West Indian Manatee
(*Trichechus manatus*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region

Jacksonville Ecological Services Office
Jacksonville, Florida

Caribbean Field Office
Boquerón, Puerto Rico

NRC034
June 26, 2012

5-YEAR REVIEW
West Indian Manatee/*Trichechus manatus*

Includes both subspecies:

Florida manatee, *Trichechus manatus latirostris*
Antillean manatee, *Trichechus manatus manatus* (in Puerto Rico and the U.S. Virgin Islands)

TABLE OF CONTENTS

List of Figures

List of Tables

5-YEAR REVIEW

West Indian Manatee/*Trichechus manatus*

Includes both subspecies:

Florida manatee, *Trichechus manatus latirostris*
Antillean manatee, *Trichechus manatus manatus* (in Puerto Rico and the U.S. Virgin Islands)

I. GENERAL INFORMATION

A. Methodology used to complete the review: U.S. Fish and Wildlife Service (FWS, Service, or USFWS) staff from the Jacksonville and Caribbean Ecological Services offices conducted this review. Information sources included current recovery plans, peer-reviewed scientific publications, unpublished reports, unpublished field observations, and information and personal communications from qualified Service, State/Commonwealth and other biologists or experts. Information in the review includes new material and analyses made available after the publication of both recovery plans: the Florida Manatee Recovery Plan – third revision (USFWS 2001) and the Recovery Plan for the Puerto Rico Population of the West Indian (Antillean) Manatee (USFWS 1986).

The federally listed West Indian manatee (*Trichechus manatus*) includes two subspecies: the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*). We have elected to present information separately for the Florida manatee in Chapter One and for Antillean manatees that occur in Puerto Rico and the Virgin Islands in Chapter Two. We present our recommendation/evaluation for the listed entity, the West Indian manatee, in the Results section of this document. We believe this format will allow us to clearly separate and relay the biological information and threats specific to each subspecies, and information from the individual recovery plans to readers of this review. This format is consistent with current recovery planning efforts which rely upon separate recovery plans for each of the subspecies, in acknowledgement of region-specific threats to these animals and their habitats (USFWS 1986, 1989, 1996, 1999, and 2001).

Analyses of the risks of known threats to the persistence of the Florida manatee were conducted through contracts with U.S. Geological Survey (USGS) staff from Patuxent, Maryland and Gainesville, Florida. This work was also done in coordination with staff from the Florida Fish and Wildlife Conservation Commission (FWC). We relied heavily on information from these sources in our review of the Florida population.

B. Reviewers

Lead Regional Office: Southeast Region - Atlanta, Georgia
Kelly Bibb: 404-679-7132

Lead Field Offices: Jacksonville Ecological Services Office - Jacksonville, Florida
Dawn Jennings: 904-232-1580 x 114
Jim Valade: 904-232-2580 x 118
Nicole Adimey: 904-232-2580 x 123

Caribbean Field Office - Boquerón, Puerto Rico
Carlos Díaz: 787-851-7297 x 230

Cooperating Field Offices: South Florida Ecological Services Office - Vero Beach, Florida
Kalani Cairns: 772-562-3909 x 240

Panama City Ecological Services Office – Panama City, Florida
Gail Carmody: 850-769-0552

Georgia Ecological Services Office – Athens, Georgia
Sandy Tucker: 706-613-9493 x 230
Athens Suboffice - Brunswick, Georgia
Strant Colwell: 912-265-9336 x 30

C. Background

C.1. FR Notice announcing initiation of this review: 70 FR 19780, dated April 14, 2005, announced the comment period for a five-year review of the Florida manatee (*Trichechus manatus latirostris*). On March 24, 2006, the Service announced the re-opening and expansion of the review (71 FR 14940) to assess the status of the entire listed entity (*Trichechus manatus*), including both the Florida manatee and Antillean manatees (*Trichechus manatus manatus*) that are found in Puerto Rico and the U.S. Virgin Islands.

C.2. Species status: The West Indian manatee's status was reported as **"**Unknown" for the 2006 FWS Recovery Data Call because the data call was for the species throughout its range, including areas outside of the U.S. and U.S. territories. While the manatee is well known within the U.S. and Puerto Rico, little is known about the species outside of these areas. There is a significant level of uncertainty with regard to threat levels outside of the U.S. and information regarding population size, demographic characteristics, etc., are lacking. Despite the lack of information outside the U.S., current information regarding the status of the Florida manatee suggests that this population is growing in most areas of the southeastern U.S. The Antillean manatee population in Puerto Rico, while not as well studied as the Florida manatee, is also thought to have increased over the past 40 years. Manatees are virtually nonexistent in the U.S. Virgin Islands; sightings and strandings in this area are extremely rare.

C.3. Recovery achieved: A quantified assessment of recovery achieved has not been determined for the Antillean manatee in Puerto Rico. However, an assessment of recovery achieved was determined for the Florida manatee, pursuant to the 2006 FWS Recovery Data Call. In that assessment, recovery achieved was reported as a "3" – implying that up to 75% of the recovery tasks identified in the Florida Manatee Recovery Plan (2001) had been achieved or were continuing to be implemented.

C.4. Listing history:

Original listing

FR notice: 32 FR 4061
Date listed: 1967 - Endangered Species Preservation Act of 1966 80 Stat. 926; 16 U.S.C. 668aa(c)
Entity listed: *Trichechus manatus latirostris* – Florida manatee
Classification: Endangered

Revised listing

FR notice: 35 FR 18319
Date revised: 1970 - Appendix A of 50 CFR 17 was amended to include additional names to the list of threatened and endangered species. This listing incorporated West Indian manatees into the list and encompassed the species' range in the Caribbean and northern South America, thus including both Antillean and Florida manatees in the listing.
Entity listed: *Trichechus manatus* – West Indian manatee
Classification: Endangered

C.5. Associated actions: Critical habitat was designated for the Florida manatee (listed in that regulation as *Trichechus manatus*) in 1976 (50 CFR Part 17.95(a)).

C.6. Review history: Because the manatee was designated as an endangered species prior to enactment of the Endangered Species Act of 1973, as amended (ESA), there was no formal listing package identifying threats to the species, as required by Section 4(a)(1). As such, there was no initial, formal status review nor was a threats analysis conducted; there is no baseline accurately describing the status of manatees at the time of or before listing.

Subsequent to the listing, researchers initiated a series of aerial surveys, a carcass salvage program, and other studies to ascertain the status of the manatee and threats posed to the species. Data from these initiatives were reviewed and summarized at the first manatee workshop conducted in 1978 (Brownell *et al.* 1978). Findings from the workshop were incorporated into the status section of the first manatee recovery plan (USFWS 1980).

Since that time, additional field studies have been conducted in the southeastern U.S. and Puerto Rico to better define threats and the effects that they exert on the status of the manatee. Two additional workshops were held in 1992 and 2002 to review and discuss findings (O'Shea *et al*. [eds.] 1995, Lefebvre *et al.* [eds.] 2002). Additionally, two habitat workshops were conducted in 1999 and in 2004 to address threats to Florida

manatee habitat (USFWS 2000, USFWS *in review*). Recovery plans were published for the Antillean manatee in 1986 and for the Florida manatee in 1989, 1996, and in 2001. These included updated status reviews and threats assessments. Annual recovery data calls have also incorporated status reviews in their inherent requests for current recovery information.

Previous 5-year reviews for *Trichechus manatus* were noticed on July 22, 1985 (50 FR 29903) and on November 6, 1991 (56 FR 56884). In these reviews, different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors, threats, *etc.* as they pertained to the different species' recovery. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. In particular, no changes were proposed for the status of the manatee in either of the reviews.

C.7. Species' Recovery Priority Number at start of review (48 FR 43098): 5C. The "5" indicates a high degree of threat and low recovery potential; the "C" reflects a high degree of conflict.

C.8. Recovery Plan or Outline

Name of plan: West Indian Manatee Recovery Plan (*Trichechus manatus*)
Date issued: April 15, 1980
Date(s) of previous revisions: None

Name of plan: Florida Manatee Recovery Plan (*Trichechus manatus latirostris*), Third Revision
Date issued: October 30, 2001
Date(s) of previous revisions: July 24, 1989 and January 29, 1996

Name of plan: Recovery Plan for the Puerto Rico Population of the West Indian (Antillean) Manatee (*Trichechus manatus manatus*)
Date issued: December 24, 1986
Date(s) of previous revisions: None

II. REVIEW ANALYSIS

CHAPTER ONE - FLORIDA MANATEE

A. Application of the 1996 Distinct Population Segment (DPS) policy

A.1. Is the species under review listed as a DPS? No

A.2. Is there relevant new information that would lead you to consider listing manatees in Florida as a DPS in accordance with the 1996 policy? Not at this time.

B. Recovery Criteria

B.1. Does the Florida manatee have a final, approved recovery plan containing objective, measurable criteria? Yes

B.2. Adequacy of recovery criteria:

B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the subspecies and its habitat? No

Runge *et al.* (2004) reviewed the utility of the 2001 recovery plan criteria from a population modeling perspective. He noted that the measures are largely redundant and that 1) no population can grow at a fixed rate indefinitely; limiting resources will eventually prevent the population from continuing to grow at that rate and the population will ultimately reach stability; 2) the reproductive criterion is difficult to estimate and the modeling results are difficult to interpret; and 3) demographic recovery criteria should be linked to statistically-rigorous field data, as well as to the specific population models that are intended for their evaluation.

In addition to concerns raised in Runge *et al.* (2004), we note that the criteria are applied to each of four subpopulations (see p. 13). Current scientific information indicates that while these may be useful management units, they are not sufficiently distinct to be considered subpopulations. We believe that the criteria should be revised and applied either to each coast of Florida or to the Florida manatee as a whole.

Our recommendations in this review are therefore based on more recent demographic analyses and a threats analysis of the five listing factors, instead of the existing recovery criteria.

B.2.b. Are all of the five listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

Florida Manatee Recovery Plan - Reclassification from Endangered to Threatened

The 2001 Florida Manatee Recovery Plan contains the following criteria for reclassification from endangered to threatened status. The italicized text was taken directly from the recovery plan:

FACTOR A: THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF A SPECIES HABITAT OR RANGE

In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), threats to the manatee's habitat or range must be reduced or removed. This can be accomplished through Federal, State or local regulations (identified in Factor D below) to establish minimum spring flows and protect areas of important manatee habitat:

a. *Minimum flows to support manatees at the Crystal River Springs Complex, Homosassa Springs, Blue Spring, Warm Mineral Spring, and other spring systems, as appropriate, have been identified by State water management districts (WMD) or other organizations in terms of quality (including thermal) and quantity.*

   No minimum flows have been completely established for these important springs; however, this process is underway for a number of them. See **Table 1** for a list of State springs and the year in which the minimum flow rule-making process is scheduled or proposed to begin.

b. *A network of the Level 1 (Primary) and 2 (Secondary) warm-water refuge sites are protected as manatee sanctuaries, refuges or safe havens.*

   All Primary sites, except the Weeki Wachee/Mud Creek/Jenkins Creek complex, have been protected. Secondary sites are variously protected, with some sites continuing to go unprotected and others fully protected. Ten of the 47 total warm-water sites either need protection or are in need of additional protection. See **Table 2** for the list of sites.

c. *Feeding habitat sites associated with the network of warm-water refuge sites above in (b) have been identified by the Habitat Working Group for protection in terms of extent, quantity and quality.*

   While all important warm-water refuge sites within the network have been identified, the Manatee Habitat Working Group has not yet identified nor characterized feeding sites associated with these refuges.

c. *A network of migratory corridors, feeding, calving, and nursing areas must be identified by the Manatee Habitat Working Group and protected as manatee sanctuaries, refuges and/or safe havens in the following Florida counties: Duval (including portions of Clay and St. Johns counties in the St. Johns River), Volusia, Brevard, Indian River, Martin, Palm Beach, Broward, Dade and Monroe on Florida's Atlantic Coast; Citrus, Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee and Collier on Florida's Gulf Coast; and Glades County on the Okeechobee Waterway.*

   The Manatee Habitat Working Group is in the process of identifying a network of migratory corridors and other use areas to ensure protection of feeding, calving and nursing areas throughout the state. Many of these sites are already known in the various counties and are variously protected under the Florida Manatee Sanctuary Act and/or the Federal Endangered Species Act/ Marine Mammal Protection Act.

FACTOR B: OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

"Take" in the form of harassment, is currently occurring at some of the winter refuge sites and other locations. This "take" is presently not authorized under the Marine Mammal Protection Act of 1972, as amended (MMPA), or the ESA.

No criteria were identified for Factor B in the 2001 Florida Manatee Recovery Plan. There are no data at this time to indicate that harassment is limiting the recovery of the Florida manatee. Efforts have been made to minimize harassment at warm-water refuges. The Service has designated sanctuaries at warm-water sites, patrols these areas, and uses its permitting authorities to minimize harassment. Outreach and education programs are also in place to minimize harassment in these areas. Takings related to scientific and educational activities are addressed through the Service's Division of Management Authority. Violations are addressed through law enforcement actions.

FACTOR C: DISEASE OR PREDATION

In light of the fact that disease and/or predation are not known to limit the Florida manatee, no reclassification criteria were identified in the recovery plan. However, diseases, such as the manatee papilloma virus, are being monitored closely through various research efforts, including the Manatee Carcass Salvage program.

FACTOR D: THE INADEQUACY OF EXISTING REGULATORY MECHANISMS

The current legal framework outlined below allows Federal and State government agencies to take both broad scale and highly protective actions for the conservation of the manatee and its habitat. The Service believes the regulatory mechanisms are adequate for recovery. However, additional specific actions under these laws such as those listed pursuant to Factor A and E must be accomplished (as well as meeting the demographic criteria) before the Service will consider this species for reclassification.

Factor A (a) Establish Minimum Flows

STATE Florida Water Resources Act of 1972, Chapter 373, F.S. (specifically Minimum Flows and Levels, Sect. 370.42, F.S. and Establishment and Implementation of Minimum Flows and Levels, Sect. 370.421, F.S.)

Factor A (b)(c) and (d) Protect Important Manatee Habitats

FEDERAL Endangered Species Act; Marine Mammal Protection Act; Clean Water Act, Sect. 401, 402 and 404; Rivers and Harbors Act, Sect. 10; National Environmental Policy Act; and Coastal Zone Management Act;

STATE Florida Manatee Sanctuary Act, Sect. 370.12(2), F.S.; Florida Water Resources Act of 1972, Chapter 373, F.S.; Florida Air and Water Pollution Control Act, Chapter 403, F.S.; State Lands, Chapter 253, F.S.; and State Parks and Preserves, Chapter 258, F.S.; and

LOCAL Florida Manatee Sanctuary Act, Sect. 370.12(o), F.S. which allows local governments to regulate by ordinance, motorboat speed and operations to protect manatees.

Factor E (a)(b)(c) Reduce or Remove Unauthorized "take"

FEDERAL Marine Mammal Protection Act; and Endangered Species Act; and

STATE Florida Manatee Sanctuary Act, 370.12(2), F.S.

State water management districts are processing minimum flow determinations for Volusia County's Blue Spring, Levy County's Fanning and Manatee springs, and Hillsborough County's Sulphur Spring, all springs of significance to manatees. Existing power plant discharges have been made safe for manatees through conditions in Clean Water Act NPDES permits, which insure the presence of warm water when manatees need it most. Addressing anticipated disruptions to these discharges continues to be problematic, although plans are being developed to minimize the effect of these changes on the large numbers of manatees that winter at these sites.

Subsequent to the 2001 Florida Manatee Recovery Plan, there have been numerous additions and improvements to Federal, State and local manatee protection zones throughout peninsular Florida as well as a number of ongoing studies to assess the effectiveness of these protection zones. To reduce unauthorized "take" associated with boat facility construction and the boats that use them, the Service, State, and permitting authorities have developed permitting guidance to minimize the effects of these activities on manatees. In addition, the State of Florida recently drafted a management plan in conjunction with their decision to reclassify the State status of the manatee from "endangered" to "threatened." In addition, numerous counties have adopted manatee protection plans and other manatee protection measures (Section IIC2d)).

Refer to discussions of Factors A and E in this section for additional information.

FACTOR E: OTHER NATURAL OR MANMADE FACTORS AFFECTING ITS CONTINUED EXISTENCE
The most predictable and controllable threat to manatee recovery remains human-related mortality. In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), natural and manmade threats to manatees need to be reduced or removed. This can be accomplished through establishing the following Federal, State or local regulations, tasks and guidelines to reduce or remove human caused "take" of manatees:

a. State safe havens and/or Federal manatee refuges have been established by regulation and are being adequately enforced to reduce unauthorized watercraft-related "take" in the following Florida counties: Duval (including portions of Clay and St. Johns in the St. Johns River), Volusia, Brevard, Indian River, Martin, Palm Beach, Broward, Dade and Monroe on the Florida Atlantic Coast; Citrus, Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee and Collier on the Florida Gulf Coast; and Glades County on the Okeechobee Waterway.

State safe havens and Federal manatee refuges and/or sanctuaries have been established by regulation in each of these counties, with the exception of Glades County, and are being enforced by law enforcement officers.

b. One half of the water control structures and navigational locks listed as needing devices to prevent mortality have been retrofitted.

Over half of the structures and locks have been retrofitted (Section IIC2e).

c. Guidelines have been drafted to reduce or remove threats of injury or mortality from fishery entanglements and entrapment in storm water pipes and structures.

Although no guidelines have been drafted, efforts are underway to reduce this threat (Section IIC2e).

***DEMOGRAPHIC CRITERIA*:** The demographic recovery criteria listed below do not reflect the best available and most up-to-date information on the biology of the species.

The current population benchmarks, as included in the Recovery Plan, are as follows:

a. statistical confidence that the average annual rate of adult manatee survival is 90% or greater;
b. statistical confidence that the average annual percentage of adult female manatees accompanied by first or second year calves in winter is 40% or greater; and
c. statistical confidence that the average annual rate of population growth is equal to or greater than zero.

The Recovery Plan also recommends that these population benchmarks should be achieved with a 95% level of statistical confidence. When they are achieved in each of the four regions for the most recent ten year period of time, the Service may conclude that the manatee is not in danger of extinction throughout all or significant portion of its range and reclassify to threatened, provided the listing/recovery factor criteria (A-E above) are also met.

Florida Manatee Recovery Plan – Removal from the List of Endangered and Threatened Wildlife (Delisting) These were not assessed for this review, as the current demographic criteria are not adequate and we believe, in light of recent research, that all criteria should be reassessed. See Synthesis and Recommendations sections.

The 2001 Florida Manatee Recovery Plan contains the following criteria for removal from the List of Endangered and Threatened Wildlife. These criteria are presented exactly as written in the recovery plan.

LISTING/RECOVERY FACTOR CRITERIA: *Tasks listed with each criterion are examples of actions that may reduce or remove the identified threats.*

Listing/Recovery Factor A: The Present or Threatened Destruction, Modification, or Curtailment of a Species Habitat or Range *(The Warm-water Task Force and Habitat Working Group identified in other portions of this plan are tasked to further refine and improve these criteria.) In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), threats to the manatee's habitat or range must be reduced or removed. This can be accomplished through Federal, State or local regulations to establish and maintain minimum spring flows and protect the following areas of important manatee habitat:*

a. Minimum flow levels to support manatees at the Crystal River Spring Complex, Homosassa Springs, Blue Springs, Warm Mineral Spring, and other spring systems as appropriate, in terms of quality (including thermal) and quantity have been adopted by regulation and are being maintained.(Task 3.2.4.3)

b. A network of level 1 (Primary), 2(Secondary) and 3 (Tertiary) warm-water refuge sites have been protected as either manatee sanctuaries, refuges or safe havens. (Task 1.2.3, 1.3, 3.2.2, 3.2.3, 3.2.4, 3.3.1)

c. Adequate feeding habitat sites (extent, quantity and quality) associated with the network warm-water refuge sites identified by the HWG and are protected. (Task 3.1(3), 3.3.8).

d. The network of migratory corridors, feeding areas, calving and nursing areas identified by the HWG are protected as manatee sanctuaries, refuges or safe havens. (Task 1.3, 3.3.1)

Listing/Recovery Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes *"Take" in the form of harassment, is currently occurring at some of the winter refuge sites and other locations. This "take" is presently not authorized under the MMPA or ESA. However, there are no data at this time to indicate that this issue is limiting the recovery of the Florida manatee. The actions in this plan that address harassment are recommended in order to achieve compliance with the MMPA and ESA and as a conservation benefit to the species. Statutory mechanisms outlined in Factor D to protect and enact protection regulations for important manatee habitats identified in Factor A and enact regulations to address unauthorized "take" identified in Factor E, will also assist to reduce or remove these threats. Recovery actions and their subtasks specifically addressing this issue are 1.1, 1.11, 4.4 and those tasks identified in Factors A, D and E.*

Listing/Recovery Factor C: Disease or Predation *At this time, there are no data indicating that this is a limiting factor, thus no delisting criteria are necessary.*

Listing/Recovery Factor D: The Inadequacy of Existing Regulatory Mechanisms *The current legal framework outlined below allows Federal and State government agencies to take both broad scale and highly protective action for the conservation of the manatee and its habitat. The FWS believes these regulatory mechanisms are adequate for recovery. However, additional specific actions under these laws such as those listed pursuant to Factor A and E must be accomplished (as well as meeting the demographic criteria) before the FWS will consider this species for removal from the List of Endangered and Threatened Wildlife.*

Factor A (a) Establish Minimum Flows (Task 3.2.4.3)

STATE Florida Water Resources Act of 1972, Chapter 373, F.S. (specifically Minimum Flows and Levels, Sect. 370.42, F.S. and Establishment and Implementation of Minimum Flows and Levels, Sect. 370.421, F.S.)

Factor A (b)(c) and (d) Protect Important Manatee Habitats (Task 1.2, 1.3.1, 1.3.2, 1.4, 3.2.2, 3.2.3, 3.2.4, 3.3.1, 3.3.8)

FEDERAL Marine Mammal Protection Act; Clean Water Act, Sect. 401, 402 and 404; Rivers and Harbors Act, Sect. 10; National Environmental Policy Act; and Coastal Zone Management Act;

STATE Florida Manatee Sanctuary Act, Sect. 370.12(2), F.S.; Florida Water Resources Act of 1972, Chapter 373, F.S.; Florida Air and Water Pollution Control Act, Chapter 403, F.S.; State Lands, Chapter 253, F.S.; and State Parks and Preserves, Chapter 258, F.S.; and

LOCAL Florida Manatee Sanctuary Act, Sect. 370.12(o), F.S. which allows local governments to regulate by ordinance, motorboat speed and operations to protect manatees.

Factor E (a)(b)(c) Reduce or Remove Unauthorized "take" (Task 1.1, 1.2, 1.3.1, 1.3.2, 1.4, 1.6, 1.7, 3.3.1)

FEDERAL Marine Mammal Protection Act; and
STATE Florida Manatee Sanctuary Act, 370.12(2), F.S.

Listing/Recovery Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
The most predictable and controllable threat to manatee recovery remains human-related mortality. In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), natural and manmade threats to manatees need to be reduced or removed. This can be accomplished through establishing the following Federal, State or local regulations, tasks and guidelines to reduce or remove human caused "take" of manatees:

a. State, Federal and local government manatee conservation measures (such as, but not limited to speed zones, refuges, sanctuaries, safe havens, enforcement, education programs, county MPPs etc.) have been adopted and implemented to reduce or remove unauthorized watercraft-related "take" in the following Florida counties: Duval (including portions of Clay and St. Johns in the St. Johns River), Volusia, Brevard, Indian River, Martin, Palm Beach, Broward, Dade and Monroe on the Florida Atlantic Coast; Citrus, Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee and Collier on the Florida Gulf Coast; and Glades County on the Okeechobee Waterway. These measures are not only necessary to achieve recovery, but may ultimately help to comply with the MMPA. (Task 1.3, 1.4, 1.5, 3.3.1).

Stable or positive population benchmarks as outlined in the demographic criteria provide measurable population parameters that will assist in measuring the stabilization, reduction, or minimization of watercraft related "take." Two other indices (weight of evidence) will assist in measuring success include: (1) watercraft-related deaths as a proportion of the total known mortality; and (2) watercraft-related deaths as a proportion of a corrected estimated population. These and other indices should be monitored.

b. All water control structures and navigational locks listed as needing devices to prevent mortality have been retrofitted. (Task 1.6)

c. Guidelines have been established and are being implemented to reduce or remove threats of injury or mortality from fishery entanglements and entrapment in storm water pipes and structures. (Task 1.7, 1.6.3)

DEMOGRAPHIC CRITERIA: These were not assessed for this review, as the current demographic criteria are not adequate and we believe, in light of recent research, that all criteria should be reassessed. See Synthesis and Recommendations sections.

