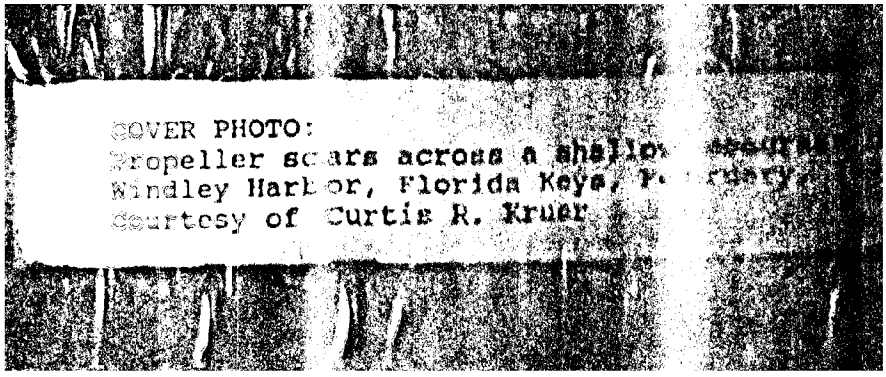
STATEWIDE ASSESSMENT OF PROPELLER DAMAGE TO SEAGRASS

A Report to the Florida Department of Community Affairs Pursuant to National Oceanic and Atmospheric Administration Award No. NA17OZ0501



COVER PHOTO:
Propeller scars across a shallow
Windley Harbor, Florida Keys, F
Courtesy of Curtis R. Kruer

STATEWIDE ASSESSMENT OF PROPELLER DAMAGE TO SEAGRASS

FINAL REPORT

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March, 1993

Department of Natural Resources
Division of Marine Resources
Florida Marine Research Institute

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Seagrasses are a vital component of Florida's coastal ecology and economy. The uninformed and negligent operation of powerboats in waters much shallower than they were designed to operate is severely damaging seagrass beds throughout the state. The negative impacts of this threat are increasing as Florida's population of coastal residents and seasonal visitors increases.

This project identifies and quantifies areas of damaged seagrass beds throughout the state. For the first time, the state-wide magnitude of this problem is scientifically documented. High damage site were identified and specific actions needed for corrective measures were suggested. The information acquired from this survey has been incorporated into the Marine Resources Geographic Information System for analyses and effective dissemination of information to resource managers and appropriate regional and county goverments.

Recognizing the value of having the extent and spatial distribution of propeller damage information, the Florida Department of Natural Resources has committed to develop, test, and implement a state-wide management plan for propeller damage to seagrass during the next two years. This Coastal Zone Management Program funded study is serving as the foundation for development of the state-wide management plan and is guiding implementation of the management plan. The management effort involves heavy interaction with local governments.

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State-wide Assessment of Propeller Damage to Seagrass

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pursuant to
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Submitted by
Florida Department of Natural Resources
Florida Marine Research Institute

March 31, 1993

EXECUTIVE SUMMARY

Seagrasses are a vital component of Florida's coastal ecology and economy. The uninformed and negligent operation of powerboats in waters much shallower than they were designed to operate is severely damaging seagrass beds throughout the state. The negative impacts of this threat are increasing at an alarming rate as Florida's population of coastal residents and seasonal visitors increases. The needless destruction of shallow seagrass beds through boating activities can be avoided without imposing undue hardships on the boating public.

This project identifies and quantifies areas of damaged seagrass beds throughout the entire state. For the first time, the state-wide magnitude of this problem is scientifically documented. High damage sites were identified and specific actions needed for corrective measures were recommended. The information acquired from this survey has been incorporated into a geographic information system for analyses and effective dissemination to DNR resource managers and appropriate regional and county governments.

Recognizing the value of having the extent and spatial distribution of propeller damage information, the Department of Natural Resources has committed resources to develop, test, and implement a state-wide management plan for propeller damage to seagrass during the next two years. The Coastal Zone Management Program funded study is serving as the foundation for development of a state-wide management plan and is guiding the implementation of the management plan. Site specific corrective measures have been identified by this study and are currently being put into action. The management effort involves heavy interaction with local governments.

INTRODUCTION

Seagrasses are a vital component of Florida's coastal ecology and economy. As the population of the state grows, threats to the health and existence of these priceless ecological communities also increase. Several of these threats (dredge and fill, construction of docks in shallow waters, water pollution) are now being brought under control by an organized network of federal, state, and local resource management programs. However there still exists one major threat which is poorly understood by resource managers and public planners and as such is not being regulated on a consistent basis throughout the state.

Nearly all seagrass beds in Florida show some signs of needless damage caused by boat propellers digging trenches across these submerged wetlands. Many seagrass beds contain areas which are completely denuded of all vegetation by intense and repeated boating activity in inappropriate locations. Although this threat has existed since the introduction of motorized boats, the negative impacts of this threat are increasing at an alarming rate as Florida's population of coastal residents and seasonal visitors increases.

The needless destruction of shallow seagrass beds through boating activities can be avoided without imposing undue hardships on the boating public. Several preliminary management practices targeted at alleviating unnecessary boating damage to seagrass beds have been implemented in isolated cases. This project identifies and quantifies damaged seagrass beds throughout the entire state. Specific types of boating activities or navigational circumstances leading to seagrass damage are identified and discussed. For the first time, the state-wide magnitude of this problem is scientifically documented.

A general assessment to obtain an idea of how prevalent and substantial the impact of boat propeller scar damage is throughout the state of Florida was initiated by the Florida Marine Research Institute's (FMRI) Coastal and Marine Resource Assessment (CAMRA) section. Using a combination of aerial photography and aerial surveys, propeller scar damage in seagrass beds was mapped on National Oceanic and Atmospheric Administration (NOAA) nautical charts. The resultant information was stored in a digital format in the Marine Resources Geographic Information System (MRGIS) of the FMRI for data analysis and distribution to appropriate federal, state, and local agencies.

Due to both the complexity and the expansiveness of seagrass communities in the Florida Keys, a local consultant with extensive experience was subcontracted to conduct the Monroe County portion of this project. The contractor's data and findings are incorporated into this report as appropriate. The contractors full report is included as Appendix A.

DISCUSSION OF THE PROBLEM

The importance of seagrasses as a natural resource is well documented from extensive research in the last thirty plus years (Durako, et al., 1987). Seagrass communities are recognized as a vital link in near shore benthic resources and are also considered to be one the most productive ecosystems in existence (Dawes, 1987; Zieman and Zieman, 1989). Zieman and Zieman (1989) produced a conceptual framework which appropriately illustrate the importance of seagrasses: 1. High production and growth - Seagrasses yield high net productivity. 2. Food and feeding pathways - Grazing of the seagrasses and detrital material both in place and in movement to other locations. 3. Shelter - Seagrasses are a primary nursery for finfish and shellfish. 4. Habitat Stabilization - The stabilization of sediment with the root systems and reduction of particle suspension near substrate water interface. 5. Nutrient effect - The provision of organic matter by decay and the uptake and release of nutrients into the water column.

The recovery of seagrasses from impacts such as propeller scar damage has been studied in recent years (Godcharles, 1971; Zieman 1976) and research continues to take place as the problem of propeller scar damage to seagrasses appears to be growing eg. Durako et al., 1992 and currently Clinton Dawes Ph.D. According to Dawes (pers. comm.) of the University of South Florida, the program at the Cockroach Bay Aquatic Preserve began in January of 1993 and is a two year study involving the recovery of seagrasses in old scar and new scars created for the study. This type of research enables us to better understand the ramifications of propeller scar damage to the seagrasses and time frames for recovery.

Initial research by Zieman (1976) indicated Thallasia testudinum may require at least two years before recolonization begins. Even after five years some propeller scars had not recovered from being damaged. His study also stated that Halodule wrightii recovers much quicker than does the T. testudinum. Durako's (et.al. 1992) research documented that H. wrightii would only require 0.9 - 1.8 years to regain their natural densities and T. testudinum would take approximately 3.6 - 6.4 years to achieve natural short shoot densities. Some research has indicated, that dependent on the size of a seagrass bed complete recovery may take ten years (Lewis and Estevez, 1988).

Seagrass recovery is dependent on several factors for regrowth; sediment composition (eg. Florida Bay vs. Tampa Bay), position of the propeller scar with regard to water current (flow) and depth (Godcharles, 1971; Zieman, 1976; Durako, et al. 1992). Zieman (1976) indicated that propeller scars may not fill in with sediment if located in areas of extreme current. From this condition, the severed rhizomes may grow up or down the side of the propeller scar but were not seen to cross over it. Durako (et al., 1992) explains how the sediment environment of south Florida with predominately carbonate sediments, would exhibit a different regrowth period for the seagrasses in propeller scars than the prop damaged seagrasses of Tampa Bay, which inhabit a quartz-sand sediment environment. The depth of the scar is also a contributing factor to regrowth of propeller scar damaged seagrass bed. Studies involving trenches or excavations cut into seagrass beds of 6 inches to 18 inches deep were very slow to recovery

(Zieman, 1976 and Godcharles, 1971). The trenches-excavations filled in readily, although regrowth was slow even after two years.

Over the years there have been various impacts have reduced the areal extent of seagrasses of Florida including dredge and fill, water pollution, and boat propeller damage. A dominant benthic ecosystem in the state, seagrasses offers a wide variety of benefits ranging from habitat, nursery and its link in the food chain (Zieman and Zieman, 1989). Damage to seagrass beds by boat propellers was noted as early as the 1950's and 1960's (Woodburn, 1957; Phillips, 1960) and has steadily become a significant impact. Damage to seagrasses from boat propellers results from one or more of the following combinations; boaters misjudging water depth, taking short cuts, commercial fishing, recreational boating, recreational fishing, and intentional propeller dredging to create a channel (Woodburn, et al., 1957; Godcharles, 1971; Zieman and Zieman, 1989; The Wilderness Society et al. 1990). Damage may consist of an isolated boat propeller scar or a series of boat propeller scars which have defoliated portions of the seagrass beds leaving an area which may be completely void of seagrasses or other plants.

In addition to the current research of damaged seagrass beds, resource managers have already established management programs for Weedon Island Sate Preserve, Cockroach Bay Aquatic Preserve (TBRPC, 1993), and John Pennecamp Coral Reef State Park. Other counties and state agencies are also adopting similar programs. Any combination of the management programs may be implemented; monitoring of propeller scar damage using aerial photography, better channel marking to aid boaters, closure of specific areas to combustion engines and/or boater education as a means of reducing the amount of propeller scarring in seagrass beds.

