Sarasota Bay

By David A. Tomasko[1] and Gary E. Raulerson[2]

Background

Sarasota Bay first took shape approximately 5,000 yr ago (Estevez, 1992) as a result of the formation and development of offshore barrier islands during a period of continuing sea-level rise. The Sarasota Bay watershed (fig. 1) contains a number of archeological sites, including shell middens, sand mounds, and cemeteries of various prehistoric cultures, some of which date back to 10,000 B.C. (Deming and others, 1990).

During the 1870s, a resort hotel in Osprey was one of the first business ventures to take advantage of Sarasota Bay's wealth of natural beauty, although commercial fishing had occurred since the late 1700s (Whelan, 1992). During the period of 1895–1903, the first large-scale channel alteration activities took place in Sarasota Bay as the dredging project "Suwanee" enlarged or created channels at the pass out of Palma Sola Bay, at Longboat Pass, and in the area between Little Sarasota Bay and Venice (Whelan, 1992).

Population growth in the watershed has been dramatic, especially in the post-World War II years. For example, in 1989 the population of Manatee and Sarasota Counties together (an area which includes areas outside of the Sarasota Bay watershed) was estimated at 425,400 (Sarasota Bay National Estuary Program, 1995); by the year 1995, that number was at approximately 513,900. As population in these two counties was less than 150,000 in 1940, this change represents an increase of nearly four times in population in just over 50 yr.

During this period of rapid growth, much environmental damage occurred as a result of large-scale dredge and fill projects, such as the conversion of Bird Key into a finger fill canal community and the dredging (in the 1960s) of the Gulf Intracoastal Waterway. The dredging of the Gulf Intracoastal Waterway may have increased the hydrologic instability of Midnight Pass—the movement of which precipitated its permitted closure and subsequent failed reopening in winter 1983—which has altered circulation in Little Sarasota Bay (Sheng and Peene, 1992).

Water quality in Sarasota Bay is influenced by the area of watershed that drains into different parts of the bay. In the northern portion of the bay (hereafter Upper Sarasota Bay) (see fig. 2), 153 km^2 (59 mi^2) of watershed drain into 117 km^2 (45 mi^2) of open water. In the southern portion of the bay, 236 km^2 (91 mi^2) of watershed drain into 18 km^2 (7 mi^2) of open water. Thus, the ratio of watershed to open water in the northern part of Sarasota Bay is 1:3, while in the southern part of the bay this ratio climbs to 13:4, a roughly tenfold increase.

According to data from 1990, residential land use accounted for approximately 42% of the total watershed, while 36% of the watershed was a combination of forested upland, rangeland, and open/recreational uses (Heyl, 1992). Commercial and industrial land uses accounted for 10% of the watershed, and agriculture (cropland and citrus) accounted for 9% of the land. The remainder of the watershed (about 4%) consisted of wetlands and open water bodies (lakes and streams).

Scope of Area

In keeping with standard methodology for seagrass mapping efforts in Sarasota Bay, the study area is divided into five segments: (1) Sarasota County portion of Upper Sarasota Bay, (2) Manatee County portion of Upper Sarasota Bay, (3) Roberts Bay, (4) Little Sarasota Bay, and (5) Blackburn Bay (fig. 2). These delineations are coincident with mapping efforts and analyses dating back to 1988.

Methodology Employed To Determine and Document Current Status

Seagrass mapping efforts have played an important role in measuring the success and failure of maintaining and expanding on improvements to water quality in Sarasota Bay and other estuaries. These mapping efforts are conducted on a roughly biennial basis by the Southwest Florida Water Management District (SWFWMD), which conducts seagrass mapping to fulfill obligations under the comprehensive conservation and management plan (Sarasota Bay National Estuary Program, 1995) of the U.S. Environmental Protection Agency's National Estuary Program.

Seagrass maps are produced through a multiple-step process. First, aerial photography is obtained, usually in the

[1] PBS&J.

[2] Sarasota Bay National Estuary Program.

