Assessment of Boat Propeller Scar Damage within the Greater Charlotte Harbor Region

Cooperative Agreement between the Charlotte Harbor National Estuary Program and the Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute

Produced by Grantee: Florida Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
100 Eighth Ave. Southeast
St. Petersburg, FL 33701

Submitted by: Kevin Madley, Jim Krolick, and Bill Sargent

Prepared for: Charlotte Harbor National Estuary Program

Submitted to: Catherine Corbett

The Charlotte Harbor National Estuary Program is a partnership of citizens, elected officials, resource managers and commercial and recreational resource users working to improve the water quality and ecological integrity of the greater Charlotte Harbor watershed. A cooperative decision-making process is used within the program to address diverse resource management concerns in the 4,400 square mile study area. Many of these partners also financially support the Program, which, in turn, affords the Program opportunities to fund projects such as this. The entities that have financially supported the program include the following:

U.S. Environmental Protection Agency
Southwest Florida Water Management District
South Florida Water Management District
Florida Department of Environmental Protection
Florida Coastal Zone Management Program
Peace River/Manasota Regional Water Supply Authority
Polk, Sarasota, Manatee, Lee, Charlotte, DeSoto and Hardee Counties
Cities of Sanibel, Cape Coral, Fort Myers, Punta Gorda, North Port, Venice and Fort Myers Beach
and the Southwest Florida Regional Planning Council.

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Introduction

The Fish and Wildlife Research Institute (FWRI) of the Florida Fish and Wildlife Conservation Commission (FWC) performed this assessment of extent and severity of boat propeller scars in seagrass habitats under cooperative agreement with the Charlotte Harbor National Estuary Program (Charlotte Harbor NEP). Data compiled by the Florida Marine Research Institute for the 1995 report *Scarring of Florida's Seagrasses: Assessment and Management Options* (Sargent, F.J, et al.) found that Charlotte Harbor has been one of the most severely scarred areas of Florida. This document reports on a project that serves as an update to the 1995 work for the coastal portion of the Charlotte Harbor NEP study area and provides area resource managers with an analysis of the current extent, location and severity of boat propeller scarring. The survey area encompassed all estuarine waters within the Charlotte Harbor NEP boundary (Figure 1).

Submerged aquatic vegetation (SAV) is an integral part of the Charlotte Harbor estuarine system and an important natural resource that performs a number of significant functions. For example, seagrasses help to maintain water clarity, stabilize bottom sediments, provide habitat for many fishes, crustaceans, and shellfish, and they make up the food for many marine animals. Most importantly, these areas are the nursery grounds for most of Charlotte Harbor's recreationally and commercially important fisheries. The Charlotte Harbor NEP's Management Conference developed 2 goals specific to the preservation and restoration of submerged aquatic vegetation within the greater Charlotte Harbor watershed:

> **FW-2:** Meet the stated objectives for the target extent, location, and quality of the following habitats in the Charlotte Harbor NEP study area:
>
> a) native submerged aquatic vegetation should be maintained and restored at a total extent and quality no less than caused by natural variation; …
>
> and
>
> **FW-3**: Reduce propeller damage to seagrass beds, identified from the 1992-1993 baseline data, within the Charlotte Harbor NEP area by the year 2010. Reduce all severely scarred areas to light scarring and reduce 70 percent or more of the moderately scarred areas to light scarring.

The Greater Charlotte Harbor region has experienced a 29 % decrease in seagrass coverage since the 1940s (Harris et al, 1983). This seagrass loss is mostly within the southern portion of the study area and is believed to have originated from various causes, such as Sanibel Causeway Island construction, Intercoastal Waterway dredging activities, changes to water flow and quality characteristics (Harris et al, 1983). Boat propeller scars are also a cause of seagrass loss in the Charlotte Harbor system. Lee and Charlotte counties ranked 3rd and 4th among 31 coastal counties for the amount of scarred seagrass in data collected in the early 1990's (Sargent et al. 1995). As the amount of people settling in the coastal counties and the number of registered vessels continue to increase, the Charlotte Harbor NEP stakeholders need to know how the increase in boating activity may be affecting the SAV of the Charlotte Harbor region.

Propeller scarring of seagrasses usually occurs when boaters motor through water that is shallower than the drafts of their boats. The propellers tear some combination of the seagrass leaves, stems and roots, managing at times to remove the sediments, creating unvegetated, linear troughs of varying lengths (Figures 2 and 3). The amount of destruction from a scar-producing event depends on water depth and the size, speed, and path of the vessel. Some vessels create scars in areas at low tide that would not do so at high tides. Although linear features are most often associated with the term "prop scar," some areas of seagrass habitats have been completely denuded by repeated scarring. In other instances, a linear scar can become a larger feature if the sediments are scoured to undercut the seagrass bed. This erosion can result in detachment of large sections of seagrasses that then float away leaving behind patches of bare sediment wider than the original prop scar.

Sargent et al. (1995) listed nine situations that account for the vast majority of prop scars:

1) when boaters misjudge water depth and accidentally scar seagrass beds;
2) when boaters who lack navigational charts or the skill to use them stray from marked channels and accidentally scar seagrass beds;
3) when boaters intentionally leave marked channels to take shortcuts through shallow seagrass beds, knowing that seagrass beds may be scarred;
4) when boaters carelessly navigate in shallow seagrass beds because they believe scars heal quickly;
5) when inexperienced boaters engage in recreational or commercial endeavors over shallow seagrass flats, thinking that their boat's designed draft is not deep enough to scar seagrasses or that the design will prevent damage to their boat;
6) when boaters overload their vessels, causing deeper drafts than the boaters realize;
7) when boaters anchor over shallow seagrass beds, where their boats swing at anchor and scar seagrasses;
8) when boaters intentionally prop-dredge to create a channel, and;
9) when inexperienced boaters, ignorant of the benefits of seagrasses accept and mimic local boating behavior that disregards negative impacts to the environment.

Seagrass habitats are especially susceptible to prop scarring because they exist in shallow depths, generally less than 2 meters (6.6 feet). Sunlight is needed by seagrasses for photosynthesis, thus the affinity of the plants for shallow locations. Averaging only 2.1 meters (7 feet) in depth, Charlotte Harbor is relatively shallow and susceptible for high levels of prop scarred habitat (Stoker 1986).

The slowest Florida seagrass species to recover from prop scar damage, turtle grass (*Thalassia testudinum Banks ex König*), reportedly regrows into the scarred area within a range of 2-8 years in Florida (Dawes and Andorfer, 2002) with complete recovery reaching 10 years (Lewis and Estevez, 1988). Areas subject to repeated boat impacts may never have the opportunity to recover. Because seagrass habitats are known to be critical feeding and sheltering areas for wading birds, juvenile finfish, and shellfish,

cumulative scar damage results in reduction of valuable habitat. Decreasing productive habitat for wildlife to use may affect the condition of wildlife populations.

