distribution and abundance, (b) threats and impediments to conservation, (c) the socioeconomic significance of the species to local communities, and (d) legislation and conservation measures
3. Suggested short-term and long-term recommendations for research and conservation in the region
4. Essential conservation and research actions needed in specific countries

The review of the current status of manatees in the 20 range countries was complicated by the fact that most recent information related to manatees outside of Florida has not been published in peer-reviewed

journals. In fact, most available information tends to be anecdotal and/or is found in unpublished reports, abstract meetings, theses, newspaper articles, or presentations in which quality control is uncertain. To verify the accuracy of such information as much as possible, experts from each country were involved and consulted. In many cases, we relied on personal communications or anecdotal accounts; as a result, considerable uncertainty exists regarding the status and distribution of manatees in many countries. Details of our sources including references, contributors, and reviewers are listed in full at the end of the report.

Current Status of the West Indian Manatee

The review indicates that the status, distribution, infrastructural support, and conservation of manatees vary widely among the countries of the Wider Caribbean. As noted, in some countries information is largely anecdotal, but in a few others, empirical data collected over many years are available to inform management decisions. Since publication of the original Regional Management Plan for manatees in 1995, some countries have initiated new programmes or projects that have started to contribute useful insights, but in others no new information is available.

In most parts of the species' range, the population status of manatees is unknown, population sizes have never been estimated, and population trends are uncertain, although local and regional experts suggest that numbers in many countries may be declining at present. Population "estimates" (not true estimates, as many are based on hunches and guesses), developed as part of a review conducted to evaluate the status of sirenians for the Red List (World Conservation Union-IUCN), indicate that manatee population sizes may range from approximately 10 (the Bahamas) to 3,400 (Florida) individuals, with most being in the 100-500 range. The number of manatees in the Wider Caribbean Region, including Brazil and Florida, may be in the neighbourhood of 9,000 animals. We reiterate that this figure is based on data of highly variable quality (or no data at all) and should be considered as only a crude approximation.

Manatees face similar threats throughout their range, which include habitat degradation and loss, watercraft collisions, incidental catch/accidental take in fishing gear, pollution, human disturbance, natural disasters, and hunting. Although hunting of manatees is illegal, they are hunted in many areas for meat, oil, amulets, and other products and, on a more restricted basis, as a socio-cultural activity. Although threats due to hunting are diminishing in some areas, all other threats appear to be increasing in most areas. Pollution from agriculture and mining was consistently noted in reports from Central American countries. Manatee deaths as a result of boat strikes have been documented in places such as Florida, Belize, Colombia, Costa Rica, and Venezuela.

Efforts to Conserve Manatees at National and Regional Levels

Manatees cross certain international borders (e.g., Mexico and Belize), so coordinated regional efforts are needed to complement and supplement those in particular countries. This need becomes highlighted as one considers that the number of manatees thought to exist in certain individual countries may be too small for the population there to have a high probability of long-term survival, but the combined populations among several nearby countries may provide a better guarantee of survival if those populations interbreed. Outside of the United States (Florida), the population of manatees in southeastern Mexico and Belize is likely the largest. In that regard, safeguarding that population as a resource of regional importance should be a high priority.

Fortunately, the foundations for international, coordinated efforts are developing. A number of governments have declared special manatee protection areas and several have developed or are currently

developing national or bilateral management plans to protect manatees at the national and/or sub-regional levels.

All countries in which manatees have recently been reported have national legislation protecting the species. At the international level, some changes have occurred recently. Since 1995, fourteen governments have ratified their participation in the different international conventions and protocols protecting the species and its habitat.

Recommendations

The report provides a series of recommended activities to be undertaken by individual countries and the region as a whole. Country-specific recommendations are based on statements from local experts and/or published information and recommendations included in local manatee management plans. Short-term, priority measures (focused conservation actions, selected research, development of local education and awareness programmes, and enhanced enforcement of protective legislation) should be developed and implemented as quickly as possible. Long-term research and conservation measures should allow the implementation and strengthening of research, education, and conservation programmes designed to ensure the recovery and maintenance of manatees and the protection of the habitats necessary for their survival. Naturally, the emergence of any programmes, but especially long-term ones, requires a commitment of funds and other resources to this issue.

Some of the key recommendations include—

1. *Assessment of manatee current status and distribution*
   Assessments of "status" of a species or population should include a number of factors, such as abundance, population trends, demography, and the identification and control of threats. Because the population status of manatees is unknown in most parts of the species' range, a countrywide qualitative assessment of manatees along coastal areas is necessary in most range countries. Understanding how many manatees exist and the habitats they prefer is a fundamental step toward establishing appropriate conservation measures. Ultimately, the species' status also needs to be evaluated by the health and structure of local populations. This is particularly important in areas in which coastal waters are polluted by the inappropriate disposal of wastewaters from agricultural and mining industries.

2. *Define guidelines for data collection/census*
   It is necessary to develop standardized protocols and techniques for data collection and analysis. This will ensure that the results are comparable both within and among countries. Some field methods such as aerial surveys have been used for several years and are well standardized. Yet, other new methods such as the use of sidescan sonar to find manatees in areas with limited water visibility are fairly new and not well developed. Thus, people developing techniques and collecting information in the field need to have the proper training to ensure that methods are developed satisfactorily, data collected are of good quality, and results are comparable and replicable.

3. *Environmental education and enforcement of relevant laws*
   Manatees have some level of legal protection throughout their range. Yet, in many countries manatees are still illegally hunted, dying as result of other human-related causes (i.e., incidental entanglement and boat collisions) and losing their habitat (both in quantity and quality).

Enforcement of existing laws is crucial for the species' survival. Additionally, the success of any conservation effort relies on an effective public education/awareness component. Thus we recommend that environmental education programs be established along the coasts to educate the local communities. If the recommendations to increase environmental education and law enforcement are fully embraced, this single action can have a significant positive effect on the status of manatee populations.

4. *Preparation or update national recovery plans*
   Recovery plans develop protocols for protecting and enhancing species populations and assign priority tasks and timelines to appropriate stakeholders. The Action Plan for the Conservation of Marine Mammals in the Wider Caribbean Region (MMAP) recommends that a national recovery plan should be developed if marine mammal populations are subjected to one or more of the following: over-utilization, inadequate monitoring and/or enforcement of protective regulations, and degradation of habitat, and other factors (disease, etc). Because manatee populations fit these characteristics in most parts of their range, we recommend that countries develop or update their national recovery plans in order to ensure the continued survival of manatee populations.

Recommendations must be adopted as an integrated, multi-faceted programme in which the scientific findings and educational programmes provide support of and inform wise conservation and legislative measures. As a final caution, it is important to note that some human activities (e.g., some forms of eco-tourism) may appear to be benign but can actually have unforeseen and negative consequences for wildlife. In addition, such activities can provide much-needed local infusions of funding. For conservation to succeed, managers and decision makers must take a careful, measured approach to assessing the long-term costs and benefits to manatees, ecosystems, and people of the Wider Caribbean.

1. INTRODUCTION

1.1. REVIEW OF TAXONOMY AND GENERAL BIOLOGY

1.1.1. Common Names

West Indian manatees are known as sea cows or manatees, and in Spanish they are commonly known as "vaca marina" and "manatí." The generic name *Trichechus* comes from the Greek *trichos* for hair and *ekh* for have, which refers to the facial hairs and bristles. The specific name is believed to have originated from the Carib Indian word *manati*, which refers to a woman's breast (Reeves *et al.* 1992). The axillary nipples of the manatee were thought to resemble human breasts and people associated manatees with the mythical mermaid (Reeves *et al*. 1992, UNEP 1995).

1.1.2. Classification and Taxonomy

Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia
Order	Sirenia
Family	Trichechidae
Genus and Species	*Trichechus manatus* (Linnaeus 1758)
	Trichechus inunguis (Natterer 1883)
	Trichechus senegalensis (Link 1795)
Family Dugongidae	
Genus and Species	*Dugong dugon* (Müller 1776)
	Hydrodamalis gigas (Zimmermann 1780)

The families Trichechidae (manatees) and Dugongidae (dugongs) have obvious similarities, but they possess some differences as well (see Reynolds and Odell 1991 for pictures of anatomical differences). For example, manatees have numerous cheek teeth but lack functional incisors. Dugongs, however, have incisors in the upper jaw and molars in both jaws. Dugongs have flippers lacking nails whereas two species of manatees (*T. manatus* and *T. senegalensis*) have nails at the ends of their flippers. Manatees have a rounded, single fluke for propulsion, whereas dugongs have split flukes similar to those of dolphins and whales (Vaughan 1986, Reynolds and Odell 1991). Other differences are highlighted by Reynolds and Odell (1991) and by comparative chapters by Marsh (2002; for dugongs) and Reynolds and Powell (2002; for manatees).

Two subspecies of West Indian manatees are currently recognized based on skull characteristics (Domning and Hayek 1986): the Antillean manatee, *T. manatus*, and the Florida manatee, *T. manatus latirostris*. However, the subdivision of *T. manatus* into two subspecies is currently under question by the findings of genetic studies of mitochondrial DNA. Garcia-Rodriguez *et al.* (1998) noted shared haplotypes between manatees in Florida and those in Puerto Rico and the Dominican Republic. These haplotypes represent single-copy mitochondrial DNA types that are present in each animal and are passed along to offspring through maternal inheritance. However, Vianna *et al.* (2006) showed that there is a marked population structure with a distinctive spatial distribution. Genetic diversity decreases in the extremes of the latitudinal distribution of *T. manatus*, with Florida and Brazil having low haplotype diversity. Highest haplotype diversity is found in Colombia, followed by Mexico. Additionally, there are

large genetic differences between populations from South America (Guyana, Venezuela, and Brazil) and those from the Greater Antilles (Puerto Rico and Dominican Republic). Genetic data available at this time suggest that there are up to three mitochondrial DNA groupings, which correspond to the following regions: (1) western and southern Gulf of Mexico, Central America, and northwestern South America, (2) Florida and the Greater Antilles, and (3) northeastern South America, east of the Lesser Antilles (Deutsch *et al.* 2007).

The range of *T. manatus* overlaps with that of *T. inungus* near the mouth of the Amazon River (Reeves *et al.* 1992). Hybridization there is suggested by shared mtDNA haplotypes of some individuals (Vianna *et al.* 2006).

1.1.3. Geographic Range and Distribution

The genus *Trichechus* is primarily tropical in distribution and is found along the Atlantic basin. The West Indian manatee occurs as far south as Bahia in Brazil and as far north as Rhode Island in the United States although sightings north of the Carolinas are rare (Fig. 1). Throughout most of its range, the West Indian manatee appears to prefer the shallow waters of rivers and estuaries that contain aquatic vegetation.

Figure 1. General distribution of the West Indian manatee, *Trichechus manatus.* For detailed information on local distributions, see country-specific sections.

The Florida manatee is found in the southeastern United States, where it is the only subspecies of manatee that inhabits both subtropical and temperate waters. Florida manatees are also unusual due to their need for warm-water springs and industrial effluents during periods of cold weather (Reynolds and Odell 1991, Reeves *et al.* 2002). The Antillean manatee is found throughout the remainder of the species' range. Manatees occasionally sighted in Texas are probably Antillean manatees and not Florida manatees (Reeves *et al.* 1992).

The Amazonian manatee is endemic to the freshwater habitats of the Amazon River basin (Lefebvre *et al.* 1989, Reynolds and Powell 2002). The West African manatee is found in the estuaries, rivers, and coastal waters of West Africa from the Senegal River in the north to the Cuanza River (Angola) in the south (Reynolds and Odell 1991, Reynolds and Powell 2002).

The family Dugongidae is represented by only one surviving member, the dugong. Dugongs are found in the marine tropical and subtropical waters of the Indo-Pacific (Marsh 2002). The other member of the family, Steller's sea cow, is extinct and existed in sub-Arctic waters of the Bering Sea until 1768 (Reynolds and Odell 1991, Reeves *et al.* 1992).

1.1.4. Biology

The two subspecies of *T. manatus* are not generally considered to be distinguishable externally, although *T. m. manatus* seems to be less rotund than is *T. m. latirostris*, possibly as an adaptation to produce and maintain body heat (Rommel *et al.* 2003). Adult manatees can reach a length of 3.9 m (about 13 ft) and a weight of 1,500 kg (3,500 pounds). Newborn calves generally range from 80 to 160 cm (2.6 ft to 5.2 ft) long and weigh approximately 30 kg (70 pounds). Females and males are very similar in size and appearance (Reeves *et al.* 1992) although the former may be somewhat more robust than the latter. The only obvious external sexual dimorphism involves the location of the urogenital aperture. In females, the opening is located just anterior to the anus and in males it is located just posterior to the umbilicus (Moore 1951).

Adaptations of manatees are described by a number of authors (e.g., Reynolds and Marshall in press, Reynolds and Odell 1991, Reeves *et al.* 1992; multiple chapters in Reynolds and Rommel 1999). These references provided most of the information used in the brief descriptions that follow.

The West Indian manatee, like all manatees, has a fusiform body, horizontally flattened fluke, and no obvious neck crease (Fig. 2; Reeves *et al.* 1992, Reynolds and Odell 1991). The skin is rough and generally gray to brown in colour, although colour varies with age (newborns are darker) and the amount and type of epiphytic growth (e.g., barnacles or algae). The eyes are small and no external ear is present. Their snout has bristles on the upper and lower lip pads, and a muscular, flexible lip is used, in conjunction with the forelimbs, to manipulate food (Odell 1982; Marshall *et al.* 1998 a,b, 2000; Reep *et al.* 1998). Because aquatic vegetation is a nutritionally poor food source, it is advantageous for manatees to be efficient in gathering and handling vegetation (Marshall *et al.* 2000). Six to eight molars occur in each side of the upper and lower jaws, situated toward the rear of the mouth. They are continuously replaced from back to front after weaning and throughout the life of the manatee, an extremely unusual adaptation because most mammals exhibit a vertical tooth replacement that is discontinuous (Reynolds and Odell 1991). Nostrils are located on the tip of the snout, and muscular valves open and close them as the animal surfaces and dives (Hartman 1979).

Manatees have paddle-like, flexible forelimbs with nails on the dorsal side. The flexibility of the forelimbs allows animals to walk along the substrate and caress companions. Manatees have no dorsal fin. Females have two teats, one present in a fold of skin behind the axilla of each flipper (Odell 1982, Reeves *et al.* 1992).

Figure 2. Manatees underwater (Photograph by Patrick M. Rose).

1.1.5. Life History

Reviews of sirenian reproductive biology and behaviour appear in Boyd *et al.* (1999) and Wells *et al.* (1999), respectively. The lifespan of the manatee is not known with certainty. The oldest manatee aged in Florida was 59 years old (Marmontel 1995). Longevity over 55 years has been documented by sectioning the manatee's periotic (ear) bones, which develop growth layer groups throughout the life of the animal (Marmontel 1993, Bolen 1997). Although the maximum age is around 60, the average age of non-calves recovered by the carcass salvage programme in Florida is about 12 (Bolen 1997). Thus, many animals do not come close to realizing their full reproductive potential. In Puerto Rico, the longevity of wild manatees seems to be around 27 years (Mignucci-Giannoni *et al.* 2000a).

Manatees generally become sexually mature between three to five years of age at a body length of approximately 2.7 m (10 ft) (Boyd et al 1999, Glaser and Reynolds 2003). When males attain this size, their testes increase in size dramatically (Hartman 1979, Hernandez *et al.* 1995, Reynolds *et al.* 2004). The age at which males sire and produce their first offspring is unknown (Hernandez *et al.* 1995), but the fact that manatees exhibit promiscuity and sperm competition (Reynolds *et al.* 2004) suggests that small, but mature males may not impregnate many females.

Females appear to reach sexual maturity at an age of three to five years (Hartman 1979, Marmontel 1995, Rathbun *et al.* 1995, Wells *et al.* 1999). Evidence for senescence is unclear, but female manatees continue reproducing in the wild into their thirties (Marmontel 1995). One captive manatee in Florida gave birth at an estimated age of 43 to 48 years (U.S. Fish and Wildlife Service 2001). Females give birth, usually to a single calf, after a gestation period of between 11 and 14 months (Rathbun *et al.* 1995, Reynolds and Odell 1991). A few cases of twins have been documented (Marmontel 1995, Rathbun *et al.* 1995, Reeves *et al.* 2002, SEMARNAT 2001, Wells *et al.* 1999).

1.1.6. Social Structure

Manatees have been described as solitary animals; the strongest association seems to be between a female and her calf (Hartman 1979, Rathbun *et al.* 1995). Calves of Florida manatees usually stay with their mother for one to two years (Reynolds and Odell 1991, Koelsch 2001). Calving intervals vary among individuals but they may tend to be approximately 2 to 2.5 years (Marmontel 1995, Rathbun *et al.* 1995, Koelsch 2001). Newborn calves are dependent on their mothers for nutrition, but calves seem to be nutritionally independent by the end of the first year. A dependent calf rarely moves farther than several meters from the mother and it usually travels in a parallel path behind the mother's pectoral flipper (Reynolds 1981). Calves learn about travel corridors and feeding and resting areas from the mother (Reynolds and Odell 1991). Male manatees have no role in rearing or protecting the calf, and they tend to join other manatees for reproductive reasons. Other manatee associations are more casual and temporary.

Manatees group to feed, migrate, rest, and cavort, but associations are highly variable and short term. When in groups, manatees exhibit social facilitation; that is, if one animal feeds or rests, other associates seem to act likewise. Group composition is variable and juveniles and adults of both sexes may associate. Juvenile males may remain together for long periods of time (Hartman 1979).

Groups of up to 22 individuals have been reported in different areas throughout the range of the species (Auil 2004). In Florida, large groups of manatees (300 to more than 500 animals, Craig and Reynolds 2004) are observed in winter when ambient water temperature drops below 19°C (66°F). Such aggregations are resource-based (rather than primarily social), and they occur in natural springs and near power or industrial plants discharging warm water (Reynolds and Wilcox 1985, Laist and Reynolds 2005a). Manatees appear to be non-territorial. No evidence has been documented of animals defending or guarding parts of their home range (Hartman 1979).

1.1.7. Mating Patterns

Manatees are promiscuous and more than one male seems to mate with an estrous female. The male consorts and the estrous female, collectively called a mating herd, may stay together for periods of up to about a month (Hartman 1979, Rathbun *et al.* 1995, Reynolds *et al.* 2004). The female in estrus becomes the focal point of a mating herd and as many as 17 male manatees can be part of it (Hartman 1979, Reynolds 1979). Juvenile males may join and leave the herd, but a nucleus of mature males appears to be continually present with the focal female. The female appears receptive to actual mating for a short, one-to-two day period of time. During this period, males vigorously try to gain a favourable position to achieve intromission. At those times, juvenile males are likely to remain at the periphery and they rarely compete with older males (Hartman 1979).

Mating herds are frequently observed in shallow water at the peak of courtship (Fig. 3; Hartman 1979). In Florida, they are seen mostly in the warm months (Rathbun *et al.* 1995). In different parts of the species' range, mating activity peaks are between March and August (UNEP 1995). Estrous females may travel more often outside their normal home ranges. Males appear generally to have larger home ranges than females, so as estrous females wander, they appear to attract numerous males (using as yet undetermined sensory cues) into the mating herd. This results in a wider choice of mates (Wells *et al.* 1999). Manatees are sperm competitors, but which males are successful sires is unknown (Reynolds *et al.* 2004). Mating can take place either at the surface or underwater.

Figure 3. A mating herd of 11 manatees was sighted along the beach of Longboat Key, Florida (Photograph courtesy of Mote Marine Laboratory).

1.1.8. Foraging Behaviour

Sirenians are unique among marine mammals in that they are aquatic herbivores. In addition, they are hindgut fermenters (or digesters), which means that they spend most of the day foraging (Reynolds and Rommel 1996, Reynolds and Marshall in press). In fact, manatees spend approximately 6 to 8 hours feeding at any one time during the day or night (Hartman 1979, Reynolds 1977, Best 1981). Seagrasses and other aquatic plants are not exceptionally nutritious, but this is not a problem for hindgut digesters because their large intestines function as enlarged fermentation vats. Large intestines can measure more than 20 meters long, and weigh, with contents, in the neighbourhood of 70 kilograms and represent an impressive 14 percent of the body weight (Reynolds and Rommel 1999).

Sirenians exhibit a suite of adaptations for benthic foraging that influence hydrostasis, or the maintenance of equilibrium in the water (Domning and Buffrenil 1991). Manatees often use their pectoral flippers to manipulate and hold pieces of floating or loose plant material to their mouths. Their snout is extremely mobile and represents a short “elephantine” trunk (Marshall *et al.* 1998a). The lip region of the snout is enlarged (especially the upper lip) and is equipped with six fields of short, stout vibrissae or whiskers called bristles (Reep *et al.* 1998). Sirenian whiskers are unusual among mammals in that their vibrissae are used for both prehensile manipulation and sensory purposes. Both manatees and dugongs explore objects or food in their environment using this muscular-vibrissal complex (Marshall *et al.* 1998b, 2000). Psychophysical testing of manatee tactile discrimination power has

demonstrated that West Indian manatees are highly capable of using the snout, muzzle, and associated sensory hairs to discriminate between objects of various textures (Bachteler and Dehnhardt 1999).

The muscular, mobile snout of sirenians is just one part of the food gathering apparatus. Both manatees and dugongs have a hard upper and lower palate. They do not possess incisors and canines, only cheek-teeth. Both groups can use these structures to grind plants and transport food farther in the mouth (Marsh *et al.* 1999). In dugongs, it is suspected that the upper and lower hard palate may do most of the mastication. However, manatees evolved in riverine systems that contain a lot of terrestrial grasses (Domning 1982). These grasses are highly abrasive and quickly wear down teeth. All herbivores must contend with the issue of tooth wear due to the abrasive properties of plants. For example, horses have dealt with tooth wear by evolving very tall teeth (called hypsodont teeth, as opposed to humans' shorter brachydont teeth). Horses' teeth may take 20 to 30 years to wear down, and tooth wear is correlated to an animal's lifespan. In contrast, elephants (which are close relatives to the sirenians) have evolved specialized cheek teeth that slowly erupt over the lifespan of the animal (see page 3, Biology section, for an explanation of manatee tooth replacement).

Manatee feeding techniques vary according to the part of the plant being consumed and the growth form of the food source (Hartman 1979). Manatees act as browsers when they feed on plants floating at the surface or plants having considerable height in the water. They feed on the stems and go from crown to base (Hartman 1979). However, if they feed on submerged plants producing simple leaves from basal clusters or rhizomes, they tend to behave like grazers. Their mouths and flippers often touch the substrate and their body is generally tilted. A variety of feeding techniques allows manatees to forage on the bottom, in the middle of the water column, at the surface and on overhanging and bank vegetation.

Domning (1977, 1980) suggests that the cranial morphology of the various sirenian species is related to their feeding position in the water column. The intermediate deflection of the rostrum of the West Indian manatee allows this species, and presumably the West African manatee, to have the widest foraging preference in the water column. In contrast, the rostrum of the Amazonian manatee has virtually no deflection and the speciesprefers to feed only at the surface.

As the West Indian manatees move among riverine, estuarine, and marine environments, they consume plant species present in each of those habitats. Some of the plants consumed are included in Tables 1 and 2 (Reynolds 1977, Hartman 1979, Best 1981, Packard 1981, Bengtson 1983, Ledder 1986, O'Shea 1986, Smethurst and Nietschmann 1999, Jiménez 1999, 2000, Reid 2000, Nathai-Gyan and Boodoo 2002, Aguilar-Rodriguez *et al.* 2004, Spiegelber and Ganslosser 2005, Riquelme *et al.* 2006).

Manatees inadvertently consume a variety of invertebrates, including bivalves, snails, amphipods, isopods, shrimp, crabs, and tunicates, found in the roots and foliage of macrophytes (Hartman 1979, Reynolds 1977, Best 1981). In addition to consuming vascular plants, manatees feed on freshwater algae including *Enteromorpha*, *Oscillatoria*, and *Navicula* and the marine algae *Ulva lactuta* and *Caulerpa prolifera* (Mignucci-Giannoni and Beck 1998). Manatees may unintentionally eat invertebrates, which supply protein. In Jamaica, they have been observed eating fish captured in gillnets (Powell 1978).

1.1.9. Thermoregulation and Movement

Behavioural and physiological traits of manatees are associated with their diet. They consume aquatic macrophytes that are a poor source of nutrients because their composition is 90 to 95% water (Best 1981). Marine angiosperms have even lower concentrations of protein and carbohydrates than some freshwater plants (Wells *et al.* 1999). A diet based on food items relatively poor in quality may explain why manatees eat large quantities of food (on average about 7-8% of their body weight in wet weight; Best 1981, Etheridge *et al.* 1985). Adults can feed for six to eight hours a day in periods lasting from one to two hours (Hartman 1979).

For manatees (*T. manatus* and *T. inunguis*), scientists have generally suggested that the metabolic rate is far below that expected for a mammal of their size (Scholander and Irving 1941, Gallivan and Best 1980, Irvine 1983). Rommel *et al.* (2003) used data from the preceding studies to recalculate the metabolic rates of a 450-kg Florida manatee and suggested that the observed rate was between 20 and 65% of the predicted one. Higher metabolic rates are related to a high core body temperature. In Florida, where winter water temperatures may be 40 to 50°F lower than manatee core body temperature, staying warm is a notable challenge. However, heat is a byproduct of cellulolysis, and manatees may be able to increase heat production using their large cellulose fermentation "vats" (i.e., the large intestines). Interestingly, Florida manatees have much greater girth abdominally than do manatees of the same species in Central America where waters are warmer (Rommel *et al.* 2003). Researchers have speculated that the Florida manatees have, through natural selection, acquired larger cellulose fermentation structures than their warm-water relatives possess, simply as an adaptation to staying warm (Reynolds and Marshall in press).

The need to constantly process food to secure additional heat from cellulolysis constitutes a point of vulnerability for sirenian populations that occupy cooler waters (e.g., Florida; some waters occupied by dugongs). When cold fronts occur, such animals may seek warm water to survive the lower temperatures (e.g., Craig and Reynolds 2004). When this happens, the animals may find little to eat near the sources of warm water, and as they fast; their internal generation of heat may decline dramatically. After the front passes, these animals may venture out to feed, but in so doing enter cold water where they may be vulnerable without their internal "furnaces" at work.

In the winter months, Florida manatees migrate south to warm-water sites where aggregations of several hundreds of individuals are formed (Reynolds and Wilcox 1985). In the summer months, manatees can disperse for distances exceeding 800 km (497 miles) (Reid *et al.* 1991; see Deutsch *et al.* 2003 monograph on tagging). Exchange of individuals among areas some distance apart in the Caribbean is theoretically possible.

Table 1. Freshwater and estuarine plants and grasses consumed by West Indian manatees, *Trichechus manatus*, in different parts of their range (Only plants reported during direct observations of feeding events are included.)

Species	Brazil	Colombia	Costa Rica	Florida (U.S.)	French Guiana	Mexico	Nicaragua	Puerto Rico (U.S.)	Trinidad & Tobago	Venezuela
Brachiaria sp.		x	x							
Cabomba aquatica										
Ceratophyllum demersum				x						
Cyperus sp.		x	x							
Eichhornia crassipes	x		x	x		x			x	x
Elodea densa				x						
Eleocharis acicularis	x			x		x				
Halodule wrightii				x						
Hydrilla verticillata				x						
Languncularia racemosa	x									
Myriophylum spicatum				x						
Montrichardia arborescens									x	x
Najas guadalupensis				x						
Panicum hemitomon				x			x	x		
P. maximum		x	x							
P. mole				x						
P. paniculatum						x				
P. purpurascens				x						
Paspalum vaginatum				x						
Pennisetum purpureum		x								
Phragmites communis				x						
Potamogeton pectinatus				x						
Sorghum halapapense		x								
Rhizophora sp.					x					
R. mangle				x	x					
Rhabdadenia biflora	x									
Utriculata sp.				x						x
Vallisneria neotropicalis				x						

Table 2. Some marine plants consumed by West Indian manatees, *Trichechus manatus*, in different parts of their range

Species	Bahamas	Florida	Guyana	Mexico	Panama	Suriname
Halodule wrightii		x				
Ruppia maritime		x	x			
Syringodium filiforme		x				
Thalassia testudinum	x	x		x	x	
Utriculata sp.		x	x			x

1.1.10. Communication

Acoustic communication in manatees involves sounds with peak frequencies from 2.5 to 5 kHz. Sounds have been described as chirps, whistles, or squeaks, and they can last between 0.15 to 0.5 seconds (Hartman 1979, Reynolds and Odell 1991). Manatees use sounds in several contexts including aggravation, sexual interactions, fear, and play (Hartman 1979). Unlike cetacean echolocation, manatee vocalizations do not seem to be used for navigation (Hartman 1979). Tactile communication also seems to be important because manatees are frequently seen caressing each other and rubbing on objects. Outside of the mating season, males and females engage in social interactions including kissing, nuzzling, rubbing, and cavorting. Such encounters are casual and brief. Juvenile males engage in homosexual behaviour that can last several hours (Hartman 1979).

Manatees are most sensitive to low-frequency sounds. Some studies found that manatees are most sensitive to sounds in the frequency 1.5 kHz (roughly similar to the frequency of sound that a television emergency signal tone makes; Bullock *et al.* 1980). However, other studies that examined ear anatomy suggest that manatees can hear best at slightly higher frequencies, namely around 5 kHz (similar to a smoke detector signal; Glaser and Reynolds 2003). Yet, behavioural audiograms suggest that manatees can hear sounds with frequencies as high as 46 kHz, with the best sensitivity between 10 kHz and 20 kHz (Gerstein *et al.* 1999). Similarly, studies using auditory evoked potential measurements (AEP) indicate that manatees respond to test stimuli from 4 kHz and 40 kHz (Mann *et al.* 2005).

Hearing studies have practical importance because manatees are often struck and killed or severely injured by watercraft. In Florida, approximately 100 manatees are killed each year by watercraft (FFWC 2004). The ability of manatees to hear and localize boat sound is an important issue, especially to develop conservation strategies. Researchers predict that manatees have relatively good localization abilities, which is consistent with the results of studies showing that manatees can detect approaching boats (Mann *et al.* 2005). Those studies have found that manatees located in shallow water and at the edge of channels respond to approaching vessels by increasing their swimming speed and heading toward the nearest deep water (Nowacek *et al.* 2005).

1.2. GENERAL STATUS IN THE REGION

1.2.1. Species Population Information

The status of manatees at the national level varies among countries from vulnerable to endangered to locally extinct. Deutsch *et al.* 2007 conducted a recent overview of population sizes for each country in the Wider Caribbean Region based on interviews with local manatee experts. The suggested population size was calculated on best available data (often sparse), and they ranged from fewer than 10 to more than 1,000 manatees (Table 3). The information from that report and the one included in this plan (see Status and Distribution section for each country) suggests that countrywide population trends are often unknown but in some cases are declining or stable. Anecdotal evidence and interviews with local people suggest that significant declines have occurred in some locations over the past 30 to 50 years.

Table 3. Population estimates of West Indian manatees, *Trichechus manatus* (unless specified, estimates were reported in Taylor *et al*. 2006). Minimum population refers to minimum counts or estimates based on best available data. Note: Trend I = possible increasing, S = likely stable, D = probably declining, U = unknown due to data deficiency, [1] = N. Auil pers. comm., [2] = E. Quintana-Rizzo pers. comm., [3] = US Fish and Wildlife Service 2001.

Country	Trend	Minimum population	Population estimate
Bahamas	I	3-5	10
Belize	S/D	400-700 [1]	1000[1]
Brazil	S/D	<500	500
Colombia	U/D	100-1000	500
Costa Rica	D	31-66	100
Cuba	U/D	U	100
Dominican Republic	D	30-45	100
French Guiana	S	10s?	100
Guatemala	U	53±44[2]	150[2]
Guyana	D	?	100
Haiti	U	8	100
Honduras	S	11	100
Jamaica	U/D	<50	50
Mexico	U	1000-2000	1500
Nicaragua	D	71	500
Panama	U	10-100	100
Puerto Rico (U.S.)	S	128	300
Suriname	D	10s?	100
Trinidad and Tobago	D	25-30	100
United States (Florida)	I	3276[3]	3400[3]
Venezuela	D	?	100
Total	1		9010

1.2.2. General Threats throughout the Distribution Range of the Species

The distribution of sirenians is linked to availability of the aquatic vegetation they require to survive. Hence, sirenians of all species are found in coastal and riverine habitats close to humans. This simple fact causes sirenians to become exposed to a variety of activities that can, alone or in combination, threaten their existence (Reynolds and Odell 1991).

Several threats affect manatees in different parts of their range. Most threats are human-related and include poaching, habitat loss, chemical contamination, entanglement in fishing/shrimp nets, and watercraft collisions (Lefebvre *et al.* 1989, Quintana-Rizzo 1993, U.S. Fish and Wildlife Service 2001, Jiménez 2002, Reynolds and Powell 2002, Castelblanco-Martinez *et al.* 2003, MADVT 2005, Castelblanco-Martinez 2004). Non-human related threats include occasional exposure to red tide and cold water temperatures (U.S. Fish and Wildlife Service 2001), as well as hurricanes (Langtimm and Beck 2003). Exposure to cold is more common for Florida manatees than for Antillean manatees because the latter inhabit warm, tropical waters.

Poaching has extensively reduced populations of West Indian manatees throughout most of the species' range (Lefebvre *et al.* 1989). Manatees, like other K-selected species (Glaser and Reynolds 2003), are particularly susceptible to over-exploitation because of their low reproductive rates. Manatees continue to be hunted despite the fact that they are legally protected in many countries (see country specific sections on Major Threats and Legislation). In the past, manatees were hunted for many reasons: their flavourful meat, oil used for cooking, and bones used for weapons and medical purposes including body pain, arthritis, muscle pain, menstrual regulation and whooping cough (UNEP 1995, Auil 1998). Nowadays harvested manatees appear to be used almost exclusively for meat (Correa-Viana *et al.* 1990, Jiménez 2002). Manatee meat may cost just a few ($5-$8US) dollars/pound or may bring higher prices (up to $100 per pound) in local markets of Central America (Jiménez 2002, Quintana-Rizzo 1993). In Belize and Mexico, bones are still crafted into sculptures and jewelery by artisans (Morales-Vela and Olivera-Gomez 1992a, Auil 1998).

Poaching in Nicaragua has been documented to kill three to nine manatees each year. Hunters include men of different ages and ethnic backgrounds (e.g., Creole and Garifona; Jiménez 2002). In the 1990s there were reports of manatee poaching in Belize that appear to be the result of poaching from Guatemala and possibly Honduras (E. Quintana-Rizzo unpubl.). In August-September 1995, at least 35 manatee carcasses were found in the Port Honduras area, Belize (Bonde and Potter 1995). A year later, a second report of poaching was documented south of Port Honduras where another nine manatees were found dead (Morales-Vela *et al.* 2000).

Straddling populations of manatees occupy waters of more than one country, so poaching in one or a few locations may affect the status of manatees across several countries. This has previously resulted in countries blaming each other for the illegal activities although over time this has apparently become less of an issue (E. Quintana-Rizzo unpubl.).

Manatee hunters appear to use similar techniques in Central and South America (Auil 1998, Cruz 1994, Jiménez 2000, Castelblanco-Martinez 2004, Quintana-Rizzo pers. comm.). Manatees are struck with a harpoon attached to a buoy or a canoe. Then the animal is chased until it is exhausted, dragged to shore or close to the canoe, and killed by stabbing it in the back or hitting it on the snout. The dead or dying animal is brought to shore and butchered.

Although hunting continues to be one of the major threats to Antillean manatees, other human-related activities have been identified as causes or potential causes of manatee deaths. For example, entanglement of manatees in fishing gear or nets has been reported in Nicaragua and Colombia (Jiménez 2002, Castelblanco-Martinez 2004). Entrapment in shrimp nets and crab pot lines has been reported in Florida (U.S. Fish and Wildlife Service 2001).

In Florida, the most significant threat to manatees is fast-moving boats. Manatee deaths or serious injury from boat strikes exponentially increased by 7% per year and accounted for 24% of the total population mortality between 1976 and 2000. This appears to be related in part to growing numbers of manatees and in part to the increase in human populations, including people using watercraft, in the same areas used by manatees. The human population in Florida has increased by 130% since 1970. Increases in boat traffic also result in the alteration of habitat quality and pollution of the aquatic environment. The second largest human-related cause of manatee deaths in Florida is entrapment in water control structures and navigational locks that subsequently crush the trapped individuals (U.S. Fish and Wildlife Service 2001).

Proximity to people can also affect the habitat of sirenians. The sirenians depend on submerged, floating, or even emergent vegetation to survive. Disruption of habitat due to dredge and fill, coastal runoff, or even scarring from boat propellers can affect the quality and quantity of the food they eat and thus affect nutrition, growth, and reproduction. Seagrass scarring leads to erosion and fragmentation of seagrass beds, ultimately resulting in loss of the complete habitat (Dawes *et al.* 1997). As seagrass beds are nursery grounds from numerous marine species, loss of seagrass habitat is detrimental not only for sirenians but for the entire ecosystem. This has led the state of Florida to increase protection of seagrass beds (Sargent *et al.* 1995).

Very few studies have examined the effects of contaminants on manatees, but manatees are probably exposed to relatively high levels of many pollutants because of their attraction to industrial and municipal outfalls. A study of Florida manatees found that levels of most contaminants examined (organochlorines and some metals) were low (O'Shea *et al.* 1984, Ames and Van Vleet 1996), although D. Wetzel (pers. comm.) has found PCBs in tissues of manatees sampled in relatively pristine parts of the Mexican coast. Therefore, chemical pollution degrades sirenian habitat, even in rather undeveloped locations, and can potentially affect their general health and survival. One factor that may protect sirenians from some types of chemical contaminants, relative to other marine mammals, is that the former occupy a low trophic level as herbivores and may therefore be less exposed than are top predators.

Aside from chemical pollution, sirenians in some parts of their ranges are exposed to high levels of noise pollution due to intensive boating activity. There is some evidence in Florida that watercraft-induced noise affects manatees' choice of habitat and behaviour (Glaser and Reynolds 2003). It appears that manatees sometimes intentionally forage and travel at night to avoid encounters with watercraft (Buckingham *et al.* 1999, Smethurst and Nietschman 1999, I. Jimenez pers. comm.).

Thus, simply being near people can cause sirenians to be hunted deliberately, accidentally killed or injured, exposed to noise pollution and chemical pollution, displaced from preferred habitat, and otherwise affected. In highly populated regions of the world, the synergistic or cumulative effects of people on sirenians are unmeasured but are likely not to be insignificant. More specific threats and

conservation problems affecting manatees in different countries is discussed in the section on the national status of the species.

1.2.3. Legal Status

Manatees are protected in most Caribbean countries by a combination of national legislation and international treaties and agreements (Table 4). The former are considered in greater detail in the country-specific sections; the latter are briefly described here.

There have been changes in the international legal status of the West Indian manatee in some of the countries of the Wider Caribbean since the development of the first UNEP Regional Management Plan in 1995 (UNEP 1995). Fourteen countries have ratified their participation in the different conventions and protocols protecting the species and its habitat (Table 4).

West Indian manatees are listed as endangered in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; http://www.cites.org/common/com/AC/16/E16-Inf-15.pdf#search=%22manatee%22). This prohibits the trade of any manatee products. West Indian manatees are considered to be vulnerable to extinction by the International Union for the Conservation of Nature (IUCN, Sirenia Specialist Group 1996), but the recommended status has recently been changed to endangered for both *T.m. manatus* and *T.m. latirostris* (Taylor *et al.* 2006).

All sirenians are protected by the Cartagena Convention Protocol Concerning Specially Protected Areas and Wildlife (SPAW Protocol, http://www.cep.unep.org/law/spawnut.html), which provides protection for special coastal and marine areas and wildlife. Specifically, the Protocol prohibits the possession, taking, killing, and commercial trade of any Sirenian species, including parts or by-products. The SPAW Protocol assists with the promotion of relevant agreements, *inter alia* CITES, the Convention on Biological Diversity (CBD), the Convention on Migratory Species (CMS), the Ramsar Convention on Wetlands, and provides linkages for their implementation. The mission of the latter is the conservation and wise use of wetlands by national actions and international cooperation as a means to achieving sustainable development throughout the world. The Ramsar Convention is safeguarded by UNESCO (United Nations Educational, Scientific and Cultural Organization) and has a secretariat co-located with the IUCN (http://www.ramsar.org).

The Cartagena Convention (http://www.cep.unep.org/law.html) sets out environmental policies to control pollution from ships, waste-dumping at sea, land-based sources, seabed activities, and airborne pollution, as well as protecting rare or fragile ecosystems and the habitats of depleted, threatened or endangered species (http://cep.unep.org/cartagena-convention). This Convention has been ratified by 23 member states in the Wider Caribbean Region which encircles the Caribbean Sea and Gulf of Mexico from as far north as Florida in the United States to as far south and east as French Guiana on the north coast of South America, as well as Mexico, Central America, and the many small island States and territories of the insular Caribbean. The Cartagena Convention is supplemented by three Protocols, which provide specificity to the broader issues addressed by the Convention. The Protocol on combating oils spills (the Oil Spills Protocol) was adopted at the time of the Convention in 1983. The Protocol concerning biodiversity issues or the SPAW Protocol became international law in 2000. The Protocol on land-based sources and activities of marine pollution (LBS Protocol) was adopted by governments in 1999 and has not yet entered into force.

The Convention on Biological Diversity also protects manatee habitat (http://www.biodiv.org/convention/default.shtml). This Convention, ratified by the majority of the world's governments, promotes the conservation of biological diversity and the sustainable use of its components. The Convention's governing body is the Conference of the Parties, consisting of all governments (and regional economic integration organisations) that have ratified the treaty. The CBD Secretariat operates under the United Nations Environment Programme (UNEP).

The International Convention for the Prevention of Pollution from Ships (MARPOL Convention) also protects manatee habitat. MARPOL is the main international convention aimed at controlling pollution from the shipping sector. The Convention was adopted in 1973 and modified by the Protocol of 1978. It covers all the technical aspects of pollution from all types of ships, except the disposal of waste into the sea by dumping. The Convention regulates what kind and quantities of polluting substances that ships may discharge into the sea, taking into account the ecological sensitivity of different sea areas (http://www.imo.org/Conventions/contents.asp?doc_id=678&topic_id=258).

Manatee habitat is also protected by the United Nations Convention on Law of the Sea (UNCLOS, also called simply the Law of the Sea or LOS), which establishes general obligations for safeguarding the marine environment. The Convention creates an innovative legal regime for controlling mineral resource exploitation in deep seabed areas beyond national jurisdiction through an International Seabed Authority. This treaty provides new universal legal controls for the management of marine natural resources and the control of pollution. The Convention is formed by 153 parties. Its Secretariat resides within the United Nations Division for Ocean Affairs and the Law of the Sea (http://www.lawofthesea.net/convention.htm). Table 4 lists the countries that have signed or ratified CITES, Ramsar, the SPAW Protocol, the Convention of Biological Diversity, the MARPOL Convention, and UNCLOS.

1.3. ECOLOGICAL IMPORTANCE

Manatees may serve as cultivation grazers in the same way that dugongs do (Fig. 4, Reynolds and Powell 2002). Manatee grazing may benefit seagrasses by (1) aiding in dispersal when plant fragments escape ingestion or (2) increasing nutrient levels from fecal matter scattered over the beds. Grazing has been reported to stimulate new growth, which in turn could enhance the nutritional value of the vegetation for the succeeding grazing events. *Thalassia* beds grazed by green turtles have higher nitrogen levels than those that are ungrazed. However, intensive grazing of seagrass blades stresses the beds, and green turtles eventually have to abandon their grazing plots. Nevertheless, the long-term effects of manatees grazing on seagrass beds are unknown (Provancha and Hall 1991).

Table 4. Legal status of the West Indian manatee, *Trichechus manatus*, throughout its distribution range. Note: ratif = ratified.

Country	National Legislation	Ramsar Convention (1971)		CITES (1973)		SPAW Protocol (1990)		Convention on Biological Diversity (1992)		MARPOL (1973)	UNCLOS
		Signed	Ratif.	Signed	Ratif.	Signed	Ratif.	Signed	Ratif.	Signed	Ratif.
Bahamas	x		x					x	x	x	x
Belize	x		x		x		x	x	x	x	x
Brazil	x	x	x		x			x	x		x
Colombia	x		x		x	x	x	x	x	x	x
Costa Rica	x		x		x			x	x		x
Cuba	x		x		x	x	x	x	x	x	x
Dominican Republic	x		x		x		x	x	x	x	x
French Guiana (French Department)	x		x		x	x	x		x	x	x
Guatemala	x		x		x	x		x	x	x	x
Guyana	x				x				x	x	x
Haiti								x	x		x
Honduras	x		x		x			x	x		x
Jamaica	x		x	x	x	x		x	x	x	x
Mexico	x		x		x	x		x	x	x	x
Nicaragua	x		x		x			x	x		x
Panama	x		x		x	x	x	x	x	x	x
Suriname	x		x		x			x	x	x	x
Trinidad & Tobago	x		x		x	x	x	x	x		x
United States (including Puerto Rico)	x		x		x	x	x	x		x	
Venezuela	x		x		x	x	x	x	x	x	x

2. NATIONAL STATUS

The following accounts are designed to provide an overview of several aspects of manatee biology and conservation at the level of the individual countries bordering the Caribbean Sea. The level of detail provided for each country varies depending on the amount of information available, but all accounts provide information concerning status and distribution, conservation threats, socioeconomic importance, and legal status of manatees.