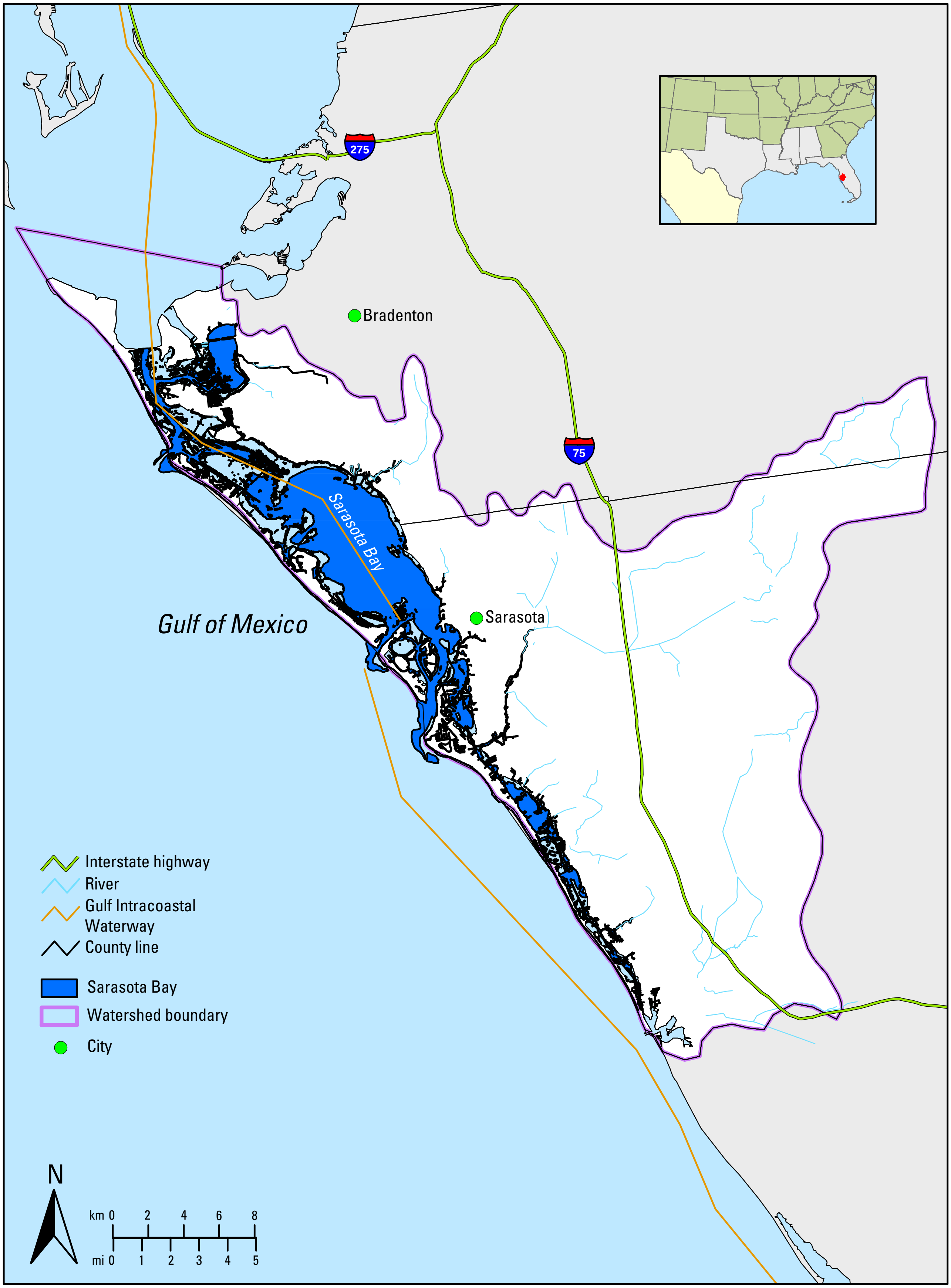

Figure 1. Watershed for Sarasota Bay.

late fall to early winter. This time of year is associated with good water clarity and relatively high seagrass biomass.

Second, photointerpretation efforts are conducted in the field to verify seagrass coverage suggested in the photography. The seagrass classification system is divided into two classes—continuous (<25% unvegetated bottom visible within a polygon) and patchy (>25% unvegetated bottom visible within a polygon)—with a minimum mapping unit of 0.2 ha (0.5 acres).

Third, polygons are integrated into an ArcInfo (Environmental Systems Research Institute, Inc., Redlands, Calif.) program. For some past efforts (i.e., 1988, 1990, 1992, 1994, and 1996), individual polygons were delineated onto Mylar® (DuPont Teijin Films) overlays, cartographically transferred by using a zoom transfer scope to U.S. Geological Survey (USGS) quadrangles, and then digitally transferred to an ArcInfo database for further characterization. These techniques allowed for the seagrass maps to meet U.S. National Map Accuracy Standards for 1:24,000-scale maps. For 1999 and 2002 seagrass maps, the 1:12,000-scale U.S. National Map Accuracy Standards were met. While photography remained at a scale of 1:24,000, the higher positional accuracy standard required the use of tighter ground control and more sophisticated mapping techniques. Analytical stereo plotters were used for photointerpretation rather than stereoscopes. This technique allowed for the production of a georeferenced digital file of the photointerpreted images without the need for additional photograph-to-map transfer. Rather than redrawing seagrass coverage polygons for each mapping year's efforts, the previous efforts' digital coverages were used as the baselines, and only the changes in seagrass coverage were mapped. Areas with no change between efforts are coincident with the earlier effort's coverage.

Fourth, hardcopies of plots are made of the photointerpreted seagrass coverage, and 60 randomly chosen points are identified for a classification accuracy assessment of the produced map. A hand-held Global Positioning System unit is used, along with the map and the latitude and longitude of the randomly located stations, to develop an unbiased determination of the map's classification accuracy. A 90% classification accuracy standard is required for these efforts; for example, 94% accuracy was achieved for 2002 efforts (i.e., 64 of 68 stations that could be visited had been accurately described in the map).

Status and Trends

For Sarasota Bay in 2002, the majority of coverage was in the northern portions of the bay, in the segments of Upper Sarasota Bay in Manatee County (62% of 2002 coverage) and Upper Sarasota Bay in Sarasota County (24% of 2002 coverage). Roberts, Little Sarasota, and Blackburn Bays contained 3%, 8%, and 3%, respectively, of the 2002 seagrass coverage.

In this study, historical seagrass changes between 1880 and 2002 were examined. The estimates for 1880 were based on the assumption that seagrasses grew down to approximately 2 m (6 ft) in water depth, which may be an underestimate of depth distribution in some areas and an overestimate of depth distribution in other areas. Estimates from 1950 were based on photography that was not groundtruthed or subject to intensive analysis based on geographic information systems. Therefore, estimates from 1988 to 2002 are more likely to be accurate than those from 1880 and 1950. Baywide, seagrass coverage declined from 1880 to 1950, with a further decline from 1950 to 1988. This decline was followed by a period of increased coverage which peaked in 1996, when values were 676 ha (1,671 acres) higher than in 1988, a 19% increase. Since 1996, coverage is down 462 ha (1,141 acres), an 11% decrease. Still, seagrass coverage in 2002 was 6% higher than in 1988. Despite evidence of a "leveling off" of seagrass coverage, the percentage of seagrass cover in the continuous coverage category has continued to increase since 1988.