Methods

The methods used for this study follow those described in the 1995 report by Sargent et al. that were used to survey and map propeller scars around the coastline of Florida, including the Charlotte Harbor region. A combination of analysis of aerial photography and field observations during low elevation flights were used to collect the propeller scar extent and severity data, which was then converted into maps using a geographic information system (GIS). The process involved five main steps:

1) Collection and standardization of aerial photography appropriate for evaluating the seafloor within the study area.
2) Creation of draft maps through digital delineation of polygons that represent locations and degree of propeller scarred areas seen in the digital imagery.
3) Flights over the study area to edit the draft maps produced from Step 2.
4) Edits to the draft maps based on field observations in Step 3.
5) Quality control and assurance measures of the final maps with a geographic information system (GIS).

Descriptions of each of those five process steps follows:

1) Aerial photography of the entire study area was gathered, scanned, and georeferenced. Collection of the photography was originally funded by the Southwest Florida Water Management District (i.e. photographs from Venice through the northern tip of Pine Island) and the South Florida Water Management District (i.e. photographs from the northern tip of Pine Island through Estero Bay) for the specific reason of mapping SAV extent. The1:24,000 scale, natural color photography was flown in December of 1999. Mosaics were created from the scanned imagery, then converted to MrSID compression formats to decrease file sizes and allow for easier use of the imagery.

2) Delineation of the scarred habitat polygons was performed with ArcGIS 8.3 software. An image analyst was able to view the digital imagery and create polygons "on top" of the images. The polygons were coded as Light Scarring, Moderate Scarring, or Severe Scarring as illustrated in Figure 4.

3) After creating the draft maps showing polygons of scarred areas, flights were arranged for flying above the study area to evaluate the draft maps. The three flight surveys were conducted from light, fixed-wing aircraft (Cessna 172 from Andersen Aviation, LLC at Charlotte County Airport) during April and May of 2004. Flight altitudes varied from 1,000 to 1,500 feet. Flight speeds were maintained at 80-90 mph. Hardcopy map atlases were created so the flight researchers could easily view and edit the draft polygons as the flights proceeded.

4) Edits to the existing polygons were marked on the maps, then these edits were copied into the digital map using ArcGIS 8.3 software.

5) Several procedures were used to standardize this data with the data used in the Sargent et al. (1995) project. First, using the ERASE function in ArcGIS, a shoreline

layer from the FWC Marine Resources GIS was used to erase any portions of the scar polygons that overlapped with a land feature. This step was necessary to eliminate any polygon edges that would be coincident with the pre-existing shoreline of a larger scale (i.e. 1:40,000). Next, both the Sargent et al. 1995 data and the data created during this project were intersected with the 1999 seagrass data layers previously existing from projects of the SWFWMD and the SFWMD. With the ArcGIS INTERSECT function, only those portions of the scarred habitat polygons that are coincident with a portion of a seagreass habitat polygon remain. As a result, the remaining scarred habitat polygons contain only area that is seagrass habitat as known to exist from the seagrass mapping efforts of the SFWMD and the SWFWMD. A map of the scar polygons is shown in Figure 5.

It should be noted that by using the 1999 seagrass data to standardize the Sargent et al. 1995 data, in effect, we re-calculated the Sargent et al. data for the Charlotte Harbor NEP area. Thus, the acreage calculations, county rankings, etc. in the Sargent et al. study did not directly transfer to this study. This was necessary to be able to perform a reliable trend analysis for the amount of scarred habitat between the two studies.

Results and Discussion

Florida continues to be a popular destination for people re-locating from other parts of the world. The population of coastal counties in Florida continues to swell (Figure 6), with predictions for even more rapid growth during the next two decades when the "baby boomer generation" reaches retirement ages.

Associated with a growing population is the growing use of the natural resources of Florida's unique coastal areas. The amount of registered boats within the coastal area of the Charlotte Harbor NEP have more than doubled within each county, except Sarasota, in the period from 1980 to 2000 (Figure 7). Those numbers account for county registered vehicles only; many more boaters travel from outside the coastal counties to recreate among the seagrass habitats within the Charlotte Harbor NEP.

The scarred seagrass habitat in the 1993 results for Charlotte County, Lee County and the small portion of Sarasota County within the Charlotte Harbor NEP boundary amounted to 21,816 acres (Figure 8). In contrast, the amount of scarred seagrass habitat in the 2004 analyses increased to 30,064 acres (Figure 9). Results from this study indicate that the amount of seagrass habitat that has been affected by propeller scarring has increased 38% from 1993 to 2003. The amount of severely scarred seagrass habitat has increased 71%, while the amount of lightly scarred seagrass has declined 50% (Figure 10). Presumably, the decrease in lightly scarred area results from habitats that have been classified as light scarring in the previous study that are now contained within the areas classified as moderately and severely scarred.

For purposes of assessing status and trends of seagrass coverage within the Charlotte Harbor NEP boundary in another research effort, Charlotte Harbor NEP and FWC staff reported seagrass coverage by seagrass segments. The locations and names of the segments are illustrated in Figure 8. For this study, those same segments were used to assess the propeller scarred habitat data (Table 1; Figure 12). Trends in the percent gains/losses of scarred habitat should be reviewed with caution, especially for the river

segments. For instance, trends in the Lower Caloosahatchee River segment indicate a 100% decline in scarred habitat; however, the actual loss of SAV in the entire segment accounts for the 100% decline, not a decline in boating activity. Thus, changes in coverage of seagrass habitat in a segment may be partially responsible for changes in the percent gains or losses for the segments.

The amount of scarred habitat in Lee County is 14,312 acres compared to 7,443 acres in Charlotte County (Figure 13). While Lee County has nearly twice as much scarred seagrass habitat as Charlotte County, it should be considered that Lee County contains more than twice the amount of seagrass habitat as Charlotte County. Trend analyses by counties indicate that the amount of scarred seagrass habitat increased from 28% to 43% in Lee County and from 52% to 58% for Charlotte County.

Examinations of prop scar prevalence indicate areas around docks, marinas, channel edges, oyster bars, and mangrove islands are exceptionally susceptible to repeat scarring. These are areas that draw vessels on repeat trips and often over very shallow water. For example, the researchers in this project noticed that the edges of many mangrove islands and oyster bars were heavily scarred from boats using them as navigational aides to maneuver through the estuary. Likewise, channel edges are often locations of severe scarring because a high percentage of boats travel the channels with a minority of them actually missing the deepwater and scaring the channel edges.