2.1. REDEFINING "STATUS" OF MARINE MAMMAL STOCKS

Ragen *et al*. (2002) assessed criteria currently used to assess the status of marine mammals in the United States and concluded that, although the factors normally examined are useful, they do not provide a comprehensive picture. It is essential that future studies provide as complete an assessment as possible to promote wise conservation and management decisions. For example, scientists commonly assess status of marine mammals by conducting population surveys to count individuals in the wild and carcass salvage programmes to provide some information regarding numbers of dead individuals and cause of death. However, Ragen *et al.* (2002) noted that a more comprehensive view requires that a number of additional factors be assessed, including (a) health of individuals and the population, (b) population demography, and (c) the extent to which future threats are understood and under control. All too often, these additional criteria are neither adequately assessed nor factored into conservation and management decisions. An incomplete approach to evaluating status could lead to an unclear understanding of the real status of the species even after years of research—neither an effective nor a cost-efficient approach to providing the optimal information to guide conservation or mitigation decisions. For that reason, this report advocates as an ultimate goal the comprehensive approach endorsed by Ragen *et al.* (2002), although present funding and personnel limitations in many countries may require very fundamental initial approaches to status evaluation.

Figure 4. Manatee feeding on seagrasses (Photograph courtesy of Mote Marine Laboratory)

2.2 BAHAMAS

2.2.1. Status and Distribution

Manatees have never been common in the Bahamas. Sightings occur infrequently with no known area of persistent use. Although shallow seagrass beds are abundant throughout much of the Bahamas, limited freshwater sources may restrict the distribution of manatees there (Lefebvre *et al.* 2001).

The first report of manatees in the Bahamas occurred in 1904 in the Bimini Islands. Between 1965 and 1977, unconfirmed sightings of manatees were reported on Grand Bahama Island, and in 1975 a manatee was sighted at West End, Grand Bahama Island (Odell *et al.* 1978). Manatee sightings in the Bahamas increased throughout the 1990s, primarily in the northern islands. Twenty-five manatee sightings were recorded from 1995 to 1999 throughout the islands: Cat Island, Eleuthera Island, New Providence Island, Andros Island, Highbourne Cay, and Staniel Cay (Exumas), Great Harbour Cay (Berry Islands), Bimini, and many of the Abaco Islands (Lefebvre *et al.* 2001). In Andros Island and Walkers Cay (Abacos), residents reported not seeing manatees before the 1990s. In Bimini, a manatee was frequently seen for a period of six weeks in 1998. Between June 1997 and March 1998, one or two manatees were reported in the Abaco chain of cays including Tilloo Cay, Harbortown, Man of War Cay, Little Abaco Cay, and Walkers Cay. The only known mortality recorded for the Bahamas was a carcass recovered in 1975 from Freeport, Grand Bahamas Island (Lefebvre *et al.* 2001).

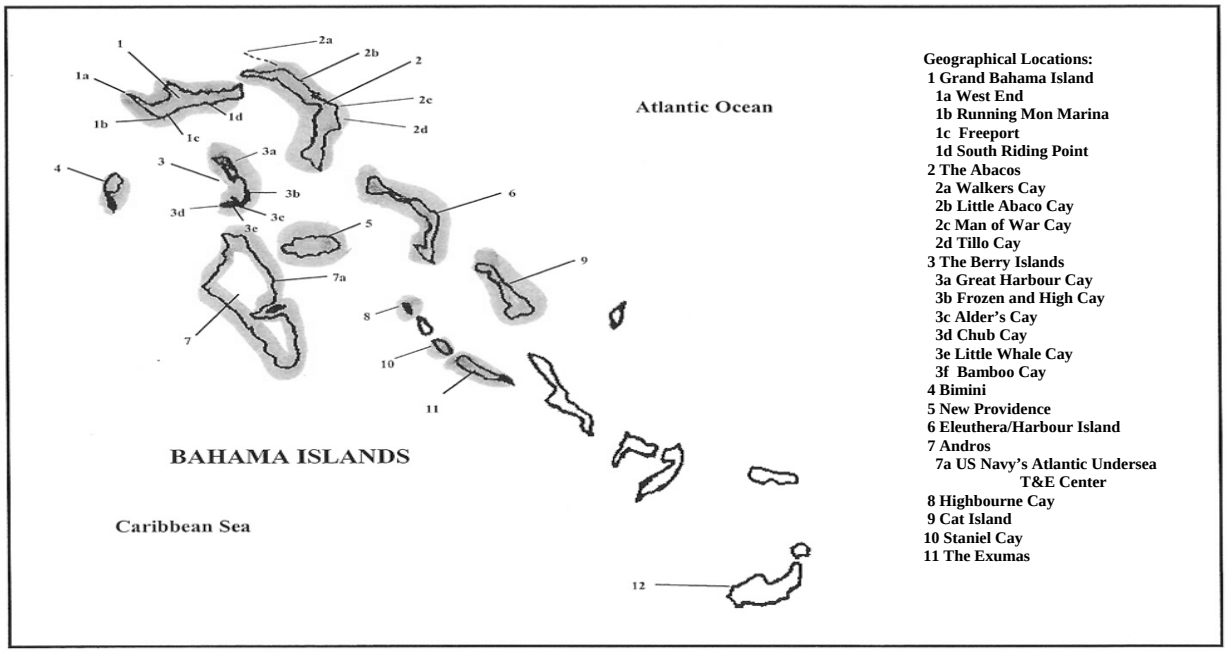

Figure 5. Distribution of manatees, *Trichechus manatus,* in the Bahamas based on best available data from documented sightings.

Researchers determined the identity of one individual as a manatee known from Florida (Lefebvre *et al.* 2001). From November 1998 to December 1999, a small adult female manatee was reported at the U.S. Navy's Atlantic Undersea Testing and Evaluation Center at Andros Island. In 2000, she was sighted at Great Harbour Cay, Berry Islands, an area 90 miles north of her earlier sighting in Andros Island. Distinctive scar patterns on her body revealed that these sightings were of the same individual. And

photo-identification analysis revealed that she had been originally photographed during the winter of 1994 as a calf at Crystal River on the west coast of Florida. In 1995, she was a juvenile, independent of her mother, but still using the Crystal River area (Reid 2000). This provided the first evidence of manatee movements from Florida to the Bahamas. However, the deep waters and strong currents separating Florida and the Bahamas probably make repeated movement of manatees between the two areas unusual. This suggests that manatees seen in the Bahamas are waifs; i.e., individuals from nearby populations that likely failed to orient to coastal waters, drifted with oceanic currents, and encountered the Bahamas islands (Lefebvre *et al.* 2001).

During summer 2000, this individual was frequently seen in Great Harbour Cay with a small adult male manatee (Reid 2000) and was sighted less frequently in other parts of the Berry Islands, including Chub Cay, Frozen and High cays, Alder's Cay, and Little Whale Cay. She gave birth to a calf in September 2001, the first known birth of a manatee in the Bahamas (Reid 2000, 2001a).

In 2001, at least two manatees were seen repeatedly at Grand Bahama Island, specifically at West End, South Riding Point, Bamboo Cay, and Running Mon Marina. Sightings were most common along the south shore of Grand Bahama Island, probably due to available habitat, which seems suitable for maintaining manatees. Manatees spend a large portion of their time resting within the marina basins and canals, travelling between inlets, and feeding offshore on seagrass beds (Reid 2001b).

2.2.2. Major Threats and Conservation Problems

Manatee hunting has not been reported in the Bahamas. Boat strikes are known to cause injury and death to manatees elsewhere and may pose a problem for manatees in high boat use areas of the Bahamas. Although idle speed regulations exist for boating safety or property protection, speed limits are not always obeyed. Thus, enforcement of regulated speed limits would help ensure the safety of manatees in the Bahamas. However, no record exists of manatees being recovered dead due to boat collisions (Lefebvre *et al.* 2001, Reid 2001b).

2.2.3. National Legislation and Conservation Measures

Manatees are protected under the Wild Animals Protection Act (Chapter 248, 21 of 1968 E.L.A.O. 1974), which prohibits the taking or capture of any wild animal from The Bahamas (The Government of The Bahamas 2004). In 2005, the government also created the Marine Mammal Protection Act (No. 12), which monitors and regulates human interactions with marine mammals. The Act prohibits taking, selling, or harassing any marine mammal (The Government of The Bahamas 2006). The Bahamas presently has one Ramsar site with a surface area of 32,600 hectares (ha) in Great Inagua Island (The Annotated Ramsar List 2007).

2.3. BELIZE

2.3.1. Status and Distribution

Belize has been referred to as the last stronghold for manatees in the Caribbean (O'Shea and Salisbury 1991), an assessment related in part to the quality and quantity of habitat available to manatees. A significant portion of the total area of the country includes the Belize Barrier Reef lagoon system, coastal lagoons, a convoluted and underdeveloped coastline, thousands of mangrove cays, and slow winding rivers, which are prime manatee habitat areas. The coastal waters and lagoons contain abundant seagrasses, encompassing an area of about 4,214 km^2.

This is estimated to be 72% of the total benthic habitat. In addition to the excellent habitat available to manatees, Belize also has a low human population density along much of its coast, helping preserve the quality of the existing conditions (Lefebvre *et al.* 1989).

Published literature suggests that the manatee population in Belize numbers between 300 and 900 individuals (O'Shea and Salisbury 1991, Auil 1998). However, manatee scientists currently working in Belize suggest that there are at least 1,000 individuals there (N. Auil pers. comm.). Of the countries bordering the Gulf of Honduras (i.e., Belize, Guatemala, and Honduras), Belize had the most manatee sightings during aerial surveys conducted over the inshore waters (Auil 2000, Quintana-Rizzo 2005a).

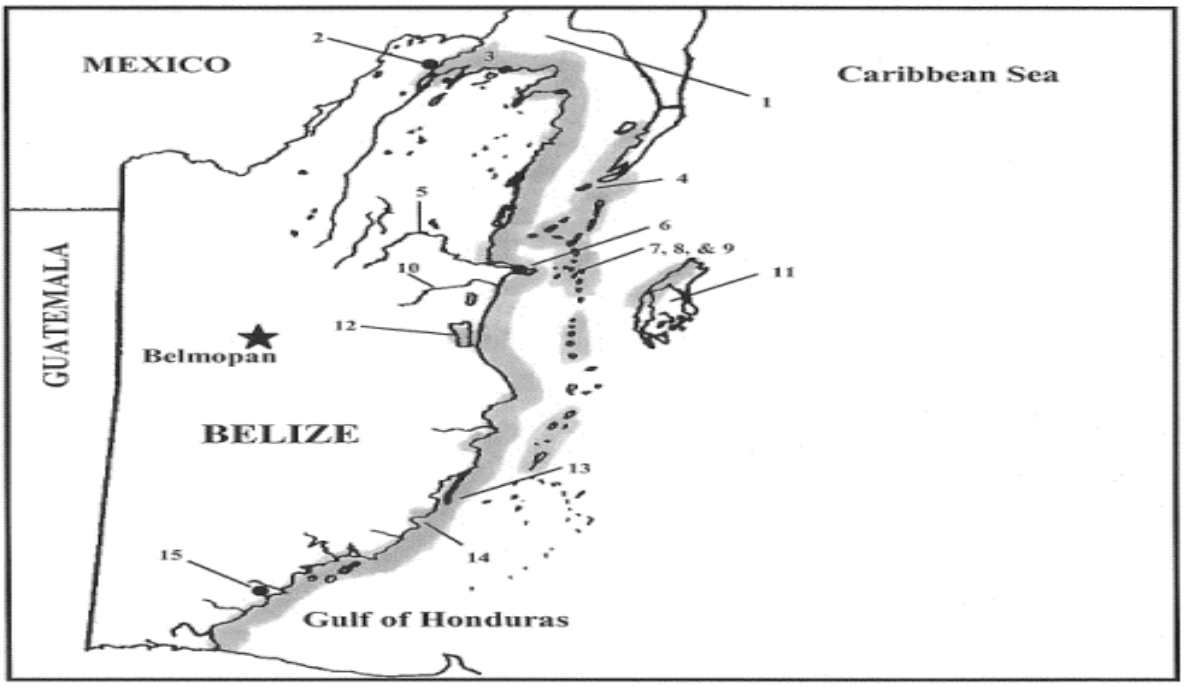

Figure 6. Distribution of West Indian manatees, *Trichechus manatus*, in Belize according to recent aerial surveys.

Manatee distribution has been mainly studied using aerial surveys because this is the most effective technique to examine distribution over large areas. In Belize, trend analysis based on aerial survey data collected from 1997 to 2002 suggests that the manatee population is stable or slowly declining. However, analysis of reproductive indices indicates that calf percentages are near or above the values reported for a healthy, growing population (O'Shea and Salisbury 1991; Auil 1998, 2004). The

discrepancy in results using different indices of the manatee population makes it difficult to conclude anything definite about the status of the species in the country (Auil 2004).

Manatees are unevenly distributed in Belize. Areas used consistently by a high number of manatees are Placencia Lagoon, Southern Lagoon, Indian Hill Lagoon, Port Honduras, and an area of 25 km (15 miles) radius around Belize City, which includes the coast of the city, the Belize River, Sibun River and the cays (Auil 1998, Bengtson and Major 1979, O'Shea and Salisbury 1991, Quintana-Rizzo 2005a). Seasonal differences in habitat use have also been documented (Auil 2004). In the dry season, manatees are more likely to use rivers than offshore areas such as the cays. This distribution pattern reverses in the wet season. The greater use of rivers in the dry season appears related to manatees' need for freshwater to drink. Freshwater supply is limited at far-off cays and atolls. In the wet season, the increase in rainfall may help animals to have their water needs met so that they do not need to spend so much time in the nearshore habitats. Manatees may also avoid the rivers in the nearshore habitats during the wet season due to the faster water currents from river outflow (Auil 2004). Rainfall and strong currents also increase water turbidity, which has a negative effect on the growth of aquatic vegetation eaten by manatees in the inshore habitats.

In recent years, research has focused on areas known to be important manatee habitat. There are four long-term site-specific manatee research projects currently underway, which provide important insight into the residency and ecological patterns of the species in different parts of the country. For example, manatees in Southern Lagoon are year-round residents (Powell *et al.* 2001). Southern Lagoon seems to also be an important site for manatees from adjacent countries. Recently, two satellite-tagged manatees travelled from Mexico along the coastline to Belize, with one stopping in Southern Lagoon and the other near Placencia. The first manatee stayed in Southern Lagoon for three months before returning to Chetumal Bay, Mexico. This is the first documentation of transboundary movement from the north to Belize (Auil pers. comm., Morales pers. comm.).

Between the Belize Barrier Reef and Belize City, there is a 13-km-long string of mangrove islands called Drowned Cayes (Self-Sullivan and LaCommare 2003, 2004). Despite general, seasonal changes in distribution between inshore and offshore habitats found by Auil (2004), manatees appear to use the Drowned Cayes habitat year-round for feeding, resting, socializing, and as a nursery (Self-Sullivan and LaCommare unpubl. data). Ongoing studies are examining the diurnal and nocturnal use of resting sites by manatees in the Drowned Cayes area (M-L.C. Bacchus pers. comm.). In contrast, areas of the Belize Barrier Reef near the Drowned Cayes and at Basil Jones Reef (75 km north of the Drowned Cayes near the border with Mexico) have been identified the presence of male manatees on a seasonal basis only, with frequent use during the summer/wet season and no use during the winter/dry season (Self-Sullivan et al. 2003).

The seasonal occurrence of male manatees along the reef may represent a reproductive strategy where males use the reef as a geographical marker for a travel corridor while searching for estrous females (Self-Sullivan *et al.* 2003). At the northern side of the Basil Jones Reef cut, manatees have been consistently observed between the end of the dry season and the end of the wet season on the reef. More than 250 resightings of 21 identifiable manatees were recorded from 1994 and 1999. Two manatees were resighted consistently over a three-year period (Smith 1999, Self-Sullivan *et al.* 2003). In other areas like Gallows Reef, manatees were sighted mainly in the warmer months, but the resighting frequency was undetermined. In some areas of the reef, manatees were not observed during the winter

(Self-Sullivan *et al.* 2003). One manatee was sighted in both the Gallows Reef and the Basil Jones Reef. This type of movement suggests that the Barrier Reef is a travel route of north-south movements and breaks in the reef seem to serve as stopover points during travel. Movements along the reef may be related to seasonal changes in water temperature, salinity, and depth (Self-Sullivan *et al.* 2003b).

Although 26% of the identifiable manatees reported at the Basil Jones and Gallows Reefs sites in Smith's study (1999) were of unknown sex, no females have been observed at these reef sites by either Smith or Self-Sullivan. The specific ways in which males use the Belize Barrier system during the mating season remain unclear and requires further investigation. In the Southern Lagoon, where tagged females have been consistently located and tracked for years, males have been recorded as moving through coastal waterways and along the coast (Auil and Powell unpubl. data).

Manatees have been consistently sighted at Turneffe Atoll, opportunistically as well as during boat and aerial surveys (N. Auil, A. Valentine, E. Hines, S.B.P. Holguin, Hancock, pers. comm.). They are most frequently observed within the western regions of the mangrove and seagrass lagoon system where waters are more protected (Holguin 2004). Turneffe is one of three coral atolls located east of the Belize Barrier Reef; it is approximately 30 miles long and 10 miles wide, with more than 200 mangrove islands within the central lagoon. Manatees have been sighted during all seasons at Turneffe Atoll, but with the exception of the tagged animal, no individual animals have been identified as yet. Without more data on the individual animals using Turneffe Atoll, it cannot be determined whether these sightings are of residents or transients.

2.3.2. Major Threats and Conservation Problems

Based on a population size of 1,000, the annual mortality was estimated to be approximately 2%. Causes of death include entanglement in fishing gear, poaching, watercraft-related injuries, and perinatal (calf < 150 cm in length; Auil and Valentine 2004). Poaching of manatees for food has occurred for decades, but few reports have been documented in recent years. Poverty and cultural practices seem to be one of the primary causes for hunting today. The Port Honduras area in the Toledo District has been an area of special concern with regards to manatee hunting (Auil 1998). At least 11 illegal manatee slaughtering sites were identified there in the 1990s (Bonde and Potter 1995). Slaughter sites are inconspicuous clearings of mangrove by the shore. Since the establishment by TIDE (Toledo Institute of Development and the Environment) of a ranger station on a cay in Port Honduras, no new poaching events have been reported. Poaching has been less common in the north, but there are reports of manatee hunters in the Corozal and Belize Districts (Auil 1998, Auil and Valentine 2004). The most recent report of poaching in the last two years came from the northeastern coast, where Mexican fishermen apparently slaughtered an undetermined number of manatees (SWEET 2006). Slaughter of a single adult can produce up to 450 kg (1,000 lbs) of meat that is sold or used for community subsistence (Auil 1998). It is uncertain if poaching continues in the southern border area, and it is likely to go unreported if it does occur.

Although poaching has been a problem in Belize, manatees are now facing other threats attributed to human activities. Watercraft collision was the predominant cause of death from 1996 to 2003 and the trend is increasing (Auil and Valentine 2004); some manatees have been reported to have boat scars. In 2006, a pregnant female was found dead in Buttonwood Bay; the animal was struck by a boat propeller possibly when the animal was seeking shelter in shallow water to give birth to its calf (http://www.cdnn.info/news/eco/e060303.html). Manatees are most vulnerable to collisions in the waters near Belize City because a large number of water taxis travel from the city to the cays nearby (Auil 1998). The number of registered boats also increased significantly in the mid-1990s, resulting in

the development of boat regulations in manatee areas. In fact, in the Drowned Cayes area, an ongoing photo-ID project indicates that 44% of the animals using the area carry boat scars (Self-Sullivan, unpubl. data).

From 1996 to 2003, death of perinatal manatees was the second leading category of deaths in Belize (Auil and Valentine 2004). Perinatal mortalities involve unexplained deaths of manatees less than 150 cm in length (U.S. Fish and Wildlife Service 2001). This trend declined over the seven years reported. Entanglement in fishing gear is not common but there have been reports of calves caught in nets (Auil and Valentine 2004).

Manatees are also threatened by the alteration and destruction of their habitat. In Belize, coastal zone development has increased due to tourism. Coastal and cay development requires the removal of littoral forests, seagrass destruction by dredging of canals, and mangrove destruction by the construction of seawalls. Development pressures also bring problems of water pollution because new structures result in more waste products being pumped directly into the sea or adjacent rivers and streams (Auil 1998). There has been an increasing trend in manatee strandings since 1996. The number of strandings per month was about one between 1996 and 2003.

2.3.3. Socioeconomic Significance of the Species to Local Communities

In Belize, manatees have been historically hunted for their meat, which is distributed within a community or sold at markets. Some body parts such as bones have been used to create sculptures and jewelry, which are also sold (Auil 1998). In 1998, gift shops at the Philip Goldson International Airport and in San Pedro (Ambergris Cay) sold sculptures and jewelry made from manatee bones. Although artifacts were confiscated and vendors were warned about their violations, it has not been possible to identify the supplier of the bones.

Today manatees have a significant economic value as a tourist attraction. Tourism is very profitable in Belize, particularly in relation to water activities like scuba diving and snorkeling. Snorkeling packages include visits to see manatees in their natural habitat for an average price of US$70.00 per person. Because the activity is not monitored, it can result in harassment of the manatees if tourists swim uncontrolled in the animals' vicinity. In 1992, this type of harassment became very common in the Swallow Caye and manatees stopped using the area. As a result, local tour operators persuaded Friends of Swallow Caye, a local non-governmental organization, to lead an effort to prohibit snorkeling with manatees in favour of boat observations for the commercial industry. This site and almost 9,000 acres of adjacent seagrass and mangrove habitat were legislated as Swallow Caye Wildlife Sanctuary in 2002. The sanctuary is currently co-managed by Friends of Swallow Caye and the Forest Department.

2.3.4. National Legislation and Conservation Measures

Belize has signed a number of international and regional treaties protecting wildlife and the marine environment (Table 4). At the national level, the Manatee Protection Ordinance (1933–1936) provided the first protective legislation for the species in Belize. In 1981, manatees were included as an endangered species in Wildlife Protection Act No. 4 of the Forest Department. The Act prohibits the killing, taking, or molesting of manatees, as well as possession and sale of any part of any manatee (Auil 1998). In 1996, the Conservation Division of the Forest Department implemented regulations prohibiting swimming with manatees, in part because manatees occupying locations frequented by tourists left those areas. In 1997, the Belize National Manatee Working Group discussed the benefits and

the possible guidelines needed for a successful practice of swimming with manatees. The Forest Department was considering allowing this activity if certain rules were established including the development of swimming guidelines, a requirement that tour guides complete a course in underwater manatee observation, and limiting swimming to specific days (Auil 1998). However, the Department has not allowed any commercial swim-with-manatee operations yet (C. Self-Sullivan pers. comm.).

Three protected areas in the country have been created specifically to protect critical manatee habitat. Swallow Caye Wildlife Sanctuary and Corozal Bay Wildlife Sanctuary (adjacent to Mexico's Chetumal Bay manatee protected area) have grassroots management, whereas Gales Point (Manatee) Wildlife Sanctuary will likely be managed by a community group within the next year. No management plans have been produced for these sanctuaries, but at least two should be developed by the end of 2007.

Belize has nearly 60 protected areas that encompass more than 40% of the country. Of this, more than 43% of protected areas are within the coastal zone. Areas such as Southern Lagoon, Gales Point, and Corozal Bay, all used by manatees, have been ratified as Wildlife Sanctuaries. The Burden Canal, located near Belize City, was established as a Nature Reserve to protect mangrove species (Auil 1998). The protection of the large population of manatees inhabiting the Belizean waters may promote population increases that could serve as a source for recovering populations in the adjacent countries of Mexico, Guatemala, and Honduras (Auil 1998).

Auil (1998) developed a recovery plan for manatees in Belize. The creation of the plan was supported by the Belize National Manatee Working Group with the Coastal Zone Management Project in Belize through an agreement with UNEP-CEP. The recovery plan summarizes major threats and conservation problems faced by manatees. It also summarizes education guidelines to ensure the protection of the species. A number of non-governmental organisations are involved in environmental education, but few focus specifically on manatee-related education. The Belize Audubon Society plays an important role in educating school children and adults about manatees and their habitat, and the Toledo Institute of Development and the Environment provides manatee education and monitoring in Punta Gorda (Auil 1998).

Another conservation measure proposed by the Belize Manatee Recovery Plan is the promotion of economic incentives to hunters who protect rather than kill manatees. For example, manatee tour guide positions can be created for former hunters. One animal can bring more revenue per day over a week of tourism than a one-time hunt (Auil 1998); this shift in resource use could provide a sustainable livelihood for local communities that previously relied on hunting.

2.4. BRAZIL

2.4.1. Status and Distribution

In Brazil, West Indian manatees have probably been extirpated from the states of Espírito Santo, Bahia, and Sergipe (Albuquerque and Marcovaldi 1982, Borobia and Lodi 1992, Lima *et al.* 1992, Lima 1997). Manatees are found from Alagoas to Amapá, but their distribution is discontinuous (Lima, 1997, Luna 2001). Important habitats for manatees include the coast of Alagoas, north of Pernambuco; Acaú/Ponta de Pedras; the estuary of the Mamanguape River (Paraíba); the coastline of Sagi (Rio Grande do Norte); the east coast of Ceará, Golfão Maranhense, and Baía de Tubarão (Maranhão); mangrove areas in Maranhão and Pará; and the region between the island of Maracá and the Oiapoque estuary (Amapá) (Lima 1997, Luna 2001). The West Indian manatee population is estimated to be around 500 animals (Lima 1997, Luna 2001); Amazonian manatees are not considered in this report.

West Indian manatees introduced by Projeto Peixe-Boi have been sighted in areas where manatees have historically been recorded including the Real and Mosqueiro rivers (Sergipe), estuarine areas of the Tatuamunha and Manguaba rivers (Alagoas), the north coast of Alagoas, and the area south of Pernambuco (Lima *et al.* 2004). West Indian manatees appear to be sympatric with the Amazonian manatee in the inshore waters and the northeastern side of Marajó Bay (Domning 1981, Lima *et al.* 1994, Luna 2001), which may have resulted in some hybridization (Vianna *et al.* 2003, 2006). In the Amazon River basin, the predominant species is the Amazonian manatee.

Figure 7. Distribution of West Indian manatees, *Trichechus manatus,* in Brazil according to best available data from reported sightings.

2.4.2. Major Threats and Conservation Problems

Historically, the major threat to manatees was intense hunting that started when Brazil was colonized, resulting in an apparent population decline and a reduction of their home range. Hunting pressure nearly disappeared in the northeastern part of the country after several actions took place including the creation of federal law Nº 5.197, which protects wildlife species (1967), and the development of a strong educational programme by Projeto Peixe-Boi in 1980.

In the 1990s, major threats to manatee survival included incidental entanglement in a variety of fishing gear (gillnets, stationary nets placed in the mouth of rivers, shrimp nets, and pound nets) and deliberate harvest for food and other purposes (see below) (Lima 1997, Oliveira *et al.* 1994, Parente *et al.* 2004). At least 43 calves were entangled in the northeast between 1981 and 2002. These incidental entanglements may relate to an expansion of human activities there (e.g., tourism, fishing, and the installation of aquaculture farms and salt mines), with a resultant decrease in quiet habitat for females and their calves (Lima *et al.* 1992, Parente *et al.* 2004).

Protected areas have been created especially for calves and their mothers, but they are largely unenforced. Environmental degradation in some parts of Brazil may also have affected the behaviour of manatees. For example, mangrove areas used for aquaculture projects have many motorboats that have the potential to restrict the movement of manatees to freshwater sources, feeding, and reproductive areas. The increase in the number of boats and jet skis increases the potential for manatee mortality. Along the northern coast of Brazil, coastal ecosystems are well preserved. The main threat that manatees face in this part of the country is hunting with harpoon. Other threats include incidental entanglement in set nets called "zangarias." In 2005, nine manatees died as a result of incidental entanglement in the state of Maranhão, and this represented a notable increase in this type of mortality. The existence of these problems suggests that there is a need for educational programmes that help create awareness. However, because education does not necessarily produce appropriate changes in human behaviours, there is also a need for regulations, protected areas, and enforcement.

2.4.3. Socioeconomic Significance of the Species to Local Communities

In Brazil, hunting of manatees was described as part of the history of the early years of the colonization. The activity was common among indigenous peoples. In the northeastern part of the country, the method of capture involves harpooning a manatee from a canoe and then following the animal until it dies (Lima 1997). Another technique used in the north consists of putting a net at the mouth of rivers used by manatees so that animals become entangled as they swim. Hunting requires some knowledge about the biology and habits of the species and, thus, it is a specialized activity. Knowledge is transferred from one generation to the next (Lima 1997).

Hunting is now almost nonexistent in Brazil due to the environmental campaigns developed and conducted by IBAMA directly within the coastal and riverine communities. As part of the same effort, Projeto Peixe-Boi employs local people, including former hunters, to report sightings of wild manatees and to monitor manatees that are reintroduced to the wild, which helps promote awareness of the value of living manatees.

2.4.4. National Legislation and Conservation Measures

Federal law Nº 5.197 has protected manatees since 1967 (Table 5); hunting is considered a crime. The species has been listed among the Brazilian Fauna Species Threatened to Extinction since 1989 (Brasil 1989, 2003) and it is the only species classified in the Action Plan of Aquatic Mammals of Brazil as "critically endangered" (IBAMA 1997, 2001).

In 1980, the federal government created Projeto Peixe-Boi to conduct manatee research (Table 5). In the first decade, its work focused on environmental campaigns and an extensive study examining the distribution of manatees and major threats affecting the species in the northern and northeastern parts of the country (Lima *et al.* 1992, Lima 1997, Luna 2001).

In 1992, the Rehabilitation Unit of the Aquatic Mammal Center (CMA/IBAMA) was created on Itamaracá Island, Pernambuco. The unit has received 44 orphaned manatees that were rescued in collaboration with the Northeastern Marine Mammal Stranding Network (REMANE). The animals are in a public exhibit. Eight additional manatees were born in captivity or received from institutions that kept them in inappropriate captive conditions.

In 1994, a reintroduction programme started with the release of two orphaned manatees. Currently, 13 animals have been reintroduced in areas of the original historical distribution. This helps increase the size and reproductive potential of the wild population (Lima *et al.* 2005).

Table 5. National legislation and conservation measures taken to protect manatees in Brazil

Year	Legislation	Objective
1967	Law Nº 5.197	Protection of fauna
1980	Convention IBDF/MI e FBCN	Creation of Projeto Peixe-Boi Marinho
1989	Decree IBAMA No 1.522	Official List of Brazilian Fauna Species threatened to extinction
1990	Decree IBAMA Nº. 544	Creation of Centro Peixe-Boi/IBAMA to develop projects on two sirenian species
1994	Decree IBAMA Nº 2.097	Creation of the specialist work group of aquatic mammals (GTEMA)
1996	Normative Resolution of State Consul for Environmental Protection of Alagoas, n 04	Prohibition of motorboat traffic along the coast of Alagoas to protect manatees
1997	Action Plan	Aquatic Mammal Action Plan v. I. MMA/IBAMA - species critically threatened to extinction
1998	Decree IBAMA No 143	Creation of the Center for Aquatic Mammals/ IBAMA
2000	Decree MMA Nº 98	Establishment of legislation to maintain aquatic mammals in captivity
2000	Decree IBAMA Nº 039	Creation of the Marine Mammal Stranding Network in the Northeast/REMANE
2001	Action Plan	Aquatic Mammal Action Plan v. II/MMA-IBAM – species critically threatened with extinction
2002	Normative Instruction IBAMA No 03	Regulation of marine mammals in captivity
2002	Decree IBAMA Nº 039	Creation of Executive Units of CMA in the states of Alagoas, Amazonas, Ceará, Maranhão, Para, Paraíba, and Piauí
2003	Normative Instruction MMA, Nº 03	Official List of Brazilian Faunal Species threatened with extinction
2003	Municipal Law N° 051	Declaration of Cajueiro de Praia as National Patrimony of a native population of manatees of the species *Trichechus manatus manatus*

Important geographical areas for the conservation of manatees were identified and created by the Regional Executive Units of CMA/IBAMA. The areas are in the states of Alagoas, Paraíba, Ceará, Piauí, and Maranhão. Other areas of conservation were also created simultaneously with the areas relevant to the species (Table 6) in Costa dos Corais (Alagoas and Pernambuco), Barra do Rio Mamanguape (Paraíba), and Delta do Parnaíba (Piauí).

Brazil presently has eight sites designated as Ramsar sites: Baixada Maranhense Environmental Protection Area, Ilha do Bananal, Lagoa do Peixe, Mamirauá, Pantanal Matogrossense, Parque Estadual Marinho do Parcel Manoel Luís including the Baixios do Mestre Álvaro and Tarol, Reentrancias Maranhenses, and Reserva Particular do Patrimonio Natural SESC Pantanal. These sites have a total surface area of approximately 6,434,086 hectares (The Annotated Ramsar List 2007).

Table 6. Conservation areas for manatees in Brazil

Year	Legislation	Purpose
1980	Decree Nº 84.913	Creation of National Park Cabo Orange (Amapá)
1980	Decree 84.914	Creation of Biological Reserve Lago Piratuba (Amapá)
1981	Decree 86.061	Creation of Federal Ecological Station Maracá-Jipioca (Amapá)
1993	Decree Nº 924	Creation of the Estuarine Protected Area Rio Mamanguape (Paraíba)
1993	County Law Nº 12	Creation of the Marine National Park of Paripueira (Alagoas)
1996	Decree S/N° de 28/08/96	Creation of Environmental Protected Area of Delta do Parnaíba (Piauí)
1997	Decree S/Nº de 23/10/1997	Creation of Environmental Protected Area of Corais (Alagoas and Pernambuco)
2001	Decree 22/11/2001	Marine Reserve of Soure (Pará)
2002	Decree S/N de 13/12/2002	Creation of the Reserve Mãe Grande de Curuçá/Pará
2002	Decree S/N de 13/12/2002	Creation of the Reserve Maracanã (Pará)
2002	State Decree 22.882	Area of Environmental State Protection of Tambaba (Paraíba)
2004	Decree S/Nº 02/06/2004	Creation of the Reserve Cururupu (Maranhão)

2.5. COLOMBIA

2.5.1. Status and Distribution

Manatee habitat in Colombia includes coastal lagoons, creeks, swamps, and floating meadows (UNEP 1995). West Indian manatees are found in three major zones: Río Magdalena (including the basin of the main river and its tributaries), the Atrato and Sinu rivers (independent of Río Magdalena), and the Río Orinoco that borders Venezuela (including the basin of the river and Río Meta; MADVT 2005). Some manatees live more than 1,100 km inland from the Caribbean Sea (Castelblanco-Martinez *et al.* 2003). In Río Sinu, before the construction of the Urrá Dam in 2000, manatees could be sighted up to Cienaga Grande de Lorica (MADVT pers. comm.), but they were rare or extirpated from areas as far as Tierralta, where they were once reported (Montoya-Ospina *et al.* 2001). The current distribution of manatees in the river is unknown, but the dam has significantly changed the quality of the waters of the river (MADVT pers. comm.). In Río Magdalena, manatees have been confirmed in the lower and middle reaches of the river basin, which includes wetlands and tributaries, as well as in the states of Antioquia (Río Cauca), Cordoba and Sucre (Río San Jorge) Santander, Cesar, Bolivar, Bolívar Atántico (Canal del Dique and wetlands), and Magdalena. There are unconfirmed reports of manatees in the basins of San Lorenzo, Río Cimitarra, and Río Canaletal (MADVT 2005).

Figure 8. Distribution of West Indian manatees, *Trichechus manatus*, in Colombia according to interviews and reports from published and unpublished documents.

In 2003, an oil spill (>5,000 barrels) occurred in Santander State, specifically at Cienaga de Paredes, a shallow system with water depths ranging from 0.7 to 1.2 m. Approximately 40 manatees are found in the area during the winter and half that number in the summer, at which time some manatees are thought to migrate to deeper locations such as the Peruétano channel (Holguin 2003 unpubl. report). Groups of up to 10 animals occur in Cienaga de Paredes, although groups of 2 or 3 animals are more common (Holguin and Trujillo 2003 unpubl. report). The effects of the spill on manatees and habitat are unknown.

Although manatees seem to prefer shallow waters, groups of three or more manatees are sometimes sighted in deeper water (> 5.8 m; Castelblanco-Martinez *et al.* 2003, 2004). Feeding manatees consume different types of aquatic plants (Table 1) including floating macrophytes (Aguilar-Rodriguez *et al.* 2004). Manatee distribution appears to be associated with weak currents (mean = 4.04 km/h; Castelblanco-Martinez *et al.* 2003).

2.5.2. Major Threats and Conservation Problems

The major threat to manatees is habitat loss and destruction due to contamination, deforestation, draining of wetlands, sedimentation, mining, transformation of land for cattle-ranching, development of shrimp farms, and projects for tourists (MADVT 2005). Construction of roads can also alter available habitat. In the 1970s, an extensive area of mangroves was destroyed by the construction of a highway that blocked the flow of water between the sea and the Ciénaga Grande de Santa Maria. This probably had an effect on the movement of manatees between fresh and saltwater areas (Montoya-Ospina *et al.* 2001).

Incidental entanglements are also a problem in areas like Río Magdalena, near Magangue, and Puerto Carreño (Vichada State; Castelblanco-Martinez and Bermúdez 2004 and Montoya-Ospina *et al.* 2001, MADVT 2005,). In the latter two areas, entanglement is the most critical threat to manatees, with 66 cases in the Magangue River alone in 2003 (Aguilar-Rodriguez *et al.* 2004) and 36 instances in Puerto Carreño between 1985 and 2005 (Castelblanco-Martinez and Bermudez 2004). Of those 36 cases, 26 manatees accidentally died nets or were killed by fishermen for meat.

Deaths by entanglement are more common in the beginning of the wet season (May and June) in the Meta, Orinoco, and San Jorge rivers, and they may relate to a combination of seasonal migrations by manatees and intensive fishing activities. Manatees stay in refuges in the dry season, but they migrate in search of food as winter starts because aquatic macrophytes are more abundant at that time (Aguilar-Rodriguez *et al.* 2004). Refuges are not officially protected areas, but they experience low human impact (MADVT pers. comm.). Many incidental catches occur from small nets with lead lines called "chinchorro," which are placed at the intersection of a river and a lagoon. Calves and subadults represent 62% of the animals that are caught and die in the nets; fishermen believe that adults are often large and powerful enough to escape (Montoya-Ospina *et al.* 2001, Castelblanco-Martinez *et al.* 2003, Castelblanco-Martinez and Bermudez 2004). In cases in which mother-calf pairs were captured, the mother was killed and the calf was kept as a pet without proper care or raised by fisherman for future use (as food or to be sold; Montoya-Ospina *et al.* 2001).

Directed hunting for manatees is much less common today than in the past for several reasons: more people are aware of the laws protecting manatees; manatee meat sales are not lucrative because people do not make enough money selling it; hunting is difficult to learn (Castelblanco-Martinez *et al.* 2003, Aguilar-Rodriguez *et al.* 2004); and there are few specialized manatee hunters and most people do not know the technique (Aguilar-Rodriguez *et al.* 2004). Currently, hunting only occurs in specific areas and seasons. Manatee hunting with harpoons and traps has been reported in the Meta River and in many Amazon indigenous communities. In Puerto Carreño, hunting accounts for less than 41% (n = 28) of manatee deaths (Castelblanco-Martinez and Bermudez 2004). Hunting in the Orinoco River mainly occurs during the winter (July – November) when manatees migrate from the refuges in search of food (Castelblanco-Martinez *et al.* 2003, Castelblanco-Martinez and Bermudez 2004). In the Madgalena, Sinu, and San Jorge rivers, hunting is frequent during the dry season. In areas like Atrato and Meta rivers, hunting occurs in both seasons (Montoya-Ospina *et al.* 2001).

Other types of mortality include boat collisions, stranding, and vandalism. In the basin of Río Magdalena and Puerto Carreño, there have been reports of manatees being shot (Castelblanco-Martinez and Bermudez 2004, MADVT 2005). Some of those deaths appear to be related to the political conflict and violence in the country (MADVT 2005).

2.5.3. Socioeconomic Significance of the Species to Local Communities

A manatee represents a source of food or income, although not much money is gained from selling the meat. Manatee products are commonly shared among fishing families and occasionally, they are sold in local communities. The average price of manatee meat varies among regions from US$1.60/kg (US$3.50/lb) to US$5.00/kg (US$11.00/lb (Montoya-Ospina *et al.* 2001, Castelblanco-Martinez and Bermudez 2004). Captured manatees are butchered at the site of capture or are sold alive in local markets (Montoya-Ospina *et al.* 2001). Meat is eaten fresh or salted and dried. In 1997, El Tiempo newspaper reported that four manatees were killed near Cartagena. The meat was sold on local markets as pork to avoid drawing the wrath of local environmentalists. Some Colombian cookbooks continue to include recipes for manatee.

Manatee fat is used to make candles and for cooking and frying food (Montoya-Ospina *et al.* 2001, Castelblanco-Martinez *et al.* 2003). The skin is used to make shoes, leather straps, and hammocks (Montoya-Ospina *et al.* 2001, Aguilar-Rodriguez *et al.* 2004). Bones are thought to have medicinal properties including the cure of snakebites, rheumatism, colds, and asthma. Manatee ear bones are used to 'cure' hearing problems (Montoya-Ospina *et al.* 2001, Castelblanco-Martinez and Bermudez 2004). Some communities believe that manatee genitalia, skin, and ribs have a magical significance. Others, such as the Sikuani tribe of the Orinoco, have a high regard for living manatees. The Sikuani see manatees as the most important animal living in the rivers, and they believe that the rivers and lagoons will dry if they eat manatee meat (Castelblanco-Martinez *et al.* 2003, Castelblanco-Martinez and Bermudez 2004).

2.5.4. National Legislation and Conservation Measures

Colombia has signed a number of international and regional treaties protecting wildlife and the marine environment (Table 4). At the national level, manatees have been protected since 1969 by Resolution No. 574, which prohibits hunting of any endangered mammal. The same resolution prohibits the transport, commercialization, and use of manatee products. The violation of the law results in three to seven years in prison or a fine of 50 to 300 monthly salaries at a minimum pay rate (Castelblanco-Martinez and Bermudez 2004). In 1974, the Code for Natural Resources, later reformed by Decree 622 in 1977, was created to protect the natural resources of the country. Habitat is also protected by Decreto 1681 of 1978 and Law 13 of 1990. In 1987, Decree 1608 was created to regulate the use of and research on aquatic wildlife. Decree 2356 of 1991 regulates fisheries activities that indirectly affect manatee conservation. In 1994, a regional regulation was adopted by Magangué City Hall to protect manatees.

In 1988, INDERENA (Instituto Nacional de los Recursos Naturales y del Ambiente), the government agency for natural resources, conducted a study to evaluate the status of manatees in the lower and middle zones of San Jorge River, a tributary of the Magdalena River. The project additionally helped to create educational programmes. The Corporación Autónoma Regional del Magdalena and the Corporación Regional del Atlántico have also developed educational activities. However, the duration of such programmes has been short due to limited funding (Montoya-Ospina *et al.* 2001).

In 1990, the Corporación Autónoma Regional de los Valles (CVS) of the Sinu and San Jorge rivers started a project to rescue and rehabilitate neonate and adult manatees. They also created an educational programme for the region that was supported by the Caribbean Stranding Network. The Caribbean Stranding Network helped to rehabilitate manatees in different areas in the states of Cordoba, Bolivar, and Atlántico during the 1990s.

In 1993, INDERENA created a central office to establish general policies and regional agencies to conduct wildlife management. There are no federal regulations guiding the maintenance of manatees in captivity for rehabilitation or exhibition purposes. Still, there have been captive and semi-captive manatees in several parts of the country. In Magdalena, at least 10 manatees have been kept in captivity in Magangue State and they have been used a part of the educational programme of Fundación Amigos del Manatí. Via Parque de Salamanca, located in the mouth of the Magdalena River, has a dwarf male manatee, which is also used as part of the educational programme. Other captive programmes can be found in the states of Bolivar, Cesar, Santander, and San Antero (MADVT 2005).

In 1996, the department for natural resources, Ministerio del Medio Ambiente, took the lead in developing a national recovery plan for the conservation of manatees in Colombia with the support of the United Nations. The recovery plan was developed with funding from ECOPETROL. The document reviewed all available information about manatees in Colombia and established criteria used to implement a management plan.

In Cienaga de Paredes in Santander State, the local community is proud of having manatees in the area. People are conscious of the endangered status of the species and they have created an association called ProEcomanati. The association is interested in promoting better living conditions for people living in the marsh region at the same time that they protect different natural resources. Manatees are the flagship species of the conservation work of the community (Holguin 2003 unpubl. report).

In 2004, different institutions have been involved in the different studies. The Ramsar Convention and the programme Wetlands for the Future (a special initiative of the U.S. Fish and Wildlife Service) supported the efforts of the Ministerio de Ambiente, Vivienda y Desarollo Territorial, and of local non-governmental organisations like Fundación Omacha to develop the first national programme for the conservation and management of manatees in Colombia. Data gathering and publication of the final document were funded by several organisations including the Ministerio de Ambiente, Vivienda y Desarrollo Territorial, Fundación Omacha, Fondo para la Accion Ambiental, Conservation International, WWF, Convention on Wetlands, and the U.S. Department of State.

Colombia has established three Ramsar sites: (1) Sistema Delta Estuarino del Río Magdalena, Ciénaga Grande de Santa Marta, () Laguna de la Cocha, and (3) Delta del Río Baudó. These sites have a surface area of approximately 447,888 hectares (The Annotated Ramsar List 2007).

2.6. COSTA RICA

2.6.1. Status and Distribution

Manatee distribution appears to have been consistent in Costa Rica since 1997. The distribution is continuous and extends from the Río Colorado to shallow water areas located just north of Caño California covering an area of approximately 65,000 ha (Jiménez 1998, 2005). Reports of manatee sightings exist in the following areas (from north to south): Caño Madre of Río Colorado, Caño Negro of Río Colorado, Laguna la Garza, Laguna Cahué, Laguna Yaki, Dos Bocas del Colorado, Laguna Pereira, low Río Colorado, Laguna Penitencia, Cuatro Esquinas, Río Tortuguero, Caño Sierpe, Caño California, and its tributary Caño Aguas Negras. The best manatee habitat is probably in the Tortuguero region, including Parque Nacional Tortuguero, and Refugio de Vida Silvestre Barra del Colorado (Reynolds *et al.* 1995; Jiménez 1998, 1999, 2000). Manatees can be sighted near blowing holes in Agua Fria, Caño Aguas Negras, Caño Palma, Caño Negro, Jalova, Sierpe, Caño Moreno, and Caño Palacio. Seasonal migrations downstream and upstream in rivers may occur between dry and rainy seasons, respectively (Reynolds *et al.* 1995, Smethurst and Nietschman 1999).