In table 1 and the following text, changes in coverage on a more detailed basis for the years 1988 to 2002 are examined.

Upper Sarasota Bay in Manatee County

In the Upper Sarasota Bay segment in Manatee County, seagrass coverage increased from 2,213 ha (5,469 acres) in 1988 (see fig. 3) to 2,356 ha (5,821 acres) in 1994 (see fig. 4) and then to 2,541 ha (6,278 acres) in 1996 (see fig. 5), a 15% increase. Coverage declined from 1996 to 1999 (see figs. 5 and 6) to 2,312 ha (5,714 acres), a 9% decrease, followed by an increase from 1999 to 2002 (see figs. 6 and 7) of 13 ha (30 acres). Seagrass coverage in 2002 (see fig. 7) was 5% higher than in 1988.

Upper Sarasota Bay in Sarasota County

In the Upper Sarasota Bay segment in Sarasota County, seagrass coverage increased from 773 ha (1,909 acres) in 1988 (see fig. 3) to 850 ha (2,101 acres) in 1994 (see fig. 4) and then to 1,043 ha (2,578 acres) in 1996 (see fig. 5), a 35% increase. Coverage declined 209 ha (516 acres) from 1996 to 1999 (see figs. 5 and 6), a loss of 20%. From 1999 to 2002 (see figs. 6 and 7), seagrass coverage increased by 27 ha (106 acres). Seagrass coverage in 2002 (see fig. 7) was 13% higher than in the 1988 estimates.

Roberts Bay

In Roberts Bay, seagrass coverage increased from 134 ha (331 acres) in 1988 (see fig. 3) to 140 ha (345 acres) in 1994 (see fig. 4) and then to 145 ha (358 acres) in 1996 (see fig. 5), an 8% increase. Coverage declined between 1996 and 1999 (see figs. 5 and 6) to 136 ha (330 acres), followed by an additional decline of 26 ha (58 acres) between 1999 and 2002

Figure 2. Scope of area for the Sarasota Bay vignette.

Table 1. Seagrass coverage in hectares (acres) by year for segments of Sarasota Bay.

	1988	1994	1996	1999	2002
Upper Sarasota Bay, Manatee County	2,213 (5,469)	2,356 (5,821)	2,541 (6,278)	2,312 (5,714)	2,325 (5,744)
Upper Sarasota Bay, Sarasota County	773 (1,909)	850 (2,101)	1,043 (2,578)	834 (2,060)	877 (2,166)
Roberts Bay	134 (331)	140 (345)	145 (358)	136 (330)	110 (272)
Little Sarasota Bay	215 (532)	239 (591)	290 (717)	312 (770)	282 (698)
Blackburn Bay	166 (410)	166 (410)	162 (401)	151 (373)	122 (301)
Total	3,501 (8,651)	3,896 (9,628)	4,177 (10,322)	3,742 (9,247)	3,715 (9,181)

(see figs. 6 and 7). Seagrass coverage in 2002 (see fig. 7) was 18% lower than in 1988.

Little Sarasota Bay

In Little Sarasota Bay, seagrass coverage increased from 215 ha (532 acres) in 1988 (see fig. 3) to 239 ha (591 acres) in 1994 (see fig. 4) and then to 290 ha (717 acres) in 1996 (see fig. 5), a 35% increase. In contrast to all other bay segments, coverage increased from 1996 to 1999 (see figs. 5 and 6) by an additional 22 ha (53 acres), a 7% increase. From 1999 to 2002 (see figs. 6 and 7), seagrass coverage decreased by 30 ha (72 acres), a 10% decrease. Seagrass coverage in 2002 (see fig. 7) was 31% higher than in the 1988 estimates.

Blackburn Bay

In Blackburn Bay, seagrass coverage has shown a general pattern of decline over the period of record. Seagrass coverage was unchanged between 1988 and 1994 (see figs. 3 and 4) at 166 ha (410 acres). Between 1994 and 2002 (see figs. 4–7), coverage had declined by 44 ha (109 acres). Seagrass coverage in 2002 (see fig. 7) was 27% lower than in 1988 (see fig. 3).

Causes of Change

Historical losses of seagrass coverage in Sarasota Bay (i.e., post-World War II to 1988) are probably due to a combination of direct and indirect impacts associated with rapid urbanization of the watershed and of the edges of Sarasota Bay. It has been estimated that seagrass coverage declined by approximately 30% from the 1950s to 1988 (Sarasota Bay National Estuary Program, 2000). It must be noted that the seagrass coverage estimate for 1950 is an educated guess at best: the southern portion of the bay is characterized by reduced salinities that are associated with low water clarity, and it is likely that submerged vegetation could not be easily identified.

Increases in coverage between 1988 and 1996 (figs. 3–5) are thought to be mostly due to improvements in wastewater treatment practices in the watershed. Nitrogen loads from wastewater treatment plants were estimated to have declined from 516,188 kg/yr (1,138,195 lb/yr) in 1988 to 99,790 kg/yr (220,037 lb/yr) in 1999, an 81% decrease (Sarasota Bay National Estuary Program, 2000). Overall, nitrogen loads from all sources (i.e., point sources, nonpoint sources, atmospheric deposition, baseflow, and septic tank systems) are estimated to have declined by approximately 47% between 1990 and 1999 (Sarasota Bay National Estuary Program, 2000).