Assessing the locations, extents, and severity of scarred habitats is an initial step in the process of conservation measures for these areas. Next, decisions must be made on what, how, and when steps need to proceed for reduction or elimination of the impacts to the seagrass habitat. Management considerations for reducing the impacts of propeller scarring fall within four categories: boater education, channel markers and other signage, enforcement, and limited-motoring zones. Discussion of each of the four options is included here as provided in Florida Seagrass Manager's Toolkit (Florida Fish and Wildlife Conservation Commission 2003):

(1) Boater Education

Efforts to educate boaters on the locations of shallow seagrass beds—and the importance of seagrasses to estuarine fish and shellfish communities—have been undertaken by many local governments, the FWC, FDEP, several National Estuary Programs and Estuarine Research Reserves, and the Florida Keys National Marine Sanctuary. "Boaters Guides," which include bathymetric charts showing the locations of shallow seagrass beds and other sensitive aquatic habitats, along with text explaining the importance of those habitats, have been developed for Apalachicola Bay, Biscayne Bay, Charlotte Harbor, Choctawhatchee Bay, Citrus County, Indian River Lagoon, Lake Worth Lagoon, Lee County, Saint Joseph Bay, Tampa Bay, and the Upper Florida Keys. Many of these guides can be downloaded from the FMRI website (http://www.floridamarine.org/products/products.asp) and are distributed in printed form by a number of organizations in the vicinity of each waterbody. Educational signs, which have been erected at a number of boat ramps, have also been used to provide information on the locations and importance of sensitive aquatic habitats in the vicinity of the ramps. The Citizens Advisory Committees (CACs) associated with several National Estuary Programs have implemented boater education programs in an effort to reduce boating

impacts to seagrass meadows and their inhabitants, including manatees. In the Tampa Bay region, multi-stakeholder users groups (e.g., the Cockroach Bay Users Group, at http://cbug.org) have been established for some portions of the bay where seagrass scarring has been particularly intense. One focus of these groups has been an effort to identify potential nonregulatory management actions that might be used to provide better protection for existing seagrass beds.

(2) Channel Markers and Other Signage

Efforts to provide more effective marking of navigation channels have been used in many parts of the state to reduce scarring caused by boaters who inadvertently motor onto shallow vegetated flats. Because seagrass beds in shallow waters can also be impacted by the erosive effects of boat wakes and pressure waves, signage designating slow-speed or no-wake zones has also been used as a protective measure in the vicinity of shallow grassbeds. In many cases channel marking and other signage has been used in combination with motor exclusion or caution zones to protect heavily-scarred areas, a multi-pronged approach that is described in more detail below.

(3) Enforcement of Boating Regulations

Experience suggests that many boaters will voluntarily obey regulations designed to protect seagrass resources, particularly if those regulations are developed through an inclusive, consensus-based process that includes an adequate level of public input. The results also suggest, however, that a certain percentage of boaters may tend to overlook, misunderstand or ignore such regulations. Consistent presence of enforcement personnel in areas of heavy boating activity appears to be one of the more effective tools available for reducing the potential impacts of this portion of the boating community on shallow seagrass habitats (Sargent et al. 1995). Sargent et al. (1995) also noted that mapping and monitoring of managed areas are essential for evaluating the effectiveness of management efforts, and suggested that regional or statewide management plans might be needed to provide adequate protection for large areas of seagrass habitat that fall within the jurisdictions of multiple local governments.

(4) Designation of Internal Combustion No-Entry or Slow-Speed Zones

Smith (1998) summarized 11 boating management areas that had been established in Florida prior to 1998 for the purpose of seagrass protection:

- Merritt Island NWR, No Entry Zone, Brevard County
- No Motor Power Zones Lee County
- Virginia Key, No Entry Zone, Miami-Dade County
- Pansy Bayou, No Entry Zone, Sarasota County
- J.N. “Ding” Darling National Wildlife Refuge, No Entry Zone, Lee County
- John Pennekamp Coral Reef State Park, No Combustion Motor Operation Zones, Monroe County
- Lignumvitae Key State Botanical Site, No Combustion Motor Operation Zones, Monroe County
- Gulf Islands GeoPark, Combustion Motor Exclusion Zones. Pinellas County
- Weedon Island Aquatic Management Area, Combustion Motor Exclusion and Shallow Water Caution Zones, Pinellas County

- Fort DeSoto Wetland and Aquatic Habitat Management Area, Combustion Motor Exclusion and Shallow Water Caution Zones, Pinellas County
- Cockroach Bay Aquatic Preserve, Combustion Motor Exclusion Zones, Hillsborough County

More recently, the Florida Keys National Marine Sanctuary (http://www.fknms.nos.noaa.gov) has designated a number of combustion motor exclusion and other protective zones to reduce boating impacts to seagrass and coral reef habitats in areas under its jurisdiction.

For additional information on how these four management options may be used, please refer to Sargent et al. 1995 and the Florida Seagrass Manager's Toolkit (Florida Fish and Wildlife Conservation Commission 2003). Both of these documents have been provided in digital format to the Charlotte Harbor NEP, as well as being available from the seagrass pages of the FWC website (http://research.myfwc.com/).

List of Project Deliverables

1) Aerial imagery mosaics covering the all of the estuaries in the Charlotte Harbor NEP boundary.
2) 1995 statewide propeller scar report (Sargent et al.) in digital format,
3) Seagrass Manager's Toolkit in digital format,
4) Prop scar locations and severity quick-reference pdf maps,
5) GIS data:
   a) 2003 prop scar habitat locations and severity,
   b) county boundaries,
   c) Charlotte Harbor NEP boundary,
   d) Charlotte Harbor NEP seagrass subbasins,
   e) seagrass habitat locations,
   f) shoreline,
   g) marine facilities,
   h) aids-to-navigation,
   i) bathymetry.

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	1993 Acres	2003 Acres	Gains/Losses (Acres)	Gains/Losses (Percent)
Cowpen Slough/Blackburn Bay				
Light	14	2	-12	-88%
Moderate	6	41	35	582%
Severe	0	4	4	NA
Lemon Bay				
Light	100	122	23	23%
Moderate	157	390	233	148%
Severe	111	339	227	204%
Placida Region				
Light	697	32	-666	-95%
Moderate	453	871	417	92%
Severe	8	518	510	6350%
Peace River				
Light	210	44	-165	-79%
Moderate	86	23	-64	-74%
Severe	0	0	0	NA
Myakka River				
Light	166	72	-94	-57%
Moderate	26	54	28	108%
Severe	0	4	4	NA
East Wall Charlotte Harbor				
Light	373	0	-373	-100%
Moderate	2,021	2,558	537	27%
Severe	68	19	-49	-72%
Middle Charlotte Harbor				
Light	1	32	31	5106%
Moderate	123	63	-60	-49%
Severe	0	0	0	NA
West Wall Charlotte Harbor				
Light	303	2	-301	-99%
Moderate	21	324	303	1430%
Severe	0	319	319	NA
South Charlotte Harbor				
Light	876	719	-157	-18%
Moderate	2,867	2,714	-153	-5%
Severe	190	1,434	1,244	654%
Pine Island Sound				
Light	1,946	1,718	-227	-12%
Moderate	4,543	5,178	634	14%
Severe	798	4,714	3,915	490%
Matlacha Pass				
Light	986	567	-419	-42%
Moderate	645	1,789	1,143	177%
Severe	73	1,979	1,906	2608%
San Carlos Bay				
Light	565	364	-200	-35%
Moderate	745	802	56	8%
Severe	190	1,120	931	491%
Lower Caloosahatchee River				
Light	113	0	-113	-100%
Moderate	77	0	-77	-100%
Severe	2	0	-2	-100%
Upper Caloosahatchee River				
Light	0	0	0	0
Moderate	0	0	0	0
Severe	0	0	0	0
Estero Bay				
Light	1,144	57	-1,087	-95%
Moderate	976	272	-704	-72%
Severe	136	806	669	490%
Total Scarred Seagrass Habitat	21,817	30,064	8,247	38%

Table 1. Acreages and percents of propeller scarred seagrass habitat by subbasins in the greater Charlotte Harbor region.