REPORT DEFICIENCY

At the time this report was produced two areas in Florida had not been mapped due to poor water clarity, poor weather conditions, and scheduling and logistics problems. A small portion of Monroe county and a majority of the Florida panhandle remain to be surveyed. Ancillary information for these areas have been collected and reviewed and contracts are in place to complete the aerial surveys. These two areas represent a small percentage of the seagrass regions in the state and do not detract from the immediate application of the information contained in this document.

All maps, tables, and findings published in this report are preliminary. The information contained in this report is in draft status and must be used accordingly. A refined and completed survey result is currently being developed as part of a follow through management effort being developed by DNR as a result of this Coastal Management Program funded project. The DNR management initiative is a logical expansion of Task 3 of this Coastal Management Program funded project and is explained in detail in that section of this report.

Task 1 Statewide assessment of propeller damage.

Aerial photographs were utilized to reconnoiter the distribution and magnitude of propeller damage to seagrass throughout Florida's shallow coastal waters. The most recent photographs of sufficient quality to identify propeller scars were used. Due to the fact that no comprehensive state-wide effort exists to inventory and assess benthic resources, the photographs were of various quality, scales, and media types. Photographs for localities not covered by FMRI's aerial photograph library were obtained or borrowed from the water management districts. Although a few gaps in coverage did exist, for the most part the photography was extremely useful in conducting a preliminary assessment and planning an efficient ground truthing strategy.

For most regions of the state 9 inch by 9 inch color infrared (CIR) transparencies at a scale of 1:24,000 were used. The best photographs available were 1:12,000 CIR transparencies taken in December 1991 for the Florida Marine Research Institute's Florida Keys benthic mapping project. Southwest Florida Water Management District supplied 1:24,000 CIR photographs for Tampa Bay and south to Charlotte Harbor. St. Johns River Water Management District supplied 1:24,000 CIR photographs for Mosquito Lagoon and Indian River Lagoon. The South Florida Water Management allowed use of 1:40,000 CIR transparencies for Hobe Sound, southeast Florida, Biscayne Bay, parts of the Keys and Florida Bay, southwest Florida, and portions of Charlotte Harbor. Photography of submerged aquatic vegetation for the panhandle and Big Bend regions was to have been taken as part of the EPA/USFWS Gulf of Mexico seagrass mapping project, but bad weather and poor water clarity had delayed this effort and no photographs were available.

Interpretation of the 1:40,000 scale photographs did not pose any major difficulties due to excellent through the water visibility of these regions and the fine quality of the photographs. A previous Florida Marine Research Institute study (Durako, et al, 1992) suggested that the smallest scale (least detailed) aerial photography appropriate for interpreting propeller scars for general assessment was 1:24,000. This was found to be true for regions of the state with less than optimum water clarity. Fortunately 1:24,000 scale photographs were available for most of those areas.

The oldest photographs utilized were taken in November 1990. Although two year old photographs did not represent current conditions, they did document patterns of past propeller damage and indicated hot spots which required closer examination. Even the most recent photographs were used only for preliminary assessment.

Magnifying scopes and stereoscopes designed for interpretation of aerial photographs were used to identify and delineate propeller scars observed in the photographs. This allowed the extraction of as much data as possible from the photographs. Delineations and registration marks were drawn on acetate overlays which were then used to transfer the information to nautical charts.

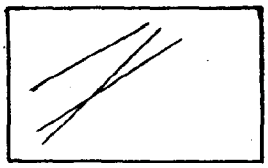
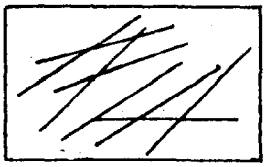
Damage was defined as scars across the seagrass bed from which shoots and rhizomes had been removed and the bottom sediment was visible. These scars were visible in photographs and from the air as sharp lines with a distinct contrast in shade tone from the seagrass. Scars typically appeared similar to those visible in the cover photograph of this report. Mapping of individual scars was beyond the scope of this state-wide survey and perhaps impossible at any level of detail. There were just too many scars and at most locations the scars were so numerous that they could not be distinguished individually. Where several scars were observed within close proximity a polygon was drawn around the scarred area. Mapping of areas less than one acre was not appropriate due to the scales involved.

An estimate of the degree of damage was then assigned to the polygon. Light impact indicated that damage was present but that less than 5% of the seagrass within the delineated area was directly impacted. Moderate impact indicated 5-20% of the seagrass was impacted and severe impact indicated more than 20% of the seagrass within the area was impacted. For example, 100 acres of seagrass classified as moderately impacted could contain between 5 and 20 acres of actual propeller scars. A "Comparison Chart for Visual Estimation of Percentage Composition" (Terry and Challenger, 1966) was used to guide estimation of damage. Figure 1 presents a graphical representation of the three levels of estimated damage. The seagrass bed in the cover photograph was assigned a damage level of severe.

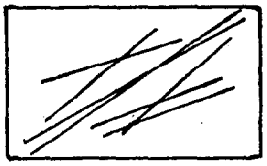
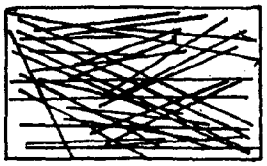
In many instances a wide variety of damage levels occurred within close proximity. The area was then assigned an average value of estimated damage level. A graphical example of this situation is provided as Figure 2.

The assignment of damage levels was subjective and should only be considered in the context of this project. For a more definitive assessment of damage, each site must be reviewed individually. Only general areas of impact were defined. This study was not designed to provide accurate assessments of seagrass loss on a detailed basis.

Light Damage Level - Each 100 acres of seagrass contains scars amounting to less than 5 acres.

A  B 

Moderate Damage Level - Each 100 acres of seagrass contains between 5 and 20 acres of scars.

C  D 

Severe Damage Level - Each 100 acres of seagrass contains over 20 acres of scars.

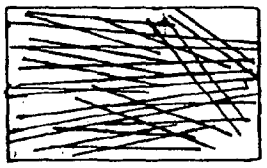
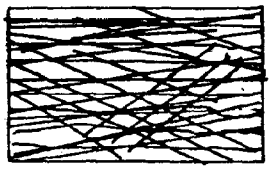
E  F 

Figure 1. Graphical representation of the three levels of estimated propeller damage identified in this project. White space within each block represents seagrass while the black marks represent scars. Light damage level ranges between blocks A and B, moderate damage level ranges between blocks C and D, while severe damage level ranges between blocks E and F.

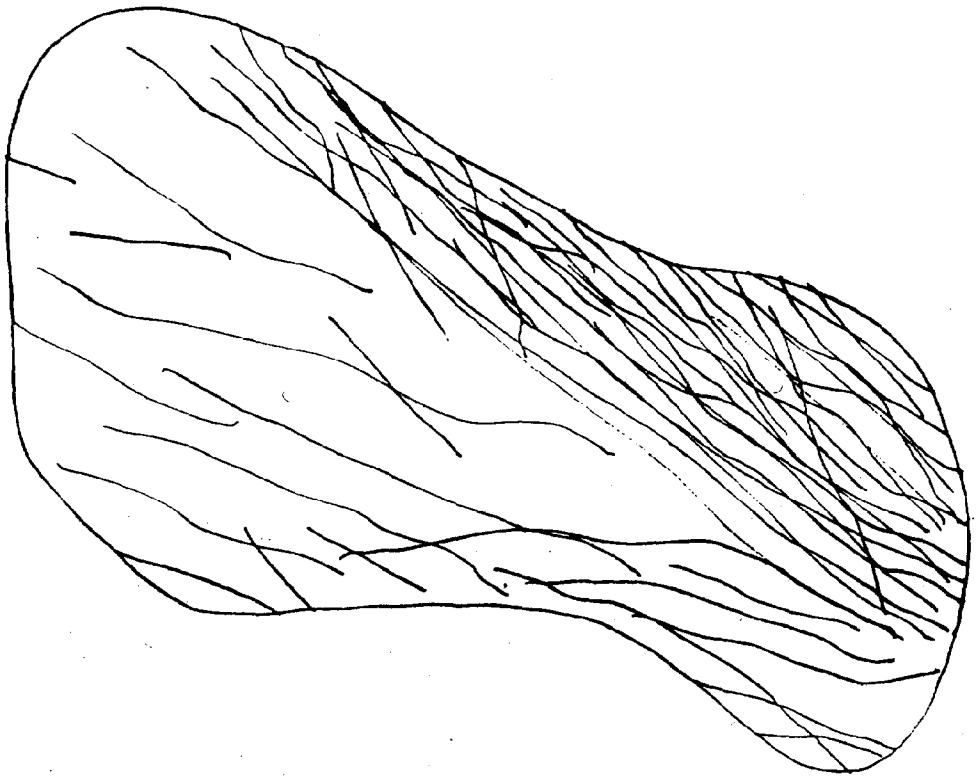


Figure 2. An example of a polygon delineation which includes all three types of damage; Light, moderate, and severe and categorized (mapped) as severe.

Polygons drawn on the overlays were transferred to nautical charts with a zoom transfer scope. The zoom transfer scope superimposed images from a drawing onto a basemap of another scale. This allowed for precise transfer of the hand drawn damage polygons from the photograph overlays onto a base map even when their scales differed. Charts of the most appropriate scale and most recent date for each region were used. In most cases 1:40,000 charts and their 1:10,000 insets were used. Use of charts with a smaller scale would have been too cumbersome and required an unreasonable number of individual charts to provide state-wide coverage. In most regions larger scale (more detailed) charts were not available for these same reasons.

National Oceanic and Atmospheric Administration (NOAA) navigational charts were chosen as the base media for drafting propeller damage polygons because they are suitably accurate, appropriately detailed, provide geographical references for positioning in offshore areas, readily available at low cost, and are used by most agencies conducting natural resource work in coastal waters. The shorelines depicted on these charts were compatible with the Marine Resources Geographic Information System (MRGIS) shoreline data which aided incorporation of damage data into the MRGIS. Transfer of information from the charts into the MRGIS was also facilitated by accurate and well distributed graticules, used for registration of geographic position, on the charts. The individual NOAA charts used are listed in Table 1.

Table 1. NOAA nautical charts and USGS topographic maps used as base maps for the drafting of polygons depicting propeller damage to seagrass.

