FINAL RECOVERY PLAN

for

JOHNSON'S SEAGRASS

(*Halophila johnsonii* Eiseman)

prepared by the

Johnson's Seagrass Recovery Team

for the

National Marine Fisheries Service
National Oceanic and Atmospheric Administration

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National Marine Fisheries Service
National Oceanic and Atmospheric Administration

Disclaimer

This recovery plan for *Halophila johnsonii* Eiseman (Johnson's seagrass) has been approved by the National Marine Fisheries Service. It does not necessarily represent official positions or approvals of cooperating agencies nor the views of all individuals involved in the plan's formulation. The National Marine Fisheries Service has determined that the information used in the development of this document represents the best scientific and commercial data available at the time it was written. The Recovery Plan was prepared by the Johnson's Seagrass Recovery Team to delineate reasonable actions that will promote protection of Johnson's seagrass. This plan is subject to modification as dictated by new findings, changes in species status, and completion of actions described in the plan. Goals and objectives will be attained and funds expended contingent upon agency appropriations and priorities.

Literature Citations should read as follows:

National Marine Fisheries Service. 2002. Recovery Plan for Johnson's Seagrass (*Halophila johnsonii*). Prepared by the Johnson's Seagrass Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. 134 pages.

Preface

Congress passed the Endangered Species Act of 1973[1] (16 U.S.C. §§ 1531-1544)(ESA), finding that (1) various species of plants and animals in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation and, (2) other species of plants and animals have been so depleted in numbers that they are in danger of or threatened with extinction (16 U.S.C. § 1531(a)). The purposes of the ESA are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in section 1531(a) (16 U.S.C. § 1531(b)). The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibility for the administration of the ESA. NMFS is responsible for most marine and anadromous species including Johnson's seagrass.

Section 4(f) of the ESA directs the responsible federal agency to develop and implement a recovery plan, unless such a plan would not promote the conservation of a species. NMFS determined that a recovery plan would promote conservation and recovery of Johnson's seagrass. The Johnson's Seagrass Recovery Team included seagrass and management experts from academia and the state and federal governments.

The NMFS agrees with the Johnson's Seagrass Recovery Team that the goals and objectives of this recovery plan can be achieved only if a long-term commitment is made to support the actions recommended here. Achieving these goals and objectives will require the cooperation of state and federal government agencies as well as private individuals and organizations.

NMFS and the U.S. Fish and Wildlife Service will soon publish new draft guidance on recovery planning. This recovery plan was drafted before the draft guidance was available and, therefore, is not written to conform with this new guidance. This recovery plan has been under development for a long time and NMFS has decided to publish this recovery plan without further delay.

[1] amended 1976, 1978-1980, 1982, 1986, 1988.

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List of Abbreviations

ASMFC	Atlantic States Marine Fisheries Commission
CARL	Conservation and Recreation Lands
CCP	Coastal Construction Permit
COE	U.S. Army Corps of Engineers
DGPS	Differential Global Positioning System
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ERP	Environmental Resource Permitting
ESA	Endangered Species Act
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FFA	Florida Forever Act
FWC	Florida Fish and Wildlife Conservation Commission
FNAI	Florida Natural Areas Inventory
FR	Federal Register
F.S.	Florida Statutes
GIS	Geographic Information System
HCD	NMFS/ Habitat Conservation Division
IRL	Indian River Lagoon
IRLCCMP	IRL Comprehensive Conservation and Management Plan
IRLNEP	IRL National Estuary Program
JCP	Joint Coastal Permit
MSSW	Management and Storage of Surface Waters Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Association
NOS	National Ocean Service
OFWs	Outstanding Florida Waters
PAR	Photosynthetically Active Radiation
PLRGs	Pollution Load Reduction Goals
SAFMC	South Atlantic Fishery Management Council
SAV	Submerged Aquatic Vegetation
SJRWMD	St. Johns River Water Management District
SFWMD	South Florida Water Management District
SWIM	Surface Water Improvement and Management Act
TMDLs	Total Maximum Daily Loads
WMDs	Water Management Districts
WR	Wetland Resource Permit Program
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service

Executive Summary

Current Species Status: Johnson's Seagrass (*Halophila johnsonii* Eiseman) was listed as threatened on September 14, 1998 (63 FR 49035): the first marine plant species to be listed under the ESA. Critical habitat for Johnson's seagrass was designated on April 5, 2000 (65 FR 17786). *Halophila johnsonii* has been found growing only along approximately 200 kilometers (km) of coastline in southeastern Florida between Sebastian Inlet and north Biscayne Bay. The species is rare, has a limited reproductive capacity, and is vulnerable to a number of anthropogenic and natural disturbances.

Habitat Requirements and Limiting Factors: Where present in its limited geographic range, *H. johnsonii* often grows in a patchy, non-contiguous distribution at water depths extending from the intertidal down to 3 meters (m). *Halophila johnsonii* appears to reproduce only through asexual branching. Principal threats to the species' survival include: 1) habitat degradation and destruction from dredging and filling, construction and shading from in- and overwater structures, prop scarring, altered water quality, and siltation; 2) inadequacy of existing regulatory mechanisms to protect seagrasses; and 3) stochastic storm events.

Recovery Goal: To delist Johnson's Seagrass and to assure its persistence throughout its range.

Recovery Objective and Criteria: *Halophila johnsonii* should be considered for delisting when the following conditions are met: 1) The species' present geographic range remains stable for at least 10 years or increases, 2) Self-sustaining populations are present throughout the range at distances less than or equal to the maximum dispersal distance to allow for stable vegetative recruitment and genetic diversity, and 3) Populations and supporting habitat in its geographic range have long-term protection (through regulatory action or purchase acquisition).

Actions Needed:

1. Identify and protect populations and habitat.
2. Initiate a range-wide mapping and monitoring program.
3. Refine habitat requirements of *H. johnsonii*.
4. Conduct detailed life history studies of *H. johnsonii* to examine vegetative fragment dispersal, survival, and sexual reproduction.
5. Determine habitat management needs and techniques.
6. Identify the genetic diversity and genetic structure of *H. johnsonii* across its geographic range.
7. Develop restoration techniques.
8. Formulate an educational outreach program for *H. johnsonii* and seagrass habitat.

Cost of Recovery Actions: The exact costs of recovery and protection are undeterminable at this time. Refer to the Implementation Schedule for cost and time estimates for individual actions. Cost estimates were not available for some actions

because the actual procedures for accomplishing these actions are not yet known. In addition, many of the actions are linked to one another so that accomplishing one may allow for others to be concurrently achieved. Therefore, exact costs were impossible to predict.

1.0 BACKGROUND

The seagrass *Halophila johnsonii* Eiseman (Johnson's seagrass) is a rare plant that may have the most limited distribution of any seagrass on earth. It frequently occurs in small (centimeters [cm] to a few m diameter) isolated patches. Unlike most *Halophilas*, which can survive perturbations by using sexual reproduction to disperse and maximize offspring, *H. johnsonii* appears to reproduce only through asexual branching or apomixis (Eiseman and McMillan 1980). There are no known seed banks; and although experiments have shown that vegetative fragments survive when transplanted into the field and in experimental mesocosms, there is only circumstantial evidence for unassisted recruitment by naturally produced fragments. Thus, the plant has a reduced capacity to repopulate an area if lost due to human or environmental perturbations. The apparent lack of sexual reproduction suggests this species may have limited genetic diversity. Because of its small size and minimal stored reserves, local populations of *H. johnsonii* may decline during periods of unfavorable conditions, be out-competed by larger seagrasses, or become overgrown by macroalgae. *Halophila johnsonii* is particularly vulnerable to sediment disturbances, trampling, and prop scarring due to its fragile nature and predominantly shallow growth habit; and, for these reasons, it will have a limited recovery potential.

1.1 Taxonomy

Presently, there are 12 recognized species of seagrass in the genus *Halophila* (den Hartog 1970). The genus is distributed in warm-temperate and tropical waters worldwide; the only pan-tropical species is *Halophila decipiens* Ostenfeld. All species of *Halophila* are morphologically distinguished from the other seagrass genera by having either a pair of leaves or a pseudowhorl of leaves at each rhizome node. Most *Halophilas* are small, shallow rooted, and have 2-3 orders of magnitude less biomass per unit area compared to other seagrass genera. Although small, biomass turnover rate is relatively high, and the plants decompose quickly (Kenworthy et al. 1989).

Diagnostic Characteristics of *Halophila johnsonii*

After many years of confusion over identification, *H. johnsonii* was formally proposed as a separate species by Eiseman and McMillan (1980). *Halophila johnsonii* was previously referred to either as *H. decipiens* or *H. baillonis* Ascherson, but it most closely resembles *H. ovalis* (R. Brown) Hooker f., an Indo-Pacific species, both morphologically and genetically (McMillan and Williams 1980). Plant classification schemes based on anatomical (den Hartog 1970) and molecular phylogenetic (Les et al. 1997) methods both place the seagrass genus *Halophila* in the angiosperm family Hydrocharitaceae, along with two other seagrass genera, *Thalassia* and *Enhalus*. Morphologically, Johnson's seagrass is recognized by the presence of pairs of linearly shaped foliage leaves, each with a petiole formed on the node of a horizontally creeping rhizome (Figure 1). The rhizome is located at or just below the sediment surface and is anchored to unconsolidated substrate by unbranched roots. The leaves are generally 2-5 cm long

(including the petioles), and the rhizome internodes rarely exceed 3-5 cm in length, making this species appear diminutive relative to the larger seagrasses. *H. johnsonii* differs from *H. decipiens* in a number of morphological, reproductive, and genetic characteristics (Table 1). The diagnostic characteristics of *H. johnsonii* remain

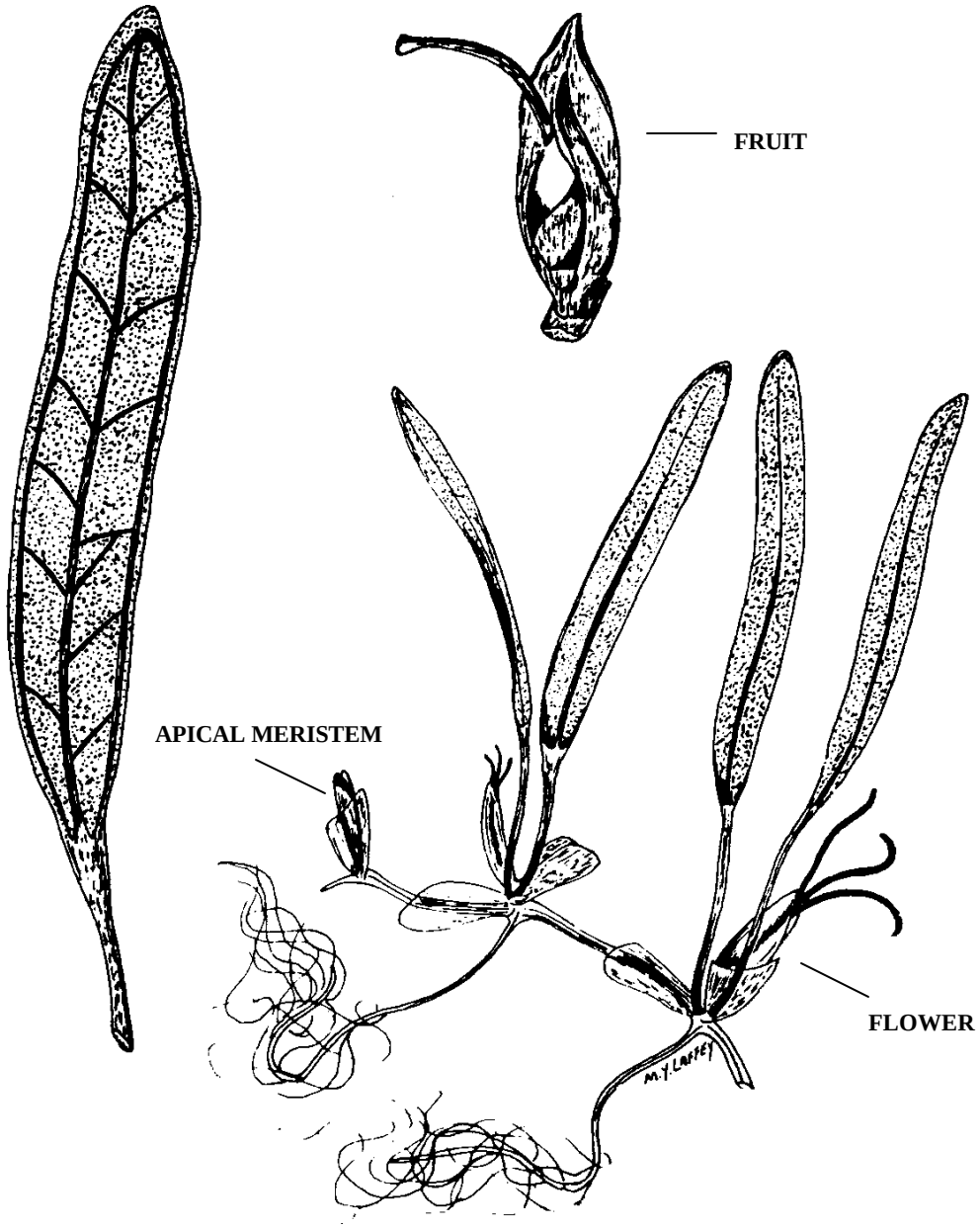
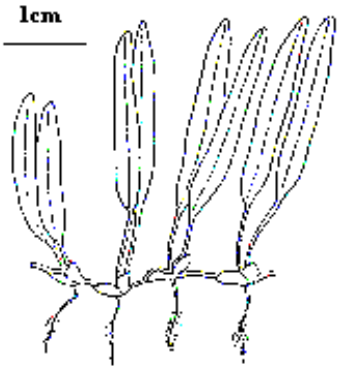
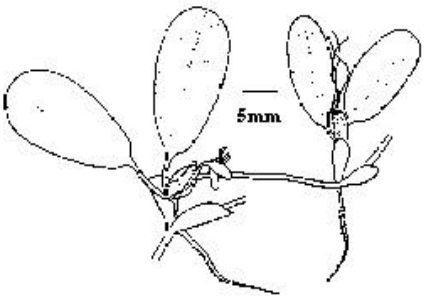


Figure 1 (See Table 1). *Halophila johnsonii*. Leaves are generally 2-5 cm long. Adapted from Eiseman and McMillan (1980).