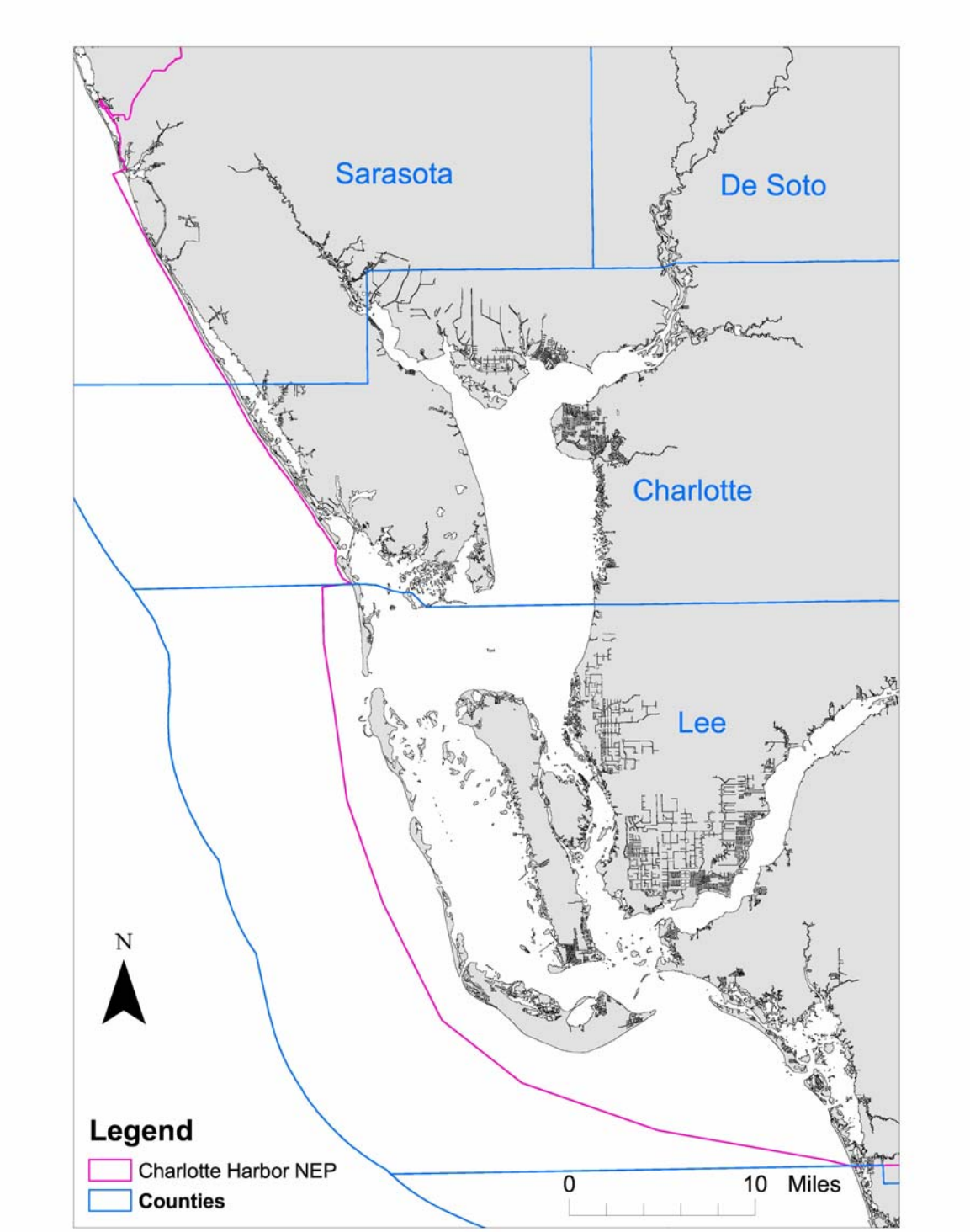


Figure 1. Coastal boundary of Charlotte Harbor National Estuary Program.

Figure 2. Example of a seagrass meadow in Charlotte Harbor with moderate and severe propeller scarring.

Figure 3. Close-up example of a propeller scars in a seagrass meadow in Charlotte Harbor. This example shows a location where scars from a twin prop vessel cross a scar from a single prop vessel.