Manatees appear to prefer areas with intermediate temperatures, abundant aquatic vegetation, forest cover, high water visibility (Jiménez 1998, 2005), little human presence (i.e., low boat traffic), and proximity to blowing holes. In the past, an inverse correlation between boat traffic and manatee sightings existed in Aguas Frias (Smethurst and Nietschman 1999) based on observations made during daylight hours. At present, boat traffic is regulated; only boats with electric or four-stroke engines are allowed, and these are required to travel at or below 5 km/h within an area of approximately 1 km (A. Gómez-Lépiz pers. comm.).

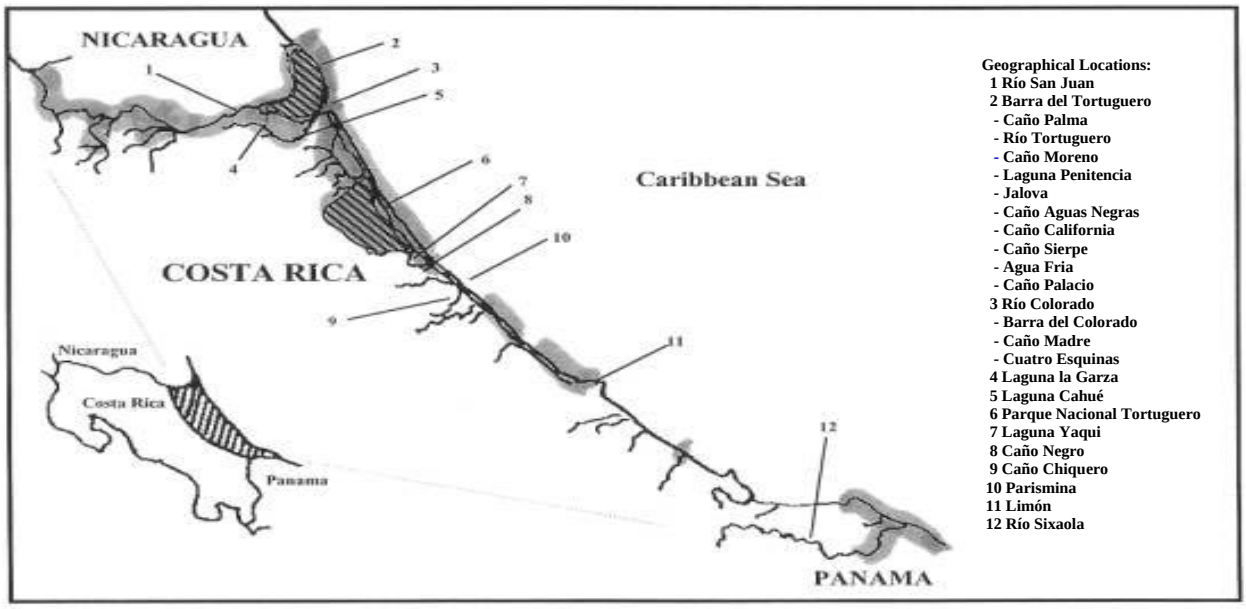

Figure 9. Distribution of West Indian manatees, *Trichechus manatus*, in Costa Rica according to interviews and boat and land- based observations.

Frequent reports of manatee sightings in the area suggest that manatees are beginning to use the area to a greater extent since the implementation of these regulations. At night manatees appear to use areas avoided during the day (I. Jiménez pers. comm.)

The area between Limón and Panama seems to be less favourable habitat, with mountains reaching the sea and few rivers or lagoons (Lefebvre *et al.* 1989). However, manatees have been sighted in a coral reef area between Panama and Costa Rica (Jiménez 1999). Interviews with local people suggest that manatees are more common and are observed in larger groups (i.e., 7 to 20 animals) now than they were 10 years ago, especially near Parismina and Barra del Colorado (Jiménez 2005). An increase in number of sightings could reflect changes in the behaviour of manatees or actual increases in number of animals inhabiting Costa Rican waters.

2.6.2. Major Threats and Conservation Problems

Four threats affect manatees in Costa Rica: watercraft, poaching, contamination, and habitat degradation. The number of motorboats has increased significantly since 1996 in Parismina and Tortuguero (Jiménez 2005). Additionally, the boats being used are becoming larger, with more and more powerful engines. Manatees are struck by boats (Smethurst and Nietschman 1999) even in protected areas like Parque Nacional Tortuguero (Jiménez 2005). As noted, during the day manatees appear to avoid using areas frequented by boats, even if the areas are prime habitats.

Poaching is also a threat, although it does not appear to be significant at present. Jimenez (2000) noted that there were no manatee hunters less than 60 years old in the coastal region of the Caribbean coast, although in 1998 Smethurst and Nietschman (1999) interviewed a former manatee hunter who reported that three men from Barra del Colorado asked him to teach them how to hunt manatees. Still, local manatee researchers indicate that manatee hunters are uncommon in Costa Rica (A. Gómez-Lépiz, C. Espinosa). Incidental entanglements, especially of calves, have been reported. Although gillnets are illegal, there is little to no enforcement of their use (Jiménez 2000). Entanglements are uncommon in Parque Nacional Tortuguero and Refugio de Vida Silvestre Barra del Colorado (Jiménez 2005).

Habitat in Costa Rica has been degraded or destroyed by commercial banana cultivation, logging, and ranching. Banana cultivation has increased sediment build-up along some sections of rivers and lagoons (Smethurst and Nietschman 1999). Additionally, the banana industry is the main source of water pollution due to contaminants, especially carbamates and organophosphates, which can also affect wetlands and fish (Smethurst and Nietschman 1999, Jiménez 2005). Costa Rica was the second largest banana export country in the world from 2000 to 2004, according to the United Nations Conference on Trade and Development. One-third of the pesticides imported are used by the banana industry (Jiménez 1999). Indeed, two or three fish kills per year have been reported after heavy rains when pesticides are washed out from the banana plantations into the river system (Smethurst and Nietschman 1999). The effect of these pollutants on manatees is unestablished but likely is directly or indirectly detrimental to their survival in affected areas.

Deforestation related to banana cultivation or other factors increases sedimentation processes along the shore and even the flow of rivers. For example, Caño Chiquero once had a calm lagoon commonly used by manatees, but strong currents and deeper waters there may now inhibit manatee use (Jiménez 2000).

2.6.3. Socioeconomic Significance of the Species to Local Communities

The only significance of manatees to the local communities today involves ecotourism (Jiménez pers. comm.). The increase in recent years in sightings of manatees has stimulated their use as a local attraction in some areas.

2.6.4. National Legislation and Conservation Measures

Costa Rica has signed international conservation agreements (Table 4), which protect both manatees and their habitat. At the national level, manatees have been protected since 1953. In 1992, Ley de Conservación de la Vida Silvestre No. 7317 characterized manatees as endangered. People have become more aware of the presence of manatees in Costa Rica over the past several years. The institution responsible for this change and most of the manatee educational programmes is Fundación Salvemos al Manatí de Costa Rica (FSMCR), which was established in 1996. The FSMCR has been closely involved in research and educational programmes. They have created and distributed a comic book for children and a book describing the ecology and conservation of manatees in Costa Rica. The FSMCR is also responsible for creating a play about manatees using puppets that has been seen by more than 1,000 people including members of different local communities and elementary and high school students (Espinoza Marín 2002) and has published several newspaper articles related to manatees.

In 2004, Ignacio Jiménez from FSMCR created the "Plan de Conservación del Manatí en Costa Rica." The first draft of the document was written with the support of UNEP-CEP in 1998 and the final document was created as a collaborative effort of local and national participants interested in the conservation of the manatee. Although the Costa Rican government has not officially adopted the plan, institutions like the Area de Conservation Tortuguero and FSMCR use the document to plan their conservation activities (Jiménez 2005). In fact, the two institutions have developed environmental campaigns to educate people on the importance of regulated boating speed zones in sensitive habitats. They have also worked to develop boat traffic signals in areas within the park that are important to manatees.

Other conservation initiatives include the study of ecological aspects such as the habitats used in particular areas of Costa Rica. For this purpose, two attempts to capture and tag four manatees using VHF transmitters were carried out in 2004 and 2005, but neither was successful in capturing animals. Yet, understanding ecological aspects of the species is an important issue; thus a study was conducted to evaluate the possibility of attracting manatees to particular sites in order to be captured, tagged, and released.

The study, which was conducted in the Parque Nacional Tortuguero, tested the use of aquatic plants that form part of the diet of local manatees as bait. Plants used included *Eichhornia crassipens, Hydrocotyle ranunculoides, Urochloa mutica,* and *Paspalum repens*. The study also tested the effectiveness of fruits such as mangos, apples, carrots, and lettuces as potential baits. The general set up of the experiment included plants tied in a rope that was hung in a horizontal line at the surface of the water column in narrow rivers (attached to trees on either side of the bank). Over a period of eight months, manatees ate only *Paspalum repens,* and as a result, an enclosure was built to see if manatees would enter and continue eating the plants. This proved successful as well, and thus attracting manatees in such a way will eventually be used to capture them for tagging purposes (Gómez 2006).

Conservation initiatives also include the development of protected areas. Costa Rica has 11 Ramsar sites with a surface area of 510,050 hectares. Those sites include areas such as Gandoca-Manzanillo, Caño Negro, and Puntarenas (The Annotated Ramsar List 2007).

2.7. CUBA

2.7.1. Status and Distribution

Information on the status of manatees in Cuba is limited. Local researchers have speculated—without corroborating scientific data—that Cuba possesses a large manatee population because the coast is extensive and has excellent habitat for manatees (Santos Mariño 2006). Shallow protected coastal areas and many rivers are found on both the northern and southern coasts (Lefebvre *et al.* 1989). Since 2002, sightings of manatees have been documented for almost every province including, from west to east, Pinar del Rio, Matanzas, Villa Clara, Ciego de Ávila, Camaguey, Las Tunas, Granma, Holguin, and Guantanamo. Manatees have also been sighted off Isla de la Juventud, an island classified as a "municipio especial" (special municipality; Santos Mariño 2006).

The current distribution of manatees appears similar to that documented by a comprehensive national survey conducted in 1986, which indicated that manatees were distributed along both coasts with greater concentrations in the Ensenada de la Broa, Río Hatiguanico, and southern coast of Zapata Peninsula (Lefebvre *et al.* 2001). These regions have numerous estuaries, abundant submerged aquatic vegetation, and a sparse human population. The highest counts of manatees during aerial surveys conducted in Zapata Peninsula, Ensenada de La Broa, and Río Hatiguanico were 39 (in 1987), 20 (in 1992) and 25 (in 1996). An aerial survey conducted between the mouths of Río Jatibonico del Sur and Río Agabama (including the lower portion, which is called Manatí), south of Sancti Spíritus Providence, counted 44 manatees (Lefebvre *et al.* 2001). There are no current population estimates of manatees for the entire country.

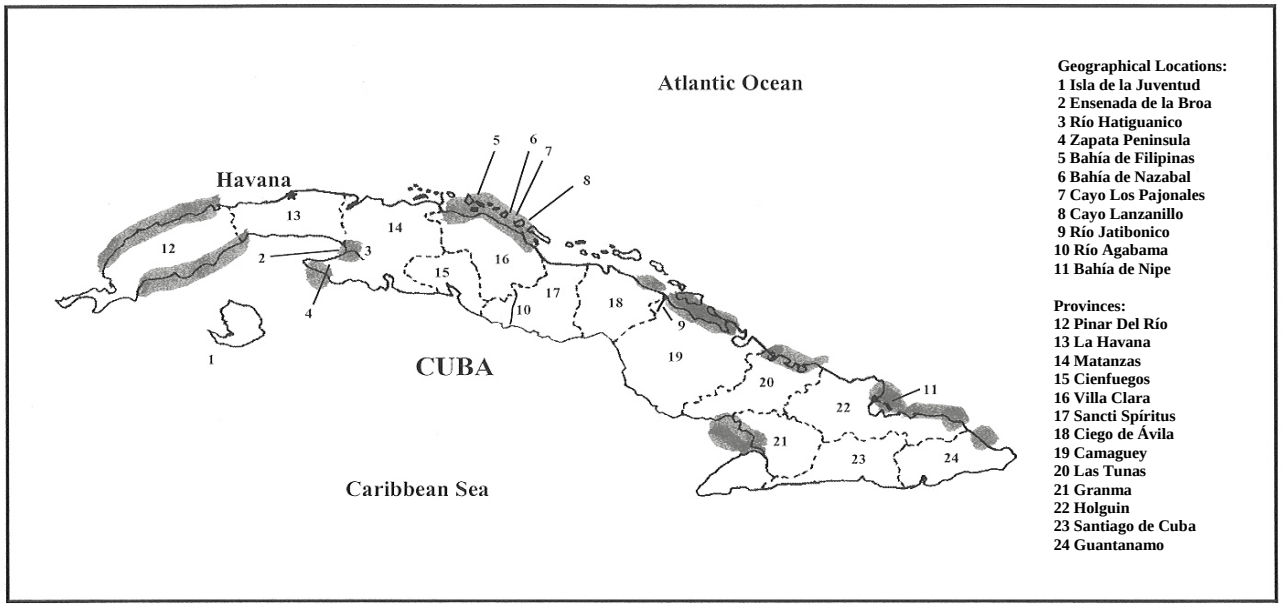

Figure 10. Distribution of West Indian manatees, *Trichechus manatus*, in Cuba according to results from aerial surveys, documented sightings, and interviews with local residents.

The province of Villa Clara (north-central Cuba) is the only area in the country in which records of manatee sightings have been kept since 1992. A local research project has been working with native fishermen, who collect data on manatee sightings and habitat use. The information gathered to date

indicates that manatees use the keys of this province for resting and feeding, coastline areas for feeding, and lagoons mostly for resting. Manatees appear to drink fresh water in the mouth of rivers. Two areas of Villa Clara (Bahia de Nazabal and Cayo Los Pajonales) have the greatest numbers of manatee sightings, especially of those with calves. Two other areas, Bahia de Filipinas and Cayo Lanzanillo, have abundant seagrass beds that may be consumed by manatees (Santos Mariño 2006). Other areas of the country where manatees have not been reported may be used as transient areas. Those areas have deeper waters, which are probably not optimal habitat for manatees (Santos Mariño 2006).

2.7.2. Major Threats and Conservation Problems

In 2003 and 2004, three manatee deaths were documented in the province of Villa Clara. Interviews with local people indicated that the major threats affecting manatees include incidental entanglement, poaching, environmental pollution, and boat collisions (Santos Mariño 2006). In fact, the number of manatee deaths related to poaching is very low. Only two confirmed cases of poaching have been documented since 2005 (Santos Mariño 2006). Environmental pollution is a problem in Cuba as well. The wastewaters of mining companies are dumped into the environment and may have a negative, albeit undocumented impact on manatees (Santos Mariño 2006). In 1981, approximately eight manatees died, apparently due to exposure to residues from the sugar cane industry. Bahía de Nipe, Cuba's largest bay, is said to have been abandoned by manatees because of contamination (UNEP 1995).

2.7.3. Socioeconomic Significance of the Species to Local Communities

Sustainable hunting of manatees does not occur in Cuba. Poaching does not seem to be a major threat, although a few cases have been reported in the past few years. Santos Mariño (2006) reported that more than 80% of people interviewed were aware of the laws protecting manatees. This may explain why poaching has declined, although it has not stopped completely.

2.7.4. National Legislation and Conservation Measures

Cuba has signed a number of international and regional treaties protecting wildlife and the marine environment (Table 4). At the national level, manatees have been protected since 1936 under Decreto-Ley 707; its article 39 prohibited manatee captures and levied 500-peso fines and/or imprisonment for 180 days. In 1955, article 75 of Decreto 2724 (Reglamento de la Ley General de Pesca) prohibited hunting of manatees. In 1982, the Ministry of Fisheries created Decreto 103, permanently prohibiting the capture of manatees in all national territories with fines of 100 pesos and confiscating captured animals, fishing gear, and boats. The Cuban government plans to develop a manatee action plan. The first workshop to update the manatee status and identify the different threats affecting the survival of the species took place in June 2006.

Cubans are aware of the status of manatees in the country (UNEP 1995, Santos Mariño 2006). Nevertheless, it is difficult to evaluate the effectiveness of regulations because the country has an extensive coast and many areas are difficult to access (UNEP 1995). Yet incidental entanglement in “chinchorro” nets has been identified as a major threat for the survival of manatees. The Ministry of Fisheries (MF) plans to ban the use of chinchorro nets for the entire country by 2008. The Ministry and World Wildlife Fund Canada (WWF) have started a pilot project in the coastal area of Villa Clara to identify and develop alternative ways of living for local people. This area has the highest use of chinchorro nets in the country. Villa Clara also has three protected areas (Las Loras, Lanzanillo Pajonal Fragoso, and Las Licuas Cayo del Cristo) that the Ministry of Fisheries plans to declare as areas of special use and protection; the Ministry plans to apply similar regulatory measures to other parts of the

country (Santos Mariño 2006). This is an important step toward the conservation and protection of manatees since the implementation of management measures can be difficult due to limitations on economic development in the country.

Cuba actively promotes the need to protect nature, with many radio and television campaigns for the conservation of flora and fauna (UNEP 1995). In the Villa Clara province, environmental education programmes, which include information about manatees, have been developed and broadcast on the radio and television. An educational workshop has also been organised with local authorities and fishermen. Federación Cubana de Pesca Deportiva additionally provides support in collecting information about sightings and strandings (Santos Mariño 2006).

Cuba presently has six Ramsar sites: Buenavista, Ciénaga de Lanier y Sur de la Isla de la Juventud, Ciénaga de Zapata**,** Gran Humedal del Norte de Ciego de Ávila, Humedal Delta del Cauto, and Humedal Río Máximo-Cagüey. The total surface area of the Ramsar sites is 1,188,411 hectares (The Annotated Ramsar List 2007).

2.8. DOMINICAN REPUBLIC

2.8.1. Status and Distribution

The coastline of the Dominican Republic includes many areas with extensive seagrass beds, protected lagoons, and freshwater sources of potential importance to manatees. According to interviews and sighting reports, important areas for manatees on the northern coast include Monte Cristi, Estero Hondo, Bahía de Manzanilla, Puerto Plata, Samana, Río Yuna, and Río Maimon, all of which have shallow waters and coastal lagoons. Monte Cristi and Samana appear to be especially important (Ottenwalder 1995). Daily movements of up to eight manatees have been reported between Estero Hondo and Bahía Isabela (Domínguez-Tejo 2006). However, recent interviews suggest that the number of manatees in Monte Cristi is decreasing.

Manatees are also found on the southern coast from Río Ocoa to Oviedo including Boca de Yuma, La Romana, Nizao, Oviedo, and Pedernales. The greatest concentration of manatees in the country may occur from Boca de Yuna to Maimón (Pugibet and Vega 2000), but this needs to be evaluated and confirmed (I. Bonnelly de Calventi pers. comm.). Manatees are reported to gather frequently at springs (i.e., El Peñon, Tres Hermanas, and Las Calderas Lagoon) to drink fresh water (Campbell and Irvine 1975, Lefebvre *et al.* 1989), but coincidentally with increases in marine tourist traffic, manatee sightings are less common (I. Bonnelly de Calventi pers. comm.).

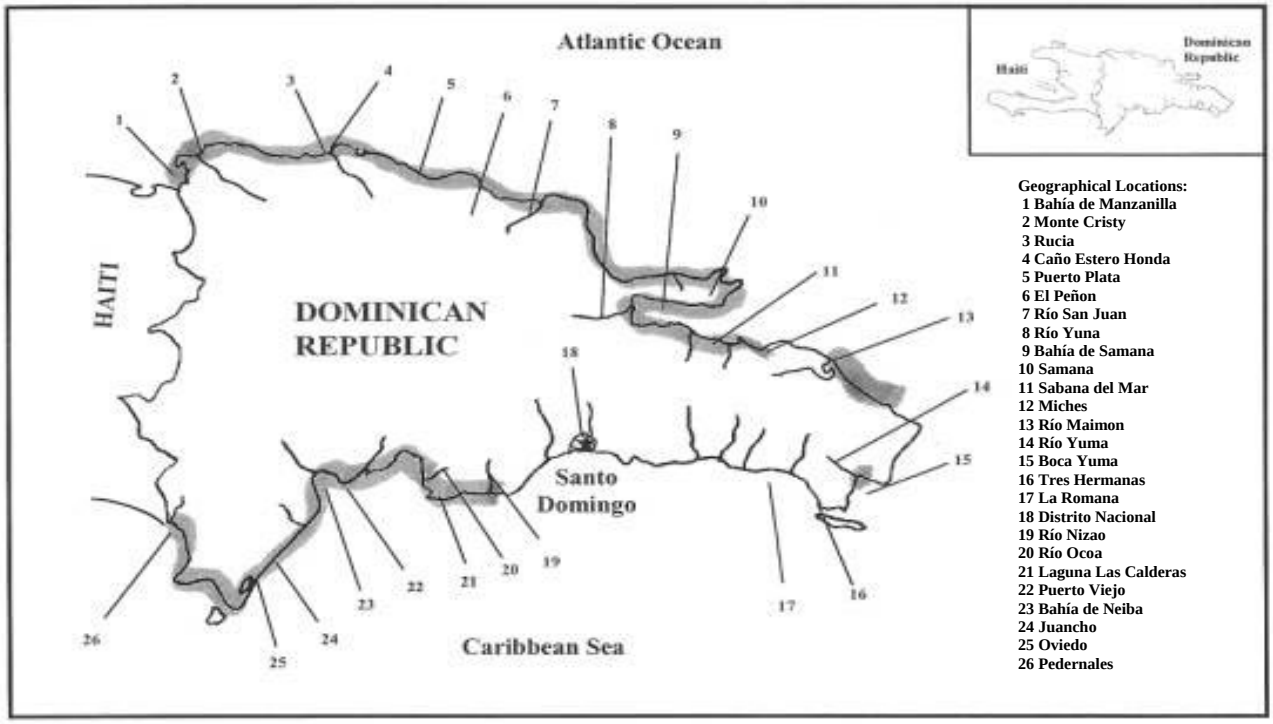

Figure 11. Distribution of West Indian manatees, *Trichechus manatus,* in Dominican Republic according to results of interviews with local residents and sighting reports.

There are few studies that have examined the size of the manatee population in the Dominican Republic. Information gathered through interviews suggests that there are between 30 and 45 manatees in the country (Pugibet and Vega 2000). However, that may be an underestimate because a minimum of 16 manatee deaths was recorded between 1995 and 2000 (see next section). If the population size is truly in

the range of 30 to 45 animals, and if the number of deaths were to remain the same in another 10 years, manatees would probably be extirpated from Dominican waters. Results from interviews are helpful to identify areas used by manatees, but they may not provide the best way to assess population size, especially when animals are difficult to observe.

Some researchers consider the population of manatees in the Dominican Republic to be declining (Pugibet and Vega 2000). However, the population is apparently reproducing, as is suggested by the reports of juvenile manatees at Puerto Plata, Miches, Distrito Nacional, Boca de Yuma, and Pedernales (Pugibet and Vega 2000).

2.8.2. Major Threats and Conservation Problems

Historically, local Indians called Taínos hunted manatees for their meat, grease, skin, and bones, even before Hispaniola was discovered. Manatees were later included in the diet of the Spanish colonials (Domínquez-Tejo 2006). Presently, illegal hunting is one of the major threats because the laws and regulations to protect the species have not been enforced. Manatees are captured using nets called chinchorro, similar to those described previously (see Cuba status report), which are regulated or prohibited in some rivers (Ottewalder 1995).

Other threats include incidental catches in fishing nets, collisions with speedboats, and noise associated with seismic activity during oil and gas exploration (Pugibet and Vega 2000). Manatees and their habitats are affected by human development (Pugibet and Vega 2000). This is a significant problem in a country where three-quarters of the population lives in the coastal zone and 95% of tourist activities are located along the coast (Bonnelly de Calventi and Lancho-Dieguez 2005). Residents and groups interested in manatee conservation have expressed considerable concern about contaminants in certain locations frequented by manatees, but neither the contaminant classes nor environmental levels have been assessed (Bonnelly de Calventi, pers. comm.).

Studies conducted from 1974 to 1995 estimated a mortality rate of 15 to 25 manatees per year, including captures (5 to 15) and natural deaths (10) (Ottewalder 1995). From 1995 to 2000, the National Aquarium and the Dominican Stranding Network recorded a total of 16 manatee deaths (4 of natural causes, 7 human-related, and 5 undetermined). The most recent records suggest that around three manatees die each year. Areas where illegal hunting has been reported or strandings have occurred include Juancho, Oviedo, Bahia de Neiba, Puerto Viejo, Boca de Yuma, Sabana del Mar, Puerto Plata, and Monte Cristi.

A major conservation problem is the lack of information available to aid development of a plan to protect the species (Bonnelly de Calventi and Lancho-Dieguez 2005). The country does not have a recovery plan that can be used to establish conservation measures to ensure the long-term viability of manatees in the wild.

2.8.3. Socioeconomic Significance of the Species to Local Communities

In pre-Columbian times, manatee fat was used by the Indians to cook, make candles, and cure diseases. Currently, manatee meat, fat, and artisanal products are still used in localized places based on these traditions (I. Bonnelly de Calventi pers. comm.). Bones have a special value because they are said to have medicinal properties. Additionally, rib bones are crafted into instruments used in medical practices like spatulas that can be used to induce vomiting (Ottenwalder 1995, Pugibet and Vega 2000, Bonnelly de Calventi and Lancho-Dieguez 2005).

2.8.4. National Legislation and Conservation Measures

The Dominican Republic has signed a series of international agreements (Table 4). At the national level, manatees have been protected since 1938 (Law 1518). In 1962, Law 5914 was created to prevent the selling of manatee products. This law was reinforced in 1987 by the creation of another law, Presidential Decree No. 289, which assigns a division of the Navy to protect waters inhabited by manatees, American crocodiles (*Crocodylus acutus*), and grouper (*Epinephelus* sp.) in the areas between Los Cocos (Monte Cristi Province) and Rucia (Puerto Plata Province). In 1974, Law 67 was created to protect all species found temporarily or permanently in national parks. However, laws and regulations are not well enforced, and poaching may occur, even in protected areas. As a result, the population of manatees has decreased and is genetically isolated. The manatee is considered to be the most endangered species in the country (Ottenwalder 1995, Pugibet and Vega 2000).

In 1995, the Dominican Stranding Network was created and has since been run by the National Aquarium. The stranding network is responsible for keeping records of manatee sightings and strandings as well as for educational programmes designed to protect the species. In the same year, the reserve "Refugio del Manati Antillano" was created in Caño Estero Hondo at the national park of Monte Cristi. This is the only protected area in the country dedicated specifically to the conservation of manatees. In 1996, Decreto 233-96 created a sanctuary encompassing more than 25,000 km^2 for marine mammals inhabiting the northeastern coast of the country (Bonnelly de Calventi and Lancho-Dieguez 2005) aside from the other mentioned legislation. Manatees exhibit daily movements between this sanctuary and the mouth of Río Bajabonico (Domínquez-Tejo 2006).

In 2005, a workshop was organised to evaluate the status of the manatees. As a result, a research, education, and conservation programme was developed. The programme was created by a multi-institutional team, which started field activities in 2006. Other conservation efforts include the development of protected areas. The Dominican Republic presently has one Ramsar site with a surface area of 20,000 hectares. Lago Enriquillo is a national park located in the southeastern portion of the island (The Annotated Ramsar List 2007).

2.9. FRENCH GUIANA (FRANCE)

2.9.1. Status and Distribution

Interviews with fishermen and other residents of French Guiana suggest that manatees (a) may be less abundant now than they were 20 years ago, (b) are present all along the coast and in most estuaries, and (c) are regularly sighted in the larger rivers such as the Oyapock, Approuague, and Maroni. In the Oyapock, sightings of manatees up to 80 km inland have been reported. The high number of reported sightings (72%) in coastal and estuarine areas suggests that these represent the main habitat for manatees in the country (de Thoisy *et al.* 2003).

The greatest number of manatee sightings year-round is reported near Coswine. This mangrove-bordered estuary is relatively shallow, warm (mean water temperature ranges between 24° and 30°C), and hyposaline (salinity range from 0.00‰ to 1.3‰; de Thoisy *et al.* 2003, Spiegelberger and Ganslosser 2005). Seagrasses and other submerged aquatic vegetation are absent in the area (de Thoisy *et al.* 2003, Spiegelberger and Ganslosser 2005) making vegetation along the banks important as food for manatees. Plant species include *Rhizophora racemosa*, *Zygia cataratae*, *Macherium lunatum*, *Pachira aquatica*, *Montrichardia arborescens* and *Scleria pterota* (Spiegelberger and Ganslosser 2005).

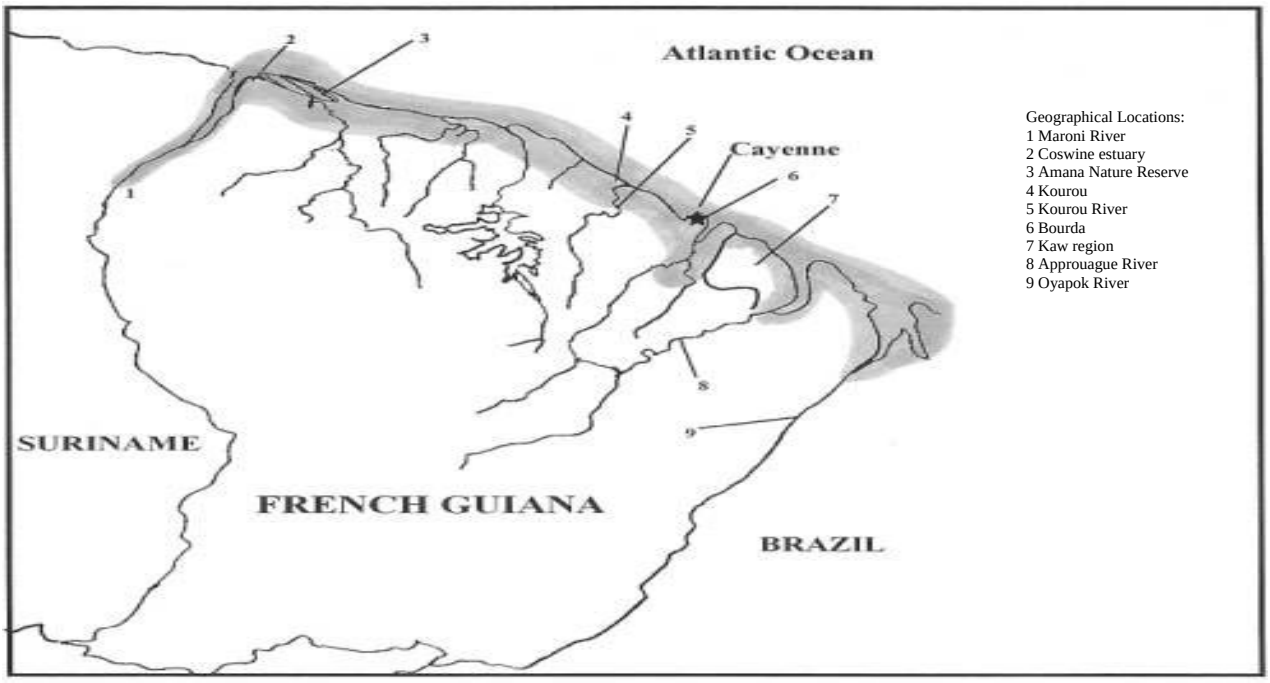

Figure 12. Distribution of the West Indian manatee, *Trichechus manatus*, in French Guiana based on best available data from documented sightings and interviews with local residents.

The Coswine swamp remains relatively pristine, making it suitable habitat for large numbers manatees in the future if it can be protected (de Thoisy *et al.* 2003, Spiegelberger and Ganslosser 2005).

Few manatee sightings occurred in the Kaw region near rocky coastal areas, along the rocky coast of a small island 5 km offshore, or a grass swamp within the region. Sightings along the rocky coasts of Kourou and Bourda have been reported during the wet season. Groups of up to seven animals have been reported near the offshore island of Ilet la Mère. No manatee sightings were reported in deep water (de Thoisy *et al.* 2003).

2.9.2. Major Threats and Conservation Problems

Manatees are still hunted for meat in the eastern part of the country. Between 2000 and 2002, 10 manatees were either killed deliberately for food (6) or taken incidentally in fishing nets (4) along the Kaw, Approuague, and Oyapock rivers, with the latter being the most egregious poaching site. Collisions with boats do not seem to be a significant threat in most areas used by manatees, except in the estuaries of the Cayenne and Kourou (de Thoisy *et al.* 2003). Habitat alteration is not a major problem in French Guiana, mainly because coastal mangrove areas have traditionally been considered unsafe and lack economic value. This provides a relatively pristine and undisturbed habitat, although their legal protection is limited (de Thoisy *et al.* 2003). Impacts of aquatic contaminant on manatees are unknown. However, emptying boat fuel tanks in commercial and fishing ports is a common practice.

2.9.3. Socioeconomic Significance of the Species to Local Communities

In some traditional cultures, the manatee is believed to be a water spirit, together with the tucuxi (*Sotalia fluviatilis*) and the tapir (*Tapirus terrestris*). In the western part of the country, Amerindians and Bush Negroes hunt manatees for the ear bones, which are considered charms with therapeutic properties. The number of manatees killed for this purpose has not been determined. However, manatees are also hunted for their meat (de Thoisy *et al.* 2003).

2.9.4. National Legislation and Conservation Measures

A management plan at the regional level is needed in French Guiana because manatees may move between French Guiana and parts of Brazil and Suriname (de Thoisy *et al.* 2003, Garcia-Rodriguez *et al.* 1998, Vianna *et al.* 2006). Amana Nature Reserve is a coastal nature reserve comprised of 94,700 hectares of land and swamps, providing protection for manatees (Tourist Board of French Guiana 2006). There are also 874 km (543 miles) of protected shorelines, which are located in different parts of the country, and are administrated by the Conservatoire du Littoral (Conservatoire du Littoral 2006). French Guiana also has two Ramsar sites, Basse-Mana and Marais de Kaw, with a total surface area of 196,000 hectares (The Annotated Ramsar List 2007).

Other conservation efforts include those by Association Kwata, such as the rescue of an orphaned manatee in 2002. Unfortunately, the manatee calf died due to a severe ulcerative colitis (G. Bossart pers. comm.). The association is involved in conservation programmes involving marine turtles, giant otters, primates, black caimans, and manatees (Harbor Branch Oceanographic Institution 2002). The manatee in French Guiana is totally protected by an inter-ministerial decree of 1986. At the international level, France has signed a series of agreements (Table 4).

2.10. GUATEMALA

2.10.1. Status and Distribution

Manatees have been reported in several parts of the Atlantic coast of Guatemala, but they have been most consistently sighted in two areas during aerial surveys: Lago de Izabal and Bahia de la Graciosa (Quintana-Rizzo 1993, 2005a,b). The largest groups of manatees observed during aerial surveys have occurred in Lago de Izabal (Quintana-Rizzo 2005a,b; Romero-Oliva 2006). Lago de Izabal, the largest lake of Guatemala with an area of approximately 727 km^2, is unusual because it connects with the ocean via a narrow river called Río Dulce (El Golfete), which extends for approximately 42 km. Lago de Izabal receives the waters of several large rivers, including Río Polochic and Río Oscuro. Manatees have only been sighted along the shallow (1 to 3 meters deep) shorelines of the lake, especially in the southwestern corner between Cayo Padre, Río Oscuro, and Punta Chapin. This area is characterized by numerous canals and lagoons with a mean depth of 2 m and freshwater vegetation including *Hydrilla sp., Pistia stratiotes, Nymphaea ampia* (Quintana-Rizzo 1993). The section was identified as a calving ground area in 1992 (Quintana-Rizzo 1993, 2005a,b), and a few years later the government declared it a protected area. The shallow waters of southwestern Lago de Izabal represent the location where calves are most regularly sighted during aerial surveys in Guatemala. Manatees also use other shallow-water sections of the lake near the towns of El Estor, Los Murcielagos, and Punta Brava. In the latter town, groups of up to 15 manatees have been sighted feeding on aquatic vegetation (Quintana-Rizzo 2005a,b).

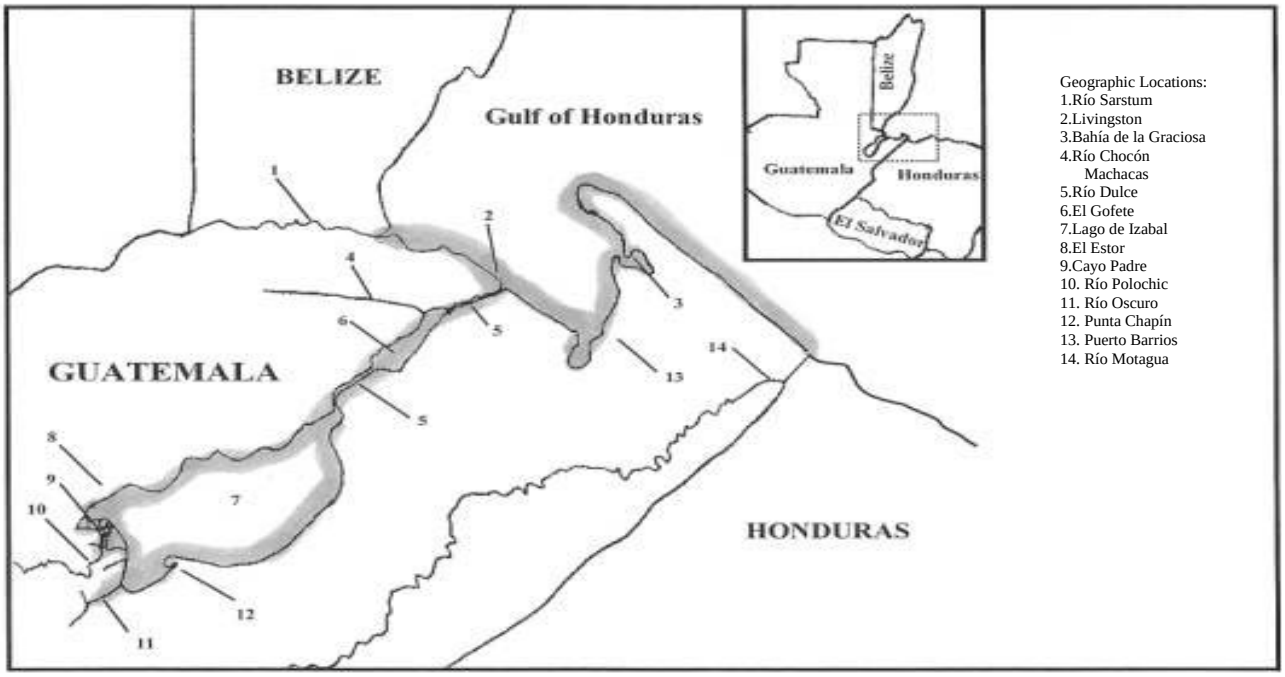

Figure 13. Distribution of the West Indian manatee, *Trichechus manatus,* in Guatemala based on best available data from aerial surveys and sighting reports.

Bahia de la Graciosa also connects directly with the Caribbean Sea. Groups of two or three manatees (including calves) have been sighted at different times of year (Quintana-Rizzo 1993, 2005a,b; Romero-Oliva 2006). The bay, formed by a system of lagoons, swamps, and rivers, has forage for manatees, including the seagrass *Thalassia testudium* (Arrivillaga and Baltz 1999). This estuarine ecosystem is considered the most important in Guatemala due to its size, conservation status, and ecological value

(Yañez-Arancibia *et al.* 1999). The bay has little human development along the coastline, which helps preserve the quality of the habitat.

Manatees are less frequently sighted in El Golfete, a narrow section of the Río Dulce. Manatees appear to use El Golfete as a corridor between Lago de Izabal and the coast. Although El Golfete has good manatee habitat, it experiences heavy boat traffic associated with tourists who navigate El Golfete to visit hotels and restaurants located along the shore. Up to six manatees have been observed in El Golfete in a single aerial survey (Quintana-Rizzo 2005b).

The manatee population was estimated to be 53 ± 44 manatees in the 1990s (95% confidence interval; Quintana-Rizzo 1993). A one-year study commenced in the summer of 2006, including aerial surveys every three months, to reexamine the population size and the distribution of manatees along the entire coast of the country, with a focus on Lago de Izabal (H. Garcia pers. comm.). In October 2006, 53 manatees were observed, the highest count yet reported in the country (Quintana-Rizzo pers. comm.).

2.10.2. Major Threats and Conservation Problems

Four major threats affect manatees in Guatemala: poaching, boat traffic, incidental entanglement, and habitat loss or contamination. Poaching may have had a negative effect on the local populations. The first signs of concern over the declining manatee population appeared in an article written in 1882 for an encyclopaedia, the Biologia Centrali Americana (Janson 1980). In the late 1970s, the numbers had declined further (Janson 1980). At present, manatee meat is sometimes sold at local markets in Livingston. In 1992 and 2001, the average price of a pound of meat was Q4.00 per pound (equivalent to US$0.53; Quintana-Rizzo 1993, del Valle 2001). This price is much less than the price of chicken or beef, which makes it affordable for people at the lowest socioeconomic levels (Herrera *et al.* 2004). In 2005, three manatee deaths related to poaching were reported (E. Quintana-Rizzo pers. comm.).

Incidental entanglement of manatees is not very common in Guatemala. However, there have been reports of a few entanglements ($n < 5$) in El Estor and the mouth of Rio Polochic. The latter is included in the Refugio de Vida Silvestre Bocas del Polochic, which is a Ramsar site. This refuge is intensively monitored and because of this, many stationary nets called chinchorros can be sighted on a daily basis at the mouth of the river. This is a real problem although fishing nets are illegal in all protected areas according to Ley de Pesca (Decreto 80-2002; Herrera *et al.* 2004). The use of chinchorros in this refuge is of particular concern because the waters in and near the reserve have been identified as important manatee calving grounds (Quintana-Rizzo 1993, 2005a,b); in fact, in 2005 a calf reportedly became entangled and died there. During aerial surveys conducted in 2005 and 2006, fishing nets were more commonly observed in the waters of this refuge than in any other area along the Atlantic coast (Quintana-Rizzo 2005b, E. Quintana-Rizzo pers. comm.). This frequency is probably related to the high productivity of the waters of the protected wetland. Such a large amount of fishing nets in a single location also indicates that the threat of incidental entanglement is of particular concern within the waters of this refuge.

Another threat to manatees is watercraft. Boats can have a negative effect, directly or indirectly, on manatees. Indirect effects include the scarring of seagrass beds, used by manatees to feed, by boat propellers. Aerial surveys indicate that areas such as the south portion of El Golfete (a popular area visited by many tourists) have moderate to severe scarring (terminology defined by Sargent *et al.* 1995). Boats can also affect manatees directly if they hit, kill or seriously injure an animal, although no boat-

related mortalities have been reported. However, motorboats are becoming more abundant and popular in Guatemala. In 2005, 94 motorboats were counted in a single aerial survey over 319 km of coastline. This was the highest number of watercraft sighted during an aerial survey for the entire Gulf of Honduras (Quintana-Rizzo 2005b).

Noise pollution from motorboats can also be a problem. Noise can degrade the quality of the habitat, but the effects that noise has on manatee behaviour are unclear. Watercraft traffic and speed are not regulated in Guatemala even within protected areas like the Refugio de Vida Silvestre Bocas del Polochic and Biotopo Chocón Machacas (Quintana 2005a, Romero-Oliva 2006).

A recent concern is the development of two mining operations in the northeastern corner of the Lago de Izabal near the town of El Estor. One mining company has concessions to explore an area of approximately 259 km^2 in size, equivalent to approximately one-third the Lago de Izabal. Another mining company is conducting explorations in an area adjacent to the first mining company, potentially looking to deforest an area of approximately 81 km^2. The combined area that would be deforested by these mining companies is equivalent in size to half of the lake (47%, 340 km^2). The two companies plan to extract water from the lake, and one plans to dump wastewaters directly into the protected area, Refugio de Vida Silvestre Bocas del Polochic. This is a Ramsar site that provides protection to numerous wetlands and wildlife species, some of which are endangered. The owners of the mining companies argue that the project will not have a significant effect on manatees and their habitats. Nonetheless, there is a great concern among environmental agencies and scientists about the effects that mining will have on the environment, such as sediment runoff after the heavy storms of the wet season. There is evidence from operations around the world that nickel mining contributes to deforestation, erosion, and water pollution (National Geographic 2006).

2.10.3. Socioeconomic Significance of the Species to Local Communities

Manatees have cultural significance to locals. The Mayans apparently hunted manatees for meat and believed that manatees had supernatural powers. For example, the ear bone was used as an amulet that protected its owner from evil powers (Janson 1980). The Mayans had a special process to prepare dried manatee meat, called “bucan,” which was eaten at important feasts and thought to increase a man’s strength and virility (Janson 1980). The Spanish explorers found that manatees were abundant in Guatemala and welcomed them as a source of food. The famous explorer Fuentes y Guzman wrote “not only in Lake Izabal and the Río Dulce, but along the entire coast from Mexico to Nicaragua they are caught in huge quantities during the whole year.” Freebooters and pirates who preyed upon the Spanish ships often anchored along the Guatemalan coast and also began to rely upon bucan as a staple in their diet, for which they became known as buccaneers (Janson 1980).

Manatees are still hunted for their meat. In recent years there have also been reports of manatees found dead and missing their internal organs in two of the national reserves. It was unclear why an animal would be killed without taking the meat. A calf was also found in the same condition, but it appeared that the animal was originally caught by accident in fishing net. The person who found it said that the organs were removed to prevent the animal from sinking (F. Herrera pers. comm.), although removal of the guts would in reality likely increase the likelihood of sinking. Incidental entanglement of manatees may be a more common problem than originally thought. Because fishermen do not report most instances, the total deaths per year due to entanglement may be significantly underestimated.