Table 1. Morphological, reproductive, and genetic characteristics of *H. johnsonii* and *H. decipiens*.

H. johnsonii	***H. decipiens***
Linear leaves with entire (smooth) margins.	Oblong-elliptical leaves with serrate margins.
No hairs on blade surface.	Unicellular prickle hairs on both surfaces (unique to *H. decipiens*).
Leaf cross veins diverge at ca. 45° angles.	Leaf cross veins at ca. 60° angles.
Only pistillate (female) flowers are known so it is possibly dioecious (male and female plants) or apomictic (produces seeds without pollination or meiosis so seeds are clones of female parent).	Monoecious (both sexes on one plant).
Populations of *H. johnsonii* collected in the Indian River Lagoon (IRL) differed from *H. decipiens* in five isozymes of the seven isozyme systems tested, with major differences in three of the enzymes (Jewett-Smith et al. 1997).	See box at left.
	

Illustrations adapted from Phillips and Menez,1988.

relatively unchanged when plants are cultured in artificial conditions; thus, differences between the two species are not due to phenoplasticity.

1.2 Population Size and Distribution

Although the genus *Halophila* has one of the most extensive distributions of all the seagrasses, *H. johnsonii* has only been found growing in lagoons along approximately 200 km of coastline in southeastern Florida between Sebastian Inlet and north Biscayne Bay (Figure 2). This narrow range and apparent endemism indicate that *H. johnsonii* has the most limited known geographic distribution of any seagrass in the world.

Species of *Halophila* are documented to occur from intertidal to 85 m depths (may be the deepest growing seagrasses); shallow occurrence is frequently associated with high turbidity. *Halophilas* regularly occur in 30-40 m depths, thus are important contributors to primary production of coastal shelf environments (e.g., extensive beds on the West Florida Shelf). Some species are the primary colonizers of disturbed environments, apparently due to their tolerance to low light, their high sexual fecundity, and their rapid horizontal growth rates. Unassisted recruitment by vegetative fragments has never been documented for any *Halophila* species (Heidelbaugh et al. 1999).

In the IRL, *H. johnsonii* is one of the least abundant seagrass species (Virnstein et al. 1997). Within Johnson's seagrass' distributional range, the least abundant species is *Halophila engelmannii* Ascherson; however, *H. engelmannii* has a much wider

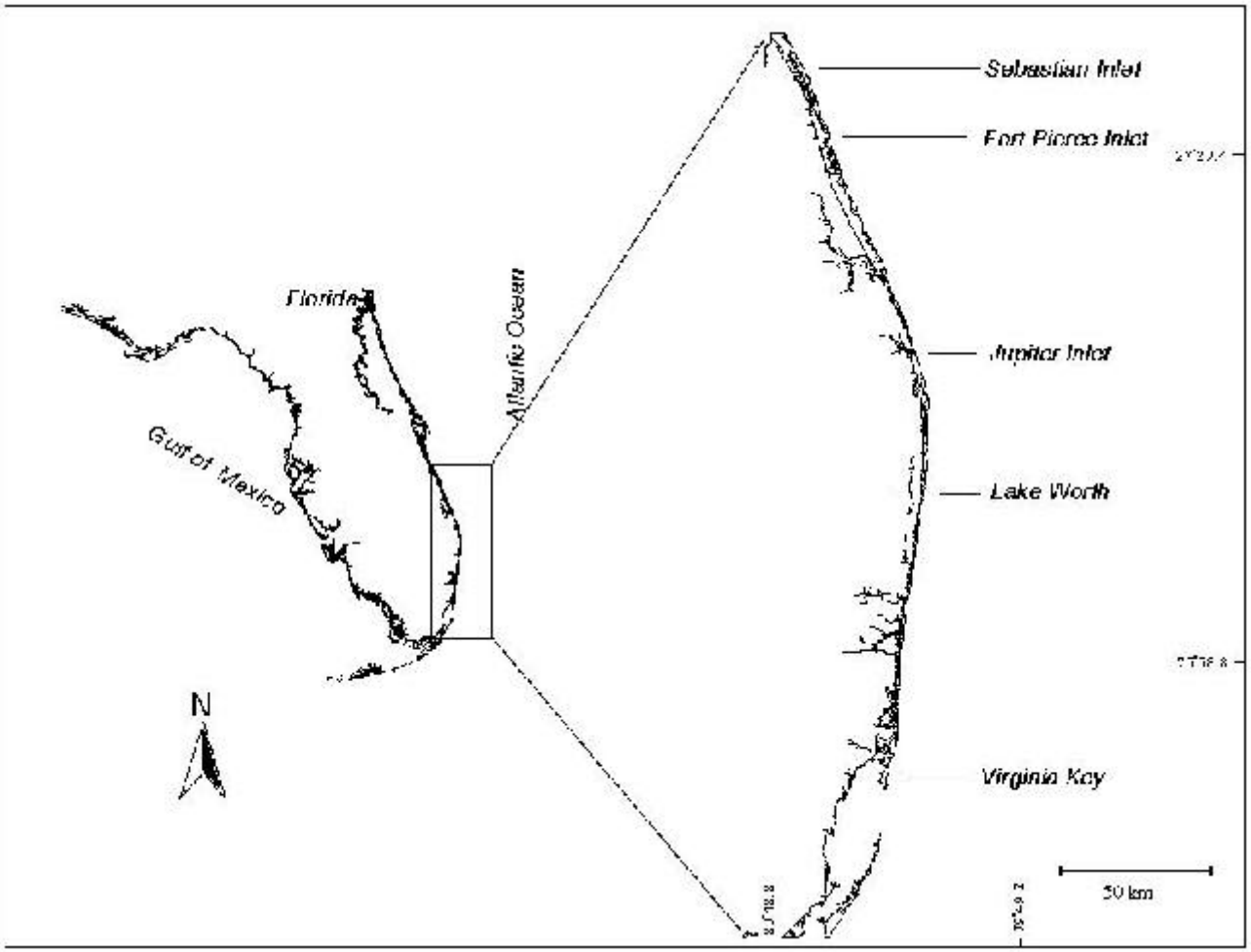


Figure 2 Geographic range of *Halophila johnsonii*: Sebastian Inlet to northern Virginia Key (Kenworthy 1997).

geographic range, including the Bahamas, Florida, Cuba and the Gulf of Mexico (Kenworthy 1997). *Halophila johnsonii* often grows in a patchy, non-contiguous distribution at water depths extending from the intertidal down to 3 m (Kenworthy 1993; Virnstein et al. 1997). Intertidal populations may be completely exposed at low tides, suggesting tolerance to dessication and wide temperature ranges. The largest known contiguous distribution of patches occurs near the northern (Sebastian Inlet) and central range of this species (Lake Worth). Although it is more commonly found in monotypic patches, Johnson's seagrass can also occur among low-to-moderate densities of *Halodule wrightii* Ascherson and *Syringodium filiforme* Kutzing, and mixed with *H. decipiens* in deeper water.

Observations of its distribution and the results of some very limited experimental work suggest that *H. johnsonii* has a wider tolerance of salinity, temperature, and optical water quality conditions than *H. decipiens* (Dawes et al. 1989). Documented salinity range is 15-43 parts per thousand (ppt) (physiological salinity tolerance range may be greater; Dawes 1989; Virnstein et al. 1997) and the species has been observed growing perennially near the mouths of freshwater discharge canals (Gallegos and Kenworthy 1996). Although specific thermal tolerances for growth and mortality have not been determined, observations indicate that Johnson's seagrass grows all year long at its northern range limits near Sebastian Inlet where temperatures have dropped below 10 degrees C. Johnson's seagrass does not exhibit photoinhibition at high light intensities as does *H. decipiens*, so it is found growing from deeper turbid waters of the interior portion

of the IRL up to the intertidal. Johnson's seagrass also grows in clear water associated with the high energy environments and flood deltas inside ocean inlets where tidal velocities approach the threshold of motion for unconsolidated sediments (35-40 cm second^{-1}).

1.3 Growth Form and Reproductive Biology

Johnson's seagrass grows vegetatively by the division of meristems located on the apex of the horizontal rhizome and in the axial point (node) where the petioles intersect the rhizome. As in all clonal plants, vegetative growth and areal coverage is achieved by meristem division, the iteration of modules (leaf pairs and apical meristems), and branching of the horizontal stem (rhizome). Since seagrasses are angiosperms, many species also reproduce sexually; however, no male flowers have ever been described nor is there any evidence of successful recruitment by seed for Johnson's seagrass, even with extensive, decade-long observations. Female flowers of *H. johnsonii* arising from the base of the petioles are enclosed in a two-leaved spathe. The fruits are long-necked with 3 stigmas, each 2-4 cm in length.

There is no evidence of sexual reproduction in this species; therefore, *H. johnsonii* must rely on asexual branching and clonal reproduction for maintenance and dispersal. Thus, *H. johnsonii* will be at a disadvantage, particularly if extirpated from an area, compared to either the highly fecund *H. decipiens* or the larger seagrasses in re-establishing after periods of unfavorable conditions. The competitive advantage of the larger seagrasses stems from their size and the energy storage capabilities of their comparatively larger rhizomes, which provide a buffer during unsuitable conditions. Small species can survive these unfavorable environmental conditions by the production of a seed bank which allows the plants to re-emerge when favorable conditions return, but seed production and viability are unknown for *H. johnsonii*.

The genetic diversity of clonal plants depends strongly on the relative proportions of sexual versus asexual reproduction (Hamrick et al. 1979). Only asexual reproduction is presently known for this species (because of the apparent absence of male flowers) and little genetic variation has been documented (Jewett-Smith et al. 1997). Limited genetic variation within, and among, patches may be possible, however, due to somatic mutation and genetic drift (Loveless and Hamrick 1984). Preliminary surveys using Randomly Amplified Polymorphic DNA analyses indicate that there are small, isolated populations of *H. johnsonii* that have clones which are genetically distinct from clones at other locations (Freshwater 1999). Two populations in the more southerly range of the species, one from near Boynton Beach and a second population from Boca Raton, exhibit higher genetic variability than populations from the central (Jupiter Inlet) and northern range (Fort Pierce Inlet, Johns Island, Sebastian Inlet) of the species. Since there are no known occurrences of male flowers, it is suspected that the extant populations of *H. johnsonii* are maintained almost exclusively by clonal growth and asexual reproduction. Consequently, gene flow may be severely restricted because of very infrequent or no genetic recombination, and the current variation in *H. johnsonii* may be due to somatic mutation associated with asexual reproduction and clonal growth. If this is the case, these isolated clones serve as important reservoirs of genetic information for the species and should be protected.

1.4 Ecological Role of *Halophila Johnsonii*

Despite its diminutive size, studies indicate that Johnson's seagrass provides similar ecological and economic benefits to the larger seagrasses i.e., a food source, a refuge, and nursery for numerous wildlife species, sediment stabilization, and deceleration of water currents and waves reducing turbidity and erosion (Zieman 1982; Virnstein et al. 1983; Phillips and Menez 1988; Fonseca 1994). Patches of *H. johnsonii* provide a level of support for epiphytes and epifauna (Hodgkin and Lenanton 1981; Virnstein and Carbonara 1985; Howard 1987; Virnstein and Howard 1987) and algae (Thompson 1978; Virnstein and Carbonara 1985; Hall and Bell 1988; Holmquist 1994). Like other *Halophila* species, because of its small size and rapid turnover rate, this seagrass is especially important in detritus and nutrient cycling (Kenworthy 1993; Bolen 1997). Green sea turtles, West Indian manatees, and dugongs are known to feed on *Halophila* species and this genus may represent a significant component of their diet (Bjorndal 1981; Packard 1981; Lefebvre pers. comm. 1991; Foley and Bolen 1996; Jupp et al. 1996).

If extirpated from an area, *H. johnsonii* will be at a disadvantage compared to either the highly fecund or larger species in re-establishing itself due to its known lack of seed banks and limited energy storage capabilities. However, rapid growth assists *H. johnsonii* in playing an opportunistic role in the recovery of disturbed sites, and it will stabilize the sediments of disturbed sites before the larger seagrasses can establish themselves (Packard 1981; Fonseca 1989; Kenworthy 2000). *Halophila johnsonii*

stabilizes sediments by increasing the threshold velocity for sediment motion as has been reported for the similar-sized *H. decipiens* (Fonseca 1989).

1.5 Current Status and Historical Conditions

Halophila johnsonii has only relatively recently been identified as a distinct species (Eiseman and McMillan 1980) and no historical information on the species' distribution is available. No monitoring program exists specifically for *H. johnsonii*. The most comprehensive and quantitative distribution and abundance data comes from the State of Florida Surface Water Improvement and Management Act of 1987 (SWIM) Project. Since 1994, all seagrass species have been monitored twice a year within 1-m^2 quadrats placed every 10 m along 75 fixed transects in the IRL between Sebastian Inlet and Jupiter Inlet. The following information is based on this seagrass monitoring program (Virnstein et al. 1997).

In the IRL, *H. johnsonii* is discontinuous. It occurs over a range of depths (intertidal to 1.8 m), salinities, and water quality. *Halophila johnsonii* was found at 20 of 33 transects within the IRL during 1994-1997, but at not more than 12 transects at any one sampling time. Eight of the transects were specifically located to include *H. johnsonii*; the species is therefore over-represented in this monitoring program compared to random sampling. Where it does occur, its distribution is patchy, both spatially and temporally. It occurred in 4.6% (106 of 2,280) of the 1-m^2 quadrats sampled within the IRL. Average percent cover (measured as shoot frequency within grid cells of the quadrat) over all sampling dates and transects was 1.5%.

Halophila jonsonii is a perennial plant with no strong seasonal pattern, although it generally exhibits some winter decline. Monitoring in the IRL indicates that there is spatial and temporal variation in the abundance of *H. johnsonii* patches (Virnstein et al. 1997). Although the monitoring data are limited, no large distributional gaps have been detected in the IRL, and there has been no overall increase or decrease in abundance or geographic range over the period from summer 1994 to summer 1999. The recent increase in search effort (as this plant becomes more widely recognized) may be responsible for any apparent increase in reported occurrences.