As a result of reductions in nitrogen loads, water quality has improved in nearly every portion of Sarasota Bay. Between 1968 and 1998, nitrogen and phosphorus concentrations declined in most parts of the bay, with no segments showing evidence of degradation (Dixon and Heyl, 1999).

A potential cause of the 1996–99 decreases in seagrass coverage in Sarasota Bay is the 1997–98 El Niño event, which caused annual rainfall amounts to be 20% to 48% higher than the 1988–99 average (as measured at Tampa International Airport). The excessive loads of nutrients and suspended

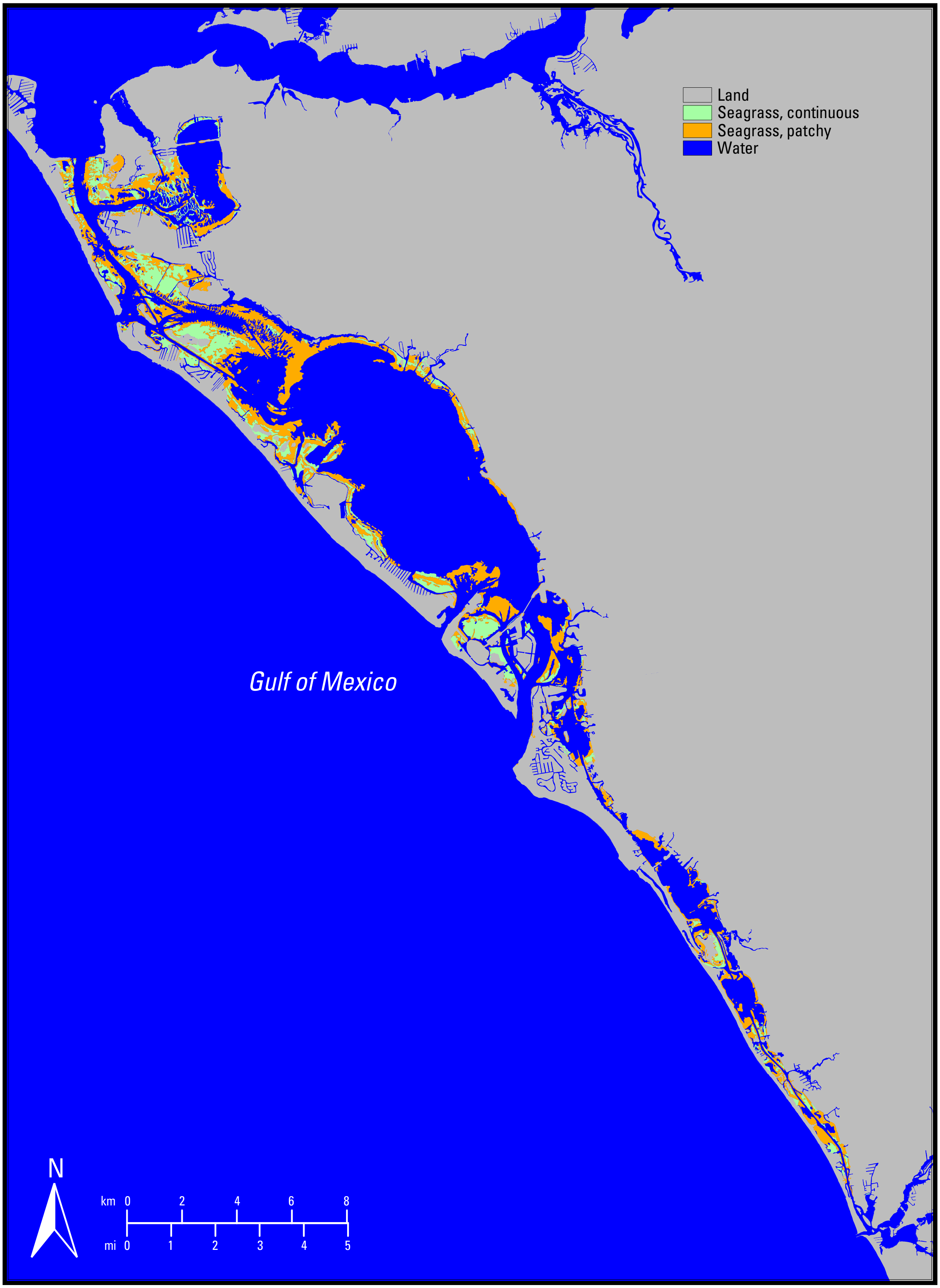

Figure 3. Distribution of seagrass in the Sarasota Bay system, 1988.

