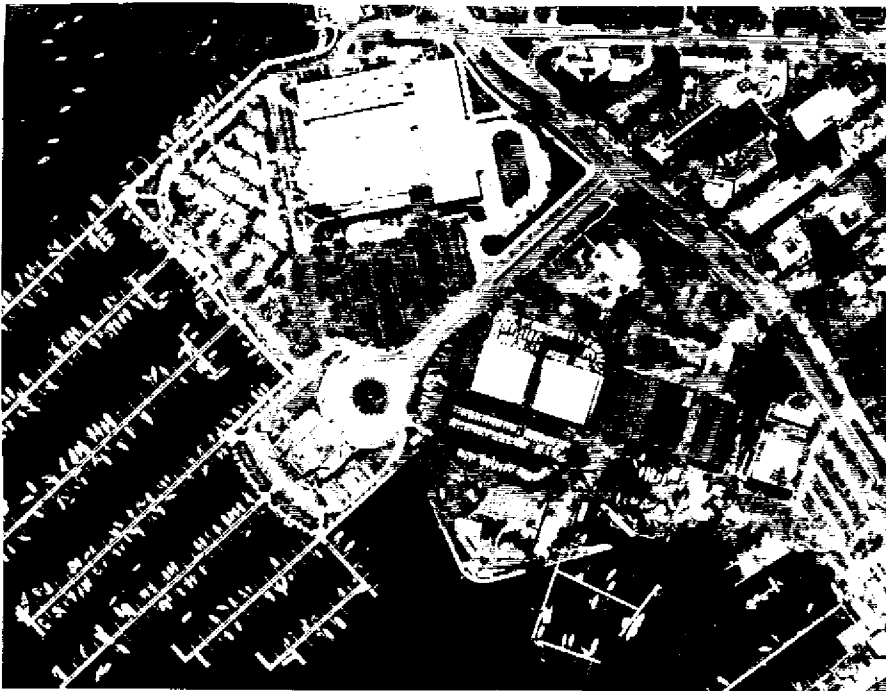


TP-70A

LOCATION AND ASSESSMENT OF HURRICANE ANDREW DAMAGED VESSELS ON BISCAYNE BAY AND ADJOINING SHORE AREAS

VOL. 1: TEXT AND APPENDICES

SA: FLSGP-M-93-001 for
Vol. 2: MAPS



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FLORIDA SEA GRANT COLLEGE PUBLICATION



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Cover Photographs:

Vol. 1: Vertical photograph, Dinner Key Marina, Grove Key Marina,
Merrill-Stevens Dry Dock (left to right), 26 August 1992.

Vol. 2: Oblique photograph, Matheson Hammock Marina, 25 August 1992.

ABSTRACT

Biscayne Bay, Florida, experienced damage to shoreline boating facilities and docked/anchored vessels as a result of Hurricane Andrew. The purposes of this project were to assess damage to in-the-water vessels, to map the locations of these vessels, and to determine areas of potential impacts of vessel sinkings and wreckage on the bay environment.

An initial count and characterization of vessel damage, as totally submerged, partially submerged, wrecked but floating, and wrecked aground, was made using remote sensing techniques. This damage assessment was compared with a field determination of damaged/sunken boats remaining several months after the storm. Remaining vessels were identified by type, hull material, engine, fuel/holding tanks aboard, overall condition, afloat or submerged status, and accessibility for removal. Actual/potential threats to the environment, public safety implications, and navigational hazards also were noted.

A Geographic Information System (GIS) data base and coverages were created using the photo interpreted data and field observations. The GIS maps include coastal features, habitats, vessel locations, and vessel attributes. The analysis related damaged and sunken vessel location and distribution to benthic, tidal and shore habitats. Vessel concentrations were used to define low, medium, high, and very high potentially impacted areas of seagrasses, non-living (barren) substrate, mangroves, and upland shore.

Problems encountered with available remotely sensed data sources and the coordination of the data following such a sudden catastrophic event are discussed. The project provides guidelines for developing hurricane vessel damage assessment strategies to cope with similar future natural hazards.

I.

BACKGROUND

Hurricane Andrew, the third most powerful hurricane in mainland U.S. recorded history, struck south Florida on August 24, 1992, with sustained winds of 234 kph, gusts of 282 kph, and a storm surge of 5 m (Culp and Wong, 1992; Rappaport, 1992). Andrew's wake in Florida left 40 people dead and over \$20 billion in damage (Lewis, 1993).

An army of relief workers and scientists descended on the storm blighted area to provide assistance and to carry out baseline assessments of the storm's impact (Mossberg, 1993; Ogden, 1992). The magnitude and extent of damage to south Dade mainland communities, Homestead, Leisure City, Cutler Ridge, South Miami, however, overshadowed the storm's impact on coastal and shore facilities, vessels, and marine habitats. The estimated \$200 million (FEMA, 1992) damage to pleasure boats (vessels) paled alongside \$20 billion in damage to landside infrastructure. Dislocations of small waterside communities, as the Dinner Key boat liveaboards, and, the damage or destruction of some 1000 vessels, correspondingly, went unnoticed and unattended.

In the days and weeks following the storm, questions about Hurricane Andrew's potential impact on the multi-million dollar south Florida marine recreational industry loomed dauntingly on the horizon. This impact was difficult to predict since no comprehensive damage assessment estimates were possible.