The ESA requires that the FWS, to the maximum extent practicable, incorporate into each recovery plan objective, measurable recovery criteria which, when met, would result in a determination that the

species be removed from the List of Endangered and Threatened Wildlife. The Manatee Population Status Working Group thus far has not proposed delisting criteria to the FWS "as specific, quantitative habitat criteria have yet to be developed" (Appendix A). In lieu of criteria from the MPSWG, the FWS will use the population benchmarks for reclassification (downlisting) to help determine the long-term success of manatee conservation efforts and recovery. While these benchmarks are dependent on the amount and statistical reliability of the data available, we believe these "vital signs" are currently the best scientific indicators of the overall health of the manatee population. If future scientific studies indicate that other survival, reproduction, or population growth rates or other population indices are more appropriate for demographic recovery criteria, the FWS will modify these benchmarks.

Those benchmarks are as follows:

- *a. statistical confidence that the average annual rate of adult manatee survival is 90% or greater;*
- *b. statistical confidence that the average annual percentage of adult female manatees accompanied by first or second year calves in winter is 40% or greater; and*
- *c. statistical confidence that the average annual rate of population growth is equal to or greater than zero.*

These benchmarks should be achieved with a 95% level of statistical confidence. When they are achieved in each of the four regions for an additional 10 years after reclassification (an additional manatee generation), we may conclude that the population is healthy and will sustain itself such that the Florida manatee could be removed from the List of Endangered and Threatened Wildlife provided the listing/recovery factor criteria (outlined above) are also met.

C. Updated Information and Current Status

C.1. Biology and Habitat

C.1.a. Spatial distribution, trends in spatial distribution:

Florida manatees can be found throughout the southeastern United States; however, within this region they are at the northern limit of their range (Lefebvre *et al.* 2001). Because they are a sub-tropical species with little tolerance for cold, they remain in the vicinity of warm-water sites in peninsular Florida during the winter. During periods of intense cold, manatees will remain at these sites; during warm interludes, they move from the warm-water areas to feed, and return once again when the water temperature is too cold (Hartman 1979, Stith *et al.* 2007). During warmer months, manatees may disperse great distances. They have been sighted as far north as Massachusetts and as far west as Texas and in all states in between (Rathbun *et al.* 1982, Fertl *et al.* 2005, USFWS Jacksonville Ecological Services Office, unpub. data 2006). Warm weather sightings are most common in Florida and coastal Georgia.

Previous studies of the manatee in Florida refer to four relatively distinct regional "subpopulations": an Atlantic Coast subpopulation that extends along the entire east coast of Florida, into the St. Johns River north of Palatka, and includes the Florida Keys; an Upper St. Johns River subpopulation that occurs in the river south of Palatka; a Northwest subpopulation that extends from the Florida Panhandle south to the Pasco County line; and a Southwest subpopulation that extends from the Pasco

County line south to Whitewater Bay in Monroe County. Each of these "subpopulations" is composed of individual manatees that tend to return to the same warm-water sites each winter and have similar non-winter distribution patterns. Exchange of individuals between these subpopulations is considered to be limited during winter months, based on data from telemetry (Rathbun *et al*. 1990, Reid *et al.* 1991, Weigle *et al*. 2001, Deutsch *et al*. 1998, and 2003) and photo-identification (Rathbun *et al*. 1990; C. A. Beck, USGS FISC Sirenia Project, unpub. data, 2006; and K. Higgs, FWC FWRI, unpub. data, 2006). Exchanges between subpopulations occur during warm seasons and there are some documented cases of wide-ranging coastal movements and isolated events of intercoastal migration (Reid *et al*. 1991, Deutsch *et al*. 1998 and 2003, C. A. Beck, USGS FISC Sirenia Project, pers. comm., 2007).

The use of genetic analyses to assess the "uniqueness" of these subpopulations is underway. Preliminary analyses indicate that these winter groupings are not genetically isolated subpopulations (refer to Section IIC1c). As a result, these four geographic areas are now considered as "management units" instead of "subpopulations" (**Figure 1**).

C.1.b. Abundance, population trends, or demographic trends:

One to three times each winter, a coordinated series of statewide aerial surveys and ground counts, known as the synoptic surveys, are coordinated by FWC to count the number of manatees statewide. The best, current, minimum population estimate of the statewide manatee population is approximately 3,300 animals based on a single statewide count at warm-water refuges and adjacent areas in January 2001 (FWC FWRI unpub. synoptic aerial survey data, 2006). Although surveys have been conducted more recently than 2001, the weather conditions for that particular survey were ideal. As a result, the count from that year still provides the best minimum population estimate.

The most recently published information on Florida manatee population demographics (growth, survival, and reproductive rates) includes studies by Runge *et al.* (2004), Craig and Reynolds (2004), Kendall *et al.* (2004), and Langtimm *et al.* (2004). In 2005, the Manatee Population Status Working Group (MPSWG) completed a biological population assessment of the Florida manatee (MPSWG 2005). As part of that assessment, the group summarized available demographic information, apportioned the statewide population in each region based on the highest synoptic winter survey data from 2001 (**Figure 2**), and summarized sources of mortality for the period 1986 through 2003 (FWC FWRI Manatee Carcass Salvage Program unpub. data 2006). In addition, updated adult survival rates for the Atlantic Coast and Northwest regions are reported in Runge *et al.* (2007). Both of the unpublished reports (MPSWG 2005, Runge *et al.* 2007) include a discussion of methods and the assumptions and uncertainty associated with the parameter estimation. A summary of all of the manatee demographic parameters based on these sources is provided in **Table 3**.

All of these analyses indicate that, with the exception of the Southwest Region, manatees are increasing or stable throughout Florida. Population growth rates as reported by Runge *et al.* (2004, 2007) are as follows: Northwest Region 4.0%, Upper St. Johns River Region 6.2%, Atlantic Coast Region 3.7%, and Southwest Region -1.1%. In southwest Florida, estimates of adult survival and reproduction are less precise than for manatees in the other regions of Florida because the time series of data is comparatively shorter for this region and there are no demographic data available for manatees in the southern-most part of this region. Current estimates could also be biased low due to effects from temporary emigration (Langtimm *et al.* 2004). This is an area for additional research, and will remain one of our highest priorities.

C.1.c. Regional Mortality Analysis

An analysis of the causes of manatee mortality within the four geographic management units was conducted by the Manatee Population Status Working Group (MPSWG 2005) using the State's Manatee Carcass Salvage Program data from 1986 through 2003 (FWC FWRI Manatee Carcass Salvage Program, unpub. data 2006). This analysis provides a "retrospective" assessment of the status of the Florida manatee, by indicating which of the various threats is most problematic in each of the four management units. The detailed results of this analysis are shown in **Tables 4 and 5**. **Table 4** reflects mortality due to *known* causes only. **Table 5** captures the uncertainty around the "undetermined" sources of adult mortality by calculating a minimum, middle, and maximum value for the portion of mortality due to each threat. Each of the manatee death categories is described at http://www.floridamarine.org/features/view_article.asp?id=6780.

In the Northwest Region, adult mortality is almost equally partitioned between human-related and natural causes, with watercraft collision being the leading cause of human-induced mortality. For non-adults, perinatal mortality is the most common cause of death, with watercraft collisions ranked second.

In the Upper St. Johns River Region, the majority of mortality is human-related with watercraft collisions as the leading cause of death for adults. Perinatal mortality is the leading natural cause of death for non-adults, with watercraft collisions ranked second.

The Atlantic Coast Region is similar to the Upper St. Johns River Region, with human-related causes of mortality considerably more common than natural causes for adults. Again, the leading single cause of death in adults is collision with watercraft and for non-adults it is perinatal mortality followed by watercraft mortality.

In the Southwest Region**,** adult mortality is almost equally partitioned among human-related and natural causes. These proportions, however, are influenced by periodic natural mortality events from red tide blooms. For adults, watercraft-related mortality is still the leading single cause of death, although red tide mortality is a close second. Again, perinatal mortality was the leading cause for non-adults, with watercraft mortality ranked second.

C.1.d. Genetics, genetic variation, or trends in genetic variation:

A number of studies have been conducted to assess the genetic lineage and relationships among the various populations of *Trichechus manatus*. García-Rodríguez *et al*. (1998) compared sequences among eight locations across the western Atlantic to resolve the phylogeography of *Trichechus manatus* population structure and status as it occurs throughout its range (from Florida south to coastal Brazil). Their results detected three associated matriarchal lineages or clusters: (I) the "Florida and West Indies cluster"(Florida, Puerto Rico, the Dominican Republic, and Colombia) with four unique haplotypes; (II) the "Gulf of Mexico to Caribbean rivers of South America cluster" (Colombia, Venezuela, and Mexico) with seven haplotypes; and (III), the "northeast Atlantic Coast of South America cluster" (Brazil and Guyana) with four haplotypes (García-Rodríguez *et al*. 1998). They suggested that individuals in cluster I and cluster II were more closely related to individuals in cluster III than to each other; they also suggested that climatic events could explain this occurrence and that these events may have resulted in the isolation of groups over millennia, with the possible consequences of a founder effect (populations originating from a small group of individuals) and inbreeding.

Rodríguez-Lopez (2004) and Vianna *et al*. (2006) used mitochondrial (mt) DNA to identify the various haplotypes of manatees. Only one haplotype (A) was found in the Florida manatee and three were found in manatees from Puerto Rico. According to Vianna *et al.* (2006), no differentiation was found between populations in the Dominican Republic and Puerto Rico, although significant differentiation was observed between the Florida population and the Puerto Rico and Dominican Republic populations, as contrasted with observed differentiation between populations in Brazil, Guyana, and Venezuela.

New genetics research on manatees in Florida and Puerto Rico is currently underway through a collaborative effort between USGS, the University of Florida, FWC, Mote Marine Laboratory, and the Caribbean Stranding Network (R.K. Bonde, USGS Sirenia Project, pers. comm. 2007). This research will provide more conclusive information regarding the frequency of genetic exchange between manatees in these two regions. In Florida, through the use of microsatellites, researchers are now able to fingerprint individual manatees (K. Pause, University of Florida, pers. comm. 2007). Analyses to date show very similar allelic frequencies within and between the four management units, indicating high gene flow throughout the entire Florida manatee population.

C.1.e. Taxonomic classification or changes in nomenclature:

Domning and Hayek (1986) identified separate subspecies of the West Indian manatee in Florida (*Trichechus manatus latirostris*) and the Caribbean (*Trichechus manatus manatus*), based on cranial measurements. The distinctive morphological features are generally thought to be the result of and reflective of population isolation, where certain anatomical features are favored by adaptation. These subspecies will continue to be recognized and used unless future analyses prove otherwise.

C.1.f. Habitat or ecosystem conditions:

Florida manatees are found in freshwater, brackish, and marine environments (**Table 6**). Typical coastal and inland habitats include coastal tidal rivers and streams, mangrove swamps, salt marshes, freshwater springs, and vegetated bottoms (FWC 2005). As herbivores, manatees feed on the wide range of aquatic vegetation that these habitats provide. Shallow grass beds, with ready access to deep channels, are generally preferred feeding areas in coastal and riverine habitats (Smith 1993). In coastal Georgia and northeastern Florida, manatees feed in salt marshes on smooth cordgrass (*Spartina alterniflora*) by timing feeding periods with high tide (Baugh *et al*. 1989, Zoodsma 1991). Manatees use springs and freshwater runoff sites for drinking water; secluded canals, creeks, embayments, and lagoons for resting, cavorting, mating, calving and nurturing their young; and open waterways and channels as travel corridors. (Gannon, *et al*. 2007, Marine Mammal Commission 1986, 1988). As mentioned previously, manatees occupy different habitats during various times of the year, with a focus on warm-water sites during winter.

Manatees have also adapted to changing ecosystems in Florida. Industrial warm-water discharges and deep-dredged areas are used as wintering sites, stormwater/freshwater discharges provide manatees with drinking water, and the imported exotic plant, *Hydrilla sp.* (which has replaced native aquatic species in some areas), has become an important food source at wintering sites (Smith 1993).

C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

Data on manatee mortality in the southeastern United States have been collected since 1974 by the Manatee Carcass Salvage Program (O'Shea *et al.* 1985, Ackerman *et al.* 1995, Lightsey *et al.* 2006). Based on these data, the major threats to the population are readily apparent. The primary human-

related threats include watercraft-related strikes (direct impact and/or propeller) which cause injury and death (Rommel *et al.* 2007, Lightsey *et al.* 2006), entrapment and/or crushing in water control structures (gates, locks, *etc*.), and entanglement in fishing lines, crab pot lines, *etc.* Natural threats include exposure to cold and red tide. Mortality associated with these natural threats are cold stress syndrome and brevitoxicosis, respectively.

There is a substantial fraction of carcasses that cannot be identified as to cause of death. These "undetermined" causes can be the result of a carcass that is too decomposed to diagnose, a carcass that was reported but never retrieved, or if there is no specific factor or set of factors identified as the cause of death. In addition, "perinatal" mortality is used to describe manatees that are less than or equal to 150 cm in length and whose death cannot be attributed to one of the known human-related causes – these small manatees die at or near the time of birth.

An analysis of threats to the manatee population was done both qualitatively and quantitatively for this review. The qualitative approach used the five factors from the ESA, as discussed below in Section IIC2a-e. The quantitative approach was essentially a comparative population viability analysis that involved forecasting the Florida manatee population under different threat scenarios. Threats used in those analyses included watercraft collisions and anticipated losses of warm-water habitat, among others. A customized population model for the Florida manatee, referred to as the Manatee Core Biological Model (CBM) (Runge *et al.* 2007), was the framework used for that analysis (Runge *et al.* 2007); this quantitative approach is discussed in detail below in Section IIC2f.

C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

The Florida manatee has not experienced any curtailment of its range throughout the southeastern U.S. It has, however, experienced a shift in its winter distribution. Manatees are sub-tropical animals and require stable, long-term sources of warm water during cold weather. Prolonged exposure to cold water temperatures can result in debilitation and/or death due to "cold stress syndrome" (Bossart *et al*. 2004, Rommel *et al.* 2001). Historically, manatees relied on the warm, temperate waters of south Florida and on natural warm-water springs scattered throughout their range as buffers to the lethal effects of cold winter temperatures. In part, as a result of human disturbance at natural sites (Laist and Reynolds 2005a, b), manatees expanded their winter range to include industrial sites and their associated warm-water discharges as refuges from the cold. Today, nearly two-thirds of the manatee population winters at industrial warm-water sites, which are now made up almost entirely of power plants (FWC FWRI, unpub. synoptic aerial survey data, 2007).

A significant habitat threat to the Florida manatee is the potential loss of warm water at power plants and natural, warm-water springs (Laist and Reynolds 2005a, b). Natural springs are threatened by potential reductions in flow and water quality and by factors which affect manatee access and use of the springs (Florida Springs Task Force 2001). Power plants, which provide winter refuges for a majority of the Florida manatee population, are not permanent reliable sources of warm water. In the past, some industrial sources of warm water have been eliminated due to plant obsolescence, environmental permitting requirements, economic pressures, and other factors (USFWS 2000). Experience with disruptions at some sites has shown that some manatees can adapt to minor changes at these sites; during temporary power plant shutdowns, manatees have been observed to use less preferred nearby sites. In other cases, manatees have died when thermal discharges have been eliminated due to behavioral persistence or site fidelity (USFWS 2000).

Since publication of the Florida Manatee Recovery Plan in 1989, a number of conservation actions have been initiated to protect manatee habitat and improve our understanding of manatee habitat needs. All of the important warm-water refuges used by manatees have been identified, and all but one of the Primary sites are currently protected **(Table 2).** A springs study is underway to identify those in need of improvement or restoration to enhance manatee use. The spring run at Homossassa Springs was dredged in 2006 to improve manatee access; since dredging, studies indicate that the run has been attracting more animals (C. Taylor, Wildlife Trust, pers. comm. 2007). Reductions in spring flows are being addressed through the adoption of minimum flow regulations. A minimum spring discharge rate that considered the estimated flow rates necessary to support overwintering manatees, has been identified for Volusia County's Blue Spring and is expected to be adopted, pending the St. Johns River Water Management District's acceptance of a monitoring plan currently under development. Similarly, other springs used by manatees have been scheduled for, or are in the process of, developing minimum flow regulations. Those requirements would assure that adequate flows are met to support manatees. The State water management districts maintain a schedule that identifies projected time frames for establishing minimum flows at springs **(Table 1)**.

For now, potential changes in the availability of warm water from power plants are linked to fuel availability, mechanical failure, environmental catastrophes (hurricanes), and other factors. At some point in the future, power plants now used by manatees will be closed (Laist and Reynolds 2005a, b). It is believed by these authors, and others on the Warm Water Task Force, that "the retirement of older power plants in the next 10 to 20 years will eliminate discharges on which most Florida manatees now depend for winter survival," and that "the loss of major power plant outfalls could result in a substantial decline in manatee abundance along the Atlantic Coast and in southwestern Florida" (Laist and Reynolds 2005a, b).

We are planning *now* to alleviate this potential loss of industrial warm-water refugia. We are working with the State and our industry partners to abate any future loss of numbers of manatees from industrial sites by seeking long term successful implementation of sustainable alternatives. The "Recommendations for Future Manatee Warm-water Habitat" (in prep.), developed by the Warm Water Task Force, identifies the need for short-term alternatives, and for sustaining manatees in the long term without their reliance on industrial warm water sources. The Action Plan contains recommendations for obtaining necessary funding for pilot studies. The Service has begun working with agency partners to enhance access to specific spring systems, and to establish minimum flows for spring systems important for overwintering manatees. This should provide manatees with access to additional natural warm-water sites.

[Note that issues related to the sufficiency/inadequacy of regulatory mechanisms to address warm water habitats are discussed further under Factor D in Section IIC2d].

Although natural forage has diminished in some locations due to human activities (including reductions in water quality, outright destruction of forage from coastal and riverine construction activities, waterborne recreational and commercial activities, *etc.*) and exotic forage has increased in other areas, the availability of forage is not known to be a limiting factor for manatees at this time (Orth *et al*. 2006; G.A.J. Worthy, University of Central Florida, unpub. data 2006). Efforts are underway to improve water quality, minimize construction-related impacts and to minimize the loss of seagrasses due to prop scarring. Efforts are also being made to replant areas devoid of seagrass. As such, the rate of seagrass loss in many areas has slowed and many other areas, such as Tampa Bay, are experiencing regrowth in areas once characterized by seagrass loss.

In addition to conservation actions, there are a number of studies underway to assess manatee habitat use and to identify additional areas of importance to manatees for feeding, calving, resting and migrating. Service studies are investigating manatee carrying capacity at warm-water sites (J.A. Powell, Wildlife Trust, pers. comm. 2006) and yet others are assessing manatee warm water use and travel patterns during the winter (FWC FWRI, unpub. data 2006; Gannon *et al*. 2007; USGS FISC Sirenia Project, unpub. data 2006). The recovery team's Manatee Habitat Working Group is conducting an assessment of manatee wintering habitat throughout Florida. Other studies are evaluating impacts associated with Comprehensive Everglades Restoration Plan (CERP) activities on manatees that utilize the project area.

In summary, habitat requirements for manatees are quite complex. A significant threat to manatee habitat is the potential loss of natural and man-made warm-water refugia. Power plant discharges used by large numbers of wintering manatees can be disrupted and flows at natural springs can be reduced due to human consumption of groundwater. We are making progress in addressing this potential threat. The Service and the State are working together and coordinating with other agencies and industry to address possible warm water loss from a variety of angles – including seeking alternative sources of warm water in the short term, and restoring major springs to provide access to natural sources of warm water for the long term. This issue will continue to remain one of our highest priorities.

C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

Florida manatees are used for a variety of commercial, recreational, scientific, and educational purposes. Recreationally, people seek out opportunities to interact with manatees. Interactions may include viewing, provisioning, and swimming with manatees (which may occur independently or through the services of commercial dive shops) (Reynolds and Wells 2003). Non-lethal, scientific field and captive studies of manatees occur routinely (Reynolds 1999). Stranded carcasses are generally salvaged and scientists use the specimens to ascertain causes of death; tissues and other materials harvested from carcasses are also used for various studies (USFWS Division of Management Authority, unpub. data 2007). Manatees held at rehabilitation facilities may be in public displays to educate the public about manatees and manatee conservation activities (USFWS Manatee Rescue Rehabilitation and Release Program Database, unpub. data 2007). Poaching is not a threat to the Florida population.

With the exception of passive viewing and provisioning, uses on Service lands are regulated through Service National Wildlife Refuge (NWR) Special Use Permits. In other areas, some uses are regulated by Joint Endangered Species Act (ESA)/Marine Mammal Protection Act (MMPA) Marine Mammal Scientific Research Permits, and/or Joint ESA/MMPA Marine Mammal Enhancement Permits. These regulatory mechanisms authorize well-defined, limited, non-lethal takings of manatees.

Feeding manatees is against both Federal and State law – it is considered a form of "harassment" under the ESA and MMPA and the Florida Administrative Code (68C-22.002, FAC). In addition to law enforcement activities, extensive outreach initiatives exist to address these activities. In the case of "swim with" interactions, people generally swim with manatees during the winter when animals are locally abundant near aggregation sites. Citrus County, Florida, is the principal area where this activity occurs. People swimming with manatees in this area either engage in this activity independently or through the services of commercial dive shops. Recently there has been significant public interest

associated with these activities. FWS and FWC continue to implement efforts to minimize harassment.

Individuals are not authorized to initiate encounters with manatees (J. Kraus, Crystal River NWR, pers. comm. 2006). While manatees do react to swimmers, this activity is not thought to significantly affect the manatees' well-being (Sorice *et al*. 2003), as evidenced by increasing numbers of manatees using the wintering sites and healthy adult survival rates in the region. Given this evidence, we do not believe that activities described in this section significantly affect Florida manatees.

C.2.c. Disease or predation:

Viral papillomatosis was discovered in several captive Florida manatees in 1996 (Bossart *et al.* 2002); however, investigations to date have not determined this to be a threat to the manatee population. Research on this issue is continuing (Bossart *et al.* 2006; R.K. Bonde, USGS Sirenia Project, pers. comm. 2007).

Barring post-mortem (after death) predation by sharks and alligators, there are no documented cases of lethal, natural predation on Florida manatees. As such, predation does not present a threat to the manatee population.

At this time, this factor is not considered to significantly affect the recovery of Florida manatees.

C.2.d. Inadequacy of existing regulatory mechanisms:

Manatees are protected directly and indirectly through a number of Federal, State, and local laws. A complete summary of these regulatory mechanisms is shown in **Table 7**. The effectiveness of these statutes will be assessed in the context of the other factors and included in the Synthesis and Results sections later in this review.

The primary regulations at the Federal level are the Endangered Species Act of 1973, as amended (ESA), and the Marine Mammal Protection Act of 1972 (MMPA). At the State level, the Florida manatee is currently listed as endangered under Rule 68A-27.003, F.A.C. The FWC has recently proposed to reclassify the Florida manatee, pursuant to State listing criteria, from endangered to threatened (FWC 2006a). State definitions of endangered and threatened are not analogous to the Federal definitions. The proposed reclassification is expected to be adopted, pending State approval of a Florida Manatee Management Plan. FWC recently completed a draft of the management plan (FWC 2006b). The draft was released for public comment on November 9, 2006, and is expected to be finalized in 2007. The management plan describes the State's manatee conservation goals, and identifies specific regulatory actions with timeframes needed to provide adequate protection for manatees statewide. The Service's continued coordination with the State to implement their management plan for the conservation of manatees will be pivotal to the future viability of the manatee in Florida.

One important State regulatory mechanism specific to manatees is the Florida Manatee Sanctuary Act of 1978. This Act established Florida as a refuge and sanctuary for manatees. The Act protects manatees from injury, disturbance, harassment, or harm in the waters of Florida and allows for enforcement of boat speeds and operations in areas where manatees are concentrated. Since 2001, there have been numerous changes to State, Federal, and local manatee protection zones throughout peninsular Florida to provide more protection to manatees.

State laws also provide a regulatory basis to protect spring flows. However, specific regulations to ensure sufficient flows to many springs that provide important habitat for manatees have yet to be adopted. Similarly, overarching State and Federal laws could require mitigation for power plant discharges. However, specific requirements and contingency plans to address the loss or modification of individual sources have not been established.

