
PART II. RECOVERY

The goal of this revised recovery plan is to assure the long-term viability of the Florida manatee in the wild, allowing initially for reclassification from endangered to threatened status (downlisting) and ultimately removal from the List of Endangered and Threatened Wildlife (delisting).

This section of the Recovery Plan presents: (A) details on an upcoming status review; (B) objective and measurable recovery criteria; (C and D) site-specific management actions to monitor and reduce or remove threats to the Florida manatee; and (E) Literature Cited. The steps for reclassification and removal from the list are consistent with provisions specified under sections 4(a)(1), 4(b), 4(c)(2)(B), and 4(f)(1) of the ESA. The FWS must, 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. In designing these criteria, the FWS has addressed the five statutory listing/recovery factors (section 4(a)(1) of the ESA, (see page 1) to the current extent practicable.

A. STATUS REVIEW

The 1967 Federal Register Notice (32FR406) designating the West Indian manatee and several other species as “endangered” did not provide a detailed explanation for the listing. Since the manatee was designated as an endangered species prior to enactment of the ESA (1973), there was no formal listing package identifying threats to the species, as required by Section 4(a)(1). Under section 4(c)(2) of the ESA, the FWS is charged with periodically reviewing the the status of species included in the List of Endangered and Threatened Wildlife to determine whether any species should change in status from a threatened species to an endangered species, change in status from an endangered species to a threatened species, or be removed from the List.

During the 20 years since approval of the first manatee recovery plan, a tremendous amount of knowledge has been gained about manatee biology and ecology and significant protection programs have been implemented. The knowledge and the results of these protection programs are reflected in this recovery plan. The Manatee Population Ecology and Management Workshop scheduled for April 2002 will update and review the science and population ecology of manatees, including an assessment of the recovery criteria presented in this plan. The FWS has determined that the year following this workshop is an appropriate time to conduct a thorough status review of the Florida manatee and anticipates this review to take place in 2003.

The review will include:

- (1) a detailed evaluation of the population status using the most up to date demographic data and other biological indices available (The FWS anticipates that much of this data will come from the April 2002 Manatee Population Ecology and Management Workshop);
- (2) an evaluation of the status of manatee habitat as it relates to recovery;
- (3) an evaluation of the existing threats to the species and the effectiveness of existing mechanisms to reduce or remove those threats (e.g., adequate protection areas, signage, enforcement, education and compliance have resulted in a reduction or minimization of watercraft deaths) as prescribed in this recovery plan;
- (4) recommendations, if any, regarding reclassification of the Florida manatee; and
- (5) if necessary, recommendations to update or modify recovery criteria.

B. RECOVERY CRITERIA

RECLASSIFICATION FROM ENDANGERED TO THREATENED (DOWNLISTING)

The near and long term threats from human-related activities are the reasons for which the Florida manatee currently necessitates protection under the ESA. The focus of recovery is not on how many manatees exist, but instead the focus is on implementing, monitoring and addressing the effectiveness of conservation measures to reduce or remove threats which will lead to a healthy and self-sustaining population. The Florida manatee could be considered for reclassification from endangered to threatened status if the following listing/recovery and demographic criteria are met:

LISTING/RECOVERY FACTOR CRITERIA: Tasks listed with each criterion are examples of actions that may reduce or remove the identified threats and were developed from recovery team discussions.

Listing/Recovery Factor A: The Present or Threatened Destruction, Modification, or Curtailment of a Species Habitat or Range (Habitat Working Group and Warm-water Task Force 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 (identified in Factor D below) to establish 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 identified by the WMDs or other organizations.(Task 3.2.4.3)
- b. A network of the level 1 and 2 warm-water refuge sites identified in Figure 7 are 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. Feeding habitat sites (extent, quantity and quality) associated with the network of warm-water refuge sites above in (b) have been identified by the HWG for protection. (Task 3.1(3), 3.3.8).
- d. A network of migratory corridors, feeding areas, calving and nursing areas are identified by the HWG to be protected as manatee sanctuaries, refuges and/or safe havens 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. (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 reclassification (downlisting) 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 reclassification.

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 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” (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 Endangered Species 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 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. (Task 1.3, 1.4, 1.5, 3.3.1)
- b. One half of the water control structures and navigational locks listed as needing devices to prevent mortality have been retrofitted. (Task 1.6)
- 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. (Task 1.7, 1.6.3)

DEMOGRAPHIC CRITERIA: The annual synoptic surveys have too many weaknesses to reliably gauge the health of the population (see discussion of Population Size in the Introduction and in Appendix D). Therefore, the FWS has established population related benchmarks for certain aspects of manatee demographics (based upon mark/recapture studies and population modeling) that it will use to help determine the success of manatee conservation efforts. These are derived from the MPSWG’s Recommendation for Population Benchmarks To Help Measure Recovery (Appendix A). 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.

The current 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 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 (approximately one manatee generation), we 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 (outlined above) are also met.

REMOVAL FROM THE LIST OF ENDANGERED AND THREATENED WILDLIFE (DELISTING)

The Florida manatee could be considered for removal from the List of Endangered and Threatened Wildlife if the following listing/recovery and demographic criteria are met:

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, 2 and 3 warm-water refuge sites identified in Figure 7 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 removed 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: 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 MPSWG 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.

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D. NARRATIVE OUTLINE OF RECOVERY ACTIONS

OBJECTIVE 1: Minimize causes of manatee disturbance, harassment, injury, and mortality.

Manatees are killed and injured as a result of interactions with boats, water control structures, navigational locks, stormwater pipes, marine debris, and fishing gear. In rare cases, manatees are killed by vandals and poachers. Additional mortalities from natural causes, such as severe cold weather or red tide, may also significantly affect the status of the manatee population. To permit maintenance and/or growth of the manatee population to attain recovery, such causes of mortality, injury, harassment and disturbance must be minimized. This section of the recovery plan identifies activities needed to minimize sources of disturbance, harassment, injury, and mortality.

1.1 Promulgate special regulations for incidental take under the MMPA for specific activities.

FWS will evaluate its programs related to watercraft operation and watercraft access facilities and promulgate incidental take regulations under the MMPA for FWS activities (e.g., operation of vessels, managing surface waters and recreation on NWRs, and funding of boat ramps through Federal Aid). The process will lead to appropriate modification to FWS activities to ensure that such activities are minimized to the maximum extent practicable and ensure that these activities will have no more than a negligible impact on the manatee. FWS believes that programs of other federal and state agencies would benefit from a similar review and rule promulgation process.

1.2 Continue state and federal review of permitted activities to minimize impacts to manatees and their habitat.

There are three separate processes where state and federal agencies provide biological review in order to minimize impacts to manatees and their habitat. These are: (1) review of permits for development activities (such as marinas, boat ramps, and other boat-related facilities) and dredge and fill activities; (2) review of permits for marine events (boat races and regattas); and (3) review of permits for power plants and other industrial outfalls (authorization to discharge warm water through the NPDES permit). FWS, FWC and GDNR should continue to participate in all of these review processes.

1.2.1 Continue to review coastal construction permits to minimize impacts.

Dredge and fill activities and coastal construction of facilities such as marinas or large docks require permits from the COE, environmental resource permits from FDEP or the WMDs, and, in some cases, submerged land leases from Florida's Board of Trustees, and in Georgia from the GDNR Coastal Resources Division. There are several aspects of these development projects that must be considered. First, the construction process itself should be conducted in a way to minimize the direct risk to manatees. Second, the permanent effect of the facility once

it is built must be considered. For example, facilities should be designed to minimize shading of submerged aquatic plants. Third, the intended use or indirect effects of the project must also be considered. Marinas, boat ramps, and docking facilities can alter boat traffic patterns and increase boat traffic in specific areas, thus potentially increasing the possibility that manatees will be injured or killed. The effects of that traffic should be considered in the permit evaluation. Finally, the cumulative effect of multiple projects must be taken into account. While the impacts of a small single project may be negligible, multiple small projects may have a cumulative effect as great or greater than single large projects.

FWC will continue to provide assessments and recommendations on permit and submerged land lease applications to FDEP or appropriate WMD. GDNR Wildlife Resources Division will continue to provide assessments and recommendations on permit applications to the Coastal Resources Division. These permitting agencies have specific state statutory obligations to protect listed species and should use the recommendations provided by FWC and GDNR in meeting those obligations. In addition, FWC and GDNR will actively coordinate on an annual basis with the permitting agencies to ensure that the best data are available, that communication remains unimpeded, and that the review process is efficient and effective. FWS will continue to provide consultations, pursuant to section 7 of the ESA and other federal laws to the COE, USCG, and other federal agencies on permit applications where it has been determined that the activity may affect manatees or any other listed species and/or their habitat. This formal review process is a fundamental part of the manatee recovery program and must be continued. (Also refer to Task 3.3.5 regarding regulatory recommendations supporting habitat conservation.)

- 1.2.2 Minimize the effect of organized marine events on manatees.** Marine sport events may also affect manatees, and many of these events require permits from the USCG. Under section 7 of the ESA and other federal laws, the FWS reviews and comments on permit applications where it has been determined that the activity may affect manatees or any other listed species. In order to provide guidance to the USCG regarding the types of events and the locations where manatee conditions are needed, standard draft guidelines were prepared. These are also intended to assist event planners involved in the planning process for boat races, fishing tournaments, water ski events, boat parades, and other organized boating events. The guidelines and standard conditions pertaining to when, where, and under what conditions such events could be held consistent with manatee protection objectives, should be updated and agreed upon by FWS and FWC. These guidelines should be distributed to

the USCG groups in Florida. The USCG, in following those guidelines, should consult with FWS on appropriate events. FWC should provide technical expertise and data where needed to assist FWS in the review.

- 1.2.3 Continue to review NPDES permits to minimize impacts.** The NPDES has been approved by the Environmental Protection Agency (EPA) to be implemented by FDEP and GDNR. Power plants and other industries that discharge into state waters are required to obtain a NPDES permit. In Florida, power plants that have the potential to affect manatees because of the attraction of a warm-water discharge are required to have a power plant manatee protection plan (MPP) as part of the permit. FWC works directly with the utilities in the development of the plan. FWC provides a recommendation to FDEP whether to accept, modify, or reject the MPP. FWS also reviews the plan and provides an assessment. This program ensures that issuance of the NPDES permit for discharge of warm water into ambient waters of the State of Florida by powerplants includes FWS- and FWC-approved plans. GDNR Nongame and Endangered Wildlife Program provides an assessment and recommendations to the GDNR Environmental Protection Division on NPDES permits in Georgia. This permit review process should be continued. (Task 3.2.2 provides further discussion of NPDES permits.)
- 1.2.4 Pursue regulatory changes, if necessary, to address activities that are “exempt,” generally authorized, or not covered by state or federal regulations.** FWS should look at non-regulated coastal construction projects or projects authorized under general permits to assess their cumulative impact on manatees. FWS should propose changes to existing regulatory programs as appropriate to minimize such impacts.
- 1.3 Minimize collisions between manatees and watercraft.** Significant work is needed to monitor, review, assess needs to update existing protection zones (Task 2.7.2), develop new zones warranted in other areas, and make vessel operators aware of those zones. FWC has the responsibility for developing and amending state waterway speed and access rules to protect manatees. These rules aim to reduce the risk of collisions between manatees and watercraft by considering both manatee use patterns and the needs of the boating public. Further, under the authority of the ESA and MMPA and their implementing regulations at 50 CFR 17, FWS may designate certain waters as manatee protection areas, within which certain waterborne activities will be restricted or prohibited for the purpose of preventing the taking of manatees. Actions to address these needs are discussed below. In addition to these methods, alternative strategies minimizing collisions between manatees and watercraft should be investigated (Tasks 1.5.1, 1.5.2, 2.8.12, and 2.8.16).