1.6 Critical Habitat

The Recovery Team has identified the following critical habitat criteria for *H. johnsonii*: 1) populations that have persisted for 10 years, 2) persistent flowering populations, 3) the northern and southern limits of the species, 4) unique genetic diversity, and 5) a documented high abundance of *H. johnsonii* compared to other areas in the species' range. Based on these criteria, ten areas in the geographic range of Johnson's seagrass were designated as critical habitat (65 FR 17768) (Appendix II). These ten areas and their approximate acreage include: a portion of the Indian River Lagoon, north of the Sebastian Inlet Channel (5.7); a portion of the Indian River Lagoon, south of the Sebastian Inlet Channel (2.0); a portion of the Indian River Lagoon near the Fort Pierce Inlet (4.3); a portion of the Indian River Lagoon, north of the St. Lucie Inlet (2770); a portion of Hobe Sound (900); a site on the south side of Jupiter Inlet (4.3); a site in central Lake Worth Lagoon (15.0); a site in Lake Worth Lagoon, Boynton Beach (95.5); a site in Lake Wyman, Boca Raton (20.0); and a portion of Biscayne Bay (18,757). This designated area accounts for approximately 22,574 acres or 9,139 hectares.

1.7 Reasons for Listing

After a thorough review and consideration of all information available, NMFS concluded that *H. johnsonii* warrants listing as a threatened species. Procedures found at section 4(a)(1) of the ESA (16 U.S.C. 1531 et seq.) and regulations (50 CFR part 424) promulgated to implement the listing provisions of the ESA were followed. A species may be determined to be endangered or threatened due to one or more of the five factors described in section 4(a)(1). These factors and their application to *H. johnsonii* are:

1. Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range.

Habitat in the limited range in which *H. johnsonii* exists is at risk of degradation or destruction by a number of human and natural perturbations, including (1) dredging and filling, (2) construction and shading from in- and overwater structures, (3) prop scarring and anchor mooring, (4) trampling, (5) altered water quality (such as stormwater runoff and turbidity), (6) storms, and (7) siltation. Due to the fragile nature of *H. johnsonii*'s shallow root system, the plants are vulnerable to human-induced disturbances in addition to major natural disturbances to the sediment, and their potential for recovery may be limited. Destruction of benthic communities due to boating activities (propeller scarring and anchor mooring) was observed at all *H. johnsonii* sites during a NMFS study (Kenworthy 1993). Further, this impact is expected to worsen with the rapidly expanding population of this region and the predicted increase in boating activity. This activity severely disrupts the benthic habitat by severing rhizomes and significantly reducing the

viability of the populations. Trampling due to human disturbance and increased land-use induced siltation can also threaten the viability of the species.

Turbidity is another critical factor in the distribution and survival of seagrasses, especially in deeper regions of the IRL, where reduced Photosynthetically Active Radiation (PAR) limits photosynthesis. Shallow regions are less affected by turbidity unless light is rapidly attenuated. In interior lagoonal areas where salinity is low, highly colored water typically is discharged via drainage systems. These stained waters attenuate shorter wavelengths rapidly, removing important PAR as well as potentially stressing plants by lowering salinity. This is a critical factor in the vicinity of Sebastian, St. Lucie, Jupiter, and Ft. Pierce Inlets, and Lake Worth and North Biscayne Bay, where freshwater reaches the flood tide deltas and nearby seagrass meadows via rivers and canal systems discharging into the lagoon. Under certain conditions, these effects may also be severe at lagoonal sites farther from the inlets.

Degradation of water quality due to human impact threatens the welfare of all seagrass communities, including those of *H. johnsonii*, and subsequently affects fishery resource productivity, in general. Nutrient over-enrichment caused by inorganic and organic nitrogen and phosphorous loading, via urban and agricultural land run-off, can stimulate increased algal growth that may smother the understory of seagrasses, particularly *H. johnsonii*, shade rooted vegetation, and diminish the oxygen content of the water. Such

low oxygen conditions have a demonstrated severe negative impact on seagrasses and associated communities.

2. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

Overutilization for these purposes has not been a documented factor in the decline of this species.

3. Disease or Herbivory.

There are two known large herbivores that occur in the range of *H. johnsonii*—the green sea turtle (*Chelonia mydas*), and the West Indian manatee (*Trichechus manatus*); both feed upon the seagrass. Herbivorous fish also feed upon seagrass communities, but herbivory pressure alone is not likely to be a threat to the species' existence.

4. Other Natural or Human-made Factors Affecting the Species' Continued Existence.

The existence of the species in a very limited range increases the potential for extinction from stochastic events. Natural disasters such as hurricanes could easily diminish entire populations and a significant percentage of the species. Seagrass beds that are near inlets are especially vulnerable to storm surge from hurricanes and severe storm events.

5. The Inadequacy of Existing Regulatory Mechanisms.

Despite existing federal and Florida state laws to conserve and protect seagrass habitat, there is a continued and well-documented loss of seagrass habitat in the United States and Florida. For example, seagrasses have declined in many areas of the IRL (Virnstein and Morris 1996). Seagrass loss and environmental degradation of submerged lands continue despite the existing federal and state regulatory programs. Examples of regulatory programs that should positively affect seagrasses include Florida Department of Environmental Protection (FDEP) and U.S. Army Corps of Engineers (COE) dock construction, Environmental Resource Permitting (ERP), and Environmental Protection Agency (EPA)/FDEP water quality standards (light attenuation through turbidity set for phytoplankton). However, state and federal regulatory programs have not totally stopped the loss of seagrasses and the degradation of submerged lands. A steady increase in coastal populations has greatly increased Florida's assignment of enforcement responsibilities, including responsibilities for enforcing environmental and boating regulations, without a proportional increase in staff for the Florida Marine Patrol.

Stormwater management systems have been or are being installed; however, the Florida IRL Act of 1990 covers only waste water treatment plants and does not cover other large inputs that will affect water quality, which in turn could affect seagrasses (e.g., industrial discharges, brine disposal, canals, processing plants).

Many seagrass ecosystems are known to recover very slowly even under the most natural, pristine conditions. Although transplantation has had limited success, previous

mitigation efforts for loss of seagrass beds have failed (Fonseca et al. 1998). Until recently, *Halophila* species have not been transplanted successfully in the field and studies underway are incomplete (Heidelbaugh et al. 1999). Current efforts are insufficient to protect critical seagrasses. This was also the conclusion and recommendation of scientists attending the International Seagrass Workshop in Kominato, Japan in August 1993. Kenworthy and Haunert (1991) concluded that the State of Florida's light and turbidity standards were inadequate to protect seagrasses. See "State Conservation Measures; Surface Water Quality Standards" for a description of these standards under the Florida Administrative Code (F.A.C.), Chapter 62-302.

1.8 Listing Determination

Based on available information, NMFS concluded that Johnson's seagrass warrants listing as a threatened species. This species is rare, has a limited reproductive capacity, and is vulnerable to a number of anthropogenic and natural disturbances. Also, it exhibits the most limited geographic distribution of any seagrass. Within its small geographic range (lagoons on the east coast of Florida from Sebastian Inlet to central Biscayne Bay), it is one of the least abundant species. Because of its limited reproductive capacity and energy storage capacity, it is less likely to survive environmental perturbations and to be able to repopulate an area when lost. Finally, environmental degradation and habitat loss have continued despite existing federal and state conservation efforts.

H. johnsonii was listed as threatened on September 14, 1998 (63 FR 49035)(Appendix I). Critical habitat for Johnson's seagrass was designated on April 5, 2000 (65 FR 17786) (Appendix II).

1.9 Conservation Measures

1.9.1 Federal Conservation Measures

NATIONAL MARINE FISHERIES SERVICE (NMFS)

Johnson's seagrass is directly protected by provisions of the ESA under NMFS jurisdiction. Federal agencies conducting, permitting, or funding actions that may affect Johnson's seagrass are required to consult with NMFS Protected Resources Division. While the provisions of the ESA may have reduced certain threats, the adverse affects of some of these actions continue.

Federal agency actions or programs that may affect Johnson's seagrass include: COE authorization of projects affecting waters of the United States under section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act (i.e., beach renourishment, dredging, filling, and related activities including the construction of docks and marinas); EPA authorization of pollutant discharges and management of freshwater discharges into waterways and state directives to develop numerical nutrient criteria by 2003; U.S. Coast Guard (USCG) regulation of vessel traffic; management of national refuges and protected species by USFWS; management of vessel traffic and other activities by the U.S. Navy; authorization of state coastal zone management plans by NOAA/NOS; and management of commercial fishing and protected species by NMFS (NMFS 1998, page 49041).

The NMFS Habitat Conservation Division (HCD) acts in an advisory capacity in the protection of natural resources under NMFS purview and coordinates with the COE and other federal agencies on any federal projects which may affect these resources. Federal agencies, including NMFS/HCD, support the Living Marine Resource mandates, Submerged Aquatic Vegetation (SAV) policy (adopted May 1997), and Essential Fish Habitat (EFH) amendments of the South Atlantic Fishery Management Council (SAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC).

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL (SAFMC)

The SAFMC plays an advisory role in the protection of habitat essential to managed species as directed by the Magnuson-Stevens Fishery Conservation and Management Act. The SAFMC and NMFS have coordinated their efforts to address their respective mandates in the Act. The SAFMC actively comments and makes recommendations to federal and state agencies that may affect EFH, including SAV. Under the new EFH mandates of 1997, the SAFMC began identifying and describing EFHs and amending existing fishery management plans to include these EFHs. The SAFMC has also established a Habitat Advisory Panel and initiated workshops on habitat types, including seagrass habitats.

ATLANTIC STATES MARINE FISHERIES COMMISSION (ASMFC)

Based upon the importance and need to protect SAV habitats for ASMFC managed species, the ASMFC has developed policies in SAV and Habitat Conservation (ASFMC

1997). These policies have been incorporated into fishery management plans through amendments that describe EFHs for ASFMC trust resources and emphasize the need to protect and conserve SAV systems. The ASMFC encourages NMFS and USFWS to adopt and implement the plans, policies, and amendments. Depending upon the level of implementation, Johnson's seagrass and its habitat may be indirectly protected by these policies.

NATIONAL ESTUARY PROGRAM - INDIAN RIVER LAGOON NATIONAL ESTUARY PROGRAM (IRLNEP)

The Federal Water Quality Act of 1987 recognized the poor health of the nation's estuaries and need for their protection, and stated a national interest in maintaining the ecological integrity of the nation's estuaries. Section 320 of the Water Quality Act initiated the National Estuary Program.

The Indian River Lagoon Comprehensive Conservation and Management Plan (IRLCCMP) was published by the IRLNEP in November 1996 and is sponsored by the SJRWMD and the South Florida Water Management District (SFWMD) in cooperation with the EPA. Priority problems identified in the IRLCCMP include loss of seagrass beds and increasing stress on remaining beds, undesirable salinity fluctuations, and increased nutrient loading. Action plans of the IRLCCMP include water and sediment quality improvement, seagrass restoration and management, and endangered and threatened species. The elements and action plans of the IRLCCMP are mutually

supportive and complement the management efforts of the State of Florida SWIM program.

U.S. FISH AND WILDLIFE SERVICE (USFWS)

Seagrass habitat, including Johnson's seagrass, is directly protected under the ESA by the USFWS as a critical habitat for the endangered Florida manatee. Protective mechanisms include section 7 consultations for dredging or water-dependent construction (including docks and marinas), motorboat access and speed limits in seagrass beds to reduce prop scarring, a long-term habitat monitoring program, the designation of manatee refuges and sanctuaries (including the Virginia Key No Entry Zone in Dade County authorized under 62N-22 F.A.C.), and new efforts to assess and propose new manatee protection areas (U.S. Fish and Wildlife Service 2000).

1.9.2 State of Florida Conservation Measures

ENVIRONMENTAL RESOURCE PERMIT (ERP) PROGRAM

The ERP program regulates dredging, filling, and other construction activities in wetlands or other surface waters, activities in uplands that affect flooding, and all stormwater management activities throughout the state (except within the limits of the Northwest Florida Water Management District). The ERP program is designed to ensure that alterations of uplands, wetlands, or surface waters do not degrade water quality, cause flooding, or diminish habitat quality or quantity. ERP was adopted in 1994 under Part IV, Chapter 373 of the Florida Statutes (F.S.), and is implemented cooperatively by

the FDEP and the state's water management districts (WMDs). The SJRWMD and SFWMD cooperate with the Central and Southeast FDEP District offices in the region where *H. johnsonii* occurs. To allow an applicant to deal with only one agency when seeking an ERP, the review and approval or denial of the permit is performed by either FDEP or one of the WMDs, depending upon the type of activity involved. Operating agreements signed by the agencies specify the division of permitting responsibilities between the agencies. Rules implementing the ERP program have been adopted by both FDEP (including Chapters 62-4, 62-113, 62-302, 62-312, 62-330, 62-340, 62-341, 62-342, 62-343, 62-344, 62-B-49, 18-14, 18-20, 18-21 of the F.A.C.) and the WMDs (including Chapters 40C-1, 0C-4, 40C-8, 40C-40, 40C-41, and 40C-400, F.A.C for the SJRWMD, and Chapters 40E-1, 40E-4, 40E-40, 40E-41, F.A.C. for the SFWMD).

The ERP program replaced two separate permitting programs, the Wetland Resource Permit program (WR) and the Management and Storage of Surface Waters program (MSSW). The WR program controlled dredge and fill activities, and was implemented exclusively by the Department of Environmental Regulation (now FDEP), while the MSSW program managed activities affecting stormwater and flooding, and was implemented exclusively by the five WMDs. Legislation establishing the ERP program included several grandfathering provisions that retain the above WR and MSSW permitting programs for certain activities listed in subsections 373.414(11)-(16), F.S. For these grandfathered activities, Chapter 62-312 F.A.C. and the MSSW permitting rules adopted under Part IV, Chapter 373, F.S. remain in effect as they existed prior to October

3, 1993. FDEP and the WMDs implement the programs covering these grandfathered activities in accordance with the same division of permitting responsibilities that governs the ERP program.