In summary, there are a number of regulatory mechanisms in place at the Federal, State and local levels specifically intended for the protection of manatees in Florida (**Table 7**), and there are a number of others that provide an indirect benefit to manatees. State and Federal agencies continuously coordinate on the implementation of adequate regulations for manatee conservation. Studies are ongoing to evaluate the effectiveness of existing regulatory mechanisms (see Section IIC2e) using an adaptive management approach. Regulatory actions to protect manatees will continue to be developed, monitored and improved. Any future actions will be based on the best available information.

C.2.e. Other natural or manmade factors affecting its continued existence:

Primary human-related threats include watercraft-related strikes (impacts and/or propeller strikes), entrapment and/or crushing in water control structures (gates, locks, *etc.*), and entanglement in fishing lines, crab pot lines, *etc.*, all of which may cause injury and/or death.

Watercraft Strikes

The greatest human-related threat to manatees in Florida is collisions with boats, based on mortality data from the Manatee Carcass Salvage Program (O'Shea *et al.* 1985, Ackerman *et al.* 1995, Wright *et al.* 1995, Deutsch *et al.* 2002, Lightsey *et al*. 2006, Rommel *et al.* 2007). The primary conservation action in place to reduce the risk of manatee injury and death from watercraft collisions is a limitation on watercraft speed. The rationale behind this is that a slower speed affords both manatees and boaters additional response time to avoid a collision. Furthermore, if an impact occurs, the degree of trauma will generally be lessened if the colliding boat is operating at slower speeds.

Federal, State, and local speed zones have been established and/or significantly revised in 26 counties (**Table 7**). In Brevard and Lee counties, where watercraft-related mortality is among the highest reported, speed zone regulations were substantially revised and areas posted to improve manatee protection. In addition, of the thirteen counties identified in 1989 as in need of manatee protection plans, all but two have approved plans. Palm Beach and Broward counties are currently seeking agency approval of their adopted plans. Two additional counties, Clay and Levy, have proactively developed their own MPPs. Implementation of these protective measures will at least stabilize if not reduce the mortality rate from watercraft collisions. This issue is one of our highest priorities, and we will continue using an adaptive management approach to ensure this threat is under control.

Research efforts are continuing to improve our understanding of manatee/boater interactions and this review only cites more recent studies among the voluminous amount of literature on this subject.

The FWC and FWS have been working together to review previous studies and design new ones to assess the effectiveness of existing speed zone regulations. Ongoing projects (FWC 2007) include the use of a boat pattern simulator (R.O. Flamm, FWC FWRI, unpub. data 2006), aerial surveys designed to detect changes in boating patterns once an area is posted with speed regulations (R.O. Flamm, FWC FWRI, unpub. data 2006), an analysis of watercraft planing speed (J. Viera-Atwell, FWC FWRI, unpub. data 2006), and a statistical technique termed "change point analysis" (Fonnesbeck 2007).

Recent efforts are also focusing on "before and after" studies to look at the difference in boat traffic patterns prior to and following the establishment of speed zones (Gorzelany 2003, Gorzelany and Flamm 2004, and Laist and Shaw 2005). So far, results of compliance studies have shown that there is better compliance among boaters in the presence of law enforcement and a "halo effect" (boater compliance following the recent presence of law enforcement) remains in the area for about two weeks following enforcement activities (J. Gorzelany, Mote Marine Laboratory, pers. comm. 2006).

In addition, there are studies on the behavioral response of manatees to vessel traffic, such as whether or not manatees can effectively detect and localize boat noises (Gerstein 1999, Mann *et al.* 2007) and at what distances from oncoming boat(s) does a manatee respond (or not respond) (Nowacek *et al.* 2004). Other studies have recorded the behavior and distribution of manatees prior to and following the placement of a speed zone (Taylor *et al.* 2004 and 2005). Studies of boater behavior and boating use patterns have also been conducted (Sidman and Flamm 2001, Aipanjiguly *et al.* 2003, Sidman *et al.* 2004, and Keane 2004), and research is continuing to investigate boater compliance with regulations (Wright *et al.*1995, Shapiro 2001, Tyson 2001, Gorzelany 1998, 2000, 2001, 2002, 2004 and Sorice *et al.* 2004).

The FWC recently received funding to conduct a comprehensive inventory of watercraft facilities throughout Florida (F.J. Sargent, FWC FWRI, pers. comm. 2006). This project will determine the need for additional watercraft access facilities in the state, and data will be used to assist managers in their efforts to minimize boating conflicts with manatees.

The State is also funding research on technological solutions to reduce the risk of watercraft collisions with manatees. Research funded to date includes projects designed to improve the detection of manatees (through detecting the presence/absence of manatee vocalizations, use of infrared thermal imaging equipment, sonar imaging, *etc*.), as well as the development of a manatee alerting device (E.M. Haubold, FWC FWRI, pers. comm. 2006).

Efforts are also underway to improve signage and to increase the numbers of both State and Federal law enforcement officers on the water for better enforcement and boater compliance. In 2006, with the encouragement of stakeholders, the Service and FWC announced a new joint effort to encourage boaters to report accidental watercraft collisions with manatees. This effort is intended to improve rescue response and to provide a better understanding of the circumstances involved in manatee-boat strike incidents. This information will provide important insights that will be incorporated into management activities focused on reducing this threat.

Entrapment and Crushing in Water Control Structures

This threat to manatees was first recognized in the 1970s (Odell and Reynolds 1979), and measures were immediately implemented to address manatee mortality. While initial measures were mostly ineffective, recent advances in protection/detection technology have nearly eliminated this threat to Florida manatees. The most recent 5-year average for manatee deaths at structures and locks is 2.6 manatee deaths per year as opposed to 7.6 manatee deaths per year during the preceding 15 years (R.R. Mezich, FWC ISMS, pers. comm. 2006). **Table 8** includes a list of all navigational locks and water control structures, their locations, and the dates when they have been or will be retrofitted. Nearly all have been completed, and the few remaining to be retrofitted will be completed within the next few years. We believe that the threat of crushing and entrapment in water control structures will soon be eliminated.

Entanglement in Fishing Gear
The hazards of lost and improperly discarded fishing gear (especially crab traps and monofilament fishing line) have been a continuous problem for manatees, albeit a small source of mortality. Rescues associated with entanglement constituted 25% of all manatee rescues between 1991 and 2005. Much has been accomplished in recent years toward reducing the threat of entanglement. An Entanglement Working Group, comprised of agency representatives and stakeholders, was developed by the Service in 1999. This group routinely conducts derelict crab trap removals and assists other organizations planning similar clean ups (J.J. Dodson, FWC Marine Fisheries Management Section, pers. comm. 2006). Members also conduct a monofilament recycling program and engage in extensive education and outreach efforts, including workshops and the development and distribution of outreach materials to increase awareness of monofilament entanglements and to promote the recycling program.

Environmental Processes
The most common environmentally-induced source of mortality in manatees is due to a naturally-occurring toxin from the red tide dinoflagellate, *Karenia brevis*. Manatees may be exposed to this brevetoxin through inhalation and/or ingestion (Bossart *et al*.1998). "Red tide" epizootic events are the highest single cause of manatee mortality in certain years, and are considered as periodic catastrophic events in modeling predictions of future survival, particularly for the Southwest Region. The most severe effect of red tide on manatees was in 1996, when there was a mass mortality of 149 animals in the Southwest Region. The critical circumstances contributing to high numbers of red tide-related deaths are concentration and distribution of the red tide, timing and scale of manatee aggregations, salinity, and timing and persistence of the bloom (Landsberg and Steidinger 1998).

New analyses (such as ELISA or Enzyme-Link Immunosorbant Assays) show that brevetoxin exposure is a continuous source of low-level mortality even in the absence of significant red tide blooms (S.L. McDonald, FWC FWRI, pers. comm. 2006). The consistent presence of red tide events on Florida's west coast has prompted additional field training for agency personnel to improve awareness and monitoring activities. A Florida Harmful Algal Bloom Task Force has conducted extensive research and monitoring on the effects of harmful algal blooms on natural resources and human health (Steidinger *et al*. 1999). When red tide exposure to manatees has not been extensive, animals can be rescued, treated for the short term in captivity, and successfully released (USFWS Manatee Rescue Rehabilitation and Release Program Database, unpub. data 2007).

In addition to red tide events, live manatee strandings and reduced adult manatee survival rates can be attributed, in part, to hurricanes and winter storms (Langtimm and Beck 2003, Langtimm *et al.* 2006). While no deaths have been directly attributed to such events, Langtimm and Beck (2003) suggest that both direct and indirect mortality (from strandings, debris-related injuries, being swept offshore, *etc.*) and/or emigration associated with hurricanes and storms may cause a decrease in adult survival rates. New research has proposed that increased hurricane activity may affect the severity of red tides (Hu *et al*. 2006).

C.2.f. Prospective Threats Analysis
As mentioned in Section IIC2, and in addition to the mortality analysis referenced in Section IIC1c, Runge *et al.* (2007) conducted a "prospective" assessment of the risk of known threats on the persistence of the Florida manatee. This effort was essentially a comparative population viability analysis that considered the demographic effects of the major threats to Florida manatees, and evaluated how those demographic effects influence the probability of quasi-extinction. We chose to

use a measure of quasi-extinction instead of actual extinction to be more conservative. Quasi-extinction is defined as a particular threshold below which the species is not expected to persist (due to genetic, demographic, or behavioral reasons).

The analysis involved forecasting the manatee population under different threat scenarios. We believe that this type of risk assessment is extremely useful for assessing the status of a listed species, as "threatened" and "endangered" as defined under section 3 of the ESA (16 USC § 1532 (6),(20)). This type of assessment also provides guidance for identifying the most beneficial and effective management actions.

The modeling framework used for the threats analysis was a customized population model for the Florida manatee, referred to as the Manatee Core Biological Model (CBM). A more detailed description of the modeling methods and the parameters used, as well as a discussion of the assumptions, process variation (environmental, demographic, and catastrophic stochasticity), and parametric and structural uncertainty associated with the analysis is provided in Runge *et al.* (2007).

Data from the Manatee Carcass Salvage Program, 1986-2004 (FWC FWRI Manatee Carcass Salvage Program, unpub. data 2006) were used by these authors to estimate the *fractions of mortality* due to each of five known threats: watercraft strikes, loss of warm-water habitat, red tide, entrapment and crushing in water control structures, and entanglement. These are the first estimates for fractions of mortality based on a full statistical model that accounts for the carcasses in the "undetermined" category of the Manatee Carcass Salvage Program's database (Fonnesbeck and Runge 2007).

The model essentially expresses the contribution of each threat as it affects manatee persistence, by removing them, one at a time, and comparing the results to the "status quo" scenario. The "status quo" represents the population status in the continued presence of *all* of the threats, including the threat of the potential loss of warm water in the future due to power plant closures and the loss of springs and/or reduction in spring flows. Estimates for the projections of future warm water loss were previously developed by an expert panel in 2002-2003 (Runge 2004).

The threats due to watercraft, water-control structures, and entanglement were each "removed" by reducing the regional mortality of adults and calves by the estimated fractions of mortality. The threat due to loss of warm water was removed by assuming that the winter warm-water capacity for manatees will remain at current levels for the indefinite future. The threat of red tide was removed by setting the probability of occurrence of a *major* red tide event to zero; low background levels of red tide mortality that occurs each year were already incorporated into the baseline. The various scenarios were considered as "all or nothing;" either a particular threat was present at its current level (and remained at that level indefinitely), or it was removed completely. Thus, this comparison provides a measure of the relative effect of each threat on the status of the Florida manatee population. The results are based on 5000 model replicate sets.

Under the *status quo* scenario, the statewide manatee population is expected to increase slowly for the next 10 to 15 years, then decline as a result of the loss of warm-water capacity (**Figure 3**). The initiation of that threat was delayed by 15-40 years, a time frame suggested by the Service's Warm Water Task Force. As the warm-water capacity eventually stabilizes at some lower level in about 50 years, the manatee population will then stabilize over time. Under this scenario, the model predicts that it is unlikely (< 2.0% chance) the statewide population will fall below 1000 total individuals over the next 100 years, assuming the current threats remain at their current levels indefinitely. The

probability of quasi-extinction for the statewide *total* population is very small (**Figure 4**). Outright extinction did not occur in the model replications and, in the model runs, the total population size never fell below 300 individuals.

Removal of each of these threats changes the projected population size considerably, but in quite different ways (**Figure 5**). Removal of watercraft mortality allows the population to grow more quickly in the short term, but then it declines somewhat after about 20 years as a result of the effect of warm water loss. However, because of the higher intrinsic growth rate of the population, the population is more resilient and can recover more quickly from other potential threats. The population is able to maintain a greater total size in the long-term relative to the status quo, even with the same warm water limitation. In contrast, removal of the threat of warm water loss provides a buffer to the population against other threats. The population increases slowly over time and stabilizes at a much higher level (mean > 4500) than either the status quo or the no watercraft collision scenarios. Because watercraft mortality still occurs, however, there is no change in the intrinsic growth, and the population cannot rebound as quickly. Thus, these two threats operate in different ways and over different time scales, and removal of them produces quite different consequences.

Results for each threat scenario (status quo, plus removal of each of the five threats, one at a time) were also expressed as probabilities of quasi-extinction over different time frames and for different levels of *effective population size* (or its surrogate, adult population size). This analysis was conducted for two "coastal" regions of Florida – an East Coast (Upper St. Johns River and Atlantic Coast) Region, and a Gulf Coast (Northwest and Southwest) Region. For example, the status quo scenario in **Figure 6** shows about a 26% to 33% probability that the effective population size could fall below 500 adult manatees within 100 years for the East Coast and Gulf Coast, respectively. The major threat to manatees in both regions is clearly watercraft-related mortality. Removal of this one threat alone would reduce the quasi-extinction probability by an order of magnitude – this is particularly evident on the Gulf Coast. On the East Coast, the loss of warm water is more of a threat to the population than it is on the Gulf coast. The other threats (water control structures, entanglement, and red tide) are of substantially less impact; on the East Coast, red tide is not identified as a substantial threat.

Runge *et al.* (2007) combined the coastal analyses to provide an overall measure of status; quasi-extinction was then calculated as the probability that either coastal region would fall below some particular threshold (**Figure 7**). This was to evaluate the persistence of manatees on either coast of Florida because we envision a recovered population would exist on both coasts. Thus, using the example above, the probability that the effective population size could fall below 500 adults on *either* coast within 100 years under the status quo scenario is close to 50% (higher than the individual coastal probabilities given above). **Figure 8** and **Table 9** show the combinations of scenarios for the probability of the effective manatee population falling below certain thresholds over time. We looked at quasi-extinction levels of 100, 250, or 500 manatees on *either* coast of Florida for this analysis.

If threats remain at the status quo, there is about an 8.6% probability of falling below a threshold of 250 adults on either coast within 100 years (**Table 8**). The scenarios presented in **Table 9** also show that watercraft-related mortality is the single largest threat to the Florida manatee population statewide. Removal of watercraft-related mortality alone results in a 20-fold reduction from the status quo in the probability of the effective population falling below 250 adult manatees on either coast in 100 years (from 8.6 to 0.4%). Removal of the threat of loss of warm water reduces the probability of falling below 250 adults to half that of the status quo (from 8.6 to 4.2%). Runge *et al.* (2007) also

present a matrix of how various combinations of threat removal affect the persistence of the Florida manatee.

D. Synthesis

Recovery efforts for the Florida manatee are highly complex, given the tremendous amount of controversy and conflict associated with ensuring the persistence of this species. Increasing human population growth and related development in Florida, increases in recreational boating activity, and anticipated changes in the network of warm water sources pose significant challenges.

Current recovery criteria for the Florida manatee are flawed and need to be updated based on the definitions in the ESA and significant recent improvements in science allowing the Service to better assess and quantify threats on the viability of the subspecies.

Florida manatees are exhibiting positive population growth rates on the Atlantic Coast, in the upper St Johns River, and in the Northwest regions of peninsular Florida. Manatee populations in southwest Florida may be slightly declining though statistical confidence intervals are broad. The minimum estimate of the statewide population is approximately 3,300 animals.

The threats analysis indicates that the most significant threats to Florida manatees are collisions with boats and potential loss of warm water habitat throughout the state. In southwest Florida, red tide in combination with other threats such as watercraft collisions and the potential loss of warm water sites results in negative synergistic effects to population size in this part of the state.

Broad regulatory frameworks exist at both the federal and state levels to address the watercraft threat. Extensive on-the-water regulatory measures are in place to minimize the potential for collisions with boats. However, these measures are not sufficiently effective to prevent a decline of manatees in southwest Florida because of the combined effect of other threats (*i.e.*, red tide).

Efforts to protect and ensure the long term availability of warm water sources have been initiated but measures are not in place. Failure to protect existing sources or to provide secure surrogate habitats for the long-term could lead to a future decline in the Florida manatee population, reduced long term carrying capacity, and an elevated risk of extinction on either coast of Florida.

II. REVIEW ANALYSIS

CHAPTER TWO – ANTILLEAN MANATEE (IN PUERTO RICO AND THE U.S. VIRGIN ISLANDS)

A. Application of the 1996 Distinct Population Segment (DPS) policy

A.1. Is the subspecies under review listed as a DPS? No

A.2. Is there relevant new information that would lead you to consider listing manatees in Puerto Rico as a DPS in accordance with the 1996 policy? Not at this time.

B. Recovery Criteria

B.1. Does the subspecies have a final, approved recovery plan containing objective, measurable criteria? No

There is a final, approved recovery plan for the Antillean manatee in Puerto Rico, although the plan is outdated (1986) and does not include objective, measurable criteria. The plan only includes criteria that vaguely describe under what circumstances and when delisting should be considered: "Delisting should occur when the population is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes and stochastic and catastrophic events."

B.2. Adequacy of recovery criteria:

B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the subspecies and its habitat? No

B.2.b. Are all of the 5 listing factors that are relevant to the subspecies addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? No

The current Recovery Plan for the Puerto Rico Population of the West Indian (Antillean) Manatee was completed in 1986 and does not include an in-depth discussion of the five factors similar to those found in more recently published recovery plans.

B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The only recovery criterion in the 1986 recovery plan states that "delisting should occur when the population is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes and stochastic and catastrophic events." The plan does include three objectives and 18 supporting tasks. The objectives are: 1) identify, assess, and reduce human-related mortality, especially that related to gill net entanglement; 2) identify and minimize alteration, degradation, and destruction of important manatee habitats important to the survival and recovery of the Puerto Rico manatee population; and 3) develop the criteria and biological information necessary to determine whether and when to reclassify (*i.e.*, either de-list or change status to "threatened") the Puerto Rico population of manatees (USFWS 1986). Progress toward accomplishing these objectives is described in Section IIC2.

C. Updated Information and Current Status

C.1. Biology and Habitat

C.1.a. Spatial distribution, trends in spatial distribution:

The spatial distribution of manatees in Puerto Rico has been described by several researchers and is based primarily on manatee sighting locations obtained during aerial distribution surveys (Magor

1979, Powell *et al.* 1981, Rathbun *et al.* 1985, Freeman and Quintero 1990, Mignucci-Giannoni *et al.* 1989, Mignucci-Giannoni *et al.* 2000, 2003, and 2004, USFWS Caribbean Field Office, unpub. data 2006). Given the rarity of manatees in the U.S. Virgin Islands, manatee use of this region has not been assessed and is poorly understood. All of the studies suggest that manatees in Puerto Rico are more commonly observed in coastal areas from San Juan, eastward to the east coast, (and including Vieques Island) and then south and west, past Jobos Bay, to the west coast, and then about as far to the northwest as Rincon **(Figure 9)**. Manatees are concentrated in several "hot spots" including Ceiba, Vieques Island, Jobos Bay and Boquerón Bay, and are less abundant along the north coast, between Rincón and Dorado. A lack of secluded embayments, fresh water sources, and shallow seagrass beds may limit manatee use of the north coast; this area also has a short coastal shelf and is exposed to heavy surf (Powell *et al.* 1981). It is thought that manatee distribution in other areas is mostly related to the presence of protected waters in coastal embayments or cays, forage, and the presence of fresh water sources.

In cooperation with the Service, staff from USGS captured and tagged 31 wild manatees at the Roosevelt Roads Naval Station (RRNS), the Guanajibo River, Boquerón Bay, and Guayanilla Bay (Slone *et al*. 2006). These manatees were variously tracked for over 14 years, from April 1992 to June 2006. Manatee tracks aided in the identification of manatee use areas (**Figure 9**) and demonstrated a variety of behaviors. In particular, some of the tagged manatees demonstrated very restricted movement patterns (*e.g.* only within Guayanilla Bay or Ensenada Honda inside RRNS) and others demonstrated wide-ranging movement patterns (*e.g*. travel from Guanajibo to Guánica and back). Locally, movement patterns alternated between feeding areas and sources of fresh water for drinking. Slone *et al.* (2006) reported that the Guanajibo, Guánica, Yauco, and Guayanilla rivers and the Cape Hart Sewage Treatment Plant at RRNS are used by manatees to obtain fresh water. For these sites, and most other known drinking areas, manatees drink surficial fresh water.

Slone *et al.* (2006) further described heavy-use areas, defined by multiple animals making repeated use of an area as determined by satellite, GPS, and visual locations, plotted on tracking maps. Heavy-use areas in eastern Puerto Rico include Puerto Medio Mundo and the mangroves to the south, Puerca Bay, the southwest coast of Ensenada Honda, and bays southwest of RRNS, including Algodones, Naguabo, and Humacao, the northwest coast of Vieques, the ports of Mosquito and Ferro, and Ensenada Honda. On the southwest coast, tagged manatees used the mouth of the Guanajibo River and, immediately to the south, the Joyuda coast, including Puerto Real, Boquerón Bay, and the shoreline near Montalva, Guánica Harbor, and Guayanilla Harbor. Because all manatees for these studies were tagged along either the east or southwest coasts and because these manatees exhibited some degree of site fidelity in their use patterns, Slone *et al.* (2006) suggested that there may be other sites that are heavily used by manatees. Notable regions known to have large manatee populations but not visited often or at all by tagged manatees include areas around Jobos Bay, San Juan Bay, and Luquillo.

Manatee sighting and stranding records from the U.S. Virgin Islands are virtually non-existent. A single animal is known to have stranded in Main Harbor, St. Thomas in 1988 (Mignucci-Giannoni 1996). This animal represents the only significant record of presence in the area (Mignucci-Giannoni 1996). Given the paucity of records, the animal was likely a transient. Transient animals are known to occur in the Lesser Antilles, perhaps emigrating from areas such as Puerto Rico or Cuba where greater numbers of manatees can be found (Lefebvre *et al*. 2001).

C.1.b. Abundance, population trends, or demographic trends:

Manatees have been reported in Puerto Rico since the arrival of the Spanish explorers and were reportedly present in sufficient numbers to be used by the natives for food prior to that time (Powell *et al.* 1981). Reports also suggest that manatees were fairly common in the area in the nineteenth century (Husar 1977). In 1935, Barrett suggested that manatees were in the decline in the region, given the fact that the town of Manatí, where manatees were once thought to be abundant, no longer had any manatees (Barrett 1935). However, the population has persisted since that time. Aerial surveys for manatees have been conducted around the islands of Puerto Rico and Vieques since 1976, when Powell *et al.* (1981) first initiated those studies. Since this time, additional surveys have been conducted to better assess manatee distribution and abundance patterns in the area (Rathbun *et al.* 1985, Freeman and Quintero 1990, Mignucci-Giannoni *et al.* 2003, Mignucci-Giannoni *et al.* 2004, Mignucci-Giannoni 2005, and USFWS Caribbean Field Office, unpub.data 2006). Most recently, a January 2005 helicopter survey of the entire Puerto Rico coast included a count of 121 manatees, including 20 calves (Mignucci-Giannoni 2005). Mignucci-Giannoni (2005) speculated that the relative abundance of manatees in Puerto Rico may be between 150 and 360 individuals. While efforts were made to fly the various surveys with consistent methods throughout the survey period, it has been difficult to correlate various survey results for the purpose of evaluating trends. A rough comparison of survey counts from surveys conducted between 1984 and 2002 show higher numbers of manatees during recent years, which suggests that the population is not decreasing. New statistically-sound survey techniques being developed in Florida will help to provide a more accurate assessment of the Puerto Rico population.