Rapid reconnaissance of the impacted shore area, in the post-hurricane period, underscored the difficulty of estimating boat damage and assessing potential impact to bay and shore environments by groundings, spillage, flotsam. On-the-water inspection was discouraged by the authorities because of safety risks from floating debris and submerged obstructions. Shore survey was made difficult by impassable roads and by security restrictions imposed to discourage looting. Aerial reconnaissance was implemented haphazardly and much of the nearshore and bay areas were not systematically photographed until months afterwards.

Fundamental questions, as -- how many vessels are damaged or destroyed? where are they situated? what threat do they pose to public safety, navigation, and the environment? -- could not be answered.

Florida Sea Grant initially requested that a survey be undertaken to prioritize the removal of hurricane sunken and damaged vessels, using a methodology developed for derelict vessel removal in the Florida Keys (Antonini et al, 1989). It was estimated that between 500 and 1000 vessels were sunken, aground, or ashore in a wrecked or damaged state following the storm. Insurance adjusters and vessel owners were faced with the seeming

impossible tasks of trying to locate vessels and arrange for salvage, repair or disposition. Despite chaotic conditions immediately following the storm, however, most (60 to 80 percent) of the vessels were recovered from the water within 3 months time (Pybas, 1992), and 95 percent were removed within 5 months. Our survey efforts, as a result, shifted from implementing a prioritization plan for vessel removal, to mapping damaged and sunken vessel locations and identifying potentially impacted marine and shore areas.

II.

OBJECTIVES

The principal objectives of the survey were:

1. To locate vessels damaged or sunken by Hurricane Andrew and to characterize the type of storm damage on the fleet.
2. To relate damaged and sunken vessels to baywater, tidal and upland habitats.
3. To identify potential baywater, tidal, and shore impacted areas.
4. To rate potentially impacted areas based on concentrations of damaged or sunken vessels.

Secondary objectives were:

1. To evaluate post-Andrew reconnaissance and mapping quality aerial photography for hurricane damage assessment.
2. To determine the feasibility of using geographic information systems (GIS) for such mapping and analysis purposes.
3. To recommend improvements in post-hurricane damage assessment methods.

III.

STUDY REGION

The study region, defined by field reconnaissance immediately after storm passage, includes the area where most of the damaged vessels occurred. It is bounded on the north by the 79th Street Causeway, and on the south by the Card Sound Bridge (Figure 1). The area is 874 km². The northern part is in Dade County (793 km², 90.73 percent); the southern part is in Monroe County (81 km², 9.22 percent).

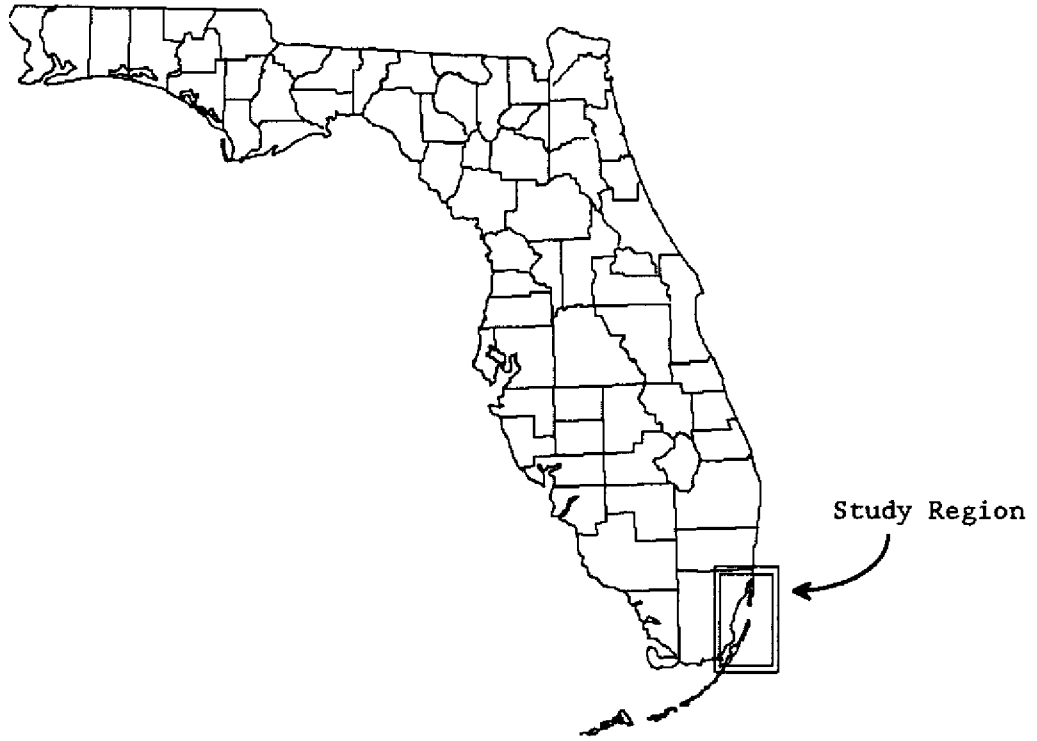


Figure 1: Location of Study Region

IV.

DATA SOURCES

Aerial photography, flown within 2 weeks following Hurricane Andrew, was the prime source for identifying vessel condition. Figure 2 shows photo coverage and Table 1 lists photo specifications for principal sources.