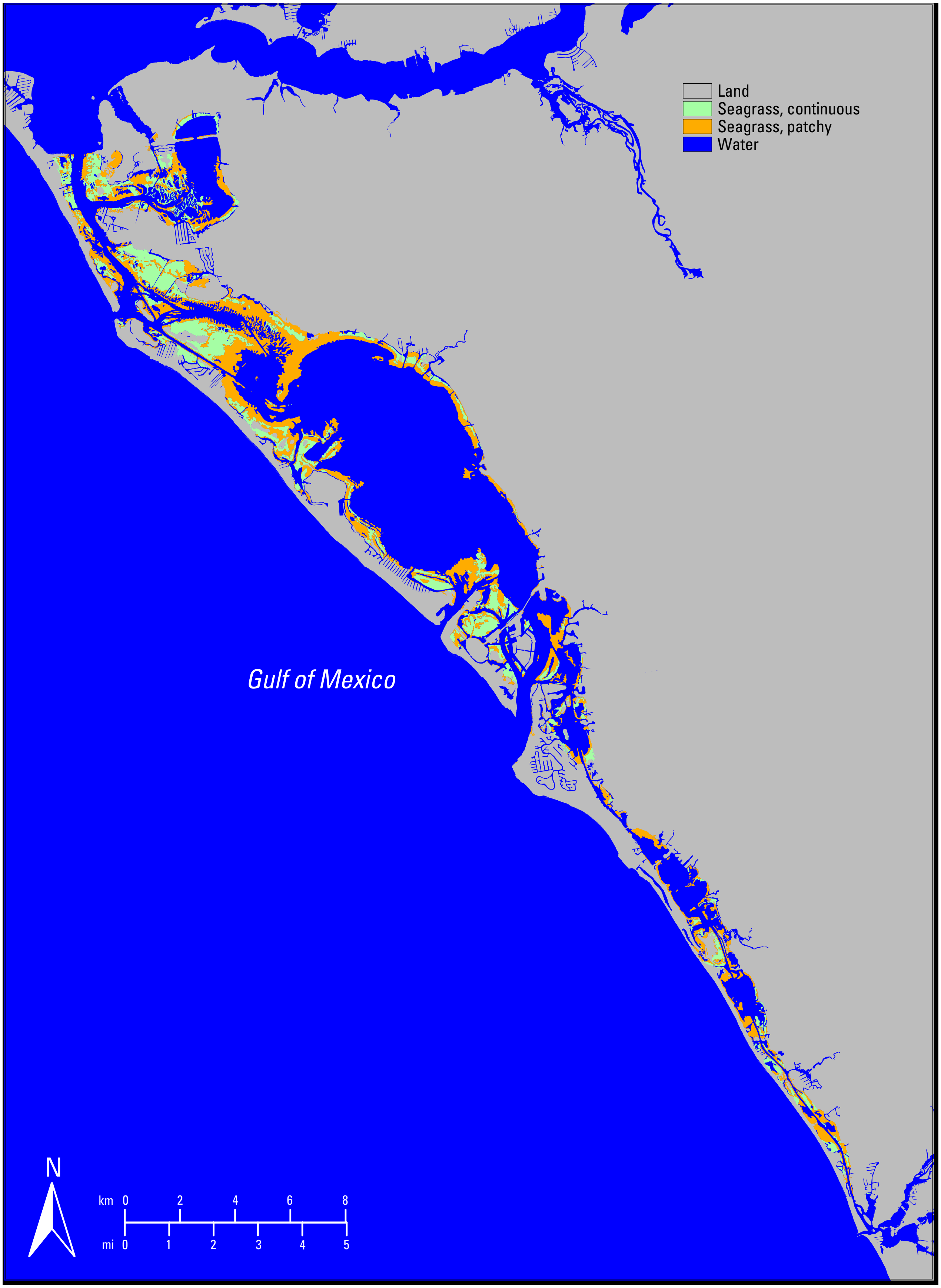

Figure 4. Distribution of seagrass in the Sarasota Bay system, 1994.