C.1.c. Genetics, genetic variation, or trends in genetic variation:

A number of studies have been conducted to assess the genetic lineage and relationships among the various populations of *Trichechus manatus*. García-Rodríguez *et al*. (1998) compared sequences among eight locations across the western Atlantic to resolve the phylogeography of *Trichechus manatus* population structure and status as it occurs throughout its range (from Florida south to coastal Brazil). Their results detected three associated matriarchal lineages or clusters: (I) the “Florida and West Indies cluster"(Florida, Puerto Rico, the Dominican Republic, and Colombia) with four unique haplotypes; (II) the “Gulf of Mexico to Caribbean rivers of South America cluster” (Colombia, Venezuela, and Mexico) with seven haplotypes; and (III), the “northeast Atlantic Coast of South America cluster” (Brazil and Guyana) with four haplotypes (García-Rodríguez *et al*. 1998). They suggested that individuals in cluster I and cluster II were more closely related to individuals in cluster III than to each other; they also suggested that climatic events could explain this occurrence and that these events may have resulted in the isolation of groups over millennia, with the possible consequences of a founder effect (populations originating from a small group of individuals) and inbreeding.

Rodríguez-Lopez (2004) and Vianna *et al*. (2005) used mitochondrial (mt) DNA to identify the various haplotypes of manatees. Within Puerto Rico, three haplotypes were identified and general patterns based on matrilineal occupancy on the island were found. Their results showed that only the haplotype A (the haplotype also unique to Florida) was found along the north shore and only the B haplotype was found on the south shore. A mixture of A and B, as well as another closely related haplotype (A2) were found in animals from the east and west coasts of Puerto Rico, suggesting mixing between the north and south groups. According to Vianna *et al.* (2006), no differentiation was found between populations in the Dominican Republic and Puerto Rico, although significant differentiation was observed between the Florida population and the Puerto Rico and Dominican Republic

populations, as contrasted with observed differentiation between populations in Brazil, Guyana, and Venezuela. These authors also reported that interpopulation differentiation and within population genetic diversity was likely the result of "a combination of the linear stepping-stone model of dispersal along shallow coastal waters, as influenced by the species' latitudinal distribution." As such, one would expect that the Puerto Rico population would be more genetically distant from the Brazilian population, given the species' apparent preference for moving along uninterrupted coastlines as opposed to open, marine waters. This may also explain why dispersion has not occurred between South America through the Lesser Antilles. In summary, Vianna *et al*. (2005) concluded that population designation by country appears to represent natural divisions.

New genetics research on manatees in Florida and Puerto Rico is currently underway through a collaborative effort between USGS, the University of Florida, FWC, Mote Marine Laboratory, and the Caribbean Stranding Network (R.K. Bonde, USGS Sirenia Project, pers. comm. 2007). This research will provide more conclusive information regarding the frequency of genetic exchange between manatees in these two regions.

C.1.d.Taxonomic classification or changes in nomenclature: Domning and Hayek (1986) identified separate subspecies of the West Indian manatee in Florida (*Trichechus manatus latirostris*) and the Caribbean (*Trichechus manatus manatus*), based on cranial measurements. The distinctive morphological features are generally thought to be the result of, and reflective of, population isolation, where certain anatomical features are favored by adaptation. These subspecies will continue to be recognized and used unless future analyses prove otherwise.

C.1.e. Habitat or ecosystem conditions:

Antillean manatees in Puerto Rico inhabit the island's coastal regions and, as such, are a largely marine population of manatees. As such, manatee habitat in Puerto Rico includes seagrass beds, sources of fresh water, quiet backwaters, and open areas used as travel corridors (Magor 1979; Lefebvre *et al.* 2000).

Seagrass beds, the manatees' primary feeding habitat, are widely distributed around the island, with patchy distribution along the northwest coast. Seagrass beds are mostly made up of turtle grass, shoal grass, manatee grass, and star grass (*Thallassia testudinium*, *Halodule wrighti*, *Syringodium filiforme* and *Halophila sp*., respectively). Seagrass composition varies from site to site. *Syringodium* and *Halophila sp.* are predominant in areas with increased turbidity and *Thallassia* may also occur in these areas, albeit in patches. Composition also varies through time by succession and other natural factors. For example, Armstrong (1981) detected a two-fold increase in lagoonal *Thallassia* in Cayo Enrique, Parguera, from 1936 to 1980. Vicente *et al.* (1991) detected significant hurricane-related impacts to the seagrasses of RRNS and Vieques Island following Hurricane Hugo in 1989. Increases in suspended sediments in the water column from hurricanes and human activities can reduce light penetration and thus alter successional patterns in seagrass communities.

Lefebvre *et al.* (2000) reported that manatees fed more often in *Thallassia* beds and that there was limited use of *Syringodium*. Manatees occasionally feed on mangroves and green algae (Mignucci-Giannoni 1998) and, when in the vicinity of coastal rivers, may feed on water hyacinth. Mignucci-Giannoni (1998) also mentioned that, based on a limited sample size, calf diets were highest in *Halodule*. Even though seagrass beds are abundant throughout open waters of the eastern, western, and southern coasts of Puerto Rico and Vieques, manatees prefer to feed in the shallows within these areas. Lefebvre *et al.* (2000) suggested that, without an adequate understanding of the manatees' habitat

requirements and feeding behavior in Puerto Rico, it may appear that manatees in this region have unlimited food resources.

NOAA's National Ocean Service benthic maps for Puerto Rico show that 625 km ^{2} was classified as seagrass beds. Even though seagrass beds are abundant throughout open waters of the eastern, western, and southern coasts of Puerto Rico and Vieques at depths up to 80 feet, manatees prefer to feed in the shallows within these areas. Díaz et al. (1994) suggests that manatee feeding behavior suggests a selective feeding strategy.

Reid *et al.* (2001) assessed the condition of seagrass beds in eastern and western Puerto Rico for the purpose of establishing baseline conditions by which to gauge the effect of future human and natural activities on this resource. In quantitatively assessing these conditions, selected sites were characterized as "healthy, productive shallow-water Caribbean seagrass meadows."

Slone *et al.* (2006), in their discussion of Puerto Rico manatee tracking studies, described regular manatee movements between feeding areas and sources of fresh water. Fresh water sources include Guanajibo, Guánica, Yauco, Loiza, and Guayanilla, as well as effluent from the RRNS Cape Hart Sewage Treatment Plant. The extent to which manatees require potable water is unknown, although Ortiz *et al.* (1998) note apparent preferences for habitat where osmotic stress is minimal, reporting that "manatees may be susceptible to dehydration after an extended period if fresh water is not available." Given these observed behaviors and the apparent need for potable water, availability of fresh water appears to be an important component of this animals' habitat. In addition to sources of potable drinking water and foraging habitat, manatees also require open areas as travel corridors and quiet backwaters in which to rest, calve, and engage in other activities (Magor 1979; Lefebvre *et al.* 2000).
.
While aerial and telemetry studies have identified important manatee habitat and use patterns, there has been no single, region-wide assessment of manatee habitat conditions in Puerto Rico. Some threats to manatee habitat have been identified and their effects on habitat condition assessed; others are postulated. For example, Vicente (1991) and Reid *et al.* (2001) described and assessed hurricane impacts to seagrass beds. Resource managers have observed changes at sites used by manatees for drinking water and have speculated that these alterations, at times, may preclude manatee access and reduce the availability of potable water (C. Diaz, USFWS Caribbean Field Office, pers. obs. 2007). (These alterations have been correlated with efforts to increase/improve the availability of fresh water for human consumptive purposes.)

C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

Overall, threats to manatee habitat have not been quantitatively assessed in Puerto Rico. While seagrass beds in eastern and western Puerto Rico (including Vieques) have been mapped (Reid *et al.* 2001), only threats from hurricanes (including hurricane-related groundings) have been assessed in any detail. The extent to which seagrass communities have been disrupted or eliminated due to marine construction activities is unknown, although impacts from major ports such as San Juan and RRNS are likely extensive. While propeller scarring has been identified as a cause of seagrass loss from the Commonwealth's 55,000 registered boats, the magnitude of this phenomenon remains unknown; other

observed boating impacts include seagrass disturbance caused by anchoring (Otero 2003). Oil spills have also been documented (Mignucci-Giannoni 1999). Water from coastal rivers is used for drinking and other human uses; to better process water, reservoirs have been built and rivers dammed (C. Diaz, USFWS Caribbean Field Office, pers. obs. 2007). Increases in commercial and recreational activities (such as port expansion and recreational boating activities) are likely to affect Puerto Rico's manatee habitat. Human demands for potable water will likely increase, as will the effects these demands have on sources of drinking water for manatees.

Adverse effects to manatee habitat are being avoided and minimized through the collective efforts of the Service, the US Army Corps of Engineers, Puerto Rico's Department of Natural and Environmental Resources (DNER), and others. These agencies, through Federal and Commonwealth authorities, are working with the development community through proactive and regulatory means to minimize development project impacts on manatee habitat. No wake areas, marked navigation channels, boat exclusion areas, standard construction conditions for marinas and boat ramps, *etc.* are but a few of the strategies used to minimize these impacts. Manatee protection areas are currently in the planning stages. Management plans, such as those developed by the U.S. Navy, have also been developed to minimize impacts to habitat. In addition, research efforts continue to identify important manatee habitat and use patterns. Information and databases obtained through these efforts provide important sources of information for agency staff that assess and minimize development impacts on manatees and their habitat.

In summary, we do not believe there are significant threats to seagrass habitat at this time. The potential loss of fresh water sources may be the most limiting of the manatee habitat variables in the future. Proactive management concerning the potential loss of this resource will alleviate this as a future threat to the population. This is an area for additional research and monitoring.

C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

Manatees in Puerto Rico are used for a variety of scientific and educational purposes. Non-lethal, scientific, field and captive studies of manatees occur routinely (Reynolds 1999). Stranded carcasses are generally salvaged and scientists use these specimens to ascertain causes of death; tissues and other materials harvested from carcasses are used for various studies (USFWS Division of Management Authority, unpub. data 2007). Manatees held at rehabilitation facilities may be in publicly accessible displays, educating the public about manatees and manatee conservation activities (USFWS Manatee Rescue Rehabilitation and Release Program Database, unpub. data 2007). At one time, hunting occurred; however, since 1995, no hunting events have been reported.

Scientific research and enhancement activities are regulated through Service Joint Endangered Species Act (ESA)/Marine Mammal Protection Act (MMPA) Marine Mammal Scientific Research Permits, and/or Joint ESA/MMPA Marine Mammal Enhancement Permits. These regulatory mechanisms authorize well-defined, limited, non-lethal takings of manatees. In no instances have these authorizations allowed for excessive uses that have known significant, pronounced, detrimental effects on the status of Antillean manatees in Puerto Rico. There is no information suggesting that this factor poses a threat to the recovery of this subspecies.

C.2.c. Disease or predation:

There are no significant known diseases, predators, or other environmentally-induced sources of

mortality in Puerto Rican manatees. Parasitism, while not a cause of death, has been well documented in these animals (Mignucci-Giannoni *et al.* 1999). A single instance of depredation of a manatee by a shark was reported by Falcón-Matos *et al.* (2003). We do not consider this factor to be a threat to manatee recovery.

C.2.d. Inadequacy of existing regulatory mechanisms:

Manatees are protected directly and indirectly through a number of Federal and Commonwealth laws. The primary regulations at the Federal level are the Endangered Species Act of 1973, as amended (ESA), and the Marine Mammal Protection Act of 1972 (MMPA). Section 17 of the ESA provides that any more restrictive conflicting provisions of the MMPA take precedence over the ESA. As a result, the Service does not issue incidental take authorization in conjunction with ESA consultations on Federal actions. **Table 7** includes a list of pertinent *Federal* Laws which provide protection for both West Indian manatee subspecies. Puerto Rico has many laws and regulations that provide significant levels of protection for the Antillean manatee and its habitat. In particular, the Puerto Rico New Wildlife Law of 1999 and its regulations provide for severe fines for any activities that affect Puerto Rico's endangered species, including the Antillean manatee. Currently, the extent of these laws provides for complete protection of the species and we do not believe that existing regulatory mechanisms are inadequate to ensure the continued survival of the species in Puerto Rico.

Commonwealth Authorities and Laws

The protection and conservation of natural resources is primarily based on the 1952 Constitution of Puerto Rico. Commonwealth authorities also include: the Organic Law of the Department of Natural Resources (1972); the New Wildlife Law of 1999; Regulation No. 6766 for the management of vulnerable and endangered species in the Commonwealth of Puerto Rico (dated February 11, 2004); the Aquatic Safety and Navigation Law of 2000; Law No. 147 for the protection, conservation and management of coral reefs in Puerto Rico (dated July 15, 1999); Regulation No. 4860, for the use, patrol, conservation, and administration of territorial waters, submerged lands, and the coastal zone (declares that submerged lands are in the public domain) (dated December 29, 1993); Law No. 307 of the Commonwealth Planning Board (identifies areas to be designated as marine reserves) (dated July 12, 2000). The Regulation of 2001 for the Management of the Maritime Zones provides controls for the use of submerged patrimonial lands.

C.2.e. Other natural or manmade factors affecting its continued existence:

Manatee deaths in Puerto Rico have been reported for decades, but were documented with greater consistency starting in the mid-1970s; since 1990, the documentation of manatee mortalities in Puerto Rico has been conducted by the Caribbean Stranding Network (CSN). Since 1975, at least 156 manatee deaths have been reported in Puerto Rico (Mignucci-Giannoni et al. 2000; Mignucci-Giannoni 2006a, 2006b, and 2006c). About 36% of these deaths were due to natural causes, and nearly the same percentage was due to anthropogenic causes. Causes of death could not be identified for the remaining 31% of the carcasses. The majority of natural causes of death were deemed perinatal. Human-related deaths included directed captures, animals that were shot or speared, and collisions with watercraft. Since 1995, there have been no reported mortalities due to captures or hunting. Prior to 1981, no manatee deaths in Puerto Rico were attributed to watercraft collisions. Subsequent to this, 30 deaths are thought to have been caused by watercraft; from 1990 to 2005, 17.4% of all known manatee deaths have been attributed to this cause. As such, watercraft collisions are now the primary source of human caused manatee mortality in Puerto Rico.

The most notable threat in Puerto Rico is collisions with watercraft. However, the number of deaths over the years has been relatively small, generally ranging from one to three deaths per year (Mignucci-Giannoni et al. 2000). In 2006, however, five adult manatees were killed in a single watercraft accident in San Juan Bay, when a vessel struck a mating herd (Mignucci-Giannoni 2006a). This high profile event was the catalyst for a public conference, attended by Puerto Rico's First Lady and local heads of the U.S. Coast Guard, the Department of Transportation, DNER, CSN, and the Service where the importance of manatee protection and manatee conservation strategies in Puerto Rico were discussed. DNER's Secretary proposed working with the Service to designate manatee protection areas, starting in San Juan Bay; the Secretary also agreed to participate in activities that would improve the new DNER Marine Mammal Program's response to stranding events, and promote education and awareness activities. This included the development of a training program with NOAA and the Service to further enhance the stranding response program.

Manatees living in coastal island habitats are exposed to extreme environmental conditions. These saline environments are constantly influenced by tide and wave action, island currents, coastal winds, and other phenomena. These stressful living conditions may contribute to the high percentage of dependent calf deaths and to the large number of calves rescued in Puerto Rico. These conditions are further compounded by tropical storms. In 1996, a manatee calf death was correlated with heavy surf produced by Hurricane Hortense (Bonde *et al. in preparation*). In 1998, Hurricane Georges was identified as the cause of a manatee cow and calf separation event, when the calf needed to be rescued.

Live strandings in Puerto Rico have been addressed through the CSN's manatee rescue, rehabilitation, and release program. (The program was recently expanded to include assistance from the new DNER Marine Mammal Program.) Between 1990 and 2006, CSN rescued 26 manatees, including 22 calves. Although not all of the rescues have been successful, this program has significantly contributed to an improved public awareness of manatee conservation activities in Puerto Rico.

In summary, we feel that the continued scientific monitoring of manatee mortality in Puerto Rico is critical to our continued understanding of the threats to this population. Proactive measures are recommended to actively manage the threat of watercraft collisions.

D. Synthesis

The population of Antillean manatees in Puerto Rico is at least stable, if not slightly increasing. The most notable threat to this small population of manatees is collisions with watercraft, where the loss of a single individual may be locally significant. Protections put in place over the past 40 years have been effective, as demonstrated by reductions in poaching activity and accidental drowning of manatees in nets.

Increased government involvement, boater licensing courses, increases in press coverage and increased NGO participation in conservation activities have increased public awareness and promoted a positive outlook for conservation of this species.

III. RESULTS

We have considered a tremendous amount of information and new analyses for this status review. We have also taken into account the recent increase in management actions and implementation of new research initiatives, and the extensive amount of interagency coordination and stakeholder

involvement regarding the manatee in both Florida and Puerto Rico. Included below is a summary of our primary concerns within each of the 5 factors discussed in Section IIC2a-e:

Factor A - Present or threatened destruction, modification or curtailment of its habitat or range:

Potential losses of warm-water habitat in Florida may result in a decline in the current Florida manatee population and may reduce the overall carrying capacity of the habitat. The magnitude of this threat to the status of the species is dependent upon the size of the manatee population and the extent of the seasonal reduction in range in Florida.

Factors B - Overutilization for commercial, recreational, scientific, or educational purposes and C - Disease or predation:

No significant threats have been identified under either of these factors.

Factor D - Inadequacy of existing regulatory mechanisms:

Federal regulatory frameworks are broad as are those in the Commonwealth of Puerto Rico and the State of Florida. Implementation and effectiveness of these statutes is variable.

No inadequacies in current regulatory mechanisms have been identified for the Antillean manatee in Puerto Rico.

Federal and state laws have resulted in extensive on-the-water protection measures in Florida. These protections result in slowing boats to reduce the frequency and severity of collisions with boats. Based on adult survival rates they appear to be sufficiently effective in the St Johns River, along the Atlantic Coast, and in northwest peninsular Florida. In southwest Florida, where the additive effects of red tide may exacerbate the effects of other threats, current regulatory mechanisms limiting watercraft collisions may not be sufficiently effective.

State and Federal regulatory frameworks are available to address the potential loss of warm water habitats. We are working now to develop plans to alleviate this future threat. Efforts have been initiated but final measures are not yet in place.

Factor E - Other natural or manmade factors affecting its continued existence:

The primary human-induced threat to the West Indian manatee is collisions with watercraft. Although extensive on-the-water regulatory measures are in place to minimize the potential for collisions, we are particularly concerned about it, in combination with other threats, in southwest Florida. Our ability to continue to manage this source of mortality for manatees range-wide is critical for the long-term viability of the species.

Conclusion

West Indian manatee populations are stable to increasing throughout the majority of the species' range under the current level of threats. In Florida, manatees are exhibiting positive growth, good reproductive rates, and high adult survival throughout most of the state. In Puerto Rico, although the number of manatees is small, the population appears to be stable.

Under the ESA, the definition of an "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. In contrast, the definition of a "threatened" species is one which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The current abundance of the species in Florida alone is at about 3,300 animals. Three of four management units in Florida are exhibiting increasing rates of growth, and several threats are being addressed in a systematic manner. In addition, even under the current threat scenario, assuming the future loss of important warm water sources , the results of the prospective threats analysis for Florida manatees alone (Runge *et al.* 2007; Section IIC2f) show that there is about an 8.6% probability of falling below a quasi-extinction threshold of 250 adults on either coast within 100 years. We believe this threshold is conservative and that 100 years is a reasonable length of time for measuring the risk to extinction given the life span of manatees. Further, we believe many of the conservation actions we have outlined are designed to moderate, minimize or reduce the magnitude of the other significant threat (that is, watercraft collisions). Therefore, we believe the West Indian manatee no longer meets the definition of an endangered species. However, because of the threats of potential habitat loss (Factor A) and watercraft collisions (Factor E) and the concerns regarding the adequacy of regulatory mechanisms associated with those threats, we believe the West Indian manatee should be classified as threatened.

A. Recommended Classification:
_X_ Downlist to Threatened

B. New Recovery Priority Number: Not applicable.

C. If a reclassification is recommended, indicate the Listing and Reclassification Priority Number (FWS only)

Reclassification (from Endangered to Threatened) Priority Number: 2

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Florida Manatee
Florida manatees are most threatened in the Southwest Region where it is unclear as to whether or not recent management efforts are sufficient to address threats from watercraft, red tide, and the expected eventual loss of artificial sources of warm water.

To enhance our ability to continue to manage the threats rangewide, natural sources of warm water need to be protected, access to important natural springs needs to be restored, contingencies to minimize the effects of the loss of artificial sources of warm water need to be in place, the State management plan should at least maintain the "status quo" in on-the-water protection for manatees from collisions with boats, and the effective implementation of the ESA and MMPA to ensure the long-term viability of the species needs to be improved. Therefore, we recommend the following course of action for Florida manatees:

Factor A - Present or threatened destruction, modification or curtailment of its habitat or range:

1. Establish minimum flow requirements to guarantee sufficient manatee winter habitat at key natural springs and restore access to springs in the St. Johns River watershed, Homosassa Springs, and other sites.
2. Develop and implement a comprehensive management strategy to address manatee protection in the Ten Thousand Islands National Wildlife Refuge and Everglades National Park.
3. Assess forage availability near wintering sites to determine the potential carrying capacity of these sites, assess the long-term effect of habitat modification on the population, and manage accordingly.
4. Ensure that contingency plans and cooperative agreements with key industry and government partners are developed and utilized to mitigate the adverse effects of anticipated changes in artificial sources of warm water.

Factors D - Inadequacy of existing regulatory mechanisms and E - Other natural or manmade factors affecting its continued existence:

1. Propose regulations (in consultation with the Corps of Engineers and other Federal agencies) pursuant to section 112(a) of the MMPA to address direct, indirect, and cumulative threats from future development and resolve conflicts with the current consultation process under section 7 of the ESA.
2. Ensure that the State of Florida's manatee management plan will be sufficient to control watercraft injury and mortality.
3. Ensure losses of power plant warm water effluents are adequately mitigated through coordination/consultation with EPA in association with Clean Water Act section 316 (b) requirements for once-through cooling systems.

Section 4(b)(1)(A) ESA Compliance

1. Update the Florida Manatee Recovery Plan and, at a minimum, revise the demographic recovery criteria; as written, these criteria are considered inadequate (Section IIB2a). Consider restructuring the Florida Manatee Recovery Team.
2. Continue to monitor the status of Florida manatees through surveys, photo identification and genetics research. New research on population genetics in Florida and in Puerto Rico is underway, and we will investigate whether manatees in each of these areas could be considered as distinct populations when that information becomes available.
3. Use the results of new research to review and update the scientific information used in the manatee Core Biological Model, especially to gain a better understanding of manatee population dynamics in southwest Florida.
4. Concurrent with actions 2 and 3, use updated demographic information to assess the effects of improved State and Federal management efforts since 2000.

Section 4(c)(2) ESA Compliance

1. Expedite the next Federal status review and conduct it in 2009-2010, when updated adult survival rates will be available. If the above issues are satisfactorily addressed, it may be most appropriate to remove the manatee from the list of threatened and endangered species at the Federal level and provide protection under the MMPA only.

Antillean Manatee in Puerto Rico and the U.S. Virgin Islands
The following measures would further enhance the long term protection of manatees and their habitat in Puerto Rico and the U.S. Virgin Islands:

Factor A - Present or threatened destruction, modification or curtailment of its habitat or range:

1. In Puerto Rico, further discussions about State safe havens (manatee refuges and sanctuaries) and/or Federal manatee protection areas (including speed restricted and exclusion areas, as defined in 50 CFR 17 Subpart J) should be should be held between the Service and the Puerto Rico Department of Environment and Natural Resources regarding the following municipalities: Fajardo, Ceiba, Naguabo, Vieques, Arroyo, Patillas, Guayama, Lajas, and Cabo Rojo. More specifically, refuges should be established in Jobos Bay in Guayama; in Pelican Cove, Ensenada Honda and the Cape Hart Sewage Plant in the RRNS area; in that area west of Mosquito Pier to Punta Arenas in Vieques; in La Parguera and Bahía Montalva in Lajas; and in Laguna Rincón, Bahía Boquerón and Puerto Real in Cabo Rojo. Other areas may be included as information on distribution and use is further refined. The loss of habitat, including the loss of freshwater sources and seagrasses due to a variety of causes, should be monitored and prevented.

Factors D - Inadequacy of existing regulatory mechanisms
and E - Other natural or manmade factors affecting its continued existence:

1. If established, manatee protection areas should be adequately enforced to minimize unauthorized watercraft-related "takings."
2. An outreach program should be developed to reach younger generations who take "boat" training courses.
3. Manatee conservation efforts should be properly marketed to target boating communities, developers, and non-users with the message of "losing one manatee is one too many."
4. Marina and other boating access development projects should be reviewed to address potential increases in the likelihood of manatee-boat collisions resulting from these projects.
5. Construction of marinas and other boat access should be assessed to identify, quantify, avoid, and minimize threats to manatees.
6. Guidelines should be drafted to further reduce or remove threats of injury or mortality from fishery entanglements.