Number	Scale	Official Title
Chart 11378	1:40,000	Intracoastal Waterway - Santa Rosa Sound to Dauphin Island
Chart 11393	1:40,000	Intracoastal Waterway - Lake Wimico to East Bay
Chart 11402	1:40,000	Intracoastal Waterway - Apalachiacola to Lake Wimico
Chart 11404	1:40,000	Intracoastal Waterway - Carrabelle to Apalachicola Bay
Chart 11405	1:80,000	Apalachee Bay
Chart 11407	1:80,000	Horeshoe Point to Rocks Islands
Chart 11408	1:80,000	Crystal River to Horseshoe Point
Chart 11409	1:80,000	Anclote Keys to Crystal River
Chart 11412	1:80,000	Tampa Bay and St. Joeseph Sound
Chart 11413	1:40,000	Tampa Bay - northern part
Chart 11414	1:40,000	Tampa Bay - southern part
Chart 11425	1:40,000	Intracoastal Waterway - Charlotte Harbor to Tampa Bay
Chart 11427	1:40,000	Intracoastal Waterway - Fort Myers to Charlotte Harbor
Chart 11430	1:40,000	Everglades National Park - Lostmans River to Wiggins Pass
Chart 11432	1:50,000	Everglades National Park - Shark River to Lostmans River
Chart 11433	1:50,000	Everglades National Park - Whitewater Bay
Chart 11441	1:30,000	Key West Harbor and approaches
Chart 11442	1:80,000	Sombrero Key to Sand Key
Chart 11445	1:40,000	Intracoastal Waterway - Bahia Honda to Key West
Chart 11448	1:40,000	Intracoastal Waterway - Big Spanish Channel to Johnson Key
Chart 11449	1:40,000	Matecumbe to Bahia Honda Key
Chart 11451	1:80,000	Miami to Marathon and Florida Bay
Chart 11463	1:40,000	Intracoastal Waterway - Elliot Key to Matecumbe
Chart 11465	1:40,000	Intracoastal Waterway - Miami to Elliot Key
Chart 11467	1:40,000	Intracoastal Waterway - West Palm Beach to Miami
Chart 11485	1:40,000	Intracoastal Waterway - Tolomato River to Palm Shores
USGS map	1:24,000	Marquesas Keys West
USGS map	1:24,000	Marquesas Keys East
USGS map	1:24,000	Cottrell Key
USGS map	1:24,000	Key West

After charts were preliminarily marked with damage polygons, aerial surveys were conducted for groundtruthing and refinement of the delineations and damage classifications. In some cases where seagrass beds or shorelines had complicated geometry the original aerial photographs were brought along as ancillary data and also edited in-flight. Aerial surveys were critical to accurate data collection since not all scarring was visible in even the best photographs. Numerous areas of damage were added to the charts during the overflights and a more accurate assignment of damage levels was possible.

Florida Marine Patrol aircraft and pilots were used for the aerial surveys when possible. The local knowledge these pilots had of each region, the natural resources present, and common boating patterns was invaluable to the project. Light fixed-wing aircraft (Cessna 172) were flown in regions where seagrass was distributed along straight and continuous shorelines. The Indian River Lagoon and the southeast Intracoastal Waterway were surveyed from a plane. The Cessna was found to be very economical. Regions with convoluted shorelines and numerous islands were surveyed by helicopter (Hughes 500). Tampa Bay, Biscayne Bay, Wacassasa Bay, and parts of Florida Bay were surveyed with a helicopter. The ability of the helicopter to maneuver and hover improved the accuracy of the survey and also reduced time spent circling and returning to spots of interest.

Survey altitudes between 300 and 500 feet provided the best observation perspective. At higher altitudes scars were usually not visible and at lower altitudes too much flight time was required to cover large areas. In a few locations were conditions permitted, higher altitudes were flown. Flight speeds between 80 and 100 knots were used depending on the complexity of scarring and clarity of the water.

Good weather and water clarity were essential for aerial surveys. Optimum conditions were clear skies, calm sea state, winds less than 10 mph, a high sun angle, and clear water. Rain and high winds made seeing through the surface of the water impossible. Sun glare reflecting off the water in late afternoon and early morning also hampered observations. Turbidity caused by rough water during storms usually persisted for several days afterward. Dark colored water discharged from organically stained rivers during and after rain storms was the major impediment for aerial surveys. River discharge continued for many days after the large frontal systems passed through the panhandle and Big Bend regions. Surveys were attempted during poor conditions but it proved to be impossible to observe seagrass and scars when weather and water conditions deteriorated past certain limits.

Photo-documentation in the form of 35mm slides and Hi8 video was collected during the aerial surveys. One such photograph was placed on the cover of this report. These photographic records were placed in a photo library at the Florida Marine Research Institute and made available to all interested parties. In a few instances this information was referred to when drafting the final version of the propeller scar damage charts. Slides depicting damage were provided to newspapers and a Hi8 video of damage in the Keys was provided to a local public television station for inclusion in a documentary. Local resource managers have requested copies

of some of this photo-documentation. A marina expansion permit review and the development of an aquatic preserve management plan have been facilitated with the use of this photography.

During the aerial surveys, it was quite common to observe boats in the process of creating propeller scars in shallow seagrass beds. A wide variety of examples of this activity were captured with both the still photography and the video.

After aerial surveys for a region were completed, the damage information was edited and recompiled onto a clean set of charts. The clean set of charts was then used in the transfer of damage information into the Marine Resources Geographic Information System. All charts and photograph overlays have been archived for future reference.

Task 2 Implement the resultant information on the Marine Resources Geographic Information System.

Information from the finalized charts was transferred into the MRGIS through manual digitization. Plots were produced and checked against the original charts to ensure an accurate transfer had been conducted. All positional accuracies of the final data layer fell within accepted standards for work of this type.

ARC/INFO is the geographic information system software used by the MRGIS. This software is used by numerous county governments, the water management districts, the Department of Environmental Regulation, several divisions of the Department of Natural Resources, the United States Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the Florida Game and Fresh Water Fish Commission, Regional Planning councils, several state universities, many private consulting companies, and utilities. The seagrass damage information is in a digital format which can easily be shared with other agencies which need it. The MRGIS can also incorporate various types of data generated by these agencies and use it for spatial analyses with the damage data. The propeller damage data is now in a format which is extremely accessible to those who need it and in this format it is also ready for use in powerful spatial analyses and map production.

A great wealth of information such as boat ramps, marinas, boating traffic and densities, navigation channels, artificial reefs, fishing grounds, manatee occurrences, coastal wetlands, population and housing densities, and transportation networks can also be displayed on maps produced by the MRGIS. Relationships of propeller damage to any type of geographic phenomena can be analyzed, displayed and turned into paper maps by the MRGIS.

Examples of paper maps which can be produced by the MRGIS are presented as Figures 3 and 4. Examples of larger maps accompany this report. All of these maps are preliminary and are to be used as examples only. These maps were generated on a Calcomp 68436 Electrostatic Plotter. A wide variety of sizes and formats of maps can be produced by the MRGIS. Customized maps can be produced in only a few hours if they are not too complicated. The

ability to produce customized paper maps makes the data and results of complex analyses readily available to anyone who needs the information.

The estimates of damaged areas presented in Table 2 were calculated by the MRGIS. These estimates can be instantly recalculated for the entire state or any portion thereof as new data become available.

Figure 3. (refer to facing page) Detailed map depicting areas of seagrass containing propeller scars at Pine Island, Charlotte county, an area nominated for management action. Note the damaged area to the southwest (lower left) of the marina. South bound boats leaving the marina take a short cut across the shallow seagrass beds and cut scars through the seagrass. A marked deepwater boat channel (narrow band of blue) extends due west from the marina to open water and the Intracoastal Waterway. This information was supplied to the regional aquatic preserve manager and is being incorporated into a regional aquatic preserve management plan.

DETAILED PROPELLER SCAR DAMAGE TO THE SEAGRASS AREAS OF PINE ISLAND

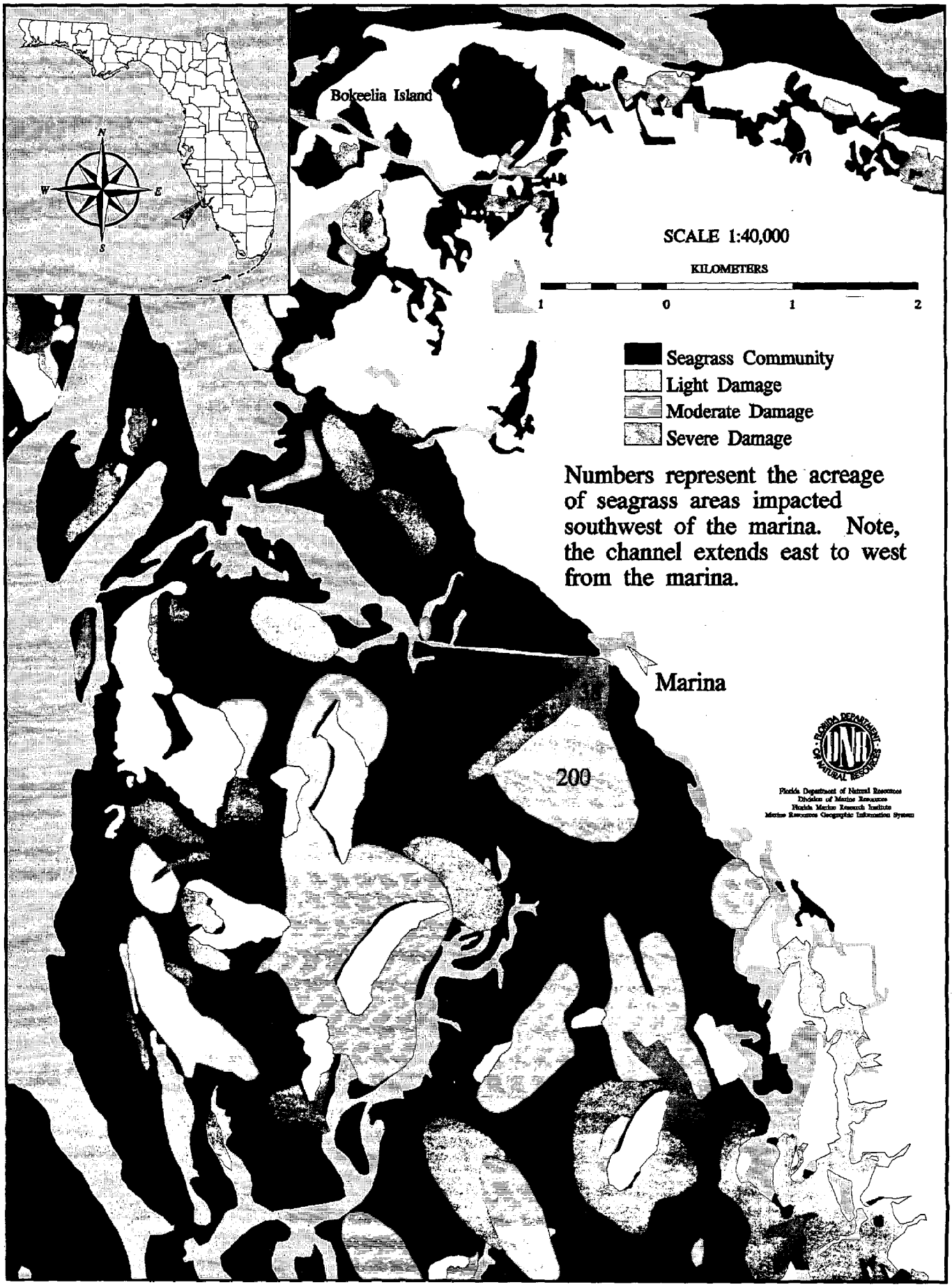


Figure 4. (refer to facing page) Areas of propeller scar damage at Windley Key, Monroe county, an area targeted for implementation of management action to protect shallow water seagrass habitats.