Table 1: Aerial Photography Specifications

Source	Scale	Date (no. days after storm)	Format (inches)	Stereo
Smith Aerial Photography Inc.	1:7000	1, 14	3 x 5	No
Smith Aerial Photography Inc.	1:2500	2	11 x 14	No
Continental Aerial Surveys Inc.	1:7400	2	9 x 9	No
FDOT	1:6800	6	9 x 9	Yes
NASA	1:13500	5 - 12	9 x 9	No

Print copies of the National Ocean Service (NOS) 1:40,000 scale hydrographic charts and US Geological Survey (USGS) 1:24,000 scale, 7.5' quadrangles were acquired (Figure 3). Digital files of NOS bathymetry and shoreline, US Census Bureau (TIGER) roads, and National Wetlands Inventory (NWI) habitats were obtained from Florida Department of Natural Resources (FDNR), Marine Research Institute (MRI), St. Petersburg.

The Florida Marine Patrol (FMP) provided derelict vessel (DV) reports for the 45 DVs situated in the study region. These reports contained information on vessel location and condition (Appendix 1). FMP also made available an emergency survey of vessel damage caused by the storm (Palfrey, 1992).

US Army Corps of Engineers (USACE, 1992) provided maps and photographs of vessel debris from 153 sites in the bay. USACE information on the Dinner Key outer anchorage was particularly useful.