Section 4(b)(1)(A) ESA Compliance
1. Update the Recovery Plan and develop delisting criteria.
2. Continue to monitor the status of manatees in Puerto Rico through improved (statistically-sound) survey methodology and genetics research.
3. Continue to monitor and report on sources of manatee mortality through the carcass salvage effort, and statistically evaluate the fractions of mortality due to the various causes.
4. Initiate demographic studies to better understand adult survival, juvenile recruitment and population growth.
5. Initiate new research to investigate the importance of freshwater resources in Puerto Rico to the manatee population.
6. Assess whether manatees in Puerto Rico can be considered as a DPS following advancements in genetics research.

V. REFERENCES

The following references cited in this review are on file in the Jacksonville Ecological Services Office manatee library:

Ackerman, B.B., S.D. Wright, R.K. Bonde, D.K. Odell, and D.J. Banowetz. 1995. Trends and patterns in mortality of manatees in Florida, 1974-1992. Pages 223-258 *in* T.J. O'Shea, B.B. Ackerman, and H.F. Percival, editors. Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington, D.C.

Aipanjiguly, S., S.K. Jacobson, and R.O. Flamm. 2003. Conserving manatees: knowledge, attitudes, and intentions of boaters in Tampa Bay, Florida. Conservation Biology 17: 1098-1105.

Armstrong, R.A. 1981. Changes in Cayo Enrique, La Parguera, Puerto Rico, from 1936 to 1980 using aerial photoanalysis. MS Thesis. University of Puerto Rico, Mayaguez Campus. 54 pp.

Barrett, O.W. 1935. Notes concerning manatees and dugongs. J. of Mammalogy 16:216-220.

Baugh, T.M., J.A. Valade, and B.J. Zoodsma. 1989. Manatee use of *Spartina alterniflora* in Cumberland Sound. Marine Mammal Science 5(1):88-90.

Beck, C.A. 2006. USGS FISC Sirenia Project. Unpublished data.

Bonde, R.K. 2006, 2007. USGS FISC Sirenia Project. Personal communication.

Bonde, R.K., A.A. Mignucci-Giannoni, and G.D. Bossart. In preparation. Sirenian pathology and mortality assessment. *In* E. Hines, J.E. Reynolds, III, L.V. Aragones, A.A. Mignucci-Giannoni, and M. Marmontel, editors. Sirenian conservation: issues and strategies in developing countries. University Press of Florida, Gainesville, FL.

Bossart, G.D., D.G. Baden, R.Y. Ewing, B. Roberts, and S.D. Wright. 1998. Brevetoxicosis in manatees (*Trichechus manatus latirostris*) from the 1996 epizootic: gross, histologic, and immunohistochemical features. Toxicologic Pathology 26(2):276-282.

Bossart, G.D., R.Y. Ewing, M.T. Lowe, M.J. Sweat, S.J. Decker, C.J. Walsh, S. Ghim, and A.B. Jenson. 2002. Viral papillomatosis in Florida manatees. Experimental and Molecular Biology 72:37-48.

Bossart, G.D., R.A. Meisner, S.A. Rommel, J.D. Lightsey, R.A. Varela, and R.H. Defran. 2004. Pathologic findings in Florida manatees (*Trichechus manatus latirostris).* Aquatic Mammals 30(3), 434-440.

Bossart, G.D., M. Rehtanz, S. Ghim, S.D. McCulloch, J.Goldstein and A.B. Jenson. 2006. Final report: Sentinel Species Studies for Emerging Marine Mammal Disease and Ecosystem Health: Validation of an Experimental TmPV-1 Vaccine and the TmPV-1 ELISA Test in Florida Manatees with TmPV-1 Infection and Emerging Disease Screening of Bottlenose Dolphins: The Indian River Lagoon Bottlenose Dolphin Health Assessment Project.

Brownell, R.L., Jr., K. Ralls, and R. Reeves (eds.). 1978. Report of the West Indian ManateeWorkshop, Orlando, Florida, 27-29 March 1978. Unpubl. 26 pp. + 3 appendices.

Craig, B.A., M.A. Newton, R.A. Garrott, J.E. Reynolds, III, and J.R. Wilcox. 1997. Analysis of aerial survey data on Florida manatee using Markov Chain Monte Carlo. Biometrics 53:524-541.

Craig, B.A. and J.E. Reynolds, III. 2004. Determination of manatee population trends along the Atlantic coast of Florida using a Bayesian approach with temperature-adjusted aerial survey data. Marine Mammal Science 20(3):386-400.

Deutsch, C.J., R.K. Bonde, and J.P. Reid. 1998. Radio-tracking manatees from land and space: Tag design, implementation, and lessons learned from long-term study. Marine Technology Society Journal 32(1):18-29.

Deutsch, C.J., B.B. Ackerman, T.D. Pitchford, and S.A. Rommel. 2002. Trends in manatee mortality in Florida. Abstract. Manatee Population Ecology and Management Workshop, Gainesville, Florida. April 1- 4, 2002.

Deutsch, C.J., J.P. Reid, R.K. Bonde, D.E. Easton, H.I. Kochman, and T.J. O'Shea. 2003. Seasonal movements, migratory behavior and site fidelity of West Indian manatees along the Atlantic Coast of the United States. Wildlife Monographs 151:1-77.

Diaz, C.A. 2007. USFWS Caribbean Field Office. Personal observation.

Diaz, C.A., S.M. Rice, P. Torres, D. Corales, F.Gilbes, V.P. Vicente, B.Yoshioka and M.Barreto. 1994. Status, distribution and habitat assessment of the Antillean manatee at Roosevelt Roads and Vieques Island Naval Stations. U.S. Fish and Wildlife Service. Final Report to the Navy. Cooperative Agreement 14-16-0004-89-945.

Dodson, J.J. 2006. FWC Marine Fisheries Management Section. Personal communication.

Domning D.P. and L.C. Hayek. 1986. Interspecific and intraspecific morphological variation in manatees (Sirenia: *Trichechus*). Marine Mammal Science 2(2):87-144.

Falcón-Matos, L., A.A. Mignicci-Giannoni, G. M. Toyos-Gonzalez, G.D. Bossart, R.A. Meisner, and R.A. Varela. 2003. Evidence of a shark attack on a West Indian (*Trichechus manatus*) in Puerto Rico. J. Neotrop. Mammal. 10(1):1-10

Fertl, D., A.J. Schiro, G.T. Regan, C.A. Beck, N.M. Adimey, L. Price-May, A. Amos, G.A.J. Worthy and R. Crossland. 2005. Manatee occurrence in the Northern Gulf of Mexico, west of Florida. Gulf and Caribbean Research 17:69-74.

Flamm, R.O. 2006. FWC Fish and Wildlife Research Institute. Unpublished data.

Florida Springs Task Force. 2001. Florida's springs: strategies for protection and restoration. Prepared for David B. Struhs, Secretary, Florida Department of Environmental Protection and the Citizens of the State of Florida. 59 pp.

FWC. 2005 Florida's Wildlife Legacy Initiative: Florida's Comprehensive Wildlife Conservation Strategy. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

FWC. 2006a. DRAFT Manatee Management Plan, *Trichechus manatus latirostris.* Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 227 pp. + addendum

FWC. 2006b. Final biological status review of the Florida manatee (*Trichechus manatus latirostris*) Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida.

FWC. 2007. Enhanced Manatee Protection Study. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Final Report. 37 pp. + appendices.

FWC Florida Marine Research Institute. 2003. Manatee Mortality Database. http://floridamarine.org/features/view_article.asp?id=12084. Accessed 20 February 2003.

FWC FWRI. 2006. Unpublished data.

FWC FWRI. 2006. Unpublished synoptic aerial survey data.

FWC FWRI 2006. Manatee Carcass Salvage Program. Unpublished data.

Fonnesbeck, C.J. 2006. FWC Fish and Wildlife Research Institute. Unpublished data.

Fonnesbeck, C.J. 2007. Estimating the efficacy of Florida manatee protection zones in Brevard County, Florida. Journal of Wildlife Management (in review).

Fonnesbeck, C.J, and Runge, M.C. 2007. Estimating the relative contribution of anthropogenic causes of death to Florida manatee (*Trichechus manatus latirostris*) mortality using Bayesian hierarchical modeling. Marine Mammal Science (In review).

Freeman J. and H. Quintero. 1990. The distribution of West Indian manatees (*Trichechus manatus*) in Puerto Rico. Final report to the US Marine Mammal Commission, Contract No. T5360348-3. 20 pp + appendices.

Gannon, J.G., K.M. Scolardi, J.E. Reynolds III, J.K. Koelsch, T.J. Kessenich. 2007. Habitat selection by manatees in Sarasota Bay, Florida. Marine Mammal Science 23(1): 133-143.

García-Rodríguez, A.I., B.W. Bowen, D.P. Domning, A.A. Mignucci-Giannoni, M. Marmontel, R.A. Montoya-Ospina, B. Morales-Vela, M. Rudin, R.K. Bonde, and P.M. McGuire. 1998. Phylogeography of the West Indian manatee (*Trichechus manatus)*: how many populations and how many taxa? Molecular Ecology 7(9):1137-1149.

Gerstein, E.R. 1999. Psychoacoustic evaluations of the West Indian manatee (*Trichechus manatus latirostris*). Ph.D. Thesis. Florida Atlantic University. 150 pp.

Gorzelany, J. 1998. Evaluation of boat traffic patterns and boater compliance in Lee County, Florida. Final report to the Florida Department of Environmental Protection. Tallahassee, Florida. 109 pp.

Gorzelany, J. 2000. Evaluation of vessel traffic and boater compliance in association with new boat speed regulations in the lower Caloosahatchee River. Pages 9-18 *in* R.S. Wells, editor. State of Florida manatee research conducted by Mote Marine Laboratory 1999-2000. Mote Marine Laboratory Technical Report No. 721. Sarasota, Florida.

Gorzelany, J. 2001. Effects of increased police enforcement on boater compliance in speed restricted areas. Mote Marine Laboratory Technical Report No. 782. Sarasota, Florida.

Gorzelany, J. 2002. Evaluation of boater compliance in association with new boat speed regulations at two locations in Estero Bay. Final report submitted to the FWC. Mote Marine Laboratory Technical Report No. 850. Sarasota, Florida. 36 pp.

Gorzelany, J. 2003. A characterization of boater traffic in Terra Ceia Bay, Florida. Final report submitted to the FWC. Mote Marine Laboratory Technical Report 894. Sarasota, Florida.

Gorzelany, J. 2004. Evaluation of boater compliance with manatee speed zones along the Gulf Coast of Florida. Coastal Management 32: 215-226.

Gorzelany, J. 2006. Mote Marine Laboratory. Personal communication.

Gorzelany, J., and R.O. Flamm. 2004. A characterization of recreational boat traffic patterns prior to the establishment of speed restrictions in Lemon Bay, Florida. Final report submitted to USFWS, Jacksonville, Florida. 61 pp.

Hartley, W.C. 2006. FDEP Blue Springs State Park. Personal communication.

Hartman, D.S. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. American Society of Mammalogists Special Publication No. 5. 153 pp.

Haubold, E.M. 2005. FWC Fish and Wildlife Research Institute. Personal communication.

Higgs, K. 2006. FWC Fish and Wildlife Research Institute. Unpublished data.

Hu, C., F.E. Muller-Karger, and P.W. Swarzenski. 2006. Hurricanes, submarine groundwater discharge and Florida's red tides. Geophysical Research Letters 33: L11601.

Husar, S.L. 1977. The West Indian manatee, *Trichechus manatus.* U.S. Fish and Wildl. Res. Rept., 7:1-22.

Keane, H.L. 2004. Regulation is more effective than education in altering boating patterns in Tampa Bay, Florida. Final report submitted to FWC. 25 pp + appendices.

Kendall, W.L., C.A. Langtimm, C.A. Beck, and M.C. Runge. 2004. Capture-recapture analysis for estimating manatee reproductive rates. Marine Mammal Science 20(3):424-437.

Kleen, J.M. 2006. USFWS Crystal River NWR. Personal communication.

Koelsch, J.K. 2001. Reproduction in female manatees observed in Sarasota Bay, Florida. Marine Mammal Science 17(2):331-342.

Kraus, J. 2006. USFWS Crystal River NWR. Personal communication.

Laist, D.W. and J.E. Reynolds, III. 2005a. Influence of power plants and other warm-water refuges on Florida manatees. Marine Mammal Science 21(4): 739-764.

Laist, D.W. and J.E. Reynolds, III. 2005b. Florida manatees, warm-water refuges, and an uncertain future. Coastal Management 33: 279-295.

Laist, D.W. and C. Shaw. 2006. Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. Marine Mammal Science 22(2):472-479.

Landsberg, J.H. and K.A. Steidinger. 1998. A historical review of *Gymnodinium breve* red tides implicated in mass mortalities of the manatee (*Trichechus manatus latirostris*) in Florida, USA. Pages 97-100 *in* B. Raguera, J. Blanco, M.L. Fernández, and T. Wyatt, editors. Harmful Algae. Xunta de Galicia and Intergovernmental Oceanographic Commission of UNESCO 1998.

Langtimm, C.A., and C.A. Beck. 2003. Lower survival probabilities for adult Florida manatees in years with intense coastal storms. Ecological Application. 13:257-268.

Langtimm, C.A., C.A Beck, H.H. Edwards, B.B. Ackerman, K.J. Fick-Child, S.L. Barton, and W.C. Hartley. 2004. Survival estimates for Florida manatees from the photo-identification of individuals. Marine Mammal Science 20(3):438-463.

Langtimm, C.A., M.D. Krohn, J.P. Reid, B.M. Stith, and C.A. Beck. 2006. Possible effects of the 2004 and 2005 hurricanes on manatee survival rates and movement. Estuaries and Coasts 29 (6A):1026-1032.

Lefebvre. L.W., J.E. Reynolds III, T.J. Ragen, C.A. Langtimm (eds.) 2002. Manatee Population Ecology and Management Workshop Proceedings. USGS FISC Sirenia Project and University of Florida, Gainesville, Florida. 63 pp.

Lefebvre, L.W., M. Marmontel, J.P. Reid, G.B. Rathbun, and D.P. Domning. 2001. Status and biogeography of the West Indian manatee. Pages 425-474 *in* C.A. Woods and F.E. Sergile, editors. Biogeography of the West Indies: Patterns and Perspectives. CRC Press, Boca Raton, FL. 582 pp.

Lefebvre, L. W., J.P. Reid, W.J. Kenworthy, and J.A. Powell. 2000. Characterizing manatee habitat use and seagrass grazing in Florida and Puerto Rico: implications for conservation and management. Pacific Conservation Biology 5: 289-298.

Lightsey, J.D., Rommel, S.A., A.M. Costidis, and T.D. Pitchford. 2006. Methods used during gross necropsy to determine watercraft-related mortality in the Florida manatee (*Trichechus manatus latirostris*). J. of Zoo and Wildlife Medicine 37(3):262-275.

Magor, D.M. 1979. Survey of the Caribbean manatee (*Trichechus manatus, L.*) on Vieques Island, Puerto Rico. Unpublished report to the U.S. Navy. 58 pp.

MPSWG. 2005. Biological Assessment of the Florida Manatee. Report from the Manatee Population Status Working Group Florida Manatee Recovery and Implementation Team to the USFWS, Jacksonville, FL.

Mann, D., G. Bauer, D.E. Colbert, J. Gaspard, and R.L. Reep. 2007. Sound localization abilities of the West Indian Manatee. Final Report: January 2007 State of Florida Fish and Wildlife Conservation Commission Project FWC 03/04-28. 55pp.

Marine Mammal Commission. 1988. Preliminary assessment of habitat protection needs for West Indian manatees on the east coast of Florida and Georgia. Document No. PB89-162002, National Technical Information Service. Silver Spring, Maryland. 120 pp.

Marine Mammal Commission. 1986. Habitat protection needs for the subpopulation of West Indian manatees in the Crystal River area of northwest Florida. Document No. PB86-200250, National Technical Information Service. Silver Spring, Maryland. 46 pp.

McDonald, S.L. 2006. FWC Fish and Wildlife Research Institute. Personal communication

Mezich, R.R. 2006. FWC Imperiled Species Management Section. Personal communication.

Mignucci-Giannoni, A.A. 2006a. West Indian manatee (*Trichechus manatus*) deaths due to watercraft collision in San Juan Bay, Puerto Rico, 16-18 August 2006: Preliminary Report.

Mignucci-Giannoni, A.A. 2006b. Marine mammal stranding/mortality cases, 2000-2005. Caribbean Stranding Network Report, Red Caribeña deVaramientos, Caribbean Stranding Network, San Juan, Puerto Rico, 5 pp.

Mignucci-Giannoni A.A. 2006c. West Indian manatee (*Trichechus manatus*) mortality analysis: 1990-2005. Progress report, Red Caribeña deVaramientos, Caribbean Stranding Network, San Juan, Puerto Rico, 6 pp.

Mignucci-Giannoni A.A. 2005. Estatus del manati de las Indias Occidentals (*Trichechus manatus*) en Puerto Rico. A report by Antonio Mignucci, Investigacion Ambiental. Prepared on February 21, 2005. 13 pp. (As translated by Teddie Forbes, Administrative Automation Assistant, on January 29, 2007.)

Mignucci-Giannoni A.A. 1999. Assessment and rehabilitation of wildlife affected by an oil spill in Puerto Rico. Environmental Pollution 104 (1999) 323-333

Mignucci-Giannoni, A.A. 1996. Marine mammal strandings in Puerto Rico and the United States and British Virgin Islands. Doctoral Dissertation. Department of Marine Sciences, University of Puerto Rico. 247 pp.

Mignucci-Giannoni, A.A. 1989. Zoogeography of marine mammals in Puerto Rico and the U.S. Virgin Islands. MS Thesis. Department of Marine Affairs, University of Rhode Island, Kingston, R.I. 448 pp.

Mignucci-Giannoni, A.A, M.M. Alsina-Guerrero, G.M. Toyos-Gonzalez, and .R.J. Rosario-Delestre. 2004. Aerial surveys for marine mammals and sea turtles off the southeast coast of Puerto Rico. Final Report: Marine Assessment and Protection Among Estuarine Systems. Universidad Metropolitana, Puerto Rico 16 pp.

Mignucci-Giannoni, A.A, M.M. Alsina-Guerrero, V.M. Rosado-Odom,G.M. Toyos-Gonzalez, and R.J. Rosario-Delestre. 2003. Aerial surveys for marine mammals and sea turtles off the southwest coast of Puerto Rico. Universidad Metropolitana, Puerto Rico 16 pp

Mignucci-Giannoni, A.A., R.A. Montoya-Ospina, N.M. Jimenez-Marrero, M.A. Rodriguez-Lopez, E.H. Williams, Jr., and R.K.Bonde. 2000. Manatee mortality in Puerto Rico. Environmental Management 25(2): 189-198.

Mignucci-Giannoni, A.A., C. A. Beck, R.A. Montoya-Ospina, and E.H. Williams, Jr. 1999. Parasites and commensals of the West Indian manatee from Puerto Rico. J. of the Helminthological Society of Washington 66(1):27-29.

Mignucci-Giannoni, A.A. and C. A. Beck. 1998. The diet of the manatee (*Trichechus manatus*) in Puerto Rico. Marine Mammal Science 14(2):394-397

Nowacek, S.M., R.S. Wells, E.C.G. Owen, T.R. Speakman, R.O. Flamm, and D.P. Nowacek. 2004. Florida manatees, *Trichechus manatus latirostris,* respond to approaching vessels. Biological Conservation 119: 517-523.

Odell, D.K., and J.E. Reynolds, III. 1979. Observations on manatee mortality in south Florida. J. of Wildlife Management 43(2):572-577.

Orth, R.J., T.J.B. Carruthers, W.C. Dennison, C.M. Duarte, J.W. Fourqurean, K.L.Heck, Jr., A.R. Hughes, G.A. Kendrick, W.J. Kenworthy, S. Olyarnik, F.T. Short, M.Waycott, and S.L. Williams. 2006. A global crisis for seagrass ecosystems. BioScience 56 (12): 987-996.

Ortiz, R.M., G.A.J. Worthy, D.S. MacKenzie. 1998. Osmoregulation in wild and captive West Indian manatees (*Trichechus manatus*). Physiological Zoology 71(4):449-457.

O'Shea, T.J., C.A. Beck, R.K. Bonde, H.I. Kochman, and D.K. Odell. 1985. An analysis of manatee mortality patterns in Florida 1976-1981. J. of Wildlife Management 49(1):1-11.

O'Shea, T.J., B.B. Ackerman and H.F. Percival, editors. 1995. Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington D.C. 289 pp.

O'Shea, T.J., L.W. Lefebvre, and C.A. Beck. 2001. Florida manatees: perspectives on populations, pain, and protection. Pages 31-43 *in* L.A. Dierauf and F.M.D. Gulland, editors. Handbook of Marine Mammal Medicine, 2nd edition. CRC press, Boca Raton, FL.

Otero, E. 2003. Quantifying the impact of propeller scarring on seagrass beds: study in two natural reserves in southwestern Puerto Rico. http://home.coqui.net/eotero2/ Accessed 29 January 2007.

Pause, K. 2007. University of Florida. Personal communication.

Powell. J.A., D.W. Belitsky, and G.B. Rathbun. 1981. Status of the West Indian manatee (*Trichechus manatus*) in Puerto Rico. J. of Mammalogy 6293): 642-646.

Powell. J.A. 2006. Wildlife Trust. Personal communication.

Rathbun, G.B. R.K. Bonde, and D. Clay. 1982. The status of the West Indian manatee on the Atlantic Coast north of Florida. Pages 152-164 *in* R.R.Odum and J.W. Guthrie, editors. Proceedings: Symposium on Non-game and Endangered Wildlife. Technical Bulletin WL5. Georgia Department of Natural Resources, Game and Fish Division, Social Circle, Georgia.

Rathbun G.B., T. Carr, N. Carr, and C.A. Woods. 1985. The distribution of manatees and sea turtles in Puerto Rico with emphasis on Roosevelt Roads Naval Station. Report prepared for: the Department of the Navy, Atlantic Division, Naval Facilities Engineering Command, Installations Planning Division, Norfolk, Virginia. 83 pp.

Rathbun, G.B., J. P. Reid, and G. Carowan. 1990. Distribution and movement patterns of manatees (*Trichechus manatus*) in Northwestern peninsular Florida. Florida Marine Research Institute Publication No 48. 33 pp.

Rector, A., S-J Ghim, G.D. Bossart, A.B. Jenson and M. Van Ranst. 2003. Isolation of a novel close-to-root papillomavirus using degenerate primer PCR and multiply-primed rolling circle amplification: the Florida manatee (*Trichechus manatus latirostris*) papillomavirus or TmPV-1. Abstract. International Papillomavirus Workshop, 2003, Mexico City, Mexico.

Reid, J.P., D. Easton, and W.J. Kenworthy. 2001. Manatee and seagrass habitat characterization in Puerto Rico. Report prepared for the Department of the Navy, U.S. Naval Station Roosevelt Station. 34 pp. + tables and illustrations.

Reid, J.P., G.B. Rathbun, and J.R. Wilcox. 1991. Distribution patterns of individually identifiable West Indian manatees (*Trichechus manatus*) in Florida. Marine Mammal Science 7(2):180-190.

Reynolds, J.E., III. 1999. Efforts to conserve manatees. Pages 267-295 *in* J.R. Twiss, Jr., and R.R. Reeves, editors. Conservation and Management of Marine Mammals. Smithsonian Institute Press, Washington, D.C.

Reynolds, J.E., III and J.A. Powell. 2005. The manatees– Family Trichechidae (*Trichechus manatus, T. senegalensis* and *T. inunguis*). *In* W.F. Perrin, B. Wursig and H. Thewissen, editors. Encyclopedia of Marine Mammals. Academic Press. San Diego, CA.

Reynolds, J.E. III and R.S. Wells. 2003. Dolphins, Whales and Manatees of Florida: A Guide to Sharing Their World. University Press of Florida, Gainesville. ISBN 0-8130-2687-3 148 pp.

Rodríguez-Lopez, M.A. 2004. Phylogeography of manatees (*Trichechus manatus)* in Puerto Rico: a management tool for species conservation. MS Thesis, Universidad Metropolitana, San Juan, Puerto Rico. 52 pp.