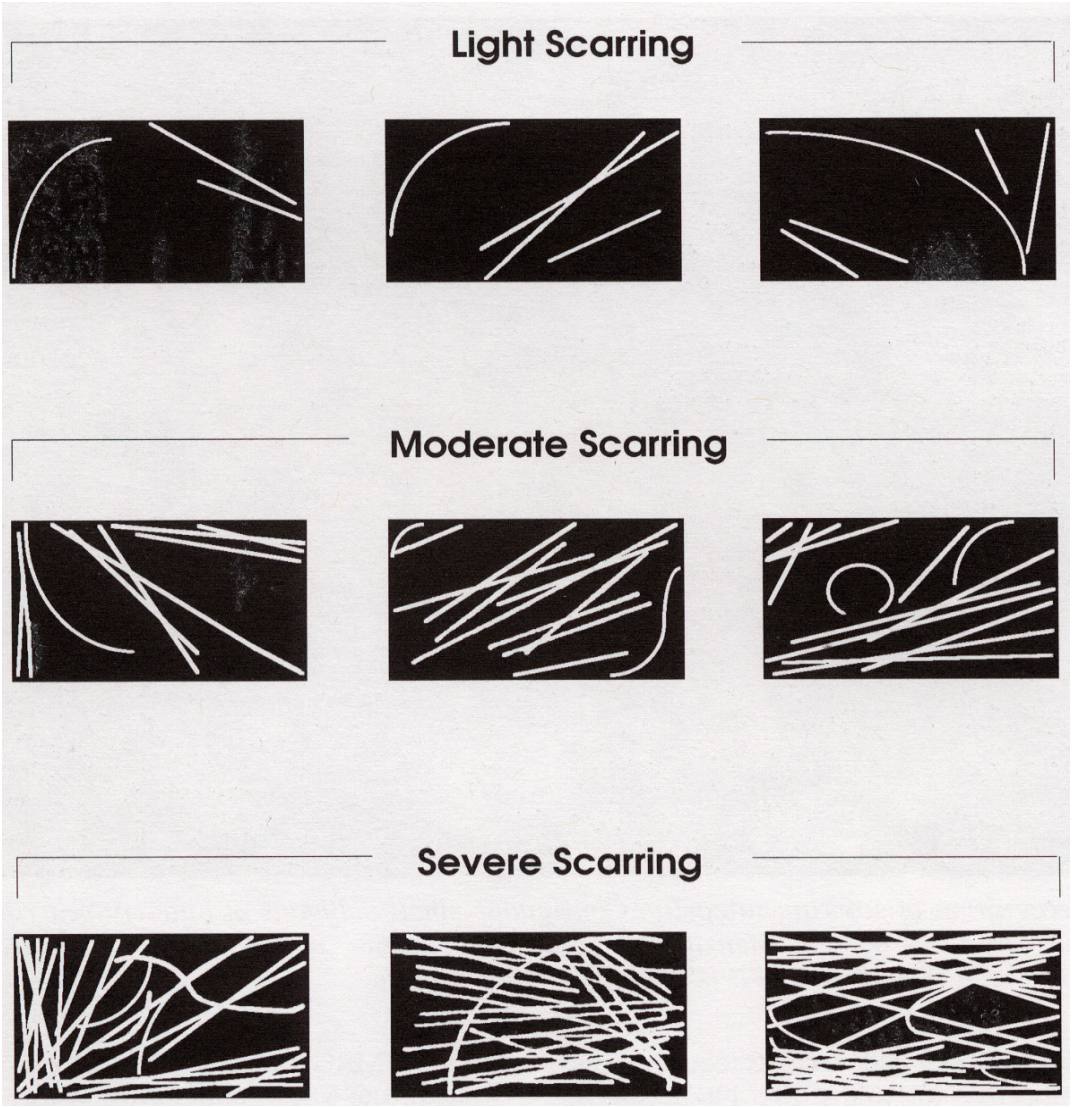


Figure 4. Diagrammatic representation of the three categories of estimated scarring intensity used as a guide for the delineation and classification of propeller scarred habitats (from Sargent et al. 1995). Black space within each block represents seagrasses, and white marks represent scarring. Light scarring is defined as the presence of scars in less than 5 percent of the delineated polygon, moderate scarring is the presence of scars in 5 to 20 percent of the polygon, and severe scarring as the presence of scars in more than 20 percent of the polygon.

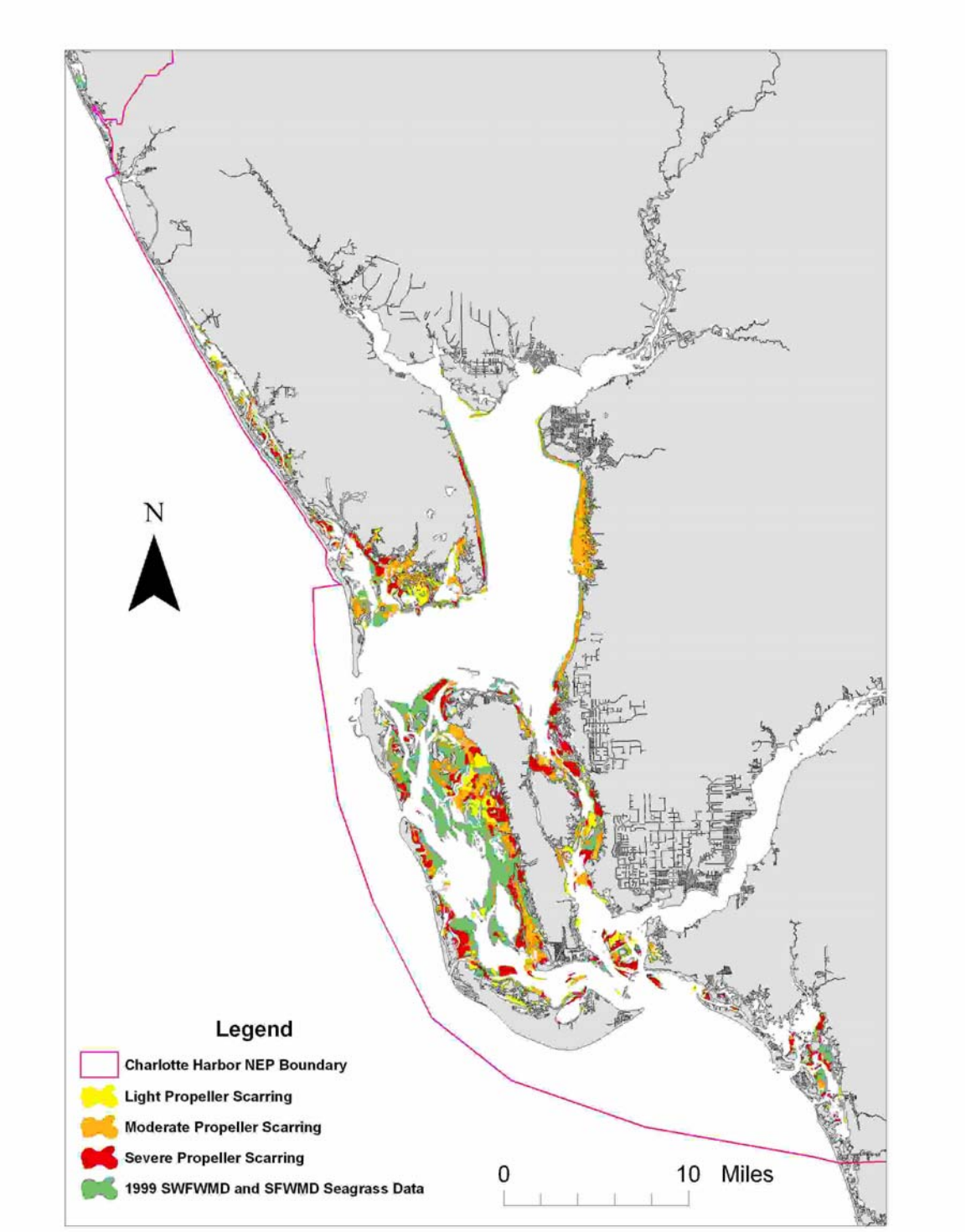


Figure 5. Map of propeller scarred seagrass polygons produced during this study.