2.10.4. National Legislation and Conservation Measures

The first legal action to protect manatees in Guatemala was taken with the creation of Acuerdo Presidencial of 1959, which declared manatee hunting illegal (Quintana 1993, Herrera *et al.* 2004). The fine for violating the law is Q50.00 or US$6.60. This law had little effect especially in remote villages. In 1981, a new Acuerdo Presidencial was created, establishing fines ranging from Q50.00 to Q300.00 (US$39.58). In 1989, Decreto 4-89 or 'Ley de Areas Protegidas' was created to protect all species in danger of extinction. This law established a penalty of 5 to 10 years in prison and a fine of Q10,000.00 (US$1,319.26) to Q20,000.00 (US$2,638.52) for individuals who collect or sell parts of endangered species. Manatees are further protected by Ley de Pesca, Decreto 80-2002, which declares that it is illegal to hunt any marine mammals in danger of extinction. The fine for breaking this law is Q8,000.00 (US$1,055.41) to Q80,000.00 (US$10,554.09), However, effective law enforcement is a problem. Guatemala has signed a series of international conservation agreements that protect manatees and their habitat (Table 4).

There are six protected areas along the Atlantic coast of Guatemala that include habitat used by manatees. Three of these areas are Ramsar sites and have a total surface area of 189,329 hectares. In 1955, the area extending from Lake Izabal through the Rio Dulce to El Golfete was declared a national park. In 1979, a section of El Golfete was established as a manatee reserve called "Biotopo para la Conservacion del Manati Chocon-Machas," which became the first reserve for manatees in Latin America. The reserve is administrated by the Universidad de San Carlos and it promotes environmental education to tourists. Fundación Mario Dary assists Universidad de San Carlos in the administration of another coastal protected area called "Area de Proteccion Especial Punta de Manabique" (Ramsar site); here Fundación Mario Dary regularly conducts environmental programmes involving several species, including manatees. Other protected areas include Refugio de Vida Silvestre Bocas del Polochic (Ramsar site), Reserva Protectora de Manantiales Cerro San Gil, and Area de Protecciún Especial Rio Sarstun (Ramsar site).

In 2004, the Guatemalan government approved the creation of the first manatee recovery plan. The general objectives of the recovery plan are to monitor and protect manatees, manage and protect their habitat, and promote the cultural and ecological value of the species throughout its range within the country (Herrera *et al.* 2004). In particular, the recovery plan recommends that annual aerial surveys be conducted to provide long-term data on manatee distribution, that the aquatic plants consumed by manatees in preferred areas be identified, and that anthropogenic effects on manatee habitats be quantified. As a result of this conservation effort, several local and international organisations have started to conduct long-term research studies on manatees in the country.

Meetings among the local organisations are regularly conducted to coordinate efforts and standardize field methods. For example, institutions such Defensores de la Naturaleza and Comision Nacional de Areas Protegias are coordinating efforts to use similar sampling techniques in the study of manatee distribution and habitat use (E. Quintana-Rizzo pers. comm.).

2.11. GUYANA

2.11.1. Status and Distribution

There is little recent information on population status or distribution in Guyana, and aerial surveys have not been attempted. Bertram and Bertram (1963) estimated Guyana's manatee population at a few thousand but reduced from earlier numbers. At the time of their survey, manatees were more common along coastal rivers, especially in wet savannah areas (e.g., the Canje, Abary and Berbice rivers), or near sluices by the outflow of drainage channels from plantations in the sugar estates of Buxton, Leonora, Uitvulgt and Airy Hall. Manatees in the ocean were likely to be travelling between rivers (Bertram and Bertram 1963, 1964, 1973). Northwestern Guyana and the area bordering Suriname (Courantyne River region) contained the greatest numbers (Bertram and Bertram 1963). Manatees were historically reported from the Arapiako, Akawini, Wuini, Barima, Sebai and Kiatuna rivers, with occasional sightings in the Demerara River and at the river mouth in Georgetown (Bertram and Bertram 1973). More recently (Eisenberg 1989, C. Haralal pers. comm.), manatees have been reported from Baramani River, Akawini River, Barakara, Yauni Bend, Overwinning, Utrecht, De Goede Hoop, Totikamp, Jagtlust, and Bamboeisi.

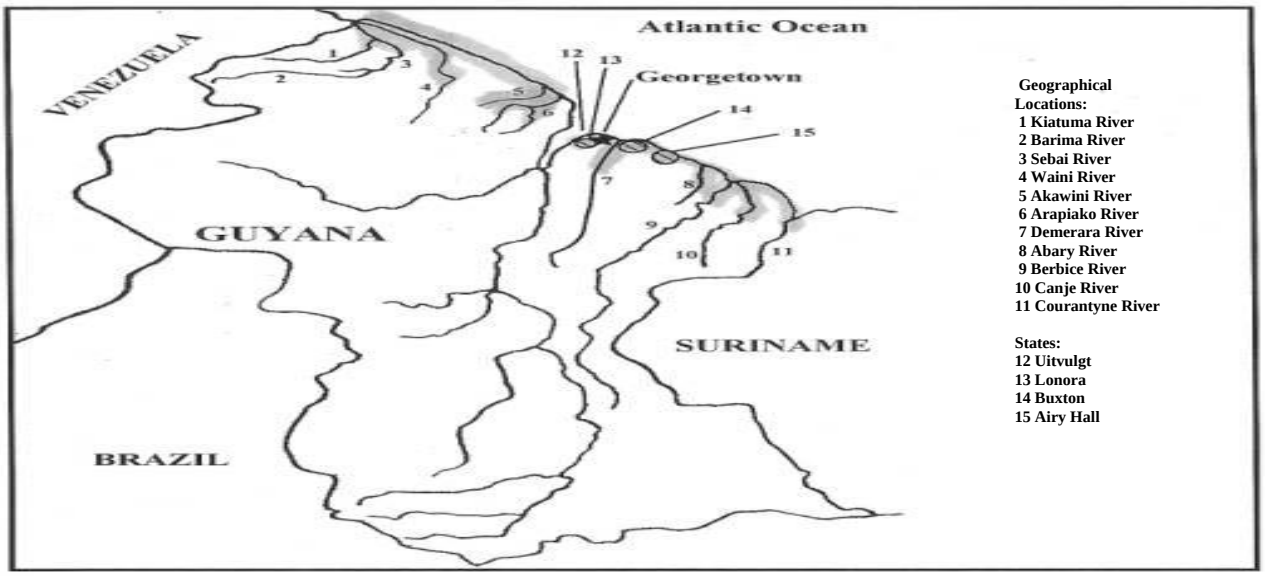

Figure 14. Distribution of the West Indian manatee, *Trichechus manatus*, in Guyana based on best available data from distribution studies conducted in 1963 and reported sightings.

2.11.2. Major Threats and Conservation Problems

Bertram and Bertram (1963, 1964) noticed an increase in motorized dugout canoes and other powered boats and suggested this was restricting manatee distribution. There is no organised hunting of manatees in Guyana although they may be taken when opportunity arises (Bertram and Bertram 1963). Accidental entanglement in fishing nets is responsible for some manatee deaths (Lefebvre *et al.* 1989).

2.11.3. Socioeconomic Significance of the Species to Local Communities

Manatees have been experimentally used as biological weed control agents in Guyana (Alsopp 1960, Bertram and Bertram 1963, National Science Research Council of Guyana and National Academy of Sciences 1973) without conclusive results.

2.11.4. National Legislation and Conservation Measures

The species has been protected since 1956 by the Fisheries Ordinance No. 30, revised in 1961 (Fisheries (Manatee Control) Regulations) (Bertram and Bertram 1963, Lefebvre *et al.* 1989). Guyana has signed a series of international agreements that help to protect manatees and their habitat (Table 4). During a workshop for manatee specialists held in 1974, the establishment of an International Centre for Manatee Research and Conservation was proposed in Georgetown (National Science Research Council 1974). No information is available on current conservation programmes.

2.12. HAITI

2.12.1. Status and Distribution

The current situation for manatees in Haiti is unknown. Available information on the distribution and abundance of manatees is based on a study conducted in the 1980s; apparently no more recent surveys of any kind have been conducted.

In 1982, a total of only eight manatees were sighted during an aerial survey conducted along the entire cost of the country. Results from the aerial survey and interviews with fishermen confirmed that in Haiti, as elsewhere, 20 years ago the best manatee habitat included sheltered areas with shallow water and extensive aquatic vegetation. Animals were sighted near Gonaives, Montrouis, and at the mouth of Riviere de l'Artibonite (Rathbun *et al.* 1985). This is an area just over 40 km long on the western side of the country.

2.12.2. Major Threats and Conservation Problems

In the 1980s, manatees were caught opportunistically in beach seines although traditional hunting was not practiced. Interviews with local residents indicated that young people only knew about manatees through conversations with older people. In contrast, older people (>50 years old) knew about manatees from personal experience. They stated that the meat used to be sold at local markets (Rathbun *et al.* 1985).

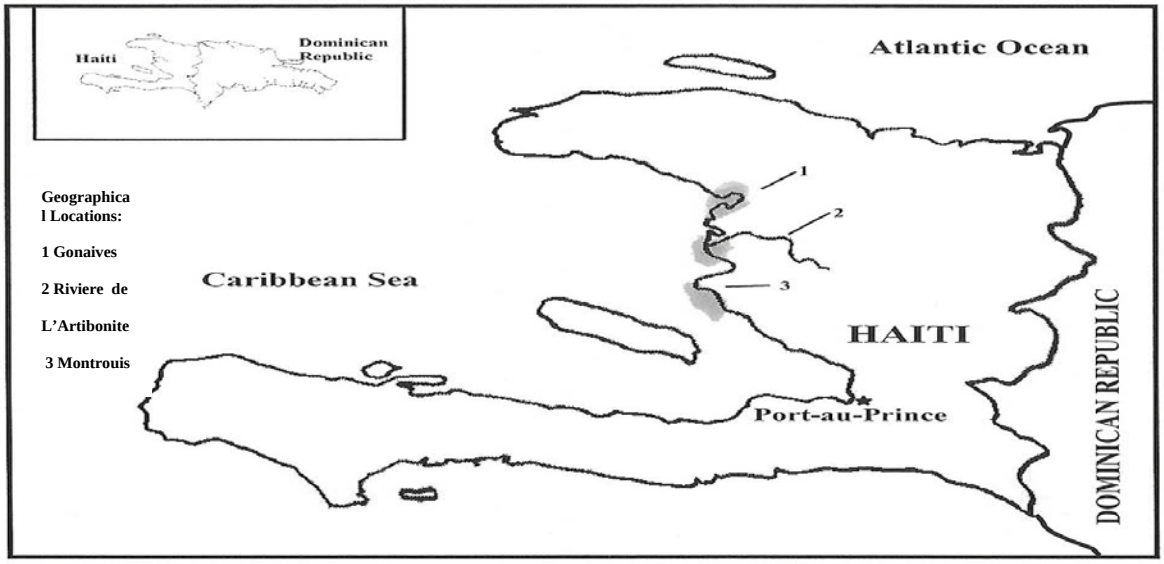

Figure 15. Distribution of the West Indian manatee, *Trichechus manatus,* in Haiti based on best available data from aerial surveys and interviews with local residents conducted in the 1980s.

2.12.3. Socioeconomic Significance of the Species to Local Communities

In the past, manatees probably represented a source of protein for the impoverished people of Haiti (UNEP 1995).

2.12.4. National Legislation and Conservation Measures

Haiti does not have marine and littoral protected areas. The country has seven protected terrestrial areas, which include national reserves and parks (Earth Trends 2006). Haiti has signed international conservation agreements that protect manatees and their habitat (Table 4).

2.13. HONDURAS

2.13.1. Status and Distribution

The Atlantic coast of Honduras has many lagoons and rivers that provide the most extensive habitat for manatees. These areas, characterized by abundant submerged aquatic vegetation and access to fresh water and shelter (Lefebvre *et al.* 1989), comprise La Mosquitia, which is the largest wetland in Central America and contains the Rio Platano Biosphere Reserve (UNEP 1995).

Three additional areas of importance to manatees have been identified. The first is the lagoon system of Caratasca in the most isolated region of the country. The wetland provides high-quality habitat for an estimated 27 to 56 manatees (Cruz 1996). The areas between Rio Sangrelaya and Laguna Ibans and between Laguna de Brus and Río Patuca also have important habitat for manatees. Scientists estimate that between 36 and 65 manatees occupy the two areas, although they did not observe manatees there or in Caratasca during aerial surveys conducted in the mid-1990s (Cruz 1996). The remainder of the coast does not provide much suitable habitat because it has steep shorelines, strong surf, and few slow-moving rivers (Lefebvre *et al.* 1989). Within this part of the coast, the wetland between the Ulua and Chamelecon rivers was identified as a suitable area for a small number of manatees (5 to 8) (Cruz 1996). The small refuge area between the Cuero and Salado rivers may also contain a few animals.

Recent aerial surveys conducted between 2000 and 2006 along the western coast sighted manatees in Masca, Bahia de Omoa, Punta Sal, Laguna Thompson, Río Cuero, Río Salado, Laguna Gauimoreto, Río Chapagua, and Río Aguan (Auil 2000, Quintana-Rizzo 2005a, Gonzalez-Socoloske *et al.* 2006, Gonzalez-Socoloske 2007),

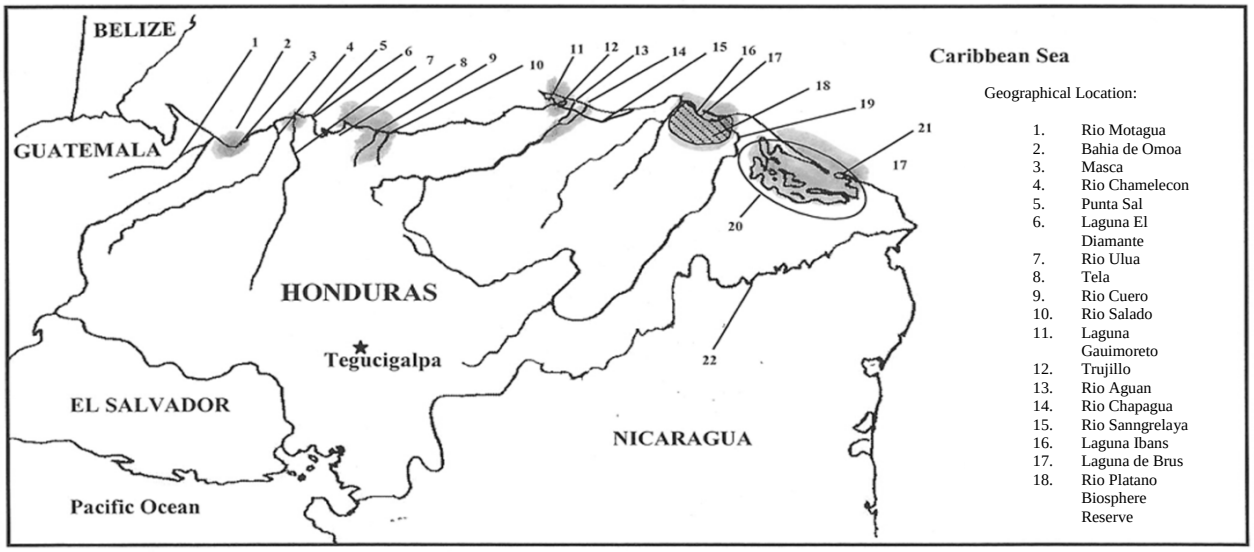

Figure 16. Distribution of the West Indian manatee, *Trichechus manatus*, in Honduras based on best available data from aerial surveys and reported sightings.

Of these, Punta Sal is a semi-enclosed lagoon forming part of a marine national park. Updated information of the status and distribution of manatees is unavailable for the areas between Río Aguan and Río Coco along the border with Nicaragua. In the 2000 aerial surveys, four manatees were seen between Río Motagua and Tela; specifically, one manatee was sighted near Masca, one near Omoa, and two in Punta Sal (Auil 2000). In 2005, four manatees were sighted during an aerial survey conducted

from Río Motagua to the north of Laguna Grande (Quintana-Rizzo 2005a. In 2006, a total of 18 manatees was sighted during six days of continuous surveys over the area from Laguna El Diamante (east of Tela) to Río Aguan (west of Trujillo; Gonzalez-Socoloske *et al.* 2006, Gonzalez-Socoloske 2007). In the 2005 survey, an adult manatee with a calf was sighted during the survey whereas no calves were seen in the 2000 and 2006 surveys. The 2000 and 2005 surveys spotted manatees along the coast, whereas the 2006 surveys spotted manatees within lagoons and rivers, especially within the Cuero y Salado Wildlife Refuge. It is estimated that the refuge has between 6 and 15 manatees (Gonzalez-Socoloske *et al.* 2006, Gonzalez-Socoloske 2007).

The recent distribution of manatees between Laguna El Diamante and Rio Aguan is similar to that reported by Rathbun *et al.* (1983) in the early 1980s. However, the number of manatees sighted per hour in 2006 for this part of the country was significantly lower than in the 1980s surveys (Gonzalez-Socoloske *et al.* 2006, Gonzalez-Socoloske 2007), due either to fewer manatees present, different survey conditions or observer experience, or dissimilar survey methods.

Manatees appear to have changed their distribution over the past several years because no manatees were sighted in the rivers east of Trujillo in the 1980s whereas sightings occurred in Chapagua and Aguan in 2006. The area presently appears to be very important habitat for manatees (Rathbun *et al.* 1983, Gonzalez-Socoloske *et al.* 2006, Gonzalez-Socoloske 2007). Manatees were not frequently sighted during field observations conducted in the Cuero y Salado Wildlife Refuge. It is unclear if this is due to a low population number or because of higher human avoidance by manatees in this region. Most manatee sightings within the refuge occurred in the mouth of the Rio Cuero (Gonzalez-Socoloske pers. comm.).

2.13.2. Major Threats and Conservation Problems

Harpooning manatees was openly practiced until the 1970s when it started to decrease for one or more reasons: (1) hunters' fears of being captured and paying a larger fine than the profit they could make by selling manatee meat were increasing, (2) the amount of time and energy invested in hunting was greater than the possibility of capturing an animal, especially because manatee numbers were declining, and (3) the interest of young people in other commercial activities such as lobster fishing diminished interested in manatee hunting (Cruz 1996). Manatees may have adopted nocturnal feeding habits in response to hunting (Lefebvre *et al.* 1989), but manatee behavioural patterns in Honduras are not clearly understood.

Another threat to manatees is the widespread use of fishing nets. Fishing nets were traditionally used by garifunas (an ethnic group that descended from a mix of Amerindian and African people), but in the 1980s nets became popular among different ethnic and social groups. Fishing nets are used in the mouth of important rivers and lagoons that are also used by manatees. Because of this, incidental entanglements have occurred since the late 1970s (Cruz 1996). Recent interviews with fishermen indicate that manatees are still occasionally killed in gillnets. In 2000, an adult manatee died this way in the Cuero y Salado Wildlife Refuge and was subsequently eaten (Gonzalez-Socoloske *et al.* 2006).

Habitat alteration and destruction is also a threat to manatees. Industrial development is greatest in Honduras along the Atlantic coast. In fact, two of the coastal states (Cortes and Atlantida) contained 49% of the national industry in the 1990s. As a result of this development, industrial wastes are dumped in the water. In the late 1980s and early 1990s, around 10 million kilograms of pesticides were used by banana plantations (Cruz 1996). A percentage of those probably ended up in coastal waters due to runoff. Additionally, coastal development leads to the removal of littoral forests, seagrass destruction by

dredging of canals, and mangrove destruction from the construction of seawalls. Hydroelectric dams also have an impact on the environment. The largest hydroelectric dam has been located in Río Ulua and was built in 1982. The impact of this project was never studied but other large hydroelectric dams have since been proposed. One of them was to be located in Río Patuca in the Mosquitia region. However, the project was put on hold because of opposition from environmental groups. The project would have dissected the largest tropical rainforest north of the Amazon and the large quantities of suspended sediments would likely have caused problems downstream (HPSG 1998).

2.13.3. Socioeconomic Significance of the Species to Local Communities

Manatees are hunted mainly for their meat. In the past, the head, brain, and visceral organs were also eaten. Fat from the eye and ear were used as hair products and fat mixed with oil from slider turtles (*Trachemys* sp.) was used as a facial cream. Fat from other parts of the body were used to fry food. Bones were crushed into a powder used for medicine (Cruz 1996).

2.13.4. National Legislation and Conservation Measures

Honduras has signed a series of international conservation agreements (Table 4). At the national level, article 49 of Fisheries Law, Decree No. 154, has protected manatees since 1959. In 1974, Direccion General of Recursos Naturales y Renovables protected wildlife species and marine resources, in general, with no specific attention being paid to manatees until 1985. Additional protection is provided by Decreto Ley No. 134-90, which establishes that each municipality provides protection to marine mammals and marine protected areas (Cruz 1994).

Honduras has six designated Ramsar sites, with a surface area of 223,320 hectares (The Annotated Ramsar List 2007). Of these, four sites are located along the Caribbean coast. In 1987, Fundación Cuero y Salado (FUCSA) was created to manage the 13,225-hectare wildlife refuge called Refugio de Vida Silvestre Cuero y Salado (Cruz 1996), a Ramsar site which provides full protection for manatees. Additionally, Parque Nacional Jeanetter Kawas, located in Punta Sal, a semi-closed coastal lagoon located 40 km west of Cuero y Salado, was declared a marine national park and a Ramsar site, with 22.3 km of coastline and a total area of 78,150 ha. The area is administrated by Fundación Para la Protección de Lancentilla, Punta Sal and Texiguat (PROLANSATE; Cruz 1994). Two other Ramsar sites are Laguna de Bacalar and Refugio de Vida Silvestre Punta Izopo (The Annotated Ramsar List 2007). In 1990, the Institute of Marine Science was created as a private initiative on Roatan Island (Cruz 1994); The institute has conducted rescues and recorded sightings of marine mammals since 1993 (Cruz 1996).

2.14. JAMAICA

2.14.1. Status and Distribution

Information about the current status of manatees in Jamaica is limited. Initial records go back to 1851, but the most extensive studies were done in the 1980s and 1990s. Aerial surveys conducted during that time indicated that manatees are mostly found along the southern coast of Jamaica (UNEP 1995). Between 1981 and 1982, as many as 13 manatees were sighted, but in 1991 only two adult manatees were observed, and in 1993 eight animals were observed in two different surveys (UNEP 1995). A two-day survey conducted in 1998 documented 11 manatees including two calves for the entire country (Lefebvre *et al.* 2001). The results from these surveys suggest that the total manatee population is probably no higher than 14 to 30 animals, and the Natural Resources Conservation Department estimated that fewer than 100 manatees were left in Jamaica (Mignucci-Giannoni *et al.* 2003, National Environment and Planning Agency 2006).

The distribution of manatees described above appears to be related to the favourable habitat conditions in the southern part of the country where there exist extensive areas of shallow, calm water, numerous bays, abundant seagrasses and freshwater sources (Lefebvre *et al.* 2001). There are reports of manatees drinking fresh water near the mouth of coastal rivers (National Environment and Planning Agency 2006). The northern coast of Jamaica does not seem to have much favourable habitat for manatees as it is characterized by deep and rugged shoreline; however, it also has several river mouths (Lefebvre *et al.* 2001).

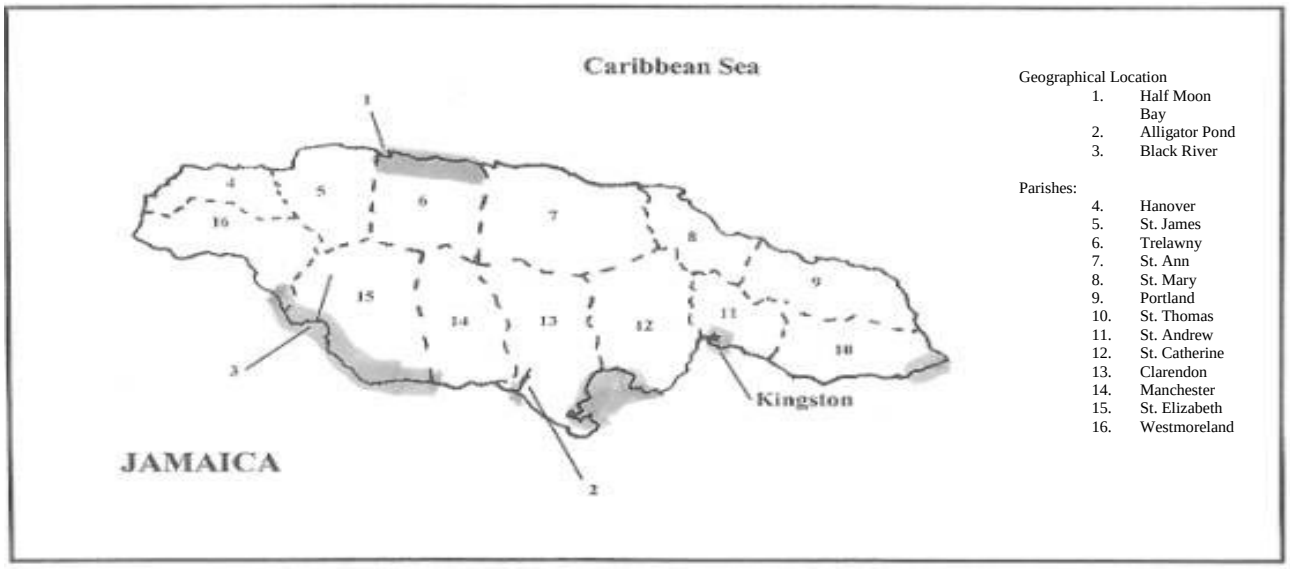

Figure 17. Distribution of the West Indian manatee, *Trichechus manatus,* in Jamaica based on best available data from aerial surveys and reported sightings.

There have been rare reports of manatees in the coastal waters around Trelawny, St. Mary, Hanover, Westmoreland, St. Elizabeth, Manchester, Clarendon, St. Thomas, and St. Catherine (National Environment and Planning Agency 2006). Four female manatees were captured at different times starting in 1981 to live in semi-captive conditions in the Alligator Hole River. They were introduced to this river by "Operation Sea Cow," a project developed by the Natural Resources Conservation Department (NRCD; see section "National legislation and conservation measures" for details about the project). Three remain in Alligator Hole River (Mignucci-Giannoni *et al.* 2003).

2.14.2. Major Threats and Conservation Problems

According to the Natural Resources Conservation Department of Jamaica, the major cause of manatee mortality is accidental or planned entanglement in gillnets by fishermen (National Environment and Planning Agency 2006). In 1993, an aerial survey identified gillnets in every area considered to be good manatee habitat, including those with mother and calf sightings. As a result, female and juvenile manatees are more susceptible to being captured by beach seining. Fishermen state that manatees frequently drown before they are seen entangled in the net (Lefebvre *et al.* 2001).

The Natural Resources Conservation Department reports that the number of manatees being killed in this way appears to have decreased due to several possible factors: an increased awareness of the presence of manatees by fishermen, a decrease in the number of people reporting the killing, or an actual decrease in the numbers of manatees being killed by entanglement (National Environment and Planning Agency 2006).

Destruction of coastal mangroves and seagrass beds is also believed to be a threat to manatees because manatees may feed on mangrove leaves hanging over the water. Coastal mangroves are mainly destroyed for housing and residential development, agriculture, and free trade/economic zones. Additionally, coastal areas containing seagrass have been affected by industrial discharges, thermal effluent, dredging operations, and pollution (National Environment and Planning Agency 2006).

2.14.3. Socioeconomic Significance of the Species to Local Communities

In prehistoric times, manatees were a resource used by Arawak Indians. In the 15th and 16th centuries, manatees were similarly exploited by Amerindians (UNEP 1995). In the 1980s and 1990s they were still hunted for their meat (Lefebvre *et al.* 2001). Today manatees are a tourist attraction (Taylor *et al.* 2006).

2.14.4. National Legislation and Conservation Measures

The manatee is the most endangered mammal in Jamaica (Mignucci-Giannoni *et al.* 2003). They have been protected since 1971 by the Wildlife Protection Act, which makes it illegal to hunt or possess protected species. The fine for breaking the law is J$10,000.00 or 12 months of prison (UNEP 1995). In 1980, the Natural Resources Conservation Department initiated a project called ”Operation Sea Cow.” Its objective was to manage the remaining manatee population in Jamaica and assess the possibility of having a small captive population for breeding, display, and education. The project introduced four manatees into semi-captive environment of the Alligator Hole River. The Organization of American States funded the project but it ceased four years later (National Environment and Planning Agency 2006). The surviving females are extremely evasive of humans. All animals have wounds and marks from the time they were captured and were kept tied. No apparent justification exists for keeping three reproducing female manatees apart from the rest of the population, especially when the population size is probably very low. Additionally, it is unclear if the river can sustain a small manatee population. In 1996, the animals depleted food resources in the river and a supplemental feeding programme was established. (Mignucci-Giannoni *et al.* 2003).

In 1987, the Government of Jamaica, with support from the UNEP-CEP, agreed to develop a management plan for the West Indian manatee in Jamaica. The project focused on the whole island and on the manatees impounded in the Alligator Hole River. The project intended to conduct a public educational programme, estimate the population size of the manatees in Jamaica, determine the carrying capacity of the Alligator Hole River, and prepare and implement a management plan for the country (National Environment and Planning Agency 2006). However, these objectives have been difficult to accomplish due to limited access to the river (Lefebvre *et al.* 2001).

As part of the public educational programme, educational materials including pamphlets, posters, and automobile stickers were distributed. Posters were placed at fishing beaches, pamphlets were given to students, and stickers were given to environmentalists with vehicles. There is an urgent need for more and better public education. The NRCA, in association with the Jamaica Natural History Society, the Environmental Foundation, and Save the Manatee Club (USA), plans to develop a public awareness campaign (National Environment and Planning Agency 2006). Jamaica has signed/ratified a series of international conservation agreements that protect manatees and their habitat (Table 4).

Other conservation efforts include the establishment of protected areas. Jamaica has three Ramsar sites with a surface area of 37,765 hectares. These are Black River Lower Morass, Palisadoes – Port Royal, and Portland Bight Wetlands and Cays. West Indian manatees have been reported in the latter two sites (The Annotated Ramsar List 2007).

2.15. MEXICO

2.15.1. Status and Distribution

In a country encompassing some of the most important manatee habitat, and where the species used to be widely distributed, numbers appear to have been reduced (Husar 1978, Campbell and Gicca 1978) due to an expanding human population and associated activities (Colmenero-Rolón 1991). Habitat degradation and destruction are likely the most significant threats nowadays. This is a result of inappropriate coastal and urban development, wetlands destruction for cattle grazing and agriculture, oil and gas exploitation, and the fishery and port industries (Ortega-Argueta and Morales-Vela 2005).

Manatees are present along the coast of the Gulf of Mexico from Río Panuco, Veracruz, to southern Quintana Roo; however, they are relatively abundant only in wetlands of the states of Veracruz, Tabasco, Chiapas, and Campeche in the Gulf of Mexico and the bays and coastal artesian springs along the coast of Quintana Roo (Colmenero-Rolón 1984, 1991; Colmenero-Rolón and Hoz-Zavala 1986; Colmenero-Rolón and Zárate 1990; Lefebvre *et al.* 1989; Morales-Vela and Olivera-Gómez 1992b; Morales-Vela *et al.* 2000, 2003; Ortega-Argueta 2002). In Tamaulipas, the only recent record of manatees exists from the finding of some manatee bones in the Río Soto La Marina two decades ago (Lazcano-Barrero and Packard 1989), but the presence of manatees has not been confirmed.

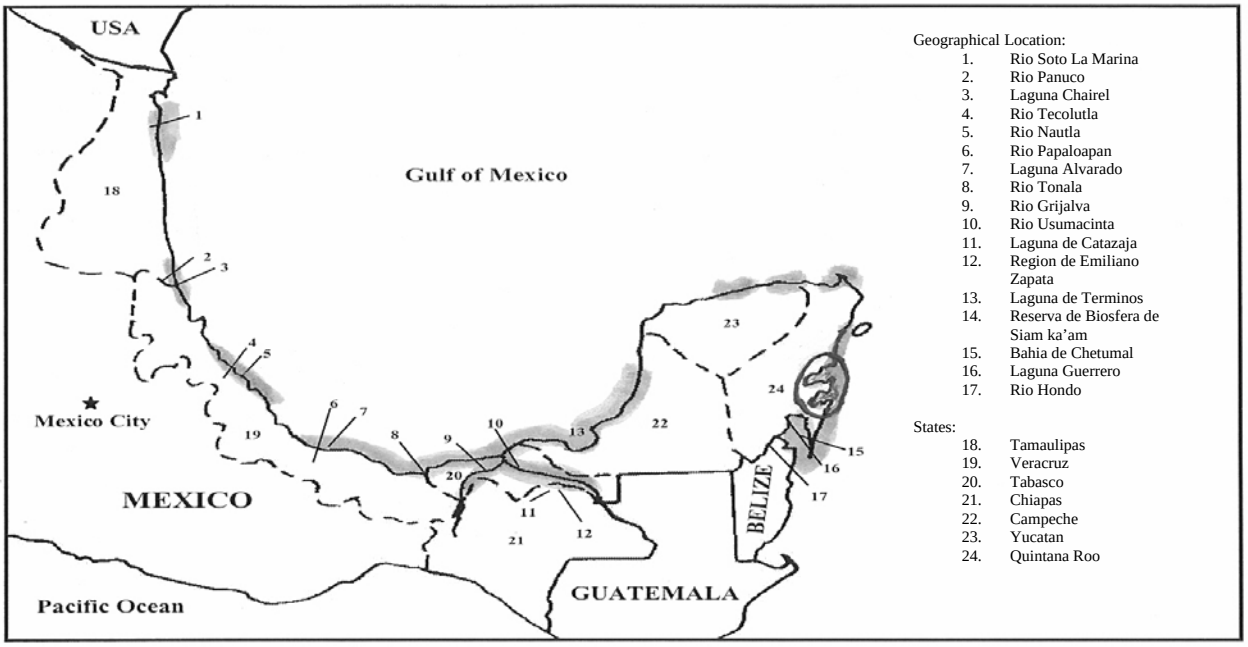

Figure 18. Distribution of the West Indian manatee, *Trichechus manatus,* in Mexico based on best available data from boat surveys, aerial surveys, and interviews.

More recently, interviews and boat surveys conducted along the entire coast of Veracruz in 2002–2003 confirmed the presence of a reduced manatee population in the lagoon system adjacent to the Tamaulipas border, in the Río Panuco and Laguna Chairel system (Ortega-Argueta, unpubl. data). In Veracruz, the occurrence of manatees is sparse and occurs mainly within estuarine and freshwater systems such as lagoons interconnected with the Río Nautla, Río Tecolutla, Río Papaloapan and Laguna Alvarado system, and Río Tonala (Colmenero-Rolón and Hoz-Zavala 1986, Colmenero-Rolón 1991,

Ortega-Argueta 2002, Rodriguez-Ibañez 2004). More than 200 inner lagoons and several rivers including Alvarado Lagoon, El Lodo Lagoon, Ríos Cala Larga, Acula, Limón, Pajarillos, El Tragadero, La Canica (near Costa de la Palma), Hondo, and Gavilanes form the Laguna Alvarado system.

Tabasco state has potentially important, but to date unevaluated habitats for manatees in the Rios Grijalva and Usumacinta and their tributaries (e.g., Rios San Pedro, San Pablo, San Antonio, Chilapa, and González) plus adjacent lagoons (Colmenero-Rolón and Hoz-Zavala 1986, Arriaga-Weiss and Contreras-Sánchez 1993). In Chiapas the manatee population is likely to be reduced and restricted to Laguna de Catajazá and several small lagoons around the Catazajá and Emiliano Zapata region (Colmenero-Rolón and Hoz-Zavala 1986). In Campeche manatees occur in several freshwater systems connected to Laguna de Términos (e.g., Río Palizada-laguna del Este towards Boca Chica; Río del Este-lagunas de Atasta, Pom; Río Chumpán-Balchacah; and Río Candelaria-Panlau), but records of manatees from the coastal areas are uncommon (Campbell and Gicca 1978, Colmenero-Rolón and Hoz-Zavala 1986, Morales-Vela *et al.* 2003). Manatee abundance along the northern and western coast of the Yucatan Peninsula is low, and the sporadic manatee presence on the north coast of Yucatan Peninsula could be attributed to nomadic animals from Quintana Roo or south of Campeche (Morales-Vela *et al.* 2003).

Manatees are present in Quintana Roo throughout the year, with the greatest concentrations in Sian Ka'an Biosphere Reserve and in the Bahia de Chetumal (BCH)–Laguna Guerrero–Río Hondo system (Colmenero-Rolón *et al.* 1988, Morales-Vela and Olivera-Gómez 1997). New data from a telemetry study with GPS radio transmitters in BCH in 2006 showed that two male manatees undertook large trans-border movements between Mexico and Belize, using important habitat for manatees in both countries (Morales-Vela and Padilla-Saldívar 2006).

At the national level, the only published population assessment was made by Heinsohn (1976), who estimated 5,000 manatees. Based on analysis of aerial survey results, interviews with local people and scientists, and evaluations of some lagoon systems in the Gulf of Mexico, B. Morales-Vela and A. Ortega-Argueta (pers. comm.) have more recently estimated, with caution, that between 1,000 and 2,500 manatees occur in Mexico.

The size of the manatee population in Quintana Roo is estimated to be 220 to 250 individuals based on aerial surveys (Morales-Vela and Padilla-Saldívar, unpubl. data). Estimates for BCH vary among years with a minimum of 60 animals (Zárate-Becerra 1993), an average of 90 animals (range = 51–130; Morales-Vela and Olivera-Gómez 1994), and a maximum of 143 animals (Morales-Vela and Padilla-Saldívar, in press). BCH has been proposed as one of the most important mating and calving areas of western Caribbean (Morales-Vela and Olivera-Gómez 1992b), with calves representing 7.9% of the sightings in this area (Morales-Vela 2000).

New research to determine genetic variability, movements, and health conditions among individual manatees from Quintana Roo and Tabasco is ongoing. These studies will in the near future provide valuable information about the status of the manatee population in Mexico.

2.15.2. Major Threats and Conservation Problems

Accelerated development along the coasts of the Gulf of Mexico and freshwater systems in Veracruz, Tabasco, and Campeche are cause of concern for the future of wetland viability. Wetland habitat is continually being lost along the coastal zone. New areas are being developed for tourism, improvement

of urban zones, and fishing activities. In the past two decades, Quintana Roo in particular has undergone rapid changes in its coastal zone (Salazar-Vallejo *et al.* 1993). A large portion of the coastal area between Cancún and Chetumal is scheduled for massive tourism-oriented development, causing considerable concern about how future development will affect natural resources, particularly wetlands. All inlets used by manatees in the coastal tourist corridor of Cancún-Tulum have been modified by resorts and eco-tourism parks, such as Xel-ha, Xcaret, and Xpu Ha. The manatee-protected area of BCH and the Sian Ka'án Biosphere Reserve, both crucial for manatee conservation in Quintana Roo, are suffering a constant pressure of human encroachment around them. Manatees frequently use the mouth and lower six kilometres of the Río Hondo. In the BCH collisions between manatees and army boats have occurred, albeit infrequently, in the mouth and along the shorelines of the Rio Hondo; however, annual boat races in BCH–Rio Hondo represents a real threat to the manatees in this area. Local authorities need to develop regulations to minimize this risk.

Some of the principal causes for the perceived decline in the manatee population along the northern and western coasts of the Yucatan Peninsula in the last 35 years include increased use of fishing nets that entangle manatees, hunting for local consumption, and severe weather (Morales-Vela *et al.* 2003). In addition, Colmenero-Rolón and Hoz-Zavala (1986) suggested that loss of manatees from the Río Papaloapan and Laguna de Alvarado in Veracruz resulted from the construction of the Miguel Alemán dam along the Río Papaloapan, increased pollution in the Río Coatzacoalcos and Río Papaloapan, and boat traffic (Colmenero-Rolón 1991). In Laguna de Alvarado, specifically, pollution, loss of the vegetation due to agricultural development and cattle ranching, fishing, development of a port facility, and hunting are all considered to be important causes of habitat degradation and the resulting decline in manatee populations (Ortega-Argueta 2002). Gillnets entangle and kill manatees. In addition, gillnets set for long periods of time across rivers and tributaries of Usumacinta, Grijalba, Chacamax, and Palizada hinder manatee mobility between habitats and may affect their feeding and reproductive activities (Colmenero-Rolón and Hoz-Zavala 1986).

Extensive use of pesticides in agricultural areas adjacent to rivers and embayments occurs in Mexico and Belize. Additionally, a partial sewage treatment system in Chetumal discharges wastewater directly into the Chetumal Bay. These represent potential threats to manatees in Quintana Roo (Rojas-Minguer and Morales-Vela 2002). Moreover, runoff containing oil-related pollutants (PAHs) is present in Quintana Roo and elsewhere throughout coastal Mexico, a problem that is likely exacerbated by oil and gas extraction and distribution.

In Tabasco, Colmenero-Rolón (1991) noted that habitat modification due to construction and modification of waterways for waterborne transportation might affect manatee health and survival. Subsistence and some commercial hunting also persist in areas of Veracruz (Alvarado, Cosamaloapan, Minatitlan) and Campeche (Colmenero-Rolón *et al.* 1990, Ortega-Argueta 2002). In Quintana Roo and other southeastern states prior to 1990, manatee ribs were used in the handicraft industry, and figurines and bone jewelry were sold for up to US$500 in markets in Chetumal, Cozumel, Playa del Carmen and Mérida (B. Morales-Vela pers. comm.).

An industry focused on placing manatees in public display facilities is also cause for concern. Manatees held in captivity in Mexico are often formerly wild individuals that were sick or orphaned, mainly from the Veracruz and Tabasco regions. Protocols for captive management, including acceptable conditions under which manatees are removed from or released back into the wild, must be developed and implemented, especially when the animals are removed from a small and vulnerable wild population.

In addition, small groups of wild manatees have sometimes become isolated by natural (storms) or anthropogenic (dams) processes (e.g., in Laguna de Las Ilusiones and Camellones Chontales in Tabasco). The viability of these populations should be evaluated and appropriate conservation measures developed.

2.15.3. Socioeconomic Significance of the Species to Local Communities

The manatee was a meaningful animal in the daily lives of the Mayan and Olmec civilizations (de Landa 1978, Bradley 1983, McKillop 1985). The most important product derived from manatee harvests was the meat itself as a food source, but the meat and bones were also thought to have medicinal properties and the fat was used for cooking (Colmenero-Rolón *et al.* 1988). In several localities in Mexico, manatees have until recently been considered "white meat fish" of high traditional value during religious holidays (e.g., Easter) when consumption of other meat is prohibited. Some people in Mexico acknowledge that manatees may also play an important role in “deepening” rivers by clearing the aquatic vegetation that interferes with boat traffic in channels (Colmenero-Rolón and Hoz-Zavala 1986).

2.15.4. National Legislation and Conservation Measures

Manatees were first protected in Mexico in 1921 when hunting was deemed illegal under the Ley de Pesca. In October 1981, the Departamento de Pesca prohibited the commercialization of products from manatees. Manatees in Mexico are classified by the term “subject to special protection” by Secretaría de Desarrollo Social (Colmenero-Rolón y Hoz-Zavala 1986). In 1994, the manatee was officially declared a species at risk of extinction (Diario Oficial de la Federación 1994).

In October 1996, the Quintana Roo state government declared the Mexican portion of BCH a special Manatee Protection Area. In April 1998, the government of Belize created the Corozal Bay Wildlife Sanctuary on the Belizean side of Chetumal Bay. Thus, the entire embayment, an important habitat for manatees in both Belize and Mexico, is now protected for manatees. North of BCH, in the Sian Ka'an Biosphere Reserve, manatees are also protected. In Tabasco, an important population of manatees inhabits the Biosphere Reserve of Pantanos de Centla.

Colmenero-Rolón (1991) developed a recovery plan for Antillean manatees in Mexico and identified priority actions to be taken for their management. The federal government then created a National Manatee Technical Advisory Committee in 1996. This group is now creating a nanatee recovery team, which includes voluntary members (scientists, managers, students and personnel from private organisations) to address key manatee conservation issues at a national scale. Members of the National Manatee Advisory Committee, federal and local authorities, and other national experts in marine mammalogy attempt to coordinate their activities with research programmes involved in a range of studies such as radio-telemetry, molecular analysis and health assessments.

The only research groups focused on manatee research at the national level are based in Tabasco (University of Tabasco) with one fulltime member (Dr. David Olivera), and in Quintana Roo (ECOSUR), where a longer-term programme involves two fulltime members (Dr. Benjamin Morales and Ing. Janneth Padilla) and several graduate students. In other areas, conservation activities for manatees involve students, volunteers, private wildlife parks, and locals NGOs.

Injured, sick, and orphaned manatees have been rescued and placed in captivity for rehabilitation. Currently there are 23 captive manatees, maintained in seven private and public facilities in the southern country. In 2004 the first manatee was born in captivity in Mexico at the Veracruz Aquarium (Ortega-

Argueta and Morales-Vela 2005). In Chetumal Bay a male manatee calf was rescued in 2003; despite his apparent good health, repeated efforts to reintroduce him to the wild failed, so he is now kept in captivity in rural facilities in Laguna Guerrero to support environmental education, public awareness, and research programmes (see w2.ecosur-qroo.mx/manati/index.htm Padilla-Saldívar 2004).

Several educational programmes are being carried out in different Mexican states. For example, 7 September was declared as National Manatee Day, a time when the National Advisory Committee members provide education and awareness activities with assistance from local governments, NGOs, and the public. Among other things, people receive caps, T-shirts, stickers and pamphlets. The Committee intends to compile the successful education and awareness materials of local educators and volunteers over the last 10 years into a single national manatee educational programme.

Other conservation efforts include the establishment of several protected areas. Mexico presently has 65 Ramsar sites with a surface area of 5,263,891 ha (The Annotated Ramsar List 2007). Additionally, Mexico has signed a series of international conservation agreements that protect manatees and their habitat (Table 4).