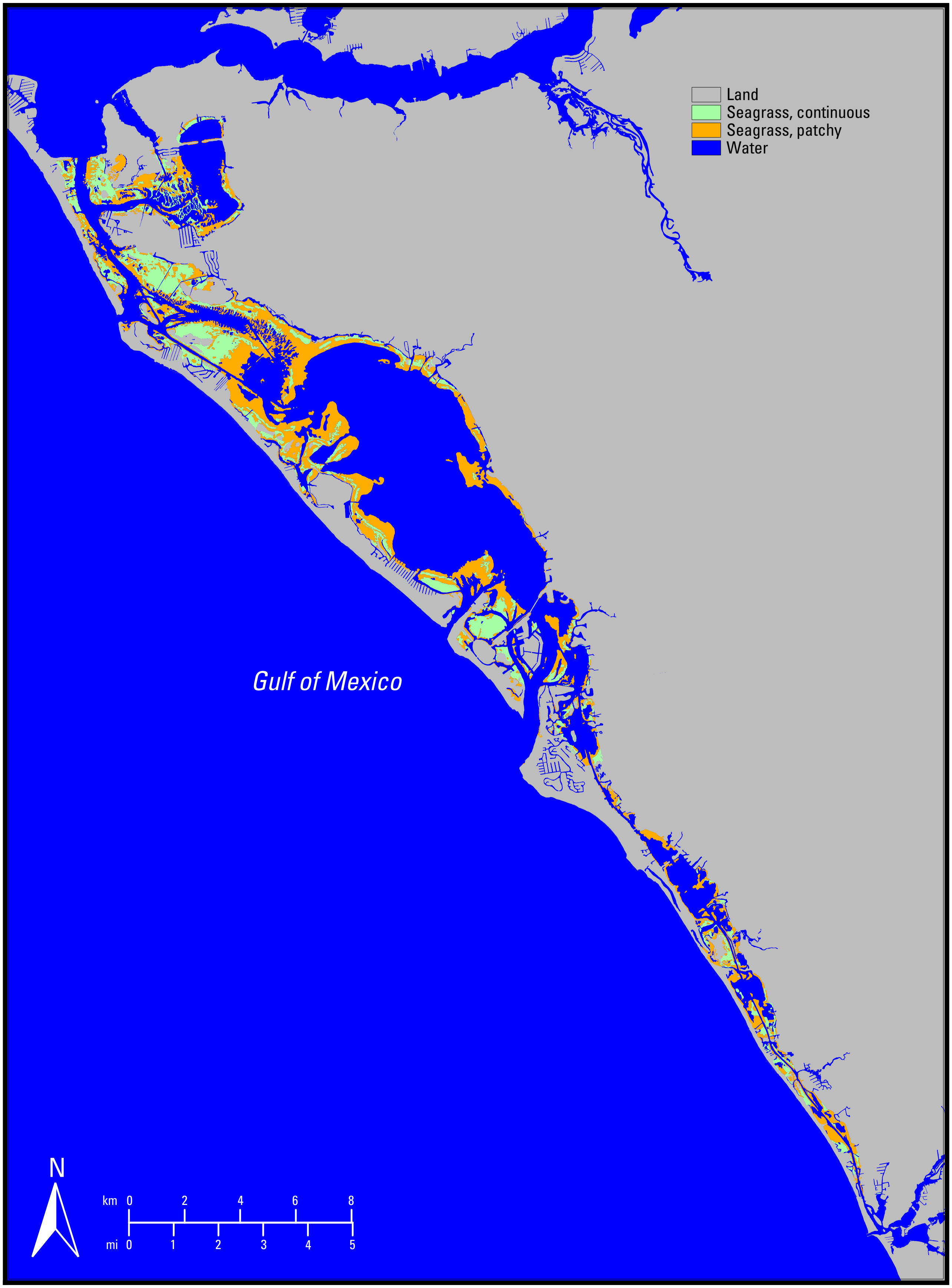

Figure 5. Distribution of seagrass in the Sarasota Bay system, 1996.

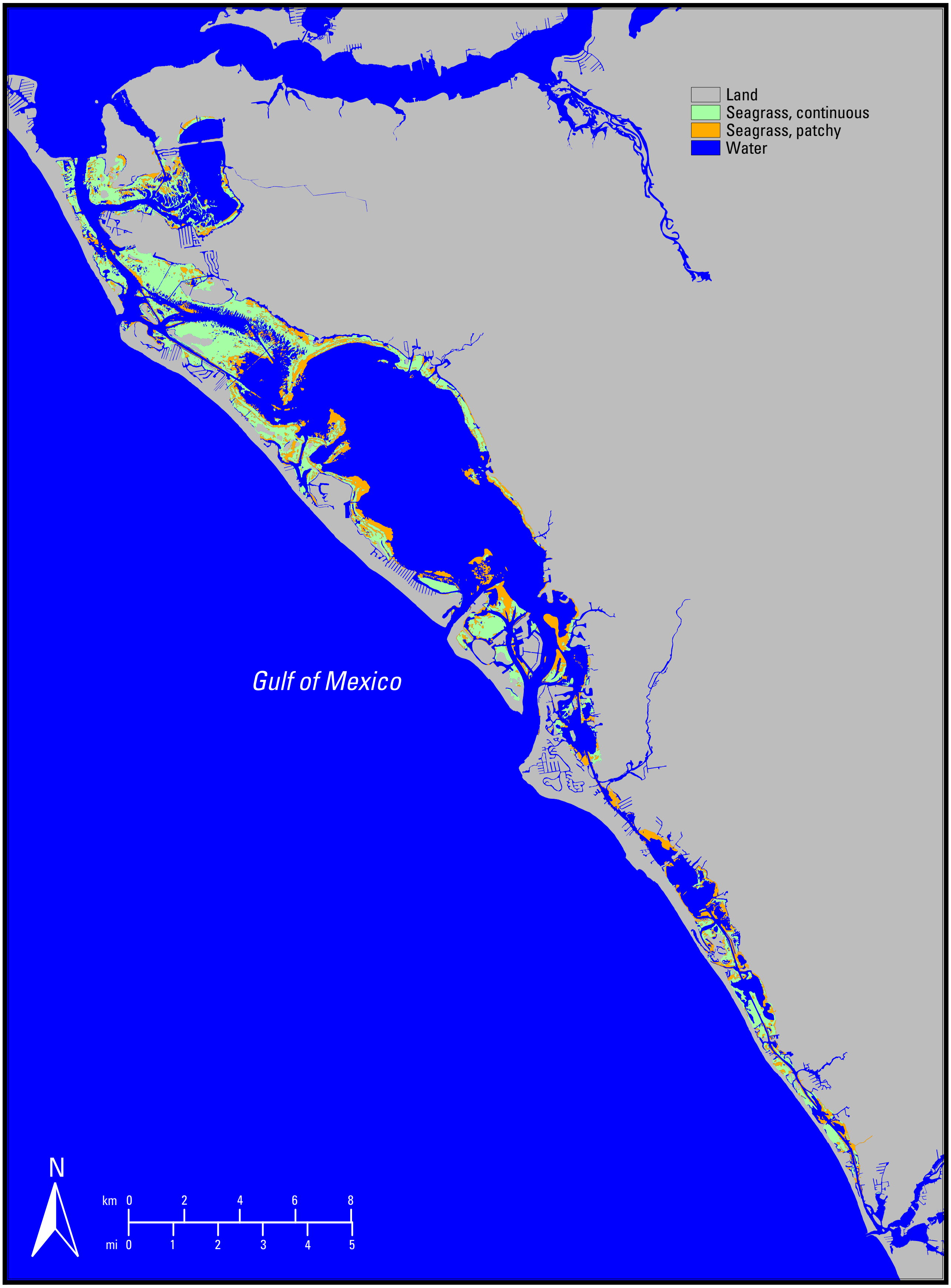

Figure 6. Distribution of seagrass in the Sarasota Bay system, 1999.