DETAILED PROPELLER SCAR DAMAGE TO THE SEAGRASS AREAS OF WINDLEY HARBOR, FLORIDA BAY

Coral Community	15
Bare Bottom Community	120
Hardbottom Community	1,785
Seagrass Community	12,552

Area Calculations in Acres

Light Damage	50
Moderate Damage	181
Severe Damage	232

Table 2. Areas of seagrass identified to have been impacted by boating activities in Florida counties. Unit of measurement is acres. Light damage is defined as scars occurring in up to 5% of the identified area; moderate damage is scars occurring in 5% to 20% of the identified area; heavy damage is scars occurring in more than 20% of the identified area. Counties west of Dixie County and a small portion of Monroe County were not yet surveyed at the date this report was compiled. These data are preliminary and subject to refinement.

COUNTY	AREAS OF SEAGRASS IDENTIFIED		
	LIGHT	MODERATE	SEVERE
Brevard	4,878	2,300	15
Broward	1	0	0
Charlotte	2,251	6,117	239
Citrus	5,676	1,480	0
Collier	2,182	1,603	110
Dade	3,587	4,466	4,053
Dixie	2,605	1,105	0
Hernando	793	759	4,194
Hillsborough	3,068	7,457	453
Indian River	332	61	0
Lee	7,467	7,907	1,492
Levy	3,327	109	0
Manatee	4,485	2,719	475
Martin	22	5	0
Monroe	9,164	6,493	2,455
Palm Beach	89	36	0
Pasco	1,042	1,645	169
Pinellas	6,746	6,554	3,087
Sarasota	913	439	42
St. Lucie	45	46	0
Volusia	1,492	1,104	382

Task 3 Develop a final report and provide the results to resources managers with site specific recommendations for implementation of corrective measures.

The preliminary findings of this project were provided to several agencies during the actual course of the project. Many agencies were contacted in the beginning stages of this work and awareness of the issue created a demand for information as it was being collected. Several newspapers have written articles on the project and the issue of propeller damage. One article is presented in Appendix B. Miami public television station WLRM channel 2 requested some of the aerial video for inclusion in a documentary about environmental problems in the Florida Keys. Efforts aimed at educating the public through the news media will continue.

Specific management actions to protect the shallow water seagrasses of Windley Key, Monroe county, have been proposed and are discussed in detail in Appendix C. A map depicting the propeller damage around of Windley Key is provide as Figure 2. The southwest Florida Aquatic Preserves office utilized data from this study to develop an aquatic preserve management plan which incorporates measures to protect seagrass from propeller damage. An area of heavy damage in Pine Island Sound has been targeted for implementation of a management action (Refer to Figure 1). Assistance was provided to Pinellas County, Hillsborough County, and the Florida Park Service in the refinement of management plans for specific localities.

All these management activities are being incorporated in the Department's newly funded initiative on seagrass propeller scar damage management and education which is discussed below. A list of agencies which have expressed an interest in actively participating in this initiative is provided as Appendix D.

DNR Seagrass Propeller Damage Management and Education Efforts

Through the Coastal Zone Management Program a survey of propeller damage to seagrass has been conducted. It has taken almost 3 years from our perception that this was a growing and state-wide problem to receiving funding and conducting the survey. During this time-frame propeller damage to seagrass has become a state-wide issue. As a result of this survey, propeller damage to seagrass is one of the few coastal management issues that now actually has information available to assess the magnitude and distribution of a problem in order to develop sound management actions.

Recognizing the value of having the extent and spatial distribution of prop damage information, the Department of Natural Resources has committed resources to develop, test, and implement a state-wide management plan for propeller damage to seagrass during the next two years. This effort involves heavy interaction with local governments. A discussion of the Department's currently funded seagrass propeller damage management and education project as it was proposed is provided below. The DNR project builds upon the Coastal Zone Management

Program study and some critical portions have already been fulfilled by completing this study. Several other portions are already well underway.

A. Need

Seagrass meadows are one of Florida's most important submerged marine habitats and are critically important to productivity in shallow water areas of the State.

As Florida's population grows, the number of boats on the water increases. Propeller damage to seagrass beds has recently been recognized as a significant problem in Florida's shallow waters (we estimate tens of thousands of impacted acres). Concerns are being expressed, statewide, as public awareness to the problem grows. There exists no state-wide plan for managing propeller damage or for educating the public on the issues. A comprehensive state to local approach to management needs to be action oriented and tested.

B. Objective

To reduce impact of boat propellers to seagrass, thus reducing wetlands loss, through the development and implementation of a state-wide propeller damage to seagrass management plan that targets high resource impact areas. To develop a prototype public education instrument that focuses on educating boaters on how to minimize propeller damage to seagrass and brings awareness of the Management Plan to the public.

C. Expected Results or Benefits

Seagrasses are critical wetlands components of Florida's natural resources. Seagrass meadows provide a direct food source to herbivores, such as sea turtles and manatees, and to numerous organisms dependent on the detrital matter they produce. Because this habitat is subtidal and extensive in distribution, it provides a constant and expansive structural shelter for fish and shellfish important to the fishery and ecosystem. In addition, the complex food web and tremendous organism diversity and quality provide a major food source to all stages of many coastal species including the endangered manatee and several sea turtles. Seagrass meadows improve water quality by removing nutrients and by providing a baffle effect on waves and currents, which causes settling of suspended particles in the water column.

Florida has documented losses of seagrass ranging from 81% in Tampa Bay to 30% in Indian River Lagoon. These losses have been impacting estuarine dependent species and the overall quality of the affected ecosystems. Large scale losses have been attributed to dredge and fill activities and decreases in water quality. However while these issues are being addressed, propeller damage has been increasing due to the growing boating population and lack of a comprehensive approach to addressing the issue and educating the boating public. It is possible that loss of seagrasses due to propeller damage far exceeds the losses due to other factors.

This project will provide a comprehensive state-wide Management Plan, test the implementation of the Management Plan, monitor the results of the test implementation, and develop the consensus for state-wide implementation of the Management Plan. The results will be a reduction in loss of seagrass habitat due to boat propeller damage. In many areas regrowth of seagrass can be expected thus increasing the contribution of this important habitat.

D. Approach

A six step approach to accomplishing the objective is proposed.

1. Determine the magnitude and locations of propeller damage state-wide. Schedule: This has been accomplished with completion of the Coastal Zone Management Program funded survey.

2. Develop a comprehensive state-wide management plan that incorporates the knowledge from the state-wide seagrass propeller damage mapping efforts (see F). The Management Plan will include locator maps specifying the locations of impact, and evaluation and determination of the likely cause of impact (e.g. improperly marked or spaced channel markers, unmarked channels, negligence by boaters.), an evaluation and recommendation for management policy or remedial actions on either state-wide or local levels, and an evaluation and recommendation of the agency(s) that should implement policy (if needed) and remedial actions (e.g. increased channel marking, boater education). This management plan will be developed in consultation with the Department of Natural resources (Divisions of Law Enforcement, Marine Resources, Recreation and Parks, State Lands, and General Counsel), the Office of the Governor (Office of Planning and Budget), the Department of Environmental Regulation (Office of Intergovernmental Affairs), the Department of Community Affairs (Coastal Zone Management Office), and Pinellas, Dade, Sarasota and Monroe Counties (offices of marine resources and environmental management). Schedule: A draft plan will be fully developed by the 12th month of the project.

3. Test implementation of Management Plan recommendations in Pinellas, Dade, Sarasota, and Monroe Counties. A management plan has no demonstrable merit without commitment and accomplishment of actions. It will be very difficult to implement a state-wide comprehensive plan for reducing propeller damage to seagrass without a demonstration that recommendations can be implemented at the local level and that the net result is a reduction of impact. The Department will contract the proper county or other appropriate agency to facilitate implementation. Schedule: We propose to complete the components of the Plan for the regions that include the aforementioned counties within the first 4 months of the project and implement recommendations that cross the spectrum of impact reduction measures included within the Plan during the first year of the project.

4. Monitor results of the test implementation of recommendations. In order to determine

the effectiveness of the Plan, implementation sites must be monitored to determine if propeller damage is reduced. Aerial photography and videography will be used to document the status of propeller scars for selected sites in each county. Scars will be documented prior to a remedial action and will be documented 12 months after that remedial action. This will not be a controlled experiment but a simple measure of change in propeller scars. The Department has already conducted research to assess the methods for monitoring propeller scar damage in a separate project. The general effectiveness of remedial action can be determined by this cost efficient approach. Schedule: 12 months after remedial action at a selected site. This would extend to the end of Year 2.

5. State-Wide Plan Implementation: The success of the project is dependent on implementation of a state-wide plan that acknowledges the distributed roles and authorities of carrying out the plan. A consensus building process will be enacted during Year 2 to fully develop the action items of the Plan and establish the roles and authorities of the agencies. The Interagency Management Committee (a committee that addresses coastal management issues) will be used to provide the forum for consensus building at the federal, state, and local level and the forum for executive implementation of the Management Plan. Three workshops will be held to accomplish the goals. Schedule: Completion of Year 2.

6. A certain component of the Management Plan will be education and information distribution. We propose to develop a map series for distribution in the five test implementation counties. Information distribution concerning boating and habitat protection is an important factor in managing boaters for the reduction of impact to seagrasses. Using Geographic Information System (GIS) technologies the Department will produce accurate and informative maps that act as a pictorial magnet for getting information to the boater. Befits include boater access information, resource protection, and boater education. Seagrass propeller damage and other resource cautions (e.g. manatees) will be incorporated into the maps. We are currently producing a similar type of informational map for Tampa Bay in cooperation with the National Estuary Program and that would be a model for a propeller damage informational series. The opened color brochure would be an approximate 24"x36" map on one side and information and insets on habitat and species on the other. We also propose the prototype development of signs that would contain the same information. Sign placement would need to be determined. Schedule: The development and printing, the establishment of a targeted distribution method, and distribution of the informational series would occur during Year 1.