2.16. NICARAGUA

2.16.1. Status and Distribution

Nicaragua has the most extensive wetlands and mangrove forests on the eastern side of Central America (Jiménez 2002). The extent of these habitats is greater than that of similar areas in Belize, where manatees are much more abundant. Thus, Nicaragua could potentially support a much larger manatee population than it does currently. Manatees are almost continuously distributed along the coastline of Nicaragua. Along the northeastern coast, reports exist of groups of up to 20 manatees in Laguna Bismuna and Bismuna Tara. Each of these areas has an area of at least 20,000 ha, with abundant seagrasses and mangroves. However, Laguna Bismuna also supports more fishing nets than any other area in the country due to the high productivity of the lagoon (Jiménez 2000).

Interviews indicate that manatees are frequently sighted in Laguna de Wounta despite the fact that animals are regularly hunted there. The lagoon measures approximately 18,000 ha in area and has abundant aquatic vegetation and slow water currents. Manatees are sighted mainly in the northeastern and southern portions (Tapam Laya and Sinkula; Jiménez 2000). Manatee sightings have also been reported relatively frequently in Laguna de Pahara and Laguna Krukira, and less often in Sandy Bay, Río Wawa, Laguna de Karata, Rio Walpasiksa, Río Prinzapolka, and Río Bambana. Río Coco and Laguna Gracias a Dios appear to contain good manatee habitat (i.e., slow water currents, shallow water, and abundant aquatic vegetation), but no manatees have recently been sighted in either location (Jiménez 2000).

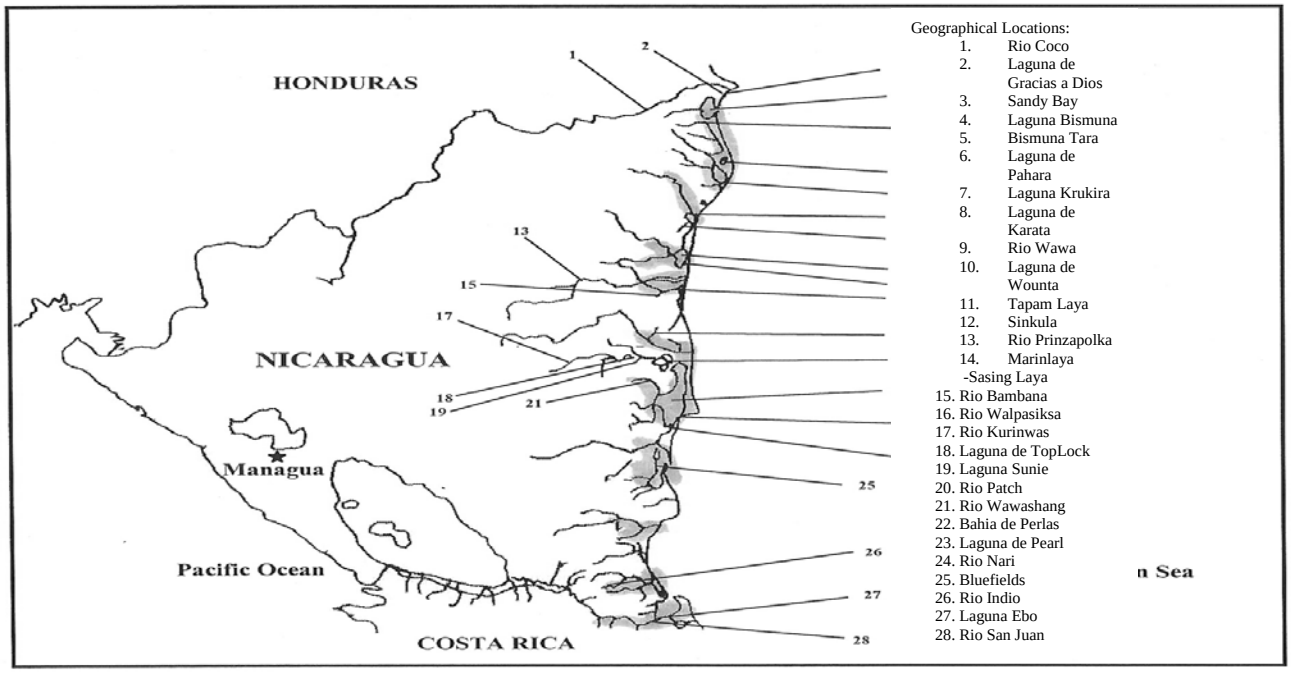

Figure 19. Distribution of the West Indian manatee, *Trichechus manatus*, in Nicaragua determined from best available data gathered by boat surveys, interviews, and reported sightings.

Along the central coast, the lagoons and rivers where manatees are sighted are larger than those in northern Nicaragua. Fishing is done from motorboats, resulting in relatively high levels of boat traffic. Manatees are sighted in Marinlaya, Sasing Laya, Laguna de Top Lock, Laguna Sunie, Laguna Ebo, and Río Kurinwas. Manatees have been sighted feeding along the shore of Bahia de Perlas, Río Wawashang, Río Nari, and Río Patch, where abundant seagrasses exist. In the south, the areas inhabited by manatees

have a low human population density. Manatees use Río Indio and Río San Juan, which form part of the Biosphere Reserve of the Southeast of Nicaragua. The rivers are characterized by low boat traffic and abundant vegetation (Jiménez 2000).

Local people claim that manatees migrate between lagoons, as well as between lagoons and the rivers in the northern and central sections of the coast. Animals that live in brackish waters visit shallow water areas where they can easily access aquatic vegetation. Manatees can move up to 60 km upstream from the mouths of rivers (Jiménez 2000, 2002). Movements of manatees may be related to tidal state as animals apparently use incoming tides (and resultant deeper water) to move from upstream in rivers or elsewhere. In the dry season, manatees seem to move out of some lagoons where water levels become too low.

2.16.2. Major Threats and Conservation Problems

The two primary threats to manatees in Nicaragua are illegal hunting and incidental captures in nets. Several towns still hunt manatees each year including four (Bismuna, Krukira, Tara, and Haulover) that form part of the Miskito Indian Community (Jiménez 2002). These towns are all located within the Miskito Coast Biological Reserve, charged with protecting all wetlands along the east coast; however, insufficient funds limit Reserve personnel and enforcement of protection legislation. Jiménez (2002) reported that Miskito Indians were unaware of the existence of the reserve. This lack of communication between the government and local communities may explain why three of the Miskito communities have the highest manatee hunting rates in the country. The human impact on the reserve is likely significant, as 30,000 people live within its borders.

From 1999 through part of 2000, between 41 and 49 manatees were killed by accidental entanglement in fishing nets (Jiménez 2002). In 2001, it was estimated that 1,464 lbs of manatee meat was consumed in La Mosquitia. That same year, interviews with local people indicated that manatee meat was actually the least consumed meat per family of all species hunted in the area (Espinoza 2004). Manatee meat was consumed at an average rate of 4.2 lbs per family, an order of magnitude less than that of freshwater turtle and deer meat.

2.16.3. Socioeconomic Significance of the Species to Local Communities

Manatees are hunted mainly for their meat, and it is estimated that 30 to 40 animals are killed every year in the country (Jiménez 2000, 2002). The local people do not associate any healing powers with manatee parts (Jiménez 2002). Manatee meat is reported to be soft and to taste better than other meats and fish commonly consumed in this area (Espinoza 2002). Manatee meat is sold in several places including markets in Laguna de Perlas and Bluefields, and thus hunting is a lucrative business. This commercialization differs from traditional practices in which meat was shared among community members. Today a pound of manatee meat is sold for around US$0.62 (Espinoza 2004). Although manatees are killed mainly for their meat, other parts of the body are also used; for example, the skin and viscera (Espinoza 2004) are used as lobster bait or to make whips (Jiménez 2002).

Hunting occurs in several villages, including San Vicente, Kakabila, Bismuna, Krukira, Tara, and Haulover (Jiménez 2002). In a few of these towns, hunting is a socio-cultural activity involving the participation of many men and community celebrations after each successful hunt. In Haulover, manatee hunters are highly respected members of the community. Young men are expected to become hunters when they reach the appropriate age, usually around 35. Hunting in Haulover occurs on a regular basis (Jiménez 2000). In this village, everyone has consumed manatee meat and at least one member of each

family participates in the hunt and passes on the tradition (Espinoza 2004). Those that are interested in learning to harpoon learn by watching other family members who practice the activity often.

Cultural differences among hunting communities in Nicaragua affect the resulting impact each community has on manatee populations. In some villages, a few people participate, using canoes to look for manatees. In other villages such as Haulover, groups of up to 40 men participate, using motorboats. In still other communities, poaching is opportunistic and the number of people involved in any one event is small. Finally, other communities such as Krukira use long shrimp nets (at least 250 meters long) in which manatees are accidentally trapped. In some Nicaraguan communities, hunters are highly respected, whereas in others they are not. Some people do not hunt anymore because the technique is too difficult and requires a lot of strength and knowledge. Young people in many communities appear to be more interested in fishing than in hunting. Some young people also look for a better lifestyle and thus migrate to other countries like Costa Rica or the United States (Espinoza 2004).

2.16.4. National Legislation and Conservation Measures

Nicaragua has signed a series of international conservation agreements (Table 4). At the national level, manatees are protected under the general hunting law, Legislative Decree 306 of 1956. In 1972, the manatee-hunting season was closed indefinitely. In 1977, Decree No. 625 increased manatee protection by forbidding the commercial take or export of wildlife species. However, indigenous and local people living along the coast are often unaware of the laws (Jiménez 2002). The presence of enforcement personnel is rare and in some communities, the only people available to help with manatee protection are a local judge, a “sindico” (native leader in charge of natural resource use), or the local pastor. This lack of authoritative enforcement probably explains why manatee meat is sold openly in some local markets. In communities like Wawa, people are aware of the importance of protecting manatees due to the educational campaigns of local environmental organisations such as Programa Ambiental Regional para Centroamérica. In Rama Cay, the environmental project called Proyecto de Conservación y Desarrollo Forestal has promoted protection of manatees. As a consequence, some hunters do not hunt anymore; however, others are not willing to change unless they receive some type of compensation or are offered an alternative way of living (Jiménez 2000).

In 1999, the Biosphere Reserve of the Southeast of Nicaragua was established, encompassing a series of protected areas including the Biological Reserve of Indio Maíz and the Wildlife Refuge Río San Juan, a Ramsar site. The Biosphere Reserve includes in its management plan activities designed specifically to conserve and protect manatees. The number of manatees in the reserve is probably lower than in some other areas, but the quality of available habitat is much higher. However, since the Reserve is adjacent to the Tortuguero Conservation area in Costa Rica, which has excellent manatee habitat and good enforcement, both areas provide a safe and high-quality area for manatees to use (Jiménez 2002).

In 2005, “Ley Especial de Delitos contra el Medio Ambiente y Recursos Naturals,” or Special Law of Environmental and Natural Resources Crimes, was established to protect the environment and natural resources. In this law, Decree No. 41 prohibits the capture of aquatic resources, in particular of those species classified as threatened or endangered of extinction by CITES. Decree No. 26 prohibits the capture of species without a special permit, with a fine from US$1,000 to US$10,000 for breaking the law. Decree No. 27 establishes that hunting any endangered species is an ecological crime; the penalty ranges from US$ 5,000 to US$20,000. The fine is doubled if the activity takes place in a protected area. Decree No. 28 establishes that any person breaking the CITES convention can be fined from US$2,000 to US$10,000 (M. Chamorro pers. comm.).

2.17. PANAMA

2.17.1. Status and Distribution

The Caribbean coastline of Panama is extensive but appears to harbour relatively few manatees. In 2004, 49 manatees, including 9 calves, were sighted during aerial surveys (Riquelme *et al.* 2006). Manatee habitat ranges from the wetlands of San San Pond down to Peninsula Valiente, including the waters of several rivers (Sixaola, Changuinola, Mananti, Guariviara, and Cañas), lagoons (Jugli and Damanai), and the Panama Canal (Mou Sue *et al.* 1990, Riquelme *et al.* 2006). Of these areas, manatee sightings are rare in Río Sixaola (Riquelme *et al.* 2006).

Results from aerial and boat surveys conducted in the 1980s and again in 2005 suggest that Río San San and its tributary, the Río Negro, are the main manatee habitats in the country. The area is part of Bocas del Toro Providence. In La Olla lagoon, near the mouth of the Río San San, large groups of manatees, including a high proportion of calves, can be sighted (Mou Sue *et al.* 1990, Riquelme *et al.* 2006). Ruiz (2006) reported sightings of up to 30 manatees. He estimated that around 100 manatees use the area, which forms part of the San San Pond Sack Wetland.

The San San River basin and La Olla Lagoon provide important habitat for manatees with foraging areas comprised mainly of grasses such as *Panicum* spp. and shallow waters surrounded by mangrove forests, which provide shelter and food for manatees (Mou Sou *et al.* 1990, Riquelme *et al.* 2006). Another important area with good quality habitat for manatees is the Humedal de Importancia Internacional Damani Guaribira. This protected area probably supports a large number of manatees (Ruiz 2006), although the actual number of animals inhabiting this wetland is currently unknown.

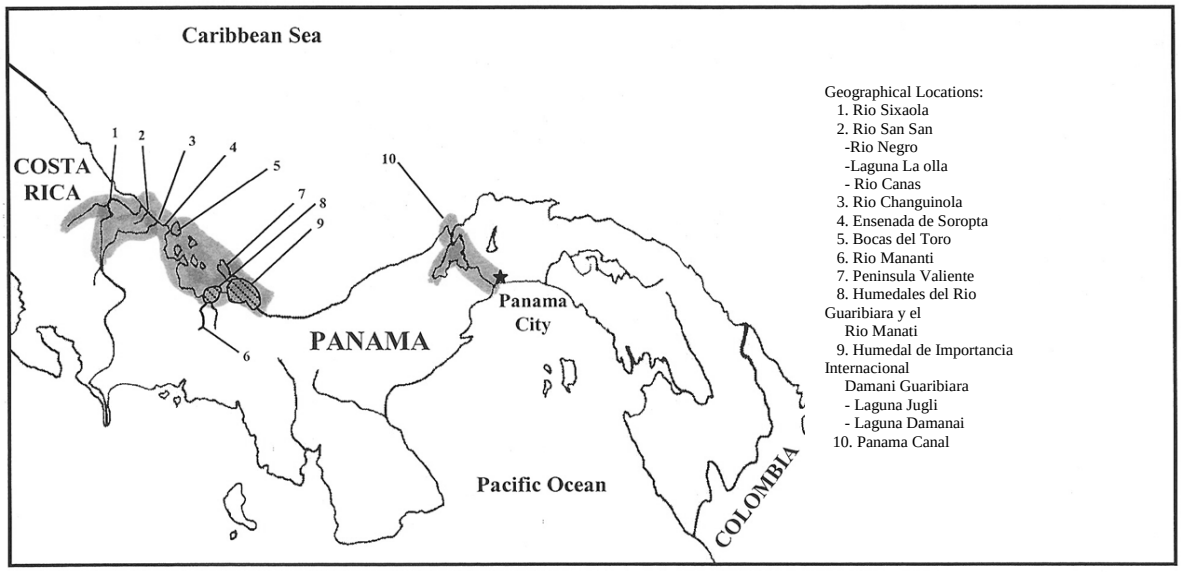

Figure 20. Distribution of the West Indian manatee, *Trichechus manatus,* in Panama from best available data from aerial surveys and interviews.

Manatees appear to migrate upriver, taking advantage of high tides (Mou Sue *et al.* 1990, Riquelme *et al.* 2006). Ruiz (2006) reported that such movement occurs at night when manatees travel to feeding areas, which are covered mainly by imperial grass (*Axonopus scoparitus*). Riquelme *et al.* (2006) reported that during movements upriver, manatees feed on a variety of vegetation, from freshwater macrophytes such as water lettuce (*Pistia stratoires*) and water hyacinth (*Eichhornia crassipes*) to true

grasses such as Guinea grass (*Panicum maximum*; Riquelme *et al.* 2006). In the morning, manatees move down river to La Olla where they can feed on abundant mangrove vegetation such as red *Rhizophora mangle* (Riquelme *et al.* 2006, Ruiz 2006), black mangrove *Avicennia germinans*, and white *Laguncularia racemosa* (Riquelme *et al.* 2006). Nightly movements of manatees away from the mouth of the river may be an avoidance manoeuvre related to human activities such as night fishing (Ruiz 2006). In the past, fishermen reported that manatees migrated back and forth between Rio San San and either Lagunas de Changuinola in Panama or Lagunas de Gandoca in Costa Rica. However, currently such movements appear to be uncommon. It is possible that the natural conditions of the lagoons have changed and that manatees do not use those lagoons anymore (Ruiz 2006). For example, there has been an increase in sedimentation rates and of the number of fast boats using the Laguna de Gandoca. Ruiz (2006) suggested that these impacts forced manatees to leave the lagoon and move to the protected area of Río San San, which has less human development and where manatees are now more abundant.

Other areas of importance within the Bocas del Toro Providence include Lagunas de Changuinola and Ensenada de Soropta, which offer excellent habitat for manatees. Groups of up to nine manatees have been sighted in a stretch of water within Lagunas de Changuinola called Quebrada Lagarto (Riquelme *et al.* 2006). Relatively high numbers of manatees (up to 11 at a time) have also been sighted in Ensenada de Soropta. Sorope Canal and the offshore waters near the mouth of Rio Caña are the only marine habitats where manatees have been found in Panama. Soropta Canal is located about 10 km from the mouth of the Rio Changuinola and faces Isla Colon's Boca del Drago area. It is a shallow-water habitat of pristine coral reefs and patches of seagrass (Riquelme *et al.* 2006). In 2004, three manatees were sighted in the Sorope Canal, probably feeding on the cove grasses and mangrove stands. The cover might serve not only as forage but might also allow manatees to move between channel systems and nearby rivers (Riquelme *et al.* 2006). In the eastern part of the country, manatees were sighted in Punta Tiburon in the 1970s (Mou Sue and Chen 1990) and have more recently been observed in Rio Caña (TNC 2006). Rio Caña is the only known river in which manatees seem to move to the sea (Ruiz 2006).

2.17.2. Major Threats and Conservation Problems

On a small scale, hunting and motorboat traffic represent a threat to manatees. Hunting is no longer common because younger people do not usually practice the activity. However, reports of poaching still occur in areas such as Río San San where a manatee was shot and the meat distributed among several families (Riquelme *et al.* 2006). Manatee hunting has been reported in Laguna de Chiriqui, specifically at the mouth of Rio Caña y Rio Guariviara (TNC PROARCA-APM 2006).

In the same river, motorboat traffic is a problem (Mou Sue *et al.* 1990). In 2002, boat propellers wounded one manatee, although it is unknown whether the animal survived the collision (Riquelme *et al.* 2006). In some parts of the San San Pond Sack Wetland, an aquatic transportation system has been implemented using boats with high-powered engines (140 to 200 hp). This type of activity has increased the transit of boats through important manatee feeding areas. Thus, although the San San Pond Sack Wetland is one the most important manatee areas in the country, it is also the only area in which motorboats are a real threat to manatees (Ruiz 2006).

Unlike the threats imposed by hunting and boats, massive environmental degradation (i.e., caused by the banana industry, cattle ranching, and recreational activities) represents a serious problem for manatees. In fact, questionable agricultural practices are considered a high threat to manatees in Panama (TNC PROARCA-APM 2006). Banana plantations, occupying approximately 5,000 ha of the country (Riquelme *et al.* 2006), use fungicides such as ethylene bisdithiocarbamates (EBDCs) and chlorothanil

that are carried by rainfall into coastal waters. The plantations also have controlled discharges that are said to kill large numbers of aquatic animals (Riquelme *et al.* 2006), especially fish, two or three times a year (TNC PROARCA-APM 2006). The waters of the Río San San and Changuinola are among the areas affected by the discharges (Ruíz 2006). In those two areas, there are at least five point sources of water flowing from banana plantations (TNC PROARCA-APM 2006). This type of agricultural practice also discharges great amounts of sediments and organic matter, which can deposit at the bottom of lakes and rivers and alter the depth of water bodies to the point that manatees may not have been able to enter particular areas to feed. Interestingly, manatees have neither been reported to avoid contaminated areas nor to die directly from contaminant exposure. Cattle ranching is also a problem in the San San Pond Sack Wetland because agrochemicals, used to maintain pastures, are sometimes discharged in the waters of the lagoons located within this wetland system. Other agricultural activities have destroyed mangroves and native plants along much of the coastline. In the San San Pond Sack Wetland, gramineous plants that are inedible by manatees such as *Typha dominguensis* and *Acrostichum aureum* have colonized and invaded shorelines known to be manatee-feeding grounds (Ruíz 2006).

Many residential houses and hotel complexes have been built near the wetlands of Archipiélago de Bocas del Toro. No system exists to treat wastewater from these facilities; instead, waters are channelled directly to the coastal marine system of the archipelago. This affects manatees directly as their habitat is becoming contaminated. Development also brings more people, boats, and noise to watercourses. This is a great problem in Rio Carbón and Laguna de Gandoca (TNC PROARCA-APM 2006).

2.17.3. Socioeconomic Significance of the Species to Local Communities

In the wetland of San San Sak, there are plans to use manatees as a tourist attraction. However, the plans are hindered by several factors, including the limited participation of local people, the lack of infrastructure to promote the activity, and the fact that few people visit this wetland (Ruíz 2006).

2.17.4. National Legislation and Conservation Measures

In 1967, the wildlife law Decreto no. 23 established that hunting of manatees, among other species, is prohibited. In 1980, Resolution No. DIR-002-80 of Ministerio de Desarrollo Agropecuario (Dirección Nacional de Recursos Naturales Renovables RENARE) declared that manatees are endangered (UNEP 1995). In 2006, this law was ratified with Ley 5 de 2006, which establishes that manatee hunting is an ecological crime. At the international level, Panama has signed a series of international conservation agreements that protect manatees and their habitat (Table 4).

Manatee habitat is protected in two large areas. In 1998, the Bastimentos National Marine Park was created in Bocas del Toro archipelago to protect more than 13,000 ha of which more than 11,000 ha are marine habitat. In 1993, the San San Pond Sack Wetland (near the border with Costa Rica) was created to conserve many species of birds, reptiles, and mammals, including manatees. The site measures approximately 16,414 ha and encompasses channels and shallow brackish and freshwater lakes in the lower basin of the Río Changuinola and Río San San. These two rivers are considered important manatee habitat (Mou Sue *et al.* 1990, Riquelme *et al.* 2006, Ruiz 2006). Due to its importance, this wetland reserve was declared a Ramsar site (The Annotated Ramsar List 2007) and it has had its own management plan since 2004. One of the objectives of the plan is to involve community groups and the private sector in activities oriented to manage and protect this area (Ruiz 2006). The San San Pond Sack Wetland and Bastimentos National Marine Park, plus La Amistad International Park and the Palo Seco Forest Reserve, comprise the La Amistad/Bocas del Toro Bi-national Site (The Nature Conservancy 2004).

The level of awareness about manatees among local people has increased over the past several years due in large part to the efforts of a local organisation, Asociación de Amigos y Vecinos de la Costa y la Naturaleza (AAMVECONA), which has developed a series of environmentally sound economic activities. AAMVECONA has also built a community development centre that doubles as an ecotourism centre. Together with ANAM, AAMVECONA has conducted monitoring activities, particularly to protect manatees and sea turtles (Riquelme *et al.* 2006).

In 2004, AAMVECONA obtained funding from Conservation International and Proyecto de Alianzas Para Ecosistemas Criticos to conduct a long-term project called Raising Awareness to Conserve Manatee Habitats through environmental monitoring in local communities. The study will identify water pollutants and their sources, place signs in important manatee habitats, and conduct educational campaigns (Riquelme *et al.* 2006, Ruiz 2006).

2.18. PUERTO RICO (U.S.A.)

2.18.1. Status and Distribution

Manatees have been observed along the entire coast of main island of Puerto Rico including the waters of Isla de Vieques. However, they are not evenly distributed (Lefebvre *et al.* 2001, Mignucci-Giannoni 2005). Manatee distribution seems to be related to the availability of freshwater sources, distribution of marine seagrasses, and the degree of protection from strong waves (Powell *et al*. 1981, Rathbun *et al*. 1985, Mignucci-Giannoni 2005). Manatees are sighted more frequently in protected coastal areas having any three of the above characteristics. Manatees in Puerto Rico rarely enter rivers, except for the river mouth to drink fresh water.

Aerial surveys conducted since the late 1970s have shown that manatees are more abundant on the eastern and southern coasts than on the northern side of the island, which is characterized by deep waters, little vegetation, and few protected embayments. In contrast, the southern, western, and eastern coasts have shallow waters containing extensive seagrass beds (Powell *et al*. 1981). Manatees are found from Dorado to Fajardo along the north coast, from Fajardo to Yabucoa on the east coast, from Patillas to Cabo Rojo on the south coast, and from Cabo Rojo to Mayagüez on the west coast. Higher concentrations of manatees are found in Ceiba on the east coast, Bahia de Jobos in Guayama and Salinas on the southeast coast, Bahia Guayanilla and Bahia Guánica on the southwest coast, and in Boquerón, Joyuda and Guanajibo River mouth on the west coast. (Powell *et al*. 1981, Rathbun *et al*. 1985, Mignucci-Giannoni 2005). Manatees are rarely seen between Aguada and Manatí on the northwest and north-central coast of the island, although records exist for Aguada, Aguadilla, Isabela, Quebradillas, Arecibo, and Manatí. Manatees do not use the offshore islands (Mona and Desecheo), except for Isla de Vieques (Powell *et al.* 1981, Lefebvre *et al.* 2001, Mignucci-Giannoni 2005) and some rare sightings in Isla de Culebra and Isla de Caja de Muertos (island located 8.4 km south from Ponce; A.A. Mignucci-Giannoni, unpubl. data). Some vagrant manatees have been recorded in St. Thomas in the U.S. Virgin Islands and in Virgin Gorda in the British Virgin Islands (A.A. Mignucci-Giannoni, unpubl. data).

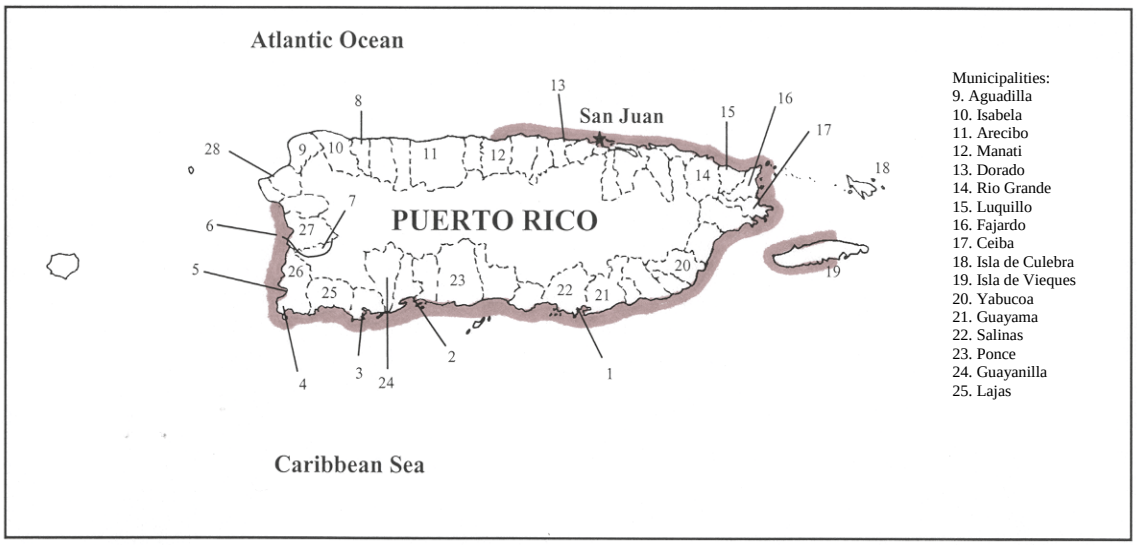

Figure 21. Distribution of the West Indian manatee, *Trichechus manatus*, in Puerto Rico based on best available data from aerial surveys and reported sightings (original map provided by A.A. Mignucci-Giannoni).

The number of manatees inhabiting the island's waters is unknown. Aerial surveys conducted in the 1970s produced a maximum count of 51 manatees (Powell *et al.* 1981), but the total number of manatees

observed has increased over time. In the mid-1980s, a total of 62 manatees was sighted (Rathbun *et al.* 1985). More recently, counts have exceeded 100 manatees (aerial survey in 2002: 112 manatees; survey in 2005: 121 manatees; Mignucci-Giannoni 2005). The island's population may be somewhere between 150 and 360 individuals (Mignucci-Giannoni 2005).

The numbers vary depending on the agency that is consulted. The U.S. Fish and Wildlife Service, basing its numbers on yearly linear surveys in a high-wing airplane platform, estimates the population to be at 100 individuals, while the Red Caribeña de Varamientos (Caribbean Stranding Network, CSN), basing its numbers on synoptic surveys onboard a helicopter, estimates the population to be at 350 individuals.

Manatees are found in Puerto Rican waters year around. Observations from aerial surveys indicate that the number of sightings is slightly lower for summer than for winter, but no explanation has been found for this trend (Mignucci-Giannoni 2005). Manatee movements are apparently restricted to the island. A radio-tagged manatee moved 50 km south from the Roosevelt Roads Naval Station to Puerto Patillas, and another manatee from Ceiba moved 9 km to Isla de Vieques. Another tagged animal travelled 210 km along the northwest and northern coast from Río Guanajibo to Luquillo, where he stayed for several weeks (Lefebvre *et al.* 2001, Mignucci-Giannoni *et al.* 1999). Similar to the other two tagged manatees, this individual used shallow seagrass areas to feed. The vegetation most important to manatee diets in Puerto Rico appears to be the marine seagrasses *Thalassia*, *Syringodium*, and *Halodule* (Powell *et al.* 1981, Mignucci-Gianoni and Beck 1998).

Recent genetic studies have shown that manatees in Puerto Rico, like other populations along the home range of the species, have a low genetic diversity. Although manatee movements between Puerto Rico and other countries have not been documented, genetic studies have demonstrated that manatees from Puerto Rico have three haplotypes based on mitochondrial DNA (García-Rodriguez *et al.* 1998, Vianna *et al.* 2006).

One haplotype is found only on the northern side of Puerto Rico, the same as the one haplotype reported for Florida and the Dominican Republic. Another haplotype is found only on the southern coast of Puerto Rico and is similar to one found in the Dominican Republic. Both haplotypes are found on the east and west coasts of the island. The other haplotype, unique to the island, is found in one of the areas of convergence of the other two haplotypes (Vianna *et al.* 2006). New developments on this study involve the use of microsatellites, which show that the Puerto Rico population of manatees is reproductively isolated from the same haplotype found in Florida, documenting how distinct these populations are (Kellogg *et al.* 2007).

2.18.2. Major Threats and Conservation Problems

The Caribbean Stranding Network reported 121 manatee deaths from 1990 through 2006, an average of 7.1 deaths per year (Mignucci-Giannoni *et al.* 2000a, A. A. Mignucci-Giannoni unpubl. data). Dead animals were recovered year-round and along all the coasts but occurred most frequently in the rainy season (June to November, 63.6%) and off the southern coast (39.7%), particularly in Guayama, Salinas, and Guayanilla. Reports decreased for the northern (29.8%), eastern (18.2%), and western (10.7%) parts of the island. Reported deaths were biased towards females (58.9%) and adults (38.8%) and calves (35.5%; A.A. Mignucci-Giannoni unpubl. data). In the same 17-year period, most deaths were due to natural causes (43.8%), including perinatal deaths (23.1%) and complications from illnesses such as pneumonia and bacterial infections (17.4%); the rest of the known-cause deaths were from anthropogenic causes (28.9%), mainly watercraft collisions (19.8%; A.A. Mignucci-Giannoni unpubl.

data). Watercraft collisions have been on the rise since first documented in 1990. A recent watercraft mortality included five animals in a mating group in San Juan Bay, Puerto Rico's major port. The female and four males were all killed instantly by a large-propeller vessel.

Hunting does not seem to be a problem in Puerto Rico after the mid-1990s. The last case of illegal poaching was documented in 1995. In 2001, an adult manatee was recovered in northeastern Puerto Rico with signs of a shark attack, the first confirmed report of shark predation on a West Indian manatee (Falcón-Matos *et al.* 2003).

2.18.3. National Legislation and Conservation Measures

Manatees are protected by the U.S. Marine Mammal Protection Act (16 USC § 1361 *et seq*. 1976 & supp. V 1981) and the Endangered Species Act (16 USC § 1531 *et seq*. 1976 & supp. V 1981; Lefebvre *et al.* 1989, Mignucci-Giannoni 2005). Manatees also receive protection from several Commonwealth of Puerto Rico laws: Ley de Pesca del Estado Libre Asociado (1943), Ley de Vida Silvestre (1977), Nueva Ley de Vida Silvestre (No. 241 of 1999), and Reglamento para Regir la Conservación y el Manejo de la Vida Silvestre, la Especies Exóticas. All laws are regulated by the Department of Natural and Environmental Resources. Manatee hunting and harassment is illegal, and violations of the law can be sanctioned with a US$100,000 fine (UNEP 1995, Mignucci-Giannoni 2005).

Rathbun and Possardt (1986) prepared the first recovery plan for the Puerto Rico population of the West Indian manatee. Despite the fact that both federal and commonwealth laws protect the species, the current recovery plan has not been updated and is obsolete. As in other areas of the species' geographical distribution, management decisions in Puerto Rico are mostly made in relation to knowledge obtained from the Florida population, where the environment and behaviour is different from the Puerto Rico population. The ultimate goal of the 1986 plan is to recover the population of manatees in Puerto Rico so that it can be removed from the Endangered Species List, establishing criteria and biological information needed to determine if and when to reclassify the local manatee population. With this purpose in mind, the plan intends to identify, assess, and reduce human-related mortality. It also attempts to identify and minimize the alteration, degradation, and destruction of habitats important to the survival of the Puerto Rican manatee population. In addition to the plan, the stranding network was created to rescue and rehabilitate orphaned and injured manatees in Puerto Rico and Caribbean waters. It has actively led mortality and stranding investigations for 17 years, cared for orphaned calves and sick manatees, and successfully released rehabilitated manatees back into the wild in Puerto Rico and the greater Caribbean region (Jiménez-Marrero *et al.* 1995, Martínez-Díaz *et al.* 2001, Mignucci-Giannoni 1998, Mignucci-Giannoni 2003a, Moore and Mignucci-Giannoni 1993, Valede *et al.* 1999).

In 1992, the U.S. Geological Survey's Sirenia Project began a radio-tracking project to determine movements and migration patterns of manatees in Ceiba (Reid and Bonde 1993, Reid *et al.* 1994a,b), and in 1996 efforts were focused on the southwest coast of Puerto Rico near the mouth of the Rio Guanajibo (Mignucci-Giannoni *et al.* 1999). In 2003 research focused on Boquerón and Guayanilla bays, and in 2005 research was conducted again in Ceiba. Since 1992, the Sirenia Project together with the University of Florida and CSN have conducted population genetic studies and to date have analyzed more than 130 samples, both through mitochondrial and nuclear DNA studies (Kellogg *et al.* 2007). After the initial aerial surveys of Powell *et al.* (1981) and Rathbun *et al.* (1985), the Caribbean Field Office (CFO) of the Fish and Wildlife Service and CSN have conducted regular surveys along the coastline. These are linear surveys conducted aboard a high-wing airplane, while the CSN surveys are synoptic surveys aboard a helicopter (Mignucci-Giannoni *et al.* 2000b,c; 2003b; 2004a,b; 2006).

Efforts on public education and community outreach have been conducted, mostly through the CSN with the help of Save the Manatee Club and corporate sponsors. Posters, brochures, booklets, and calendars have been printed and distributed to school children since 1990 along with visits to schools, summer camps, and environmental fairs. There are no Ramsar sites in Puerto Rico. However, the United States has signed different international conservation agreements that protect manatees and their habitat (Table 4).

2.19. SURINAME

2.19.1. Status and Distribution

There is little information on the status and distribution of manatees in Suriname. Most available reports are from the 1970s and 1980s. During that time, manatees were reported to use most of the coastal areas including rivers and creeks up to 60 km inland. The habitat was apparently good for manatees because mangrove forest was common in the coastal regions and estuarine rivers. Husson (1978) stated that manatees were never found in the open ocean but that they inhabited swamp forest areas, where they reportedly grazed on stands of *Montrichardia arborescens* (Lefebvre *et al.* 2001). Dekker (1978) reported that mokko-mokko (Montrichardia) was one of the favourite food items of manatees and that they also ate floating plants such as water lilies (*Nymphaea odorata*). In contrast, Bertran and Bertram (1973) reported that manatees are not found in the floating savannahs but are present in the small creeks transecting them. They also said that manatees did not seem to use areas farther upriver because of the rapids in the upstream portions of the rivers.

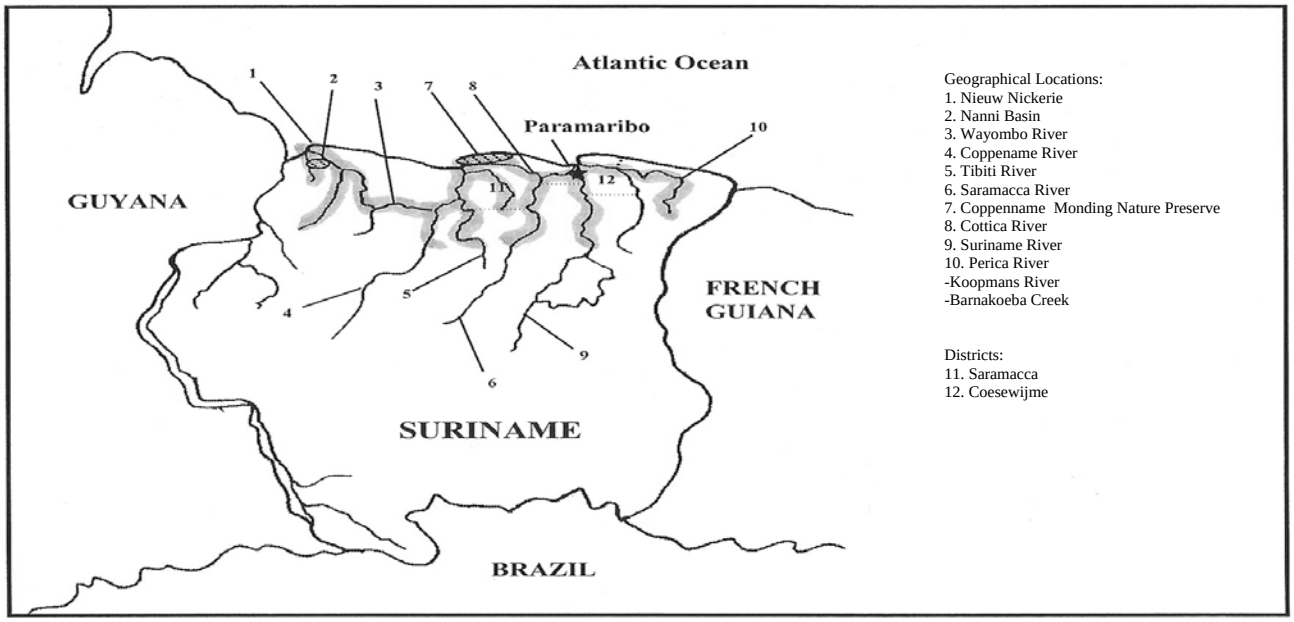

Figure 22. Distribution of the West Indian manatee, *Trichechus manatus*, in Suriname based on best available data from reported sightings.

Most manatees were sighted in the Nanni basins of Nieuw Nickerie. Those areas are considered potential reserves for the natural populations of manatee in Suriname (Dekker 1978). Manatees were also sighted in the Suriname and Saramanaca rivers; the Cottica River with its tributaries including Perica River and Koopman's and Barbakoeba creeks; the Commewijne River and its tributary, Cassewenica creek; and the Coppename River and its tributaries, the Coesewijme, Wayombo, and Tibiti rivers (Dekker 1978, UNEP 1995).

2.19.2. Major Threats and Conservation Problems

Because the status of the species is currently unknown, the threats and conservation problems that manatees face in Suriname are generally poorly defined. However, urbanization, development of natural areas for agriculture, and pollution have all been noted as potential threats. In the late 1970s, habitat

alteration seemed especially worrisome because almost 95% of the human population in the country lives in coastal areas (UNEP 1995). The Department of Nature Conservation, which is part of the Ministry of Natural Resources, stated in its 1993 report that manatees are still hunted for food in some areas of Suriname (Lefebvre *et al.* 2001).

2.19.3. Socioeconomic Significance of the Species to Local Communities

Manatees provide a certain amount of revenue for the country. The Amsterdam aquarium acquired two Suriname manatees for its display, one in 1966 and the other one in 1972 (Dekker 1978). Also, as noted above, manatees are still hunted for food and for their ear bones, which are thought to have medicinal powers (Lefebvre *et al.* 2001).

2.19.4. National Legislation and Conservation Measures

Manatees are protected by the Nature Protection Act and the 1954 Suriname Game Ordinance (UNEP 1995). Manatees have been reported in the Coppenamemonding Nature Reserve, located east of the mouth of the Coppename and Suriname rivers, in the Saramacca District. The reserve, which is the only Ramsar site in the country, has an area of 12,000 ha that includes intertidal mudflats and mangrove swamps (The Annotated Ramsar List 2007). It was established in 1966 and is protected and managed by the Forest Service of the Ministry of Natural Resources. The reserve is threatened, however, by urbanization, the expansion of agricultural activities, and infrastructural works for crude oil and mining. The Conservation Action Plan for Suriname considers the reserve as one of the top priority sites for coastal conservation (Western Hemisphere Shorebird Reserve Network 2003). Suriname has been involved in other conservation effort. The country has signed/ratified a series of international conservation agreements that protect manatees and their habitat (Table 4).

2.20. TRINIDAD & TOBAGO

2.20.1. Status and Distribution

Present distribution of manatees is fragmented mainly as a result of local extirpations due to habitat unsuitability. The historical distribution of manatees in Tobago included the leeward coast and the Bucco reef-lagoon complex. Presently, the species is absent from the nearshore waters around the island (Khan 2002). In Trinidad, the historical distribution of manatees ranged along the eastern, southern, and western coastal swamps, rivers, bays, and islets of the island. Their current range includes the coast along the Ortoire River mouth, Cocos-Manzanilla Bay coastline, Mayaro Bay, within the Nariva Swamp region of the Nariva River, Cocal Lagoon and L'Embranche River, the Charamel River, Balandra River and Bay, Salibia River and Bay, the Matura River, and the North Oropouche River (Khan 2002). Optimal habitat for manatees included sheltered coastal areas, rivers with slow water flow, and areas with access to food and fresh water (Khan 2002).

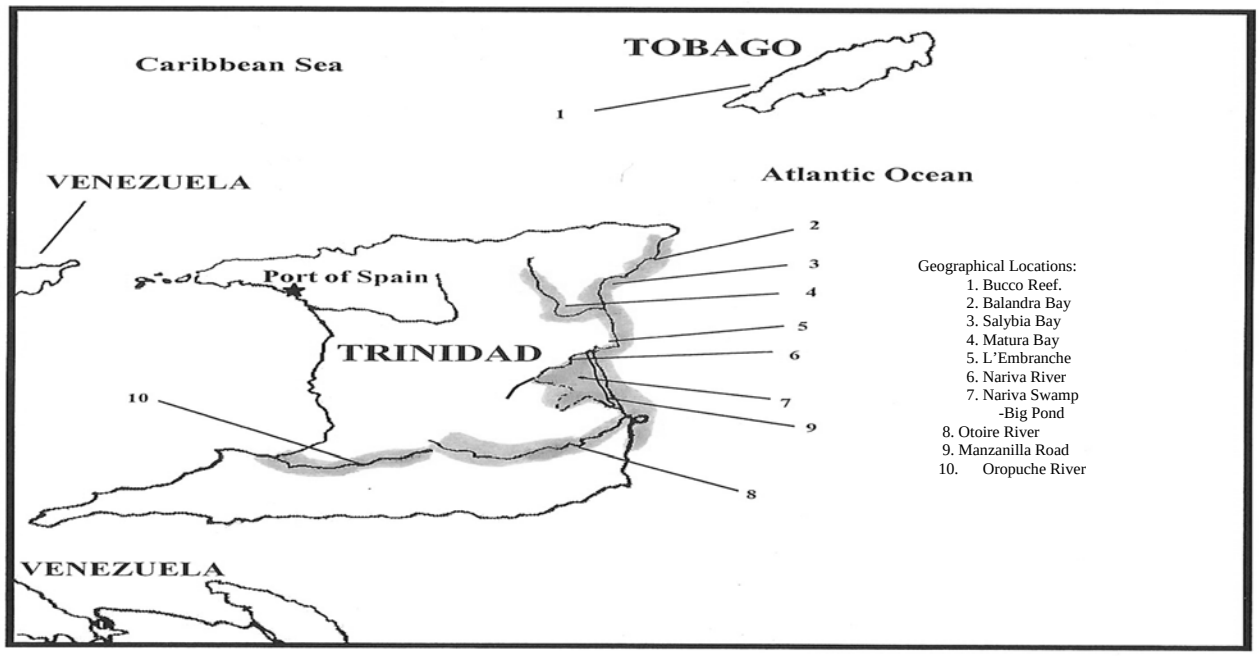

Figure 23. Distribution of the West Indian manatee, *Trichechus manatus,* in Trinidad and Tobago based on best available data from aerial surveys, boat surveys, and interviews.

The most concentrated population of manatees is found in Big Pond, a large body of water not subjected to seasonal change in water levels, with easy access and no direct connection to the sea, in the northern Nariva Swamp (Boyle and Khan 1993, Khan 2002). A breeding population of manatees exists in the Nariva River and Cocal Lagoon on the eastern edge of the Nariva Swamp (Khan 2002). Additional sightings have occurred in the North Oropouche, Charamel, and Ortoire rivers (Amour 1993, Boyle and Khan 1993).