Rommel, S.A., A.M. Costidis, T.D. Pitchford, J.D. Lightsey, R.H. Snyder, and E.M. Haubold. 2007. Forensic methods for characterizing watercraft from watercraft-induced wounds on the Florida manatee (*Trichechus manatus latirostris*). Marine Mammal Science 23(1):110-132.

Rommel, S.A., M. Pitchford, and T. Pitchford. 2001. Cold-related deaths of Florida manatees: final report to the USFWS. FMRI Grant No. 2280, FMRI Project Identification No. 9322-160-2280, FWC/FMRI File Code: 2280-00-F. 21 pp.

Runge, M.C. 2004. Manatee warm-water carrying capacity: integrating expert consensus and mathematical models. Abstract. Manatee Habitat Workshop, September 27-29, 2004. Jupiter, Florida.

Runge, M. C. 2003. A model for assessing incidental take of manatees due to watercraft-related activities. Appendix I *in* U.S. Fish and Wildlife Service, Environmental Impact Statement: Rulemaking for the incidental take of small numbers of Florida manatees (*Trichechus manatus latirostris*) resulting from government programs related to watercraft access and watercraft operation in the state of Florida (March 2003). U.S. Fish and Wildlife Service, Jacksonville, Florida.

Runge M.C., C.A. Langtimm, and W.L. Kendall. 2004. A stage-based model of manatee population dynamics. Marine Mammal Science 20(3):361-385.

Runge M.C., Sanders-Reed C.A., and Fonnesbeck C.J. 2007. A core stochastic population projection model for Florida manatees (*Trichechus manatus latirostris*). U.S. Geological Survey Open-File Report 2007-1082. 41 pp.

Runge M.C., Sanders-Reed C.A., Langtimm C.A., and Fonnesbeck C.J. 2007. A quantitative threats analysis for the Florida manatee (*Trichechus manatus latirostris*). Final report to U.S. Fish and Wildlife Service, Jacksonville, FL, Intergovernmental Contract No. 40181-5-N012 (March 2007). U.S. Geological Survey Open-File Report 2007-1086. 34 pp.

Sargent, F.J. 2006. FWC Fish and Wildlife Research Institute. Personal communication.

Schwartz, F.J. 1995. Florida manatees, *Trichechus manatus,* (Sirenia: Trichedchidae), in North Carolina 1919 – 1994. Brimleyana 22:53 – 60.

Shapiro, S.L. 2001. Assessing boater compliance with manatee speed zones in Florida. Final report submitted to the U.S. Fish and Wildlife Service, Grant No. 2280. St. Petersburg, Florida. 73 pp + appendices.

Sidman, C., and R.O. Flamm. 2001. A survey of methods for characterizing recreational boating in Charlotte Harbor Florida. Final report submitted to Florida Sea Grant, Project No. E/WCIND-1. Gainesville, Florida. 50 pp.

Sidman, C.F., T.J. Fik, and F.J. Sargent. 2004. A recreational boating characterization for Tampa and Sarasota bays. Florida Sea Grant Publication TP130. University of Florida, Gainesville.

Slone, D.H., J.P. Reid, R.K. Bonde, S.M. Butler, and B.M. Stith. 2006. Summary of West Indian manatee (*Trichechus manatus)* tracking by USGS-FISC Sirenia Project in Puerto Rico. A report prepared for the USFWS, 14 July 2006. 8 pp.

Smith, K.N. 1993. Manatee habitat and human-related threats to seagrass in Florida: a review. Florida Department of Environmental Protection, Bureau of Protected Species Management. Report. Tallahassee, Florida. 38 pp.

Sorice, M.G., Shafer, C.S., and Scott, D. 2003. Managing endangered species within the use/preservation paradox: Understanding and defining harassment of the West Indian manatee (*Trichechus manatus).* Coastal Management 31(4), 319-338.

Sorice, M.G., R.O. Flamm, and S.L. McDonald. 2004. Evaluation of vessel compliance with manatee speed zones and an investigation of methods to improve compliance rates. Final grant report submitted to the U.S. Fish and Wildlife Service. Grant No. 2335. St. Petersburg, Florida. 90 pp.

Steidinger, K.A., J.H. Landsberg, C.R. Tomas, and J.W. Burns. 1999. Harmful algal blooms in Florida. Submitted to: Florida's Harmful Algal Bloom Task Force, 65 pp.

Stith, B.M., D.H. Slone, and J.P. Reid. 2007. Review and Synthesis of Manatee Data in Everglades National Park. Final Report for USGS/ENP Agreement # IA F5297-04-0119, November 2006. 110 pp.

Taylor, C.R., J.A. Powell, and K.J. Frisch. 2004. Evaluation of manatee speed zones. Final report submitted to the National Fish and Wildlife Foundation. Contract No. 199-0273-002. St. Petersburg, Florida 25 pp.

Taylor, C.R., J.A. Powell, and K.J. Frisch. 2005. Evaluation and monitoring of proposed manatee sanctuaries and reserves. Final report submitted to the USFWS. Grant No. 41910-113-4044. St. Petersburg, Florida 29 pp.

Tyson, S. 2001. Haulover Canal boater activity and compliance study. Report prepared for USFWS Jacksonville, Florida, USFWS Grant Agreement No. 1448-40181-97-G-100 49 pp + appendices.

USFWS. In review. Manatee Habitat Workshop Proceedings: Proceedings of the Manatee Habitat Workshop, Delray Beach, Florida, November 30 and December 1, 2004. USFWS Jacksonville Ecological Services Office, Jacksonville, Florida. 107 pp.

USFWS. 2001. Florida manatee (*Trichechus manatus latirostris*) recovery plan, third revision. USFWS. Atlanta, Georgia. 144 pp. + appendices.

USFWS. 2000. Florida manatees and warm water: proceedings from the warm-water workshop, Jupiter, Florida August 24-25, 1999. 69 pp.

USFWS. 1999. South Florida multi-species recovery plan. USFWS, Atlanta, Georgia. 2172 pp.

USFWS. 1998. Contingency plan for catastrophic manatee rescue and mortality events. Prepared by the Manatee Recovery Program, Jacksonville, Florida for Southeast Region, USFWS, Atlanta, Georgia. 11 pp.

USFWS. 1996. Florida manatee (*Trichechus manatus latirostris*) recovery plan, second revision. Prepared by the Florida Manatee Recovery Team for the USFWS. Atlanta, Georgia. 160 pp.

USFWS. 1989. Florida manatee (*Trichechus manatus latirostris*) recovery plan, first revision. Prepared by the Florida Manatee Recovery Team for the USFWS. Atlanta, Georgia. 98 pp.

USFWS. 1986. The recovery plan for the Puerto Rico Population of the West Indian (Antillean) manatee. Prepared by the USFWS in cooperation with the Manatee Recovery Team. 28 pp.

USFWS. 1980. West Indian manatee recovery plan. Prepared by the USFWS in cooperation with the Manatee Recovery Team. 35 pp.

USFWS Caribbean Field Office. 2006. Unpublished data.

USFWS Crystal River National Wildlife Refuge. 2006. Unpublished data.

USFWS Division of Management Authority. 2007. Unpublished data.

USFWS Jacksonville Ecological Services Office. 2006. Unpublished data.

USFWS Manatee Rescue, Rehabilitation, and Release Program Database. 2006. Unpublished data.

USGS FISC Sirenia Project. 2006. Unpublished data.

Vianna, J.A., R.K. Bonde, S. Caballero, J.P. Giraldo, R.P. Lima, A. Clark, M. Marmontel, B. Morales-Vela, M.J. de Sousa, L. Parr, M.A. Rodríguez-Lopez, A.A. Mignucci-Giannonni, J.A. Powell, and F.R. Santos. 2006. Phylogeography, phylogeny, and hybridization in trichechid sirenians: implications for manatee conservation. Molecular Ecology 15:433-447.

Vicente, V.P. 1991. The impact of Hurricane Hugo on benthic communities around Roosevelt Roads Naval Station and Vieques Island. Report to the U.S. Navy. U.S. Fish and Wildlife Service, Caribbean Field Office, Puerto Rico.

Viera-Atwell, J. 2006. FWC Fish and Wildlife Research Institute. Unpublished data.

Warm Water Task Force. In preparation. Recommendations for future manatee warm-water habitat. Draft recommendations from the Warm-water Task Force to the USFWS, Jacksonville, FL.

Weigle, B.L., I.E. Wright, M. Ross, and R.O. Flamm. 2001. Movements of radio-tagged manatees in Tampa Bay and along Florida's west coast, 1991-1996. Florida Marine Research Institute Technical Report TR-7. St. Petersburg, Florida 156 pp.

Worthy, G.A.J. 2006. University of Central Florida. Personal communication.

Wright, S.D., B.B. Ackerman, R.K. Bonde, C.A. Beck and D.J. Banowetz. 1995. Analysis of watercraft-related mortality of manatees in Florida, 1979-1991. Pages 259-268 *in* T.J. O'Shea, B.B. Ackerman, and H.F. Percival, editors. Population Biology of the Florida Manatee. National Biological Service, Information and Technology Report No. 1. Washington D.C.

Zoodsma, B.J. 1991. Distribution and behavioral ecology of manatees in southeastern Georgia. MS Thesis. University of Florida. Gainesville, Florida. 202 pp.

LIST OF ACRONYMS AND ABBREVIATIONS

The following standard abbreviations for units of measurements and other scientific/technical acronyms and terms are found throughout this document:

C	Celsius
CBM	Core Biological Model
CERP	Comprehensive Everglades Restoration Plan
CFR	Code of Federal Regulations
CI	Confidence Intervals
CITES	Convention on International Trade in Endangered Species
CSN	Caribbean Stranding Network
CWA	Clean Water Act
DNA	Deoxyribonucleic Acid
DNER	[Puerto Rico] Department of Natural Environmental Resources
DPS	Distinct Population Segment
DRI	Development of Regional Impact
ELISA	Enzyme-Link Immunosorbant Assay
ESA	Endangered Species Act of 1973, as amended
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FISC	Florida Integrated Science Center
FL	Florida
FMRI	Florida Marine Research Institute
FPL	Florida Power and Light
FR	Federal Register
FS	Florida Statutes
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
FWS	U.S. Fish and Wildlife Service
GPS	Global Positioning System
HWG	Habitat Working Group
ISMS	Imperiled Species Management Section
MARPOL	Marine Pollution Convention
MMPA	Marine Mammal Protection Act of 1972, as amended
MPP	Manatee Protection Plan
MPSWG	Manatee Population Status Working Group
Mt	mitochondrial (DNA)
N	number
NEPA	National Environmental Policy Act
NGO	Non-Government Organization
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
RRNS	Roosevelt Roads Naval Station
SAV	Submerged Aquatic Vegetation
SE	Standard Error
Sect	Section
Service	U.S. Fish and Wildlife Service
TECO	Tampa Electric Company
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WMD	Water Management District

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the West Indian Manatee (*Trichechus manatus*)

Includes both subspecies:

Florida manatee, *Trichechus manatus latirostris*
Antillean manatee, *Trichechus manatus manatus* (in Puerto Rico and the U.S. Virgin Islands)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

__X__ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable: 2

Review Conducted By: Dawn Jennings, Jim Valade, and Nicole Adimey - Jacksonville Field Office; Carlos Diaz - Caribbean Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 4/2/2007

REGIONAL OFFICE APPROVAL:

Southeast Regional Director, Fish and Wildlife Service

Approve _____ Date 4/6/2007

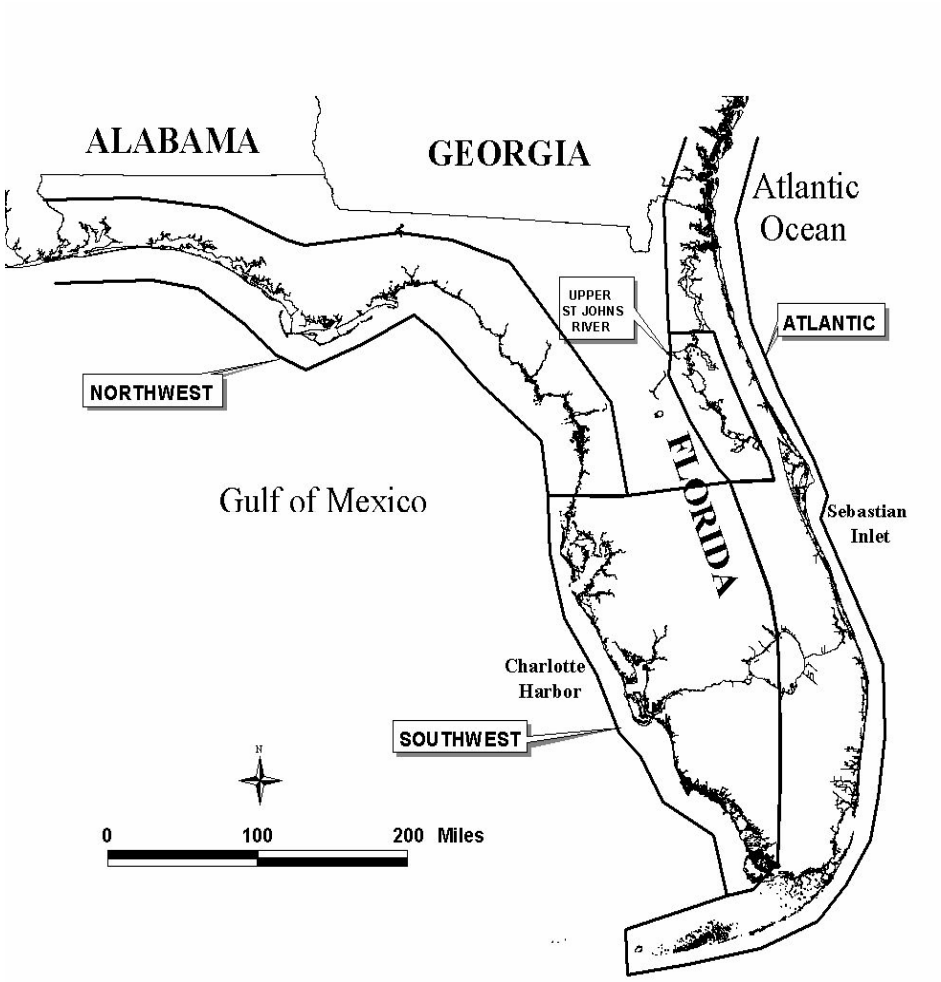

Figure 1. Florida manatee distribution within the four designated regional management units. USFWS (2001).

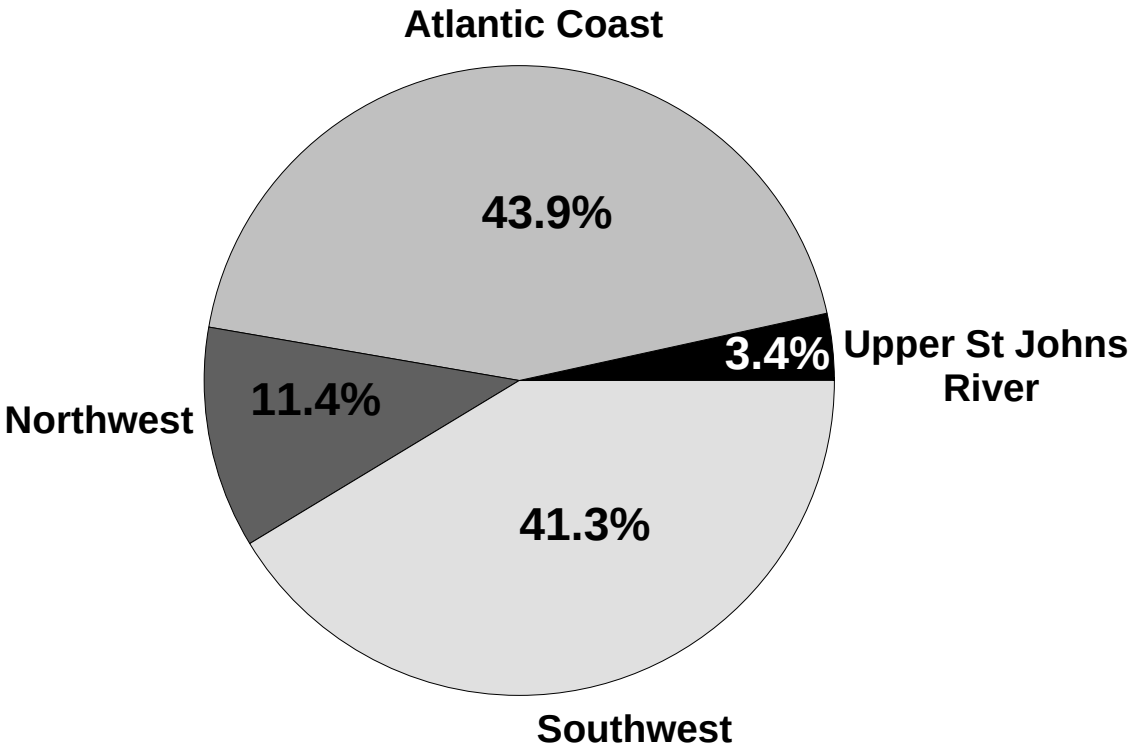

Figure 2. Florida manatee population distribution among regions. Percentages are based on the highest minimum statewide count for each region (winter 2001, N=3300; FWC, unpublished data, MPSWG 2005).

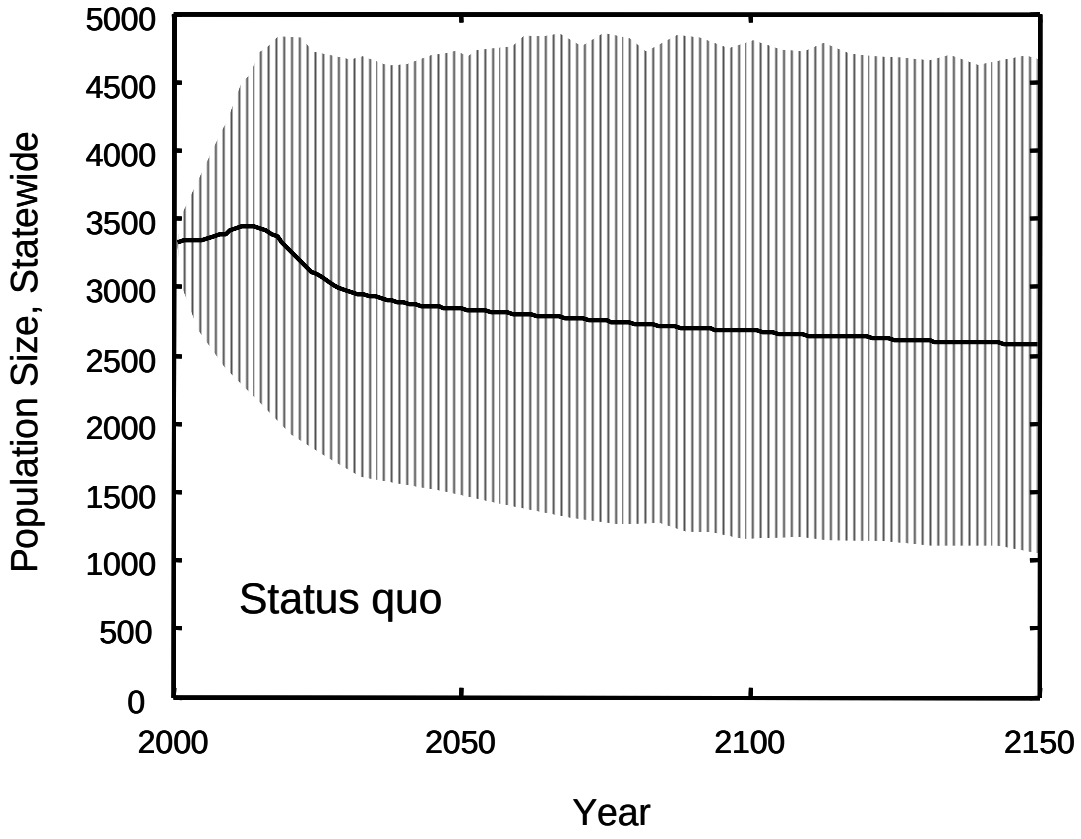

Figure 3. Projected Florida manatee population size, 2001-2150, under the status quo scenario. The bold line depicts the mean population size; the shaded area represents the 95% projection intervals (Runge *et al.* 2007).

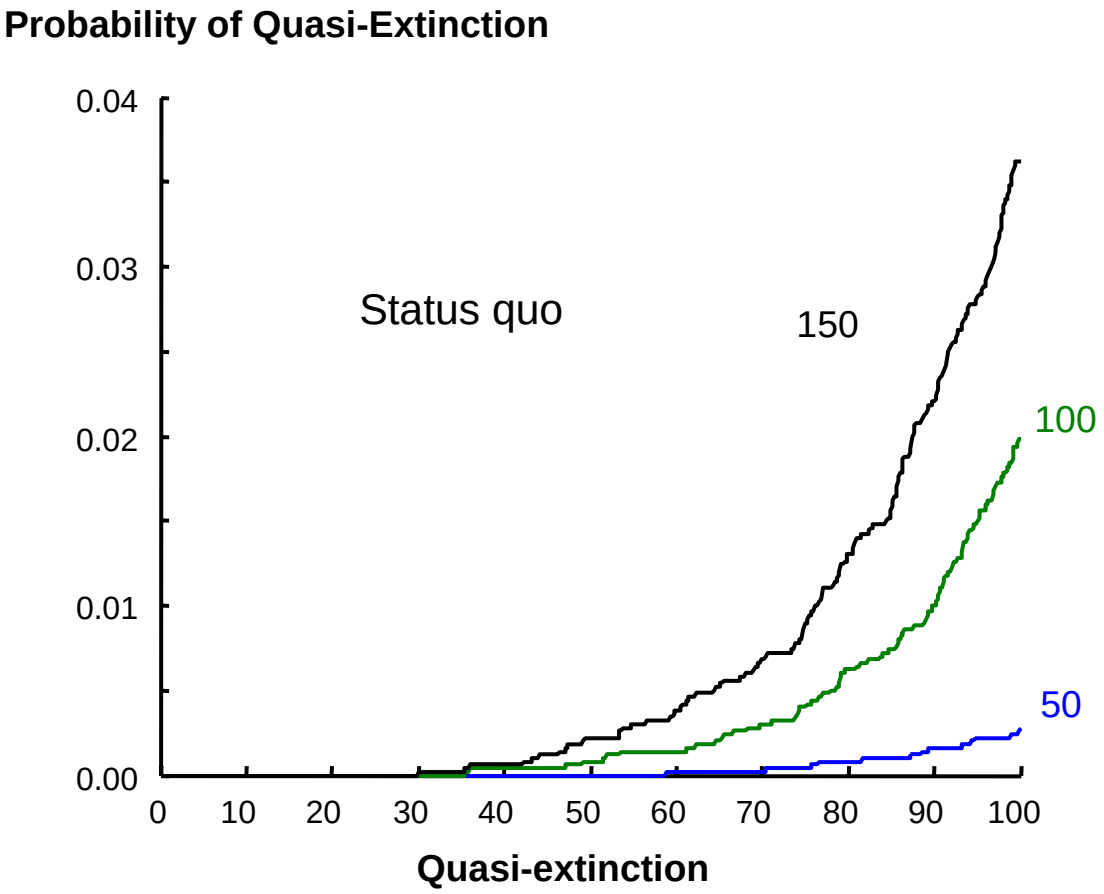

Figure 4. Probability of the total population size falling below a range of thresholds for the statewide population under the status quo scenario. For example, the probability that the total statewide population will fall below 1000 animals within 100 yr is 2.0%. Note that the sample size in the simulation was 5000 replicates, so 0 should be read as <0.0002, and the reader should bear in mind that there is sampling uncertainty associated with very low frequencies (Runge *et al.* 2007).