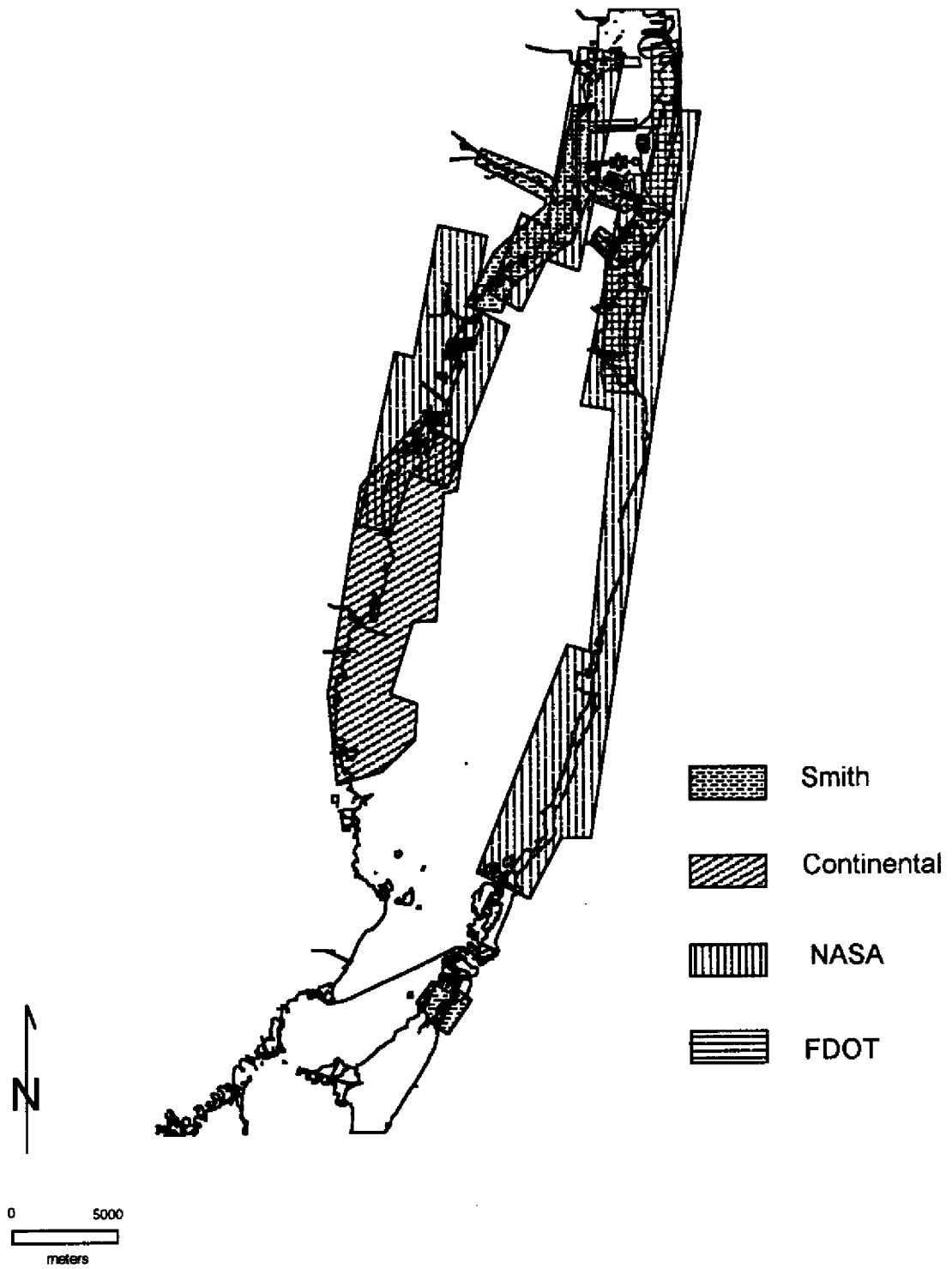


Figure 2: Aerial Photographic Coverage

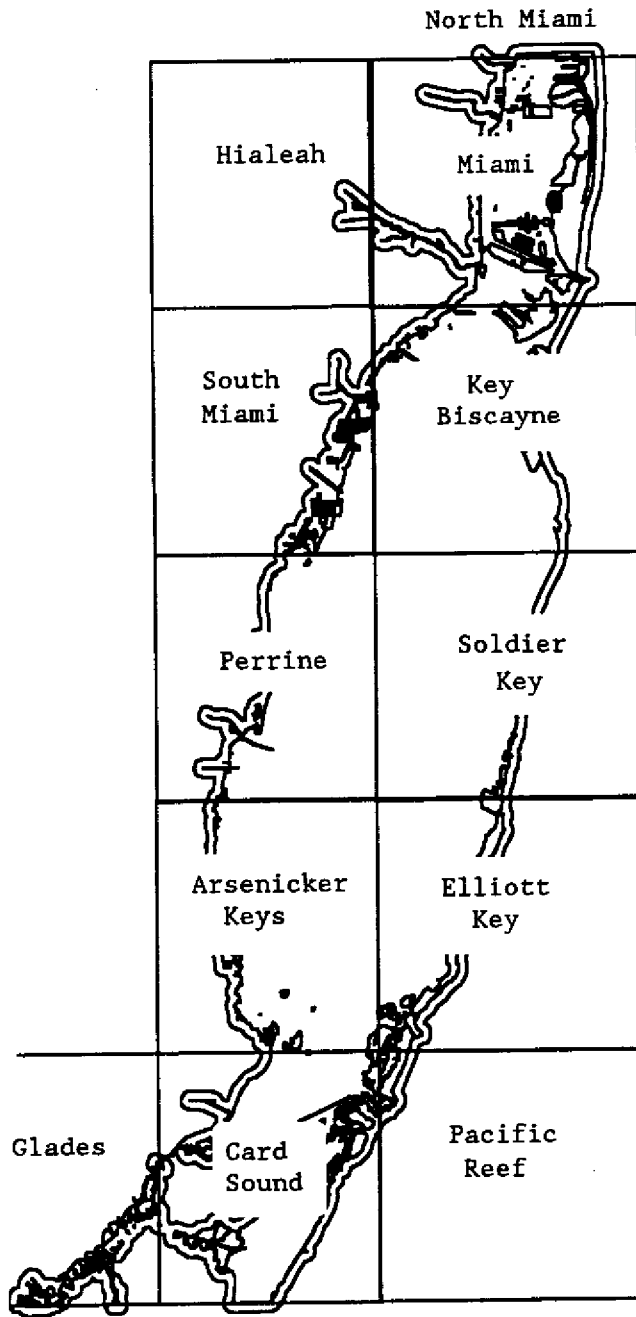


Figure 3: Base Map (7.5' USGS) Coverage

The Dade County benthic map, 1:40,000 (DERM, 1983) was used to describe bottom communities in Biscayne Bay.

V.

METHODOLOGY

1. Aerial Photo Interpretation

Photographs were mounted into strips and mosaiced. Areal coverages were assembled and data gaps were noted. Preference for interpretation was given to large-scale sources, as Smith, FDOT, Continental; smaller-scale NASA photography was used to fill in missing areas (Table 1).

A 10x magnification scope was used to directly identify vessel status as unaffected or affected by the storm, using diagnostic criteria (list, shape, debris trail, etc.). Clearly identifiable affected vessels, further, were distinguished as: totally submerged (Photo 1), partially submerged (Photo 2), wrecked but floating, wrecked aground (Photo 3). Vessels where storm-damaged condition was questionable, or where photo signatures appeared to be storm-derived but unclear as to source, i.e., vessel, flotsam, etc., were designated as unknown/other. Vessel location and condition were noted on photo acetate overlays; this information was transposed to USGS 1:24,000 quadrangles.

2. Interpretation of Derelict Vessel Reports

Each DV report contained a photograph, vessel description and chart location. DV condition categories paralleled storm-damaged vessel designations. Location and condition for DVs were plotted on USGS quadrangles.

3. Field Survey

A field survey was conducted between 18-23 January 1993 to identify any hurricane damaged, wrecked vessels or derelict vessels remaining in the water or along the shore. These vessels were located on aerial photographs and information was recorded on data sheets (Appendix 2). All cases were adjusted to mean lower low water.

4. Base Map Compilation

A digital base map was compiled using shoreline (mean lower low water datum) from NOS 1:40,000 hydrographic charts and road features from TIGER 1:24,000 files. Grid coordinate system was the Universal Transverse Mercator (UTM), Zone 17.

An attempt was made to incorporate bathymetry from a preliminary issued NOS digital file but problems in the file structure, like truncated contours at channel cuts, spoil banks, and shoreline, made this impractical. All hurricane damaged and derelict vessel locations, marked on aerial photograph