- 1.3.1 Develop and refine state waterway speed and access rules.** FWC is responsible for developing and amending state waterway speed and access rules to protect manatees under the State of Florida Manatee Sanctuary Act. FWC will monitor and review the effectiveness of existing zones and make appropriate modifications as needed. FWC will establish additional zones, as needed, to protect manatees throughout the state and implement where appropriate.
- 1.3.2 Develop and refine federal waterway speed and access rules.** As necessary and appropriate, federal rules should be promulgated and existing rules should be modified in cooperation with the State of Florida and other concerned parties to protect the manatee. Particularly, waterways in or adjacent to NWRs, National Parks, and other federally-managed areas within manatee habitat should be protected as warranted. Under the authority of the ESA and MMPA and their implementing regulations at 50 CFR 17, FWS may establish boating speed and access rules in conjunction with efforts to designate certain waters as manatee sanctuaries (areas where all waterborne activities are prohibited), no entry areas or manatee refuges (areas where certain waterborne activities such as boat speeds may be regulated) (Task 3.3.1).
- 1.3.3 Post and maintain regulatory signs.** The effective use of regulatory and informational signs is essential in providing the public with on-site information on manatee protection measures. Sign messages, to the greatest extent possible, should be uniform, understandable, and concise. Sign design and placement should provide for uniformity, rapid identification as a regulatory sign, and should be located at a site where it is readily observable to the target audience. Regulated areas should be posted by the appropriate agency. Of critical need is the continued effort to inspect and repair/replace signs as needed in an expedient manner. A task force, which includes the USCG, FWC, FWS, the navigation districts, and those counties with sign-posting responsibilities needs to be established. This task force should focus on improving the sign-posting and maintenance process and will explore innovative sign designs that would contribute to better compliance and enforcement.
- 1.4 Enforce manatee protection regulations.** Enforcement is one the highest priorities for manatee recovery. Compliance with manatee protection regulations will reduce human-caused manatee mortality, particularly that caused by watercraft collisions. Effective enforcement of these regulations is needed to maximize protection efforts and to minimize manatee injuries and deaths.

(Also refer to Task 1.11 and its related tasks regarding enforcement of regulations prohibiting harassment).

- 1.4.1 Coordinate law enforcement efforts.** Enforcement of manatee protection rules is provided by officers of FWS and FWC-DLE, USCG, and local law enforcement agencies, as well as the courts. To ensure compliance with the waterway speed and access rules and with manatee harassment provisions, enforcement capabilities must be expanded and coordinated. Although efforts have increased significantly during the past two years, manatee enforcement operations still must be expanded in both geographic scope and frequency. To meet these needs, federal and state enforcement agencies should take all possible steps to increase funding and heighten agency priority for manatee-related law enforcement activities. Those activities should be maintained at levels commensurate with those of vessel traffic, watercraft-related manatee deaths, and added enforcement responsibilities. To carry out enforcement activities as efficiently and cost-effectively as possible, involved agencies are encouraged to coordinate enforcement efforts. In addition, enforcement agencies should review and assist as possible with the development of new manatee protection statutes and regulations, the posting of manatee regulatory signs, enforcement training seminars, studies to monitor regulatory compliance, and actions by the judiciary to prosecute violations.
- 1.4.2 Provide law enforcement officer training.** Law enforcement officers responsible for enforcing manatee regulations need to receive training in order to acquire knowledge and skills to enhance their abilities. Officers should be given training on manatee regulations during appropriate agency training courses. Refresher training should be conducted annually at appropriate opportunities.
- 1.4.3 Ensure judicial coordination.** Designated personnel will meet periodically with members of the judiciary to ensure their knowledge of present manatee protection regulations or changes thereto, as well as to provide a forum for information exchange.
- 1.4.4 Evaluate compliance with manatee protection regulations.** Compliance with manatee protection regulations is paramount to their subsequent success. FWS, FWC, and local governments should evaluate compliance with manatee protection regulations through research, surveys and other methods to ensure effectiveness and to identify needed improvements (Task 2.7.2.2.).

- 1.4.5 Educate boaters about manatees and boater responsibility.** State-wide speed limits, boat operator licenses, and mandatory boater education will enhance efforts to reduce watercraft-related manatee deaths by offering opportunities to educate boaters about rules to protect manatees and to reduce boat speeds in other areas where manatees may occur. New proposals to establish state-wide boating safety measures should be encouraged. Particular efforts should be made to integrate manatee protection concerns into any new boater education programs (Tasks 4.1 through 4.3.). A website should be developed to allow the public and boating community easy access to manatee protection zone information (Task 4.2.2).
- 1.4.6 Evaluate effectiveness of enforcement initiatives.** In recent years, both federal and state agencies have been using targeted enforcement strategies in an attempt to increase boater compliance with speed zones and ultimately reduce manatee injuries and death. FWS strategy has been to allocate significant enforcement manpower to specific areas on designated weekends. These enforcement teams travel to various locations around the state, with particular emphasis given to those zones within counties where there is a history of high watercraft-caused manatee deaths. FWC has increased its emphasis on enforcement and compliance with manatee speed zones by adding new officers, conducting law enforcement task force initiatives, increasing overtime, and increasing the proportion of law enforcement time devoted to manatee conservation. FWS and FWC should evaluate the effectiveness of these and other enforcement efforts and make adjustments, as appropriate. The research should evaluate if there are significant changes in boater compliance as a result of additional enforcement, and determine the residual effect of the enforcement efforts, if any.
- 1.4.7 Provide updates of enforcement activities to managers.** It is important for managers to have a good understanding of enforcement activities and special initiatives in order to determine if the desired outcomes (reduction of manatee injury/death and enhanced public awareness and compliance) are achieved. In addition, up-to-date information on enforcement activities is needed for outreach and media contacts. As part of a new manatee enforcement initiative, FWC provides updates of manatee-related enforcement every other week to FWC managers. Such data summary and distribution should continue. Other law enforcement agencies also should provide similar updates of their special enforcement details. Information provided in the updates should be standardized across agencies so that a law enforcement database can be developed to provide information on effort, number of

citations and/or other contacts, vessel registration, size, type, disposition of the case, and other pertinent information.

1.5 Assess and minimize mortality caused by large vessels. Large vessels (e.g., tugs and cargo vessels) and large displacement hull vessels are known to kill manatees. Some animals appear to be pulled into propeller blades by the sheer power of generated water currents, while others are crushed between the bottom and the hull of deep draft ships. When moored, large vessels also can crush manatees between their hulls and adjacent wharves or ships.

1.5.1 Determine means to minimize large vessel-related manatee deaths. Studies should be undertaken to: (1) further review mortality data for evidence of deaths attributable to large vessels; (2) examine barge, tug, and other large vessel traffic patterns relative to manatee distribution; (3) assess the feasibility and cost of installing propeller guards or shrouds on large displacement hull vessels or tugs routinely plying waterways used by manatees; (4) evaluate ways to educate harbor pilots about threats large vessels pose to manatees; and (5) identify other possible mitigation measures to minimize these threats. Actions to implement appropriate measures should be taken based on study findings.

1.5.2 Provide guidance to minimize large vessel-related manatee deaths. FWS and FWC will promote use of devices such as fenders to maintain minimum stand-off distances of four feet at maximum compression between moored vessels and between vessels and wharves to minimize manatee deaths. If studies support actions to address the threat of large vessel propeller-related incidences to manatees, it is recommended that propellers of large displacement hull vessels, particularly tugs that tend to remain in harbors or rivers, be retrofitted with a propeller guard or shroud to reduce these types of mortalities.

1.6 Eliminate manatee deaths in water control structures, navigational locks, and drainage structures. The second largest source of human-related manatee death is due to entrapment in water control structures and navigational locks. These structures are owned and operated by the WMDs, COE, and FDEP and are primarily located in South Florida. They have been responsible for an average of 10 manatee deaths per year since 1995 and a total of 167 deaths since 1976. An ad hoc interagency task force was established in 1991 (current members include South Florida WMD, COE, FWS, DERM, FWC, and FDEP) to examine steps to prevent such deaths. This group meets at least twice a year to discuss recent manatee deaths and measures to protect manatees from structure-related mortality. The overall goal is to eliminate completely structure-related deaths.

In addition to causing crushing deaths, manatees may become trapped in the extensive canal systems of south Florida. Manatees passing through open structures become trapped once the structures close, due to changing water conditions. Manatees trapped in the shallow canal systems are vulnerable to cold stress during the winter. An evaluation and mapping of manatee-accessible canals is needed, and actions should be taken to prevent manatee entry into these areas.

FWS also should assess the need for manatee protection technology and help to update standard operating procedures at the lock systems at Lake Moultrie, South Carolina and Lake Seminole, Florida/Georgia.

Entrapment in drainage structures such as pipes, culverts and ditches also lead to injury and death of manatees. Installation of barriers or guards on such structures can prevent future entrapments.

1.6.1 Install and maintain protection technology at water control structures where manatees are at risk and monitor success. Pressure sensor devices have been installed at the five water control structures in south Florida through a South Florida WMD/COE cooperative project. Although the success of these devices generally has been encouraging, two structures equipped with the device have failed to eliminate all manatee deaths at them. An investigation at S-25B, after two deaths in December 1999, revealed that modifications to the sensitivity were required to provide the needed protection for manatees; after a manatee death at S-27 in January 2000, the South Florida WMD moved the manatee sensor strips in an attempt to get them closer to the actual gate. Thus, while it has been demonstrated that manatees can be successfully protected through the installation of pressure devices at water control structures, it is possible that as more devices are installed and operated, occasional failures will occur until all site-specific maintenance and installation needs are identified and resolved.

Twenty identified water control structures should be equipped with a manatee protection system (MPS) (pressure devices or removable barriers) by the year 2004. Removable barriers should be installed at structures where the pressure sensor devices are not feasible or appropriate. Standard operating procedures to protect manatees also have been developed for periods when the barriers are removed for high flow or cleaning the debris off the barriers. MPSs will be installed at additional water control structures in the Central and South Florida Project on a case-by-case basis as part of the Comprehensive Everglades Restoration Plan (CERP), and standard operating procedures and the need for a MPS should be assessed and installed as needed for other structures in manatee habitat.

The FDEP is designing and preparing to install barriers at the Kirkpatrick Dam, the tainter valve culvert pipes at Buckman Lock, and the downstream side of Inglis Lock. FDEP anticipates to complete this work during the summer of 2001.

- 1.6.2 Install and maintain protection technology at navigational locks where manatees are at risk and monitor success.** Manatee protection devices have been installed at the St. Lucie, Port Canaveral, and Taylor Creek Locks. The long-term plan is to continue installing these protective devices on the remaining locks in order of their potential to harm manatees until all such structures are equipped with manatee protection devices. The COE should continue to partner with local sponsors to accomplish this retrofitting as quickly as possible. The COE should prepare an annual report assessing the performance of the manatee protection devices and evaluating the needs for modification and improvement.

FDEP has contracted with HBOI to install an acoustic array system at Buckman Lock similar to arrays installed at the COE's Canaveral and St. Lucie Locks. FDEP plans to reopen Buckman Lock for operation once the manatee protection systems are installed on both the Buckman Lock and Kirkpatrick Dam. It is anticipated that these projects will be completed during the summer of 2001 (the State of Florida has also budgeted \$800,000 to begin restoring the Oklawaha River). Currently FDEP's Inglis Lock at Lake Rousseau/Withlacoochee River is not operating; long-term plans are to replace the existing lock with a smaller one which includes manatee protection equipment.

- 1.6.3 Minimize injuries and deaths attributable to entrapment in drainage structures.** Sites where manatees have been rescued or died due to entrapment in drainage structures should be identified and, as warranted, steps taken to install barriers or guards which prevent such entrapment at these culverts or drainage structures. Additionally, stormwater outfalls or similar drainage structures in aggregation areas should be retrofitted with appropriate barriers to prevent manatee entrapment. Federal, state, and local permits should require that new drainage structures (greater than 18 but less than 84 inches in diameter) in manatee habitat be grated or otherwise made inaccessible to manatees.

- 1.6.4 Assess risk at existing and future water control structures and canals in South Florida.** Using existing data bases and/or field inspections, categorize all structures as to whether manatees could pass through the structure, and what level of risk the structure poses. Similarly, characterize all canals (including minor irrigation ditches and storm water connector canals) as to whether manatees have access. Based on interagency

recommendations, some canals may be designated as off-limits to manatees. The South Florida WMD should establish manatee-safe barriers to prevent access to designated areas. The CERP will dramatically alter the water delivery system in south Florida. New canals and water retention areas will be created, and existing canals will be modified or eliminated. It is critical that the COE and South Florida WMD coordinate closely with FWS and FWC and consider impacts to manatees from this long-range restoration project. Only manatee-safe structures should be installed, and manatee access to newly-created areas should be evaluated by the interagency task force.

1.7 Minimize manatee injuries and deaths caused by fisheries and entanglement. Due to the dynamic nature of commercial and recreational fishing and gear, information on interactions with fishing techniques and gear should be kept under review by FWS, GDNR, and FWC, and measures to reduce or avoid such interactions should be taken. This review should also assess the impacts of the mariculture industry and develop recommendations to minimize impacts to manatees and habitat. To minimize adverse entanglement interactions, the following steps are needed. A working group, which was established in 1999 to address fishery and marine debris and to make recommendations to minimize impacts, should continue to meet regularly.