Proprietary Authorization to Conduct Activities on Sovereign Submerged Lands

In addition to regulatory permission, activities on sovereign (state-owned) submerged lands also require what is termed "proprietary authorization". Statutory authority for proprietary authorization is provided by Chapter 253, F.S., and the rules implementing this statute are in Chapter 18-21, F.A.C. Requests for proprietary authorization are reviewed in conjunction with the regulatory application and are granted or denied at the same time. More stringent resource protection measures are afforded for the state's Aquatic Preserves designated under Chapter 258, F.S. Additional requirements for Aquatic Preserves include: more restrictive water quality requirements (62-4.244(2), F.A.C.) and adequate demonstration that the activity is clearly within the public interest based on the public interest criteria listed in Chapter 373.414(1)(a), F.S. The majority of *H. johnsonii* habitat is already located within existing Aquatic Preserves and Outstanding Florida Waters (OFWs) (See Aquatic Preserves and OFWs Sections).

Joint Coastal Permits

Chapter 161, F.S. provided the FDEP Bureau of Beaches and Coastal Systems with the authority to regulate coastal construction activities via a Coastal Construction Permit (CCP). However, a Joint Coastal Permit (JCP) is issued when both a CCP (pursuant to

Section 161.041, F.S.) and an ERP permit (pursuant to Part IV, Chapter 373, F.S) are required. Chapter 62B-49, F.A.C. outlines the procedures and requirements that must be met to obtain a JCP. Requests for proprietary authorization are reviewed in conjunction with the JCP application and are granted or denied at the same time.

The COE and FDEP/WMDs have joint WR and ERP permit application forms. FDEP or one of the WMDs acts as the lead agency to receive all applications for state and federal wetland permits and forwards copies of such applications to the COE within five working days. Issuance of the state permit constitutes federal section 401 water quality certification, unless such certification is specifically waived in the permit. However, the actual state and federal permitting processes remain separate, and applicants are required to obtain all required federal, state, regional, and local permits prior to initiating construction activities.

Delegation of ERP to Local Governments

To further streamline the permitting process, Section 373.441, F.S. provides authority for FDEP and the WMDs to delegate all or a portion of ERP to local governments. If granted delegation for specified activities, all necessary authorizations under the ERP program as well as any needed additional local permits will be granted or denied at the same time by the local government. To implement this statutory authority, FDEP has adopted a rule (Chapter 62-344, F.A.C.) specifying the application procedures and outlining criteria that will be used to approve or deny a delegation request. At present

there has been no full delegation of ERP to any local government, although a comprehensive delegation to Broward County is currently nearing finalization. A partial delegation of a Noticed General Permit for single family home construction within the Indian Trails Water Control District has been granted to Palm Beach County. A full delegation of the stormwater permitting program (under Chapter 62-25, F.A.C.) has been granted to the City of Tallahassee in northwest Florida.

FDEP AQUATIC PRESERVES PROGRAM

The FDEP Aquatic Preserves program (adopted under Chapter 258, F.S.) provides additional water quality protection to sovereign submerged lands with exceptional biological, aesthetic, or scientific value. Five of the state's 43 aquatic preserves are located within the region where *H. johnsonii* occurs. Rules implementing the Aquatic Preserves program are Chapter 18-18, F.A.C., which is specific to the Biscayne Bay Aquatic Preserve and Chapter 18-20, F.A.C., which covers all other aquatic preserves. Special management plans have been developed for all aquatic preserves.

Aquatic Preserves within the range of *H. johnsonii*:

- Indian River Lagoon, Malabar to Sebastian (Brevard/Indian River Counties)
- Indian River Lagoon, Vero Beach to Ft. Pierce (Indian River/St. Lucie Counties)
- Indian River Lagoon, Jensen Beach to Jupiter Inlet (St. Lucie/Martin/Palm Beach Counties)

- Loxahatchee River to Lake Worth Creek (Martin/Palm Beach Counties)
- Biscayne Bay (Dade County)

SURFACE WATER QUALITY STANDARDS; CLASSIFIED WATERS

The FDEP's surface water quality standards, adopted in 1979, are designed to protect the public health or welfare and to enhance the quality of waters of the State. The State's surface waters have been separated into five classes according to their designated uses (F.A.C. 62-302). These water quality classifications are arranged in order of the degree of protection required, with Class I water having generally the most stringent water quality criteria and Class V the least. Classifications are as follow: Class I - Potable Water Supplies; Class II - Shellfish Propagation or Harvesting; Class III - Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife; Class IV - Agricultural Water Supplies; and Class V - Navigation, Utility and Industrial Use. The majority of Florida's surface waters are designated Class III waters. The range of Johnson's seagrass occurs predominantly within Class III waters and in a few locations designated as Class II water.

Class I, II and III waters share water quality criteria established to protect "recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife." The nutrient, light and turbidity standards for Class I-III waters are:

a) Nutrients: A narrative criterion which states, "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of

aquatic flora or fauna."; b) Transparency (light): The depth of the compensation point for photosynthetic activity shall not be reduced by more than 10% as compared to the natural background value; and c) Turbidity: ≤ 29 Nephelometric Turbidity Units above natural background conditions (F.A.C. 62-302.48 (b); 62-302.68; and 62-302.70).

Water-quality based targets are to be developed by FDEP and WMDs for use in protecting seagrass populations threatened by eutrophication (D. Joyner pers. comm. 2000). The WMDs will be establishing Pollutant Load Reduction Goals (PLRGs) for SWIM waters. The developed PLRGs will be used by the FDEP as a basis for establishing Total Maximum Daily Loads (TMDLs) for waters on the State of Florida's (303(d)) list of impaired waters (expected completion date of 2012). The agencies will use these numerical nutrient criteria to identify needed management activities as part of the state's SWIM plans and other water management plans.

OUTSTANDING FLORIDA WATERS (OFW)

A water body may be designated as an OFW as well as being classified as Class I, II or III. More than 200 water bodies throughout the state have been designated as OFWs, where more stringent water quality and permitting standards apply. These include the aquatic preserves previously discussed, as well as waters within national and state parks. Chapter 62-302.700 lists those waters designated as OFWs. In addition to the aquatic preserves previously listed, the major OFWs in the range of Johnson's seagrass include: Archie Carr, Hobe Sound and Loxahatchee National Wildlife Refuges; Savannas State

Reserve; John D. MacArthur State Park; and Sebastian Inlet, Ft. Pierce Inlet, Hugh Taylor Birch, John U. Lloyd Beach, and Oleta River State Recreation Areas (F.A.C. 62-302.700).

FDEP BUREAU OF INVASIVE PLANT MANAGEMENT

The FDEP Bureau of Invasive Plant Management regulates the importation, possession, collection, planting, relocation, or treatment of aquatic plants pursuant to Chapter 369, F.S. (implemented by Chapters 62C-20, 62C-52 and 62C-54, F.A.C.). The Bureau is charged with protecting sovereign lands from improper and excessive collection of native aquatic plants for purposes of sale, revegetation, restoration, or mitigation.

FDEP ECOSYSTEM MANAGEMENT INITIATIVE

FDEP began the Ecosystem Management Initiative in 1993. Ecosystem management provides for new, voluntary, parallel permitting and approval processes that give regulatory incentives to applicants. These optional processes require that projects be designed to provide some net environmental benefit. All of these optional processes are alternatives to, but do not replace, the current permitting system.

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION (FWC)

Division of Marine Resources

The FWC actively maintains a permitting program within its Division of Marine

Fisheries to address the harvest of seagrass for educational, scientific and restoration purposes. Fishery practices that may harm seagrass in state waters are also regulated by the FWC, aside from Aquaculture which is regulated by the Florida Department of Agriculture and Consumer Services (FDACS). The FWC, Bureau of Protected Species Management acts as a commenting agency contributing to the protection of seagrass through the ERP programs administered by the FDEP and WMDs. Comments are provided based on the protection of manatee and marine turtle habitat, which includes Johnson's seagrass throughout its range. The FWC is largely responsible for the enforcement of state regulations regarding seagrass and marine habitat protection through the Division of Law Enforcement's Bureau of Marine Enforcement. Management-oriented research programs for seagrass are a significant part of the FWC's FMRI operations. Seagrass outreach and education efforts are an integral part of the operation of the Division of Marine Fisheries, Office of Environmental Services, and FMRI.

FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES (FDACS)

Florida Regulated Plant Index

The Florida Regulated Plant Index (established pursuant to Section 581.185, F.S.) is administered and maintained by the FDACS Division of Plant Industry via Chapter 5B-40, F.A.C. Listed plant species are categorized as endangered, threatened, or commercially exploited. Permits for the taking, transport, and sale of plants on the Regulated Plant Index are reviewed by FDACS, but there is no provision for FDACS to

regulate construction or other land alteration activities. *Halophila johnsonii* was listed as a state endangered species but then subsequently removed from the Regulated Plant Index a few years prior to receiving federal listing. Although Section 581.185, F.S. provides for the automatic listing as a state endangered species of "all species determined to be endangered or threatened pursuant to the federal ESA of 1973," Johnson's seagrass, since its Federal listing in 1998, has not been placed back on the Regulated Plant Index.

Florida Endangered Plant Advisory Council

FDACS's Division of Plant Industry acts as liaison for the Endangered Plant Advisory Council (established under Section 581.186, F.S.) which serves to improve the protection of threatened, endangered, and commercially exploited plant species on the Regulated Plant Index. The council periodically examines listed species, as well as other native plants that have been proposed for inclusion on the Regulated Plant Index, to determine whether a particular plant species should be removed from the list, transferred to a different category, or added to the list.

Division of Agricultural Environmental Services

FDACS Division of Agricultural Environmental Services regulates pesticide use within the state (via Chapter 487, F.S., and Chapter 5E, F.A.C.), and is responsible for coordinating state strategies to protect federally-listed threatened and endangered species from the use of pesticides.

LAND CONSERVATION ACT OF 1972

The Land Conservation Act of 1972 (Chapter 259, F.S.) establishes a land acquisition program to conserve and protect environmentally endangered lands in Florida. Criteria for selecting lands include consideration of important wildlife and plant habitats, including endangered and threatened species habitats.

FLORIDA FOREVER ACT

The Florida Forever Act (FFA) (Chapter 259, F.S.), passed by the 1999 Florida Legislature, was effective as of July 2000. This act replaces the Florida Preservation 2000 Act which created a funding mechanism to support land acquisition programs in Florida and was implemented by Chapter 18-8, F.A.C., Conservation and Recreation Lands (CARL). Changes to this legislation are expected relative to the operation of the FFA. Federal listing of *H. johnsonii* may encourage land acquisition or other land conservation measures by the state.

THE FLORIDA ENVIRONMENTAL LAND AND WATER MANAGEMENT ACT OF 1972

The Florida Environmental Land and Water Management Act of 1972 (Sections 380.10-12, F.S.) created the Area of Critical State Concern Program, which establishes a procedure for increased protection of lands of statewide importance, including critical habitat for threatened or endangered species. This act also establishes the Development of Regional Impact program, which requires that permit applications for certain large-

scale developments affecting more than one county must undergo more stringent review, including review of the development's impact on wildlife habitat.

STATE COMPREHENSIVE PLAN

The State Comprehensive Plan (Chapter 187, F.S.) includes goals and policies to conserve wildlife habitat and prohibit the destruction of endangered species and associated habitat. Local government comprehensive plans must be consistent with provisions in the state plan. Listing of *H. johnsonii* may encourage its conservation through Florida's planning procedures, supervised by the Florida Department of Community Affairs.

FLORIDA NATURAL AREAS INVENTORY

The Florida Natural Areas Inventory (FNAI) was established in 1981 as a cooperative effort of FDEP and the Nature Conservancy. Funding for FNAI has been provided primarily by the CARL Trust Fund (authorized by Section 253.023, F.S.). One of the primary tasks of FNAI is to collect and disseminate information on the status and distribution of threatened and endangered species of plants and animals in Florida. These data facilitate environmentally sound planning and natural resource management. FNAI supported the listing of *H. johnsonii*.

ST. JOHNS RIVER AND SOUTH FLORIDA WATER MANAGEMENT DISTRICTS

Indian River Lagoon Surface Water Improvement and Management Plan (IRL SWIM)

and Indian River Lagoon National Estuary Program Comprehensive Conservation and Management Plan (IRLCCMP)

These plans list seagrass as the most critical habitat in the IRL, and have been developed with the goal of restoring the integrity and functionality of seagrass beds within this system (Steward et al. 1994, IRLNEP 1996).

1.9.3 Summary of Conservation Measures

A variety of conservation measures exist to protect *H. johnsonii* and its habitat. *H. johnsonii* habitat is included in the designation of critical habitat for the Florida manatee and is therefore subject to ESA section 7 consultation. *H. johnsonii* habitat is also protected through Aquatic Preserves or designated OFWs. However, these conservation measures must be further analyzed to determine if they will ensure the long term protection of the species or the maintenance of its geographic distribution.

2.0 RECOVERY STRATEGY

The recovery strategy for *H. johnsonii* is based on two key premises: 1) very little information is known about the species, including its reproductive biology, historical distribution, or methods for restoration, and 2) it is not certain if existing regulatory mechanisms are adequate to protect the species. Based on this information the recovery program was developed to: 1) conduct monitoring and research to better define habitat requirements, life history and restoration techniques; and 2) protect the species in its current state through ESA consultation, assessment of the adequacy of existing regulatory mechanisms, and outreach.

3.0 RECOVERY OF JOHNSON'S SEAGRASS

3.1 Objectives and Criteria

The recovery objective for *H. johnsonii* is to delist the species by assuring its long-term persistence throughout its range. *Halophila johnsonii* should be considered for delisting when all of the following criteria are met:

(1) The species' present geographic range remains stable for at least 10 years or increases,

(2) Self-sustaining populations[2] are present throughout the range at distances less than or equal to the maximum dispersal distance to allow for stable vegetative recruitment and genetic diversity, and

(3) Populations and supporting habitat in its geographic range have long-term protection (through regulatory action or purchase acquisition).

Quantitative information, including the number of self-sustaining populations necessary and the quality and quantity of habitat required to further define and meet these criteria, are included as recovery plan actions in Section C below.