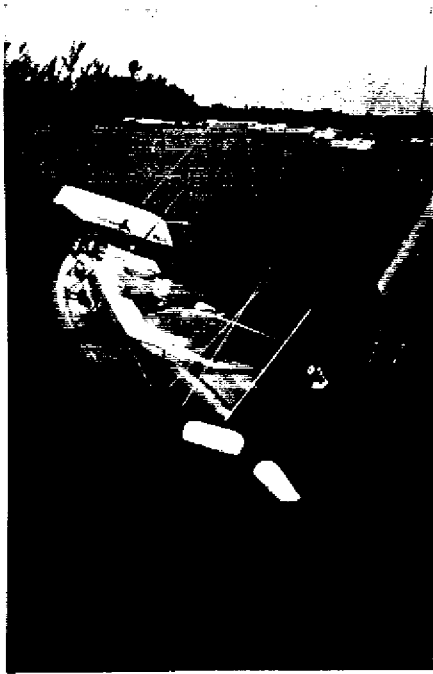


Photo 1: Completely Submerged Vessel, Dinner Key

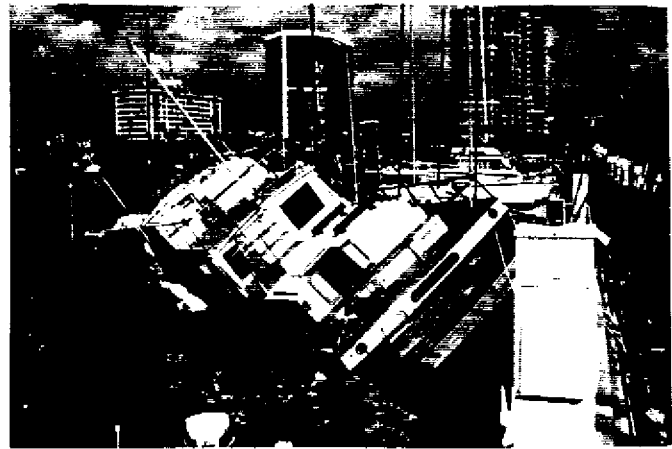


Photo 2: Partially Submerged Vessel, Dinner Key



Photo 3: Wrecked, Aground Vessel, Pier House Restaurant, Coral Gables

acetate overlays, were transferred to USGS quadrangle (1:24,000) print copies. Locations were digitized and vessel characteristics were recorded in attribute tables.

A habitat map of benthic, tidal, and upland units was compiled from two sources. Generalized seagrasses, hardbottom, and barren substrate units were digitized from the DERM (1983) 1:40,000 scale map. Mangroves were selected from the NWI (1984-1990) 1:24,000 digital map file. The DERM (1983) shoreline served as the seaward boundary of the mangrove unit.

Mapping accuracy is related to the scale and resolution of the base map, habitat maps, and photo interpretation. Base map scale is 1:40,000; habitat map resolution distinguishes 11 units at 1:24,000. Photo interpretation scale varies from 1:2,500 to 1:13,500. Map accuracy for maps produced from varied sources is set by the smallest scale source, all other factors being equal. It was reasoned, however, that map scale could be enlarged since map resolution was reduced, or made coarser, by lumping 11 benthic units into 3 composite mapping categories. Correspondingly, some project results are presented at large scale: vessel locations where photo interpretation was carried out at large-scale; and potential impact zones where boundaries are based on combinations of concentrations of vessels with generalized habitat boundaries. General regional maps are presented at approximately 1:90,000 scale.

VI.

CARTOGRAPHIC ANALYSIS

The analysis followed a multi-staged approach. First, vessel locations and damage conditions were mapped. Second, baywater, tidal and shore ecologic units were synthesized from digital and printed sources and mapped. Third, vessel locations were overlain on synthesized ecologic units to determine relative vessel concentrations. Fourth, relative vessel concentrations were scaled. Fifth, potentially impacted baywater, tidal, and upland areas were identified.

Interpretation of aerial photography, taken within a 2 week period after Hurricane Andrew, revealed 918 damaged and sunken vessels. These were mapped in Figure 4; concentrations of damaged vessels at 4 marinas (Dinner Key, Matheson Hammock, Black Point, and Homestead Bayfront) were mapped at large-scale in Figure 5. Table 2 gives a summary of vessel locations and damage conditions. Appendix 3 provides specific information for each identified vessel.

There were 45 abandoned, derelict vessels existing in the study region prior to Hurricane Andrew. These are shown in Figure 6 and described in Appendix 4. A field reconnaissance, carried out during 18-22 January 1993, revealed 51 vessels remaining in the water. These are mapped in Figure 7 and described in Appendix 5. Table 3 summarizes conditions of the pre-storm derelict vessels, hurricane damaged vessels existing in September 1992, and

Table 2: Summary of Hurricane Damaged Vessel Condition
 [number of vessels, percent in ()]

Location (USGS Quad.)	Condition							Total
	Submerged		Floating	Aground	Undetermined	Total		
	Completely	Partially						
Key Biscayne	53	146	113	90	35		437 (47.6)	
South Miami	23	36	51	97	29		236 (25.7)	
Miami	8	19	34	36	25		122 (13.3)	
Perrine	0	10	25	22	1		58 (6.3)	
Arsenicker Keys	3	9	7	8	2		29 (3.2)	
Card Sound	1	5	8	8	6		28 (3.1)	
Soldier Key	0	2	1	2	1		6 (.07)	
Elliott Key	0	0	0	2	0		2 (.02)	
Totals	88 (9.6)	227 (24.7)	239 (26.0)	265 (28.9)	99 (10.8)		918 (100)	

Table 3: Summary Condition of All Damaged Vessels
Number of Vessels, Percent ()

Damaged Vessel Source	Submerged Completely	Submerged Partially	Floating	Aground	Undetermined	Total
Pre Hurricane Derelict Vessels	6 (13.3 %)	37 (82.2 %)	2 (4.4 %)	0 (0.0 %)	NA	45 (100.00 %)
Hurricane Damaged Vessels, September 1992	88 (9.6 %)	227 (24.7 %)	239 (26.0 %)	265 (28.9 %)	99 (10.8 %)	918 (100.00 %)
Hurricane Damaged and Derelict Vessels Remaining in Water, Jan. 1993	5 (9.8 %)	27 (52.9 %)	8 (15.7 %)	11 (21.6 %)	NA	51 (100.00 %)

vessels remaining in the water in January 1993. Figure 8 shows all (1001) vessels, damaged or sunken in the study region, existing prior to or resulting from Hurricane Andrew. (The map in Figure 8 served as the basis for deriving vessel concentrations and potential impact assessments.)