1.7.1 Minimize injuries and deaths attributed to crab pot fishery. With the recent increasing trend of manatee rescues from crab trap buoy lines, information on interactions with buoy lines should be kept under review by FWC and FWS, and steps should be taken to improve reporting and documentation of such incidents. Steps to identify and implement measures which would reduce or avoid such interactions should be taken, including research regarding gear interactions and ways to avoid them, outreach, and promulgation of regulations (e.g., gear modification) if necessary.

1.7.2 Minimize injuries and deaths attributed to commercial and recreational fisheries, gear, and marine debris. Sites where interactions with recreational and/or commercial fishing gear occur should be identified and, as warranted, steps should be taken to assess and implement actions to prevent potentially threatening interactions with fishing gear. Strategies to reduce monofilament entanglements also need to focus on educating the fishing community on properly discarding monofilament and provide an avenue for recycling it. Strategies also should encourage underwater and drift line debris clean-up of monofilament and other debris in popular fishing areas used by manatees (Task 2.7.4).

- 1.8 Investigate and prosecute all incidents of malicious vandalism and poaching.** Poaching, shooting, butchering, and other malicious vandalism against manatees are rare occurrences. All reports and evidence regarding such incidents should be turned over to FWS law enforcement agents for investigation and prosecution to the fullest extent of the law.
- 1.9 Update and implement catastrophic plan.** FWS and FWC Contingency Plans for Catastrophic Rescue and Mortality Events for the Florida Manatee should be reviewed annually and updated as needed by those who would be involved in the response. Additionally, guidance and notification procedures between FWC and FWS should be developed and updated as needed for events that do not reach unusual or catastrophic levels in order for such events to be documented.
- 1.10 Rescue and rehabilitate distressed manatees and release back into the wild.** Thousands of reports have been provided by the public regarding sick, injured, orphaned, entrapped, and wayward manatees that appear to be in need of assistance. While many clearly do not require intervention, 30 to 40 manatees are rescued every year. Some are assisted and immediately released, while others are taken to one of three critical-care facilities for supportive treatment. Animals successfully treated are released, and to the extent possible, their progress is monitored through tagging and tracking studies. Publicity surrounding distressed manatees, their rescues, treatment, and outcome help to educate millions of people every year about manatees and the problems that they face. The number of manatees successfully treated and released back into the wild provides an important safeguard to the wild population of manatees.
- 1.10.1 Maintain rescue network.** FWS is responsible for the rescue and rehabilitation network and coordinates this program through an endangered species/marine mammal enhancement permit. Participants are authorized to participate in the program through Letters of Authorization (LOAs) under the permit held by FWS Jacksonville Field Office. Letter holders: (1) verify the status of manatees reportedly in distress; (2) rescue and/or transport rescued manatees; and (3) treat and maintain distressed manatees. The terms and conditions of the LOA describe the letter holders' level of participation and responsibilities in the program, based on their level of experience and resources. FWS must retain a current permit to authorize these activities and must maintain, update, and modify participant LOAs. As needs and circumstances dictate, letter holders may be added or removed from the program.

To ensure prompt, effective responses to distressed manatees, a rescue coordinator is needed to coordinate and mobilize rescue network teams. FWC 's FMRI maintains a network of

field stations to conduct manatee research throughout the state. Field station activities are coordinated through the FMRI's Marine Mammal Pathobiology Laboratory's manager, who acts as the rescue coordinator. FMRI's existing network of staff, resources, and contacts with local law enforcement officials (and others likely to receive reports of distressed manatees) provides the necessary infrastructure for the program. Reports of distressed animals are directed to the rescue coordinator and his/her staff, who in turn contact authorized participants to respond. FWS is notified of ongoing rescues and unusual or significant events, as appropriate. GDNR maintains similar capabilities through its Nongame and Endangered Wildlife Program in their Brunswick, Georgia office.

1.10.2 Maintain rehabilitation capabilities. Adequate facilities are needed to place and treat injured animals. Every year, there are approximately 50 manatees in captivity at any given time, including manatees receiving critical and long-term care treatment. In 2000, there were three critical-care and six long-term care facilities treating manatees, including three out-of-state facilities. In order to maintain our ability to treat distressed manatees, critical care space must be available for these animals. While every effort is made to release treated manatees in a timely manner, some animals are not immediately releasable. Manatees that cannot be released quickly may be transferred to long-term care facilities to make room for critical-care cases. When necessary, existing facilities may expand their holding areas, or additional facilities may be authorized to create room for long-term care cases. Critical-care facilities provide the resources needed to conduct these activities; some costs are statutorily defrayed throughout the State of Florida.

1.10.3 Release captive manatees. As manatees complete the rehabilitation process, their medical status is reviewed by respective facility veterinarians in anticipation of their release. Following this review of physical and behavioral parameters, facility veterinarians recommend that the animal is either ready for release or should be retained for further supportive care. If an animal is deemed healthy, FWS (with input from the Interagency Oceanaria Working Group (IOWG)) evaluates the status of the animal in the context of captive release guidelines and determines whether or not the animal should be released. When an animal is deemed releasable, a release site and release date are identified, and appropriate follow-up monitoring plans are selected. The animals are then transported to the selected site and released. Follow-ups are then conducted, relying on either active monitoring (in which the animals are tagged with satellite, very high frequency (VHF), and/or sonic tags and tracked via satellite and in the field) or passive monitoring (which relies on marking the animals with PIT tags and freeze-brands or by their unique, distinctive

markings). These animals are then monitored opportunistically in the field during field studies and/or through the carcass salvage program. Methods identified during a 1998 captive release workshop should be implemented to improve survival rates for released captives. Behavioral parameters need to be evaluated to assess their value in the captive release process.

1.10.4 Coordinate program activities. In addition to authorizing network participants, FWS coordinates many of the day-to-day needs of the program. All transfers and releases, research proposals, and follow-up monitoring plans, program concerns, etc., are evaluated and acted upon by FWS. Many of these are discussed and resolved through the IOWG, which meets twice a year to coordinate rescue, rehabilitation, and release activities and to manage captive program activities to meet manatee recovery objectives. Inherent in this are reviews on the status of rescue and rehabilitation activities, record keeping, development and review of rescue, transport, rehabilitation, maintenance, and release methods, informational exchanges, etc. A product of these meetings will include the development of an annual work plan describing projected releases and monitoring activities.

1.10.5 Provide assistance to international sirenian rehabilitators. Manatee rescue and rehabilitation activities in the United States and Puerto Rico are characterized by more than 30 years of experience and expertise. Rescue and transport techniques, medical practices, and release protocols have been successfully developed and are models for similar efforts. These experiences and expertise should be shared with other countries developing manatee and dugong rescue and rehabilitation programs.

1.10.6 Provide rescue report. An annual report summarizing each year's rescue and rehabilitation activities will be prepared consistent with the requirements of FWS's endangered species/marine mammal enhancement permit. In the interim, monthly updates will be made available to program participants through FWS's internet website.

1.11 Implement strategies to eliminate or minimize harassment due to other human activities. In some cases, human activities (e.g., fishing, swimming, snorkeling, scuba diving, manatee observation, and provisioning) may also disturb, alter behavior or harass manatees. Such disturbance could be life-threatening to manatees, for example, if it occurs in warm-water refuges and animals subsequently move into colder waters. Areas of such conflict should be identified and management actions implemented in order to reduce negative impacts on manatees. Harassment of manatees is considered a form of take as defined in both the ESA and MMPA. Any activity that results in a

change of natural behavior which could create harm to the animal is considered take. Most waterborne activities, as well as some upland activities, have the potential to disturb and harass manatees. The following efforts are needed to minimize the impact of these activities.

1.11.1 Enforce regulations prohibiting harassment. Where clear and convincing evidence of harassment is occurring, enforcement of regulations controlling such activities is needed.

1.11.2 Improve the definition of “harassment” within the regulations promulgated under the ESA and MMPA. The current definition of harassment is very vague, making it difficult to enforce. Regulatory definitions need to be amended to specify, to the greatest extent practicable, what actions and activities constitute manatee harassment.

OBJECTIVE 2: Determine and monitor the status of manatee populations. The success of efforts to develop and implement measures to minimize manatee injury and mortality depends upon the accuracy and completeness of data on manatee life history and population status. Population data are needed to identify and define problems, make informed judgments on appropriate management alternatives, provide a sound basis for establishing and updating recovery criteria and management plans, and to determine whether or not actions taken are achieving management objectives. The tasks outlined below are essential to a complete understanding of manatee population status and trends. For all tasks, publication of peer-reviewed results is the preferred method of information dissemination. A detailed research plan is presented in Appendix D and includes informative background information and more detail than is presented here in the narratives.

2.1 Continue the MPSWG. The interagency MPSWG was established in March 1998 as a subcommittee of the recovery team. The group’s primary tasks are to: (1) assess manatee population trends; (2) advise FWS on population criteria to determine when species recovery has been achieved; and (3) provide managers with interpretation of available information on manatee population biology. The group also has formulated strategies to seek peer review of their activities. The MPSWG should continue to hold regular meetings, refine recovery criteria, annually update regional and statewide manatee status statements, convene a population biology workshop early in 2002, analogous to the one held in 1992, and publish the results of the workshop.

2.2 Conduct status review. After the Population Status Workshop referenced in Task 2.1 is held, FWS will conduct a status review of the Florida manatee. The review will include: (1) a detailed evaluation of the population status using the benchmark data obtained from the 2002 Population Biology Workshop; (2) an evaluation of the status of manatee habitat as it relates to recovery-based

information obtained from the HWG; (3) an evaluation of existing threats to the species and the effectiveness of existing mechanisms to control those threats; (4) recommendations, if any, regarding reclassification of the Florida manatee from endangered to threatened; and (5) objective, measurable criteria for delisting.

2.3 Determine life history parameters, population structure, distribution patterns, and population trends. Population research and data are needed to determine the status of the Florida manatee population. Data collection should be focused so that information on manatee sightings, movement patterns, site use and fidelity, and reproductive histories all can be utilized for further analyses of manatee survival and reproductive rates. Tools which should be continued as a means of gathering these data include: (1) the Manatee Individual Photo-identification System (MIPS); (2) the carcass salvage program; (3) PIT-tagging; (4) telemetry studies; and (5) aerial survey. It is particularly important to utilize these tools at important wintering sites, areas of high use, and poorly-studied regions.

2.3.1 Continue and increase efforts to collect and analyze mark/recapture data to determine survivorship, population structure, reproduction, and distribution patterns. Photographs using standardized protocols for data collection and coding should be collected annually and documented in the field, especially at the winter aggregation sites; these efforts should be expanded, particularly in Southwest Florida. In addition, PIT tags should be inserted under the skin of all manatees that are captured during the course of ongoing research or rescue/rehabilitation. All manatees captured, recaptured, rescued, or salvaged should be checked for PIT tags and other identifying information, because these data provide an additional source of life history information (changes in manatee size, reproductive status, and general condition between time of tagging and recovery). Methods for reliably checking for PIT tags on free-swimming manatees should be developed and tested, and plans should be developed for re-examining the utility of PIT-tagging manatees of certain age classes (juveniles and subadults) or in specific areas where photo-ID is not a feasible way to re-identify individuals.

Analyses using mark-recapture modeling procedures to estimate annual survival rates should be updated annually, utilizing data in MIPS and comparing results to analyses of PIT tag data. To enhance the accuracy and precision of survival estimates, dead manatees previously identified by photographic documentation must be noted in the MIPS database before mark-recapture analyses are undertaken. This research should include estimates of sample sizes required to determine population traits, such as survival and reproductive rates.

Additionally, emphasis should be placed on estimating variance and 95% confidence intervals.

Concurrently with data collection and monitoring, it is important to conduct long-term studies of reproductive traits and life histories of individual females. Such studies would provide information on: (1) age at first reproduction; (2) age-specific birth rates; (3) calving interval; (4) litter size; and (5) success in calf-rearing. The relative success of severely- and lightly-scarred females in bearing and rearing calves also should be determined.

2.3.2 Continue collection and analysis of genetic samples to determine population structure and pedigree. Collection of tissue samples from salvage specimens and from living manatees at winter aggregation sites, captured during research, or rescued for rehabilitation should continue. Continued genetic analysis through collaborations with state and federal genetics laboratories may reveal greater population structure than has been demonstrated thus far (i.e., a significant difference between east and west coasts, but not within coasts). Such research will improve our ability to define regional populations and management units. Stock and individual identity for forensic purposes ultimately will be possible. Analytical techniques recently developed for identifying the structure of other marine stocks should be investigated.