3.1.1 Revision of Recovery Criteria

The recovery criteria, and boundaries and locations of critical habitats, may be revised on the basis of new information. A long-term research and management plan will be

[2] Self-sustaining population is a population that has been documented to persist for at least 10 years.

developed by a Johnson's Seagrass Implementation Team. The team core group will be members of the Recovery Plan Team and will use the approved Recovery Plan in addressing and implementing recovery strategies for *H. johnsonii*.

3.2 Recovery Program

The recovery actions for *H. johnsonii* have been organized under eight major recovery needs (or actions): 1) Identify and protect populations and habitat; 2) Initiate a range-wide monitoring program; 3) Refine habitat requirements of *H. johnsonii*; 4) Conduct detailed life history studies of *H. johnsonii* to examine vegetative fragment dispersal, survival, and sexual reproduction; 5) Determine and implement habitat management needs and techniques; 6) Identify the genetic diversity and genetic structure of *H. johnsonii* across its geographic range; 7) Develop restoration techniques; and 8) Formulate an educational outreach program to increase awareness of *H. johnsonii* and its status. Each of the major actions includes an introductory narrative followed by specific recovery actions for the species. Unless otherwise specified, actions described apply to the entire range of the species.

Action 1. Identify and protect populations and habitat

Existing populations of *H. johnsonii* must be protected from present and foreseeable threats, including those that involve direct removal of the plant and/or adverse modification of its habitat. Protective management measures should be applied to entire habitats supporting Johnson's seagrass. Ten areas in the geographic range of Johnson's seagrass were designated as critical habitat (65 FR 17768) (Appendix II). This designated area accounts for approximately 22,574 acres or 9,139 hectares.

A long-term management program should be established based on special protection areas (areas having suitable habitat characteristics for supporting Johnson's seagrass). Elements such as state lands, aquatic preserves, acquisition, conservation agreements, easements, donations, or sanctuary arrangements will also be used for the protection of Johnson's seagrass populations and habitat.

1.01. Develop detailed baseline distribution maps (In coordination with Section 2, Monitoring).

1.01.A. Identify areas with persistent populations.

1.01.B. Map and delineate areas with flowering populations.

1.01.C. Identify areas of high abundance or areas that are conducive to the survival of the species.

1.02. Protect the geographic extremes of the range and genetically unique populations (In coordination with Section 5, Management and Section 6, Genetics).

Action 2. Initiate a range-wide monitoring program.

Factors affecting the recruitment, survival, and spread of a rare plant are complex (Schemske et al. 1994). For many seagrasses, little is known about their reproductive ecology, especially the production and dispersal of sexual or asexual propagules, two processes which are critical for their persistence or recovery. The patchiness and limited geographic range of *H. johnsonii* beds presents challenges and opportunities in

monitoring the status of this rare species. Monitoring should provide information on the recruitment and mortality of patches as well as providing information on inter- and intra-patch dynamics. Because of the extremely limited latitudinal range of *H. johnsonii*, monitoring should detect any changes in the northern or southern distributional limits or range extensions of this species, i.e., intensive surveys should be undertaken to precisely determine these distributional boundaries and to especially assess their year-to-year stability. To satisfy the criteria for de-listing, there is also a critical need to determine whether population stability is affected by patch size and spacing and whether this varies from north to south. Distribution maps have important implications regarding the stability of this rare species and its ability to recover from stochastic perturbations that may eliminate individual patches or entire populations. An important goal of the initial mapping would be to identify if any major distributional gaps presently exist in the southern part of the range.

Random sampling strategies, unless highly intense, are inappropriate for assessing the recovery potential for *H. johnsonii* because they could misrepresent the distribution and abundance of this species by having a relatively high probability for sample points to miss patches/beds. Rather, by surveying selected areas to locate *H. johnsonii* patches and establishing sampling stations both within and outside of patches, much information regarding patch dynamics can be gained. Because of *H. johnsonii*'s small size and understory growth habit, and also its deep-edge growth habit and resolution limitations, aerial photography cannot be used to monitor changes in its distribution and abundance.

Initial aerial photography surveys of the region from Jupiter Inlet south, however, would be useful for locating potential seagrass-occurrence sites for subsequent ground-truthing surveys. The FWC Bureau of Protected Species Management's 1999 dock study and 1996-1997 marina siting survey (Smith and Mezich 1999, Bureau of Protected Species Management 2000), and Palm Beach County Department of Environmental Resource Management (DERM) data (Palm Beach County DERM 1992, 1990) would also be useful for locating potential seagrass-occurrence sites. Spatially explicit, in-situ monitoring would then be required to verify distribution and abundance. The shoot density and cover within a statistically representative number of patches could be determined and tracked along with the variability of patch location and size (determined by Differential Global Positioning System (DGPS)) and the collection of a suite of environmental parameters thought to affect these characteristics (such as optical water quality, water depth, and salinity). This combined tracking of information would allow correlative examination of the role of year-to-year environmental variation in affecting the vigor and abundance of this species. Monitoring should attempt to match up study sites with locations where current and past water quality data exist.

The relative contributions of vegetative growth and propagule dispersal versus sexual reproduction and seed recruitment (unknown for this species) on the maintenance, establishment, and genetic diversity of patches, need to be understood for effective conservation and management (Schemske et al. 1994). The presence of numerous small patches across the marine landscape provides for an increased chance that some patches

will survive perturbations and provide a recruitment source for post-impact recovery. Recent work on seagrass population genetics has demonstrated the importance of sampling over several spatial scales to determine the relative importance of various reproductive strategies to population establishment and maintenance, demography, and genetic diversity (Procaccini et al. 1996). This information is critical to resource managers in their evaluation of species recovery in the context of demonstrated spatial and year-to-year patterns of population distribution and abundance. Primary goals of a monitoring program are an understanding of *H. johnsonii*'s demography and the determination of whether the density, abundance, and distribution of beds are expanding or declining.

2.01. Determine whether the distribution and size of beds are expanding or declining and identify factors influencing expansion or decline.

2.02. Determine the precise northern and southern distributional limits of *H. johnsonii* and monitor the temporal variation in these limits using DGPS and in-situ sampling.

2.03. Determine whether patch size, abundance, or spacing vary from north to south, and identify if there are presently any large distribution gaps (see Protect Populations and Habitat section).

2.04. Monitor persistence. Establish permanent monitoring plots at (a) the northern and southern distribution limits, (b) the geographic extremes of the natural lagoon systems within the known geographic range (i.e., the southern end of the IRL and the northern end of Lake Worth), (c) sites with existing or long-term water quality data, and (d) sites identified to have unique or diverse genotypes present (e.g., Boynton Beach, Boca Raton, etc.). Annual monitoring should be conducted for 10 years to determine whether criteria for de-listing have been met.

Action 3. Refine habitat requirements of *Halophila johnsonii.*

With no sexual reproduction, limited dispersal capability, and limited capacity to store energy and nutrients during periods of stress, *H. johnsonii* must sustain continuous vegetative growth and reproduction in order to replace natural mortality. Therefore, favorable environmental conditions must be nearly continuously maintained for continuous growth. Critical environmental factors to support seagrasses include, but are not restricted to, light, temperature, salinity, and unconsolidated sediments. Where *H. johnsonii* grows, conditions usually include light levels maintained at a minimum of 10% surface incident light, salinity of at least 15 ppt, water temperature between 10^{o} C and 35^{o} C, and sediments that are unconsolidated sand or sand mixed with silt-clay. The effects of short-term poor conditions (i.e., low light or poor water quality) on *H. johnsonii* are currently unknown.

3.01. Identify sites with and without *H. johnsonii*. At these sites, conduct a correspondence analysis between *H. johnsonii* distribution/abundance and environmental factors (habitat characteristics) including: temperature, salinity, light intensity, water motion, tidal exposure, sediment characteristics and stability, and eutrophication (Also see Actions 7.01, 7.02 and 7.03).

3.02. Locate ephemeral populations of *H. johnsonii* and identify the characteristics (listed in Action 3.01) of these sites.

3.03. Identify the habitat characteristics which favor populations with female flowers (assuming male flowers should co-occur with females) and experimentally manipulate these conditions in the laboratory or mesocosm to attempt to induce flowering.

3.04. Conduct experiments to determine the effect of other seagrass species on the distribution and abundance of *H. johnsonii* and assess the similarity of habitat requirements between *H. johnsonii* and other species.

3.05. Determine if water quality and water management programs are appropriate for determining changes in conditions which would affect the continuous vegetative growth and reproduction of *H. johnsonii.*

3.06. Select areas throughout the geographic range of the species which have suitable environmental conditions for perennial and flowering populations for use in the development and management of special protection areas for *H. johnsonii* (In coordination with Action 5.13).

Action 4. Conduct detailed life history studies of *Halophila johnsonii* to examine vegetative

fragment dispersal, survival, and sexual reproduction.

Initial field and mesocosm research and surveys of natural populations indicate that female flowers are formed in isolated populations, but there is still no report of the presence of male flowers. Male flowers are either non-existent or very rare, and asexual reproduction could be the primary means of growth and dispersal of this species. Yet there is evidence for a wide range of fluctuation in populations, and considerable efforts are needed to explain and understand the recovery and colonization processes. Dispersal and recruitment by vegetative fragments is presumed to be an important mechanism for maintaining the disjunct populations of *H. johnsonii*. Research efforts should focus on determining the maximum dispersal distances by vegetative fragments, and the critical life stages which are responsible for maintaining populations. Experimental design should cover the following:

4.01. Estimate rates of new short shoot (the vertical shoot formed by the branching of the horizontal rhizome/apical meristem) formation and death rates in natural populations

and in experimental fragments manipulated in mesocosms under different environmental conditions.

4.02. Experimentally determine the mechanism for recruitment of patches (clones), and maximum dispersal distances of vegetative fragments. Use this information to determine the number of self-sustaining populations necessary to ensure their presence throughout the range.

4.03. Experimentally manipulate in the laboratory or mesocosm, light, temperature, salinity, and nutrients to determine their effects on flowering and growth of vegetative fragments.

4.04. Collect and transplant fruits of *H. johnsonii* to determine whether fruits of *H. johnsonii* germinate and whether apomixis occurs.

Action 5. Determine and implement habitat management needs and techniques.

Maintenance of suitable habitat for this species will require use of management procedures to alleviate or prevent degrading conditions (based on habitat requirements). Section 7(a)(2) of the ESA requires every federal agency to insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat (50 CFR 402.01). The feasibility of developing a 4(d) rule with specific protective

regulations for *H. johnsonii,* such as extending take prohibitions to this threatened plant, will be examined. Water quality-based targets are to be developed by the FDEP and WMDs for use in protecting seagrass populations threatened by eutrophication (D. Joyner pers. comm. 2000). The WMDs will develop PLRGs for SWIM waters, and the FDEP will use these values as a basis for determining TMDLs for waters on the State of Florida's 303(d) list of impaired waters. The agencies will use these PLRGs and TMDLs to identify needed management activities as part of the state's SWIM plans and other water management plans.

Successful management of Johnson's seagrass and its habitat will require an improvement in the accuracy of impact assessment on the species and its habitat and an examination of the interagency review process for projects that may impact the species and its habitat. Identifying impacts to seagrass habitat, particularly from large projects, is, in the long run, more important than a "point-in-time" management approach of avoiding currently existing patches. Seagrasses are provided a greater level of protection from human activities on those state-owned submerged lands within designated aquatic preserves and within the boundaries of federally-designated areas. Existing regulatory authorities and seagrass protection regulations will be examined and applied to protect *H. johnsonii* and its habitat. A multi-agency management approach, utilizing various educational and enforcement methods, will be implemented to reduce prop scarring and trampling of shallow water seagrass beds. Over the long term, this comprehensive

approach should reduce scarring or trampling to levels that do not significantly affect habitat quality and quantity.

5.01. Establish and convene an Implementation Team to develop a long-term research plan for the species and coordinate implementation of recovery plan actions.

5.02. Recommend to Federal and state agencies that they adopt sampling protocols for *H. johnsonii* for the permit application and monitoring requirements of project sites (see Appendix III).

5.03. Incorporate pre- and post-construction (of in- and over-water structures) monitoring data of *H. johnsonii* distribution and abundance, from federal, state, and local agencies, into a centralized Geographic Information System (GIS) tracking system to improve protection and management and to determine cumulative impacts.

5.04. Provide educational opportunities and workshops for federal, state, and local permitting agencies, including training in field identification, sampling protocols, and the identification of designated critical habitat.

5.05. Establish federal and state interagency coordination during the permit review process (e.g., NMFS, COE, FDEP, SJRWMD, SFWMD, FWC) for projects that may

affect *H. johnsonii* or its habitat so that impacts to the species can be avoided or minimized.

5.06. Improve or maintain water quality and sediment conditions appropriate for continuous vegetative growth and reproduction of natural populations of *H. johnsonii* throughout its geographic range, addressing point and non-point sources and water quality-based targets (PLRGs and TMDLs). Coordinate these actions with existing programs, including, but not exclusively, the Indian River Lagoon National Estuary and SWIM programs and the Lake Worth Management Plan.

5.07. Establish PLRGs and determine TMDLs for a specific water body or segment within a water body, describing the management actions required to reach these guidelines (including stormwater treatment, wastewater reuse, and best management practices for upland use).

5.08. Monitor water bodies, or the segments within, for the predicted responses of water quality and seagrass to the implementation of water quality management actions and assess the effectiveness of these specific management actions.

5.09. Assess current federal, state, and local seagrass protection regulations and programs (specifically those addressing human activities on submerged lands and within

the boundaries of federally-designated areas) for their level of effectiveness in protecting *H. johnsonii* and its habitat.

5.10. Assess enforcement efforts of existing submerged lands/seagrass protection regulations to determine their effectiveness in protecting *H. johnsonii*. Implement modifications to increase effectiveness of enforcement actions, if needed.

5.11. Preserve natural shoreline buffers on waterfront properties and encourage shoreline restoration.

5.12. Identify and recommend the acquisition of privately-owned submerged land vegetated with *H. johnsonii* and its adjacent uplands through local, regional, state and federal programs. Public acquisition of these few tracts will preserve the seagrass habitat associated with them and provide upland watershed buffer protection.