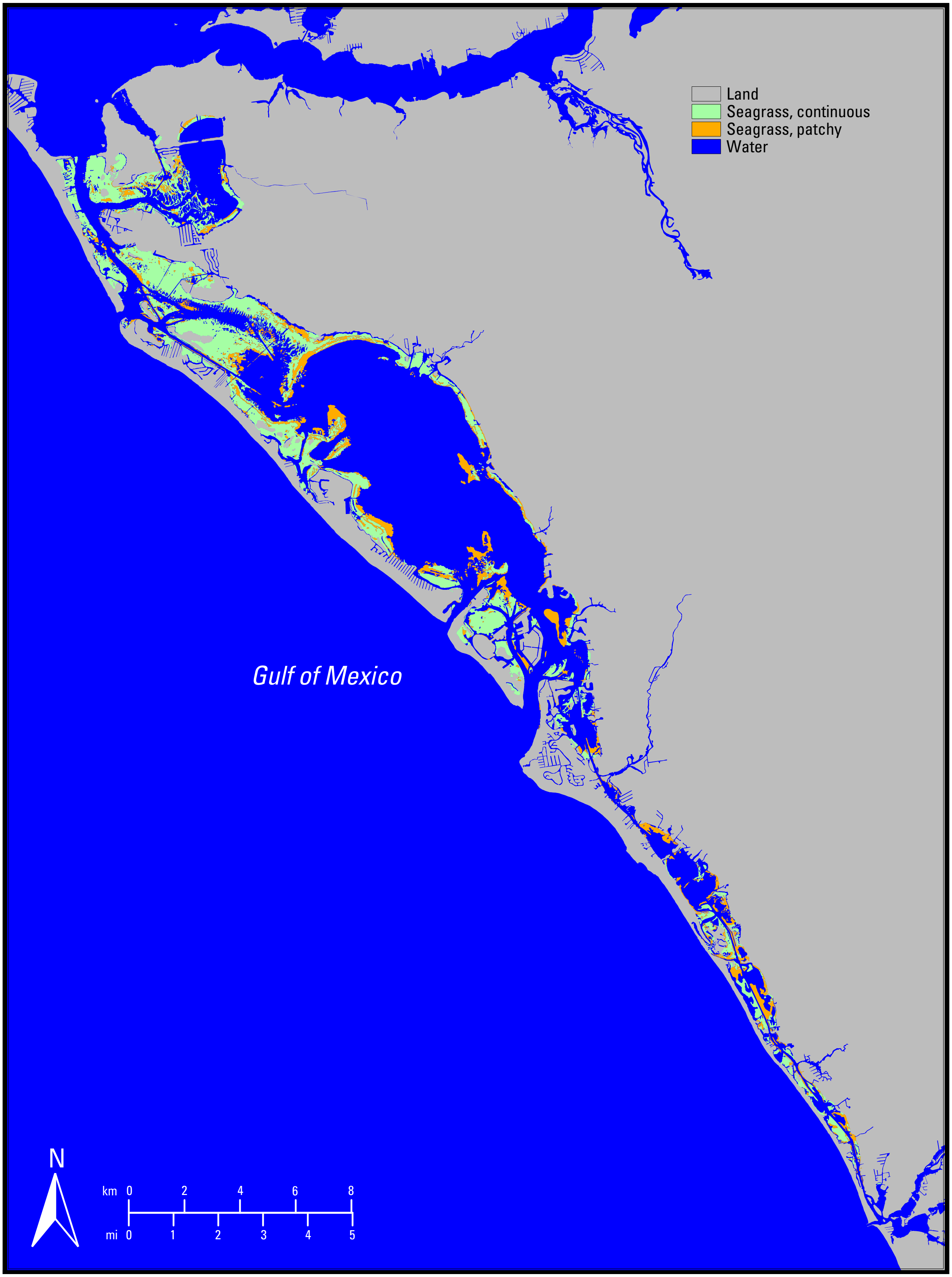

Figure 7. Distribution of seagrass in the Sarasota Bay system, 2002.

solids that accompanied this El Niño event would have most likely caused a considerable decrease in water clarity, which could account for the loss of seagrass coverage in most parts of Sarasota Bay. Little Sarasota Bay was the only bay segment to have an increase in coverage between 1996 and 1999 (table 1).

Between 1999 and 2002 (figs. 6 and 7), seagrass coverage increased in the northern portion of the bay, where most (86%) of the bay's seagrass is located. In contrast, coverage in Roberts and Blackburn Bays decreased by a combined total of 75 ha (185 acres) between 1996 and 2002 (figs. 5–7), while coverage in Little Sarasota Bay declined by 30 ha (72 acres) between 1999 and 2002 (figs. 6 and 7). Determining the cause of these declines is a pressing need for better understanding recent trends of water quality and seagrass health in the southern portions of Sarasota Bay.