Paternity cannot be established in wild manatees without the ability to determine family pedigrees. This information is needed to determine if successful reproduction is limited to a small proportion of adult males, which has important implications for the genetic diversity of the Florida manatee population. By continuing the development of nuclear DNA markers, pedigree analysis can be applied to the growing collection of manatee tissue samples. Pedigree analysis also would improve greatly our knowledge of matrilineal relationships and female reproductive success. Identification of factors associated with successful breeding by males is important in assessing reproductive potential in the wild and in captivity.

2.3.3 Continue carcass salvage data analysis to determine reproductive status and population structure. Information and tissue samples collected from all carcasses recovered in the salvage program to determine reproductive status should be continued. Resulting estimates of reproductive parameters complement information obtained from long-term data on living manatees and will help to determine trends and possible regional differences in reproductive rates. The salvage program yields important information on the

manatee population sex ratio and proportion of age classes (adult, subadult, juvenile, and perinatal) within each cause-of-death category. Annual changes in these proportions may indicate increases or decreases in certain types of mortality, and thus should be considered as part of the weight of evidence that supports (or rejects) a reclassification decision. Ear bone growth-layer-group analysis should be continued to determine more precise ages of dead manatees, particularly those that have a known history through the MIPS database, telemetry studies, or PIT tag data. Although the age structure of the carcass sample is biased toward younger animals, opportunities may occur to document better the natural age structure within specific regions because of age-independent mortality events.

- 2.3.4 Continue and improve aerial surveys and analyze data to evaluate fecundity data and to determine distribution patterns, population trends, and population size.** Aerial surveys provide limited information on the proportion of calves to adults, which may provide insights on reproductive trends when a long time-series of surveys have been conducted by one or relatively few individuals in the same geographic regions. Calf counts from such surveys should be continued and should be compared to those obtained by photo-ID methods.

As appropriate and possible, local and regional aerial surveys should be undertaken or continued to improve information on habitat use patterns and changes in distribution. Documentation of changes in distribution at power plants will be particularly important when changes in warm water availability occur.

Methods to correct for various types of visibility bias in surveys should be developed. Standard procedures for survey teams involved in annual statewide surveys need to be developed and implemented. Where appropriate, strip transect aerial surveys should be used, as it is possible to use this type of survey data to detect regional population trends. Specifically, strip transect surveys should be continued on an annual basis in the Banana River, and their feasibility should be investigated in remote coastal areas of Southwest Florida. To the extent possible, all aerial surveys should be designed to estimate accurately a minimum population number.

- 2.3.5 Continue collection and analysis of telemetry data to determine movements, distribution, habitat use patterns, and population structure.** Multi-year telemetry studies have been completed for the Atlantic coast and Southwest Florida from Tampa Bay through Lee County, and research findings have been summarized in manuscripts currently

undergoing peer review. Radio-tracking has provided substantial documentation of seasonal migrations, other long-distance movements, and local movements that reveal patterns of site fidelity and habitat use. Such information is needed from each region, particularly Southwestern Florida and the Everglades and areas where anticipated changes are likely to impact manatees, in order to develop management strategies for all significant subgroups within the regional population, however transitory they may be.

Steps should be undertaken to incorporate geographic positioning system (GPS) technology into telemetry studies to improve the accuracy of manatee location data. Such improvements will be helpful in studying precise habitat-use patterns (e.g., the extent to which manatees use marked boat channels verses waterway margins for travel) and the location of preferred foraging sites, especially around warm-water refuge sites.

- 2.3.6 Continue to develop, evaluate, and improve population modeling efforts and parameter estimates and variances to determine population trend and link to habitat models and carrying capacity.** Uncorrected aerial survey data do not permit statistically valid population estimation or trend analysis. Models to correct for the inherent bias and uncertainty have been developed, and these efforts need to be continued.

It also is important to utilize models such as that developed by Eberhart and O'Shea (1995). The underlying assumptions of a population model, the importance of parameters used in the model, the accuracy and uncertainty of the parameter estimates, the relationships of the parameters, and the appropriateness of the mathematics implemented in the model need to be critically evaluated and updated. Also, comparisons need to be made between predicted outcomes of a model and estimates or indices of population trend from other modeling efforts or other data sets. Steps should be taken to improve and to develop more complex models incorporating additional life history information and which better reflect our understanding of the processes involved in population dynamics.

Where estimates of model parameters need to be developed or improved, other relevant tasks should be modified or strengthened. Because parameters can vary over space and time and such variation affects population growth rates, emphasis should be placed on estimating variance and 95% confidence intervals along with developing best estimates of particular population parameters.

It is important for those developing manatee population models to coordinate their activities and to interact directly with research biologists who have collected manatee life history data or who are very familiar with manatee ecology. Interaction with management also is needed to help focus the questions addressed by present and future modeling efforts. Estimates of the number of manatee deaths that can be sustained per region, while still allowing population stability or growth to be achieved are needed. Coordination is needed to develop better models that meet the needs of manatee biologists, policy makers, and managers. The MPSWG is best positioned to track research developments, link important players, and provide one level of peer review and evaluation. Additional peer review from other internal and external sources also is essential.

As manatee habitat requirements are documented and recovery criteria are identified (based on habitat needs) (Task 3.1.1), it will become possible to link regional population and habitat models and estimate optimum sustainable populations for regions. Integration of population and habitat information is essential to understand the implications of habitat change before negative impacts on manatee population trends can occur. The MPSWG and Geographic Information System (GIS) Working Group should meet jointly on an annual basis to coordinate their activities and progress. Summary reports of these meetings should be distributed to all agencies and interested parties involved in manatee recovery efforts.

2.3.7 Conduct a PVA to help assess population parameters as related to the ESA and MMPA. The FWS should conduct a PVA and/or other modeling exercises to: determine minimum viable population(s); model effects of various scenarios of stochastic events; determine consequences of losses of industrial warm-water refuge sites; further test and refine demographic recovery criteria; and assist in determination of negligible impacts under the MMPA.

2.4 Evaluate and monitor causes of mortality and injury. The manatee salvage/necropsy program is fundamental to identifying causes of manatee mortality and injury and should be continued. The program is responsible for collecting and examining virtually all manatee carcasses reported in the Southeastern United States, determining the causes of death, monitoring mortality trends, and disseminating mortality information. Program data are used to identify, direct, and support essential management actions (e.g., promulgating watercraft speed rules, establishing sanctuaries, and reviewing permits for construction in manatee habitat).

The current manatee salvage and necropsy program components are: (1) receiving manatee carcass reports from the field; (2) coordinating the retrieval and transport of manatee carcasses and conducting gross and histological examinations to determine cause of death; (3) maintaining accurate mortality records; and (4) carrying out special studies to improve understanding of mortality causes, rates, and trends. The carcass salvage program should continue to: (1) describe functional morphology of manatees; (2) assess certain life history parameters of the population; and (3) collect data on survival of known individuals.

To improve the program, FWC should continue to hold manatee mortality workshops to review critically its salvage and necropsy procedures and methods. These workshops: (1) establish and improve “state-of-the-art” forensic techniques, specimen/data collection, and analyses; (2) identify and create projects focusing on death categories that are unresolved; (3) prepare for and assist with epizootics; (4) generate reference data on manatee health; and (5) generate suggestions for attainment of a “healthy” manatee population.

To implement the salvage and rescue program in Florida, FWC maintains a central necropsy facility called the Marine Mammal Pathobiology Laboratory (MMPL) which is located in St. Petersburg. FWC also has three field stations on the east coast situated in Jacksonville, Melbourne, and Tequesta, and one field station on the west coast at Port Charlotte. The GDNR, South Carolina Department of Natural Resources, Louisiana Department of Wildlife and Fisheries, Texas Marine Mammal Stranding Network, University of North Carolina at Wilmington, and others help to coordinate carcass salvages and rescues in other Atlantic and Gulf coast states. FWS and FWC should provide assistance to these manatee salvage and rescue programs through workshops, providing equipment and assistance when possible. The MMPL will maintain and curate the Southeast U.S. Manatee Mortality Database to facilitate management and enhance communication among state agencies and reinforce timely reporting.

2.4.1 Maintain and improve carcass detection, retrieval, and analysis. To the extent possible, the historic mortality database should be reviewed and updated to reflect the cause of death categories currently in used. To estimate the number of unreported manatee carcasses, studies should be done on carcass detection and reporting rates. Studies focusing on carcass drift, rate of decomposition, and how decomposition affects necropsy results should be conducted. Periodic peer reviews should be conducted of necropsy methods, data recording and analysis, and documentation of tissues collected. Selected representative samples should be archived with appropriate national tissue banks. Workshops such as FWC Manatee Mortality Workshop should continue to be conducted to strengthen collaborative

research and information sharing. Partnerships with other agencies and process analysis of carcass retrieval protocols should be ongoing to improve efficiency.

2.4.2 Improve evaluation and understanding of injuries and deaths caused by watercraft.

Longitudinal studies should be established to examine the effect of boats and boating activity on population growth and reproductive success. Investigations of the characteristics of lethal compared to non-lethal injuries and causes should be developed using data from carcasses and photo-ID records. Another important data set would be that characterizing healing in rescued injured animals; under-reporting of watercraft mortality may occur as individuals die from complications resulting from injuries sustained by boats. Lethal and non-lethal injuries should be investigated to characterize size of vessels, relative direction of movement of vessel, and propeller vs. blunt trauma statistics. Research on mechanical characteristics of skin and bones should be developed to obtain a better understanding of the effects of watercraft-related impacts. Regional studies are needed to characterize boating intensity, types of boats, boating behavior, and boating hot spots in relation to manatee watercraft-related mortality.

2.4.3 Improve the evaluation and understanding of injuries and deaths caused by other anthropogenic causes. Research is needed to continue to assess manatee behavior leading to vulnerability around the water control structures and navigational locks, as well as operational or structural changes that can prevent serious injury or death of manatees. MMPL should continue to associate forensic observations obtained at necropsy with specific characteristics of the particular structure that caused the death.

Commercial fishing is not a major culprit involved in manatee mortality, unlike the case with most other marine mammals. However, manatees have been killed by shrimp trawls and hoop nets, and in recent years injuries and death from monofilament entanglement, hook and line ingestion, and crab pot/rope entanglement have been more prevalent. There is a need to improve the evaluation and understanding of injuries and deaths of manatees caused by commercial and recreational fisheries. To reduce the increasing numbers of fishing gear entanglements, a multi-agency Manatee Entanglement Task Force has been established and should continue to focus on creating changes in data collection protocols, potential technique/gear modifications, innovative tag designs, entanglement research, gear recovery/clean-up, and education/outreach efforts. Research on rates of entanglement, types of gear, and geographical and temporal changes in rates and types of entanglements should be developed. Studies on behavioral characteristics of manatees contributing to

entanglement should be pursued. Research on the amount of marine debris in inshore waters should be conducted, particularly where there are high levels of manatee entanglement. Programs to remove marine debris and recycle monofilament line also should be encouraged and continued (Task 1.7.2).

Although no known death or pathology has been associated with toxicants, some concentrations of contaminants have caused concern. Over time, concentrations of chemicals found in manatees from early studies have changed, possibly as a result of the regulation of chemical use. Such changes highlight the need to monitor tissues for chemical residue and also can provide insight into the presence of different or new compounds in the environment. While a broad range of tests have been conducted, there needs to be a greater focus on endocrine disruptor compounds. These compounds can alter reproductive success and have a dramatic effect on population growth.

- 2.4.4 Improve the evaluation and understanding of naturally-caused mortality and unusual mortality events.** By definition, natural causes of mortality are not directly anthropogenic and thus not easily targeted by management strategies. However, some aspects of natural mortality may be influenced by human activities. These activities include but are not limited to: (1) sources of artificial warm water; (2) nutrient loading; and (3) habitat modification.

Cold stress can be a cause or contributing factor to manatee deaths during the winter. Acute cold-related mortality is related to hypothermia and metabolic changes which occur as a consequence to exposure to cold. Research should continue to focus on critical cold air and water temperatures affecting manatee physiology (particularly as it pertains to acute cold- and cold stress-related mortality). To provide important clues as to how manatees deal with cold temperature, future research should study behavioral adjustments to cold (e.g., directed movement to warm-water refuges, time budget during cold periods, and surface resting intervals during warm spells). Research identifying the manatee's anatomical and physiological mechanisms for heat exchange are an important step to understanding the biological limitation of the species. Ancillary research should include identification of natural warm-water sites, because a growing population of manatees may be seasonally-limited by overcrowding at the larger well-known warm-water refuges.