There are no current population estimates. In 1993, a study involving boat/helicopter surveys and a series of interviews with fishermen concluded that the Trinidad manatee population did not exceed 100 animals (Amour 1993). A 1991 aerial survey over the North Oropouche River/Nariva Swamp areas recorded evidence of four manatees and a follow-up boat survey found signs of manatee feeding

(Seddon 1992). The Manatee Subcommittee of the Trinidad and Tobago Field Naturalist Club initiated research on manatee distribution in 1993 and estimated there are approximately 25 to 30 manatees along the eastern coast of Trinidad (UNEP 1995). More recently, Khan (2002) reported that fewer than 30 manatees occur annually within local east coast waters. Nathai-Gyan and Boodoo (2002) reported that the same manatee population size (20 to 30) inhabits the Nariva River. They indicated that this population is viable with at least four births since 1996. However, Trinidad's manatee population is relatively small compared to those of other countries.

Manatees migrate in response to seasonal changes in water levels, which affect food availability and water salinity. They can probably migrate between Venezuela and Trinidad and between local river systems and coastal bays (Khan 2002). Nathai-Gyan and Boodoo (2002) indicated that manatees migrate out to the Atlantic Ocean on the east coast.

2.20.2. Major Threats and Conservation Problems

Long-term development plans and their heavy impact on the hydrology and ecology of the area threaten Trinidad's manatee populations. Such impacts include swamp and wetland drainage, dam construction, pesticide runoff, aquatic pollution, felling of mangroves, and quarrying, dredging, and timber cutting in the North Oropouche (Hislop 1985, Seddon 1992, Amour 1993, Boyle and Khan 1993, Nathai-Gyan and Boodoo 2002). Sluice gate and canal construction in the river systems has blocked access for local manatee populations and possibly isolated two populations in the Nariva Swamp (Boyle and Khan 1993). This could be detrimental to the genetic flow of an already small, vulnerable population.

The Nariva Swamp, which serves as the major manatee habitat in Trinidad, is also subject to the perennial problem of fires, which are set mainly by farmers, hunters, and fishermen to clear vegetation. Fires become uncontrollable most of the time due to strong coastal winds and thus destroy valuable habitat (Nathai-Gyan and Boodoo 2002). The Nariva Swamp is also affected by improper agricultural practices. Thousands of hectares converted to rice fields use illegally constructed irrigation systems and dump salt water into the manatee habitat (Nathai-Gyan and Boodoo 2002).

Oil exploration is intense along the southern and eastern coasts of Trinidad. Increasing oil exploration may harm manatees because of the associated barge traffic and pollution that affect habitat quality. Additionally, manatees may be susceptible to the noise produced by motorboat traffic, seismic activity, and oil and gas exploration (Khan 2002).

Accidental entanglement of manatees in nets has occurred in the North Oropouche River (Hislop 1985, Khan 2002), L'Embranche River (Boyle and Khan 1993, Khan 2002), the Nariva Swamp region of the Nariva River (Boyle and Khan 1993, Khan 2002, Nathai-Gyan and Boodoo 2002), Ortoire River, Cocal Lagoon and L'Embrance River, the Charamel River, the North Oropouche River, Matura River, and Salibia Bay and River (Khan 2002). Data on poaching are contradictory (Amour 1993, Boyle and Khan 1993), but Seddon (1992) reported that manatee meat is occasionally available in local markets, although it is unclear if it is derived from premeditated or opportunistic manatee harvests. Khan (2002) reported that young manatees are captured and kept as oddities and/or possible sources of food. Nathai-Gyan and Boodoo (2002) indicated that most of the poaching takes place in the Nariva area and the method used is mainly harpooning.

The use of manatees as a tourist attraction could pose a potentially high risk to the small Trinidad populations. Unregulated, intrusive human activity could have a negative effect on local manatee

populations, especially in the Nariva Big Pond - Cocal Lagoon and upper Nariva River since these populations are semi-enclosed and thus have limited means of human avoidance (Khan 2002).

2.20.3. National Legislation and Conservation Measures

The Conservation of Wildlife Act of 1980 encompasses manatees under its jurisdiction by default. The Nariva Swamp habitat is protected under the Fisheries Act of 1975 and was declared a Prohibited Area under Legal Notice No. 78 of l993 of the Forest Act of l955. However, under the Fisheries Act of l990, manatees could be hunted legally unless the owner of the area objected to it. Moreover, enforcement of protective measures is not adequate due to lack of officers. The Nariva Swamp, Oropouche River, and Ortoire River are proposed National Park sites. The Nariva Swamp has been declared a Ramsar site in 1992 (Amour 1993, Boyle and Khan 1993, The Annotated Ramsar List 2007). Trinidad and Tobago has ratified a series of international conservation agreements that protect manatees and their habitat (Table 4).

The Manatee Subcommittee of the Trinidad and Tobago Field Naturalists Club has been involved since 1991 in environmental education programmes for schools and public workshops (Boyle and Khan 1993). In 2002, the Manatee Conservation Trust accepted the task to prepare a National Manatee Recovery Plan, supported by the Regional Coordinating Unit of the Caribbean Environment Programme of UNEP. The Manatee Conservation Trust is a non-profit organisation of Trinidad and Tobago that has been collaborating with the Government Forest Division (Nathai-Gyan and Boodoo 2002).

The major objectives of the Manatee Recovery Plan are to prevent reduction in size of existing manatee populations and to ensure the preservation of the habitats used by manatees. The document outlines a four-year manatee conservation programme and lists priority actions that need to be completed by the end of this period. The activities include an assessment of the status and distribution of manatees in the country, identification of essential habitat especially within the Nariva Swamp, and development of regulatory guidelines and a specific management plan for the Nariva Swamp (Nathai-Gyan and Boodoo 2002).

2.21. UNITED STATES

2.21.1. Status and Distribution

The Florida subspecies (*Trichechus manatus latirostris)* occupies riverine, estuarine, and coastal habitats of the southwestern United States (Reynolds and Powell 2002, U.S. Fish and Wildlife Service 2001). The subspecies is limited primarily to peninsular Florida during winter due to the availability of warm water in this region. During the non-winter months, manatees have been found as far north as Rhode Island and as far west as Texas.

Scientists estimate that there may be at least 3,300 manatees in U.S. waters. For management purposes, the Florida manatee population is considered to comprise four regional subpopulations, the two smallest of which (Northwestern Florida and St. Johns River subpopulations) are growing (U.S. Fish and Wildlife Service 2001, Runge *et al.* 2004), the largest of which (East Coast subpopulation) is stable or growing slightly (Craig and Reynolds 2004[1]), and the second largest of which (Southwestern Florida subpopulation) is likely in decline (Runge *et al.* 2004). Glaser and Reynolds (2003) suggest that the status of manatees in Florida may be better than it has been for a century or more due to protective legislation, widespread public awareness, and interest among Florida residents.

Figure 24. Distribution of the West Indian manatee, *Trichechus manatus*, in United States based on aerial surveys, boat surveys, interviews and documented sightings. The dark shading indicates year-round distribution, while the light shading indicates seasonal or occasional occurrence.

In a recent review of the status of sirenians for the IUCN-World Conservation Union, Taylor *et al.* (2006) recommended that a listing of 'endangered' could be supported for *T. m. latirostris*. The subspecies is considered endangered under the U.S. Endangered Species Act, although the state of Florida downlisted the subspecies to threatened under state statutes.

[1] Runge et al. (2004) suggest that the East Coast subpopulation is stable or in decline, but the authors have recently reconsidered their data and used a modified analytical approach that is likely to cause their findings to agree generally with those of Craig and Reynolds

Life history attributes appear in Reynolds and Powell (2002). Based primarily on the well-studied manatees in Crystal River (northwestern Florida) and at Blue Spring (northeastern Florida), some important traits affecting reproductive potential and survival are as follows:

- Maximum life expectancy: 60 years
- Gestation period: 1–13 months
- Annual adult survival: variable; as high as 96% in some locations
- Age at sexual maturity: 3–4 years in females; as early as 2 years in males
- Percent of adult females that are pregnant: 0.33
- Mean interbirth interval: 0.5 years
- Litter size: one, although twins sometimes occur

Integration of these sorts of data into models suggests that the optimal annual rate of increase is approximately 6.5% under ideal conditions (Boyd *et al.* 1999). A well-established carcass salvage programme is conducted by the state of Florida; more than 400 dead manatees (equivalent to approximately 12% of the estimated minimum population size of 3,300) have been recovered in a single year (Marine Mammal Commission 2005).

2.21.2. Major Threats and Conservation Problems

As a general rule, survival of manatees worldwide is jeopardized by a range of current threats— incidental taking in fishing gear, habitat loss, watercraft collisions, hunting, pollution— as well as future threats associated with human population growth and human activities (Reynolds 1999). The unrelenting, and sometimes poorly controlled effects of human population growth in Florida may be the greatest threat to the sustainability of a range of living and non-living natural resources, the West Indian manatee prominent among them.

In the United States, hunting does not appear to constitute a major threat to manatees, but the extent to which other factors, such as pollution, are affecting manatees is unknown due to a general lack of information. For Florida manatees, loss of warm water during winter may constitute the greatest single short-term threat (Laist and Reynolds 2005a,b), although collisions with watercraft continue to kill several dozen animals annually and seriously injure an unknown number of other animals (Marine Mammal Commission 2005). Between 2000 and 2004, human-related deaths constituted 28.7% (458 out of 1,595) of the total manatee mortality (Marine Mammal Commission 2005).

In addition to human-related threats, manatees in southwestern Florida (the only subpopulation thought to be in decline) experience high levels of mortality due to red tides (Flewelling *et al.* 2005). In fact, red tides may cause a higher percentage of the total annual manatee mortality in a given year (e.g., 140 deaths in 1996) than any other single known cause. The extent to which human activities may exacerbate the frequency and intensity of red tides is a matter of debate (Van Dolah 2005). The effects of factors such as global climate change on manatee population status are uncertain. Hurricanes, for which frequency and intensity appear related to climate change, lower adult survival in Florida manatees (Langtimm and Beck 2003).

2.21.3. Socioeconomic Significance of the Species to Local Communities

The issue of socioeconomic importance can be considered from two perspectives. In some locations, such as the Crystal River, manatee-based tourism provides economic support to the community. On the other hand, the enforcement of protective legislation has sometimes led to cessation or reduction of some lucrative businesses (e.g., dock building in Lee County). Boat-speed regulatory zones for manatee

protection have led some local fishermen and others to complain that transit time (and associated costs) has become hard to bear. To the best of our knowledge, there is no comprehensive, up-to-date cost-benefit analysis of manatees to local communities in Florida.

2.21.4. National Legislation and Conservation Measures

Two U.S. federal laws directly protect the Florida manatee: the Marine Mammal Protection Act of 1972, and the Endangered Species Act of 1973. The general provisions of these statutes are described by Baur *et al.* (1999) and recent amendments are described in various annual reports of the Marine Mammal Commission (www.mmc.gov). Protection of manatees under these laws is discussed by Reynolds 1999, U.S. Fish and Wildlife Service 2001, and Glaser and Reynolds 2003. As required under the Endangered Species Act, a recovery plan for Florida manatees exists (U.S. Fish and Wildlife Service 2001). The current iteration of the recovery plan is the fifth since 1980, and an additional revised plan is underway by the U.S. Fish and Wildlife Service, assisted by numerous other agencies and stakeholders. Additionally, the United States has signed international conservation agreements that protect both manatees and their habitat (Table 4).

In April 2007, a five-year review for the West Indian manatee including both subspecies was completed by the U.S. Fish and Wildlife Service as required by the Endangered Species Act. This act uses five criteria for evaluation of status of a taxonomic group: (1) the present or threatened destruction, modification, or curtailment of a species' habitat or range, (2) over-utilization for commercial, recreational, scientific, or educational purposes, (3) prevalence or effects of disease or predation, (4) the inadequacy of existing regulatory mechanisms, or (5) either natural or man-made factors affecting the species' continued existence. According to the Fish and Wildlife Service, the current status of manatees could warrant a change in official listing from endangered to threatened. Under the act, an endangered species is one that is in danger of extinction in the immediate future throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. It is important to realize that changing the listing status from endangered to threatened does not require that protective measures already in place be changed as well. The Fish and Wildlife Service review includes a recommendation, and not a formal decision, to downlist Florida manatees to threatened status. A decision to downlist can only occur after a formal rulemaking process involving public and agency comment.

The primary basis for suggesting that manatees be downlisted has to do with the status of manatees in Florida. For three of the four regional management units (subpopulations) of manatees in Florida, population analyses show positive growth. The review also included consideration of current threats on manatee populations using the core biological model (CBM), which can incorporate changing levels of threat, specifically watercraft, red tide, entanglement, availability of warm water, and deaths due to dams/locks. The model also includes such factors as environmental, demographic, and catastrophic stochasticity. Using the best scientific data available at this time, the CBM indicated that if warm-water refuges disappear, the future manatee population would exhibit a steady decline for approximately 50 years, with acceleration of that decline thereafter; the result would be about an 8.5% chance of quasi-extinction (< 250 animals on either coast) in 100 years and a 14% chance 50 years later. The specifics of the manatee five-year evaluation and threats analysis can be found at http://www.fws.gov/northflorida/Manatee/manatees.htm. Although the CBM was based on extensive data for Florida manatees, the extent to which most parameters appropriate for that subspecies apply to the Antillean subspecies is unknown. In most parts of the species' range (i.e., the range of both subspecies), the status of manatees is unknown, population sizes have never been estimated, and many populations may be declining at present (Table 3, Taylor *et al.* 2006).

2.22. VENEZUELA

2.22.1. Status and Distribution

Information about the current status of manatees in Venezuela is scarce. Although Venezuela has an extensive Caribbean coastline, manatee sightings along much of the coast are rare due to a lack of suitable habitat (i.e., rocky, deep and cool waters lacking significant freshwater input). The absence of manatees along parts of the coast of Venezuela represents a major discontinuity in the range of the species (Lefebvre *et al.* 1989).

In the 1980s, observations from aerial surveys and information generated through interviews concluded that there were no resident manatees in Lago de Maracaibo and Boca del Dragón (O'Shea *et al*. 1986, Correa-Viana *et al.* 1990). However, recent studies (Manzanilla-Fuentes 2006) have shown that a relatively small number of manatees actually use some parts of Lago de Maracaibo, South America's largest lake, located 180 km inland in northwestern Venezuela. A total of 27 manatee sightings (adults and calves) was reported along the northern side of the lake, located in Bahía El Tablazo. It is unclear if sightings were of different animals or of the same animal sighted over time. Animals were reported in groups of one to four with solitary animals being more common. Manatee density was sparse (less than 0.01 manatee/km). Manatee observations within the bay occurred along the coast of Isla de Toas and in the creeks of Isla San Carlos, areas characterized by extensive mangroves that provide food and protected areas for manatees. Bahía El Tablazo has higher salinity than the rest of Lago de Maracaibo, as it is closest to the Golfo de Venezuela (Manzanilla-Fuentes 2006).

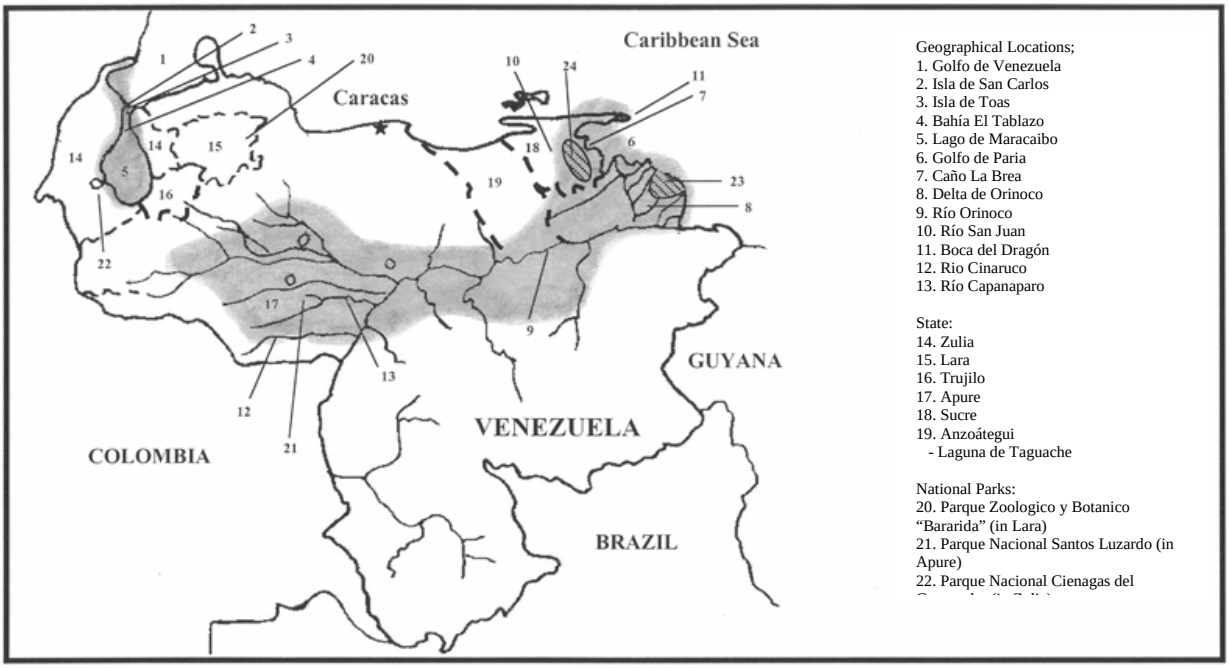

Figure 25. Distribution of the West Indian manatee, *Trichechus manatus,* in Venezuela based on best available data from aerial surveys and interviews of local residents.

Interviews with local people indicate that most animals in Bahía El Tablazo are adults. Interviewees indicated that manatees are sighted more often in the dry season and that the animals use the bay for different purposes: feeding, travelling, mating, and "playing"; the latter was the most commonly reported activity (Manzanilla-Fuentes 2006).

No current systematic information is available regarding the status of the species for much of the eastern coast of Venezuela, an area characterized by good quality habitat for manatees. It has slow-moving rivers, estuaries, warmer water, and mangrove swamps (O'Shea *et al.* 1986, Correa-Viana *et al.* 1990). There were frequent reports of manatees in the waterways of the extensive Orinoco Delta and throughout the middle Orinoco in the 1980s. In 2003, three manatees were sighted in Golfo de Paria within Parque Nacional Turuepano (S. Boher pers. comm. with Self-Sullivan and Mignucci-Giannoni 2006). The park is located to the north of the San Juan River in the western end of the gulf (Sucre State). In 1992, 11 manatee sightings were recorded in Golfo de Paria. In the same year, manatees were also sighted in Caño La Brea and Laguna de Taguache (Lefebvre *et al.* 2001).

2.22.2. Major Threats and Conservation Problems

Although reduced over the past several years, illegal hunting still occurs in Venezuela. In areas around Lago de Maracaibo, people have been reported to consume manatee meat. In small towns located near Isla Toas, even young people have reported the consumption of manatee meat. Results from interviews suggest that the manatee population is declining in this part of the lake. Interviewees said that manatees were abundant throughout the country 40 years ago, and that the numbers were so high in some areas of Lago de Maracaibo that it was difficult to navigate at low tide because manatees were found everywhere. Interviewees also said that due to their abundance, manatees were easy to catch with nets, and locals often captured and released animals in this way purely for amusement, rather than out of necessity. Local people have suggested that manatees probably moved away from the area after a channel was dredged, reducing habitat quality (Manzanilla-Fuentes 2006). It is possible that the trend is similar for the rest of the country, but such a trend remains unconfirmed. Venezuelan biologists indicate that incidental entanglement is also a threat (M. Balladares and C. Balladares pers. comm.). However, no specific information is available about the number of animals that have died this way in recent times.

Manatees have also died as a result of other anthropogenic causes, some of them unclear. In Golfo de Venezuela, for example, three manatees were found dead in 2003. One manatee died as a result of a boat collision and had severe skull injuries and propeller scars on the back. Another, a calf, found close to the town of Santa Rosas de Aguas, died from a deep wound in the abdomen—an injury unlikely to be caused by a boat. The cause of death for the third animal is unknown (Manzanilla-Fuentes 2006). Lago de Maracaibo is the site of extensive oil and gas exploration and development. These activities are likely to affect habitat quality as a result of heavy boat traffic and pollution (Correa-Viana *et al.* 1990) or even to affect manatees directly.

2.22.3. Socioeconomic Significance of the Species to Local Communities

For some people in Venezuela, manatees are still a source of food. However, hunting has declined significantly since the middle of the past century (O'Shea *et al.* 1988, Lefebvre *et al.* 1989). Captive manatees are used for educational purposes and as an exhibit at a state park called Parque Zoologico y Botanico Bararida, located in Barquisimeto, Lara state, and other calves area displayed in Parque Sur Maracaibo, Zulia state. Two more manatees were bought from the Venezuelan government and sent to the Dallas World Aquarium in 1999 (A.G. Manzanilla-Fuentes pers. comm.).

2.22.4. National Legislation and Conservation Measures

Manatees are protected under a general hunting law, Ley de Protección a la Fauna Silvestre of 1970 (articles 11 and 77), Resolución MARN (Ministry of the Environment and Renewable Natural Resources) No. 127 of 1978, and Resolución MARN No. 95 of 1979. Additionally, Venezuela has ratified several international conservation agreements (Table 4) that protect manatees and their habitat.

Venezuela has 43 national parks and five Ramsar sites. Manatees have been reported in one of the Ramsar sites, Ciénaga Los Olivitos (The Annotated Ramsar List 2007). At least 11 of the parks protect areas along the coast including the inshore waters of some rivers and estuaries (Arassari Trek 2006). One such park is Parque Nacional Santos Luzardo in the state of Apure. The park was created in 1988 and protects 584,368 ha of land and coastal areas of two rivers, the Cinaruco and Capanaparo. In 1991, an area of 226,130 ha of mangroves, evergreen forest, and marshes in southeastern Lago de Maracaibo became Parque Nacional Ciénagas del Catatumbo. The park is located in Zulia State. In the same year, Parque Nacional Delta del Orinoco Mariusa, with an area of 331,000 ha that includes swamps, estuarine habitat, and coastal mangroves, was created northeast of the Orinoco Delta (Gobierno Bolivariano de Venezuela 2006). More recently, it has been recommended that Bahia El Tablazo in Lago de Maracaibo become a protected area for manatees. In this area, independent researchers have conducted educational programmes related to manatees in the local communities (Manzanilla-Fuentes 2006).

3. SUGGESTED SHORT-TERM AND LONG-TERM RECOMMENDATIONS

Effective manatee conservation in the Wider Caribbean is a complex task and will require the dedicated and coordinated efforts of legislators, managers, scientists, community leaders, and other stakeholders. The difficulty arises from the need to reconcile the protection of a species and the habitat on which it depends while respecting the needs and traditions of people who rely on that same habitat for their survival. In many developing countries where manatees are found, people have varying levels of education and socioeconomic backgrounds. In an area of poor socioeconomic conditions, manatee conservation is not likely to be a high priority. In addition, tremendous economic and political pressure exists for the maintenance and expansion of fishing, logging, and coastal development, activities known to negatively impact manatees and their habitats. The great challenge is to unite socioeconomic development and manatee and habitat conservation in a sustainable framework. This is likely to be a slow process, and will require a concerted effort from the various segments of the society.

The following discussion contains recommendations for short- and long-term activities necessary for effective conservation of the West Indian manatee in the Wider Caribbean Region. Recommendations are grouped in two categories:

1. Short-term or Priority Measures should be implemented immediately or as quickly as possible. They include conservation, research, education, and law enforcement measures.

2. Long-Term Research and Conservation Measures should allow the implementation and strengthening of research, education, and conservation programmes designed to ensure the recovery and maintenance of manatees and the protection of the habitats necessary for their survival.

Recommendations must be adopted as an integrated, multi-faceted programme, where the scientific findings and educational programmes provide support for protective and legislative measures. Some recommendations are repeated in the two categories of measures. For example, countries that lack recent information on local populations could conduct aerial surveys to examine current distribution and abundance trends. The same technique could be used to monitor the status of populations over time and identify any spatial and temporal trends. Additionally, environmental education is both a short-term and long-term priority, although the actual design of educational activities will vary according to immediate and long-term objectives. Recommendations provided include the recommendations and guidelines of the Marine Mammal Action Plan (draft) and of manatee management plans available for some countries.

All recommendations are summarized in Table 7 included at the end of this section. Following is a section outlining country-specific strategies for manatee conservation. These recommendations were identified in the course of reviewing the status of manatees in the Wider Caribbean. Local researchers who are currently working with manatees provided other recommendations.

3.1. SHORT-TERM OR PRIORITY RECOMMENDATIONS

3.1.1. Assess Current Status and Distribution of Manatees

Directed research, designed to provide useful information regarding both manatees and people, should form an integral part of any recovery plan for a species or population. Without scientific information to inform decision makers, it is extremely difficult to know the appropriate steps to conserve any species or habitat. A country-wide qualitative assessment of status[2] and distribution of manatees along coastal areas is necessary for every manatee range country. The present plan has accomplished this assessment in a few countries, but lack of recent or reliable data in other countries has so far prevented the completion of this task.

To assess distribution and relative abundance of manatees, researchers may conduct aerial surveys in areas where this technique is appropriate. Ideally, aerial surveys should be conducted periodically, if possible two to four times a year, for a minimum period of a year to identify trends. Researchers may also conduct interviews at the country level. Questions should be designed to obtain information regarding areas where manatees seem to occur most often or for particular purposes (i.e., mating, resting) and at what times of the year. Past or current manatee hunters, fishermen, and local residents of coastal areas are the most appropriate subjects for interviews since they know the areas in question.

3.1.2. Define Guidelines for Data Collection/Censusing

It is necessary to develop standardized protocols and techniques for data collection and analysis. This will ensure that the results are comparable both within and among countries. Most of the techniques involved in the recommended activities (e.g., carcass salvage programmes, aerial surveys) are relatively costly and effort-intensive. Therefore, it will be essential to devise affordable (and sustainable) protocol alternatives for those countries with limited available research funds to ensure that needed manatee distribution data are still gathered.

- Aerial surveys: Several fundamental types of aerial surveys are routinely conducted to assess manatee biology (i.e., synoptic, distributional, intensive search, etc.). Information regarding survey protocols and types can be found on the Web sites for the Mote Marine Laboratory Manatee Research Programme (www.mote.org) and the Florida Fish and Wildlife Research Institute (http://research.myfwc.com/features/view_article.asp?id=1765).

- Photo-identification surveys: Documenting individual manatees over long periods of time allows researchers to compile life histories of these distinctive individuals, which can then be used to calculate reproductive rates, adult survival rates, site fidelity, and seasonal movement patterns. Samples of datasheets used during photo-identification surveys (land and boat) are included in the appendix to this report.

- Interviews: Although development of a questionnaire would seem to be a simple task, care must be taken to design the survey instrument in such a way that it does not lead or prejudice the people

[2] Optimally, assessments of "status" of a species or population should include a number of factors, such as abundance, population trends, demography, and the identification and control of threats. We believe that countries in the Wider Caribbean should aspire, over time, to developing databases that allow a thorough assessment of status to be done. However, given the paucity of data in most locations, a logical and useful first step toward assessing status would involve (a) assessing relative abundance, (b) identifying threats, and (c) assessing whether those threats are under control.

being interviewed. In addition, the questionnaire should be standardized. Therefore, researchers interested in conducting interviews should design their surveys carefully and ideally consult with someone with expertise in survey design. In Nicaragua, for example, standardized interviews have helped to understand the culture of the native communities that still hunt, and results of the research have helped to establish better educational programmes that promote manatee protection (Espinoza 2004). Examples of these interview sheets are available on the Web site of Fundación Manatí - Trichechus (http://www.fundacionmanati.org). When possible, boat or aerial surveys should be used to confirm the results from interviews with regard to manatee distribution and habitat.

- Characterization of manatee habitat: Methods can follow the standardized methods developed for the Mesoamerican Region by the Mesoamerican Barrier Reef System Project (MBRS). The MBRS developed a manual of methods for monitoring and characterizing seagrass communities (in terms of biomass and composition) and water pollution and quality. These methods were designed with the collaboration of local experts from the Mesoamerican region, and they can be adopted in other regions interested in studying manatee habitat. A manual describing the methods in both English and Spanish can be downloaded from the Information Center of the MBRS at http://www.mbrs.org.bz/.

- Stranding and necropsy protocols: Protocols can be adopted from the existing "Manual of procedures for the salvage and necropsy of carcasses of the West Indian manatee" by Robert Bonde, available from the Sirenian Project (http://cars.er.usgs.gov/Manatees/manatees.html), and the "CRC Handbook of Marine Mammal Medicine" by Leslie A. Dierauf and Frances M.D. Gulland, available for purchase from CRC Publishers (http://www.crcpress.com/).

3.1.3. Provide Protection for Manatees and Manatee Habitat

3.1.3.1 Improve Manatee Awareness

The success of any conservation effort relies on an effective public education/awareness component. Manatee conservation awareness campaigns must emphasize that manatees represent an integral component of the native fauna, culture, and history, and they are vulnerable to the hazards associated with development and human activities such as gillnetting and hunting. By clarifying the reasons for laws restricting such activities, the resistance offered by affected people may be reduced. Means of communication such as radio, television, magazines, and newspapers are the most effective ways to incorporate the environmental dimension into the daily lives of people. Radio public service announcements may provide an efficient method of spreading public awareness to some rural areas. The awareness programme might also include a widely distributed poster, illustrated leaflets and brochures, a slide show, and signs on the waterway.

Responsible stewardship of the environment is compatible with efforts to protect manatees and other endangered species. Special activities may be planned such as a manatee day during a local festival or an adopt-a-manatee programme. In Mexico, for example, 7 September was declared as National Manatee Day, and every year members of the National Manatee Committee meet that day to develop local education and awareness activities.

Wider Caribbean countries, especially neighbouring countries, should coordinate the production of educational materials (brochures, videos, and posters) to maintain a more cost-effective system. For example, the programme in Belize may be used as a model for public education programmes in other places. However, it is important to note that the realities and needs of people in each country vary. Thus,

methodological designs and individual education and public awareness programmes must consider and reflect the local cultures they address. Educational materials should be developed in multi-lingual format, including Native Indian languages, for distribution among local people and tourists. Educational programmes should be designed to involve the local community at all levels.

Environmental education programmes should focus on coastal regions inhabited by manatees where local communities interact with the animals. Materials developed should address particular audiences. For example, a programme developed and distributed to the schools on the Caribbean coast should encourage children to learn more about manatees through special projects or class field trips to view manatees in their local habitats. The information can be reinforced at home through televised lectures or the airing of available videos on manatees (e.g., from Save the Manatee Club in Florida) on local television. Adults should be encouraged to participate in selected scientific studies on manatees in their communities. It is of great importance in implementing regional programmes to prepare materials specifically for distribution among, and to address issues associated with, indigenous communities.

For example, in most places, there are usually only a small number of active manatee poachers, so environmental activities directed at reducing their impact might produce significant positive results. Caution must be exercised, however, not to stimulate interest in a potential product where poaching has not previously occurred. In the most impoverished areas in particular, it is important to provide not only penalties for poaching but also viable economic alternatives. Specific measures to raise the standard of living should be implemented to the point where poaching is no longer necessary for survival and enforcement efforts are accepted by the people and not seen as oppression for purposes that do not benefit the local population.

Education and outreach programmes should also target fishermen, encouraging them, as possible, to use gear that does not capture or injure manatees and to release living manatees from nets rather than kill them. Local residents should be thoroughly informed about any existing regulations prohibiting them from killing or harming manatees.

An educational programme should be developed specifically targeting national and local law enforcement agencies so that they understand the protective laws and the need for their enforcement. The importance of their task may be restated at law enforcement workshops and training sessions. Educational programmes must also reach local authorities, managers, and policy-makers, who are instrumental in getting the laws approved and enforced, as well as providing the necessary funds for investigation and regulatory activities.

The potential for using manatees and their habitats as ecotourism attractions, and the benefits it might incur to the local economy by employing local people who have knowledge about manatees, may cautiously be invoked as a stimulus for hunters to support conservation. Tourist-related jobs could include lodging, transportation, guides, services, arts, and crafts. However, ecotourism activities, if not properly and carefully conducted, may accidentally produce many undesirable and/or unforeseen impacts to species and habitats (see section 3.2.5, “Develop guidelines for manatee-watching in the wild and associated activities”). For example, boats have had a heavy impact on manatees in Florida. In fact, the largest identified cause of manatee death is collisions with watercraft (U.S. Fish and Wildlife Service 2001). Thus, an ecotourism venture that dramatically increases unregulated motorboat traffic in an area frequented by manatees could kill, injure, or displace manatees.

3.1.3.2. Protected Areas

The designation of protected areas is increasingly used as a tool to achieve conservation goals. Before elaborating the value of protected areas for species conservation, one fact must be recognized and accommodated: without adequate enforcement, meaningful involvement of local communities, and well-articulated management plans that outline protected area goals, objectives, and benchmarks, protected areas have minimal value. Therefore, if a country wishes to pursue the commendable goal of creating a protected area, it must substantiate such an objective with a commitment to provide funding and personnel to ensure that local residents become enfranchised, protective measures are enforced, and a management plan is developed and implemented.

Management plans for environmentally sensitive areas should be developed or expanded to ensure the protection of manatee habitat. Protected areas for manatees should include their basic requirements for living: water, appropriate food sources, and shallow, protected areas. Scientific investigations should be used to identify key habitats for designation as protected areas. Investigations should also identify and seek to fill gaps in knowledge related to specific habitat requirements for manatees locally and regionally. Because manatees are herbivorous, protected areas should include habitats with abundant and healthy marine and freshwater vegetation. Areas used regularly for essential biological functions (e.g., mating and calving) should be designated as critical habitats and enjoy the most stringent protection. As manatees may travel from one location to another, protection or speed zone regulations must be granted to corridors connecting protected areas, thereby creating manatee reserve networks. In general, SPAW criteria should be used in the evaluation of potential protected areas.

When a number of areas are identified, it is necessary to identify the areas of highest priority. In theory, at least, the best way to conserve manatees might be to establish protected areas of adequate size that provide the resources manatees need, and where any activity that threatens the animals' well-being (whether it be hunting, net fishing, boating, or development) is restricted or prohibited. Whereas the establishment of protected areas that exclude certain types of human activity can be seen as economically costly in the short term, such areas have the potential to provide substantial immediate benefits such as regulated recreational activities and educational opportunities for the public (as long as such activities are designed to minimize human impact on the protected habitat) and long-term economic benefits for local residents through ecotourism, sustainability of resources, etc. Additionally, these protected areas can serve as valuable control sites for future ecological experimentation and comparative analyses. The U.S. National Oceanic and Atmospheric Administration provides helpful information on marine protected areas on its Web site: http://mpa.gov/information_ tools/archives/ what_is_mpa.html.

The success in the establishment of a new reserve or implementation of an existing park will depend partially on the support received from the various segments of the society. Besides the general public, it is important not to neglect the traditional cultures living within the boundaries of the protected area. Involving native or other local people in the administration of the reserve will give them a sense of worth, prevent resistance to protective measures, and improve the possibility of success.

For cases where it is impossible or impractical to exclude certain human activities, the best alternative may be to establish a biosphere reserve. In a biosphere reserve, local human populations are not removed from the protected area; instead, a zoning system is defined for the region. Zoning defines certain areas in a local region to be maintained as permanently untouched (such as areas identified as mating grounds, in the present case) and other areas where a controllable take of certain resources may be allowed for subsistence. This system, however, requires considerable information on both the species

and the region that are to be protected. The selection process of zones takes into consideration the rights of the peoples affected by the designation of the protected area and includes provisions for local residents to participate in the decision-making process.

One example of a biosphere reserve is the Reserva de la Biosfera Maya in Guatemala. The reserve is recognized by the United Nations as very important because it protects 1.5 million ha of subtropical rainforest. The reserve has three zones: (1) a nucleus in which only research, conservation, and ecotourism activities are allowed, (2) a multiple use zone in which natural resources can be used and extracted in a sustainable way according to laws established by the government, and (3) a buffer zone in which conservation activities to protect the land are promoted and used. More information about this type of reserve is available at http://www.condesan.org/e-foros/biosf/biosf4_9.htm.

Wider Caribbean countries that have not signed and ratified the SPAW Protocol and Ramsar Convention should do so and become involved in the consolidation of biosphere reserves as conservation tools, appropriate to the environmental, cultura, and socioeconomic needs of the region. Management of discrete areas is also an important way to achieve the objectives of the Caribbean-wide Marine Mammal Action Plan for the protection and conservation of marine mammals.

As noted above, appropriate management goals and objectives should be incorporated into existing and future marine protected areas to increase their value to manatee conservation. Further, specific mechanisms should be established to ensure multidisciplinary inputs to choose, review, plan, and implement marine protected area management. A comprehensive ecosystem-based management plan that includes socioeconomic considerations for each protected (or special management) area needs to be developed. A legislative framework can be advocated that allows funds generated by providing access (e.g., user fees) to be allocated to the protected area.

3.1.3.3. Enforce Relevant Laws

Enforcement of existing laws is likely to be problematic, especially given the level of poverty of many countries of the region and understaffed law enforcement agencies. However, it must be recognized that even in an affluent country like the United States, enforcement of existing laws that protect manatees is inadequate and assessments of the efficacy of existing regulations is uncertain (U.S. Fish and Wildlife Service 2001). Thus, lack of funding to support enforcement and to gauge the effectiveness of programmes is a ubiquitous problem.

Manatees must be maintained as a protected species as currently provided by laws of most Wider Caribbean countries. Countries of the region should ratify the SPAW Protocol, the CITES Convention, and the Convention of Migratory Species if they have not done so. The Convention of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve marine, terrestrial, and avian migratory species throughout their range. It is an inter-governmental treaty**,** included under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale.

- Law enforcement regulations to reduce/ban gillnetting: The significance of manatee mortality or injury due to accidental entanglement in nets is generally unknown. However, as one of the greatest immediate threats to manatees in the region, gillnet fishing in rivers must be banned; this will require that appropriate regulations be developed, implemented, and enforced. Attention must be given to nets illegally placed across or near the mouths of rivers, thereby blocking river and lagoon access.

Restrictions of fishing should be implemented in areas used by manatees for breeding and rearing calves. Data on the frequency of entanglements as well as on the characteristics of the different fishing gear and methods used during these incidents should be collected. By taking full advantage of opportunities to collect data on incidental entanglements, it will be possible to increase understanding of entanglement problems and identify ways to resolve them.

To address matters relating to incidental entanglement, it is necessary to develop working relationships with the fisheries authorities and stakeholders. Cooperation among local fishermen, authorities, and researchers can be useful to seek and promote better fishing practices that prevent the incidental entanglement of manatees. Management actions need to incorporate appropriate socioeconomic considerations that identify alternative livelihoods for displaced fishermen. It is also important to recognize that modifications to fishing gear or fishing practices can have an unintended negative effect on other species. Thus, before any fishing gear or practice is formally implemented, it is necessary to determine its effectiveness. The development of educational materials about fishing-related mortalities can help to create awareness among local communities. A public awareness campaign developed for relevant stakeholders can also help to foster relationships with the proper authorities. The campaign should also foster the involvement of the public in efforts to mitigate/minimize fisheries interactions with manatees.

- Law enforcement regulations against manatee hunting: Direct exploitation of manatees is usually driven by the demand for products or commodities to be sold (e.g., meat, blubber, oil, bone carvings). In some countries, illegal hunting seems to be disappearing. Despite this trend, the take of even a few manatees every year may represent the difference between growth and decline of very small manatee populations. Efforts should be made to educate local communities that (a) hunting manatees is illegal, (b) manatees have values beyond being commodities, and (c) well-designed programmes that conserve manatees have certain benefits in terms of ecosystem maintenance and productivity. Following such education/awareness programmes, there may be sufficient peer pressure not to hunt that the problem may be eliminated. If not, hunters should be initially warned and later apprehended to set the example among violators.

3.1.3.4. Reduce Human-Related Injuries and Mortality

Maintenance and increase of law enforcement regulations are vital to reduce human-related injuries and deaths. Information related to manatee mortality can be useful for understanding the impact that certain threats have on a particular manatee population. If the information is systematically collected over time, it can be used to focus management, enforcement, and educational efforts and thereby help enhance conservation. Carcasses can be used to facilitate anatomical, genetic, and other studies.

- Boat strikes: can kill or seriously injure animals to the extent that reproduction is impaired. In Belize, for example, boat collisions were the main cause of death of manatees from 1996 to 2003 (Auil and Valentine 2004). In Florida, watercraft collisions represent the largest identified cause of manatee deaths (U.S. Fish and Wildlife Service 2001) and account for approximately 20 to 30% of the annual mortality (as many as 98 manatees a year; Marine Mammal Commission 2006); boats also seriously injure manatees and may thereby compromise the health of individuals sufficiently that they succumb more easily to disease or other factors. Boat speed regulatory zones exist in Florida, but their existence and their effectiveness in reducing mortality are controversial.

Figure 26. A manatee showing permanent scars from boat strikes. (Photograph courtesy of Mote Marine Laboratory).

Caribbean local and national governments should work to educate stakeholders about the risk of injury and death to manatees due to watercraft collisions. It is also necessary to initiate a system to obtain reports of boat strikes to determine rates and distribution of strikes. Measures should also be taken to manage vessel traffic in high-use habitats for manatees, restrict close approaches of manatees by boaters, and improve vessel and propeller designs. These and other recommendations regarding human behaviour around marine mammals appear in Reynolds and Wells (2003).

3.1.4. Promote Co-operation and Exchange of Information on Manatee Conservation at the National and Regional Levels

The results of all scientific research should be encouraged to be made available and disseminated through relevant scientific and public forums in the Wider Caribbean Region and globally. International cooperation is needed to create better research and educational programmes and to stop manatee poaching at the regional level. For example, international cooperation among Belize, Guatemala, and Honduras will be essential to eliminate manatee poaching in Port Honduras. A manatee working group could be established in this region to generate an education/awareness programme for local communities. The National Manatee Working Group of one of these countries, Belize, has already been collaborating with specialists from Mexico and the United States to develop research priorities, educational programmes, and conservation efforts designed to stop manatee poaching. This initiative should be extended to other countries to create an international working group that meets annually.

This is an area in which the Caribbean Environment Programme of the United Nations (UNEP) could play an extremely effective coordination role. UNEP should, for example, create a systematic process by which countries of the Wider Caribbean provide information regarding new programmes, programme effectiveness, and conservation issues associated with manatees and their habitat. This information should be shared regularly (i.e., semi-annually) with all governments and organisations that cooperate in this endeavour.

3.1.4.1. Prepare/Update National Recovery Plans and Organise Recovery Teams

The Revised Draft Action Plan for the Conservation of Marine Mammals in the Wider Caribbean Region (MMAP) proposed that a national recovery plan should be developed if marine mammal populations are subjected to one or more of the following:

- Overutilization,
- Inadequate monitoring and/or enforcement of protective regulations, and
- Degradation of habitat, and other factors (disease, etc).

Manatee populations fit these characteristics in most parts of their range. In order to ensure the continued survival of manatee populations, it is recommended that countries develop or update their national recovery plans. Recovery plans develop protocols for protecting and enhancing species and/or populations. The plan should contain goals, objectives, guidelines, information needs, justification of research and management programmes, and an implementation schedule for activities designed to further the preservation of the species. The plan should be tailored to the specific needs and conditions of each country. Recovery plans from Colombia, Costa Rica, Belize, Florida, Guatemala, Venezuela, the United States, and Puerto Rico can be used as examples. Copies of some of the recovery plans are available online on the Web sites of each national environmental agency. The recovery plan for the Florida manatee is available on the Web site of the U.S. Fish and Wildlife Service, http://www.fws.gov/northflorida/Manatee/Documents/Recovery%20Plan/MRP-start.pdf.

National recovery plans should be based on the best available data for each country and include an annotated list of the activities to be adopted in the fields of conservation, scientific research, law enforcement, and education. The recovery plan should also include, to the extent possible, a contingency plan dealing with effects of catastrophic events (such as oil spills, hurricanes, epizootics), a protocol for rescue and rehabilitation of distressed or injured manatees, and guidelines for the release and re-introduction of rehabilitated animals to the wild. The Caribbean Stranding Network in Puerto Rico might be contacted regarding the latter points, given its previous involvement with injured manatees. It is advisable to produce and distribute a list of individuals and agencies available to help during such events.

The recovery plan should be revised and updated at least every five years to reflect changes in available information, agency leadership, status of threats, or other factors. It should include criteria for determining the status of the species (see earlier definition) and for assessing progress in reaching recovery goals. The Action Plan for the Conservation of Marine Mammals in the Wider Caribbean Region considers that a population is recovering if—

- it is stable or increasing,
- habitat is adequate to support the needs of that population, and
- threats (direct to species or indirect to habitat) are identified and controlled.

Elaboration of this recovery plan should involve the participation of investigators, conservationists, managers, policy-makers, government officials, and non-governmental, grass roots, and community organisations. This group of experts should comprise the national recovery team, in charge of coordinating the implementation of recovery activities and monitoring and evaluating the recovery plan's progress at the national level. The establishment of national recovery teams can be done at low cost, but at least some of the work that is needed to implement a plan successfully will likely require

involvement of paid personnel; wholly-volunteer networks have been unsuccessful in many cases in maintaining critical programmes over the long term. Bilateral agreements with countries which have already developed their recovery plans could be undertaken to assist with the preparation of recovery plans in other countries.

3.1.4.2. Establish an Information and Co-operation Network

3.1.4.2.1. Regional Manatee Network

The development of a regional manatee network is of great importance in the Wider Caribbean. The network would allow researchers, managers, and students to exchange information. It could also help coordinate efforts and the sharing of experiences among people with similar conservation and education interests. The creation of a centralized library is of great need. Much of the information generated about manatees in the Wider Caribbean countries does not reach a wide audience because the information is not easily available. However, many reports, theses, and articles are in electronic format and should be put in an electronic database that people can access on the Internet.