A habitat map of Biscayne Bay and adjoining shore areas, compiled from digital and print copy sources (NWI, 1984-1990; DERM, 1983) is shown in Figure 9. This concluded Stage 1 and Stage 2 analysis, preparation of source materials.

The Stage 3 overlay process combined maps in Figures 8 and 9 to identify the location and number of vessels found on each habitat unit: seagrasses, hardbottom, barren substrate, mangrove, upland within 100 m of the shoreline (limit of photo interpreted damaged vessels). Area (total, percent) and number of vessels situated in each habitat unit, are listed in Table 4.

Table 4: Habitats and Damaged Vessels

Habitat	Area		Vessels	
	km	%	subtotal	%
Seagrasses	328	37.53	90	8.99
Barren	98	11.21	592	59.14
Hardbottom	172	19.68	0	0.00
Mangroves	76	8.70	23	2.30
Upland	119	13.62	273	27.27
Undetermined	81	9.27	23	2.30
Total	874	100.01	1001	100.00

Stage 4 scaling was carried out at regional and operational mapping levels. In order to determine vessel concentrations per unit area, the region was grided into .25 km² cells and vessel counts per cell were tallied and graphed (Figure 10). A vessel damage epicenter -- greatest concentration of damaged vessels -- was identified and individual boat locations were plotted to show the density and distribution of hurricane damaged vessels emanating from the epicenter (Figure 11). The location of damaged vessels and their distance from the epicenter were graphed in relation to the eyewall of the hurricane at landfall (Figure 12). This concluded the regional analysis.

Scaling at the operational mapping level included overlaying the 1001 damaged vessels on the synthesized habitat zones. A buffer was delineated around each vessel, of 100 m for those on baywater (seagrasses, hardbottom, barren substrate) habitats, 50 m for vessels on tidal (mangroves), and 10 m for ones on uplands. (A buffer is the theoretical area of potential influence each vessel may have on its surrounding ecosystem.)