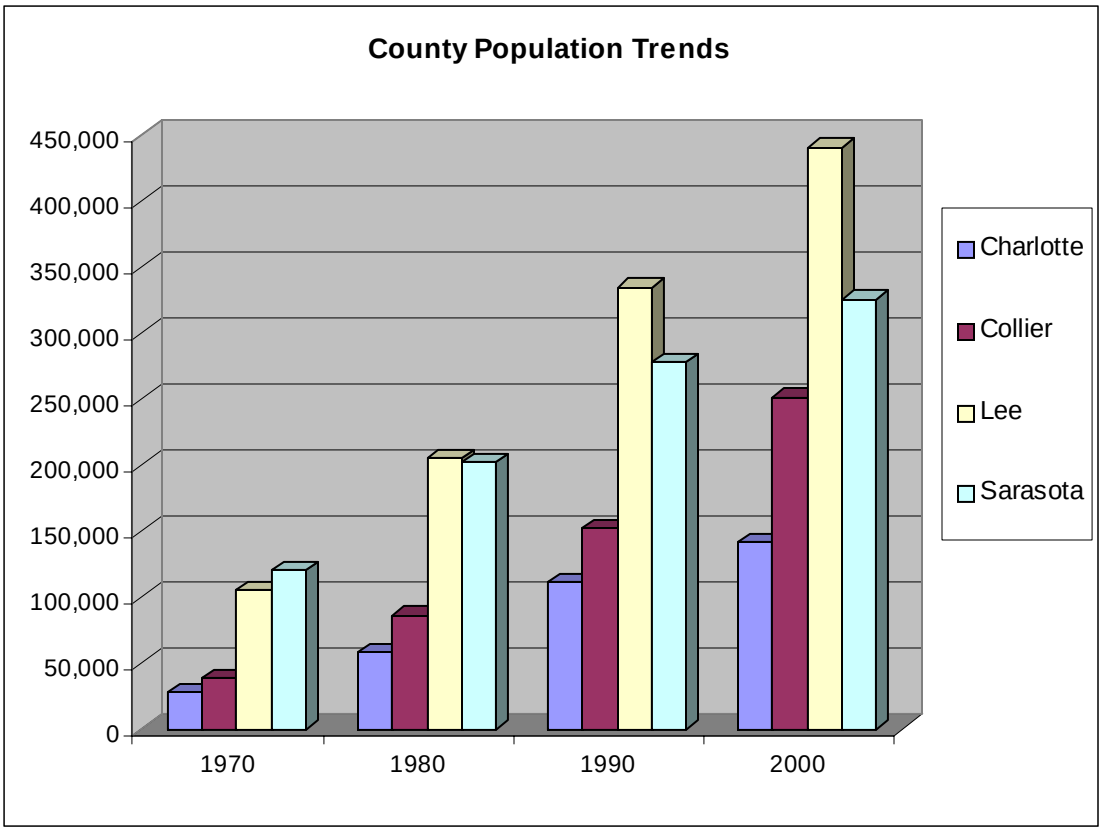


Figure 6. Population trends for the four coastal counties surrounding the Charlotte Harbor National Estuary Program boundaries.

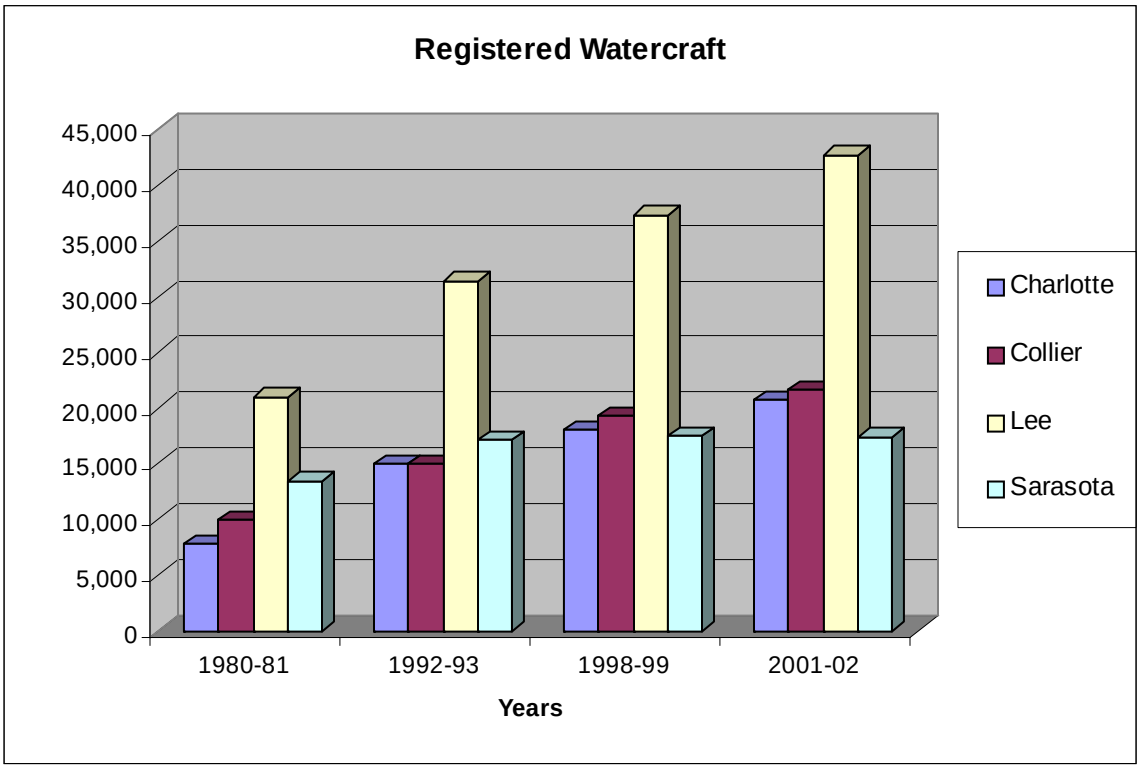
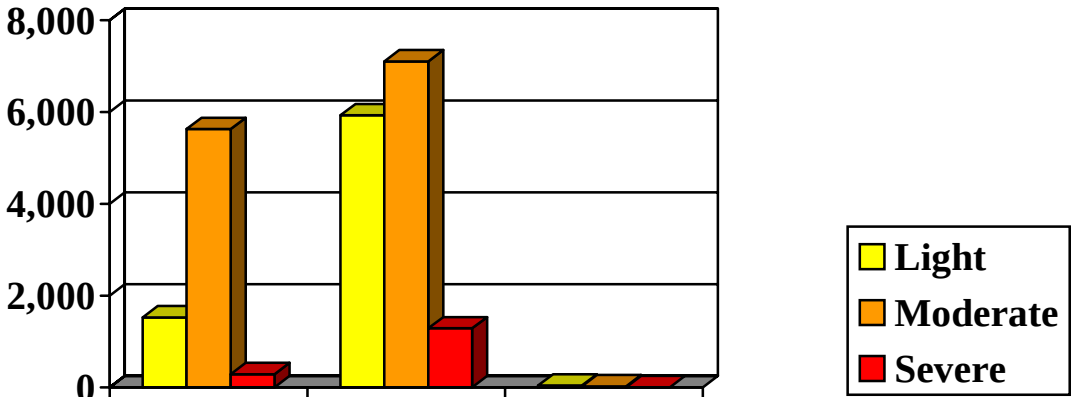
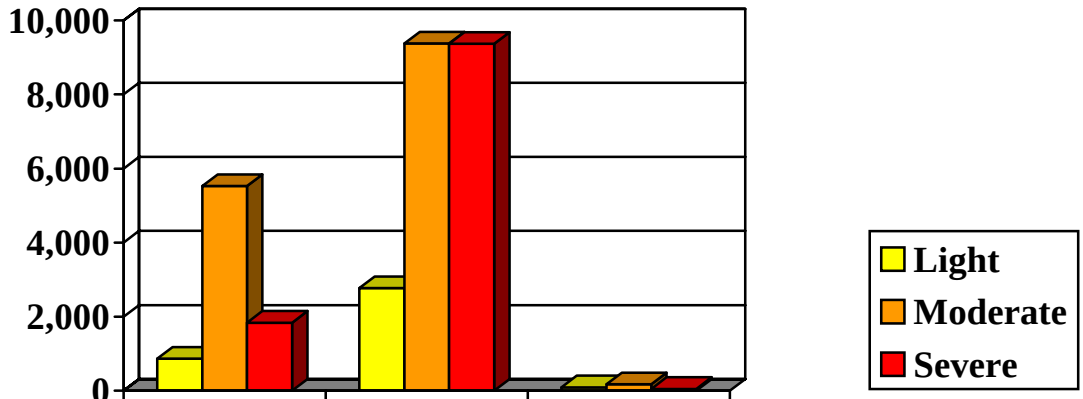


Figure 7. Numbers of registered watercraft (recreational and commercial) for the four coastal counties surrounding the Charlotte Harbor National Estuary Program boundaries.