Research is needed to improve our ability to detect brevetoxin in manatee tissues, stomach contents, urine, and blood. At the same time, environmental detection of red tides, their strengths, and the development of retardants are necessary. More advanced immunological

research utilizing manatee cell cultures may result in the development of better treatment of manatees exposed to brevetoxin.

Improved methods are needed to subdivide the perinatal category into categories of: (1) clearly fetal; (2) at or near the time of birth; and (3) clearly born. Once these categories are well-defined, analysis can ascertain the life stage subject to the greatest impact, thus allowing for the future development of appropriate management policies. Field research focusing on factors affecting calf survival should be conducted (e.g., age of mother at reproduction, behavior, characteristics of calving areas, and human disturbance).

The FWS and FWC have created complementary manatee die-off contingency plans (Geraci and Lounsbury 1997; FWS 1998) that have been merged into one comprehensive document (FDEP *et al.* 1998). The document contains information and guidance from the two plans together with advice and provisions outlined in the executive summary from Wilkinson (1996). Research and investigations should follow the protocols and recommendations found in the Contingency Plans. In addition, there should be ongoing collection and storage of tissues and samples from healthy and non-mortality event manatees to establish a baseline and to aid interpretation of test results obtained during a catastrophic event and for retrospective studies. Investigators should contact and work closely with other research projects monitoring and evaluating harmful algal blooms. FWC mortality workshops should continue and help to facilitate and develop cooperative arrangements among investigators and institutions.

2.5 Define factors that affect health, well-being, physiology, and ecology. Relatively little attention has been paid to the health and well-being of individual manatees, although factors affecting individuals ultimately influence the overall status of the population. There is a need to determine the relatively constant internal state in which factors such as temperature and chemical conditions remain stable and therefore within a range of values that permit the body to function well, despite changing environmental conditions. Stress is part of existence, and not all stress is bad for an individual. However, a stressor can affect homeostasis and health, and thereby precipitate a chain of events that can compromise the survival of an individual. There also is a need to understand the factors that underlie large-scale trends. For example, individual manatees compromised by severe injury or disease may not be able to reproduce successfully. Similarly, sublethal effects of toxicants and even the effects of nutritional, noise-related, and disturbance-related stresses can impair immune function and potentially reduce the ability of individuals to reproduce. Study plans and protocols should be developed, collaborators identified, and results published.

2.5.1 Develop a better understanding of manatee anatomy, physiology, and health factors.

Efforts should be made to develop and publish a synthesis of: (1) current knowledge of manatee serology; (2) ranges of values associated with manatees in various demographic groups; (3) anomalies identified in manatees via serum analyses; and (4) any remaining unanswered questions. Major organs and organ systems have been examined by a variety of scientists over the years. Those systems or organs which have been ignored are important to assessing manatee health and should be studied; these include: (1) the lymphatic system; (2) most parts of the endocrine system; and (3) non-cerebral parts of the brain. In addition, potential changes in reproductive tracts routinely should be assessed as part of ongoing life history assessments. Manatee histology (microscopic anatomy) has been relatively unstudied, compared to gross anatomy. It is of no less importance in understanding normal organ or tissue functions, as well as abnormalities thereof; therefore, responsible agencies should respond to this important deficiency.

Anatomical and experimental studies have indicated that manatees osmoregulate well in either fresh or salt water; however, it is unclear whether or not manatees physiologically require fresh water to drink, and it is unknown what stresses may be created when fresh water is not available. Research should be continued, and managers attempting to protect resources sought by, if not required by, manatees should bear in mind that fresh water is a desirable and possibly necessary resource for healthy manatees.

Body indices research at FMRI has initiated certain measurements documenting the body condition of manatees. Maintenance of this work, and refinements/extensions thereof, should be continued to gain a better understanding of physiology and health of individuals and the population.

Continuous long-term monitoring of individual manatees allows for documentation of an animal's health. Information should be gathered on: (1) the acquisition and severity of new wounds to facilitate research on the length of time required for injuries to heal; and (2) any effects of injuries on behavior or reproduction. Natural factors affecting the health of the population also should be monitored during the course of photo-ID studies on wild individuals (e.g., cold-related skin damage, scars caused by fungal infections, and papilloma lesions).

As discussed earlier, brevetoxin has been implicated or suspected in major and minor mortality events for manatees for decades. Tests now exist to allow pathologists to assess,

even retrospectively, manatee tissues for signs of brevetoxicosis. The important questions include: (1) how many manatee deaths can be truly attributed to exposure to brevetoxin over the years; (2) if red tides are a natural occurrence, how can effects of red tides on manatees be reduced or mitigated; (3) would changes in human activities (i.e., creation of warm-water refuges which lead to aggregations of manatees) appreciably change vulnerability of the animals; and (4) have human activities contributed to increased prevalence and virulence of red tides.

Inasmuch as a single epizootic event can cause 2 to 3 times as many manatee deaths as watercraft causes annually, gaining a better understanding of the issue is vital and urgent. Development of cell lines and testing of manatee tissues would represent an extremely useful approach. In particular, preliminary results indicate that exposure to brevetoxin reduces manatee immune system function. Further study of the immune system will define levels of concern and will help to identify when rehabilitated manatees are ready for release into the wild. Other natural toxins have affected marine mammals (e.g., saxitoxin) and may represent another potential problem for manatees. Exposure of cultured cells of manatees to saxitoxin and assessment of the responses of those cells, would be useful.

Toxicant studies demonstrate that a few metals occur in high concentrations in manatee tissues. Testing for toxicants can be extremely expensive, thus a carefully-constructed study plan should be developed first to address the most critical uncertainties and to make the assessments as cost-effective as possible. Sediment chemistry/toxicity testing could be used as an indicator to direct toxicant studies in important habitats known to contain sediments that are contaminated.

A disease involves an illness, sickness, an interruption, cessation, or disorder of body functions, systems, and organs. As noted at the outset of this section, scientists need to learn the boundaries of normal structure and function before they can diagnose what is normal or diseased. This process has occurred to some degree through the necropsy program, but it needs considerable refinement. Over the years, cause of death for about 1/3 of all manatee carcasses has been undetermined; this percentage would doubtless drop considerably with better information about and diagnosis of manatee disease states. Planned workshops by the FMRI will attempt to bring scientists conducting necropsies on manatees together with pathologists and forensic scientists working with humans and other species. This effort should be very useful as a first step in an ongoing process of refinement.

Nutritional characteristics of manatee food plants and the importance of different food sources for different manatee age and sex classes in various regions are needed to help assure that adequate food resources are protected in different areas of the population's range. Ongoing studies should be completed to identify manatee food habits and the nutritional value of different aquatic plants important to manatees. In addition, seasonal patterns of food availability in areas of high manatee use need to be documented. Research should also address manatee foraging behavior, emphasizing ways that manatees are able to locate and utilize optimal food resources.

Since degrees of parasitic infestation may be associated with the changes in the health of manatees, assessments of changes in prevalence of parasites over time should be undertaken. Inasmuch as parasite loads are assessed, at least qualitatively, during necropsies, this should be easy to accomplish, relatively speaking.

- 2.5.2 Develop a better understanding of thermoregulation.** Although work has been ongoing to assess effects of environmental temperatures on metabolism of manatees, the relationship among temperature change, metabolic stress, onset of chronic or acute disease symptoms, and even mortality of manatees is not perfectly understood. As noted above, the relationships among manatee reproductive status, body condition, thermal stress levels, and metabolic responses to such stress remain unclear. Answers are needed as the specter of decreased availability of both natural and artificial warm-water sources looms. The research should focus not only on lower critical temperatures (the cold temperatures where metabolic stress occurs), but also on the upper critical temperature.
- 2.5.3 Develop a better understanding of sensory systems.** Vision in manatees has been well studied and tactile ability and acoustics also have been assessed. Conclusions reached as a result of acoustic studies are somewhat inconsistent and controversial, especially in terms of the extent that manatees may hear approaching watercraft. Since the auditory sense of manatees appears to be vital to their ability to communicate and to avoid injury, further studies are warranted. In addition, although chemoreception has been suggested as a mechanism by which male manatees locate estrous females, chemosensory ability of manatees is virtually unknown and should be studied.
- 2.5.4 Develop a better understanding of orientation and navigation.** It is clear from various lines of evidence that manatees show site fidelity, especially in terms of their seasonal use of warm-water refuges, but also in their use of summer habitat. To some extent, calves learn

locations of resources from their mothers. However, the way that manatees perceive their environment, cues they use to navigate, and the hierarchy of factors they use to select a particular spot or travel corridor are all unknown. As humans continue to modify coastal environments (physically, acoustically, visually, and chemically), it would be useful to understand better how such changes may interfere with the manatee's ability to orient and to locate or select optimal habitat.

2.5.5 Develop a better understanding of foraging behavior during winter. Research should address manatee winter foraging behavior, emphasizing ways that manatees are able to locate and utilize optimal food resources. Research should address food availability near winter aggregation areas and determine if they are a limiting resource. Therefore, food resources near winter aggregation sites in each region need to be assessed to ensure that food resources are adequate and protected.

2.5.6 Develop baseline behavior information. Both field studies and controlled experiments at captive facilities are needed to document basic behaviors. This documentation will allow detection and understanding of changes in behavior that occur through changes in allocation of essential resources, such as vegetation and warm water. Telemetry, photo-ID, and aerial videography have been useful tools for behavioral research. New innovative approaches are needed, particularly in habitats where visibility is poor.

2.5.7 Develop a better understanding of disturbance. Stress caused by disturbance will be difficult to document, but if manatees move away from critically important resources (e.g., warm water in winter) to avoid being disturbed, this movement could place the animals in immediate and acute jeopardy. Sources and level of activities eliciting disturbance responses need to be characterized further.

2.5.7.1 Continue to investigate how a vessel's sound affects manatees. In order to understand the nature of watercraft/manatee interactions, the primary reasons for collisions must be identified. Manatees, particularly mothers and calves, communicate vocally. Often, while vessels are still outside of visual range, manatees initiate movements as boats approach, suggesting that they respond on the basis of hearing the boats. Noise from boats or other sources may interfere with communications or provide a source of stress. Hearing capabilities have been examined through studies involving two individuals in captivity (Gerstein 1995, 1999).

There is a need for further research on hearing capabilities and the effects of noise on manatees potentially to provide another management tool to minimize collisions between manatees and boats. In particular, it is important to determine: (1) the sensitivity of manatee hearing to the different kinds of vessels to which they are exposed; (2) the range of frequencies of importance to manatee communication; (3) the abilities of manatees to localize sound sources; and (4) the role that habitat features may play in altering sound characteristics. The levels and characteristics of vessel sounds leading to behavioral changes, including potentially vacating an area, need to be determined. Development of manatee avoidance technology needs to be thoroughly researched and assessed and managers need to evaluate the MMPA and ESA “take” issues related to implementing such technology.

2.5.7.2 Investigate, determine, monitor, and evaluate how vessel presence, activity, and traffic patterns affect manatee behavior and distribution. More effective diagnosis of watercraft-related injuries and mortalities is important for describing the extent and nature of the threat posed by watercraft. Mortality workshops are intended to improve our ability to diagnose watercraft-related mortalities more effectively on both fresh and decomposed carcasses. Prevention of such injuries and mortalities is the goal. Research is needed to address the causes of watercraft mortality and the effectiveness of management actions. Importantly, such research also should investigate the effects of sublethal injuries and stress occurring as a result of boating activity. Injuries and stress may: (1) lead to reductions in animal condition and reproductive success; (2) cause animals to abandon habitat important for foraging, reproduction, or thermal regulation; or (3) impair immune system function thereby increasing the vulnerability of animals to disease, pollutants, or toxins. Thus, indirect or secondary effects of boating activity also may impede population recovery in ways that have not yet been assessed.

MML, FWC, and others are investigating reactions of manatees to boats. Preliminary information indicates that manatees perceive boats, but may, under certain circumstances, react in ways that place the animals in the path of, rather than away from, the boats. Additional studies of manatee responses to boats and vessel acoustics are needed (Task 2.5.7.1). Indirect deleterious effects of shallow-draft or jet boats that can disturb manatees and cause them to move to

boating channels or interrupt normal behaviors need to be studied. An evaluation of spatial and temporal factors associated with risk to manatees (i.e., proportion of time manatees are exposed to vessels relative to depth, habitat, and manatee activity) should be conducted. Additional factors to be investigated include: (1) types and frequency of approaches; (2) numbers of boats; (3) distance of nearest approach; (4) individual variations in manatee responses to boats; (5) influences on diurnal activity patterns and habitat use; and (6) effects on mothers and young.