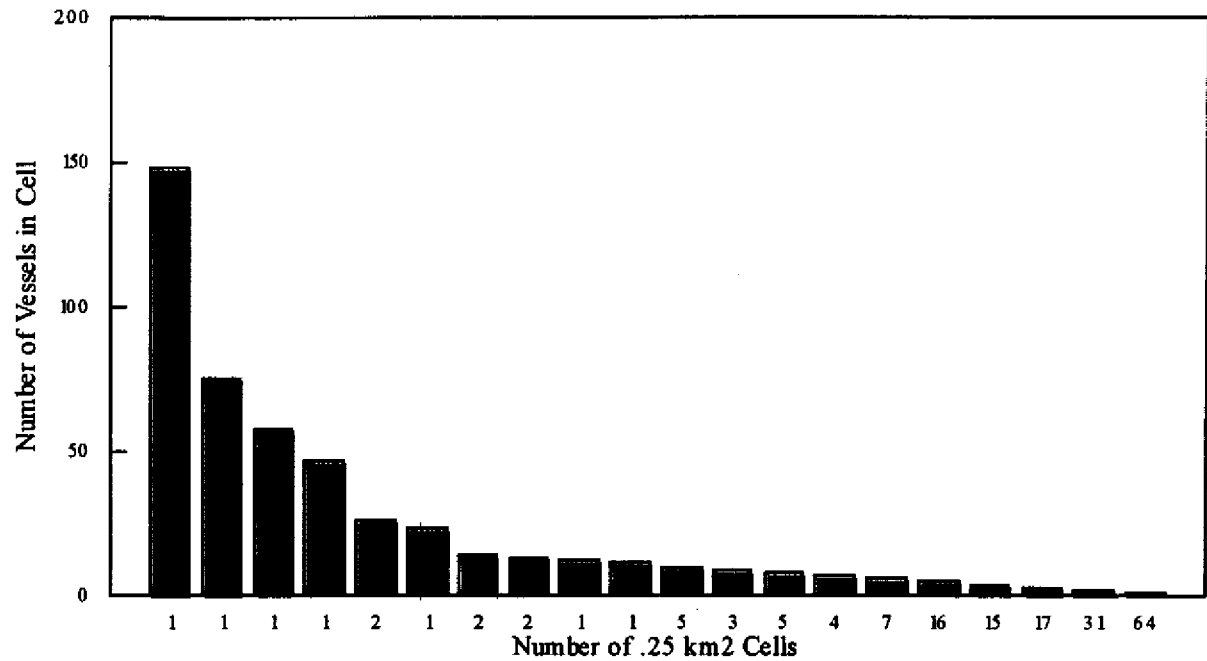


Figure 10: Concentrations of Hurricane Damaged Vessels

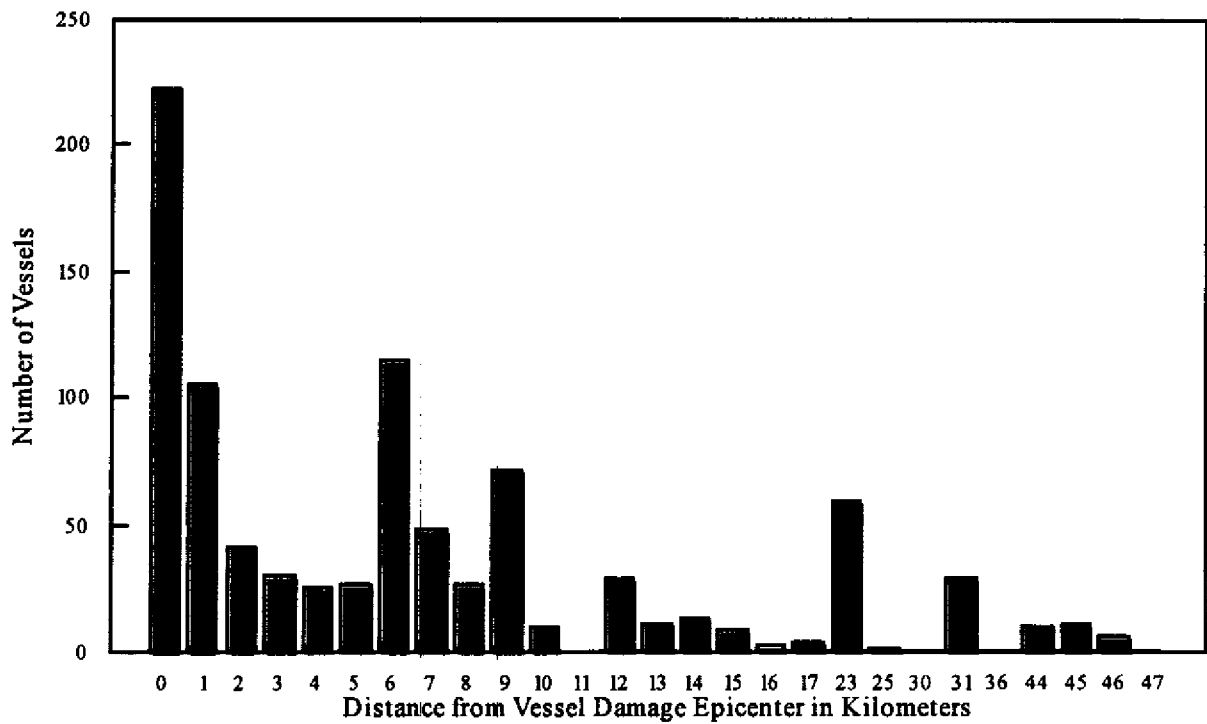


Figure 11: Density Distribution of Hurricane Damaged Vessels and Distance from Damage Epicenter