E. Location:

The plan will be state-wide while implementation testing and development of an informational series will occur in Pinellas, Sarasota, Dade, and Monroe Counties.

F. Relation to other projects

The Department is currently developing a state-wide assessment of propeller damage. Using aerial photography, aerial observations, and local expert knowledge, a delineation of low to moderate and moderate to high seagrass damage areas is being determined. The resultant information is being implemented on the Marine Resources Geographic Information System. Using GIS and cartographic techniques, the delineated areas of damage will be transferred from nautical charts into the Marine Resources Geographic Information System nautical chart map base. This provides a significant step in the development of the Management Plan. Interim propeller damage management actions have been instituted by the Department to minimize seagrass propeller damage in several small state managed areas in Pinellas and Monroe Counties. The National Estuary Program has facilitated some education and signage. Pinellas County has enacted some management actions in targeted areas. Numerous other federal, state, and local entities have been exploring enacting various forms of propeller damage management. This proposed project will comprehensively identify the areas to target for management and provide the forum to manage the effort state-wide in an interagency network that currently does not exist.

G. Public involvement

Public involvement is currently expressed through concern to government agencies. Development and distribution of the informational series will involve the public. The entire project is based on interagency coordination and cooperation from federal to local levels as outlined in the previous sections.

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Appendix A. Subcontractors report for the Florida Keys region.

DRAFT FINAL REPORT

MAPPING ASSESSMENT OF VESSEL DAMAGE TO SHALLOW SEAGRASSES IN THE FLORIDA KEYS, MONROE COUNTY

Submitted to: Florida Department of Natural Resources (DNR) - Frank Sargent, Project Manager, and the University of South Florida/Florida Institute of Oceanography, St. Petersburg, Florida

F.I.O. Contract #: 47-10-123-L3

Submitted by: Curtis Kruer, Consulting Biologist, Summerland Key, Florida

Date: March 23, 1993

Introduction

This project involved aerial mapping and assessment of vessel propeller dredging and scarring damage to mainly shallow seagrass habitats in the Florida Keys. The effort is part of an assessment by the Florida DNR Marine Research Institute of boat propeller damage to seagrass meadows around the coast of Florida. Rapid waterfront and recreational development in the Keys during the 1970s and 80s, a dramatic increase in the number and power of watercraft in the region, and the proliferation of liveaboards and jet-powered thrillcraft resulted in widespread impacts to shallow seagrass habitats (mostly less than 5 feet low water depth), especially in areas of soft substrates. The importance of healthy seagrasses in maintaining coastal water quality, stabilizing bottom sediments, recycling nutrients, and providing habitat for a variety of valuable finfish and shellfish is well documented. Disturbance of large fish and wildlife (especially wading birds) that utilize shallow seagrass flats by routine boating activity appears widespread but is little studied.

The area surveyed in the Keys extends from North Key Largo (Dade-Monroe County line) south and west to and including the Marquesas Keys, excluding

Everglades National Park (Figure 1). The Intracoastal Waterway forms the boundary between waters of Everglades National Park and the Keys for purposes of this assessment. The area of vessel damage was determined visually from the air and mapped onto the largest scale map or chart available utilizing the best fit polygon method of delineation. The degree of damage in each area was estimated and categorized as light, moderate, or severe. For a subset of sites additional information geared towards problem management was prepared.

Methods and Materials

Initial delineations were made onto navigational charts and topographic maps in the airplane as impacted seagrass areas were observed. Surveys were conducted from a Cessna 152 or 172 and began west of Key West, later proceeding east and up the Keys. Altitude was maintained at about 600' at speeds of around 80 - 90 mph. In the Lower Keys, transects were flown on a north-south orientation approximately 1,000' apart traversing the shallow water area between the Atlantic Ocean and the Gulf of Mexico. In the Middle and Upper Keys, due to a narrower shallow zone, mapping was conducted as the plane flew along the perimeter of shallow water flats and banks and over shorelines. An effort was made to map midday during optimum conditions of clear skies, low winds, and clear water.

Two or more prop scars or grounding sites in close proximity (within about 50') were deemed to represent a pattern and were enclosed in a polygon. About 1 acre was considered a minimum size for a polygon based on the scale of charts and maps used. Individual scars not enclosed in a polygon were drawn as a line and anchored on each end with an "x". The severity of impact within an area was based on a visually estimated degree of impact from prop dredging and displacement of sediment from the scars onto adjacent vegetated areas. A "Comparison Chart for Visual Estimation of Percentage Composition" provided by DNR was used to refine estimation of damage. Light impact (L) indicated that less than 5% of the polygon was impacted, moderate impact (M) indicated 5-20% of the area was impacted, and severe impact (S) meant more than 20% of the

area was impacted.

Collateral information used for mapping included 1991 color-infrared vertical aerial film (9" x 9" images, 1:12,000) of the Keys provided by DNR, 35 mm oblique aerials shot in recent years, and personal knowledge of the contractor. Ground-truthing by boat was used in a few locations to document the accuracy of delineations made and measure the width of representative scars.

In an effort to document why boating impacts were occurring a subset of sites were assessed for the probable cause based on observed boating activity, history of the area, and personal knowledge of the contractor. In addition, management recommendations were considered that would reduce or eliminate impacts at these sites.

Results and Discussion

As of the drafting of this final report a total of 18.9 hours of airplane time had been committed to mapping, from October, 1992 to February, 1993. All but the area from Islamorada south to Seven-Mile Channel had been mapped as of this draft, with the remaining area to be mapped as soon as weather and water conditions allow. Draft delineations and levels of impact recorded in the air were transferred onto clean charts and maps in the office and provided to the Florida Marine Research Institute. In addition to the area delineated and level of severity for each site, an identifying number in sequence from west to east was provided for inclusion in the computer mapping data base. Representative aerial photographs (35 mm slides) were taken of many impacted areas.

Nautical charts and topographic maps onto which delineations were placed were:

Marquesas Keys West topographic map (1:24,000, 1971)

Marquesas Keys East topographic map (1:24,000, 1971)

Cottrell Key topographic map (1:24,000, 1972)

Key West topographic map (1:24,000, 1971)

Chart 11441 (1:30,000, 1991) - Key West Harbor and Approaches

Chart 11445 (1:40,000, 1991)

side A - Bahia Honda Key to Sugarloaf

side B - Sugarloaf to Key West

Chart 11448 (1:40,000, 1990) Big Spanish Channel to Johnston Key

Chart 11442 (part, 1:80,000, 1981) - Sombrero Key to Sand Key

Chart 11449 (1:40,000, 1990)

side A - Matecumbe to Grassy Key

side B - Grassy Key to Bahia Honda Key

Chart 11463 (1:40,000, 1987)

side A - Elliott Key to Tarpon Basin

side B - Tarpon Basin to Matecumbe

Flight records for mapping follow:

Date	Area	Hours	Comments
10/08/92	west of Key West	2.0	
10/18/92	west of Key West	2.0	
11/19/92	Key West-Boca Chica	2.3	
12/12/92	Boca Chica-Sugarloaf	1.8	turbid water
12/13/92	Sugarloaf-Big Pine	3.0	
01/14/93	near Big Pine	3.8	with F. Sargent/DNR
02/11/93	N. Key Largo-Matecumbe	4.0	with F. Sargent/DNR

Approximately 700 individual impacted areas have been delineated to date along with a number of individual scars. Impacted areas range in severity from those with only a couple of scars to severely impacted areas with numerous scars and grounding sites and sizeable, previously vegetated areas filled by displaced sediment. In addition, storm generated wavewash and surge was documented, particularly in exposed locations, to erode old scarred areas further impacting adjacent seagrasses by burial. As noted by Matthews et al. (1991) virtually all seagrass banks and flats in the Keys have some prop scars with density generally greatest near developed islands and in areas of high

boating activity. All user groups are responsible to some degree with large commercial and recreational vessels (>25') responsible for the largest impacts and groundings and smaller vessels (<25') and personal watercraft responsible for numerous small scars and recently prop dredged channels in shoreline areas. Water depth of seagrasses impacted ranged from the high intertidal zone to about 5-6 feet deep at low tide. The deeper impacts were near commercial ports at Key West and Stock Island, northeast of Big Pine where trap boats shortcut through shallow channels, near Marathon and Islamorada where both large commercial and recreational vessels dock, and in and along the Intracoastal Waterway on the bayside of the Upper Keys.

Sediments in shallow seagrass beds subject to these impacts in the Keys are extremely variable. Conditions range from very fine, silt size material found on the edge of Florida Bay and in shallow embayments of the Lower Keys to coarse, well sorted material in open water banks. Fine materials are easily resuspended, emphasizing the value of bottom stabilization by healthy seagrasses. But even banks with deep, coarse sediments, including Porites finger coral banks like those found around Rodriguez Key in the Upper Keys and Pye Key and Key Lois in the Lower Keys, are heavily impacted with poor chance of recovery. Wave and current scour now prevents or retards the accumulation of fine sediments in these scars. Many prop dredged channels (i.e. north Niles Channel) now funnel currents altering sheet flow (and possibly animal movement) across flats and scouring bottom sediments, often to bedrock. Turbulence and sediment resuspension from regular, often near continuous, use of some prop dredged channels prevents revegetation and increases turbidity in the surrounding area. Sediment characteristics, usage, location, and energy regime appear to be factors that determine the speed of natural revegetation. Kenworthy et al. (1988) concluded that boat wake waves substantially elevate the bottom shear stress along shallow seagrass beds with possible implication for seagrass health. This wearing away of shallow seagrasses can be noticed along the edges of the open water oceanside access channels for the large sportfishing fleet in the Upper Keys, such as at Whale Harbor and Teatable

Relief Channels. In addition, surge and sediment resuspension on the bottom often occurs to a depth of 7 to 8 feet or more when commercial vessels hauling heavy traps ply local waters.

Most of the impacted areas mapped were defined as light impact but many, especially near developed islands, were assessed as moderately to severely impacted. Acreage figures of these areas are to be generated by the DNR once mapping is completed. Table 1 lists by site number the moderately impacted areas from a subset of sites (Lower Keys, Marquesas Keys to about Snipe Key, sites 1-255) for which additional information was collected. Table 2 lists the severely impacted sites from this same subset. This information is provided as an possible approach to closely examine the site specific basis of shallow water impacts for the purpose of management of the problem. Considered also for each site could be the history of traffic in the area and the type of craft responsible. Assessment of the probable causes of different impacts revealed the following (often more than one cause) reasons:

1. Vessels attempt to take shortcuts even though water of an adequate depth is available nearby or vessels simply pass through water too shallow for the draft of the vessel. These actions may be either accidental or purposeful. With the average size, draft, and power of vessels increasing in the Keys, locations where oversized vessels routinely plow through waters too shallow are becoming more widespread. The recent proliferation of "flats" boats in the Keys and competitive promotions by manufacturers of their vessels ability to run through very shallow or "skinny" water has resulted in an increasing in detrimental boating on shallow flats.