- 2.5.7.3 Assess boating activity and boater compliance.** Studies that characterize the intensity and types of boating activities should be conducted at selected locations around the state, with emphasis on areas where boat-related mortality of manatees is highest. Studies are underway and should be expanded to additional areas to identify and evaluate adherence to manatee speed zone restrictions through statewide boater compliance studies. The following studies should be continued and assessed: (1) the frequency of boater compliance with posted manatee speed zone restrictions; (2) the degree of boater compliance with posted manatee speed zone restrictions; (3) the levels of compliance among boat classes, seasonally, and temporally; (4) changes in compliance resulting from different enforcement regimes; and (5) changes in compliance resulting from different signage. Underlying sociological factors affecting compliance also should be investigated (Task 1.4.4). New methods for monitoring compliance, such as remote video systems, should be assessed.
- 2.5.7.4 Evaluate the impacts of human swimmers and the effectiveness of sanctuaries.** Specific circumstances or characteristics of human swimming, snorkeling, or SCUBA diving that may result in changes in manatee behavior, including vacating an area, remain to be determined. Factors to be investigated include: (1) types and frequency of approaches; (2) numbers of swimmers; (3) distance of nearest acceptable approach; (4) occurrence of contact; (5) individual variations in manatee responses to humans; (6) influences on diurnal activity patterns and habitat use; and (7) effects on mothers and young.
- 2.5.7.5 Evaluate the impacts of viewing by the public.** The relative benefits of burgeoning human attention as compared to potential adverse impacts on the animals have not been evaluated properly to determine the desirability of

increasing or decreasing control over manatee viewing activities. Studies relating marketing and overall levels of human viewing activities to changes in manatee behavior, including vacating an area, need to be conducted. Conversely, benefits accrued to the manatees from increased viewing by the public also should be evaluated for comparison.

- 2.5.7.6 Evaluate the impacts of provisioning.** In many parts of the species' range, people provide food or water to manatees, in spite of regulations prohibiting such activities. A systematic evaluation should be conducted to determine if these activities potentially adversely affect manatees in terms of changing their behavior, placing them at greater risk from other human activities, or encouraging them to use inappropriate habitat.

OBJECTIVE 3: Protect, identify, evaluate, and monitor manatee habitats. Manatee population recovery and growth depend on maintaining the availability of habitat suitable to support a larger manatee population. Manatee habitat needs include: (1) ample food sources (including submerged, floating, and emergent vegetation); (2) warm-water refuges during cold winter periods; (3) quiet, secluded areas for calving and nursing; (4) mating and resting areas; (5) safe travel corridors connecting such areas; and (6) possibly fresh drinking water. These resources are affected by development in coastal and riverine areas and by human activities in waterways used by manatees. Managers must protect the quality and quantity of essential manatee habitats and provide for human needs.

Many important manatee areas in Florida are protected through the state's Florida Manatee Sanctuary Act, which protects manatees and their habitat through designated manatee protection zones and sanctuaries; manatee areas also are protected under the ESA and MMPA manatee sanctuaries and refuges provisions. These Acts provide a means to minimize the direct and indirect effects of coastal development on manatees. Existing protection areas should be evaluated and properly-managed, and other important unprotected areas should be identified and afforded necessary protection. Resource agencies, through these authorities, are able to address and minimize the effects of development through comments to state and federal permitting agencies. County MPPs are important guidance documents for agencies and developers. Plans should be developed for those counties lacking state- and federally-approved plans. All plans should be reviewed periodically.

In order to protect adequate quantities of essential habitat in the quality necessary to recover the manatee, information is needed to identify habitats, assess their condition, and understand the factors affecting them.

Methods and means should be improved/developed to understand better and monitor the interactions that take place between manatees, manatee habitat, and humans. A HWG should be convened to assess needs and to identify the tools needed to identify, monitor, and evaluate manatee habitats and better define manatee ecology.

3.1 Convene a Habitat Working Group. A HWG (established as a subcommittee of the recovery team), that includes resource managers, manatee biologists, and experts familiar with the many features of the manatees' aquatic environment will meet on a regular basis. This group will: (1) assist managers responsible for protecting habitat; (2) help identify information needs; (3) ensure the implementation of tasks needed to identify, monitor, and evaluate habitat; and (4) refine and improve the recovery criteria that address threats to manatee habitat by October 2002.

3.2 Protect, identify, evaluate, and monitor existing natural and industrial warm-water refuges and investigate alternatives. One of the greatest threats to the continued existence of the Florida manatee is the stability and longevity of warm-water habitat. Manatees have learned to rely on natural and industrial warm-water refuges during periods of cold weather. This reliance has made it extremely important for managers and researchers to understand the role played by warm-water refuges in overall manatee survival. Protection, enhancement and/or replacement, identification, and characterization of these sites are essential to the continued recovery of the manatee population.

3.2.1 Continue the Warm-Water Task Force. A task force consisting of governmental agencies, power industry representatives, and non-government organizations has been convened to develop and implement strategies to ensure safe and dependable warm-water refuges for manatees. In developing these strategies, the task force should: (1) develop a conceptual plan for a long-term network of warm-water refuges; (2) determine the optimal northern extent of industrial warm-water refuges; (3) develop a plan to reduce the potential loss of manatees in the event that a power plant goes off-line, either permanently or for an extended period of time; (4) explore whether new sources of artificial warm water are an avenue that should be considered and, if so, identify potential new sources that could be exploited to produce consistent, dependable, and inexpensive warm water. The task force also should examine the potential effects of deregulation of the Florida power industry.

3.2.2 Develop and implement an industrial warm-water strategy. Short- and long-term strategies should be developed for industrial warm-water refuges. Efforts to address short-term concerns currently are accomplished through the state-adopted NPDES permitting program, which includes power plant-specific MPPs. These plans ensure a safe,

consistent, and dependable network of warm-water refuges. A long-term plan, addressing concerns identified in Task 3.2.1, should be developed with the creation of an effective network of warm-water refuges as its goal. The development of this plan will require that all industrial sites used by wintering manatees be identified, described, and monitored. These assessments should contain the location and physical description of each plant, expected life span of each plant, and history of manatee use at each plant. Habitat attributes associated with each plant also should be addressed. These attributes should include: (1) availability and location of forage and freshwater; and (2) an assessment of human disturbance levels over the next 5, 10, and 20 years. As more information regarding each plant is collected, BPSM and FWS should recommend modifications to existing power plant-specific MPPs to insure protection of manatees at these facilities.

3.2.2.1 Obtain information necessary to manage industrial warm-water refuges.

Research efforts should focus on collating and analyzing existing data related to manatees and industrial warm-water refuges. New research initiatives should focus on filling in data gaps concerning manatees, warm water requirements, and associated behaviors. These research efforts should include: (1) determining the tolerance of manatees to low ambient air and water temperatures; and (2) investigating manatee use of warm-water refuges and nearby habitats in relation to water temperature. Existing research efforts such as aerial monitoring of manatee use at power plants and identifying trends in the abundance of manatees at each plant should be continued. Carrying capacity and factors influencing the number of manatees which can and/or should be using each individual plant should be assessed for each facility. Building partnerships with the industry is imperative in finding resources and answers to a multitude of questions related to this issue.

3.2.2.2 Define manatee response to changes in industrial operations that affect warm-water discharges.

Current power plant operations involve activities that affect their respective warm-water discharges. For example, in the absence of demand for electricity, power companies cut back on the amount of electricity produced by certain power plants. These cut-backs may result in temporary or long-term loss of warm water or diminished flows of warm water, thereby reducing their attractiveness to wintering manatees. These operational changes and the effects they have on wintering manatees should be monitored. Understanding the response of manatees to these changes will provide important

information for managers seeking to improve short- and long-term management strategies.

3.2.3 Protect, enhance, and investigate other non-industrial warm-water refuges.

Non-industrial warm-water refuges include areas such as dredged basins which provide warm water because of their configurations and other features. For example, deep dredged basins with few inputs from adjoining ambient waters may create solar-heated, manatee-accessible systems with water temperatures several degrees above ambient. Dredged areas accessible to manatees also may penetrate sources of groundwater. When tapped into, these warm-water seeps elevate ambient water temperatures and are attractive to manatees in need of refuge from the cold. Due to the uncertainty of some of the power plant discharges being available in the future for manatees, alternatives to these discharges should be identified and developed, if needed. New environmentally-sensitive, non-industry-dependent warm-water refuges should be considered. Sites should be identified and technologies tested while existing refuges remain available.

3.2.4 Protect and enhance natural warm-water refuges. The continued functioning of the natural springs, rivers, and creeks used by manatees is essential to their recovery. Of greatest immediate importance are the spring systems at Blue Spring, Kings Bay, Homosassa Springs, and Warm Mineral Springs. These springs are used as cold season warm-water refuges by at least 20% of the manatee population during winter cold fronts (FWC, unpublished data). Critical to the continued functioning of natural warm-water sites is the maintenance of minimum spring flows and levels, maintenance or improvement of water quality, and protection of adequate foraging habitat within and adjacent to these sites.

3.2.4.1 Develop and maintain a database of warm-water refuge sites. BPSM and FMRI staff should identify and maintain an active database of all natural and non-industrial warm-water refuge sites. When new sites are discovered, these should be added to the database. Manatee use and changes in system function these sites should be monitored over time. Sites should be prioritized based on extent of manatee use and regional importance to cold season populations. FWS and FWC staff also should identify potential natural refuge sites near industrial warm-water facilities used by manatees and assess whether enhancement of these sites should be pursued.

3.2.4.2 Develop comprehensive plans for the enhancement of natural warm-water sites. If the strategy for a site includes enhancement, then a comprehensive plan should be developed addressing: (1) agency responsibilities; (2) permitting requirements; (3) funding sources; and (4) physical modifications. Existing and additional needed protection measures for each site should be identified and assessed for effectiveness. To provide for maximum protection of these warm-water sites, protection strategies also should include land acquisition, use of regulatory mechanisms, and outreach.

3.2.4.3 Establish and maintain minimum spring flows and levels at natural springs. Water demands from the aquifer for residential and agricultural purposes have diminished spring flows at important manatee wintering areas. Additionally, paving and water diversion projects in spring recharge areas can reduce water levels at springs.

A database of priority springs and flowing systems accessible to manatees should be developed and maintained by FWC staff. The database should include baseline information on water availability and quality so that adverse changes can promptly be identified and impacts mitigated. FWC and FWS should coordinate with the WMDs to prioritize establishing minimum spring flows for high manatee use systems, such as King, Homosassa and Blue Springs. Agency staff should advocate maintaining spring flow rates above the minimum levels necessary to support manatees. FWS and FWC should develop a coordinated review program with FDEP and WMDs' permitting programs on applications requesting ground water withdrawal from applicable spring systems. In addition, FWC and FWS should participate in FDEP and/or WMD springs task force efforts where manatee warm-water refuge protection issues are involved. State legislation protecting spring flow should be sought. Other recovery partners should advocate the establishment of minimum flows and levels as appropriate.

3.2.5 Assess changes in historical distribution due to habitat alteration. Summarize what is known about historical distribution in order to clarify how and to what extent artificial warm-water refuge sites and flood control canals have altered distribution and habitat use patterns.

3.3 Establish, acquire, manage, and monitor regional protected area networks and manatee habitat. The establishment of manatee sanctuaries, refuges, and protected areas, along with the federal, state, local and private acquisition of coastal areas and essential manatee habitat has created regional networks of protected areas crucial for the long-term survival of the manatee population. Management of these refuges, sanctuaries, reserves, preserves, and parks in Florida offers assurance that habitat (e.g., warm-water springs, grassbeds, and quiet secluded waterways) important to manatees are protected. These efforts need to continue as well as efforts to manage key protected areas in ways that enhance achievement of the recovery objectives.

In addition, work should be undertaken to better understand and monitor the complex interactions among manatees, humans, and manatee habitat. Information from such a program will identify future threats to manatee populations and help to explain observed manatee population trends. Presently, there is no systematic approach to monitoring the condition of important manatee habitats. To provide a means of detecting potential problems in areas supporting manatee populations, essential manatee habitat features should be monitored and evaluated. This information also will assist in determining areas which may need some additional level of protection (i.e., sanctuaries or refuges).

3.3.1 Establish manatee sanctuaries, refuges, and protected areas. Under authority of the ESA and its implementing regulations at 50 CFR 17, FWS may designate certain waters as manatee sanctuaries (areas where all waterborne activities are prohibited) or manatee refuges (areas where certain waterborne activities may be regulated). In the 1980s and 1990s, FWS designated six manatee sanctuaries in Kings Bay, Citrus County. In addition, under the NWR System Administration Act, the FWS established a 24-square-km (15-square-mi) zone, in the upper Banana River south of the NASA Causeway, in which motorboats are prohibited. Any such established areas must be posted and enforced.