5.13. Implement a multi-agency approach management program to reduce prop scarring and trampling of shallow water seagrass beds. The management program should use methods including increased boater education, installation of channel markers, active enforcement, and the establishment of limited motoring zones or closure areas.

5.14. Determine whether specific protective regulations for *H. johnsonii* will be developed under section 4(d) of the ESA in order to provide for the conservation of the species.

5.15. Establish "adverse modification" and "jeopardy" guidelines for *H. johnsonii* for use in section 7 consultation under the ESA.

Action 6. Identify the genetic diversity and genetic structure of *Halophila johnsonii* across its geographic range.

Genetic studies should continue to determine whether other pockets of higher genetic diversity exist, especially at the southern extreme of this species' range. These studies should also look for genetic indicators of sexual reproduction and use more sophisticated methods to identify the number of genetic individuals present in the species range. However, even if sexual reproduction or dispersal of fragments occurs, physical isolation resulting from the disjunct distribution of this species may still pose a threat to its persistence because of negative effects of inbreeding and clonal reproduction. Additional studies should determine whether indices of genetic diversity are correlated with species persistence. If the genetic composition of populations is linked to ecologically important processes such as growth rate and survival, then these traits and genotypes can be identified in specific populations and targeted for protection.

6.01. Determine the range of genetic variability and identify genetically unique populations within the species' geographic range.

6.02. Determine whether indices of genetic diversity are correlated with species persistence.

Action 7. Develop restoration techniques.

Because of its apparent lack of sexual reproduction, inability to disperse by sexual propagules, and its small and relatively fragile stature, *H. johnsonii* may have a limited capacity for recovering from disturbance or total destruction (removal). The extant populations are comprised mainly of non-contiguously distributed patches, which limits the ability of the plant to recover from disturbance by vegetative encroachment from adjacent undisturbed populations. Natural recruitment and recovery of *H. johnsonii* within localized populations may be substantial. However, because of the limited or absent sexual reproduction in this species, the recovery of lost populations may be enhanced by transplantation of natural or cultivated vegetative fragments.

7.01. Conduct mesocosm and field experiments to test the feasibility of transplanting excavated and naturally-dislodged (free floating and intertidal driftline) vegetative fragments of *H. johnsonii* under a broad range of environmental conditions.

7.02. Identify populations of *H. johnsonii* which grow and survive under different field transplanting conditions.

7.03. Use reciprocal field and mesocosm transplants to test the effects of different water depths, salinities, geographical ranges, and genetic stocks in controlling the distribution and abundance of *H. johnsonii*. Identify key growth and demographic characteristics that distinguish the source and the surviving transplant populations.

7.04. Develop a reliable methodology for transplanting *H. johnsonii*.

7.05. Use mesocosms to identify and maintain stocks of *H. johnsonii* that have superior characteristics for restoration.

Action 8. Formulate an educational outreach program to increase awareness of Johnson's seagrass and its status.

Halophila johnsonii may have the most limited distribution of any seagrass on earth, known to only occur in lagoons along 200 km of the southeast coast of Florida. It is the first marine plant species to be listed under the ESA. Recovery objectives, based on its threatened status are to: a) prevent the species from declining to an endangered status, and b) delist the species based on the criteria stated at the beginning of this recovery chapter. An educational outreach program will address the status of *H. johnsonii*, threats

to the species and its habitat, and management needs for protecting and conserving this species.

Threats of destruction to *H. johnsonii* and its habitat include (1) dredging and filling, (2) construction and shading of overwater structures, (3) prop scarring and anchor mooring, (4) trampling, (5) altered water quality (such as stormwater runoff and turbidity), (6) storms, and (7) siltation. Education outreach needs to address both anthropogenic and natural threats and needs to be tailored to public citizens, fishers and boaters, and to private and public agencies (including the COE, USCG, Federal Highway Administration, Florida Department of Transportation) involved with projects or activities that may affect *H. johnsonii* or its habitat.

The education efforts for *H. johnsonii* should assist in raising awareness for all seagrass habitats, the valuable role that seagrass beds play in the marine environment, threats to shallow coastal lagoon ecosystems (where human impacts are great), and the overall decline of seagrass species despite existing protective regulations for submerged lands. It will be important to integrate education about *H. johnsonii* into already existing protection plans or education programs, such as the IRL National Estuary and SWIM programs, State of Florida Coastal and Aquatic Managed Areas, and the Lake Worth Management Plan.

8.01. Develop a Web Page for *H. johnsonii* and post updates on its recovery efforts.

8.02. Adapt existing education tools such as pamphlets and brochures on Florida seagrasses to address *H. johnsonii* protection.

8.03. Coordinate with federal, state, and local agencies, conservation groups, plant societies, commercial and recreational boaters and fishers, SCUBA divers, and media to develop a positive understanding of seagrasses and *H. johnsonii*.

8.04. Develop and evaluate educational materials and curricula with schools and local environmental centers that introduce students to seagrasses, making sure to incorporate information on *H. johnsonii*, its habitat, and the ESA.

8.05. Develop and present state/federal/Water Management District regulatory workshops on survey protocol, effects of actions on *H. johnsonii*, and basic biology and proper identification of the species.

3.2.1 Recovery Action Summary

The following is a summary list of Johnson's seagrass recovery actions. Actions are listed in the order that they appear in the Recovery Chapter and not in order of priority.

1.01. Develop detailed baseline distribution maps (In coordination with Section 2, Monitoring).

1.01.A. Identify areas with persistent populations.

1.01.B. Map and delineate areas with flowering populations.

1.01.C. Identify areas of high abundance or areas that are conducive to the survival of the species.

1.02. Protect the geographic extremes of the range and genetically unique populations (In coordination with Section 5, Management; and Section 6, Genetics).

2.01. Determine whether the distribution and size of beds are expanding or declining and identify factors influencing expansion or decline.

2.02. Determine the precise northern and southern distributional limits of *H. johnsonii* and monitor the temporal variation in these limits using DGPS and in-situ sampling.

2.03. Determine whether patch size, abundance, or spacing vary from north to south, and identify if there are presently any large distribution gaps (see Protect Populations and Habitat section).

2.04. Monitor persistence. Establish permanent monitoring plots at (a) the northern and southern distribution limits, (b) the geographic extremes of the natural lagoon systems within the known geographic range (i.e., the southern end of the IRL and the northern end of Lake Worth), (c) sites with existing or long-term water quality data, and (d) sites identified to have unique or diverse genotypes present (e.g., Boynton Beach, Boca Raton, etc.). Annual monitoring should be conducted for 10 years to determine whether criteria for de-listing have been met.

3.01. Identify sites with and without *H. johnsonii*. At these sites, conduct a correspondence analysis between *H. johnsonii* distribution/abundance and environmental factors (habitat characteristics) including: temperature, salinity, light intensity, water motion, tidal exposure, sediment characteristics and stability, and eutrophication (Also see Actions 7.01, 7.02 and 7.03).

3.02. Locate ephemeral populations of *H. johnsonii* and identify the characteristics (listed in Action 3.01) of these sites.

3.03. Identify the habitat characteristics which favor populations with female flowers (assuming male flowers should co-occur with females) and experimentally manipulate these conditions in either the laboratory or mesocosm to attempt to induce flowering.

3.04. Conduct experiments to determine the effect of other seagrass species on the distribution and abundance of *H. johnsonii* and assess the similarity of habitat requirements between *H. johnsonii* and other species.

3.05. Determine if water quality and water management programs are appropriate for determining changes in conditions which would affect the continuous vegetative growth and reproduction of *H. johnsonii*.

3.06. Select areas throughout the geographic range of the species which have suitable environmental conditions for perennial and flowering populations for use in the development and management of special protection areas for *H. johnsonii* (In coordination with Action 5.13).

4.01. Estimate rates of new short shoot (the vertical shoot formed by the branching of the horizontal rhizome/apical meritstem) formation and death rates in natural populations and in experimental fragments manipulated in mesocosms under different environmental conditions.

4.02. Experimentally determine the mechanism for recruitment of patches (clones), and maximum dispersal distances of vegetative fragments. Use this information to determine the number of self-sustaining populations necessary to ensure their presence throughout the range.

4.03. Experimentally manipulate in the laboratory or mesocosm, light, temperature, salinity, and nutrients to determine their effects on flowering and growth of vegetative fragments.

4.04. Collect and transplant fruits of *H. johnsonii* to determine whether fruits of *H. johnsonii* germinate and whether apomixis occurs.

5.01. Establish and convene an Implementation Team to develop a long-term research plan for the species and coordinate implementation of recovery plan actions.

5.02. Recommend to Federal and state agencies that they adopt sampling protocols for *H. johnsonii* for the permit application and monitoring requirements of project sites (see Appendix III).

5.03. Incorporate pre- and post-construction (of in- and over-water structures) monitoring data of *H. johnsonii* distribution and abundance, from federal, state, and local agencies, into a centralized GIS tracking system to improve protection and management and to determine cumulative impacts.

5.04. Provide educational opportunities and workshops for federal, state, and local permitting agencies, including training in field identification, sampling protocols, and the identification of designated critical habitat.

5.05 Establish federal and state interagency coordination during the permit review process (e.g., NMFS, COE, FDEP, SJRWMD, SFWMD, FWC) for projects that may affect *H. johnsonii* or its habitat so that impacts to the species can be avoided or minimized.

5.06. Improve or maintain water quality and sediment conditions appropriate for continuous vegetative growth and reproduction of natural populations of *H. johnsonii* throughout its geographic range, addressing point and non-point sources and water quality-based targets (PLRGs and TMDLs). Coordinate these actions with existing programs, including, but not exclusively, the Indian River Lagoon National Estuary and SWIM programs and the Lake Worth Management Plan.

5.07. Establish PLRGs and develop TMDLs for a specific water body or segment within a water body, describing the management actions required to reach these guidelines (including stormwater treatment, wastewater reuse, and best management practices for upland use).

5.08. Monitor water bodies, or the segments within, for the predicted responses of water quality and seagrass to the implementation of water quality

management actions and assess the effectiveness of these specific management actions.

5.09. Assess current federal, state, and local seagrass protection regulations and programs (specifically those addressing human activities on submerged lands and within the boundaries of federally-designated areas) for their level of effectiveness in protecting *H. johnsonii* and its habitat.

5.10. Assess enforcement efforts of existing submerged lands/seagrass protection regulations to determine their effectiveness in protecting *H. johnsonii*. Implement modifications to increase effectiveness of enforcement actions, if needed.

5.11. Preserve natural shoreline buffers on waterfront properties and encourage shoreline restoration.

5.12. Identify and recommend the acquisition of privately-owned submerged land vegetated with *H. johnsonii* and its adjacent uplands through local, regional, state and federal programs. Public acquisition of these few tracts will preserve the seagrass habitat associated with them and provide upland watershed buffer protection.

5.13. Implement a multi-agency approach management program to reduce prop scarring and trampling of shallow water seagrass beds. The management program should use multiple methods including increased boater education, installation of channel markers, active enforcement, and the establishment of limited motoring zones or closure areas.

5.14. Determine whether specific protective regulations for *H. johnsonii* will be developed under section 4(d) of the ESA in order to provide for the conservation of the species.

5.15. Establish "adverse modification" and "jeopardy" guidelines for *H. johnsonii* for use in section 7 consultation under the ESA.

6.01. Determine the range of genetic variability and identify genetically unique populations within the species' geographic range.

6.02. Determine whether indices of genetic diversity are correlated with species persistence.

7.01. Conduct mesocosm and field experiments to test the feasibility of transplanting excavated and naturally-dislodged vegetative fragments of *H. johnsonii* under a broad range of environmental conditions.

7.02. Identify populations of *H. johnsonii* which grow and survive under different field transplanting conditions.

7.03. Use reciprocal field and mesocosm transplants to test the effects of different water depths, salinities, geographical ranges, and genetic stocks in controlling the distribution and abundance of *H. johnsonii*. Identify key growth and demographic characteristics that distinguish the source and the surviving transplant populations.

7.04. Develop a reliable methodology for transplanting *H. johnsonii*.

7.05. Use mesocosms to maintain and experimentally test the superiority of stock characteristics of *H. johnsonii*.

8.01. Develop a Web Page for *H. johnsonii* and post updates on its recovery efforts.

8.02. Adapt existing education tools such as pamphlets and brochures on Florida seagrasses to address *H. johnsonii* protection.

8.03. Coordinate with federal, state, and local agencies, conservation groups, plant societies, commercial and recreational boaters and fishers, SCUBA divers, and media to develop a positive understanding of seagrasses and *H. johnsonii*.

8.04. Develop and evaluate educational materials and curricula with schools and local environmental centers that introduce students to seagrasses, making sure to incorporate information on *H. johnsonii*, its habitat, and the ESA.

8.05. Develop and present state/federal/Water Management District regulatory workshops on survey protocol, effects of actions on *H. johnsonii*, and basic biology and proper identification of the species.