	Charlotte	Lee	Sarasota
Light	1,529	5,925	39
Moderate	5,628	7,098	21
Severe	286	1,288	2

Figure 8. Amounts of propeller scar impacted seagrass habitat in 1993 per severity category within each county of the study area. The sum is 21,816 acres. Note: calculations for Sarasota county acreages were limited to the portion of the county within the Charlotte Harbor NEP Boundary.



	Charlotte	Lee	Sarasota
Light	869	2,768	95
Moderate	5,527	9,374	176
Severe	1,840	9,365	50

Figure 9. Amounts of propeller scar impacted seagrass habitat in 2003 per severity category within each county of the study area. The sum is 30,064 acres. Note: calculations for Sarasota county acreages were limited to the portion of the county within the Charlotte Harbor NEP Boundary.

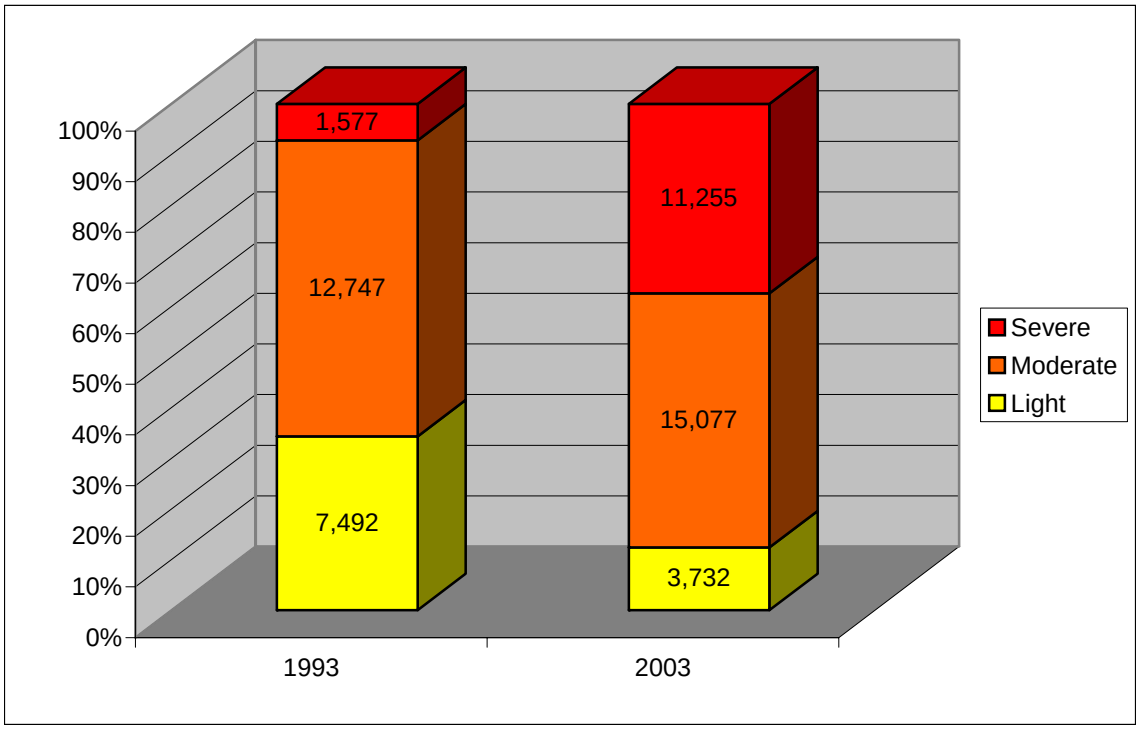


Figure 10. Amounts of seagrass habitat classified as severely or moderately scarred increased between 1993 and 2003. However, lightly scarred seagrass habitat declined in area between the same time period. The values in the columns represent actual acres of habitat in each category as measured within the Charlotte Harbor National Estuary Program boundary. The total scarred areas increased from 21,816 acres in 1993 to 30,064 in 2003.