In 2000, FWS initiated an effort to assess and propose new manatee refuges and sanctuaries throughout peninsular Florida. The goal is to consider the needs of the manatee at an ecosystem level and to use this rule-making provision to ensure that adequately protected areas are available to satisfy the life requisites of the species, with a view toward recovery. The FWS will periodically assess the need for additional or fewer manatee refuges and sanctuaries.

The establishment of No Entry, Limited Entry and No Motorboat zones by state and local regulations function similarly to FWS manatee sanctuaries. These protection areas were

established to prevent human disturbance. Examples of these types of zones include: (1) Winter No Entry Zones around power plant warm-water outfalls that attract manatees; (2) Winter No Entry Zone at Blue Spring in Volusia County; (3) Year-round No Entry at Pansy Bayou in Sarasota County; and (4) the Virginia Key and Black Creek Year-round No Entry Zones in Dade County.

- 3.3.2 Identify and prioritize new land acquisition projects.** Manatee-related land acquisition, which helps to expand regional networks of essential manatee habitat, is particularly important. In this regard, identification of priority areas must consider regional manatee habitat requirements and relationships among essential manatee habitats. To promote and guide these efforts, the HWG will establish a subcommittee, to include individuals from FWS, FWC, USGS-Sirenia, and others, to convene an annual meeting regarding acquisition projects. The subcommittee will act as a clearinghouse on the status of manatee acquisition projects and otherwise help coordinate efforts for relevant land acquisition projects by federal and state agencies, The Nature Conservancy, and others. As new information on manatee habitat use patterns and essential habitats become available, new areas for acquisition should be identified as warranted. Recent examples of local, state and federal manatee-related acquisition efforts are at Weeki Wachi Spring, Blue Waters and Three Sisters Spring in Citrus County, Warm Mineral Spring Run in Charlotte County, and Munyon and Little Munyon Islands in Palm Beach County.
- 3.3.3 Acquire land adjacent to important manatee habitats.** Several NWRs managed by FWS contain essential manatee habitat and are adjacent to other essential non-protected manatee habitat areas. Expanding these areas and establishing new refuges would significantly improve protection not only for manatees, but also for many other species. State land acquisition programs administered by the five regional WMDs, FDEP, FWC, and DCA have acquired many areas that will further manatee habitat protection and have many important acquisition projects in varying stages of development. Local and private land acquisition efforts also enhance manatee habitat protection. Particularly important areas utilized as warm-water refuges, such as Three Sisters Spring in Citrus County and Warm Mineral Spring in Sarasota County, should be considered. As possible, FWS and state land acquisition programs cooperatively should pursue expanding publically-owned lands to incorporate manatee habitat.
- 3.3.4 Establish and evaluate manatee management programs at protected areas.** After essential manatee habitats are acquired as identified in Task 3.3.5, the agencies responsible

for administering those areas should incorporate manatee protection and public awareness measures into these unit administration programs. Such management measures, depending on local conditions and human activity patterns, may be needed to ensure that activities and development projects within or adjacent to protected areas or affecting state-owned submerged lands do not adversely affect manatees or their habitat. Such measures should be updated as appropriate.

3.3.5 Support and pursue other habitat conservation options. Manatee habitat conservation can be achieved through existing regulatory means (Task 1.2 and its subtasks) and through coordination with private foundations with an interest in environmental protection. Federal and state regulatory programs can provide for additional protection of water quality and aquatic resource protection through establishment of conservation easements and mitigation. Private foundations should be approached to procure sensitive lands around important manatee habitat areas. Purchased lands can be managed with the purpose of maintaining water quality (and quantity in the case of springs) by existing local, state or federal programs or through the foundation itself. It is also possible to foster protection of privately held lands important to manatee habitat protection through government tax incentives and focused outreach efforts.

3.3.6 Assist local governments in development of county MPPs. Local governments in Florida are encouraged to develop comprehensive, multi-faceted MPPs with technical and financial assistance from FWS, FWC, FDEP, COE, special interest groups, and the general public. Each plan should be designed to ensure manatee protection by addressing a variety of recovery elements or components including: (1) regulating boat facility siting; (2) protecting manatee habitat; (3) providing for public outreach and education; and (4) ensuring appropriate levels of law enforcement. Each plan also should reflect manatee protection zones established by state and federal agencies (sanctuaries, refuges, boat speed zones) and consider if other locally-approved zones are needed. These comprehensive plans will assist in planning future development in a manner compatible with manatee protection, and will ensure local government involvement in manatee protection efforts. All efforts should be made to achieve concurrence among state and federal agencies regarding the approval of county plans.

If local governments are not willing or able to develop comprehensive plans, then FWS and FWC will offer assistance in the development of individual components which would aid in manatee recovery and form the basis for future comprehensive planning efforts. For

example, such a component might outline local government's public outreach and education efforts and set forth funding needs and sources as well as an implementation schedule. While not as valuable as a comprehensive plan, these individual components would still be helpful in achieving recovery of the manatee.

In the absence of approved MPPs, or components thereof, case-by-case decision-making on permit applications by state and federal regulatory agencies will consider the best available scientific and commercial data in order to render their decisions. It is likely that some permits will be denied or required to undergo significant modifications because of uncertainties resulting in the absence of comprehensive planning. While plans or components do not have official status as state or federal laws, certain elements, such as boat facility-siting, can be adopted as local ordinances, and the implementation of these elements can strongly influence and streamline state and federal permitting systems.

Florida's Governor Jeb Bush convened a special manatee summit in October 2000, to examine improvements which might be made to achieve better manatee protection. A special panel, including representatives from marine-related industries, environmental organizations, local governments, and state and federal agencies, evaluated the elements of a MPP. After discussing boating speed limits, boater education, law enforcement, manatee refuges and sanctuaries, and marina siting, the panel unanimously agreed that improved law enforcement and improved boater education should be a priority. Additionally the panel agreed that speed zones and sanctuaries were both effective means of protecting manatees. Governor Bush envisioned that the results of the summit would be used to develop more detailed budget priorities, legislation, and local plans for the protection and conservation of manatees, while preserving Florida's traditional culture of recreational and commercial boating.

- 3.3.7 Implement approved MPPs.** MPPs approved by FWC and FWS should be implemented with the assistance of the action agencies, as appropriate. Copies of these plans should be provided to federal and state agencies as reference documents for decision-making with regard to permitting, leasing submerged lands, project review, or other agency actions. To affirm federal support for the county MPP process, COE should incorporate county MPPs into their permit review process and consult with FWS regarding the adoption of MPPs for the purpose of permit review.

As new information becomes available on manatees and the effectiveness of measures to protect manatees and manatee habitat, there may be a need to modify MPPs. FWC and FWS shall take the lead in periodically reviewing MPPs and make recommendations regarding the need to modify and/or update them.

3.3.8 Protect existing SAV and promote re-establishment of NSAV. Manatees in most Florida waters depend upon the prolific growth of SAV (e.g., seagrass and freshwater submerged plant communities). Coastal construction activities (e.g., dock development, dredging, shoreline stabilization, and urbanization) have contributed to the destruction of SAV habitat. Water pollution contributing to reduced water transparency has reduced the abundance of SAV in most water bodies around the state. Introduction of exotic plant species has eliminated or threatened diverse assemblages of freshwater NSAV communities, providing manatees with restricted food resources in many accessible rivers, lakes, and springs. Nutrient pollution, through contamination of ground and surface waters at major manatee aggregation areas like Crystal and Homosassa Rivers, has contributed to a reduction of available food plants in these areas. Such pollution has caused dramatic increases in certain blue-green algae species (most notably *Lyngbia spp.*) that covers over SAV and prevents growth of manatee food plants.

All manatee research, resource protection, and conservation agencies/organizations should actively support the establishment of water quality standards that will protect the existing and promote the regeneration of SAV in all Florida waters. In particular, FDEP and WMDs actively should pursue changing water transparency and nutrient pollution standards to reflect the light requirements of seagrass and other NSAV species. Water transparency standards should be based on light regimes needed for native rooted aquatic plant species historically found in affected waters.

3.3.8.1 Develop and implement a NSAV protection strategy. Protection and restoration of NSAV communities can be accomplished by enforcing and augmenting existing regulatory programs. Prior to a permit being issued, an assessment of seagrass resources should be required, involving site sampling. This sampling should occur between May and October to coincide with the seagrass growing season and should be based on a standardized sampling methodology so that the assessments can be compared equitably. For seagrass communities, regulatory agencies should standardize monitoring of seagrass damage and alterations authorized through environmental resource permitting

activities. The HWG should develop and implement standardized seagrass mitigation criteria for all projects proposing any activities resulting in damage to seagrass. Freshwater NSAV communities considered for state and federal permitting programs should be afforded the same level of protection as seagrass, because the destruction or alteration of such communities often leads to dominance of exotic species. FWS and FWC should participate actively in regional and local seagrass protection working groups (e.g., National Estuarine Program focus groups) to assist in directing protection efforts in areas important to manatees.

3.3.8.2 Develop and implement a state-wide seagrass monitoring program. FWS, NFS, FWC, and FDEP should develop and implement a regular statewide seagrass monitoring program based on a biennial remote sensing effort. Monitoring efforts should involve trend analysis and comparison to historical distribution of all areas supporting seagrass growth. The FMRI should continue to be the central repository for all collected seagrass monitoring information in Florida. FDEP and FWC should establish a task force to identify total state-wide losses of seagrass due to human activities including, but not limited to, dredge-and-fill projects, dock construction, propeller-scarring, vessel-groundings, freshwater diversion projects, and industrial/municipal pollution changing water transparency. This task force should use the best available scientific data to assess the magnitude of statewide seagrass loss and modify regulatory practices to allow for recovery of seagrass in areas where it has been lost and to protect it in areas where it currently exists.

3.3.8.3 Ensure aquatic plant control programs are properly designed and implemented. Aquatic plant control programs around the state are conducted mostly in freshwater systems and are designed to control the dominance of certain species of exotic or native nuisance plants. Introduced species quickly can displace native plant communities and cause a reduction of diversity, fluctuations in NSAV abundance, and nutritional value of the habitat for manatees. It should be noted, however, that manatees have come to rely on exotic vegetation in some areas. Therefore, while efforts should support NSAV restoration, care must be taken to ensure adequate supplies of winter forage, including both native and exotic species. Such programs are especially important in areas of large manatee

aggregations, such as Crystal River, Homosassa River, Warm Mineral Spring, and Blue Spring.

FWC, FWS, FDEP, and COE should continue to coordinate aquatic plant control programs for these systems through established working groups that address the protection of manatee habitat. The focus of these groups should be to: (1) reduce the need for excessive aquatic herbicide use through a policy of maintenance control for nuisance species; (2) focus control efforts during periods of minimal manatee use; (3) remove infestations of new exotic plant species; and (4) maintain a historically diverse NSAV community accessible to manatees as much as possible. New working groups should be established for waterways where aquatic plant control programs may jeopardize the aquatic plant abundance and diversity needed to sustain recognized manatee aggregations. FWC, FDEP, and FWS should continue to coordinate state-wide aquatic plant control policies, such as the exclusion of the use of copper herbicides in manatee habitat and on areas where conflicts between manatees and aquatic herbicide use may develop.

3.3.9 Conduct research to understand manatee ecology. Habitat-oriented research is important in identifying key habitats and the factors that determine what features are important for manatees and their recovery. Research should focus on the interrelationships between humans, manatees and their environment. Researchers should continue to monitor free-ranging manatees throughout their habitat, observe behaviors, document habitat use, and define how these influence the status of the manatee. Such research will help to understand and protect the manatees' environment; therefore, efforts should be made to improve ongoing studies and methods and to develop new ones.

3.3.9.1 Conduct research and improve databases on manatee habitat. Habitat-related research should focus on: (1) evaluating food preferences, nutritional requirements, and freshwater requirements; (2) development of body condition indices as potential indicators of environmental conditions; (3) evaluation of and monitoring the extent and condition of seagrass beds; (4) the effects of manatee grazing on seagrass ecology and recovery; and (5) continuing current studies outside Florida on the relationships between manatee health and reproduction with habitat condition. Results from these studies should provide information useful in the design of monitoring studies, estimation of manatee carrying

capacity of seagrass beds in key areas, and a better understanding of the manatee's role in maintaining healthy, diverse seagrass communities.