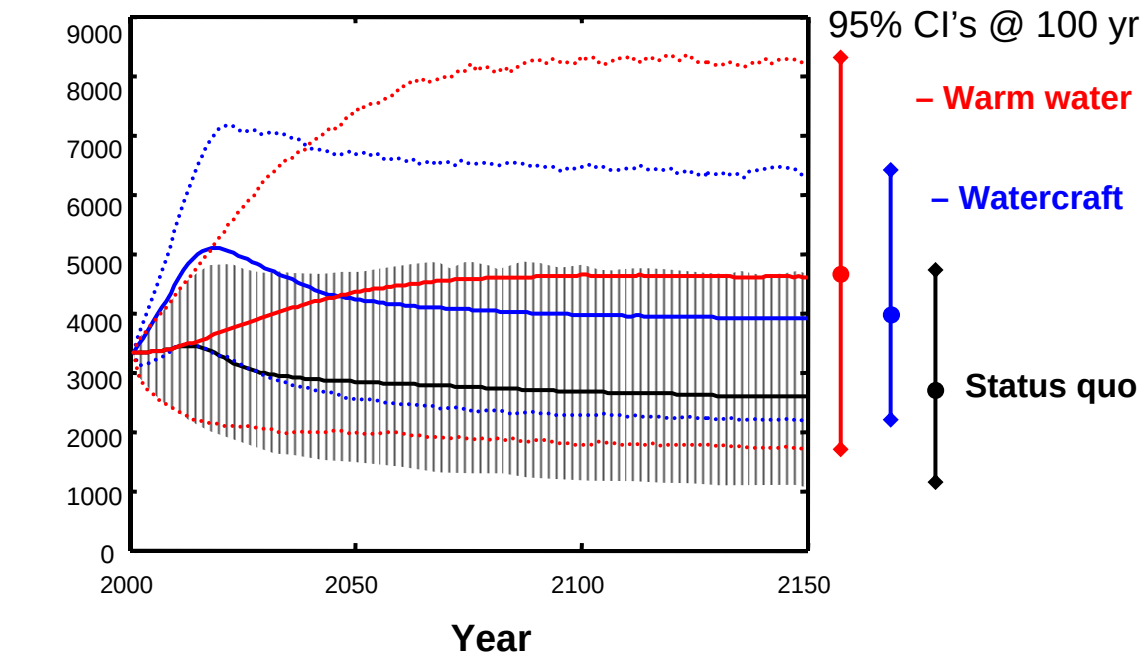

Figure 5. Projected Florida manatee population size, 2001-2150, under three scenarios: status quo (black), *without* watercraft mortality (blue), and *without* loss of warm-water (red). The bold lines depicts the mean population size; the shaded area represents the 95% projection intervals for the status quo scenario (as in Fig. 3), and the dotted lines represent the 95% projection intervals for the other two scenarios. The bars to the right of the graph show the mean and 95% projection intervals at 100 years for the three scenarios (Runge *et al.* 2007).

Probability of quasi-extinction

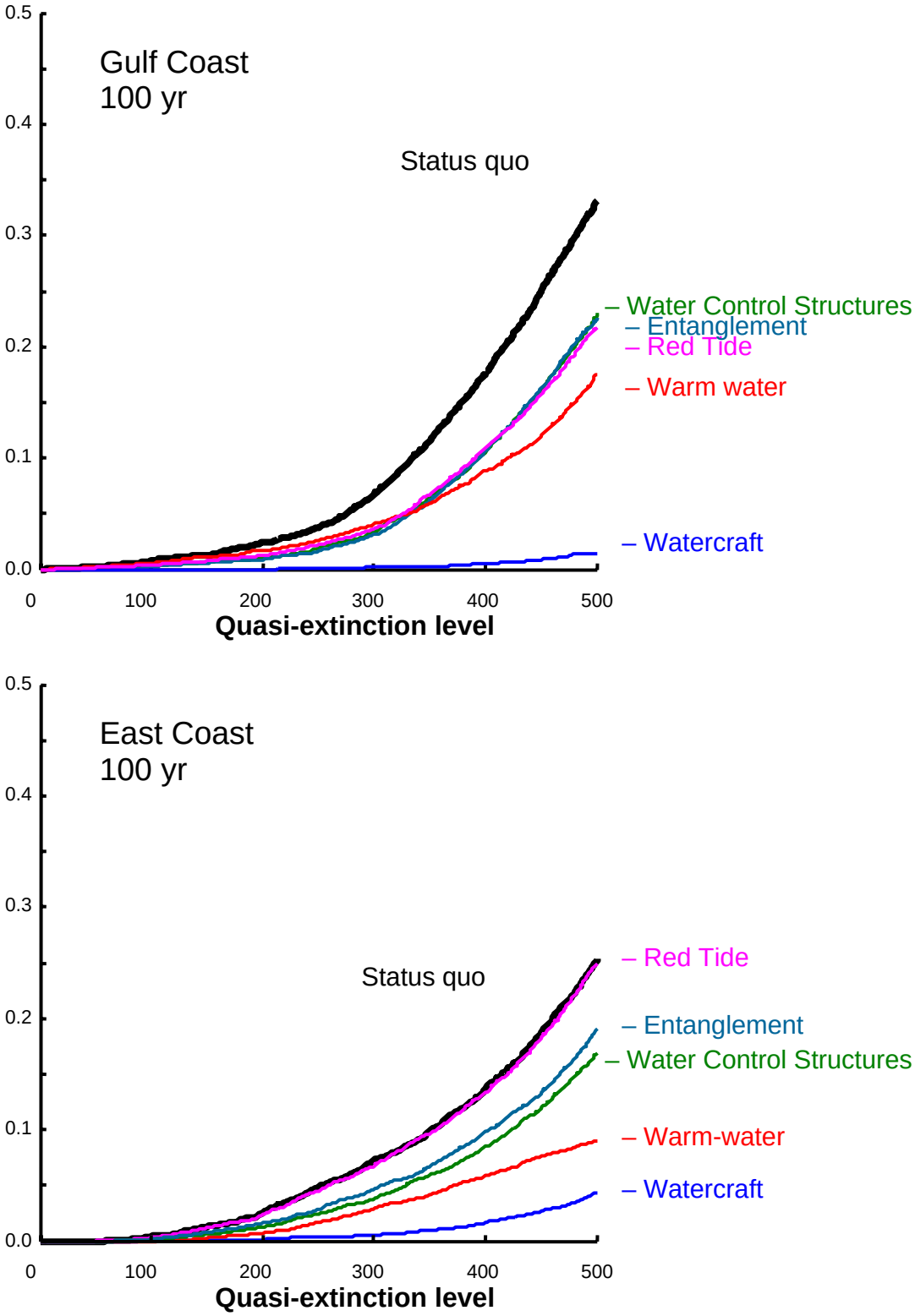

Figure 6. Probability of the adult (effective) population falling below a threshold within 100 years, as a function of the threshold, for six threat scenarios, on the Gulf coast or the East coast. The status quo scenario is shown with a solid, bold line. The other scenarios consider the one-by-one removal of major threats (Runge *et al.* 2007).

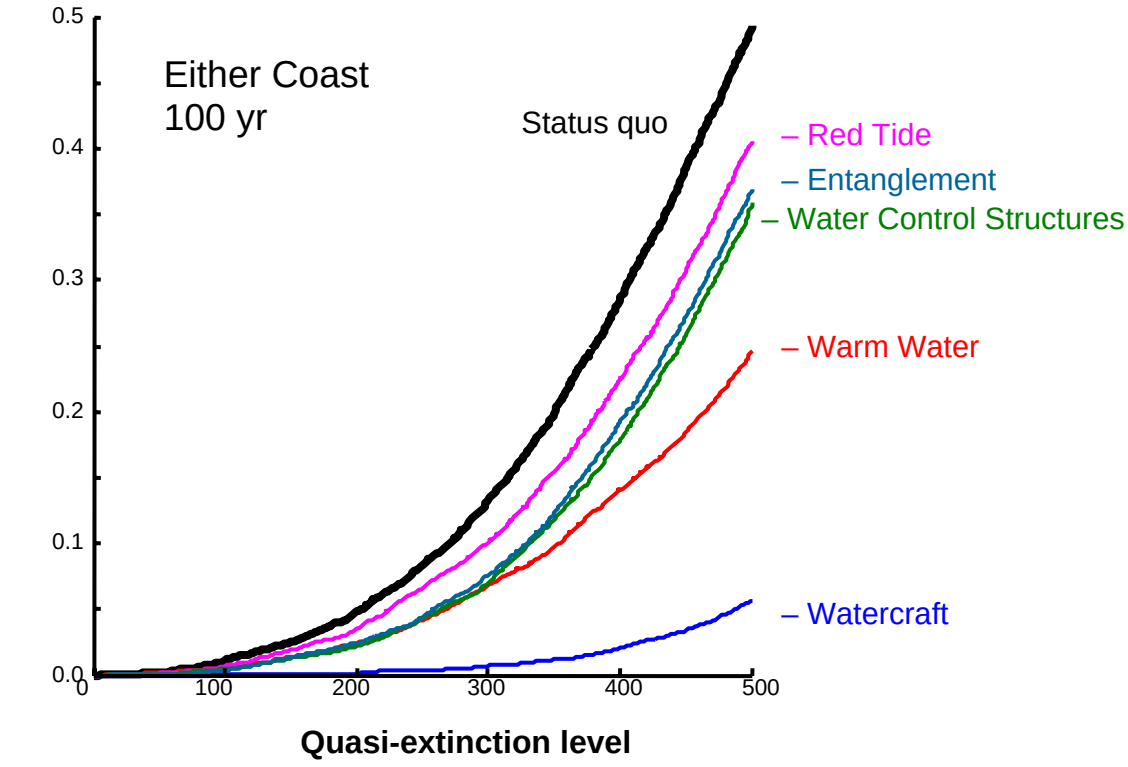

Figure 7. Probability of the adult (effective) population falling below a threshold on either the Gulf or the East coast within 100 years, as a function of the threshold, for six threat scenarios. The status quo scenario is shown with a solid, bold line. The other scenarios consider the one-by-one removal of major threats (Runge *et al.* 2007).

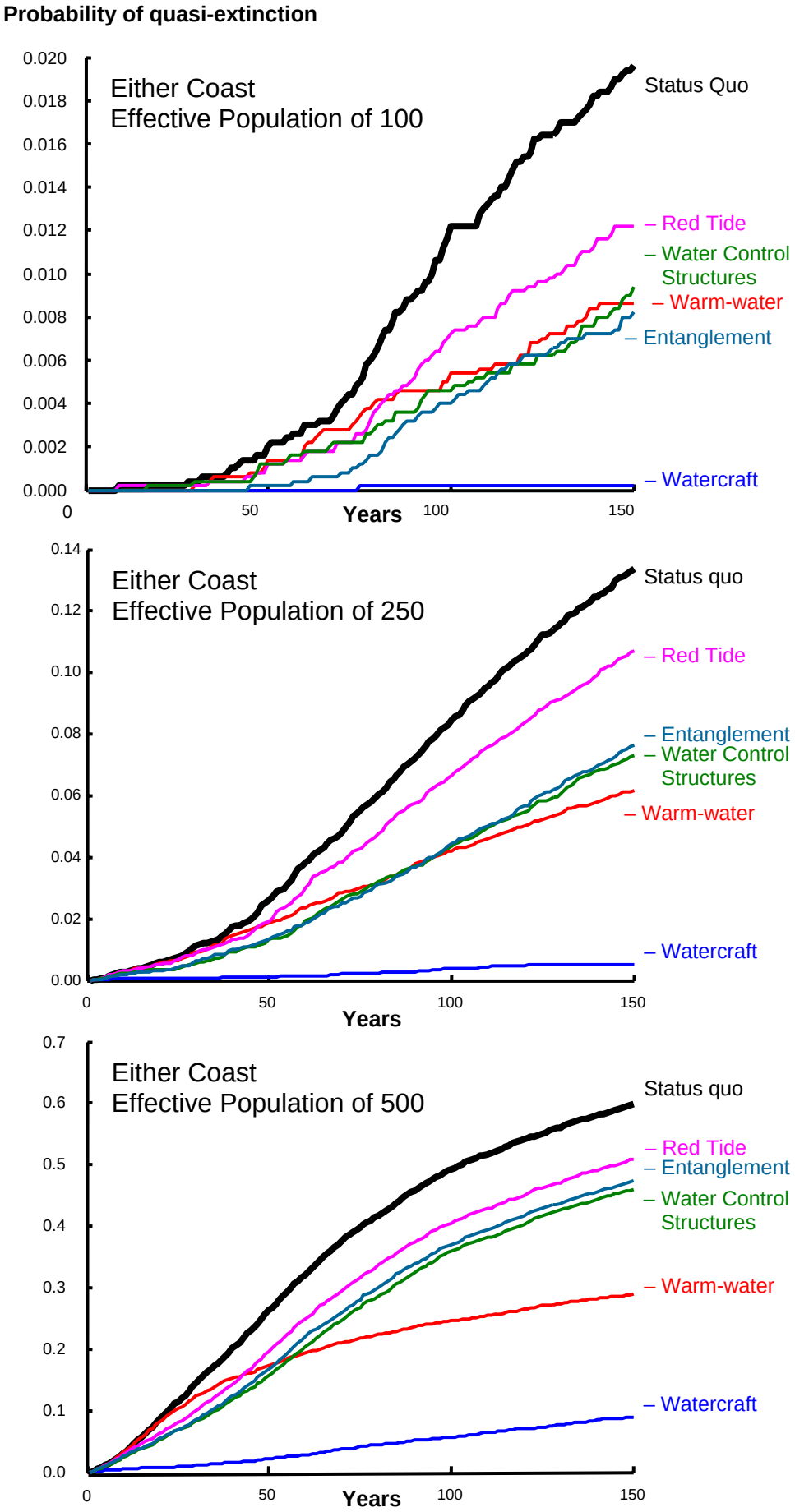

Figure. 8. Probability of the adult (effective) population falling below a threshold of 100, 250 or 500 on either the Gulf or East coast, as a function of years from present, for six threat scenarios (removal of each of the threats).

Figure 9. Antillean manatee distribution and movements in Puerto Rico. Capture locations of the 31 wild-caught manatees tracked by USGS-FISC, with areas delineated that represent the furthest extent of tracked manatee travel, and areas that were repeatedly used by several tracked animals. (Slone *et al.* 2006).

Table 1. Florida springs and years when the water management districts plan to initiate the minimum flow rule-making process.

LIST OF SPRINGS	Year Proposed for MFL Designation
EAST COAST	
Upper St. Johns River Region	
Blue Spring (Volusia County, FL)	2006
Silver Glen Springs (Marion County, FL)	2010
DeLeon Springs (Volusia County, FL)	2007
Salt Springs (Marion County, FL)	No date
Silver Springs	2008
Note: the St Johns River Water Management District has proposed to identify minimum flows for the Silver River and the "Ocklawaha River downstream of Silver River"	2008
Atlantic Region	
No springs.	
WEST COAST	
Northwest Region	
Crystal River Springs Complex (Citrus County, FL)	2010
Homosassa River Springs Complex (Citrus County, FL)	2009
Weeki Wachee/Mud/Jenkins Creek Springs (Hernando County, FL)	2006
Manatee/Fanning Springs (Dixie County, FL)	2006
Wakulla/St. Mark's Complex (Wakulla County, FL)	2006
Ichetucknee Springs Group	2008
Chassahowitzka River Springs	2008
Rainbow Spring	2008
Southwest Region	
Warm Mineral Springs (Sarasota County, FL)	No date
Spring Bayou/Tarpon Springs (Pasco County, FL)	No date
Sulphur Springs (Hillsborough County, FL)	2006

NOTE: Springs in **BOLD** currently used by manatees; other springs, if improved, could be of significance to manatees.

Table 2. Network of Primary[1] and Secondary[2] warm-water refuge sites.

East Coast:

Upper St. Johns River Region

(1) Blue Spring (Volusia County, FL)-1
(2) Silver Glen Springs (Marion County, FL)-2
(3) DeLeon Springs (Volusia County, FL)-2
(4) Salt Springs (Marion County, FL)-2
(5) The 20 Oklawaha River springs, including Silver Spring (Marion County, FL)-2

Atlantic Region

(6) Reliant Energy Power Plant (Brevard County, FL)-1
(7) FPL Canaveral Power Plant (Brevard County, FL-1
(8) FPL Riviera Beach Power Plant (Palm Beach County, FL)-1
(9) FPL Port Everglades Power Plant (Broward County, FL)-1
(10) FPL Fort Lauderdale Power Plant (Broward County, FL)-1
(11) Coral Gables Waterway (Dade County, FL)-1
(12) Sebastian River (C-54 canal) (Brevard County, FL)-2
(13) Vero Beach Power Plant (Indian River County, FL)-2
(14) Henry D. King Electric Station – Ft. Pierce Utilities (St. Lucie County, FL)-2
(15) Big Mud Creek (St. Lucie County, FL)-2
(16) Berkeley Canal (Brevard County, FL)-2
(17) Black Point Park/Black Creek (Dade County, FL)-2
(18) Palmer Lake (Dade County, FL)-2
(19) Little River (Dade County, FL)-2
(20) Turkey Point Canal (Dade County, FL)-2
(21) C-111 canal and canal just west of Card Sound Bridge (Dade County, FL)-2
(22) Biscayne Canal (Dade County, FL)-2
(23) Banana River Marine Service Marina (Brevard County, FL)-2
(24) Canals/Coves, Upper Keys (Bayside of Key Largo) (Monroe County, FL)-2
(25) Harbor Branch canal (St. Lucie County, FL)-2

West Coast:

Northwest Region

(26) Crystal River Springs Complex (Citrus County, FL)-1
(27) Homosassa River Springs Complex (Citrus County, FL)-1
(28) Weeki Wachee/Mud/Jenkins Creek Springs (Hernando County, FL)-1
(29) Progress Energy Crystal River Power Plant (Citrus County, FL)-2
(30) Manatee/Fanning Springs (Dixie County, FL)-2
(31) Wakulla/St. Mark's Complex (Wakulla County, FL)-2
(32) The 5 Santa Fe River springs, including Ichetucknee Springs (Various counties – FL) -2

Table 2 (cont.). Network of Primary[1] and Secondary[2] warm-water refuge sites.

West Coast:

Southwest Region

(33) TECO Big Bend Power Plant (Hillsborough County, FL)-1
(34) Warm Mineral Springs (Sarasota County, FL)-1
(35) Matlacha Isles (Lee County, FL)-1
(36) FPL Ft. Myers Power Plant (Lee County, FL)-1
(37) Port of the Islands (Collier County, FL)-1
(38) Progress Energy Anclote Plant (Pasco County, FL)-2
(39) TECO Gannon Plant (Hillsborough County, FL)-2
(40) Progress Energy Bartow Power Plant (Pinellas County, FL)-2*
(41) Ten Mile Canal Borrow Pit (Lee County, FL)-2
(42) Franklin Locks (Lee County, FL)-2
(43) Spring Bayou/Tarpon Springs (Pasco County, FL)-2
(44) Forked Creek (Sarasota County, FL)-2
(45) Tamiami Canal at Wootens (Collier County, FL)-2
(46) Big Cypress National Preserve Headquarters Canal (Collier County, FL)-2
(47) Sulphur Springs (Hillsborough County, FL)-2

[1]Attributes for (Primary Warm-Water Sites: (attributes are not mutually exclusive)

- consistent water temperature range (generally >20°C; >22°C for springs) sufficient to maintain manatees over a cold winter.
- consistent or dependent use by 50 or more manatees (seems like we need to have a number if this is to provide criteria for delisting and down listing)
- warm-water site of regional significance (e.g., elevated risk of cold stress, distance to other warm-water refuges, northern latitude of warm-water site or located in ambient waters that experience temperatures that are < 20°C for extended periods of time).

[2]Attributes for Secondary Warm-Water Sites: (attributes are not mutually exclusive)

- variable thermal plume temperatures
- sporadic manatee use of warm-water site
- winter areas of thermal advantage used predictably but not consistently

Table 3. Demographic indicators for Florida manatees by management unit.

Management Unit	Population Growth Rate (per year)	Minimum Population Size	Annual Conditional Reproductive Rate	Adult Survival Rates	Comments
Northwest	4.0% (95% CI 2.0 to 6.0%) 1986 – 2000 **(Runge *et al.* 2007)**	377 **(FWC *unpubl. data)***	0.43 (95% CI 0.22 – 0.54) 1982 – 1999 **(Kendall *et al*. 2004)**	0.959 SE 0.006 1986 – 2000 **(Runge *et al.* 2007)**	The number of manatees throughout region, including Crystal River and Kings Bay, has been increasing since the 1960s. The most recent aerial count for area was 274 manatees in 2005 (J. Kleen, Crystal NWR, *pers. comm.*).
Upper St. Johns River	6.2% (95% CI 3.7 to 8.1%) 1990 – 1999 **(Runge *et al.* 2004)**	112 **(FWC *unpubl. data)***	0.61 (95% CI 0.51 – 0.71) 1980 – 2000 **(Runge *et al.* 2004)**	0.960 SE 0.011 1990 – 1999 **(Langtimm *et al.* 2004)**	The number of manatees using Blue Spring has increased significantly. During the 2005 – 2006 winter, 182 manatees were counted (W.C. Hartley, FDEP Blue Spring State Park, *pers. comm.)*. In Blue Spring, survival of 1st year calves was estimated at 0.810 (0.727 – 0.873) and 2nd year calves at 0.915 (0.827-0.960) (Langtimm *et al.* 2004).
Atlantic Coast	3.7% (95% CI 1.1 to 5.9%) 1986 – 2000 **(Runge *et al.* 2007)**	1447 **(FWC *unpubl. data)***	0.38 (95% CI 0.29 – 0.47) 1982 – 1999 **(Kendall *et al*. 2004)**	0.963 SE 0.010 1986 – 2000 **(Runge *et al.* 2007)**	In contrast to FWC's estimate, Craig and Reynolds (2004) estimated the population size of animals using Atlantic Coast power plants in 2001 at 1606 (Bayesian credible interval: 1353 – 1972) They also identified trends in corrected aerial counts: 1982-1989, 5 to 7%;1990-1993, 0 to 4%; and, since 1994: 4 to 6%.
Southwest[1]	-1.1% (95% CI -5.4 to +2.4%) 1995 – 2000 **(Runge *et al.* 2004)**	1364 **(FWC *unpubl. data)***	0.60 (95% CI 0.42 – 0.75) 1993 – 1997 **(Koelsch 2001)**	0.908 SE 0.019 1995 – 2000 **(Langtimm *et al.* 2004)**	Estimated conditional, annual reproductive rate based on warm weather data from Sarasota Bay only, may not be representative of other regions.

[1]Parameter estimates for the Southwest have broader confidence intervals than those for the other management units. This is due to a number of factors, including: fewer years of photo-identification monitoring data, turbid water making photography difficult, and warmer weather in the south reducing the number of cold days when manatees are available for photography. Nonetheless, the current parameter estimates are the first published for this region and therefore reflect the best available information. More reliable information is expected for this management unit as geographic coverage, sample size, and years of study increase over time.

Table 4. Comparisons by Florida management unit and age class of the causes of death identified for animals recovered by the Manatee Carcass Recovery Program, 1986 through 2003. Percentages were calculated using the total number of animals for which cause of death could be identified. Manatees classified as not recovered, decomposed or undetermined were not included in the calculations (Runge 2003, MPSWG 2005).

Cause of Death Summary	**Northwest**			**Upper St. Johns River**			**Atlantic Coast**			**Southwest**		
	% of known cause of death			% of known cause of death			% of known cause of death			% of known cause of death		
	All ages	Adults	Non-adults	All ages	Adults	Non-adults	All ages	Adults	Non-adults	All ages	Adults	Non-adults
Known cause of death n =	170	48	122	59	25	34	1480	499	981	1404	536	868
Watercraft	25.3%	39.6%	19.7%	49.2%	72.0%	32.4%	34.7%	60.3%	21.7%	31.8%	44.2%	24.2%
Gate/Lock	1.2	2.1	0.8	8.5	16.0	2.9	6.1	12.6	2.9	1.9	3.9	0.6
Other Human	4.7	10.4	2.5	0.0	0.0	0.0	4.3	7.8	2.4	2.2	3.5	1.4
All Human-related causes	31.2	52.1	23.0	57.7	88.0	35.3	45.1	80.8	27.0	35.9	51.7	26.2
Perinatal	46.5	--	64.8	28.8	--	50.0	33.0	-	49.8	21.6	--	34.9
Cold Stress	10.0	18.8	6.6	6.8	0.0	11.8	9.4	4.8	11.7	6.5	0.9	9.9
Other Natural	7.6	16.7	4.1	6.8	12.0	2.9	12.4	14.4	11.4	12.2	11.0	12.9
Red Tide[1]	4.7	12.5	1.6	0.0	0.0	0.0	0.0	0.0	0.0	23.9	36.4	16.1
All Natural causes	68.8	47.9	77.1	42.4	12.0	64.7	54.8	19.2	72.9	64.2	48.3	73.8
Total n =	210	68	142	89	40	49	1981	718	1263	1859	696	1163
% of total not recovered, too decomposed, or undetermined	19.0%	29.4%	14.1%	33.7%	37.5%	30.6%	25.3%	30.5%	22.3%	24.5%	23.0%	25.0%

[1] Percentages include both determined and suspected red tide deaths. Red tide deaths from 1996 include all manatee deaths from the epizootic region that could not be attributed to any other cause of death and may include some deaths that were not red-tide related.