Monitoring for Seagrass Health

Currently, aerial photography and seagrass mapping are anticipated to be continuing efforts that will be conducted every 2 yr or so. Furthermore, a series of 10 fixed transects have been established throughout Sarasota Bay (an effort that is based on the design of a similar effort in Tampa Bay). At each transect, seagrass coverage is estimated for each species by using the Braun-Blanquet method (for more information, see *http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=2917578*). Also, the maximum distance offshore where seagrasses are found is noted, as well as the relative water depth at each station. Year-to-year comparisons are thus possible for examining trends in seagrass meadow composition for individual transects. At present, there is no formal report produced based on these efforts; however, useful information can still be derived from this monitoring program. For example, results of these efforts thus far suggest a general trend toward expansion of the deep edges of meadows to waters farther offshore during the period of 1998–2000; however, changes in transect location have reduced, somewhat, the strength of any conclusions drawn from this dataset.

Species Information

Shoal grass (*Halodule wrightii*) is distributed throughout Sarasota Bay. Wigeon grass (*Ruppia maritima*) is mostly restricted to Little Sarasota Bay, particularly the area behind the now-closed Midnight Pass. Manatee grass (*Syringodium filiforme*) is mostly restricted to higher salinity (and higher water clarity) portions of the bay, particularly to the northern portions close to Longboat Pass and New Pass. Manatee grass is common in the northern and western portions of Anna Maria Sound. Turtle grass (*Thalassia testudinum*) is more widespread than manatee grass and is abundant in all portions of the bay except the Little Sarasota Bay segment. Finally, star grass (*Halophila engelmannii*) is found as an understory plant in several locations, particularly at the deeper edges of seagrass meadows in Roberts Bay.

Restoration and Enhancement Opportunities

Since its inception in 1989, the Sarasota Bay National Estuary Program (SBNEP) has been the primary agency focused on restoration and protection of the natural resources of Sarasota Bay. In 1992, after 3 yr of intensive technical assessment, the bay's health was documented by SBNEP in a report (Sarasota Bay National Estuary Program, 1992) in which principal investigators for projects on pollutant-loading models, shellfish contamination, fisheries, etc., proposed various projects that would be appropriate for protecting or restoring the bay's natural resources. These projects were extensively reviewed by various technical committees, and a number of formal public presentations were made.

The SBNEP also produced a comprehensive conservation and management plan (Sarasota Bay National Estuary Program, 1995) based partly on input from the public. The comprehensive plan included a list of action plans that were to be fulfilled by various local, regional, State, and Federal agencies. These action plans focused on major issues, such as declines in water and sediment quality, loss of wetlands and other coastal habitats, loss of seagrasses, and declines in finfish and shellfish populations.

In recent years, a number of projects have been undertaken that have benefited the bay's natural resources. Wastewater nitrogen loads to the bay are believed to have declined from 515 Mg (569 tons) per year in 1988 to 100 Mg (110 tons) per year in 1999, an 80% decrease (Sarasota Bay National Estuary Program, 2000). Baywide nitrogen loads are thought to have declined by approximately 47% (Sarasota Bay National Estuary Program, 2000). As a result, water quality has improved throughout most of the bay, and seagrass cover has expanded as well.

Continued efforts are required to reduce stormwater loads of nitrogen, especially because of continued urbanization of the bay's watershed. In addition, further projects are necessary to continue to reduce point sources of pollution by increasing the quantity of wastewater treatment plant effluent that is reused and by replacing malfunctioning septic tank systems with appropriate wastewater treatment practices.

At this time, there is little enthusiasm from the Technical Advisory Committee of SBNEP for projects focusing on transplanting efforts for seagrass recovery in Sarasota Bay.

References

Deming, J., Schwarz, R.S., Carender, P., Delahaye, D., and Williams, J.R., 1990, An historic resources survey of the coastal zone of Sarasota County, Florida: Florida. Prepared for the Sarasota County Board of County Commissioners, the Sarasota County Department of Natural Resources, and the Sarasota County Department of Historical Resources.

Dixon, L.K., and Heyl, M.G., 1999, Trend analysis of water quality data for the Sarasota Bay National Estuary Program: Sarasota, Fla., Final report to Sarasota Bay National Estuary Program.

Estevez, E.D., 1992, Tidal wetlands, *in* Roat, P., Ciccolella, C., Smith, H., and Tomasko, D., eds., Sarasota Bay framework for action: Sarasota, Fla., Sarasota Bay National Estuary Program, p. 6.1–6.20.

Heyl, M.G., 1992, Point- and nonpoint-source pollutant-loading assessment, *in* Roat, P., Ciccolella, C., Smith, H., and Tomasko, D., eds., Sarasota Bay framework for action: Sarasota, Fla., Sarasota Bay National Estuary Program, p. 12.1–12.19.

Sarasota Bay National Estuary Program, 1992, Sarasota Bay framework for action: Sarasota, Fla., Sarasota Bay National Estuary Program.

Sarasota Bay National Estuary Program, 1995, Sarasota Bay—the voyage to paradise reclaimed—the comprehensive conservation and management plan for Sarasota Bay: Sarasota, Fla., Sarasota Bay National Estuary Program.

Sarasota Bay National Estuary Program, 2000, Sarasota Bay 2000: a decade of progress: Sarasota, Fla., Sarasota Bay National Estuary Program.

Sheng, Y.P., and Peene, S., 1992, Circulation and its effect on water quality, *in* Roat, P., Ciccolella, C., Smith, H., and Tomasko, D., eds., Sarasota Bay framework for action: Sarasota, Fla., Sarasota Bay National Estuary Program, p. 5.1–5.18.

Whelan, J.J., 1992, Recreation use and access assessment, *in* Roat, P., Ciccolella, C., Smith, H., and Tomasko, D., eds., Sarasota Bay framework for action: Sarasota, Fla., Sarasota Bay National Estuary Program, p. 13.1–13.20.