2. Vessels travel through marked channels with an inadequate number of markers or where the markers are poorly located, i.e. not as shown on charts or in or immediately adjacent to shallow water. If a boater passes on the wrong side of a marker located on the edge of a flat as opposed to further in the deep part of the channel, the boater may run aground. Most Keys boaters are not familiar with the Coast Guard required day marker symbols and numbering system and hence a single marker presents a problem if the boater is

unable to read the water. Many heavily impacted areas are in or near marked channels.

3. Illegal aids to navigation (i.e. PVC markers, reinforcing steel lengths, marker buoys) are widespread in Keys waters and proliferating rapidly. Only the individuals placing these markers know what is intended resulting in many boaters passing unexpectedly through shallows, often in an unsafe fashion. Many illegal aids are placed in very restricted passageways and some are still being placed to allow or encourage channel creation.

4. There is extensive shoreline development in the Keys adjacent to shallow seagrass flats. Much prop scarring is a result of boaters attempting to access shoreline residences that may or may not have a dock or from boaters recreating in shallows near residences. Although current rules limit new docks to waters greater than 4 feet in depth at low tide, there are many existing docks located in shallow water with poorly defined, if any, access channels. Many old channels in open water areas are subject to filling and are now maintained by prop dredging. Although docks cannot now be permitted in shallow water, illegal docks are often built leading to seagrass impacts. Many dredged canals leading from old subdivisions terminate in relatively shallow water causing access problems as population density and vessel size increases. High powered speed boats from residential areas race across very soft shallow flats with little regard for depth.

5. Hundreds of commercial marinas, boat and personal watercraft rentals, and public boat ramps are in close proximity to shallow seagrasses where few channel markers exist. The result is that boats are concentrated in and near shallow areas, with usage by large fish and wildlife probably decreased. The U.S. Fish and Wildlife Service (1992) determined that boating activity was adversely affecting wildlife resources (especially birds) in Keys wildlife refuges. It seems likely that most large, shallow water animals (i.e. tarpon, bonefish, permit, sharks, barracuda, snappers, stingray, eagle ray, cowfish, sawfish, bottlenose dolphin, small sea turtles, and manatee) view fast boats as predators, with the expected reaction. Although most information is

anecdotal, many commercial and recreational fishermen believe that boating activity affects the habits and abundance of fish in heavily traveled areas. Some of the worse prop dredged areas are near marinas catering to fishermen, where ample justification exists for providing safe, low impact boating.

6. Numbers of liveaboard vessels, both residential and commercial, have increased rapidly in recent years. Documented were problems of anchor and chain damage as vessels continually swing on anchor, keel and outdrive damage when vessels anchor in waters too shallow, and severe prop dredging by commercial liveaboards (principally spongers) when passing from one shallow bay or channel to another.

A review of Keys aerial photographs from the 1950s revealed that prop dredging has occurred here for a considerable period of time. But with an increasing and more affluent residential population, the increasing popularity of boating, fishing, and diving, and a vastly increased tourist population the problem has become much more widespread. Based on extensive experience of the contractor with the problem in the Keys it is obvious that just in the last few years impacts have spread and become a much more serious cumulative problem. New prop dredged channels continue to appear, some thousands of feet long, and now provide larger boat access into areas not previously heavily travelled. Many shallow flats and banks are now heavily eroded due to numerous scars and grounding events (i.e. large bank north of the east end of the Seven-Mile Bridge and banks north of Long Key Bridge).

Management Recommendations

The first step of identifying and managing this resource problem is now being taken by the Florida DNR and very timely considering the level of impact to these important public resources. Surprisingly, few if any new channel markers have been placed in Keys waters in recent years even though public sentiment has been strong in recent years that this effort is an important component of safe, low impact boating. New programs are currently underway in both John Pennekamp Coral Reef State Park and Lignum Vitae Key State Botanical

Site to prohibit motorized access onto shallow flats and treat prop dredging as damage to protected resources. Monitoring of the effectiveness of these and other management strategies, both from the air and on the water, is critical to their success. The Monroe County Department of Marine Resources is about to release a draft Boating Impact Management Plan that may be incorporated into the draft management plan for the Florida Keys National Marine Sanctuary. Ample opportunity and justification now exists to manage boating impacts in the Keys. Based on observations incorporated here a multi-faceted approach is necessary to deal with the wide range of user groups, activities, and physical impacts. Recommended is a 4-point approach that can form the basis for management to eliminate or significantly reduce the impacts at the moderately and severely impacted sites identified here and prevent an increase at those site only lightly impacted now.

1. Education

The Keys are one of the most popular diving and fishing destinations in the world with millions of visitors each year. The value of education about resource impacts is obvious but in an area where there is a continual influx of new visitors, and seasonal and permanent residents, there must be other mechanisms to insure compliance and accomplishment of resource management goals. Graphic aerial photography of vessel damage to seagrasses has proven useful in the past to educate managers, decision makers, and the public about the issue. Acknowledging the need to limit increases in vessel size, draft, and power in shallow areas, and reduce these in some areas should be an important educational goal.

2. Channel Marking

It is imperative that deviation be allowed from the Coast Guard requirements of signage and symbols that might preclude or discourage simple, easily installed and maintained markers with directional arrows. Conventional day markers are very useful in deep, open water channels and programs should proceed to relocate markers to the center of channels providing buffers along

the edges of adjacent seagrass flats. Day markers should be gated in most locations and extend well beyond the entrances to channels. In impacted areas where public funds are expended to protect seagrasses, mechanisms must be developed to require the use of channels. In sensitive areas marking should be designed to solve problems, not create new ones by improving or facilitating boater access. Illegal aids to navigation should be removed as criteria are established and new markers put in place. The resource benefits of an expensive marker system are negated if illegal markers continue to be widespread with ever increasing prop scarring around them. Benefits are also negated if extensive prop dredging and turbidity are allowed within marked channels.

3. Enforcement

Prop dredging and physical damage to seagrasses by vessels must be regarded as physical destruction of protected public resources. Considerable prop dredging in the Keys is willful, particularly where repetitive activities occur, and much of the rest is due to simple negligence. Interpretive education, warnings, and citations are requirements of a successful enforcement program. Voluntary compliance has not proven adequate in the past in the Florida Keys to solve resource problems.

4. Restricted Boating Areas

Programs currently being put in place by the Florida DNR (Pennekamp Park and Lignum Vitate Botanical Site) and the U.S. Fish and Wildlife Service (Lower Keys refuges) are good examples of moderate restrictions to protect sensitive resources from physical impacts while allowing compatible public access. Other shallow areas are being considered for management by the Florida Keys National Marine Sanctuary. Other very shallow channels, flats, and embayments in the Keys where there are little, if any, boating activity and seagrass impacts should be considered for access restrictions such as idle speed or no motor zones before problems develop. Monitoring of the success or

failure of these efforts is critical to future management of other seagrass areas where physical impacts and unacceptable levels of disturbance of shallow water fish and wildlife are occurring.

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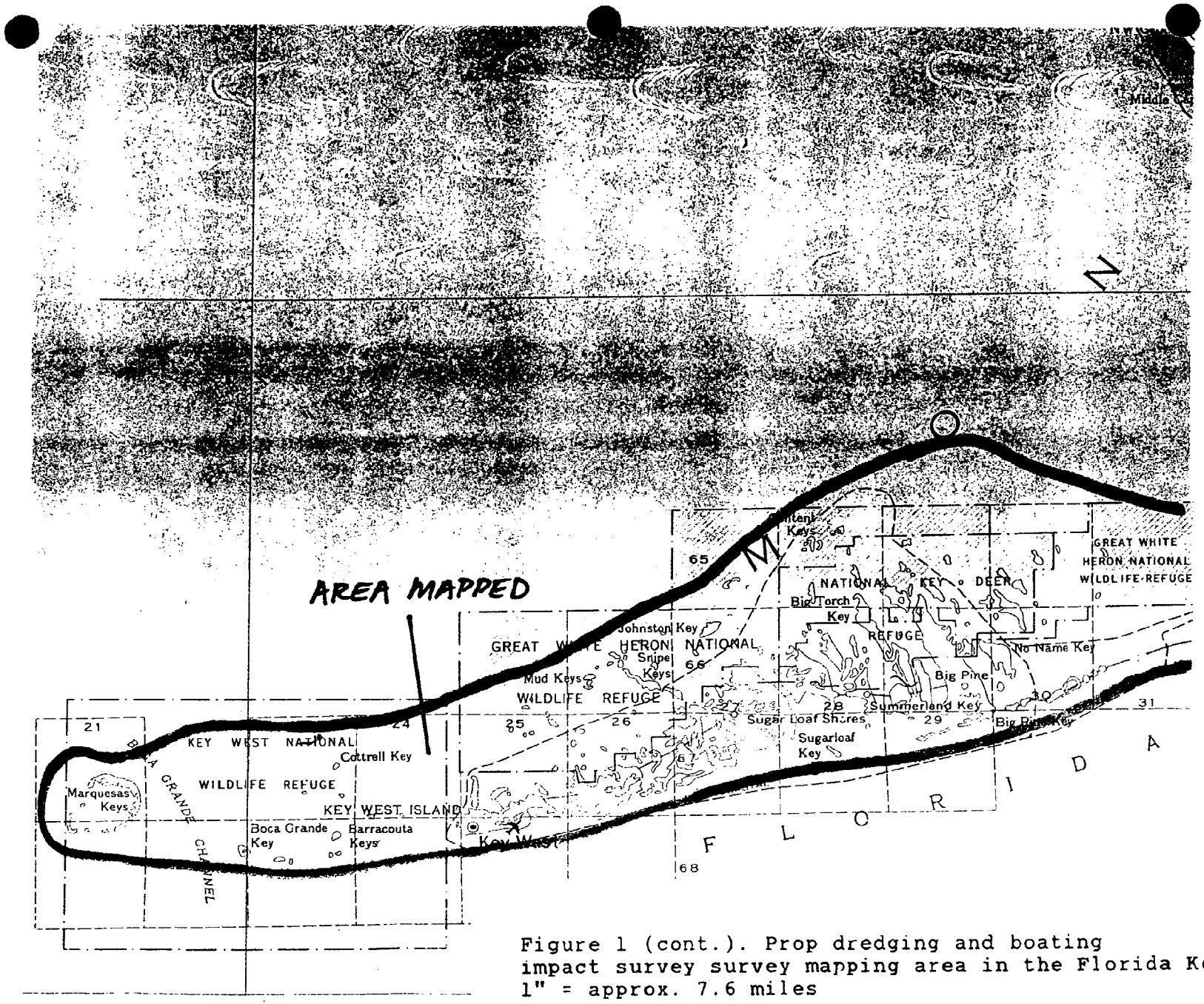