Table 5. Comparisons by Florida management unit of the causes of death identified for adult manatees, under different assumptions about the undetermined category, 1986 through 2003 (Runge 2003, MPSWG 2005).

Because a substantial portion of carcasses are in the undetermined category, the fraction of mortality due to each cause was calculated under three separate assumptions. The minimum value for the fraction of mortality due to a cause of death assumed that none of the mortalities in the undetermined category were due to that cause of death. The middle value assumed animals in the unknown group died from causes in the same proportion as the known group. The maximum value assumes all mortalities in the undetermined category are actually due to a particular cause of death. These three values represent the range of possible proportions due to a cause of death, given a lack of information about the fraction of undetermined deaths that actually belong in that category.

Cause of Death	Northwest n = 68			Upper St. Johns River n = 40			Atlantic Coast n = 718			Southwest n = 696		
	Minimum	Middle	Maximum	Minimum	Middle	Maximum	Minimum	Middle	Maximum	Minimum	Middle	Maximum
Watercraft	27.9	39.6	57.4	45.0	72.0	82.5	41.9	60.3	72.4	34.1	44.2	57.0
Gate/Lock	1.5	2.1	30.9	10.0	16.0	47.5	8.8	12.6	39.3	3.0	3.9	26.0
Other Human	7.4	10.4	36.8	0.0	0.0	37.5	5.4	7.8	35.9	2.7	3.5	25.7
All Human-related Causes	36.8	52.1	66.2	55.0	88.0	92.5	56.1	80.8	86.6	39.8	51.7	62.8
Cold Stress	13.2	18.8	42.6	0.0	0.0	37.5	3.3	4.8	33.8	0.7	0.9	23.7
Other Natural	11.8	16.7	41.2	7.5	12.0	45.0	10.0	14.4	40.5	8.5	11.0	31.5
Red Tide[1]	8.8	12.5	38.2	0.0	0.0	0.0	0.0	0.0	0.0	28.0	36.4	51.0
All Natural Causes	33.8	47.9	63.2	7.5	12.0	45.0	13.4	19.2	43.9	37.2	48.3	60.2

[1] Percentages include both determined and suspected red tide deaths. Red tide deaths from 1996 include all manatee deaths from the epizootic region that could not be attributed to any other cause of death and may include some deaths that were not red-tide related.

Table 6. Regional description of manatee habitat and region-specific threats for manatees in Florida.

Features	Northwest Management Unit	Southwest Management Unit	Atlantic Coast Management Unit	Upper St. Johns River Management Unit
Geographic Boundaries	Located along Florida's northwest coast, the southern boundary of the unit is defined by the Hernando/ Pasco county line. While the majority of use occurs east of the Wakulla River, manatees from this unit range as far west as Texas.	Located along Florida's southwest coast, the northern boundary is described by the Pasco/Hernando county line, extending south to the mouth of Whitewater Bay, along the western margin of the Everglades.	Includes Florida's coastal areas from south of the mouth of Whitewater Bay, through Florida Bay and north to the mid-Atlantic region. The unit extends into the St. Johns River as far south as Palatka.	This unit is located upstream of Palatka, Florida, extending to the headwaters of the St. Johns River.
Habitat Description	This unit incorporates coastal sea grass beds which extend from the shoreline out to the Gulf of Mexico. Significant features include the spring-fed Wakulla, Suwannee, Crystal, and Homosassa river systems, which empty into the Gulf.	This unit primarily includes in-shore and near-shore sea grass beds, which border mangrove systems to the south. Tampa Bay, Charlotte Harbor, and the Caloosahatchee River are dominant coastal features. There are numerous barrier islands south of Tampa Bay, accompanied by passes, inland waterways, etc. Tidal rivers and creeks are common in this area.	This unit primarily includes in-shore sea grass beds, which border mangrove systems to the south. Predominant features include Florida Bay, the Florida Keys, Biscayne Bay, and barrier islands and inland waterways that extend into the mid-Atlantic region. Significant waterways include the Indian River Lagoon, Banana River, and Mosquito Lagoon. From north Florida and into more northerly states, habitats are typified by large coastal rivers, such as the St. Johns River and coastal marshes.	This freshwater system includes extensive eel grass beds bordered largely by cypress and hardwood swamps. There are numerous rivers and lakes that make up this system. Notable features include the Ocklawaha River (dammed), Lake George, Lake Woodruff, and Lake Monroe. There are many small, spring-fed tributaries that discharge into this system.

Table 6 (cont.). Regional description of manatee habitat and region-specific threats for manatees in Florida.

Features	Northwest Management Unit	Southwest Management Unit	Atlantic Coast Management Unit	Upper St. Johns River Management Unit
Winter Sites	· Crystal River Springs Complex (Citrus) · Homosassa River Springs Complex (Citrus) · Weeki Wachee/ Mud Creek/ Jenkins Creek Springs (Hernando) · Progress Energy Crystal River Power Plant (Citrus) · Manatee/Fanning Springs (Dixie) · Wakulla/St. Mark's Complex (Wakulla)	· TECO Big Bend Power Plant (Hillsborough) · Warm Mineral Springs (Sarasota) · Matlacha Isles (Lee) · FPL Ft. Myers Power Plant (Lee) · Port of the Islands (Collier) · Progress Energy Anclote Plant (Pasco) · TECO Gannon Plant (Hillsborough) · Progress Energy Bartow Power Plant (Pinellas) · Ten Mile Canal Borrow Pit (Lee) · Franklin Locks (Lee) · Spring Bayou/Tarpon Springs (Pasco) · Forked Creek (Sarasota) · Tamiami Canal at Wootens (Collier) · Big Cypress National Preserve Headquarters Canal (Collier) · Sulphur Springs (Hillsborough)	· Reliant Energy Power Plant (Brevard) · FPL Canaveral Power Plant (Brevard County, FL ·FPL Riviera Beach Power Plant (Palm Beach) · FPL Port Everglades Power Plant (Broward) · FPL Fort Lauderdale Power Plant (Broward) · Coral Gables Waterway (Dade) · Sebastian River (C-54 canal) (Brevard) ·Vero Beach Power Plant (Indian River) · Henry D. King Electric Station – Ft. Pierce Utilities (St. Lucie) · Big Mud Creek (St. Lucie) · Berkeley Canal (Brevard) · Black Point Park/Black Creek (Dade County) · Palmer Lake (Dade) · Little River (Dade) · Turkey Point Canal (Dade) · C-111 canal and canal just west of Card Sound Bridge (Dade) · Biscayne Canal (Dade) · Banana River Marine Service Marina (Brevard) · Canals/Coves, Upper Keys (Bayside of Key Largo) (Monroe) · Harbor Branch canal (St. Lucie)	· Blue Spring (Volusia) · Silver Glen Springs (Marion) · DeLeon Springs (Volusia) · Salt Springs (Marion) · Ocklawaha River Springs Complex (Marion/Lake)

Table 6 (cont.). Regional description of manatee habitat and region-specific threats for manatees in Florida.

Features	Northwest Management Unit	Southwest Management Unit	Atlantic Coast Management Unit	Upper St. Johns River Management Unit
Habitat-related Concerns	Spring flow rates Water quality and SAV Storm-related impacts on habitat and adult survival Aquatic plant control activities Papillomavirus Human disturbance at warm-water springs	Manatee dependence on industrial warm-water discharges Storm-related impacts on habitat and adult survival Periodic red tide events Water quality and SAV Human disturbance Increasing boat traffic Water control structure-related deaths	Manatee dependence on industrial warm-water discharges Storm-related impacts on habitat and adult survival Water quality and SAV Human disturbance Increasing boat traffic High level of water control structure-related deaths	Spring flow rates Water quality and SAV Increasing boat traffic Water control structure-related deaths

Table 7. Existing International, Federal, and State of Florida regulatory mechanisms.

Laws	Citation	Description
International		
Convention on International Trade in Endangered Species of Wild Fauna and Florida (CITES)	27 U.S.T. 1087 T.I.A.S. No. 8249	Secures international cooperation to regulate trade that might threaten the survival of wild plant and animal species.
Federal		
Animal Welfare Act	7 U.S.C. 2131 et seq.	Provides regulatory standards for the maintenance, care, and transportation of captive animals.
Clean Water Act (Federal Water Pollution Control Act)	33 U.S.C. 1251 et seq.	Sections of the CWA protect manatee habitat viz the NPDES program which addresses thermal discharges, point source discharges and non-point source discharges.
Coastal Zone Management Act of 1972 and amendments	16 U.S.C. 1451 et seq.	Encourages states to protect coastal marine resources. For states that develop and implement coastal management programs, the Federal government provides financial incentives.
Endangered Species Act of 1973, as amended (ESA)	16 U.S.C. 1531 et seq.	Establishes policies for identifying, listing, and protecting species of wildlife that endangered or are threatened with extinction.

Federal Manatee Protection Areas	50 CFR 17 Subpart J	Provides for the designation of manatee refuges or sanctuaries in locations where there the taking of a single manatee is likely to occur.
Brevard Barge Canal Manatee Refuge (adopted Jan 7, 2002) Cocoa Beach Manatee Refuge (withdrawn July 7, 2005) Haulover Canal Manatee Refuge (adopted Nov 8, 2002) Sykes Creek Manatee Refuge (adopted Jan 7, 2002)	67 FR 693, 67 FR 66473. 69 FR 40805	Protects manatees from watercraft-related takings.
Charlotte Lemon Bay Manatee Refuge (adopted Nov 8, 2002) Peace River Manatee Refuge (adopted Nov 8, 2002)	67 FR 66473	Protects manatees from watercraft-related takings.
Citrus Blue Waters Manatee Sanctuary (adopted Nov 8, 2002) Kings Bay (Crystal River) Manatee Sanctuaries: Banana Island Sanctuary (northern shore) (adopted May 12, 1994) Banana Island Sanctuary (southern shore) (amended Feb 19, 1992) Buzzard Island Sanctuary (adopted May 12, 1994) Sunset Shores Sanctuary (amended Feb 19, 1992) Three Sisters Springs Manatee Sanctuary (adopted Oct 16, 1998) Vicinity of Paradise Isle Sub-division (Sanctuary) (amended Feb 19, 1992) Warden Key Sanctuary (adopted May 12, 1994)	FR 74881, 57 FR 5990, FR 24658, 63 FR 55556, 67 FR 66473	Protects manatees from in-water harassment.
Duval (and Clay and St. Johns counties) Lower St. Johns River Manatee Refuge (amended Apr 28, 2005)	68 FR 46898, 70 FR 21966	Protects manatees from watercraft-related takings.

Federal Manatee Protection Areas (cont.)	50 CFR 17 Subpart J	Provides for the designation of manatee refuges or sanctuaries in locations where there the taking of a single manatee is likely to occur.
Hillsborough Port Sutton Manatee Sanctuary (adopted Nov 8, 2002) Port Sutton Manatee Refuge (adopted Nov 8, 2002) TECO Big Bend Manatee Sanctuary (adopted Nov 8, 2002) TECO Big Bend Manatee Refuge (adopted Nov 8, 2002)	67 FR 66473	Protects manatees from watercraft-related takings.
Lee Caloosahatchee River- San Carlos Bay Manatee Refuge (adopted Aug 6, 2003) Pine Island-Estero Bay Manatee Refuge (amended May 23, 2005) Shell Island Manatee Refuge (adopted Nov 8, 2002)	67 FR 66473, 68 FR 46898, 70 FR 29458, 70 FR 29458	Protects manatees from watercraft-related takings.
Pinellas Bartow Electric Generating Plant Manatee Sanctuary (adopted Nov 8, 2002)	67 FR 66473	Protects manatees from watercraft-related takings.
Sarasota Little Sarasota Bay Manatee Refuge (adopted Nov 8, 2002) Pansy Bayou Manatee Refuge (withdrawn July 7, 2004)	67 FR 66473, 69 FR 40805	Protects manatees from watercraft-related takings.
Volusia Halifax and Tomoka Rivers Manatee Refuge(adopted Aug 6, 2003)	68 FR 46898	Protects manatees from watercraft-related takings.
Fish and Wildlife Coordination Act of 1958	48 Stat. 401; 16 U.S.C. 661 et seq.	Authorization to provide assistance and cooperation between Federal and State agencies to protect and increase supplies of game and fur-bearing animals, as well as to assess the effects of pollutants on wildlife.
Fishermen's Protective Act of 1967, Pelly Amendment	22 U.S.C. 1971 to 1980	Authorizes the President to restrict the importation of wildlife products from a nation that directly or indirectly engages in trade or taking that diminishes the effectiveness of any international program for endangered and threatened species.

Lacey Act	16 U.S.C. 3371-3378	Addresses the unlawful importation, export, sale, acquisition and purchase of fauna and flora collected in violation of U.S. or Indian law, as well as interstate or foreign commerce involving flora and fauna taken in violation of state or foreign law.
Magnuson-Stevens Fishery Conservation and Management Act	16 U.S.C. 1801	Ensures that all fisheries management plans assure optimum yields from specific fisheries while taking into account protection of marine ecosystems.
Marine Mammal Protection Act of 1972 (MMPA)	16 U.S.C. 1361 et seq.	Addresses the fate of individual marine mammal species, provides for protection of marine ecosystems, promotes research and international cooperation.
Marine Plastic Pollution Research and Control Act of 1987	33 U.S.C. 1912 - 1914	Implementing legislation for MARPOL, an international program that seeks to minimize discharges from ships.
Marine Protection, Research, and Sanctuaries Act of 1972 (aka Ocean Dumping Act)	16 U.S.C. 1431 et seq.	Provides for enhanced protection of unique areas in the marine environment.
Marine Resources and Engineering Development Act	16 U.S.C. 1431 et seq.	Addresses protection of coastal waters, including non-point sources; addresses the establishment of National Estuarine Research Reserves.
National Environmental Protection Act (NEPA)	42 U.S.C. 4321 et seq.	Requires reviews of legislation and other Federal actions that may affect the quality of the human environment.
National Park Service Organic Act	16 U.S.C. 1 et seq.	Conserves scenery, and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations.
Refuge Recreation Act	16 U.S.C. 460k	Authorizes the Secretary to administer refuges, hatcheries, and other conservation areas for recreational use when such uses do not interfere with the areas primary purpose

Rivers and Harbors Act	33 U.S.C. 304 et seq.	The Corps uses this authority to permit construction, excavation and fill activities in manatee habitat. As a Federal action, the ESA provides for a thorough review of these activities to ensure that they minimally affect listed species.
Wildlife Refuge System Administration Act	16 U.S.C. 668	Authorizes the Secretary of Interior to permit the use of any area within the National Wildlife Refuge System for any purpose, compatible with the major purposes for which such areas were established.

State of Florida[1]		
Crimes Animals: Cruelty	828.12	Identifies cruel acts and penalties for persons engaged in cruel or inhumane Actions towards to animals.
Florida Air and Water Pollution Control Act	403.011 f.s.	Insures that air and waters of the State meet certain quality standards.
Florida Aquatic Preserve Act	258.35 f.s.	Establishes aquatic preserves for the purpose of protecting biological, scientific, and aesthetic resources.
Florida Coastal Management Act of 1978	380.20 f.s.	Provides for developing, adopting, amending, and implementing a program for management of the coastal zone.
Florida Endangered and Threatened Species Act of 1977	372.072 f.s.	Provides for the conservation and management of endangered and threatened species.
Florida Environmental Land and Water Management Act of 1972 (DRIs)	380.012 f.s.	Provides for restoration of water quality and optimal use of state water resources.
Florida Environmental Protection Act of 1971	373.136 f.s.	Prevents any persons, agencies, or authorities from violating any laws, rules, or regulations that protect the air, water, and other natural resources of the state.

Florida Manatee Sanctuary Act 1978[2]	68C-22	Makes it unlawful in the State of Florida for anyone to intentionally or negligently treat a manatee, allows the State to promulgate rules to regulate boat speeds to prevent boat collisions with manatees and requires counties to develop manatee protection plans where substantial risks to manatees are likely.
Lee County Zones (amended Sep 20, 2005)	68C-22.005	Protects manatees from watercraft-related takings.
Brevard County Zones (amended June 24, 2002)	68C-22.006	Protects manatees from watercraft-related takings.
Indian River County Zones (amended Dec 12, 2002)	68C-22.007	Protects manatees from watercraft-related takings.
St. Lucie County Zones (amended Aug 16, 1994)	68C-22.008	Protects manatees from watercraft-related takings.
Palm Beach County Zones (amended July 20, 1993)	68C-22.009	Protects manatees from watercraft-related takings.
Broward County Zones (amended June 25, 1996)	68C-22.010	Protects manatees from watercraft-related takings.
Citrus and Associated County (Parts of Levy and Hernando) Zones (amended Nov 4, 2002)	68C-22.011	Protects manatees from watercraft-related takings.
Volusia and Associated County (Parts of Putnam, Lake, Seminole and Flagler) Zones (amended May 31, 1995)	68C-22.012	Protects manatees from watercraft-related takings.
Hillsborough County Zones (amended Jan 5, 2005)	68C-22.013	Protects manatees from watercraft-related takings.
Manatee County Zones (amended Jan 5, 2005)	68C-22.014	Protects manatees from watercraft-related takings.
Charlotte County (and Part of De Soto County) Zones (amended July 7, 2006)	68C-22.015	Protects manatees from watercraft-related takings.
Turkey Creek Zones Established (repealed June 24, 2002)	68C-22.018	Protects manatees from watercraft-related takings.
Manatee Cove Zone Established (repealed June 24, 2002)	68C-22.021	Protects manatees from watercraft-related takings.
Hillsborough County – Big Bend Zones Established (repealed June 24, 2002)	68C-22.022	Protects manatees from watercraft-related takings.
Collier County Zones (amended June 5, 1997)	68C-22.023	Protects manatees from watercraft-related takings.

Florida Manatee Sanctuary Act 1978[2] (cont.)	68C-22	Makes it unlawful in the State of Florida for anyone to intentionally or negligently treat a manatee, allows the State to promulgate rules to regulate boat speeds to prevent boat collisions with manatees and requires counties to develop manatee protection plans where substantial risks to manatees are likely.
Martin County Zones (adopted Dec 24, 1990)	68C-22.024	Protects manatees from watercraft-related takings.
Dade County Zones (adopted Dec 25, 1991)	68C-22.025	Protects manatees from watercraft-related takings.
Sarasota and Associated County (Parts of Manatee and Charlotte) Zones (amended Dec 12, 2002)	68C-22.026	Protects manatees from watercraft-related takings.
Duval County and Associated County (Parts of Clay and St. Johns) Zones (amended Aug 1, 2000)	68C-22.027	Protects manatees from watercraft-related takings.
Florida State Comprehensive Planning Act of 1972	186.001 f.s.	Establishes an integrated planning system ensures the coordinated administration of government policies that address a multitude of issues posed by the state's continued growth and development. (Includes the State's DRI process.)
Florida Statutes, Inhumane Treatment of Animals	828.12 f.s.	Provides for penalties for any person who kills any animal, or causes the same to be done, in a cruel or inhumane manner
Florida Water Resources Act	373.217 f.s.	Authorizes certain state agencies to regulate storm water management systems and the withdrawal, diversion, storage and consumption of water. Most significantly, this Act provides for spring protection through the establishment of minimum flows.

[1]In addition to Florida county regulatory measures (boat speed restrictions, sanctuaries, boat facility siting restrictions, etc.), numerous Florida municipalities have ordinances addressing similar manatee related concerns. These municipalities include (but are not limited to): Anna Maria, Boca Raton, Bradenton, Clearwater, Cocoa Beach, Crystal River, Fernandina Beach, Fort Pierce, Fort Walton Beach, Holmes Beach, Indian Shores, Inglis, Key Colony Beach, Key West, Lynn Haven, Marco Island, Melbourne, Naples, New Port Richey, New Smyrna Beach, North Port, Port Orange, Port Richey, Port St. Lucie, Sanibel, Sarasota, Sebastian, Seminole, St. Augustine, Stuart, Tampa, Tarpon Springs, Treasure Island, Wakulla, and West Palm Beach.

Table 7 (cont.). Existing International, Federal, and State of Florida Regulatory Mechanisms.

[2]The Florida Manatee Sanctuary Act requires certain counties to adopt county manatee protection plans. The following counties have adopted plans: Brevard County (2003), Broward County (2005), Citrus County (1991), Clay County (2006), Collier County (1995), Duval County (1999), Indian River County (2000), Lee County (2004), Levy County (1995), Martin County (2002), Miami Dade County (1995), St. Lucie County (2002), and Volusia County (2005). (Palm Beach County was also required to develop an MPP; while they currently have a county approved plan, the plan has yet to be adopted by FWC). The following counties have local ordinances that include manatee protection areas: Hernando and Pinellas counties.

NOTE: The states of Georgia, South Carolina, North Carolina, Virginia, Alabama, Mississippi, Louisiana, Texas, and others have natural resource regulations that provide manatees with protective measures when the species appears in local waters.

Table 8. Florid a water control structure and navigational lock retrofitting status.

Structures	Retrofitting Date	Region
Navigational Locks		
Inglis Lock	Closed	Northwest
S-193	1994	Atlantic
St. Lucie Lock	1998	Atlantic
Port Canaveral Lock	2000	Atlantic
Buckman Lock	2001	Upper St. Johns
Moore Haven Lock	2007*	Southwest
Port Mayaca Lock	2007*	Southwest
Ortona Lock	2006*	Southwest
Franklin Lock	2008*	Southwest
Vertical Navigational Locks		
S-131	2000	Southwest
S-135	2000	Atlantic
G-36	2001	Atlantic
S-127	2004	Atlantic
S-310	2009*	Southwest
Water Control Structures		
S-26	1996	Atlantic
S-29	1997	Atlantic
S-25B	1998	Atlantic
S-27	1998	Atlantic
Rodman Dam	2002	Upper St. Johns
S-21	2002	Atlantic
S-22	2002	Atlantic
S-28	2002	Atlantic
G-93	2002	Atlantic
S-20F	2003	Atlantic
S-20G	2003	Atlantic
S-21A	2003	Atlantic
S-13	2004	Atlantic
S-123	2004	Atlantic
S-25	2006	Atlantic
S-33	2006	Atlantic
S-36	Not PCA Projects	Atlantic
Rocky Creek	Not PCA Projects	Southwest
Lake Tarpon	Not PCA Projects	Southwest

* = projected completion dates.

Table 9. Probability of the adult manatee population falling below various thresholds (100, 250, or 500 animals) on either the Gulf coast or the East coast of Florida. The scenarios consider the removal of threats one at a time (except the last which removes the threats due to both watercraft and loss of warm-water). For example, in the absence of the threat due to water control structures, the probability is 4.34% that the adult population will fall below 250 animals on either the East or Gulf coasts within 100 yr, compared to a probability of 8.60% with the threat present at its current level (status quo).

Scenario	Threshold	50 yr	100 yr	150 yr
Status quo	**100**	**0.18 %**	**1.02 %**	**1.94 %**
–Watercraft	100	0.00 %	0.02 %	0.02 %
–Warm-water	100	0.16 %	0.52 %	0.88 %
–Red tide	100	0.01 %	0.66 %	1.28 %
–WCS	100	0.04 %	0.40 %	0.82 %
–Entanglement	100	0.02 %	0.46 %	0.86 %
–Watercraft & WW	100	0.00 %	0.00 %	0.00 %
Status quo	**250**	**2.46 %**	**8.60 %**	**13.10 %**
–Watercraft	250	0.12 %	0.38 %	0.60 %
–Warm-water	250	1.66 %	4.20 %	6.04 %
–Red tide	250	1.84 %	6.90 %	10.72 %
–WCS	250	1.18 %	4.34 %	7.18 %
–Entanglement	250	1.36 %	4.58 %	7.68 %
–Watercraft & WW	250	0.08 %	0.12 %	0.14 %
Status quo	**500**	**26.36 %**	**49.32 %**	**59.82 %**
–Watercraft	500	2.20 %	5.82 %	9.08 %
–Warm-water	500	18.04 %	25.06 %	29.14 %
–Red tide	500	19.52 %	40.36 %	50.66 %
–WCS	500	15.90 %	35.64 %	46.32 %
–Entanglement	500	16.32 %	36.90 %	47.08 %
–Watercraft & WW	500	0.84 %	1.18 %	1.40 %