This approach is already underway. Mote Marine Laboratory (Florida, USA; www.mote.org) has started to develop and provide to UNEP and others a library of PDFs for manatees. On a broader scope, the U.S. Marine Mammal Commission (which has supported the work of the IUCN Sirenian Specialist Group for many years) is considering including a library of sirenian-related PDFs on its Web site. Additionally, some local research groups have made their reports and publications available online and they can be accessed at no cost. For example, in Costa Rica, Fundación Salvemos al Manatí has several electronic documents available to the public on its Web site (http://www.fundacionmanati.org). Additionally, the utilization of an electronic mail network among all institutions involved in manatee research in the region can expedite the exchange of information.

A regional information-sharing system would improve cooperation among the groups currently conducting research on manatees in the Wider Caribbean. Sirenian researchers have the advantage of working with a small number of species distributed in a relatively restricted area as compared to some other marine mammal specialist groups. This allows professionals involved with manatee conservation in the Caribbean to work at an almost grass-roots level, with the tremendous advantage of facilitated coordination of activities and reduced levels of bureaucracy. The existing newsletters of the IUCN/SSC Sirenia Specialist Group, SIRENEWS, Sirenian International, and The Society of Marine Mammalogy Newsletter should be considered as important channels for sharing of information. Because they already exist, funding and time will not be required to develop another news-sharing mechanism.

3.1.4.2.2. Manatee Regional Network Co-ordinator

A regional manatee coordinator should be selected to assist with the coordination of manatee-related activities in the region. Coordinator responsibilities should include collecting, centralizing and disseminating all information concerning manatees, coordinating all research and manatee management activities, and identifying relevant sources of financial support for specific projects. To ensure that the individual selected is knowledgeable about manatee biology and has demonstrated an ability to work well with others, the selection might be done in consultation with the chair of the IUCN Sirenia Specialist Group.

3.2. LONG-TERM RESEARCH AND CONSERVATION MEASURES

3.2.1. Research on Manatees

The following discussion provides a fairly comprehensive perspective regarding research that would be useful to understand and protect manatees. Many countries have no ongoing research programmes, whereas others have virtually all components under way. For those countries with little to no current research, it is important to realize that a flourishing programme takes considerable time, dedication, and funding; thus, for such countries taking one step at a time is important. Do not be discouraged by the magnitude of a comprehensive programme! Every step taken toward such an effort can be very useful.

It should also be recognized that a tremendous amount of work has been done on Florida manatees, but that the U.S. model for certain types of research is, at times, unnecessarily expensive. Thus, countries seeking to begin a research programme and to develop local capacity should consider non-U.S. models (e.g., capture and tagging operations as conducted by Dr. Morales-Vela, Dr. Olivera Goméz and their colleagues in Mexico) as effective and cost-effective alternatives.

Research should attempt, to the fullest extent possible, to provide clear answers to questions associated with conservation (i.e., applied research) rather than to matters associated with general biology of manatees (i.e., basic research); this is especially important in areas where funds are very limited. Emphasis should be placed on acknowledgement of scientific uncertainty and in quantifying and incorporating such uncertainty into decision-making. This requires not only the development and application of new scientific methods but also the inculcation of new perspectives into the socio-political culture. All forms of invasive research should meet with internationally accepted standards, scientific methodologies, etc., prior to funding and implementation.

Long-term studies of individually identifiable animals (called longitudinal studies) can be expensive and require a long-term commitment of funding. However, longitudinal studies should be encouraged to assess life history, range and distribution, impacts of pollutants, and general health of animals. Even with minimal resources, several such studies may be initiated, expanded, or encouraged that would improve our understanding of marine mammal populations in coastal and nearshore areas. These studies may require non-lethal but invasive techniques and harassment risk. Therefore standardized protocols should be employed and experienced researchers should monitor all participants. Participants should be trained to follow protocols and national systems of permits should be implemented. Lethal methods should not be employed for research purposes on protected species such as the West Indian manatee.

3.2.1.1. Status and Distribution

Research studies must be implemented to examine the natural distributions of manatees and investigate how they vary over time or as a function of other natural factors.

- Aerial surveys: Aerial surveys have been widely used to determine manatee abundance, distribution, and habitat use in the Wider Caribbean. However, it is important to note that there are different types of aerial survey techniques and that the use of a particular technique should depend on the objectives of the research project (see Mote Marine Laboratory Web site, www.mote.org). Fundamental types of aerial surveys routinely conducted to assess sirenian populations: distributional surveys, intensive search surveys, and transects.

In some, but not all cases, aerial surveys can provide and help verify information on manatee

distribution provided by interviews. AS aerial surveys can be very expensive for developing countries, aerial surveys can be conducted at least twice a year when enough background information is available to maximize the usefulness of the surveys. Surveys should be conducted using a consistent survey route and survey method (aircraft type, air speed, altitude, number of observers, etc.) to allow meaningful comparisons among surveys (Morales-Vela *et al.* 2000). It is important to use observers who are experienced in searching for and detecting sometimes subtle signs of the presence of sirenians, and maintaining consistency in the specific observers and pilots used eliminates a possible source of bias.

In areas where little to no information exists, initial surveys should cover the entire coast, including areas of past and present manatee presence, with thorough searches in areas where manatee density might be anticipated. These areas may include river mouths, protected coves and lagoons, or sites identified during preliminary investigations. Regularly replicated aerial surveys are likely to disclose trends in manatee numbers and distribution. Once distribution patterns have been established, it may be cost effective to focus most (not all) surveys on areas known to be occupied by manatees.

- Boat surveys: Boat surveys should be dedicated to areas of highest density. After basic data have been amassed, and assuming funding is available, efforts could potentially be concentrated on the intensive monitoring of a few wild animals using radio telemetry to obtain detailed information on their movements and habitat use.

- Telemetry studies: The expense associated with telemetry raises an important general issue: it is vital to give careful consideration to the research question being addressed and to ensure that an experimental design is developed that will provide clear and useful answers to that question. It would be extremely unfortunate if considerable money were spent on poorly designed research that ultimately provides little useful information, especially in countries with limited funding. Initially, only a few VHF tags should be used, and the number increased as appropriate. The use of more costly satellite tags should only be attempted after background data have been accumulated and researchers are familiar with the techniques. Radio-tracked individuals can provide information about manatee behaviour and social structure.

Figure 27. Aerial and boat surveys are instrumental techniques for studying different aspects of manatee biology. (Photographs courtesy of Mote Marine Laboratory)

Figure 28. Research biologists tracking tagged manatees in Chetumal Bay, Mexico (Photographs by Benjamin Morales-Vela and Humberto Bahena-Basave, ECOSUR).

3.2.1.2. Biological Information Leading to Major Aspects of Population Dynamics

Threats, both natural and anthropogenic, must be identified and monitored (and quantified if possible) to obtain an understanding of their relative importance and to prioritize appropriate mitigation and regulatory measures. Current threats to the continued existence of manatees include poaching, incidental catch in fish and shrimp nets, effects of climate change (e.g., increased incidence of hurricanes), habitat loss, contamination, watercraft traffic (due to noise, disturbance, and collisions), debris ingestion, monofilament lines and hooks, and vandalism. Potential conflicts between manatees and regional human activities, such as fishing, deforestation, and construction of canals and dams should be identified and monitored. Baseline data should also be acquired on common diseases and parasites in manatees in the Wider Caribbean and their role in natural manatee mortality.

Manatee strandings also provide scientists with a means to obtain biological information as basic as where a species occurs in a given location. A stranded marine mammal is defined as any dead marine mammal on a beach or floating near shore or any living marine mammal on a beach or in water so shallow that is unable to free itself and resume normal activity. The definition refers to single dead animals, mass strandings, and unusual mortality events (an unexpected and significant die-off of any marine population that demands an immediate response). The recovery of carcasses on shores or victims of accidental entanglement in fishing nets can provide a wealth of information about life history parameters, as well as provide realistic estimates of human-induced threats and mortality.

Florida and Puerto Rico may both serve as models for the implementation of stranding programmes. It is necessary to train personnel to use appropriate sampling techniques, archive samples, and create and maintain a database of findings. Creating a list of veterinarians in the region who specialize in marine mammals would be a great resource in the case of an emergency. Cooperation among countries in the region is necessary because manatees may move across national boundaries. Thus, it is necessary to stimulate on-going efforts and initiate new measures at the local, national, and regional level to develop active stranding networks. Existing stranding networks with SPAW members/partners should be encouraged to provide training and assistance to other countries lacking such expertise. The training should include but not be limited to veterinarians, epidemiologists, and analytical chemists. In that regard, the U.S. National Marine Fisheries Service has sponsored regional training workshops (e.g., in Trinidad and Tobago in 2006) and plans exist to initiate more such training in the future.

3.2.1.3. Regionally Co-ordinated Efforts

- Research collaboration: An initiative to start regional work in part of the Caribbean started in November 2006 with the creation of a collaborative group of manatee researchers working in Mesoamerica. The objectives of the group are to develop research projects and conservation initiatives in the region, which includes the area from central Mexico to Panama. The group is composed of two or three local researchers from each Mesoamerican country plus an invited researcher from Venezuela. The group intends to assist one another in the use of field techniques whenever possible. As some countries have a stronger background in certain techniques such as radio-telemetry, researchers from these more technologically advanced countries can help train researchers in other countries interested in using the same or similar techniques. This type of collaboration should be applied in other areas of the Caribbean, as the main goal of manatee conservation work is to study, protect, and conserve the species throughout the entire region. The Mesoamerican research group proposed a series of recommendations for the region that can be applied to other parts of the Caribbean.

  Another example of regional collaboration includes the initiation of a tri-national management plan for manatees in southern Mesoamerica, more specifically in Nicaragua, Costa Rica, and Panama. The management plan is a joint effort by local organisations from each of the three countries: Fundación Amigos del Rio San Juan in Nicaragua; Comision Ambiental del Departamento de San Carlos and Fundación Manati in Costa Rica; and Asociación de Amigos y Vecinos de la Costa y la Naturaleza, Fundacion Natura, and Autoridad Nacional del Ambiente in Panamá.

- Multi-national protected areas: Animals do not follow political boundaries, and this makes regional work very important. Indeed, the problems that manatees may face in one country could affect adjacent populations if, for example, animals are protected in one country but are hunted in a neighbouring country. Protection at a large scale is thus necessary. Protected areas located along the coast of several countries can potentially serve as corridors for manatees to move in large areas. One example of this type of large-scale protection is the Mesoamerican Corridor, comprised of seven Central American countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) and the five southernmost states of Mexico (Campeche, Chiapas, Quintana Roo, Tabasco, and Yucatan). The marine ecosystems of those countries include the largest and best conserved mangroves in the Caribbean (UNEP 1999).

  Some Mesoamerican countries have coastal protected areas adjacent to each other, as is the case with Chetumal Bay Manatee Sanctuary in the most southeastern part of Mexico and the Corozal Bay

Wildlife Sanctuary in the northern part of Belize. Other countries have biosphere reserves encompassing a series of protected areas. The Southeastern Biosphere Reserve includes seven protected areas between Nicaragua and Costa Rica: Reserva Natural Cerro Silva, Reserva Natural Punta Gorda, Reserva Biológica Indio Maíz, Refugio de Vida Silvestre Río San Juan, Refugio de Vida Silvestre Los Guatuzos, Monumento Nacional Archipiélago de Solentiname, and Monumento Histórico Fortaleza de la Inmaculada Concepción de Maria. The biosphere includes a total of 7,859 km^2 of protected area in the two countries. In addition, the reserve has four Ramsar wetlands: Sistema de Humedales San Miguelito, Sistema de Humedales Bahía de Bluefields, Refugio de Vida Silvestre Río San Juan, and Refugio de Vida Silvestre Los Guatuzos.

- Studies of transboundary movements: This type of conservation initiative at a regional level is very important because manatees are known to move between countries. Recent information on tagged animals indicates that inhabitants of the protected area of Chetumal Bay in Mexico move to the Southern Lagoon in Belize, a travel distance of more than 260 km (B. Morales-Vela and N. Auil pers. comm.). This is the first record of such long distance travel and transboundary movements of manatees in the region. Because of this, it is recommended that the countries in which *T. manatus* is found become part of the Convention of Migratory Species. *T. manatus* is listed in the Appendix I of the Convention and because of this, CMS parties are required to strive toward specifically protecting the species, conserving or restoring the places where it lives, mitigating obstacles to migration, and controlling other factors that might endanger a species (CMS 2004). Studies of transboundary movements can help identify if animals are migrating or dispersing. Studies of movement patterns can help determine if the movement of animals outside of a particular area is natural behaviour or the result of anthropomorphic pressures. The second situation was documented in Belize, where manatees stopped visiting the Swallow Caye after swim-with-the-manatee programmes were allowed without being monitored (Auil 1998).

- Regional genetic work: Currently there are two laboratories conducting this type of work at the University of Florida and Mote Marine Laboratory. The manatees exhibiting transboundary movements between Mexico and Belize were males that could potentially be siring offspring in two geographical areas. Genetic studies can provide information on paternity and population sub-structure. Estimates of the level of genetic variation can also serve as an indicator of the stability of a particular population (S. Carney pers. comm.). Genetic techniques should use a greater number of and more variable microsatellite loci than those currently reported in the literature (Garcia-Rodriguez *et al.* 2000). This would give a finer-resolution of genetic variability and therefore more specific information regarding the genetic makeup of individuals in different regions.

3.2.1.4. Monitor Climate Change and its Effect on Manatee Distribution and Survival

The natural and anthropomorphic influences affecting climate change are complex and dynamic, making them difficult to analyze in relation to marine mammal health. Although the potential effect of climate change on marine mammals has been little investigated, in Florida hurricanes and other major storms are associated with diminished adult survival rates for manatees in the areas where they hit (Langtimm and Beck 2003). The decreases in manatee survival could be due to direct or indirect mortality and/or emigration from the region as a consequence of storms. If the intensity and prevalence of hurricanes are indeed related to climate change as some researchers speculate (Langtimm and Beck 2003), then climate change will likely have noticeable direct effects on the survival of manatees and perhaps other marine mammals. For example, in Northern Australia, a minimum of 27 dugongs stranded after a tropical cyclone with winds of up to 185 km/h hit the coast in the southwest Gulf of Carpentaria. The storm

surge also stranded other marine animals including 500+ green turtles (*Chelonia mydas*), sharks, and fish (Marsh 1988). Although this type of event has not been reported for manatees, the effects of major hurricanes on manatee habitat and related aquatic ecosystems should be assessed.

In addition to gross changes in behaviour or distribution that occur due to climate change, there may be other, more subtle changes that occur in terms of the physiology, biochemistry, or genetics of affected species. These may be evaluated through the careful use of environmental bio-indicators (biomarkers) in a manner similar to that used to assess effects of exposure to contaminants or biotoxins.

3.2.2. Monitor Habitat Condition

Broadly interpreted, habitat encompasses the entire ecosystem upon which a species or population depends. Manatee habitat is degraded and lost through coastal development, increased noise from boating, some fishing practices, the introduction of contaminants and other pollutants, and climate change. Coastal environments are exposed to a wide range of pollutants including persistent organochlorines, heavy metals, litter, and petroleum hydrocarbons from a variety of marine and land-based sources, including industrial and agricultural activities. The potential range of habitat alteration and degradation is immense and long-lived, and coastal species such as manatees are particularly vulnerable. Yet the effects of human activities on manatee habitats are extremely poorly monitored and not fully understood.

Actions needed in order to effectively monitor habitat quality include a description of manatee distributions and an investigation of how the distributions vary over time as a function of natural factors. Research and monitoring should be undertaken to assess habitat degradation and pollution, especially in countries with many large-scale agricultural and industrial sources of water pollutants. A rigorous description of areas where human activities will likely have an adverse impact on manatee habitat should subsequently be prepared. Information generated should be used to develop a formal risk assessment of cumulative or interactive effects of a variety of human activities. It should be noted that effects of waterborne contaminants extend well beyond manatees, including to coastal human residents. Thus, manatees could become an important sentinel species, the status of which could serve as a barometer of ecosystem and human health problems. Cost-effective model programmes for initiating contaminant analyses for manatees and other marine mammals in the Wider Caribbean and nearby areas have been developed (e.g., Wetzel and Reynolds 2006, Wetzel *et al.* 2006).

At the management level, general guidelines and criteria need to be developed to ensure that coastal and watershed development does not degrade manatee habitat. It is also necessary to designate environmentally sensitive areas where coastal and/or watershed development is restricted or prohibited, as appropriate. Local stakeholders should be involved in the design and implementation of sustainable coastal and watershed development principles.

3.2.2.1. Identify Habitat Requirements and Protected Areas of Special Significance to Manatees

It is necessary to identify and investigate the distribution of feeding areas (seagrasses and freshwater aquatic vegetation), mating areas, and calving areas used by manatees. This might ultimately include the identification of the physio-chemical characteristics of the water bodies used by manatees. Such information is important as most of the countries of the Wider Caribbean are undergoing a series of alterations involving coastal development and expanded tourism activities. Information on habitat requirements will help to identify those areas of special significance to manatees. No species can survive if its habitat disappears. Therefore, it is fundamentally important to identify, characterize and protect

manatee habitat, and evaluate and monitor changes. Identified habitat requirements should be included in the national integrated coastal zone management framework of each country.

3.2.2.2. Promote Restoration of Degraded Manatee Preferred Areas

In some countries, siltation, agricultural runoff, and sewage originating from industrial and urban development have altered habitats previously occupied by manatees. When possible, areas historically used by manatees should be returned to their original condition so that manatees can use them again.

3.2.2.3. Habitat Pollution

Near shore environments are exposed to a wide range of pollutants, both transitory and persistent. Although numerous studies have identified noticeable levels of certain contaminants (mainly organochlorines and certain metals) in the tissues of marine mammals, there are virtually no data linking contaminants and associated effects in these animals (O'Shea *et al.* 1999).

- Location of pollution source: In the Wider Caribbean, it has been broadly recognized that agricultural production and runoff have led to local concerns regarding aquatic pollutants such as pesticides, excessive nutrients, and herbicides. Actions needed include the identification of key locations where pollutants or other factors exist that could affect manatee health. In those key areas, studies should be initiated to assess (a) environmental contaminant levels in sediments, manatee food items, and manatee tissues and (b) clinical diagnostic markers of exposure or effects. Such studies should involve tissues from stranded manatees, as well as from biopsies and live-captured manatees. These studies should utilize the standardized protocols for sample collection and analysis currently in existence and use consistent analytical laboratories.

- Harmful algal blooms (HABs): The frequency and intensity of HABs should be monitored. In Florida, the circumstances contributing to red tide-related deaths of manatees include concentration and distribution of the red tide dinoflagellate *(Karenia brevis*), timing and scale of manatee aggregations, salinity, and timing and persistence of the bloom. The relationship between the frequency and intensity of red tide events should be assessed, when possible, in relation to anthropogenic factors such as eutrophication and climate changes (see section 1.c: Long-term recommendations).

3.2.2.4. Acoustic Disturbance

Noise is often a form of habitat pollution. In recent decades, anthropogenic ambient noise has increased dramatically in many coastal areas. Noise can degrade the quality of a habitat and alter its health. Behavioural and some physiological responses to increased ambient noise have been documented in marine mammals. Whether manatees can detect boat engine noise and the frequencies that are best detected is currently a topic of debate. However, a study examining the behaviour of manatees in the presence of vessels found that manatees often respond to approaching vessels that are at distances up to 68 meters. In the study, manatees were more likely to change their swimming speed if the approaching vessel was in shallow water than in deep water. Manatees responded primarily by moving toward or into deep water (channels) and increasing their speed. Unfortunately, swimming into channels puts the animals in the path of the approaching vessel before they can reach water of sufficient depth to move safely beneath the boat (Nowacek *et al.* 2004).

Another boat-approach experiment conducted in deep water reported that a study animal fitted with a radio transmitter submerged as soon as the approaching vessel headed in its direction. The animal did

not resurface until the boat had passed and was 0.6 km beyond the general area where the manatee was found (Nowacek *et al.* 2002). However, the distance at which the animal initially detected the various approaching vessels is unknown. Sound propagation is poor in shallow water, especially in seagrass areas.

It is currently unknown how well manatees can localize boat sounds or what features of the sounds lend themselves to localization. However, effects that are not immediately lethal may be significant and harmful if they lead to changes in reproduction, migration or movement patterns, distribution, foraging, social behaviour, communication, or lead to increased mortality over long periods.

A range of human activities introduces sound into the marine environment including commercial shipping and transportation, oil and gas exploration and drilling, dredging and coastal construction, and military operations. Low-frequency sound travels long distances, particularly in deep waters, which means that local sources can potentially have distant impacts.

To minimize the effects of acoustic disturbance and underwater noise, countries need to adopt a protocol to minimize noise in marine environments. Boat speed regulations can help minimize ambient noise as boat noise levels are directly related to boat speed. The faster a boat goes, the faster the propeller rotates, causing more turbulence and noise. A fast boat produces a broad range of frequencies above prevailing ambient conditions at frequencies up to 20 kHz. Conversely, when a boat travels slowly and the rotation of the propeller is reduced, the turbulence is minimal and the noise is significantly reduced. The dominant noise spectrum in this case is below 1 kHz (Gerstein 2002).

The minimization of ambient noise will require the identification of key areas for pilot studies where vessel traffic or noise-producing activities might be compared to manatee distribution and behaviour. This will also required the identification of key areas for long-term monitoring. Ongoing research by scientists in the United States may clarify this issue, eliminating the need for the development of expensive acoustic studies elsewhere in the Wider Caribbean.

3.2.3. Monitor and Modify Accordingly Manatee Awareness Programmes and Law Enforcement Measures

3.2.3.1. Manatee Awareness

All education and public awareness programmes should be evaluated on a regular basis to assess their effectiveness within the communities or the groups for which they are targeted and be modified if necessary. The use of manatee conservation educational programmes in communities near future reserves should be regularly promoted through the inclusion of an education component to all proposed and currently protected areas. An educational programme for park users and interpretation programme for parks visitors advising them of the regulations should be initiated in protected areas that contain manatees. Local personnel (park rangers, researchers, managers) must be trained and tour operators running boats in and out of the area licensed so that they become familiar and understand the value of the resource, honour all regulations regarding manatees, and help educate the public.

Because red tide events might be related to anthropogenic factors, a programme should be developed to educate the general public about the sources and potential effects of pollutants on manatees and people. Additionally, education and water management programmes onboard ships and in ports should be encouraged within the fishing, cruise line, and shipping industries. Best practice facilities for marine

waste reception at ports, marinas, and boat harbours should be widely available and well publicized. Incentives should be implemented for those that comply with national and international legislation for pollution prevention on land and sea.

3.2.3.2. Assess and Improve the Effectiveness of Existing Laws

Countries should review the laws that make up their protective legislation regarding manatees and their habitats. The protected status of manatees should be dealt with in an explicit manner, rather than by default in more general faunal protection legislation. Any ambiguities that permit double interpretations of the law must be eliminated. If necessary, legislation should be expanded to address specific areas or conflicts.

Communication among experts on legislation of each country would allow a review of the legislation at a regional level and might lead to the updating and standardization of laws and fines along the area of distribution of the manatee. This would guarantee the species a consistent regulatory framework throughout its range. As noted earlier for marine protected areas, without enforcement, legal status does not mean much.

3.2.4. Reduce and Monitor Activities That May Be Detrimental to Manatees

- Waterborne activities: Manatees are very mobile and are capable of extensive movements. Consequently, they are subject to encounters with boats in the travelled waters. The numbers of motorized boats in the region are rising as these have been replacing the traditional dugout canoes in Wider Caribbean countries. To prevent the development of a situation similar to the one in Florida, speeds will have to be regulated and boat areas designated in preferred manatee areas. As an added advantage, slow speed zones prevent bank erosion, water turbidity, and human fatalities. Disturbances such as water skiing, snorkelling, scuba diving, jet skiing, boating, and fishing should be regulated or prohibited within the proximity of manatee areas. Tourism-associated practices must be regulated to prevent manatees from moving away from preferred or critical areas.

- Coastal area development: Coastal area development is accelerating in many areas of the Wider Caribbean. If unplanned, many of these activities may detrimentally affect manatee populations by causing pollution, increased boat traffic and water turbidity, and mangrove destruction. It is necessary to consider these factors when drafting growth management plans for specific areas and to include sound and comprehensive policies regarding sewage treatment, agricultural runoff, contaminant input, mangrove destruction, deforestation, and erosion. Permit application requirements for the implementation of large-scale development in manatee habitats should include obligatory environmental impact assessments and educational and enforcement programmes.

3.2.5. Develop Guidelines for Manatee Watching in the Wild and Associated Activities

The potential effects of tourism are important to consider within the overall context of human-caused threats to manatees to ensure that manatee watching is conducted in a manner that is respectful of the animals, local human communities, and fellow tourists (for guidance on this topic, see Reynolds and Wells 2003). Intensive, persistent, and unregulated vessel traffic that focuses on animals while they are resting, feeding, nursing their young, or socializing can disrupt those activities and possibly cause long-term problems for populations. Potential negative effects include—

- disruption of normal behaviour
- increased likelihood of vessel strikes

- noise pollution from increased vessel traffic
- destruction/pollution of habitat from coastal development

Ecotourism has the potential to benefit manatee conservation. This can result primarily from a reduction in animal mortality if former hunters convert to tour guides. Small-scale ecotourism is already taking place in countries like Belize (Auil 1998). Many people are willing to travel long distances for the opportunity to observe wildlife in unspoiled ecosystems. Ecotourism may be beneficial to manatees if properly planned and managed, may represent an alternative source of income to hunters and fishermen, and may generally improve the local economy. In Florida, the yearly income from thousands of tourists interested in seeing and swimming with manatees has contributed to public support for manatee conservation.

The opportunities for developing manatee-specific ecotourism activities vary from country to country. Proper implementation of such activities requires the design of tourism plans in collaboration with local stakeholders to conserve the ecological characteristics of the area and ensure low-impact tourism development. It is important to note that there is a fine line between human-manatee contact and harassment. Because of this, at the management level, it will be necessary to (1) designate sensitive areas where ecotourism is restricted or not allowed, (2) define management strategies for visitors and granting of concessions to commercial enterprises, and (3) establish associations of ecotourism operators. Other things to consider include—

- Training programmes. They should be established at the national and regional levels and local people should serve as guides, educators, vessel operators, and interpreters. Only licensed guides, who must go through a training programme, should be allowed to take visitors for a closer viewing of the animals.

- Visitors: codes of conduct for manatee watching. The number of visitors must be limited and their presence and actions regulated and restricted to certain areas and times of the day. Visitors must receive an educational talk and be advised of the local rules. Feeding, in particular, should not be allowed and harassment in general (broadly defined as an activity that changes the "normal" behaviour of animals) should not be tolerated. Only small-scale businesses, adapted to the local community, may be allowed into the area to improve the local economy rather than negatively affect it. Operators should also be encouraged to develop partnerships with scientific organisations to provide opportunities for research.

- Assessment of manatee watching activities. When possible, research should be conducted simultaneously with ecotourism to study the effect that ecotourism has on manatee behaviour. Studies have shown that manatees respond to approaching vessels at distances ranging from 25 to 50 m. The distance at which manatees initially detect the approaching vessels is unknown (Nowacek *et al.* 2004). In Belize, ecotourism boats resulted in manatees no longer using a particular area. However, this area is now a wildlife sanctuary managed by the group of tour guides and other grassroots community members (Auil 1998). Boats can have a negative impact not only on manatee behaviour but also on the environment. In Florida, one of the most severe direct adverse effects on manatee habitat is the damage to seagrasses caused by boating activities in shallow coastal waters and estuaries. Propellers leave scars that are often tens of meters in length and that result in complete removal of rhizome and shoot biomass within the affected area (Smith 1993). Even if boats travel slowly in a manatee area, they may operate at fast speed in nearby zones, which may still be an

important habitat for manatees. Thus, ecotourism areas should include an outer zone in which boats are required to drive slowly. If studies show that ecotourism is having a negative impact on manatee populations, regulations should be revised to make the necessary changes or stop the activity.

3.2.6. Develop Guidelines for Manatees in Captivity

Removal of manatees may cause more harm than benefit to manatee conservation in the Wider Caribbean. The removal of only a few animals from small populations like those of the Wider Caribbean is likely to have an impact on the reproduction, gene pool, and maintenance of the subspecies in the area. Because of this, removal of wild manatees for captive display inside or outside of the country, as has occurred in the case of West Indian manatee exhibits in aquariums in Japan and Holland, should be carefully regulated and minimized. The possession and commercial trade of manatees, if allowed at all, should be done in accordance with the SPAW Protocol, CITES, and other relevant treaties and agreements.

- Rescue and rehabilitation: Programmes involving captive manatees should deal exclusively with rescue and rehabilitation, with high consideration given to maximizing public education during the process. Rehabilitated manatees should be returned to the wild unless they are deemed unable to re-adapt to natural conditions. In the eventual release of an animal, the area for relocation must be carefully selected and the animal marked (ideally tagged) and closely monitored. Brazil has shown that the reintroduction of rehabilitated manatees is possible and can be successful. Programmes in Florida have demonstrated the feasibility of propagating manatees in public display facilities. The monetary burden of maintaining manatees in captivity under adequate conditions, however, may be excessive for many Wider Caribbean countries. Strict guidelines should be established for cases where manatees are maintained in captivity for rehabilitation purposes to ensure that the well-being of individual manatees is upheld. All cases of captivity and semi-captivity must be approved by the agency responsible for issuing the protective laws for manatees. A veterinarian must be appointed to ensure the animals' well being, proper and daily supply of well-balanced diet, and regular health checkups. The standards used in the United States for marine mammal rehabilitation facilities are available at http://www.nmfs.noaa.gov/pr/pdfs/health/rehab_facilities.pdf.

- Public display: Captures for display and other non-rehabilitation situations must be prevented. However, in cases in which a country already has manatees on public display, the exhibition must be coupled with public education and research programmes. The economic, conservation, and educational value of those exhibits should be investigated and results disseminated to the government and the public.

  Existing captive facilities should be improved and should adopt standards for the best possible care of manatees. They must meet basic requirements regarding size of the pool/enclosure and water quality. The regulations on long-term facilities used by the United States can be used as a reference. The United States Department of Agriculture has helpful information on animal care regulations, definitions, regulations, standards, and rules of practice. The information is available in the main site of the animal care section found at http://www.aphis.usda.gov/ac/publications.html In the United States, standards for education and conservation programmes of marine mammal display facilities are developed and endorsed by the Association of Zoos and Aquariums (AZA) and the Alliance of Marine Mammal Parks and Aquariums (AAMPA); information is available on their Web sites.

3.2.7. Provide Training for Local Personnel and Biologists in the Area of Coastal Zone Management and Conservation

The continuity of programmes dedicated to manatees into long-term national initiatives will require the development of local expertise and committed individuals. Local, regional, and national biologists must be trained at various levels, from technician to scientist, as well as through internships. As the availability of wildlife programmes might be very limited at the local level, candidates may have to seek education abroad. Training may not have to be focused specifically or only on manatee biology; in fact, individuals who are broadly trained as biologists, rather than completely focused on manatees, have considerable professional strength. Programmes should preferably focus on coastal wildlife management and conservation, which provide a broader scope of disciplines. Close coordination would be maintained with the training component of the SPAW Regional Programme for protected areas and wildlife personnel.

Table 7. Summary of suggested short- and long-term recommendations

Type of recommendation	Task/subtask numbers	Description
Short-term or priority	3.1.1.	Assess manatee current status and distribution
	3.1.2.	Define guidelines for data collection/censusing
	3.1.3. 3.1.3.1. 3.1.3.2. 3.1.3.3. 3.1.3.4.	Provide protection for manatees and manatee habitat Improve manatee awareness Protected areas Enforce relevant laws Reduce human-related injuries and mortality
	3.1.4. 3.1.4.1. 3.1.4.2.	Promote cooperation and exchange of information on manatee conservation (national and regional) Prepare/update national recovery plans and organise recovery teams Establish an information and cooperation network
Long-term	3.2.1 3.2.1.1. 3.2.1.2 3.2.1.3. 3.2.1.4.	Research on manatees Status and distribution Biological information leading to major aspects of population dynamics Regionally coordinated efforts Monitor climate changes and their effect on manatee distribution and survival
	3.2.2. 3.2.2.1. 3.2.2.2. 3.2.2.3. 3.2.2.4.	Monitor habitat condition Identify habitat requirements and protect areas of special significance to manatees Promote restoration of degraded manatee preferred areas Habitat pollution Acoustic disturbance
	3.2.3. 3.2.3.1. 3.2.3.2.	Monitor and modify accordingly manatee awareness programmes and law enforcement measures Manatee awareness Assess and improve the effectiveness of existing law
	3.2.4.	Reduce and monitor activities that may be detrimental to manatees
	3.2.5.	Develop guidelines for manatee watching in the wild and associated activities
	3.2.6.	Develop guidelines for manatees in captivity
	3.2.7.	Provide training for local personnel and biologists in the area of coastal zone management and conservation

4. POSSIBLE REINTRODUCTION OF MANATEES: A CONSIDERATION FOR ENHANCED CONSERVATION AND RESEARCH

The idea of re-establishing populations of manatees in parts of their historic range where they no longer exist has been put forward for consideration. To be successful, such a venture would require (a) a substantial long-term commitment for research, monitoring, interactions among stakeholders, and enforcement; (b) a short-term commitment to acquire particular types of data to promote success; and (c) a commitment to identify threats to manatees and their habitat in the proposed reintroduction location and to work cooperatively with stakeholders to mitigate those threats prior to the actual reintroduction.

Thus, a successful reintroduction must capture and incorporate many of the specific short-term and long-term goals outlined for locations where manatees currently exist (see Chapter 3 of this report). As a single, integrated, proposed effort in a location where manatees do not currently exist, the concept is being considered separately here.

4.1 BACKGROUND

The National Park of Guadeloupe and other entities in Guadeloupe, French West Indies are interested in reestablishing manatees in the waters of the natural reserve called Grand Cul-de-Sac Marin. The species has been extinct in the waters of Guadeloupe for a number of decades, having been wiped out locally by hunting; some elders apparently recall seeing manatee meat available for food. Manatees remain a part of local folklore and the history of Guadeloupe (e.g., the town of Lamentin, named after manatees, located near Grand Cul-de-Sac Marin). In fact, a former manatee processing area exists near Vieux Bourg (Grande-Terre). This goal of reintroducing manatees has existed since a feasibility study was conducted in 2002.

Although the idea of reintroduction is being considered only in Guadeloupe at this time, a successful reintroduction project could (a) create a model that could be followed in other locations, (b) reestablish manatee populations in locations in the Caribbean where threats are currently minimal and under control, and (c) help support research on manatees in other locations as a vital preliminary step before allowing the taking of manatees from those locations. In addition, if manatees were reintroduced into parts of the former range where threats are well identified and under control, such a process could expand the range of the subspecies and ultimately provide future conservation benefits if more threatened extant populations eventually become diminished or disappear. Done properly, reintroductions could be a useful component (among many others) of a Caribbean-wide effort to study and conserve manatees. The ideas expressed below are from a report (Reynolds and Wetzel 2008) submitted to the Guadeloupe National Park Department. The constraints and questions apply specifically to the reintroduction project in Guadeloupe, but they could also apply to possible reintroductions considered in the future for other locations in the Caribbean.

4.2. ISSUES TO CONSIDER BEFORE PROCEEDING

The goal of re-establishing a species that has been extirpated by human activities is a noble one. It is also extremely difficult to achieve. Such a venture should not be undertaken unless there is reasonable assurance of success and the necessary scientific and technical data and information. Otherwise, animals selected for the reintroduction may simply be lost—a tragedy, especially when dealing with endangered species. The following represent some categories of topics or actions that should be considered prior to seriously undertaking this difficult and risky process.

4.2.1. Legal Status and Transparency

Marine mammals elicit very strong feelings among people. The taking of endangered manatees for any purpose, even a noble one, is likely to draw considerable attention and a very mixed response. It will be important for the government of Guadeloupe and the National Park to have done a very careful analysis to ensure that (a) the taking and relocation of manatees is done with transparency and in compliance with all relevant laws and conventions (e.g., CITES, SPAW Protocol), and (b) a well-articulated justification exists that notes the conservation benefits and legality of the reintroduction process.

4.2.2. Lessons to be Learned from Reintroductions of Other Species

The First International Wildlife Reintroduction Conference was held in Chicago, Illinois, on 15–16 April 2008. The Web site for the event is at: http://www.lpzoo.org/reintroworkshop/registration.html.

Information acquired from this conference or others with a similar focus in future years could save money and time and help ensure success of a manatee reintroduction programme. Countries interested in the possibility of reintroducing manatees should become familiar with similar efforts for other species in order to learn from those experiences.

4.2.3. Systematics of Manatees in the Wider Caribbean

Two subspecies of the West Indian manatee (*Trichechus manatus*) occupy waters and coastal areas of the nations of the wider Caribbean (see earlier discussions in this action plan). The Florida manatee (*T.m. latirostris*) numbers approximately 3,400 individuals and is found in the waters of Florida (USA), with occasional individuals wandering into Bahamian or Cuban waters. The Antillean manatee (*T.m. manatus*) occupies the remaining range of the species (i.e., the waters of nearly two dozen countries) and may number around 5,500 individuals. The possible reintroduction in Guadeloupe should consider only individuals representing the Antillean manatee.

4.2.4. How Many Manatees Would be Needed for a Successful Reintroduction Effort?

This is a difficult question to answer. In one sense, the more animals one could introduce, the better from the standpoints of maintaining genetic diversity and avoiding problems associated with the inherent vulnerability of small populations to extinction. However, among the countries and islands of the Wider Caribbean, only five (Belize, Brazil, Colombia, Mexico, and Nicaragua) have an estimated Antillean manatee population greater than 500 individuals. Removal of manatees from smaller populations could create undue and unacceptable risk for those groups. Reintroduction projects should remove no more than 10 individuals from any existing population.

4.2.5. Status of the Manatees that Would be Used for the Reintroduction

There are several issues to consider in this regard. The first, and perhaps most obvious, is whether the location where manatees would be collected can sustain the loss of several individuals. That question is addressed to some extent under Category 4, discussed previously. If the source of animals for the reintroduction is free-ranging manatees, it is recommended that animals sought for translocation come from as large a population of Antillean manatees as possible, to minimize the effects on the remaining population. Countries in which 100 or fewer manatees exist would be inappropriate candidates as sources of animals for the reintroduction. In fact, it would be best to avoid removing manatees from populations numbering fewer than 200 manatees.

It is useful to consider using manatees that are already held in captivity rather than wild, free-ranging manatees. Healthy captives could potentially include animals that are captive born, but there is a risk that captive-born animals (or individuals held in captivity since they were extremely young) that have lived their entire lives in a controlled environment lack the skills (e.g., foraging, locating freshwater, avoiding boats) to survive well in the wild. However, healthy captive animals that had some experience in the wild prior to being placed in captivity might be good candidates for the reintroduction because (a) it would eliminate or reduce the need for additional removals of manatee from wild populations; (b) the captive animals would be easy to assess in terms of their health and genetic make-up; and (c) costs would be significantly reduced. Having said that, it is important to note that using captive animals in this way can inadvertently create an impression among local people that there is a lot of money to be made by selling manatees. There have been situations elsewhere in which female marine mammals with young were killed, with a perception that there was a lucrative market for the young animals. Under no circumstances would it be appropriate to create an impression anywhere that future sales of manatees (available either from hunters or as part of a captive breeding programme) will occur for any reason.

As already noted, if free-ranging manatees are used for the reintroduction, only a few countries make sense as potential sources of manatees from the standpoint of sheer numbers, but there are other criteria to consider. One is genetics and genetic variability. Vianna *et al*. (2003) reviewed the results of genetic analyses for manatees in the Caribbean. There are no data available with regard to the genetic make-up of manatees that originally occupied the waters of Guadeloupe. The islands of Puerto Rico (to the north) and Trinidad and Tobago (to the south) are the closest locations that have manatees present.

Based on an analysis of the mitochondrial DNA control region, the haplotypes of Puerto Rican manatees were most similar to those of manatees from Florida and Dominican Republic. Although Vianna *et al*. 2006 did not report any genetic information for manatees from countries such as Cuba, Haiti, and Jamaica, it seems likely that manatees from those countries would have reasonably similar mitochondrial DNA haplotypes. Based on the mitochondrial DNA control region analysis, manatees from Puerto Rico and Dominican Republic had little genetic diversity (only two haplotypes).

Data were not presented by Vianna *et al*. 2003 for manatees from Trinidad and Tobago, but manatees from nearby Venezuela had three mitochondrial DNA control region haplotypes, none of which were found in Puerto Rican manatees. Colombian manatees, on the other hand, showed relatively high genetic diversity (eight haplotypes), with one haplotype in common with Puerto Rican/Dominican manatees.

However, it is important to realize that variability of the mitochondrial DNA control region does not necessarily indicate variability of the nuclear genome. A well-known marine mammal geneticist (Dr. Greg O'Corry-Crowe, pers. comm. 2008) notes that it would be much more meaningful to have variability of genes that are undergoing active selection such as the major histocompatibility complex (MHC) family of genes, which plays an important role in immune responses and reproduction. As a matter of fact, a recent postdoctoral scientist at Mote Marine Laboratory (Dr. Susan Carney) has studies underway of the MHC genes in Florida manatees, and Dr. O'Corry-Crowe studies MHC genes in other marine mammals. It might be useful to fund a small study of MHC gene variability to assess whether diversity is good for manatees from the desired collection sites. In that regard, some samples are already collected and archived and might be made available quickly.

One final point with regard to estimated population size and genetic diversity is that it might be appropriate to take a two or more manatees from each of several populations if free-ranging manatees are used and if the scientific research suggests that they are healthy and from a relatively large population. This approach would limit possible impact to any single population from which animals are taken, and it could improve the genetic variability of the introduced population.

The final important criterion to be considered carefully in selecting a location from which to extract manatees for reintroduction is the health of the individual animals. In a recent pilot study, Wetzel et al. (2008) documented levels of organic contaminants (PCBs and chlorinated pesticides) in manatees from Chetumal Bay, Mexico, and southwestern Florida that were sufficiently high to cause concern about effects on reproduction and health. It would be extremely unfortunate to translocate manatees for which immune function or reproduction were impaired; this would doom the reintroduction effort before it could really begin. In a similar vein, it would be unfortunate to introduce manatees that were infected with a disease that could affect their reproductive potential, health, or longevity. Before commitments are made to take animals from a particular location, it is recommended that careful assessments of disease agents (e.g., bacterial screens) and contaminants be done for manatees from that location. Unless the animals are cleared by a veterinarian as being healthy, they should not be considered as candidates for the reintroduction.

4.3. QUESTIONS THAT SHOULD BE ANSWERED PRIOR TO CAPTURES/REMOVALS OF MANATEES FROM ANY LOCATION

The previous discussion provides some general guidelines and some questions that must be investigated before proceeding with a reintroduction program. The following list of questions attempts to be more comprehensive and focused. This list generally corresponds to short-term recommendations that must be addressed. One caveat should be mentioned: in order to avoid speculation that the data collected are in any way biased by individuals who might gain in some way from removal of manatees from a local population, any research done should be contracted to outside parties who have no vested interest (other than what is best for manatees) in the results of particular studies.

Before proceeding with removals of manatees from any “parent” population, the National Park of Guadeloupe and French Environmental Authorities (or others who wish to consider reintroductions of manatees in the future) should facilitate or contract for studies that answer the following questions.

4.3.1. What is the size of the manatee population from which captures are proposed (assuming that manatees held in captivity are either unavailable or inappropriate for the reintroduction)?
If a wild population is estimated to be fewer than 100 to 200 individuals, this would not be an appropriate population from which to remove individuals. Ideally, manatees should be taken only from wild populations estimated to number at least 500 individuals.

4.3.2. What are the current threats to that population? An assessment should be conducted to determine human and natural factors that threaten the survival, health, or reproduction of manatees.

4.3.3. What effect do those threats currently have on manatee health and survival and are steps being taken to bring those threats under control? If poorly controlled threats are killing or reducing the health and reproductive potential of manatees in an area, removals could exacerbate an already precarious situation. Manatees should not be removed from populations for which threats are serious

and/or uncontrolled. Stated otherwise, until threats are brought under control, it would not be appropriate to diminish the size of a local manatee population through captures.

4.3.4. Are the manatees proposed for removals Antillean manatees?
As noted, they should be since it is hard to imagine that the original population of manatees in Guadeloupe could have contained animals from Florida. This is a concern, however, since Florida manatees have been observed in some locations besides the United States.

4.3.5. Do the manatees proposed for removals exhibit genetic variability in genes undergoing active selection?
This should be assessed. Tissue samples appropriate for genetic analysis are already archived for manatees from many locations in the Caribbean. All else being equal, genetic variation should be an important determinant of which group of manatees is most suitable as a parent stock for the reintroduction.

4.3.6. Are the animals healthy?
An experienced veterinarian should be contracted to assess the general health and body condition of manatees from the locations being considered. Bacterial and viral screens should be run to assess whether manatees from particular locations seem to carry infections that could debilitate individuals or be spread through the population. Body burdens of contaminants should also be assessed and compared, as possible, to toxic equivalent values. In addition, studies of biomarkers of exposure and effects should be done to assess actual responses of individuals to environmental insults.

It should be apparent that a number of questions need to be addressed before taking manatees from one location for reintroduction to another. If these questions are answered properly, a very positive outcome (independent of whether the reintroduction itself actually occurs) would be vastly improved knowledge of the status of manatees and threats to manatees in certain locations in the Wider Caribbean.

4.4. PROMOTING A HEALTHY MANATEE POPULATION IN GUADELOUPE
As above, there are several factors that would come into play in this regard. First, if the translocation were to proceed, it should attempt to establish 10 individuals in Guadeloupe's National Park. Such a group should be composed mostly of females (7 or 8 of the 10 individuals) to maximize the reproductive potential of the group. Young adult animals would be ideal, but it is impossible to determine the age of large, living manatees. Therefore, we recommend that candidates for translocation be animals at least 2.6 meters long **(**i.e., adults or very large juveniles). Such individuals should be able to breed successfully from the outset of the project.