4.0 IMPLEMENTATION SCHEDULE

Priorities in Column 1 of the Implementation Schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Abbreviations for Implementation Schedule

BPSM	FWC/Bureau of Protected Species Management
CAMA	Bureau of Coastal and Aquatic and Managed Areas
CARL	Conservation and Recreation Lands
COE	U.S. Army Corps of Engineers
DERM	Department of Environmental Resources Management
ESA	Endangered Species Act
DGPS	Differential Global Positioning System
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FWC	Florida Fish and Wildlife Conservation Commission
FMRI	FWC/Florida Marine Research Institute
GIS	Geographic Information System
HBOI	Harbor Branch Oceanographic Institute
NEP	National Estuary Program
NGOs	Non-governmental Organizations
OCAMA	FDEP/Office of Coastal and Aquatic Managed Areas
OIS	FWC/Office of Information Services
NOAA	National Oceanographic and Atmospheric Association
PLRGs	Pollution Load Reduction Goals
RFP	Request For Proposals
SJRWMD	St. Johns River Water Management District
SFWMD	South Florida Water Management District
SWIM	Surface Water Improvement and Management
UNC-Wilm.	University of North Carolina - Wilmington
WMDs	SJRWMD and SFWMD

4.1 Halophila johnsonii Implementation Schedule

IMPLEMENTATION SCHEDULE								
				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
2	1.01	Develop detailed baseline distribution maps.	2-3 yrs., repeat every 5 yrs.	NOAA, WMDs, FWC/FMRI, FDEP/CAMA, County DERM Offices	100	100	100	GIS and ground truthing. Build on present database. GIS database at NOAA or FMRI. Link with actions 2.03 and 2.04.
	1.01.A	Identify areas with persistent populations.	10 yrs.	NOAA, SJRWMD, FWC/BPSM, County DERM	30	30	30	
	1.01.B	Map and delineate areas with flowering populations.	5-10 yrs.	NOAA, FWC/FMRI	10-15	10-15	10-15	Diver survey for 1 month/year, GIS. Develop and issue request for proposals.
	1.01.C	Identify areas of abundance or areas that are conducive to the survival of the species	2 yrs.	NOAA, FWC/FMRI, WMDs				link with Actions 1.01A and 1.01B.
1	1.02	Protect the geographic extremes of the range and genetically unique populations.	continuous	NOAA, FDEP, WMDs, FWC/FMRI,	50	50		Cost depends on level of protection. Incorporate into regulatory process.
2	2.01	Determine whether the distribution and size of beds are expanding or declining and identify factors influencing expansion or decline.	10 yrs.	NOAA, WMDs, COE	30	30	30	Annual monitoring part of action 2.04. Develop GIS database.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
2	2.02	Determine the precise northern and southern distributional limits of *H. johnsonii* and monitor the temporal variation in these limits using DGPS and in-situ sampling.	10 yrs., continuing	NOAA, SJRWMD, County DERM,	5	5	5	Annual patch mapping, GIS. Link with actions 1.01, 2.03, and 2.04.
2	2.03	Determine whether patch size, abundance, or spacing vary from north to south and identify if there are presently any large distribution gaps.	3-5 yrs.	NOAA, WMDs, FWC/FMRI, County DERM	150	150	150	GIS, Link with action 1.01.
2	2.04	Monitor persistence. Establish permanent monitoring plots at (a) the northern and southern distribution limits, (b) the geographic extremes of the natural lagoon systems within the known geographic range, (c) sites with existing or long-term water quality data, and (d) sites identified to have unique genotypes present.	10 yrs. continuous	NOAA, WMDs, FDEP/OCAMA, County DERM	100-120	100	100	Sampled once/year. Link with action 2.02.
3	3.01	Identify sites with and without *H. johnsonii*. At these, conduct a correspondence analysis between *H. johnsonii* distribution/abundance and environmental factors (habitat characteristics) including; temperature, salinity, light intensity, water motion, tidal exposure, sediment characteristics and stability, and eutrophication.	2 -5 yrs.	NOAA, WMDS, County DERM, FWC/FMRI	100	100	50	GIS statistical analyses. Part of baseline. Link with actions 1.01, 2.02, 3.02, and 7.01-7.03.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	3.02	Locate ephemeral populations of *H. johnsonii* and identify the characteristics (as determined by 3.01) of these sites.	>5 yrs.	NOAA, WMDS, FWC/FMRI	30	30		Combine with actions 1.01, 1.02, 3.01, and 3.03.
3	3.03	Identify the habitat characteristics which favor populations with female flowers (assuming male flowers should co-occur with females) and experimentally manipulate these conditions in the laboratory or mesocosm to attempt to induce flowering.	2 yrs.	NOAA, FWC/FMRI	15	10	10	Combine with action 3.04, and 101.A. First need to determine if female flowers contribute to recruitment.
3	3.04	Conduct experiments to determine the effect of other seagrass species on the distribution and abundance of*H. johnsonii* and assess the similarity of habitat requirements between *H. johnsonii* and other species.	2-5 yrs.	NOAA, COE, FWC/FMRI	50	50	50	Combine with action 3.02. In-situ and mesocosm experiments. Develop and issue request for proposal: grant, contract.
3	3.05	Determine if water quality and water management programs are appropriate for determining changes in conditions which would affect the continuous vegetative growth and reproduction of *H. johnsonii*.	1-2 yrs.	NOAA, FDEP, WMDs	20-30	20-30		

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	3.06	Select areas throughout the geographic range of the species which have suitable environmental conditions for perennial and flowering populations for use in the development and management of special protection areas for *H. johnsonii*.	1-2 yrs.	NOAA, FDEP, FWC, COE	15	10		Establish preserve in critical areas. Possibly National Estuarine Research Reserve. Link with Action 5.13.
2	4.01	Estimate rates of new shoot (the vertical shoot formed by the branching of the horizontal rhizome/apical meristem) formation and death rates in natural populations and in experimental fragments manipulated in mesocosms under different environmental conditions.	2-3 yrs.	NOAA	50	30	30	Action 4.01 to be combined with action 4.02 in same study. Develop and issue request for proposal: grant, contract.
1	4.02	Experimentally determine the mechanism for recruitment of patches (clones) and maximum dispersal distances of vegetative fragments. Use this information to determine the number of self-sustaining populations necessary to ensure their presence throughout the range.	3-5 yrs.	NOAA, FWC/FMRI		30	30	To be combined with action 4.01 in same study.
2	4.03	Experimentally manipulate in the laboratory or mesocosm, light, temperature, salinity and nutrients to determine their effects on flowering and growth of vegetative fragments.	2-3 yrs.	NOAA, FWC/FMRI	40	20	20	Mesocosm experiments. Develop and issue request for proposal: grant, contract.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
2	4.04	Collect and transplant mature fruits of *H. johnsonii* to determine whether fruits of *H. johnsonii* germinate and whether apomixis occurs.	1-3 yrs.	NOAA	25			Link with action 7.02. Also individual monitoring of plants. Develop and issue request for proposal: grant, contract.
2	5.01	Establish and convene an Implementation Team to develop a long-term research plan for the species and coordinate implementation of recovery plan actions.	semi-annually	NOAA, WMDs, FWC/FMRI, FDEP, COE	25	25	25	To begin immediately.
2	5.02	Recommend to Federal and state agencies that they adopt sampling protocols for *H. johnsonii* for the permit application and monitoring requirements of project sites (Appendix III).	1-2 yrs.	FDEP, WMDs, COE, FWC/BPSM	1	1	1	Costs are for agency/public workshops.
2	5.03	Incorporate pre- and post-construction monitoring data of *H. johnsonii* distribution and abundance, from federal, state, and local agencies, into a centralized GIS tracking system to improve protection and management and to determine cumulative impacts.	1-2 yrs, ongoing	NOAA (and contractor), COE, FDEP, WMDs	25	25		Put into permit requirement. Should be done in conjunction with actions 2.04 and 8.04. Requires setting up GIS database.
3	5.04	Provide educational opportunities and workshops for federal, state, and local permitting agencies, including training in field identification, sampling protocols, and critical habitat.	Periodic intervals annually	NOAA, COE, FDEP, WMDs, FWC/BPSM	25	25		Cross-reference with actions 8.01-8.05. Link with action 5.02. (10K-meeting; 20K - Employee) Costs to hold workshop in year 1 and print brochure in year 2.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
1	5.05	Establish federal and state interagency coordination during the permit review process (e.g., NOAA, COE, FDEP, SJRWMD, SFWMD, FWC) for projects that may affect *H. johnsonii* or its habitat so that impacts to the species can be avoided or minimized.	6-9 months, within 1 year	NOAA, COE, FDEP, WMDs, FWC/BPSM	10			Travel costs for meeting to establish the process, likely out of agencies' existing funds.
1	5.06	Improve or maintain water quality and sediment conditions appropriate for continuous vegetative growth and reproduction of natural populations of *H. johnsonii* throughout its geographic range, addressing point and non-point sources and water quality-based targets (PLRGs and TMDLs). Coordinate these actions with already existing programs, including, but not exclusively, the Indian River Lagoon National Estuary and SWIM programs, and the Lake Worth Management Plan.	Initially 1-2 yrs., continuous	FDEP, WMDs, NEP				Incorporate, where feasible, into currently existing regulations.Link with action 5.07.
2	5.07	Establish Pollutant Load Reduction Goals (PLRGs) and determine Total Maximum Daily Loads (TMDLs) for specific water body or segment within a water body, describing the management actions required to reach these guidelines (including stormwater treatment, wastewater reuse, and best management practices for upland use).	5 yrs.	FDEP, WMDs	20			Link with actions 3.03, 3.05, and 4.03.Being done in Indian River Lagoon for seagrass in general.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	5.08	Monitor water bodies, or the segments within, for the predicted responses of water quality and seagrass to the implementation of management actions.	continuous	FDEP, WMDs, DERM				Link with actions 3.05 and 4.03. Link with monitoring designs and costs of action 2.04.
1	5.09	Assess current federal, state, and local seagrass protection regulations (specifically those that addressing human activities on state-owned submerged lands and within the boundaries of federally-designated areas) for their level of effectiveness in protecting *H. johnsonii* and its habitat.	ongoing	NOAA, FDEP, FWC				Partially addressed in Recovery Plan, Chapter 1. Link with action 3.05.
2	5.10	Assess enforcement efforts of existing submerged land/seagrass protection regulations. Implement modifications to increase effectiveness of enforcement actions, as needed.	6 mos.-1 yr.	NOAA, FDEP, FWC	5-10			Link with actions 3.05, 5.05 and 5.06.
3	5.11	Preserve natural shoreline buffers on waterfront properties and encourage shoreline restoration.	continuous	FDEP, DERM , COE, NEP, WMDs, FWC				Link with action 8.01. Should be part of FDEP, county existing programs.
3	5.12	Identify and recommend the acquisition of privately-owned submerged lands vegetated with *H. johnsonii* and its adjacent uplands through local, regional, state and federal programs.	continuous	WMDs, FDEP DERM, NOAA, NGOs				Florida Forever project. Cost depends on acquisition costs. Use 2000 SWIM programs. Enter into baseline GIS as acquired: action 1.01.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	5.13	Implement a multiple agency management program to reduce prop scarring and trampling of shallow water seagrass beds.	2-5 yrs.	NOAA, NEP, FDEP, FWC	50			Link with ongoing FDEP efforts. Link with action 8.01.
3	5.14	Determine whether specific protection regulations for *H. johnsonii* will be developed under section 4(d) of the ESA in order to provide for the conservation of the species.	1-2 yrs.	NOAA, FDEP, COE, FWC/FMRI				Link with actions 5.05 and 5.06. Will assist in permitting process.
2	5.15	Establish "adverse modification" and "jeopardy" guidelines for *H. johnsonii* for use in Section 7 consultation under the ESA.	1 yr.	NOAA				
2	6.01	Determine the range of genetic variability and identify genetically unique populations within the species' geographic range.	1-2 yrs.	NOAA	40	30		Link with actions 1.02, 2.03, 3.01, 4.02. Develop and issue request for proposal: grant, contract.
2	6.02	Determine whether indices of genetic diversity are correlated with species persistence.	up to 5 yrs.	NOAA	150	100	40	Link with actions 4.01, 4.02, and 7.02 in single study.
2	7.01	Conduct mesocosm and field experiments to test the feasibility of transplanting excavated and naturally-dislodged vegetative fragments of *H. johnsonii* under a broad range of environmental conditions.	2-3 yrs.	NOAA, contractors	40	40	20	Link with actions 4.01, 4.02, and 7.01 in single study. Develop and issue request for proposal: grant, contract.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	7.02	Identify populations of *H. johnsonii* which grow and survive under different field transplanting conditions.	2-3 yrs.	NOAA, FWC/FMRI	30	30	30	Actions 7.03, 7.04, 7.05, and 7.06 to be combined in one request for proposal. Link with actions 2.04, 4.02, and 4.03.
3	7.03	Use reciprocal field and mesocosm transplants to test the effects of different water depths, salinities, geographical ranges, and genetic stocks on controlling the distribution and abundance of *H. johnsonii*. Identify key growth and demographic characteristics that distinguish the source and the surviving transplant populations.	2-3 yrs.	NOAA, FWC/FMRI	75	75	75	Link with actions 2.04, 4.01, 4.02, 7.03, 7.04 and 7.06. Develop and issue request for proposal: grant, contract.
3	7.04	Develop a reliable methodology for transplanting *H. johnsonii*.	2-3 yrs.	NOAA, FWC/FMRI	20	20	20	In conjunction with 7.03.
3	7.05	Use mesocosms to maintain and experimentally test the superiority of stock characteristics of *H. johnsonii*.	ongoing, 2 -5 yrs.; maintain continuously	NOAA, FWC/FMRI	50	50	5	Link with actions 4.02, 4.03, 7.03, 7.04, and 7.05. Cost depends on personnel. State facility maintains stocks from 7.03 and 7.04. Develop and issue request for proposal: grant, contract.
3	8.01	Develop a Web Page for *H. johnsonii* and post updates on its recovery efforts.	4 months-1 yr., then continuous	NOAA, FDEP	10	10	10	An action for an existing webmaster.

				RESPONSIBLE PARTY	COST ESTIMATES ($K)			
PRIORITY #	ACTION #	ACTION DESCRIPTION	ACTION DURATION		FY 1	FY 2	FY 3	COMMENTS/NOTES
3	8.02	Adapt existing education tools such as pamphlets and brochures on Florida seagrasses to address *H. johnsonii*.	1-2 yrs, continuous supply	NOAA, FDEP, FWC	20	20		In existing Environmental Information (E&I)/Outreach and Education departments. Contribute to printing costs. Link actions 8.02, 8.03, and 8.04.
3	8.03	Coordinate with federal, state, and local agencies, conservation groups, plant societies, commercial and recreational boaters and fishers, SCUBA divers, and media to develop a positive understanding of seagrass and *H. johnsonii*.	ongoing	NOAA, FDEP, FWC/OIS, FDACS, NEP	minimal but may require workshops			Use Public Relations personnel.Cost of brochures and teaching aids. Use existing programs.
3	8.04	Develop and evaluate educational materials and curricula with schools and local environmental centers that introduce students to seagrasses, making sure to incorporate information on *H. johnsonii*, its habitat, and the ESA.	1 yr., continuous	NOAA, FDEP, FWC/OIS, FDACS	15			Use input from actions 1.01, 2.04, 3.04, 4.03, 5.04, 5.15, 7.01, and 8.02. Link with essential fish habitat and faunal survey. Input of Dept. of Education and local districts
3	8.05	Develop and present state/federal/Water Management District regulatory workshops on survey protocol, effects of actions on *H. johnsonii*, and basic biology and proper identification of the species.	Several times during first year. One every 2-3 years.	NOAA, FDEP, WMDs, FWC/OIS, FDACS	25	0	25	Link with actions 5.03, 5.04. Use actions 1.01, 2.04, and 4.03. Needed workshops, use existing programs.