Figure 1 (cont.). Prop dredging and boating impact survey survey mapping area in the Florida Keys. 1" = approx. 7.6 miles

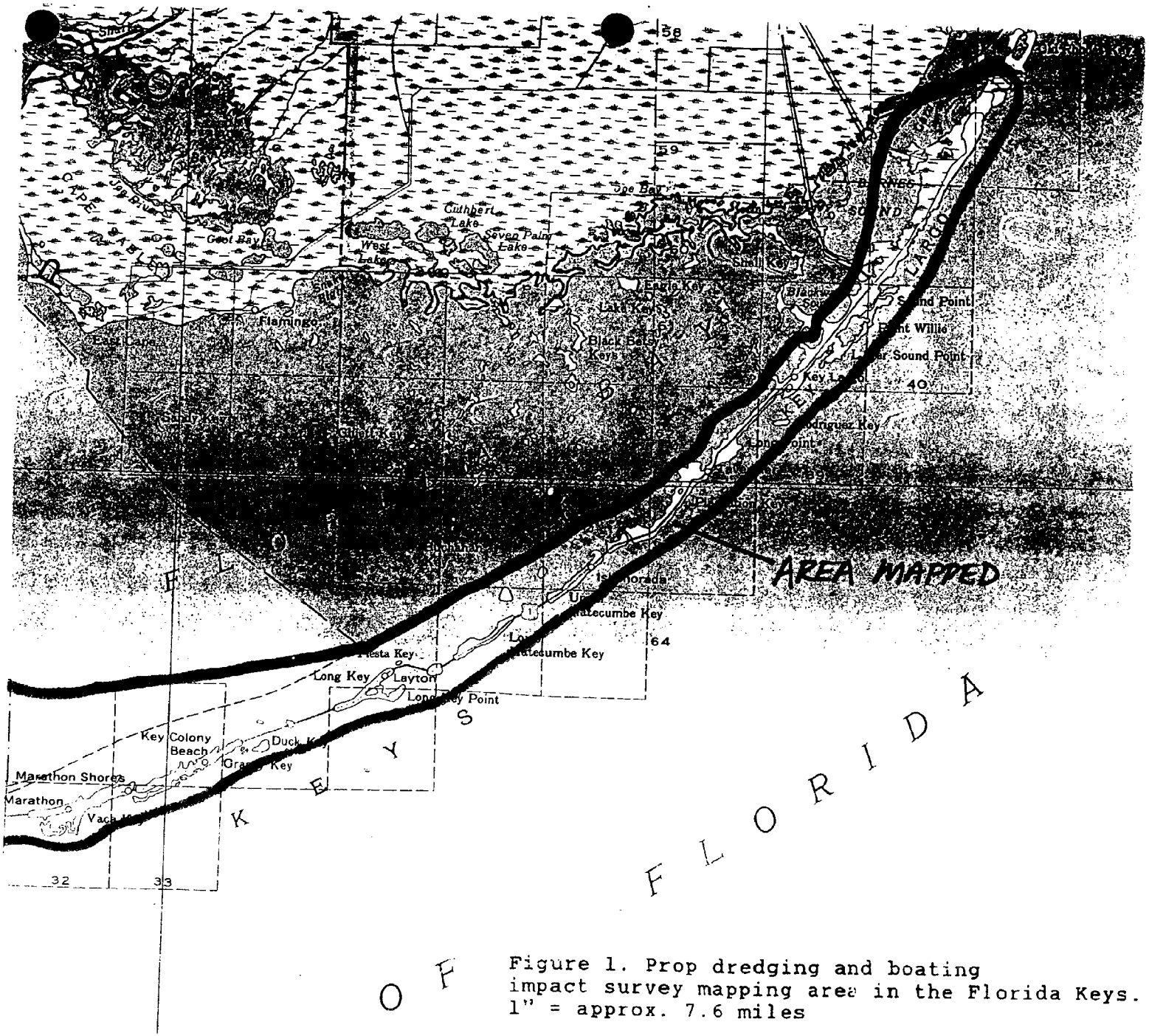

Figure 1. Prop dredging and boating impact survey mapping area in the Florida Keys. 1" = approx. 7.6 miles

Table 1. Prop dredging survey summary information for moderately impacted sites mapped from the Marquesas Keys to Snipe Key in late 1992 and early 1993 (draft).

Site #	Severity	Adjacent island	Probable cause[1]	Recomms.[2]	Comments
13	M	Marquesas Keys	S,A	E	Shallow channel between islands with popular beaches
15	M	Marquesas Keys	S,A	E	Shallow channel between 2 islands
32	M	Marquesas Keys	S,I	E	Entrance to natural channel
46	M	Boca Grande Key	S,CH	CH	At entrance to main channel, existing markers (#s 17 and 18) reflected on chart 11441 too far apart, marker 18 in shallow zone, vessels pass on shallow side.
50	M	Boca Grande Key	S,CH	CH	Markers #s 13 and 14 not located as shown on chart 11441
75	M	Archer Key	S,CH	EN,CH	Adjacent to single marker # 8 shown on chart 11441, oversize vessels; need gated markers.
105	M	Mule Key	S,CH	CH,EN	Confined area between channel markers, used by oversized vessels
113	M	Mule Key	S,CH	E	Area of concentrated traffic near channel markers
121	M	Key West	S	E	Isolated bank (Middle Grounds) in center of Northwest Channel
123	M	Wisteria Island	S,CH,L	E,EN,CH	Heavily traveled anchorage on west edge of Key West Channel
127	M	Fleming Key	S,CH	E,CH	Inadequately marked channel through large bank
142	M	Fleming Key	S	E,EN	On inside of several markers
145	M	Fleming Key	S	E,CH	On edge of main channel near marker
150	M	Key West	S,P	E,EN,CH	Outside of markers in access to Garrison Bight
151	M	Key West	S,CH,P	E,CH	Inside Garrison Bight, outside of partly marked dredged channel
152	M	Key West	S,CH,P	E,CH	Inside Garrison Bight, outside of partly marked dredged channel
155	M	Sigsbee Park	S	E,CH	At end of dredged area
156	M	Key West	S,A	E,CH	Boats accessing dredged channel
157	M	Key West	S,CH,P	E,EN,CH	Cow Key Channel, part marked, part not marked, high speed

1. S=shortcut, CH=markers, I=illegal aids, A=access, P=proximity, L=liveabor.
2. E=education, CH=new or improved markers, EN=enforcement, R=restricted area

Table 1. Prop dredging survey summary information for moderately impacted sites mapped from the Marquesas Keys to Snipe Key in late 1992 and early 1993 (draft).

Site #	Severity	Adjacent island	Probable[1] cause	Recomms.[2]	Comments
					traffic
163	M	Stock Island	S,P	E,EN,CH	Adjacent to Safe Harbor Channel
165	M	Stock Island	S,P,L	E,EN,CH	Anchorage east of Stock Island in Boca Chica Channel
166	M	Stock Island	P,L	E,EN	Anchorage east of Stock Island in Boca Chica Channel and near ramp
174	M	Boca Chica	S	E,EN	At entrance to dredged part of Boca Chica Channel
181	M	Bay Keys	S,I	E,EN	Commercial tour boats and recreational boats accessing Bay Keys from the south
201	M	Lower Harbor Keys	S,I	E,EN	Long, illegally marked channel
204	M	Channel Key	S,I	E	Part of old Backcountry Waterway
207	M	Channel Key	S,I	E,CH	Cut through bank between islands
223	M	Fish Hawk Key	S,I	E,CH	Cut through long linear bank
232	M	Geiger Key	S,I,A	E,EN	Shallow channel leaving residential canal
236	M	Saddlebunch Key	S,CH	E,CH	On bank near marked channel
238	M	Big Coppitt Key	CH,A	E,EN	Marked access to canal trailer park
245	M	Halfmoon Key	S,A,I	E,EN	Access to shallow embayment
251	M	Mud Keys	S	E,CH	Channel leaving Waltz Key Basin

1. S=shortcut, CH=markers, I=illegal aids, A=access, P=proximity, L=liveabor.
2. E=education, CH=new or improved markers, EN=enforcement, R=restricted area

Table 2. Prop dredging survey summary information for severely impacted sites mapped from the Marquesas Keys to Snipe Key in late 1992 and early 1993 (draft).

Site #	Severity	Adjacent island	Probable[1] cause	Recomms.[2]	Comments
7	S	Marquesas Keys	S	E,EN	From large vessel in early 1980s, now enlarged
129	S	Wisteria Island	S,CH,L	E,EN,CH	heavily traveled anchorage on east side of Key West Channel
138	S	Fleming Key	S,I	E,CH	At shallow end of a natural channel
158	S	Stock Island	A	E,EN	Boats accessing residential area in shallow water
160	S	Key West	A,L	E,EN	Cow Key Channel liveaboard anchorage and Cow Key Channel south of bridge
170	S	Stock Island	S	E,EN,CH	Large vessels shortcutting into Boca Chica Channel
231	S	Geiger Key	S,I,A,P	E,CH,EN	Access to Geiger Key Marina and area

1. S=shortcut, CH=markers, I=illegal aids, A=access, P=proximity, L=liveabor.
2. E=education, CH=new or improved markers, EN=enforcement, R=restricted area

Appendix B. Copy of a newspaper article discussing the problem of propeller scars in shallow seagrass beds. Kevin Lollar, Fort Myers New-Press, January 2, 1993.

Boaters 'cutting their own throats'

Props rip sea grasses

By KEVIN LOLLAR
News-Press staff writer

From the boat on the clear water off Pineland, it doesn't look like much to worry about.

Just a long, white, sandy strip where the turtle grass doesn't grow — a prop scar from a power boat.

"Boaters who go out and cut up sea-grass beds are really cutting their own throats," said Robert Repenning, manager of the Southwest Florida Aquatic Preserves. "Most of those boaters are out here to fish, and without sea grasses, you won't have nearly as many fish."