- 3.3.9.2 Continue and improve telemetry and other instrumentation research and methods.** Radio tracking provides an extremely valuable tool to determine and monitor manatee habitat use and behavior associated with environmental and habitat changes. Studies using telemetry should be designed to monitor a large number of manatees for short periods (cross-sectional studies) and individual animals (longitudinal studies) to better understand both population and individual responses to habitat change and habitat use. These studies should be coupled with health and reproductive assessments in order to make comparisons with habitat condition.

The use of conventional VHF and satellite telemetry should continue. Data generated from tracking studies should be entered into GIS databases and analyzed for correlations with habitat preferences and requirements. Verified point data should be provided to management as quickly as possible through technical reports and data transfer. Telemetry results should be published with appropriate analyses in refereed journals as frequently as the data allow.

Emerging technologies such as radio tags utilizing a Global Positioning System (GPS) and data loggers should be further investigated and incorporated to provide better resolution of manatee movements and habitat use. Tags allowing the compilation and transfer of environmental, acoustical, and physiological data should be developed further and implemented to improve our ability to correlate with environmental and habitat parameters or disturbances.

- 3.3.9.3 Determine manatee time and depth pattern budgets.** Time/depth recorders will allow evaluation of risks to manatees from vessel traffic in various habitat types by identifying the position of the animals in the water column. Such information can be related to vessel draft in the area, availability of waters deeper than vessel drafts, and time spent by manatees at specific depths. This information will contribute to a comprehensive risk assessment described in Task 3.3.11.4.

3.3.10 Define the response to environmental change. The Florida environment is not static. Future variation and change are anticipated and could impact survival, reproduction, and distribution of animals among regions, which in turn may affect population growth rates. In order to assess recovery, a need to understand how individual manatees, and consequently the population at large, respond to changes in the environment (e.g., changes in minimum flows at natural springs and elimination of industrial warm-water sources) on the redistribution of fresh water through the Everglades. Research to address such response should proceed at two levels: (1) test for correlation of changes in population parameters with known changes in the environment during long-term monitoring studies; and (2) test of hypothesized cause-effect relationships with behavioral and physiological studies and/or manipulative experimental trials.

3.3.10.1 Define response to changes in fresh water flow patterns in south Florida as a consequence of the Everglades' Restoration. Restoration of the Everglades to its historic water flow pattern is scheduled for the near future. This restoration will affect not only the distribution of fresh water leaving the Everglades, but also the estuarine ecosystem located off the south Florida coast. Studies should be structured to define how changes in sedimentation, bathymetry, seagrass beds, and fresh water input from restoration affects the distribution, survival, and reproduction of manatees.

3.3.10.2 Define response to degradation and rehabilitation of feeding areas. Marine seagrasses and fresh water aquatic vegetation are primary foods for manatees. Regionally, there have been documented declines in seagrass beds and freshwater aquatics resulting from pollution, hurricane-related die-offs, and scarring from boat propellers. Management is making attempts to reverse those declines and has been successful in areas such as Tampa Bay. Studies should be structured to define how changes in the distribution or abundance of feeding areas impact the distribution, survival, and reproduction of manatees.

3.3.11 Maintain, improve, and develop tools to monitor and evaluate manatee habitat. Protection of the manatee from human-related threats in part requires the determination of what constitutes optimal manatee habitats. Resource managers need to know what types of habitat are important to the species, including both natural and manmade features. Understanding manatee distribution in relation to the spatial arrangement of their habitat requires: (1) volumes of data; and (2) specialized computer software and appropriate

techniques to analyze the data. GIS is used as an important geo-spatial tool and data-management system to store, synthesize, retrieve, and analyze these large volumes of data on manatees and manatee habitat. Site-specific data stored in GIS include: (1) manatee carcass recovery sites; (2) manatee sighting from aerial surveys; (3) ground research; (4) telemetry studies; (5) water depths; (6) vegetation coverage; (7) waterway speed and access zones; (8) shoreline characteristics and development patterns; etc. Computer hardware, software, and databases are used by researchers, resource managers, and conservationists for scientific analyses, permit reviews, developing waterway speed and access rules, and preparing county MPPs. Programs with theoretical and technical expertise need to focus on research and development of geo-spatial techniques to foster proactive manatee conservation strategies.

3.3.11.1 Maintain, improve, and develop tools to monitor and evaluate natural and human-related habitat influences on manatee ecology, abundance, and distribution.

Utilize spatial models linked to a GIS to synthesize data and knowledge and to predict the most suitable habitats for manatees in Florida. GIS tools have the potential of evaluating human use impacts on manatees and their habitat. Analyses should be conducted to determine how human activities, such as coastal development and boating, affect manatee habitats and manatee distribution. These analyses will contribute to a comprehensive risk analysis.

3.3.11.2 Maintain, improve, and develop tools to evaluate the relationship between boating activities and watercraft-related mortality.

Utilize GIS and manatee carcass information to create density models to spatially explore areas where manatees may be at higher risk. Evaluate the mortality density information in combination with human-use data, such as boating, to contribute to a comprehensive risk assessment.

3.3.11.3 Evaluate impact of changes in boat design and boater behavior.

In recent years, changes in boat designs have resulted in changing threats to manatees. For example, the development of shallow draft vessels, such as flats boats and personal watercraft, along with high speed operation of these vessels over seagrass and other shallow water habitats used by manatees have created new threats to manatees in habitats where they were previously free of vessel interactions. The level of risk imposed by changing boating patterns needs to be evaluated. The boating industry, boating community, scientists, and wildlife

managers should work to develop predictions of threats resulting from changes in boat designs and market-trend projections.

3.3.11.4 Conduct a comprehensive risk assessment. Utilize the results from the above Recovery Tasks and information from other databases to conduct a comprehensive risk assessment for the manatee.

3.4 Ensure that minimum flows and levels are established for surface waters to protect resources of importance to manatees. Minimum flows and levels are being established by state WMDs for surface waters throughout the state, including those used by manatees (e.g., Biscayne Bay, Florida Bay and the Caloosahatchee River). Current and future withdrawals from surface waters have the potential to impact aquatic resources (e.g., SAV) important to manatees. Managers and researchers should participate in WMD efforts to set these limits to ensure that resources of importance to manatees are minimally affected.

3.5 Assess the need to revise critical habitat. Critical habitat for the Florida manatee was designated in 1976 (50CFR 17.95(a)). Much has been learned about manatee distribution in the decades since manatee critical habitat was originally defined. The FWS should assess the need to revise critical habitat for the Florida manatee.

Objective 4. Facilitate manatee recovery through public awareness and education. Compliance with regulations and management plans depends on broad public support for manatee recovery, which includes both manatee and habitat protection elements. Public support, in turn, depends on an informed public who understands manatee conservation issues and the rationale behind necessary regulatory and management actions. Knowledge of manatees, their habitat requirements, general biology, and protection measures can contribute toward the minimization of manatee disturbance, harassment, injury, and mortality. This information must be clear, consistent, concise, and readily available to the general public and target user groups. Many manatee and habitat education programs and materials are produced and made available to school systems as well as the general public and user groups; however, such efforts need to be continually evaluated and updated.

4.1 Identify target audiences and key locations for outreach. The success of a manatee/habitat conservation effort requires identification of target audiences and locations. Target audiences and key locations should be prioritized by need, i.e., areas where manatee mortality and injury are highest, areas where manatee/human interaction occurs frequently, and areas where habitat is most

at risk. These areas include, but are not limited to, the thirteen key manatee counties, high watercraft use areas, boat ramps, manatee aggregation sites, manatee observation areas, fishing piers, seagrass areas, and other areas identified as having important habitat features (e.g., fresh water areas and areas used for resting and/or calving).

4.2 Develop, evaluate, and update public education and outreach programs and materials. There are many existing manatee and habitat awareness and education materials. Materials should be developed and updated for the general public, including students. As future stewards of our environment, it is important for students to learn about endangered species and their habitats and how to take positive actions to care for our fragile ecosystems. It is also important that some materials explicitly target specific user groups, such as: (1) boaters in areas of high watercraft mortality; (2) snorkelers/divers in areas where interaction and harassment occur; (3) recreational and/or commercial fishermen in areas where entanglements are prevalent; and (4) commercial/port facilities. Innovative ways to reach the public should be explored.

4.2.1 Develop consistent and up-to-date manatee boater education courses/programs. Boater education is critical to minimizing disturbance, harassment, injury, and mortality to manatees throughout Florida. Both resident and non-resident boat use in Florida continues to increase as water-related activities become more popular throughout the state. With the increasing traffic on our waterways, education becomes crucial for both manatee and public safety. Educating the boating public about the manatee will provide a better understanding of how the manatee lives and create a greater public appreciation toward the species. Efforts should continue to update and implement a consistent manatee education program for use in federal, state, and local boater education and training programs (e.g., USCG Auxiliary Boating Safety Courses, U.S. Power Squadron Boat Safety Course, FWC On-Line Boating Safety Course).

4.2.2 Publish and post manatee protection zone information. To educate the boating community and public, organizations that produce materials (e.g., boater's guides, waterway guides, and fishing guides) should add or update the manatee protection zone information in forthcoming editions of their documents. A standardized format should be utilized to develop consistency throughout manatee habitat. Further, at all boat ramps, marinas, vessel rental operations and other access areas, efforts should be made to post signs containing information on manatee zones and "you are here" maps. Additionally, a website should be established allowing the public easy access to manatee protection zone information on the internet. This website could contain rules and regulations, detailed maps of the zones, sign

locations within individual zones, examples of each type of sign, and definitions and explanations of manatee protection zones.

- 4.2.3 Update nautical charts and Coast Pilot to reflect current manatee protection zone information.** FWS should request National Oceanic and Atmospheric Administration (NOAA) to update these documents to include: (1) a chart note referencing manatee protection zones for applicable nautical charts; and (2) information regarding the manatee protection zones for specific water bodies in Coast Pilot 4 and 5.
- 4.3 Coordinate development of manatee awareness programs and materials in order to support recovery.** There are overlap and conflicting messages among existing materials produced by various agencies and conservation organizations. A Manatee Education Committee should be convened to review materials and programs with emphasis on reducing redundancy, providing consistent, standardized messages, and coordinating production of materials among participating organizations. All appropriate recovery plan tasks for education and public awareness materials and programs which have not been developed should be identified by the committee, and any unmet needs should be addressed.
- 4.4 Develop consistent manatee viewing and approach guidelines.** Harassment is a violation of federal and state laws such as the MMPA, ESA, and Florida Manatee Sanctuary Act. While manatees may occasionally approach people on their own accord, people often chase after and pursue interactions with the animals. Human interference can disturb manatees and disrupt their natural behaviors (e.g., feeding, breeding, parenting, sheltering). Manatees which are harassed may leave preferred habitats or flee into areas with heavy vessel traffic. With increasing popularity of ecotourism, manatee harassment is an issue of growing concern statewide. Consistent viewing guidelines and education programs will be developed to teach responsible manatee viewing and approach practices, while ultimately serving to minimize disturbance. Coordination with agencies responsible for upholding marine mammal protection laws will allow for pooling of resources, thereby increasing the effectiveness of outreach materials and projects. A working group to address manatee harassment has been formed; the objective of this group is to develop easy-to-understand and comprehensive marine mammal and marine wildlife viewing education materials that promote responsible wildlife watching ethics.
- 4.5 Develop and implement a coordinated media outreach program.** Public awareness and understanding is crucial to the recovery of the manatee in Florida. Whenever possible, when media opportunities occur, all recovery partners should make an effort to coordinate information prior to

release. This coordination would serve to inform the general public with a consistent message on manatee biology, status, laws affecting them, how those laws benefit their quality of life, and why these laws are important to the recovery of the species. Such opportunities include, but are not limited to, annual mortality updates, synoptic survey results, manatee rescues and releases, and annual implementation of seasonal manatee protection zones and sanctuaries.

- 4.6 Utilize the rescue, rehabilitation, and release program to educate the public.** The media heavily publicize rescues and releases and millions of visitors see and learn about manatees at critical- and long-term care facilities every year. Program participants should incorporate accurate, up-to-date information in their news releases, publications, presentations, displays, and other media to accurately portray the status of the manatee.
- 4.7 Educate state and federal legislators about manatees and manatee issues.** Legislators in Tallahassee and Washington, D.C. can enact manatee protection regulations, or conversely, they can enact legislation that could result in harm to the species and/or its habitat. Holders of some legislative seats change as frequently as every two years, making the issue of educating legislators an ongoing one. To the greatest extent possible, at a frequency of at least every to years, recovery team partners should provide legislators with manatee awareness and education materials, as well as available status reports on the species and its management.

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