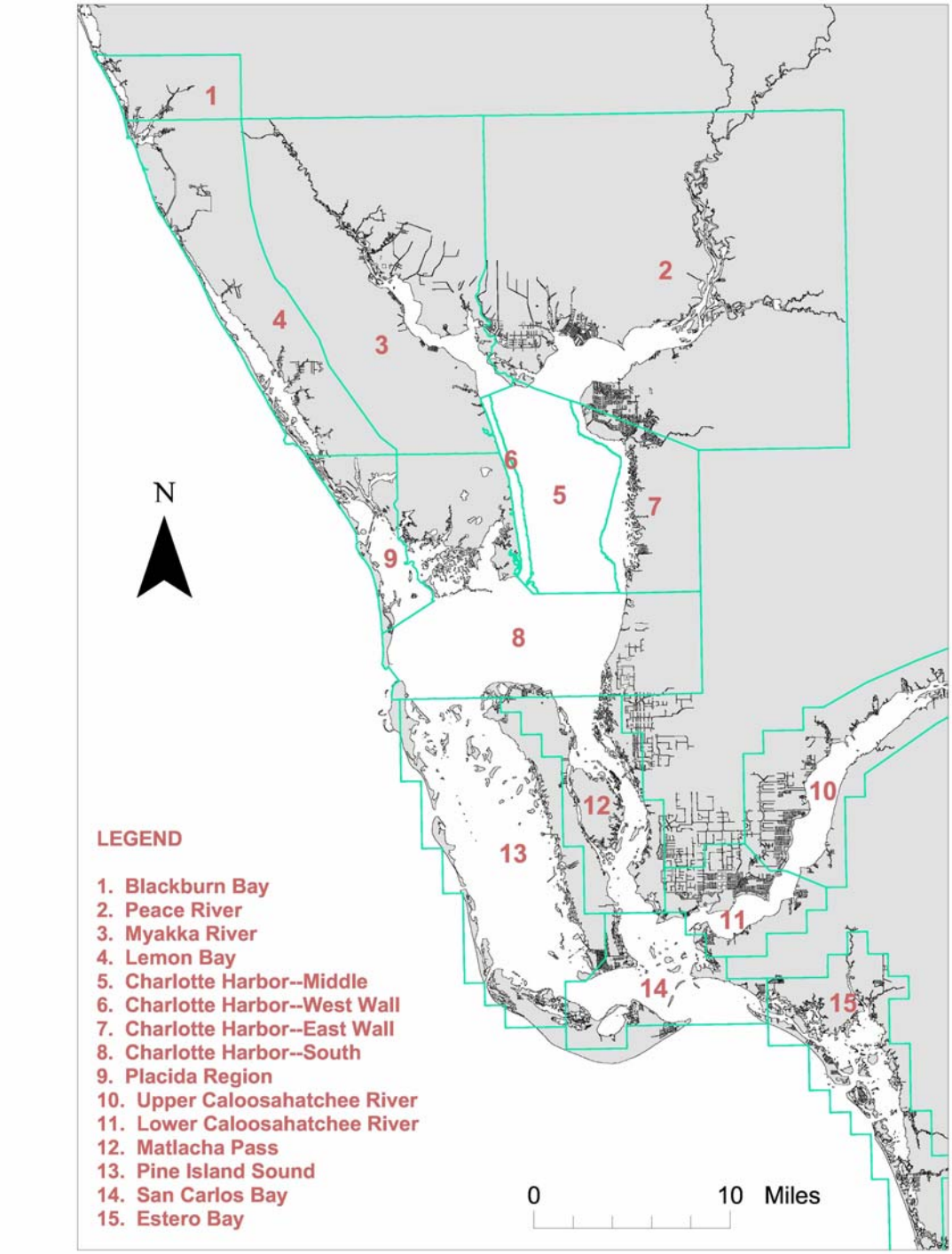


Figure 11. Locations and names of segments created for tracking and reporting of seagrass coverage in the greater Charlotte Harbor area.

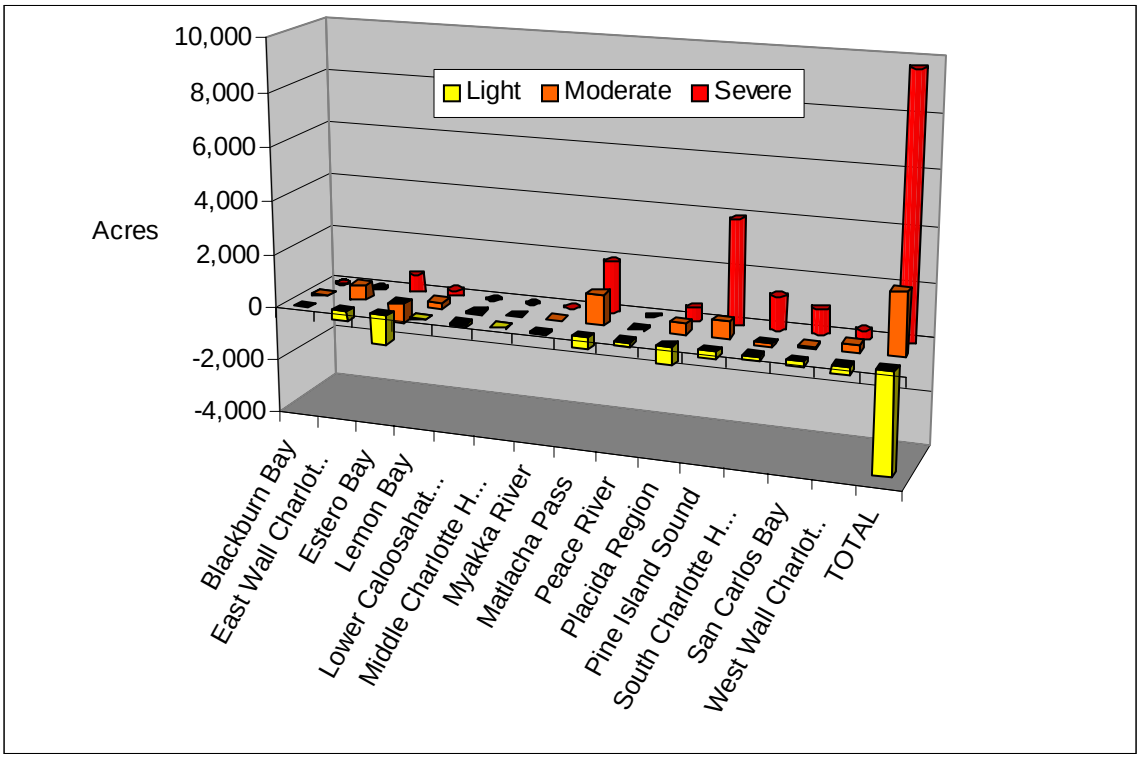


Figure 12. Comparison of propeller scarred seagrass habitat by segments in the greater Charlotte Harbor region. Total acreages per segment are represented by three component categories: Lightly scarred habitat, Moderately scarred habitat, and Severely scarred habitat.

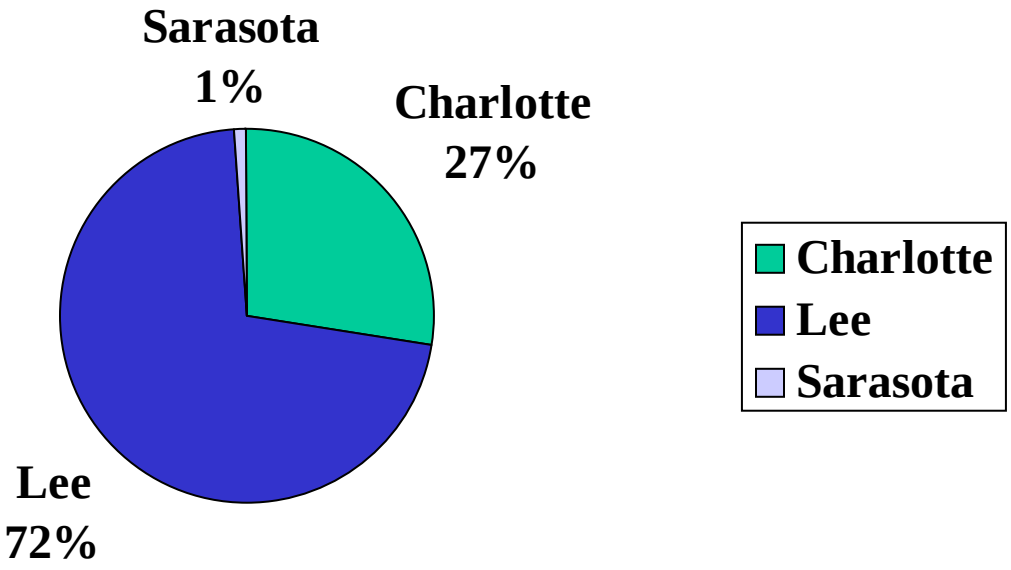


Figure 13. Percentages of scarred seagrass habitat within the Charlotte Harbor National Estuary Program. Acres of scarred habitat per county are Lee County = 21,507, Charlotte County = 8236, and Sarasota County = 321. Note: Sarasota county values are limited to the portion within the NEP boundary.