4.2 Implementation Schedule Summary

The following is a summary list of Johnson's seagrass recovery actions in order of priority.

Priority #		
1	1.02.	Protect the geographic extremes of the range and genetically unique populations (In coordination with Section 5, Management; and Section 6, Genetics).
1	4.02.	Experimentally determine the mechanism for recruitment of patches (clones), and maximum dispersal distances of vegetative fragments. Use this information to determine the number of self-sustaining populations necessary to ensure their presence throughout the range.
1	5.05.	Establish federal and state interagency coordination during the permit review process (e.g., NMFS, COE, FDEP, SJRWMD, SFWMD, FWC) for projects that may affect *H. johnsonii* or its habitat so that impacts to the species can be avoided or minimized.
1	5.06.	Improve or maintain water quality and sediment conditions appropriate for continuous vegetative growth and reproduction of natural populations of *H. johnsonii* throughout its geographic range, addressing point and non-point sources and water quality-based targets (PLRGs and TMDLs). Coordinate these actions with existing programs, including, but not exclusively, the Indian River Lagoon National Estuary and SWIM programs and the Lake Worth Management Plan.
1	5.09.	Assess current federal, state, and local seagrass protection regulations and programs (specifically those addressing human activities on submerged lands and within the boundaries of federally-designated areas) for their level of effectiveness in protecting *H. johnsonii* and its habitat.
2	1.01.	Develop detailed baseline distribution maps (In coordination with Section 2, Monitoring).

1.01.A. Identify areas with persistent populations.

1.01.B. Map and delineate areas with flowering populations.

1.01.C. Identify areas of high abundance or areas that are conducive to the survival of the species.

2 2.01. Determine whether the distribution and size of beds are expanding or declining and identify factors influencing expansion or decline.

2 2.02. Determine the precise northern and southern distributional limits of *H. johnsonii* and monitor the temporal variation in these limits using DGPS and in-situ sampling.

2 2.03. Determine whether patch size, abundance, or spacing vary from north to south, and identify if there are presently any large distribution gaps (see Protect Populations and Habitat section).

2 2.04. Monitor persistence. Establish permanent monitoring plots at (a) the northern and southern distribution limits, (b) the geographic extremes of the natural lagoon systems within the known geographic range (i.e., the southern end of the IRL and the northern end of Lake Worth), (c) sites with existing or long-term water quality data, and (d) sites identified to have unique or diverse genotypes present (e.g., Boynton Beach, Boca Raton, etc.). Annual monitoring should be conducted for 10 years to determine whether criteria for de-listing have been met.

2 4.01. Estimate rates of new short shoot (the vertical shoot formed by the branching of the horizontal rhizome/apical meritstem) formation and death rates in natural populations and in experimental fragments manipulated in mesocosms under different environmental conditions.

2 4.03. Experimentally manipulate in the laboratory or mesocosm, light, temperature, salinity, and nutrients to determine their effects on flowering and growth of vegetative fragments.

2 4.04. Collect and transplant fruits of *H. johnsonii* to determine whether fruits of *H. johnsonii* germinate and whether apomixis occurs.

2	5.01.	Establish and convene an Implementation Team to develop a long-term research plan for the species and coordinate implementation of recovery plan actions.
2	5.02.	Recommend to Federal and state agencies that they adopt sampling protocols for *H. johnsonii* for the permit application and monitoring requirements of project sites (see Appendix III).
2	5.03.	Incorporate pre- and post-construction (of in- and over-water structures) monitoring data of *H. johnsonii* distribution and abundance, from federal, state, and local agencies, into a centralized GIS tracking system to improve protection and management and to determine cumulative impacts.
2	5.07.	Establish PLRGs and develop TMDLs for a specific water body or segment within a water body, describing the management actions required to reach these guidelines (including stormwater treatment, wastewater reuse, and best management practices for upland use).
2	5.10.	Assess enforcement efforts of existing submerged lands/seagrass protection regulations to determine their effectiveness in protecting *H. johnsonii*. Implement modifications to increase effectiveness of enforcement actions, if needed.
2	5.15.	Establish "adverse modification" and "jeopardy" guidelines for *H. johnsonii* for use in section 7 consultation under the ESA.
2	6.01.	Determine the range of genetic variability and identify genetically unique populations within the species' geographic range.
2	6.02.	Determine whether indices of genetic diversity are correlated with species persistence.
2	7.01.	Conduct mesocosm and field experiments to test the feasibility of transplanting excavated and naturally-dislodged vegetative fragments of *H. johnsonii* under a broad range of environmental conditions.
3	3.01.	Identify sites with and without *H. johnsonii*. At these sites, conduct a correspondence analysis between *H. johnsonii* distribution/abundance and environmental factors (habitat

characteristics) including: temperature, salinity, light intensity, water motion, tidal exposure, sediment characteristics and stability, and eutrophication (Also see Actions 7.01, 7.02 and 7.03).

3	3.02.	Locate ephemeral populations of *H. johnsonii* and identify the characteristics (listed in Action 3.01) of these sites.
3	3.03.	Identify the habitat characteristics which favor populations with female flowers (assuming male flowers should co-occur with females) and experimentally manipulate these conditions in either the laboratory or mesocosm to attempt to induce flowering.
3	3.04.	Conduct experiments to determine the effect of other seagrass species on the distribution and abundance of *H. johnsonii* and assess the similarity of habitat requirements between *H. johnsonii* and other species.
3	3.05.	Determine if water quality and water management programs are appropriate for determining changes in conditions which would affect the continuous vegetative growth and reproduction of *H. johnsonii*.
3	3.06.	Select areas throughout the geographic range of the species which have suitable environmental conditions for perennial and flowering populations for use in the development and management of special protection areas for *H. johnsonii* (In coordination with Action 5.13).
3	5.04.	Provide educational opportunities and workshops for federal, state, and local permitting agencies, including training in field identification, sampling protocols, and the identification of designated critical habitat.
3	5.08.	Monitor water bodies, or the segments within, for the predicted responses of water quality and seagrass to the implementation of water quality management actions and assess the effectiveness of these specific management actions.
3	5.11.	Preserve natural shoreline buffers on waterfront properties and encourage shoreline restoration.

3	5.12.	Identify and recommend the acquisition of privately-owned submerged land vegetated with *H. johnsonii* and its adjacent uplands through local, regional, state and federal programs. Public acquisition of these few tracts will preserve the seagrass habitat associated with them and provide upland watershed buffer protection.
3	5.13.	Implement a multi-agency approach management program to reduce prop scarring and trampling of shallow water seagrass beds. The management program should use multiple methods including increased boater education, installation of channel markers, active enforcement, and the establishment of limited motoring zones or closure areas.
3	5.14.	Determine whether specific protective regulations for *H. johnsonii* will be developed under section 4(d) of the ESA in order to provide for the conservation of the species.
3	7.02.	Identify populations of *H. johnsonii* which grow and survive under different field transplanting conditions.
3	7.03.	Use reciprocal field and mesocosm transplants to test the effects of different water depths, salinities, geographical ranges, and genetic stocks in controlling the distribution and abundance of *H. johnsonii*. Identify key growth and demographic characteristics that distinguish the source and the surviving transplant populations.
3	7.04.	Develop a reliable methodology for transplanting *H. johnsonii*.
3	7.05.	Use mesocosms to maintain and experimentally test the superiority of stock characteristics of *H. johnsonii*.
3	8.01.	Develop a Web Page for *H. johnsonii* and post updates on its recovery efforts.
3	8.02.	Adapt existing education tools such as pamphlets and brochures on Florida seagrasses to address *H. johnsonii* protection.
3	8.03.	Coordinate with federal, state, and local agencies, conservation groups, plant societies, commercial and recreational boaters and

fishers, SCUBA divers, and media to develop a positive understanding of seagrasses and *H. johnsonii*.

3 8.04. Develop and evaluate educational materials and curricula with schools and local environmental centers that introduce students to seagrasses, making sure to incorporate information on *H. johnsonii*, its habitat, and the ESA.

3 8.05. Develop and present state/federal/Water Management District regulatory workshops on survey protocol, effects of actions on *H. johnsonii*, and basic biology and proper identification of the species.

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APPENDIX I

Listing Notice for *Halophila johnsonii*
Federal Register 63(177): 49035

— Insert FR notice here

APPENDIX II

Notice for Critical Habitat for *Halophila johnsonii*
Federal Register 65(66): 17786

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APPENDIX III

Recommendations for sampling *Halophila johnsonii* at a project site

Recommendations for sampling *Halophila johnsonii* at a project site

The following suggested approaches for sampling *H. johnsonii* are recommendations of the *H. johnsonii* Recovery Team.

OBJECTIVE:

To outline recommended survey methods for determining the distribution and abundance of *H. johnsonii* at sites under permit review. The methods should be applicable to a broad range of project scales, from a 20-m long dock, to marinas, bridges, and channels several kilometers long.

PROBLEM:

Three aspects make quantitative sampling for *H. johnsonii* difficult: (1) Poor visibility; it is sometimes difficult to see more than 0.1 or even 0.01 m^2 at a time. (2) Patchy and clumped distribution, with patches as small as 0.01 m^2, which may be clumped together within a sub-area of the project area. (3) Stratified distribution, with occurrence perhaps limited to a particular depth gradient within a project area.

RECOMMENDED METHODS: The most appropriate approach depends on scale, and the amount of expected error depends on the approach. Unless a complete survey of the entire area is done, the estimated distribution and abundance of this species may be significantly in error. With the exception of very small project areas, efficient field

sampling may require sampling in two stages. A preliminary visual reconnaissance of the site should be conducted to locate any occurrences of *H. johnsonii*. "The importance of preliminary sampling is probably the most under emphasized principal related to field studies. There is no substitute for it." (Green 1979). Following the preliminary reconnaissance, a more comprehensive sampling, using one of the techniques outlined below, should be initiated. In situ monitoring for *H. johnsonii* is absolutely necessary. Aerial photography may be used to map distributions of larger canopy-forming species; however, mapping of *H. johnsonii* cannot be done reliably from aerial photos. Because of significant seasonal and annual variation in distribution and abundance of *H. johnsonii*, surveys must be conducted during spring/summer (April 1 to August 31) period of maximum abundance, and sampling in more than one summer is recommended. Length of time between survey date and actual start of project should consider the potentially rapid turnover and migration of *H. johnsonii*. Personnel conducting the survey should clearly demonstrate that they can distinguish between *H. johnsonii* and *H. decipiens*. Surveys labeled simply as "*Halophila*" are not sufficient.

Deliverables: 1) amount (acres or square meters) impacted, 2) estimate of percent coverage and the species present/absent, 3) site map with seagrass patch or bed locations, 4) size of the patches, and, as feasible, 5) shoot density estimate.

SMALL PROJECT SITES (<0.1 ha, e.g. 10 m by 100 m, such as single-family docks). Two methods.

1. Provide a site map of submerged lands adjacent to the action area. The site map should include transects approximately every 7.5 m apart, perpendicular to the shore, and for a length 6 m longer than the proposed activity. A preliminary visual reconnaissance is necessary to fill in the information between the transects. Seagrass patches should be identified by species composition and drawn on the site map. Density can be accomplished with random sub-sampling for density within the identified patches. (An overall site map is important since it identifies seagrass habitat, not just existing seagrass patches. (Mezich pers. comm. 2000)).

2. The site is sub-divided into m^2 grids. A complete and intensive mapping of the entire area of concern can be developed by using DGPS, with coordinates provided every m^2, or every patch >0.01-0.1 m^2, with a tested map accuracy of >50-95%. If percent cover is not used, an illustrated, standardized scale of density should be used. Presence-absence should be determined for every m^2 grid cell.

INTERMEDIATE-AREA PROJECT SITES (0.1 to 1 ha, e.g., a 100-m by 100-m marina). A two-step process is required.

a. Preliminary visual reconnaissance to locate general *H. johnsonii* areas and distribution.

b. The site should then be surveyed using transects across the dominant spatial gradients (e.g., depth, inshore-offshore, channel-shoal, etc.) of the site. The number of transects and sample intervals should adequately describe distribution and abundance of *H.*

johnsonii patches. Besides noting presence-absence, x-y diameters, e.g., north-south or parallel-perpendicular to shore, of encountered patches should be noted. As possible, sub-samples of shoot density, blade length, and presence of flowering could also be recorded.

LARGE-AREA PROJECT SITES (>1 ha). Three choices are possible after preliminary visual reconnaissance.

1. Random sampling of points or quadrats within the area.

Sampling at least 10-30% of the total area.

- 2 stages: (1) visual reconnaissance, then stratify, (2) second intensive sampling, with intensity relative to abundance of *H. johnsonii* within the strata.
- singe step of 100 -1,000 points/quadrats (minimum [min.] # = ?).

2. Intensive survey of transects.

Transects across the entire area, sampling at least 10-30% of the total area.

- point-intersect sampling along transects (with the size of a "point" defined, e.g., 5 x 5 or 10 x10 cm).
- belt transect, of 0.1-2 m width.
- transects randomly located (min. # transects = 10-50 or min. spacing = 50 m).
- regularly-spaced transects (min. # transects = 10-50 or min. spacing = 50 m).
- quadrats at regular intervals along line (min. # = 10-50 or min. spacing = 50 m).

For any of these transect methods, x-y diameters of any patches encountered should be measured. At a minimum, presence-absence should be recorded at each point or each quadrat.

3. Combinations of above methods, e.g.,

(a) Intensive mapping in area of primary impact (e.g., within footprint of proposed dock), plus random points in surrounding, potentially affected area.

(b) Stratify from random point sampling, then map intensively in areas of greatest abundance.

It is the position of the Recovery Team, however, that the adoption of a valid survey protocol for identifying Johnson's seagrass be required by permitting agencies in the range of the species. In all seagrass surveys, emphasis should be placed on the identification of seagrass habitat as well as the distribution of currently existing patches.

References

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