The introduced manatees should be tagged with satellite transmitters and monitored. This would allow scientists and managers to be able to tell whether individuals wander away from Guadeloupe, a real possibility given the nomadic tendencies of certain individual manatees. It would also provide valuable biological information (e.g., habitat-use patterns) that would allow optimal, focused conservation of habitats important to the manatees. Transmitters would also permit the easy relocation of animals in order to conduct periodic assessments, ranging from simple observations of appearance and behaviour to potential recaptures to assess weight, blood chemistry or other health-related parameters. Other ways to monitor the animals and their habitat-use patterns could include aerial and boat-based surveys. In that regard, the Parc National de la Guadeloupe should hire or designate two fulltime staff members to

monitor the movements, distribution, habitat use and general health of the manatees, as well as to serve as liaisons and information officers about the manatees to the public.

With regard to the manatees potentially wandering away from Guadeloupe, there should be a transition period of a few weeks in which the translocated animals were held within the confines of one or more very large enclosures (large enough for ample food) in the waters of the Grand Cul-de-Sac Marin. This transition might facilitate some imprinting of the animals on their new home and thereby reduce the tendency of individuals to wander away.

If the introduced manatees appear to adapt well to their new environment, that would be excellent. However, other factors need to be considered before and after a translocation occurs. One is the health of the environment into which they are being introduced; studies should be done of the sediments in several locations in the Grand Cul-de-Sac Marin to be assured that health risks associated with adsorbed contaminants are minimal. An assessment should evaluate this area in terms of the presence or intensity of documented threats to manatees such as boat traffic or fishing activities.

It is also extremely important before proceeding to be assured that a reintroduction would be supported by the people of Guadeloupe. If manatee protection zones are established, it would be necessary to have compliance in order to avoid situations that sometimes occur elsewhere in which people kill and/or consume manatees in the Caribbean. It would also be vital to ensure that gillnets, crab traps, or other fishing gear that entangle manatees elsewhere are not being used in parts of the island where manatees come to exist. As noted above, the people of Guadeloupe may experience some restrictions on their activities or ways of life and, without some assurance of acceptance and compliance, a small founder population of manatees could be wiped out easily.

Implicit in all this is the need to develop an education and awareness programme for the island. Without such a programme, conservation efforts often fail. One unanticipated result of education and awareness efforts can be that people try to swim with, feed, and otherwise interact with manatees and other wildlife. The French government should strongly discourage such activities and enforce minimal interactions as a way to keep the manatees as unmolested and “natural” as possible. Some guidelines in that regard appear in Reynolds and Wells (2003).

Some threats do exist (entanglement in fishing gear; potential development of over-zealous ecotourism operations; hurricanes), but the fact is that human-related threats to manatees in Guadeloupe (or certain other, future locations considered for reintroduction) may be far less than those in the countries from which the manatees may originally be taken.

The questions that need to be addressed in Guadeloupe or any other locations considered for reintroductions of manatees prior to moving forward with the reintroduction are–

- Does the habitat appear to provide all that is necessary for manatees (food, fresh water access, quiet areas away from people)?
- Are threats or potential threats to manatees identified and under control?
- Can locations for soft-release enclosures that provide food, fresh water, and other manatee needs be identified?

- Are an infrastructure and funding base in place to permit long-term monitoring and assessment of the introduced manatees to occur?
- Are public awareness and education programmes sufficient to engender support for manatee and habitat protection measures?
- Can regulatory areas be enforced to protect manatees?

Addressing these questions would constitute important short-term recommendations. However, actual implementation of some aspects of the programme (monitoring, public awareness and education, enforcement, working with stakeholders to keep threats under control) represents a vital long-term commitment.

4.5.CONCLUSIONS

4.5.1. Overall Impressions of the Guadeloupe Proposal to Reintroduce Manatees (from Reynolds and Wetzel 2008)

There will need to be some preintroduction assessments and planning, post-introduction monitoring, regulations and enforcement, and a strong education and awareness programme in order for the reintroduction to succeed. Many of the necessary elements already exist (e.g., good habitat; committed and well-funded agencies; relative lack of human related threats) to promote an effective reintroduction of manatees to Guadeloupe. The keys to success will rest with doing the necessary evaluations prior to the event and ensuring that funds exist for monitoring, enforcement, and education for many years thereafter.

4.5.2. The Bigger Picture: Conclusions with Regard to the General Question of Reintroducing Manatees into Former Habitats in the Wider Caribbean

The issue of creating "new" populations of manatees in habitats formerly occupied by the species remains controversial. As noted above, there are a number of questions that must be addressed carefully before such efforts should be seriously considered. In any instance in which reintroduction is proposed for consideration, the burden rests with the country wishing to do the introduction to demonstrate that (a) the process will not seriously impair any other populations of manatees, (b) the environment into which animals would be introduced is one in which threats to manatees are identified and under control, and (c) there exists a long-term commitment of funds and personnel to monitor and protect reintroduced manatees. The net benefits for research and conservation of manatees in the wider Caribbean should clearly outweigh the costs of any reintroduction effort.

If a reintroduction of manatees takes place in Guadeloupe or elsewhere in the wider Caribbean, careful monitoring will allow scientists and managers to judge aspects of the project that were done well (i.e., succeeded) and those that should be improved. If the process were ever sufficiently refined and proven, reintroductions, or introductions, could become an important component of region-wide manatee conservation.

5. SUGGESTED COUNTRY-SPECIFIC ACTIONS

In order to ensure that manatee conservation efforts are regionally and nationally focused on issues of critical importance, countries should attempt to identify key conservation concerns (based on existing information). In this context, the following country-specific recommendations have been included to assist with the identification of critical issues relevant to manatee conservation in each country. Country names followed by an asterisk include recommendations provided by local experts. Countries with two asterisks include combined recommendations provided by both local experts and the authors based on existing information. Countries with no asterisk include recommendations elaborated solely by UNEP-CEP based on existing information for a particular country. The participation of experts is recognized in Appendix I, List of Contributors. Table 8, which is included at the end of this section, summarizes the recommendations for each country.

5.1. BAHAMAS

- Research: Radio-tracking studies have provided valuable information on movement patterns of manatees to and from the Bahamas. Some animals have been found to originate from Florida (Reid 2000, Lefebvre *et al.* 2001). When animals are captured and tagged, genetic samples should be taken to examine their genetic makeup. Genetic techniques should use a greater number and more variable microsatellite locis than those currently reported in the literature (Vianna *et al.* 2006). This would give a finer resolution of genetic variability and therefore more specific information regarding the geographic origin of sampled individuals.

5.2. BELIZE (*)

Although many strategies included in the Belize Recovery Plan (Auil 1998) have been accomplished, there are still some outstanding activities and with new information have come new recommendations:

- Habitat Protection: Three protected areas (wildlife sanctuaries) in Belize have been legislated specifically for manatee conservation. Each has an identified community group either formally co-managing or working towards co-management of the individual sites. Increased support for these groups is recommended, along with networking in order to strengthen each group's capacity to manage these critical manatee habitats. In this light, the following recommendations should be considered.
  1. Create management plans for the three manatee wildlife sanctuaries. The management plans for other protected areas that include manatee habitat should also be reviewed, making recommendations to include manatee protection at those sites
  2. Establish and/or continue scientific research within protected areas to monitor and improve the effectiveness of the protected area as a conservation strategy
  3. Monitor manatee movements between protected areas to determine travel corridors and additional activity centres for protection

- Recovery Plan and Regulations:
  1. Review and update the National Manatee Recovery Plan
  2. Ensure that all coastal development projects take into consideration impacts on manatees (e.g., increased boating activities, loss of seagrass beds due to dredging and filling); where applicable, strategic mitigation measures should be included in these projects' environmental impact assessments.

3. Establish and enforce boating rules (e.g., slow speed zones) in areas with high potential for conflict between manatee and human use.

- National Stranding Network: The current stranding network needs to be strengthened by recruiting and training added individuals in collecting and recording data and in maintaining the national stranding database. This can be done by—
    - Conducting at least one stranding network training session each year,
    - Updating and streamlining data to be collected for each dead stranding, and
    - Continuing the manatee rehabilitation and release project.

- Research: In order to create and carry out appropriate management strategies for the threatened manatee, it is imperative to continue and enhance research techniques. Data on life history, distribution, and relative abundance of the species will allow decision-makers to make informed choices (Auil 1998). Although current research projects continue to be carried out, new projects and scientific collaborations should be developed in areas not yet studied:
    1. Monitor manatee movements using remote-sensing techniques (VHF, PTT, GPS tracking), continually adding sites identified as critical manatee habitat.
    2. Continue health assessments and monitoring of individuals to determine life history characteristics of the Belize population.
    3. Continue collection of samples for DNA studies to identify the population relatedness within Belize and among the region. This is important in light of the reported manatee movement between Mexico and Belize.
    4. Continue photo-id database development.
    5. Continue surveys to monitor for major changes in countrywide counts.
    6. Continue fine-scale ecology and behaviour studies in the Drowned Cayes, Southern Lagoon, and Turneffe Atoll. Identify and recruit research in additional high-use sites (e.g., Corozal Bay, Placencia Lagoon, and Gulf of Honduras).
    7. Provide opportunities for individual scientists in Belize (and adjacent countries) to network and collaborate in an effort to determine a statistically valid population estimate.
    8. Encourage/require local researchers to publish the results of their projects in both popular and scientific venues. Peer reviewed publications can be used to develop site-specific management actions and direct future research. Popular publications ensure support for activities among local and international constituents.

- Educational Outreach: Educational outreach programmes directed at primary and secondary school students need to be continued. There is indication that hunting may still take place in areas perceived as “safe” for manatees. National and local educational campaigns aimed at coastal communities are recommended as a way to bring manatee conservation back into the public eye.

- Regional Collaboration: The Corozal Bay Manatee Wildlife Sanctuary in northern Belize borders southern Mexico’s Chetumal Bay Natural Protected Area for manatees. The management/research groups working in this large protected manatee system should build international relationships to conduct research, education, and particularly enforcement activities in the joint system. Similarly, the Port Honduras Marine Reserve provides habitat for the manatees that probably use the coastal waters of both Guatemala and Honduras. Collaboration along the southern border is recommended, possibly through existing partnerships such as TRIGOH.

5.3. COLOMBIA (*)

- Research: One of the most important studies needed is a detailed examination of manatee distribution zones and possible abundance of manatees in the country. Another study should identify the number of manatees kept in semi-captivity and should also examine the possibility of releasing these animals into their natural habitats. If manatees are released, the animals should be tagged and their movements monitored.

- Environmental Education: It is necessary to start the development of an environmental educational programme in coastal areas. The educational campaign should be developed to reduce or eliminate illegal hunting. Areas where manatees are sighted regularly should be declared special areas of protection.

5.4. COSTA RICA (*)

- Legislation: The implementation and enforcement of environmental regulations are necessary in important manatee habitats. One of the major problems faced by manatee populations in Costa Rica is boat traffic. Yet there is little protection to this end in key manatee areas such as Parque Nacional Tortuguero, Refugio de Vida Silvestre Barra del Colorado, and Reserva Forestal Pacuare. The presence of authorities from the Ministerio del Ambiente is needed to monitor boating activity because boat presence has a significant impact on local human communities. As indicated in the Plan de Acción para el Manatí (Jiménez *et al*. 2001), such regulatory visits are important even if they are only one component to manatee conservation. Frequent patrolling can help raise awareness and minimize the negative effects of boats on manatees.

- Environmental Education: Education is needed because activities initiated by local communities, such as poaching and entanglement in fishing nets, are still a problem for manatees in Costa Rica. Although poaching has decreased significantly, there are still sporadic reports of occurrences in the country. Fishing is also a problem because nets are placed in areas where manatees can potentially get entangled. These two problems strongly suggest that educational programmes are needed, especially in protected areas and in adjacent communities. Unique educational programmes should be designed for each community because communities have different needs and methods of exploitation associated with natural resources. For example, the community of Barra del Colorado utilizes resources more intensively than the communities of Barra de Tortuguero and Barra de Parismina. This is because Barra del Colorado has greater economic needs and is more isolated than the other two communities. It is also in the area where sporadic cases of manatee hunting for consumption have been reported (R. Sandí pers. comm.). The continuation of this illegal activity combined with the problems related to incidental entanglements reflect the lack of (1) presence of personnel from the Ministerio del Ambiente de Costa Rica and (2) coordination of activities between the authorities in charge of protecting manatees and on-the-ground conservation efforts. These problems also indicate that outside of protected areas, manatees likely face even more troubles that affect the status of the species in the entire country.

- Research: Scientific studies need to focus on providing information that can be used as a tool to conserve manatees. Radio-tagging studies can help provide basic information on relevant ecological aspects for the conservation of the species. Recent research projects have studied methods to capture manatees so that they can be radio-tagged. These studies are helpful guides for future research because they have identified capture methods based on the unique characteristics of the habitats where manatees are found.

- Implementation of Regional Conservation Initiatives: Such initiatives and treaties are needed to promote conservation with neighbouring countries, especially with Nicaragua and Panama. Manatees may migrate to and from neighbouring countries and regional efforts are needed to protect the species as the threats faced in one country will affect the animals living in another. Efforts are currently underway to start regional work with Panama.

5.5. CUBA (**)

- Assessment of Human Related Activities: The conflict between manatees and fishing activities needs to be evaluated. This issue is essential to address, as incidental entanglement is one of the major threats affecting manatees in Cuba. Collaboration with fishing communities could help identify alternative practices and ways in which current fishing practices can minimize incidental entanglement.

- Environmental Education: In areas where incidental entanglement is a problem, it is critical to implement a community-based educational campaign. The magnitude of incidental takes should be investigated as part of interview surveys.

- Assess and Improve the Effective of Existing Law: In Villa Clara, regulatory measures need to be implemented in the protected areas of Las Loras, Lanzanillo Pajonal Fragoso, and Las Licuas Cayo del Cristo.

5.6. DOMINICAN REPUBLIC

- Research: A comprehensive study examining the distribution of manatees for the entire country is urgent as no current information exists. Such a study should emphasize periodic aerial surveys to assess countrywide manatee distribution and relative abundance, and incorporate follow-up surveys. Ideally, local communities would be encouraged to participate in interview studies and population monitoring efforts. Such stakeholder involvement could build local capacity and strengthen long-term manatee conservation goals in the region.

  In addition, possible threats to manatees and their habitat should be examined, including contaminant analyses at index sites where concerns are high and manatees are known to be present. Samples collected opportunistically from stranded animals and carcasses can be used in genetic and contaminant analyses to help identify potential health concerns for local manatee populations. An expansion of the current stranding network would directly benefit these studies and help reduce incidents of manatee injury or death related to anthropogenic causes.

5.7. FRENCH GUIANA

- Research: Manatees may move between French Guiana and parts of Brazil and Suriname. A radio-tagged study could help to identify whether those movements occur. If this is the case, a management plan at the regional level is needed. Studies assessing the potential impact of contaminants on manatees and other marine life are also necessary. Bodies of water are being contaminated with fuel as a result of common practices like emptying fuel tanks in the water. Additionally, rice fields may have negative impacts on aquatic ecosystems because insecticides such as DDT, dieldrine, and aldrine may still be used (de Thoisy *et al.* 2003). A regional conservation programme is also required that focuses on protected areas.

5.8. GUATEMALA (*)

- Environmental education and enforcement of relevant laws: Poaching is still a threat to manatees in Guatemala. An environmental programme should be developed and directed at towns in which poaching still occurs. Educational programmes used in other areas such as the neighbouring country of Belize can be used as guidelines since those programmes proved to be successful in reducing illegal hunting. Additionally, existing law needs to be reinforced. Despite legal protection, hunters continue to poach manatees without fear of incurring fines. If the recommendation to increase environmental education and law enforcement is fully embraced, this single action can have a significant positive effect on the population status.

- Boat and fishing activity: Boats are not regulated in protected areas. A study examining the possible effects of boats on manatees using the southeast corner of Lago de Izabal (from Ensenada Lagartos to Punta Chapin) is strongly needed. This area is considered a calving ground because calves are regularly sighted in these shallow waters. Yet motorboats are not regulated in the area and they have been sighted in close proximity to manatees. Most boats belong to fishermen who use the area to purse seine, which is also unregulated and thus another critical area of concern. Manatee entanglements in this type of net appear to occur in this part of the lake, and they have also been reported frequently in other countries, particularly involving calves and juveniles. Purse seining needs to be regulated by the government and alternative places for fishing need to be identified.

- Research: It is unclear if manatees move out of Lago de Izabal. Yet, the movement of manatees from this area to other geographical locations is an important consideration especially if mining activities commence near the lake in an area where the highest number of manatees has been documented for the country. If funding is available, a radiotelemetry programme should be started in Lago de Izabal to study manatee movements, especially after mining activities start. If animals are captured for tagging purposes, tissues can also be collected for genetic work and contaminant analysis. A contaminant study is important because the waters inhabited by manatees in Lago de Izabal have been reported to have lead (H. Garcia pers. comm.). This not only directly affects the manatee population but also threatens the health of people who illegally consume manatee meat.

  Most current research efforts are focused on Lago de Izabal. Studies of manatees using Bahia de Manabique are needed; this is an important area for manatees but nothing is known about the animals specifically using those waters. Studies can potentially focus on behavioural observations of the species due to the good visibility of the waters in this bay. A study that compares different aspects of the ecology of animals using the waters of Bahia de Manabique versus Lago de Izabal is needed as the two areas are ecologically different, which may affect the behaviour and ecology of manatees inhabiting the two areas.

5.9. GUYANA

- Research: The most urgent task is to determine the status and distribution of manatees throughout the country. It would be preferable in this case to use large-scale aerial surveys to examine distribution. However, if this is not immediately possible due to cost and other logistics, it would be useful to obtain baseline data by conducting interview surveys and other low-cost studies.

5.10. HAITI

- Research: The most important task is to determine the current status and distribution of manatees in the country, as the only available information is based on a study conducted in the late 1980s. New surveys could use the same methodology used by Rathbun *et al*. (1985). In a country with strong need for economic support, international funding agencies like Sirenian International can be contacted to request their participation in this initiative.

5.11. HONDURAS (*)

- Research: The responsibilities of coordinating and developing manatee research should be assigned to one person or central office. This person/office should ideally be located near the North Coast so that they can have immediate access to sites where manatees are found in the country. The office responsibilities would include collecting data on manatee sightings and organising yearly flights over key areas.

  Manatee "hot spots" identified on the North Coast (i.e. Cuero y Salado Wildlife Refuge, Rio Aguan and Rio Chapagua) need to be surveyed every one or two years in late March through early May to determine any changes in distribution and relative population abundance. Those flights should be coordinated by the national manatee research coordinator and this person should seek collaboration with an external party that has previously conducted aerial surveys in the region.

  La Mosquitia coast needs to be surveyed to determine the status and distribution of manatees in that area. For completion of the initial survey, a small team can be assembled such as the one organised for the North Coast surveys. In spite of manatee sightings in aerial surveys in 2000 and 2005, the coastal section from the Guatemala border to Punta Sal needs extensive surveying to determine manatee distribution in that region. Sightings in this area might represent migratory animals and not be a true hot spot, although an exception might be the wetlands of Omoa.

  Finally, the next step towards studying manatees in Honduras is to better understand their movements and behavioural ecology. For this, it is recommended that some animals be monitored by radio and satellite-tagging studies. The best location for such tagging is Cuero y Salado Wildlife Refuge, both because of its accessibility and its consistent population of manatees. As mentioned before, this represents a future step in protecting manatees in Honduras and should be considered after several years of population surveys. It is recommended that a relationship be established with the USGS Sirenian Project team and/or the Wildlife Trust team already working on preliminary studies in Belize.

- Biological Information Leading to Major Aspects of Population Dynamics: When a manatee is found dead, a necropsy should be conducted to determine cause of death and samples preserved 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, skin tissue should be preserved for DNA analysis. In addition, the bones should be recovered for study whenever possible. A copy of all these data should be given to the manatee research coordinator.

- Environmental Education: Local education about manatees should be a high priority both on the North Coast and in La Mosquitia. Increased awareness will help generate more reported manatee

sightings and, it is hoped, encourage the reporting of dead animals. The local people of the North Coast need to be informed that the relative abundance of manatees in the region is decreasing.

- Protected Areas: The continued protection of Cuero y Salado Wildlife Refuge is highly recommended. Comparisons of recent studies with those of aerial surveys conducted in 1979-80 indicate that more ecological studies need to be carried out in Laguna Thompson. This will help determine whether excess sedimentation or chemical runoff from the African oil palm plantations are adversely affecting the ecosystem.

5.12. JAMAICA

- Research: Top priority should be given to conducting broad-scale surveys throughout Jamaica to obtain information on the patterns of distribution and relative abundance of manatees. No more manatees should be kept in semi-captive conditions until the status of the manatees in the country is determined to be stable. The removal of even a few individuals from the population can have dramatic results if population size is small.

- Develop Guidelines for Manatees in Captivity: Three manatees are currently kept in captivity in the Alligator Hole River. It is necessary to determine the carrying capacity of the river because in 1996, the food resources available for manatees in the river were depleted and a supplemental feeding programme was established (Mignucci-Giannoni *et al.* 2003). No more manatees should be introduced into the river until information is available on its carrying capacity.

5.13. MEXICO (*)

During the last meeting of the Mexican National Manatee Technical Advisory Committee (NMC) in November of 2006, the group analyzed the major threats and conservation and research problems associated with manatee protection in the country. Several priority research recommendations and conservation actions were formulated during this meeting with the intention of implementing them within the next four years. The main recommendations include—

1. The NMC recognizes the need to develop official standardized protocols in order to support the stranding programme; in particular the rehabilitation of calves and adults and the release efforts developed in different regions of Mexico. Additionally, institutions participating in the NMC that have manatees in captivity will work on standardizing protocols related to better captive management and husbandry.
2. The NMC recognizes that a large portion of the coastal area in Yucatan Peninsula and Tabasco are natural protected areas (NPA) and that several have significant manatee populations. However, NMC is concerned because some of the NPAs have serious management limitations, poor implementation of manatee conservation actions, and strong pressure to develop economic activities inside and around the areas. The Chetumal Bay NPA in particular was identified as having such problems. NMC strongly recommends a thorough evaluation of the situation in the different NPAs so that particular recommendations can be provided to the federal and state governments and better manatee conservation strategies may be implemented.
3. The NMC strongly recommends continuing to develop procedures to estimate manatee populations in the states of Campeche, Chiapas, Tabasco, and Veracruz using acoustic techniques. This will require international collaboration.
4. The NMC recognizes the necessity of continuing to study manatee genetic variability and gene flow

between manatee populations in different regions of Mexico. It is recommended that microsatellite techniques be used in such studies.

5. The NMC recommends that manatee radio-tracking programmes continue in areas with high manatee concentrations. New information about large transborder movements between Mexico and Belize and interconnecting manatee habitats of significant importance will help stimulate the development of strong regional collaboration in research and conservation activities.
6. The NMC recognizes the necessity to evaluate the effect of contaminants such as pesticides, herbicides, and PCBs on manatee populations and their critical habitats. PCBs have been detected in some manatee samples from Quintana Roo (Wetzel *et al.*, unpub data) suggesting that contamination is a problem in that area.
7. A strong educational programme at the national level is needed to support regional activities of manatee conservation. In particular, the committee identifies the necessity to disseminate information on manatee biology and supports local marine mammal stranding network activities.

5.14. NICARAGUA

- Enforcement of Relevant Laws: Illegal hunting is still a major problem in Nicaragua, and several hunting communities have been identified (Jiménez 2002, Espinoza 2004). Illegal hunting should be stopped, but in order to do so, it is necessary to identify alternative ways of living for hunters. Hunting is part of the culture and tradition of local communities, so in order to request that people stop hunting, a social-economic study needs to be conducted to identify (1) other activities that are lucrative and attractive and (2) ways to communicate these alternatives so that local people are willing to consider suggestions and lifestyle changes. The law must be strengthened and this should be accompanied by effective enforcement. Protected areas like The Miskito Coastal Biological Reserve do not have enough personnel to monitor the area (Jiménez 2002). Yet four known hunting communities exist near the reserve. More personnel need to be hired to effectively enforce conservation measures in protected areas. Funding to support this recommendation can come from the Nicaraguan government or can be supported through international collaboration.

- Environmental Education: An educational programme is urgently needed to educate known poachers on the impacts of poaching on manatees. The programme should include the participation of community leaders, local authorities, and scientists. International participation may also be helpful in this particular case to fund such a study because the Nicaraguan government may not be in a position to allocate funding specifically for this activity (Jiménez 2000). Public education is also necessary to strengthen and enforce legislation banning manatee hunting. Education also has the potential to foster pride in manatees as a significant feature of the marine environment and an umbrella species for marine conservation initiatives.

5.15. PANAMA (*)

- Research: No comprehensive study has been conducted since the late 1980s (Mou and Chen 1990). The genetic diversity and viability of the local manatee population is also unknown and should be evaluated. It is unclear if the few animals observed in the eastern part of the country (Comarca) interact or mix with the animals on the western coast (Changuinola). Additionally, the proximity of the San San Pond Sack refuge, the area with the highest number of manatees in the country, to the border of Costa Rica suggests that some genetic exchange happens between the two countries. Genetic studies can help to determine if local and regional genetic exchange is occurring, and this information can be used to establish conservation efforts on a larger scale.

A study that examines the feeding habits of manatees is also important. The study should identify the type and number of plants that manatees feed on as well as their nutritional value. The information can be used to protect critical plant species, especially in areas with aquatic contamination from agricultural runoff, such as that from banana plantations and/or cattling. Aquatic vegetation is dramatically affected by discharges from banana plantations. Research studies need more technical support to ensure the participation of local people in fieldwork activities. Local people can help in conservation programmes and can help to increase awareness among friends and family members.

- Prepare a National Recovery Plan and Organise Recovery Teams: It is necessary to develop a manatee recovery plan for the country. San San Pond Sack in the only area that has an action plan to conserve manatees. However, management, research, and education efforts are needed in all areas in which manatees are observed. Existing management plans of protected coastal areas need to be modified and actions need to be implemented to protect critical areas and ecosystems for manatees. This would ensure larger-scale management of important areas. An interagency working group needs to be formed to develop research studies oriented toward researching the biology and ecology of manatees in the North Caribbean coast of Panama. Such studies can help to identify sanctuaries and biological corridors of manatees.

- Environmental Education: It is necessary to establish relationships with potential partners that can help develop research and environmental education activities at a regional level. Those activities could help recover critical ecosystems for manatees in the region.

- Develop Guidelines for Manatee Watching in the Wild and Associated Activities: Sustainable ecotourism activities can be helpful to raise people's awareness of manatee protection and increase conservation efforts. The activity can also provide alternative means of economic support for local communities. To promote sustainable ecotourism, a manual of activities associated with manatees could be developed. The manual should carefully outline recommended activities, ways to examine their potential effects on manatees, and steps to take in case those activities are identified to have a negative impact. Currently, platforms are used in San San Pond Sack to observe manatees from a distance.

5.16. PUERTO RICO (*)

- Update National Recovery Plan: An update of the manatee recovery plan must be made a priority. This plan must take into consideration local necessities and limitations to make the plan truly useful and ensure the viability of short-term and long-term goals. The plan should be used as a reference when information on Puerto Rican manatee studies needs to be gathered. Indeed, the recovery plan should provide guidelines that managers can use immediately when making decisions and developing new research plans. Because manatees in Puerto Rico face different issues and environmental problems than so manatees in other areas, such as Florida, management decisions for manatees in Puerto Rico should be made, whenever possible, using locally based studies and data.

- Research: A better population estimate is needed. In order to achieve this, a standardized methodology for aerial surveys should be established and data collection efforts need to be planned and coordinated between agencies and organisations involved. Data obtained by aerial surveys conducted by the U.S. Fish and Wildlife Service have not yet been analyzed or made available or published. CSN aerial survey data is available in unpublished reports; however, is in the process of

being published. The analysis of these data with technology such as GIS software might reveal important habitat-use patterns that have been overlooked. Repeated synoptic surveys are needed to pinpoint a minimum number of manatees for the island in which to base management actions.

- An updated assessment of the ecosystem's carrying capacity is also urgently needed. Conservation efforts for the past 15 to 20 years have been based on the assumption that the only threat to manatee populations is human interaction, but habitat limitations and contamination may play a factor in ultimate population numbers as well. The population has remained stable in terms of numbers, with 8 to 13 carcasses recovered annually. However, carcass recovery has an upward trend in the past 17 years. It is possible that the carrying capacity of the island for the manatee may be at or close to equilibrium, in which case efforts to protect habitat and maintain a stable population would be of greater priority than the stimulation of unsustainable population growth.

More detailed studies at the species biology level are needed. Behavioural and movement studies and characterization of habitats used by manatees (based on information from radio-tracking data) are the next steps in understanding movement patterns and habitat use. Habitat use by individual manatees through the use of radio-telemetry off Jobos Bay National Estuarine Research Reserve in Salinas and Guayama on the south coast and off San Juan Bay Estuary in Toa Baja, Cataño, Guaynabo, San Juan, Carolina and Loiza on the north coast is desperately needed and should be given a high priority.

Telemetry data have also not been thoroughly published and this information is vital to further understanding of the species' use of habitat. Nuclear DNA microsatellite studies are necessary to understand the types of interactions present in the fine-scale population structure. Currently, microsatellite primers are being developed and optimized for polymorphic loci at University of Florida (Kellogg *et al.* 2007), Fish and Wildlife Research Institute, and Mote Marine Laboratory. These studies will address questions related to habitat use and migratory patterns by identifying breeding areas, determining whether northern and southern populations of the island are interbreeding, and analyzing the extent of social contact between the three haplotypes (at feeding grounds or water holes, for example). The clear genetic isolation between the Florida and Puerto Rico manatee populations (Kellogg *et al.* 2007) indicates that management decisions for the species in the United States should take into consideration that Florida and Puerto Rico manatees are different, facing different threats, and requiring different management measures. A downlisting of the Puerto Rico manatee endangered status as part of Florida's downlisting to vulnerable would be an uninformed management action and biologically irresponsible. If the genetic isolation anticipated between north and south manatee populations is confirmed by microsatellite analysis, the manatee population in Puerto Rico should not be treated as a homogenous group. Environmental managers should consider this when making plans to enhance recovery efforts of the species in Puerto Rico.

Efforts toward manatee mortality assessment should continue, especially to thoroughly document cases through the use of histopathology. These results should be published to be considered in management decisions regarding the health of the population. Rescue and rehabilitation efforts should also be continued and be properly funded, given the high cost of treatment and retraining of the animals to survive in the wild. These efforts, given the small size of the island, should be centralized in one facility with long-term trained personnel in order to avoid duplicate effort and to concentrate in enhancing treatment techniques to allow for individual survival of patients.

- Identify Habitat Requirements and Protect Areas of Special Significance to Manatees: Increased efforts should be made by local authorities to regulate and protect manatee habitat from development, focusing on areas known to be preferred feeding and breeding grounds for individuals in the population. A detailed characterization of seagrass beds intertwined with manatee radiotelemetry data and water availability in known manatee areas will enhance habitat protection efforts.

- Speed Regulation in Manatee Areas: Identify manatee areas with information from aerial surveys and regulate boat speeds in those areas to diminish to the extent possible manatee deaths due to watercraft collisions. This regulation needs to be accompanied with an amendment to the commonwealth navigational law and provide for significant fines that will serve as deterrent for boaters and jet skiers to properly navigate in areas where manatees are more at risk. This effort needs also to be coupled with education for rangers, law enforcement, attorneys, and judges to take these actions seriously and as an important conservation tool for the species.

- Enhance Public Education: Additional efforts should be made to enhance community outreach and public education about the manatee's plight. A massive educational campaign should be developed and funded to assist manatee conservation through a better educated and informed citizenship. This could involve distributing information through various media (newspaper, TV and radio public service announcements), posters, and brochures to schools and providing visiting lecturers to schools and environmental activities.

5.17. SURINAME

- Research: Surveys to determine the current status and distribution of manatees should be a highest priority in Suriname. Most available reports are from the 1970s and 1980s. Aerial surveys provide the most comprehensive data; however, if they are not possible because of expense and logistics, useful information can be obtained from interviewing local fishermen and people who live along the coast. Monitoring manatee distribution can be undertaken at appropriate time intervals (i.e. every two to five years).

5.18. TRINIDAD & TOBAGO

Recommendations proposed in this section are in accordance with The Trinidad & Tobago Recovery Plan (Nathai-Gyan and Boodoo 2002):

- Research: Information on the distribution and relative abundance of manatees is critical in Trinidad & Tobago. The most viable method suggested for this type of research in the country includes boat surveys and field interviews. Boats should have observation platforms from which observers can look for manatees during the survey. In accordance with The Trinidad & Tobago Recovery Plan, monthly boat surveys should be conducted at Nariva Swamp and quarterly surveys should be conducted at other identified manatee locations. Aerial surveys should be conducted on an annual basis throughout the country.

- Protected Areas: The Nariva Swamp is one of the most important areas for manatees in the country. The area should be designated as a Managed Resource Area and a management plan should be developed to protect this habitat. Ongoing patrols and monitoring should continue to ensure the protection of its inhabitant species and ecosystems. It is recommended that honorary game warden

status be afforded to select individuals that can be empowered with the necessary legal authority to help with ongoing patrol/monitor activities. Other important habitats for manatees are also in need of management plans, including Big Pond, Manzanilla and connecting channels, and the Mitan River. Management plans should include guidelines to reinforce current policies or regulate activities that can have a negative impact on manatees, including the restriction on boat engines, restriction on seine nets and large hooks, and control of habitat destruction. To achieve this latter goal, any project involving work in important manatee habitat should be evaluated and granted an environmental impact certificate of approval before the project is carried out. In cases where agricultural activities are permitted, a 25-m buffer area should be maintained near any natural watercourses. Littering of the waterways and open waters should be prevented with the enforcement of the Litter Act and through educational programmes.

- Modify Relevant Laws: Hunting manatees is prohibited and the fine is approximately US$160.00 or imprisonment for three months. The fine and penalty should be increased significantly to be effective.

5.19. UNITED STATES (*)

Manatee conservation and management in the United States have been guided by three decades of collaboration and four consecutive versions of a Florida Manatee Recovery Plan, including the most recent version that was approved and released in 2001 (U.S. Fish and Wildlife Service 2001). The latest plan provides detailed descriptions and justifications of necessary actions, accompanied by a prioritized implementation schedule that assigns different tasks to different agencies or other stakeholders. The primary entities that have a statutory responsibility to study and conserve manatees are the Department of the Interior (Fish and Wildlife Service and U.S. Geological Survey) and the Florida Fish and Wildlife Conservation Commission. At the federal level, the U.S. Marine Mammal Commission provides independent oversight.

The four primary recommendations for manatee recovery in Florida discussed in the recovery plan include—

- minimize causes of manatee disturbance, harassment, injury, and mortality;
- determine and monitor the status of the manatee population;
- protect, identify, evaluate, and monitor manatee habitats; and
- facilitate recovery through public awareness and education.

Significant progress has been made to address each of these categories. In fact, Wallace (1994) considered the manatee recovery programme at that time to be a model to which other species recovery programmes could aspire. It is important to note that progress towards recovery of Florida manatees depends in part at least on availability of good scientific information to inform managers and promote effective mitigation and conservation. Thanks to multi-faceted efforts and long-term funding commitments, it is safe to say that the Florida manatee is one of the best-known marine mammals in the world (Glaser and Reynolds 2003).

Although recovery of the manatee in Florida is not assured in light of the multiple effects of a burgeoning human population, the information base and infrastructure that exist provide reason for some optimism. Reflecting that sentiment and a perceived improvement in status of manatees over the past

three decades, the state of Florida recently downlisted manatees from endangered to threatened. For details of recovery actions, consult the Web pages for the U.S. Fish and Wildlife Service (http://www.fws.gov/northflorida/Manatee/manatees.htm) and the Florida Fish and Wildlife Conservation Commission (http://floridaconservation.org).

5.20. VENEZUELA (**)

- Research: There is need for baseline information on manatee distribution in Venezuela. Most recent studies have focused on a small region of Lago de Maracaibo. However, no current systematic information is available regarding the status of the species for much of the eastern coast of Venezuela. Depending on the availability of resources, baseline information can be obtained using aerial and boat surveys.

- Protected Areas: Manatee protection should be emphasized in the areas established to protect them. Local researchers recommend that Bahia El Tablazo become a protected area for manatees. Community participation and stewardship should be an integral component of the reserve's management.

- Develop Guidelines for Manatees in Captivity: Improved captivity conditions, or alternatively releasing the animal kept at Parque Zoologico y Botanico Barrida, located in Barquisemto, Lara state, is another important issue to address.

Table 8. Summary of suggested country-specific recommendations

Country	Task/subtask numbers	Description of recommendation
Bahamas	3.2.1.	Research on manatees
Belize	3.1.3.	Provide protection for manatees and manatee habitat
	3.1.3.1.	Improve manatee awareness
	3.1.4.1.	Prepare/update national recovery plans
	3.2.1.	Research on manatees
	3.2.1.2.	Biological information leading to major aspects of population dynamics
Colombia	3.1.3.1.	Improve manatee awareness
	3.2.1.	Research on manatees
Costa Rica	3.1.3.1.	Improve manatee awareness
	3.1.3.2.	Protected areas
	3.1.3.3.	Enforce relevant laws
	3.2.1.	Research on manatees
	3.2.1.3.	Regionally coordinated work
Cuba	3.1.3.1.	Improve manatee awareness
	3.1.3.4.	Reduce human-related injuries and mortality
	3.2.3.2.	Assess and improve the effectives of existing law
Dominican Republic	3.2.1.	Research on manatees
	3.2.1.1.	Status and distribution
	3.2.1.2.	Biological information leading to major aspects of population dynamics
	3.2.2.	Monitor habitat condition
French Guiana	3.2.1.	Research
	3.2.2.3.	Habitat pollution
Guatemala	3.1.3.	Improve manatee awareness
	3.1.3.3.	Enforce relevant laws
	3.2.1.	Research on manatees
	3.2.4.	Reduce and monitor activities that may be detrimental to manatees
Guyana	3.2.2.1.	Status and distribution
Haiti	3.2.2.1.	Status and distribution
Honduras	3.1.3.	Improve manatee awareness
	3.1.3.2.	Protected areas
	3.2.1.	Research on manatees
	3.2.1.1.	Status and distribution
Jamaica	3.2.1.1.	Status and distribution
	3.2.1.2.	Biological information leading to major aspects of population dynamics
	3.2.6.	Develop guidelines for manatees in captivity
Mexico	3.1.2.	Define guidelines for data collection/censusing
	3.1.3.	Improve manatee awareness
	3.1.3.2.	Protected areas
	3.2.1.	Research on manatees

Table 8 (continued). Summary of suggested country-specific recommendations

Country	Task/subtask numbers	Description of recommendation
Nicaragua	3.1.3.3.	Enforce relevant laws
	3.2.3.	Monitor and modify accordingly manatee awareness programmes
Panama	3.1.3.1.	Improve manatee awareness
	3.1.4.1.	Prepare/update national recovery plans and organise recovery teams
	3.2.1.	Research on manatees
	3.2.1.1.	Status and distribution
	3.2.2.1.	Identify habitat requirements and protect areas of special significance to manatees
	3.2.5.	Develop guidelines for manatee watching in the wild and associated activities
Puerto Rico	3.1.2.	Define guidelines for data collection/censusing
	3.1.4.1.	Prepare/update national recovery plans and organise recovery teams
	3.2.1.	Research on manatees
	3.2.2.1.	Identify habitat requirements and protect areas of special significance to manatees
Suriname	3.2.1.2.	Status and distribution
Trinidad & Tobago	3.1.3.2.	Protected areas
	3.2.1.2.	Status and distribution
	3.2.3.2.	Assess and improve the effectiveness of existing law
United States	3.1.3.1.	Improve manatee awareness
	3.1.3.4.	Reduce human-related injuries and mortality
	3.2.1.2.	Status and distribution
	3.2.2.	Monitor habitat condition
Venezuela	3.1.3.2.	Protected areas
	3.2.1.1.	Status and distribution
	3.2.6.	Develop guidelines for manatees in captivity

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APPENDIX IV

SAMPLE OF PHOTO-IDENTIFICATION DATA SHEET AND INSTRUCTIONS FOR PHOTO-ID DATA COLLECTION FORM

Manatee Photo-ID Data Collection Form

Pg_____of_____
Sighting #:_____

Date:_____
Start Time:_____ End Time:_____
Location:_____
Loc Code: _ _ _ _ Lat: _ _ . _ _ _ _ _ Lon: _ _ . _ _ _ _ _

Photographer:_____
Data Recorder:_____

ESTIMATES:	MIN	MAX	BEST
Total manatees	____	____	____
Total calves	____	____	____
Photographed	____	____	
Scarred	____	____	

ENVIRONMENTAL CONDITIONS

Weather: C PC MC OC R Conditions: E G F P
Temp (oC) Air :_____ Water:_____ Salinity:_____
Wind:_____ Secchi Depth: _____
Hindrance:_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

I.D. number _ _ _ _ _ _	1st ver _____
Name:_____	2nd ver _____

Field I.D. _____
Size class: AA, SU, CC
Repro Status_____
Habitat_____

INSTRUCTIONS FOR PHOTO-ID DATA COLLECTION USED BY MOTE MARINE LABORATORY

Information at the top of the page

- At the top corner, fill in the **page number**. The second blank will be filled in at the end of the day. This is for the total number of pages used on this particular day.
- **Date:** use this format – DD MMM YYYY. Example: 14 Jul 2001
- **Start Time:** the time (in 24 hour clock) that manatees were first seen during this sighting. Ex. 2:15 in the afternoon would be recorded as 14:15.
- **End Time:** the time (in 24 hour clock) that the sighting was ended, either because the manatees disappeared, left one site and entered another, or photography is completed
- **Location:** The location of the manatees where they were first seen for this particular sighting. The observer should be able to tell you this, if not, look it up on a navigational chart or map.
- **Photographer:** Photographer's last name
- **Recorder:** Data recorder's last name
- **Lat/Long:** latitude and longitude where the manatees were first seen for this particular sighting
- **Sighting #:** A sighting consists of all the manatees seen in the same location. Ex. If 1 or more manatees are seen in Pansy Bayou, all those manatees are part of the same sighting. The first sighting of the day will be sighting #1, the next will be sighting #2, etc.
- **Air and Water temperature and salinity:** self explanatory
- **Weather:** Choose between: Clear, Partly cloudy, Mostly cloudy, Overcast, or Rain
- **Conditions:** Choose between: Excellent, Good, Fair, Poor
- **Wind:** record direction wind is coming from and estimated speed. Ex. W 10-15
- **Hindrance:** conditions, etc. that are inhibiting the photographer from getting good photos of the manatees. Ex. glare, wind, ripples
- **#Total min:__max:__ :** this should be your best count of ALL manatees present at the site during your observations (sighting). Since it is difficult at times to get an exact number, we use a range (i.e. there were at least 5 and no more than 10). Some circumstances allow us to accurately count every manatee that is present during the sighting. In this case you would put that count in both the min and max.
- **#Calves min:__max:__ :** minimum and maximum number of calves present
- **#Photo'd min:__max:__ :** minimum and maximum number of manatees that were photographed during the sighting
- **#Scarred min:__max:__ :** minimum and maximum number of manatees that had scars or mutilations during the sighting

Information for each individual manatee

Each individual manatee seen during the sighting will have its own data collected and sketch drawn of its scars and mutilations

- **Outline of manatee:** use this to sketch any scars or mutilations that the manatee may have. Other identifiers may also be included, such as barnacles, algae patterns, etc, however SCARS and MUTILATIONS are the most important!!
  - **I.D.**

- ➢ If the manatee is known by the observer (or someone else present), record the manatee's name or catalog number. A temporary ID# for that day will **not** be necessary.
- ➢ If the manatee is unknown, it will receive a TEMPORARY ID# for that day. The temporary ID#s consist of the month, the day of the month, and a sequential letter.
  Ex. The first unknown manatee seen and photographed on 21 June would be 621A. The second unknown manatee seen on that same day would be 621B, etc. The letters will continue throughout the day. DO NOT give a known manatee a temporary ID#.

- **Size Class: AA, SU, CC**: Circle one of these
  AA = adult
  SU = subadult (juvenile). This category should also be given by experienced observed.
  CC = calf
- **Habitat**: Choose between one of the following:
  GB = seagrass bed
  DB = dredged basin; canal, boat basin, or marina with >50% altered shoreline
  DC = dredged channel
  SB = shallow bay/shoal/sand bar (unvegetated and <1.5 m deep)
  OB = open bay (>1.5 m deep)
  TRIB = tributary (river, creek, etc.)
- **ReproStatus**: reproductive status of the manatee. If the manatee is with a calf, record that and an estimated size of the calf. Use the following format for recording this: w/sc = with small calf
- **The remaining blank lines**: Use these lines to record the roll and exposure #s that are being taken of the manatee.
  - ➢ The **roll #** is written as follows: the photographer's first and last initials, the last two digits of the current year, and the roll # that the photographer is on for the current year.
    Ex. **RN0145** = the 45th roll of film that Rachel Nostrom has taken in 2001
  - ➢ The exposure #s are always preceded by the roll #. If multiple shots are taken of a particular manatee on the same roll, all of those exposures should follow the roll # on a single line.
    The roll and exposure numbers should be recorded as follows:
    RN0145: 1-5, 10-12 A series of photos can be recorded with a dash between them to signify exposures 1 through 5 (for example), otherwise exposures should be separated by a comma.

Some general comments

1. When sketching scars and/or mutilations on the manatee outlines:
   - Be as accurate as possible and include any information that may assist later when the slides are sorted for matches.
   - DARKEN in mutilations on the sketch to distinguish them from scars.
   - Note scar color outside of the manatee outline and adjacent to scar patterns. This is especially important for gray scars that may be difficult to discern later when looking at the slides.
   - Note fresh or recent wounds.

2. A manatee's sex is NEVER recorded UNLESS you have visual confirmation. Possible ways of confirmation are:
   - Observing orientation of genital opening relative to its umbilical scar and anus
     Female = genital opening is near the anus (lower, towards the peduncle and tail)
     Male = genital opening is near the umbilical scar (in the middle of its body)

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