It's the old food-chain thing. Sea

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GRASS: Provide food and shelter

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grasses provide habitat for many small creatures, which are eaten by larger creatures, which are, in turn, eaten by even larger creatures, such as snook, sea trout and redfish.

One square meter of sea grass, for example, can contain 3,000 polychates (small marine worms) and 1,500 amphipods (small crustaceans), important food sources on the lower end of the chain.

Besides that, two dozen species of shrimp, 148 species of algae, many species of crab (including blue and stone crabs), snails and other mollusks, sponges, and plenty more, live in sea-grass beds.

"We're talking a lot of productivity here," Repenning said. "If you follow it up the food chain, it eventually becomes valuable to us.

"For fish, sea-grass beds are a supermarket and a home. They provide food and shelter — little fish can hide to keep from being eaten by big fish. Sea-grass beds provide all the stuff fish need to get going."

Now, think about this: 70 percent of Florida's commercially valuable fish spend all or part of their lives in sea grasses.

Sea grasses also help keep water clear by trapping fine sediments and particles; they stabilize the bottom with their roots, much as land grasses prevent soil erosion; and floating sea-grass leaves carry nutrients to other areas.

Obviously, sea grasses are a vital part of Florida's ecosystem, but on both coasts, sea-grass beds are being cut to pieces by boaters. The Keys have the most seriously scarred grass beds — estimates go as high as 10,000 acres of prop damage.

Any heavily traveled shallow waterway, though, including the beds off Pineland, will be crisscrossed with scars.

Prop scarring is not just clipping the tops of sea grass with a propeller. It's plowing through the sediment, hacking up roots and all.

And when you talk prop scarring, you're talking almost exclusively about recreational boaters.

"A lot of people blame commercial fishermen because they see the commercial guys taking their boats into places recreational boats can't go," Repenning said. "But commercial boats can run in six inches of water and not scar the bottom. The commercial fishermen know where they can go without getting into trouble."

A small prop scar can take up to five years to heal; large scars can take 10 years.

In many cases, prop scarring arises from boater ignorance.

"A lot of people move down here from the Midwest, where they're used to boating on the Great Lakes in hundreds of feet of water with deep-draft boats," Repenning said. "They put those boats in Charlotte Harbor and start running aground every turn they take.

"Unfortunately, to run a boat in Florida, all you need is money to buy or rent a boat. There's no skill required."

Many boaters don't know how to read the water. Many don't know, until too late, that water levels can change from a safe six feet to an unsafe six inches in an instant. Some areas aren't well marked, and even in marked areas, some people don't understand the markers.

Then, again, some people just don't care, said Jud Kenworthy, a research biologist for the National Marine Fisheries Service.

"There's just kind of an unlimited-access attitude that goes with being on the water," he said. "It's a big open space; you're free to go where you want to go out there. These people lack an understanding of the value of the resource."

Certainly, some boaters will say, "Hey, so what if I run my boat through a sea-grass bed? What harm's a little scar going to do?"

Lots, said Frank Sargent, a remote sensing analyst at the Marine Research Institute in St. Petersburg.

"It's really a major problem in Florida," he said. "Granted, you're going to have some areas that get scars and won't really be harmed, but it's the repeated scarring that does the damage. It takes a lot of time for sea grasses to get re-established, and some never do."

Sea grasses are constantly threatened by human activities — dredging and filling, oil spills, temperature changes from power plant discharge, various kinds of pollution.

Although the individual resident really can't do much about these threats, he or she *can* help sea grasses by simply not chopping up the grass beds with his boat.

"If you can't convince people with arguments about resource management, ask them how much they paid for their boat," Repenning said. "Sucking up a bunch of mud can just burn a motor up. And running aground can sure bang up your hull."

Florida Marine Institute

PATHS OF DESTRUCTION: Propeller scars slice like claw marks across sea-grass beds near Pine Island in this photograph taken from a Florida Marine Patrol plane. Most prop damage in grass beds is done by recreational boaters.

"We're talking a lot of productivity here. If you follow it up the food chain, it eventually becomes valuable to us."

ROBERT REPENNING
Southwest Florida
Aquatic Preserves

TIPS

- Read the water. Grass beds look like dark areas in the water. Polarized sunglasses help you see grass beds.
- Pay attention to channel markers.
- Use navigation charts: Sea grass is shown as light green or "Grs."
- Stay in deep water. If near shallow water, drive cautiously and slowly.
- If you do run aground, stop engine and tilt the motor up; pole or walk the boat back to deep water.

Appendix C. Site specific actions to manage and protect shallow water seagrass habitats in the Windley Key area. Proposed by Curtis R. Kruer, the subcontractor for the Florida Keys portion of this project.

DRAFT PROPOSAL TO MANGE AND PROTECT SHALLOW WATER SEAGRASS HABITATS IN THE WHALE HARBOR CHANNEL/WINDLEY KEY AREA

Background

The area proposed to be managed is in the upper Florida Keys (fig.1) and encompasses a variety of shallow marine habitat types as a result of the change form exposed ocean conditions to more protected waters of Florida Bay (Fig. 2). It also includes the most heavily prop scarred shallow seagrass area in the Florida Keys (Hunt et. al. 1991, pers. observs.). Recent comparison of aerial photographs of the area in the md 1980s to current conditions revealed substantial increases in prop dredging and the loss of seagrass cover on shallow flats and the edges of channels. Additional channels have been cut through very shallow water and mangroves by personal watercraft and small outboards. Intense boating and personal watercraft activity results form 4 commercial marinas, including the large sportfishing vessel fleet at the Holiday Isle and Whale Harbor marinas, located on either side of Whale Harbor Channel. Unregulated thrillcraft use from rentals at these and other marina occur virtually nonstop during daylight hours. Racing power boats are a common sight and powerboat races are routinely run in the area. Numerous illegal aids to navigation have been placed with some markers and signage evidently recently placed as a result of requirements on submerged lands leases.

The seriousness of physical impacts, the extent of sovereign lands, and the diversity of boating activity here all combine to create a management opportunity that, if successful, can be used as a prototype for management of other impacted areas. The fact that the area is outside of an otherwise protected park or preserve lends significance to a local, state, and federal effort to design and implement management.

Proposal to Manage Boating Impacts

1. The area (see attached NOAA chart) extending from beyond the seaward edge of the Atlantic Ocean seagrass flats north to the boundary of Everglades National Park should be managed as a unit. This area is about 5 square miles, including land area . A computer mapping data base would be necessary to define natural habitats, water depths, channels, and land based and marina facilities. Only one facility exists on the Florida Bay side of U.S. 1 here, the rest are on the Atlantic Ocean side. With available aerial photography (early 1971, 1983, and 1992), a historical perspective could be put on prop dredging and wave energy scour of seagrasses.

2. Management needs to be designed and implemented a sa collective "special area" effort by local, state, and federal agencies with responsibilities to protect and manage submerged natural resources. Specific goals need to be established at the onset, such as a reduction by 90% of new prop scars over a given time frame, eliminated boating accidents, and management without precluding

traditional uses of these waterways (transit, fishing, swimming). Monitoring of the effectiveness of the plan after implementation is critical to its success and its value as a precedent.

3. Requirements of state submerged lands leases need to be incorporated into this management plan and possibly modified to meet the needs of resource protection. Existing legal authority to protect public resources in these waters need to be clearly established an shortfalls identified.

4. The following four point plan needs to be incorporated into the overall management of the area. Seagrass protection programs being implemented at the John Pennekamp Coral Reef State park and Lignumvitae Key State Botanical Site, as well as elsewhere in Florida, should be reviewed.

a. Education

The management plan and its requirements need to be widely publicized in the vicinity with land based signage and literature provided at marinas and rental facilities. Conditions of state lands leases to the marinas could include a responsibility to insure future production and distribution of materials. Promoted has to be a recognition of the severe and worsening impacts currently resulting from man's activities. Promoted also must be the concept of the need for a radical change in the way shallow waters of the Keys are used. Individually, the activities may be relatively harmless, but the cumulative impact of numerous, often constant activities, and the productive habitats in which they occur are the root of the problem.

b. Channel Marking

Critical to the success of any plan is the marking of passageways for vessels to transit from marina facilities and docks to open waters of the Atlantic or Florida Bay. Virtually every access point through shallow waters (< - 4' MLW) could be managed with markers. A minimum number of markers should be placed but this depends on implementation of other points in the plan. A review of aerial photographs and navigational charts for the area show that the marking of 2-3 transit channels on each side of U.S. 1 could provide access to open waters (Fig. 2). Mark access, where adequate depths exist, from marina and other dock facilities along shorelines would be necessary to lead to the transit channels. It appears that additional conventional large day markers would be appropriate in the main oceanside channel while stout PVC with distinctive arrows would best for the other channels. Only the main channel into the ocean and the entrance to the marina basin at Holiday Isle currently has Coast Guard approved day markers.

c. Enforcement

Necessary to insure compliance with the plan and critical to meeting established resource protection and improved safety goals.

Increased attention to the area initially may be necessary. Simplified management would make for efficient and effective enforcement.

d. Restricted Boating Zones

Consistent with resource protection plans for similar state owned bottoms in waters of the Pennekamp and Lignumvitae areas is the concept of no combustion engine zones in water shallower than 3 feet deep at low tide (tops and edges of banks) and idle speed zones near shorelines and offshore from bank edges. In combination with marking, these management tools provide the means to stop prop scarring in specific areas and provide safe access to an from marked channels (Hunt et. al., 1991). The Florida Keys National Marine Sanctuary Advisory Council has recently approved a resolution recommending setting idle speed zones within 600' of shorelines and the edges of seagrass flats in the Keys. Recent use of shallow areas as commercial watersports zones would be eliminated as incompatible with resource protection. Consideration should be given to making the main offshore channel to the ocean (about one mile long) an idle-speed zone to enhance safety and protect the bank edges from continued erosion and destabilization by large vessel wakes.

Appendix D. Agencies which have expressed an interest in actively participating in the Department of Natural Resources seagrass propeller scar damage management and education project.

Lee County - Department of Natural Resources
Chuck Litowski

Collier County - Department of Natural Resources
Mack Hatcher or Maura Kraus

Sarasota County - Department of Natural Resources
John McCarthy, Ed Freeman, Belinda Perry and George Tatge.

Monroe County Division of Marine Resources
George Garret and Doug Gregory

Pinellas County - Department of Environmental Management
Will Davis and Eric Fehrman

Florida Inland Navigation District.
David Roach and Brent Waddel

Jupiter Inlet District
Mike Rella

Brevard County Office of Natural Resource Management
Conrad White

Indian River County
Roland Deblois, Environmental Planner

Martin County
Mark Tamblyn, Environmental Planner