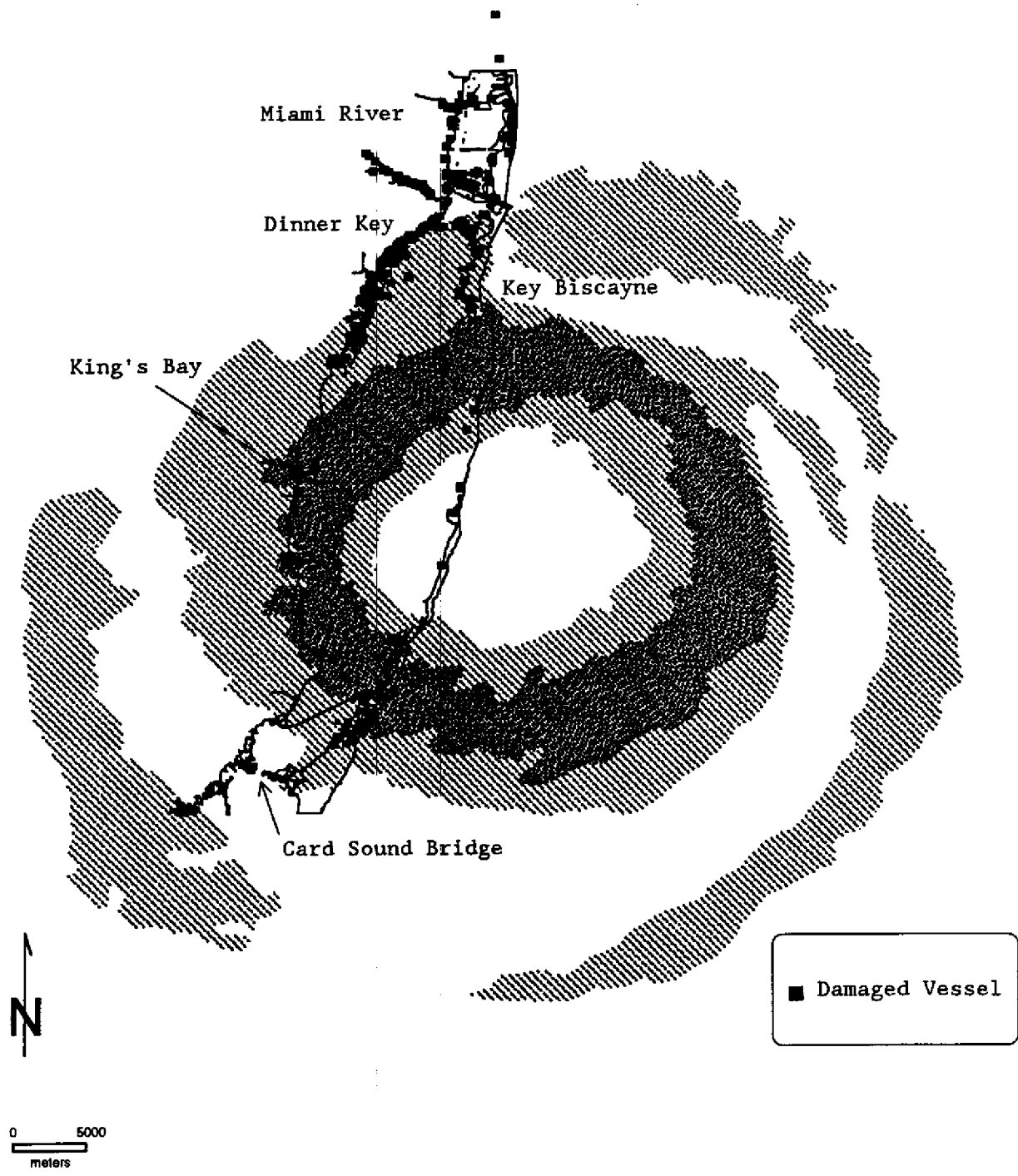


Figure 12: Location of Hurricane Damaged Vessels in Relation to Storm at Landfall (Radar Miami, August 24, 1992, 8:30 UTC)

The analysis assumed that damaged vessels in baywater habitats may have a potential impact of an order of magnitude greater than damaged vessels on land; vessels situated on mangroves were scaled at midpoint. Further assumptions were: that the potential impact of vessels on baywater and tidal habitats, closer than 100 m and 50 m, respectively, to the shoreline, did not extend landward of the shoreline; that the potential impact of damaged vessels on land, closer than 10 m to the shoreline, did extend into adjoining tidal or baywater zones. The analysis treated all vessels equally: no distinction was made for condition, as completely submerged, partially submerged, floating, or aground.

The ratio of buffered areas to the number of vessels revealed relative areal concentrations. Curve breakpoints, of 1-5, 6-15, 16-25 and >25, were used to define low, medium, high, and very high levels of vessel concentration. The distribution of buffered areas in the four levels was: low = 274, medium = 21, high and very high = 1 and 2, respectively. Table 5 gives a summary of damaged vessel potential impact areas (in hectares, ha), in each of the levels (low, medium, high, very high) for each habitat zone. Relative (percent) potential impact of damaged vessels is given by scaled categories in Table 6 and by habitat zones in Table 7.

Results of this phase of the cartographic analysis showed concentrations of damaged vessels in small areas. These small areas were grouped into 9 principal locations (Figure 13). Table 8 gives the potential impact area for each location. Appendix 6 lists area measurements, by location, level, and habitat. Appendix 7 ranks potential impact levels in descending order by location subtotal. Table 9 summarizes these data for each location by indexing potential impact on habitats. Figures 14, 15, 16, 17, and 18 map potential impact zones at 5 selected locations.

VII.

DISCUSSION

1. Regional Analysis

Hurricane Andrew's landfall in the Ragged Keys placed Miami's moored recreational vessels within the "dangerous semi-circle" of the storm's track. This fleet was exposed to Category 4 hurricane force winds plus the forward speed of the storm (Figure 12). A total of 918 hurricane damaged vessels were identified within the area south of the 79th St. Causeway (north), north of the Card Sound Bridge (south), and seaward from 100 m landward of the shoreline. Roughly, and equally, one-third of the damaged vessels were completely or partially submerged, damaged but floating, and damaged aground (Table 2).

The site of greatest devastation -- the damage epicenter -- was landward of Picnic Islands, Dinner Key (UTM 5770740/2845272). More than one-third of damaged and sunken vessels were situated less than 2 km from this epicenter. The high densities of vessels at some locations, as at Dinner Key, Coral Gables Waterway, Coral Bay, combined with their location on the fringe of the

Table 5: Summary of Damaged Vessel Potential Impact Areas
 (# vessels / wgt. zone of influence, ha.)*

Habitat	Low	Medium	High	Very High	Total
Seagrasses	45.76	11.10	0.00	40.34	97.21
Barren Substrate	140.10	76.62	3.37	65.28	285.37
Mangroves	12.82	0.00	0.00	0.00	12.82
Upland	41.36	2.86	0.09	6.40	50.71
Undetermined (Monroe County)	29.83	0.00	0.00	0.00	29.83
Total	269.87	90.58	3.46	112.02	475.94

* Weights applied to buffers surrounding damaged vessels are: 100m, seagrasses and barren substrate; 50m, mangroves; 10m, upland. Shoreline excludes landward extension of seagrasses, barren, and mangroves' impact; shoreline allows seaward extension of upland impacts

**Table 6: Relative Potential Impact of Damaged Vessels by Scaled Categories
(Column Percent of Summary in Table 5)**

Habitat	Scaled Levels				Total
	Low	Medium	High	Very High	
Seagrasses	16.96	12.25	0.00	36.00	20.43
Barren Substrate	51.91	84.59	97.40	58.28	59.96
Mangroves	4.75	0.00	0.00	0.00	2.69
Upland	15.33	3.16	2.60	5.72	10.65
Undetermined (Monroe County)	11.05	0.00	0.00	0.00	6.27
Total	100.00	100.00	100.00	100.00	100.00

**Table 7: Relative Potential Impact of Damaged Vessels by Habitat Zones
(Row Percent of Summary in Table 5)**

Habitat	Low	Medium	High	Very High	Total
Seagrasses	47.08	11.42	0.00	41.50	100.00
Barren Substrate	49.09	26.85	1.18	22.88	100.00
Mangroves	100.00	0.00	0.00	0.00	100.00
Upland	81.56	5.64	0.18	12.62	100.00
Undetermined (Monroe County)	100.00	0.00	0.00	0.00	100.00
Total	56.70	19.03	0.73	23.54	100.00

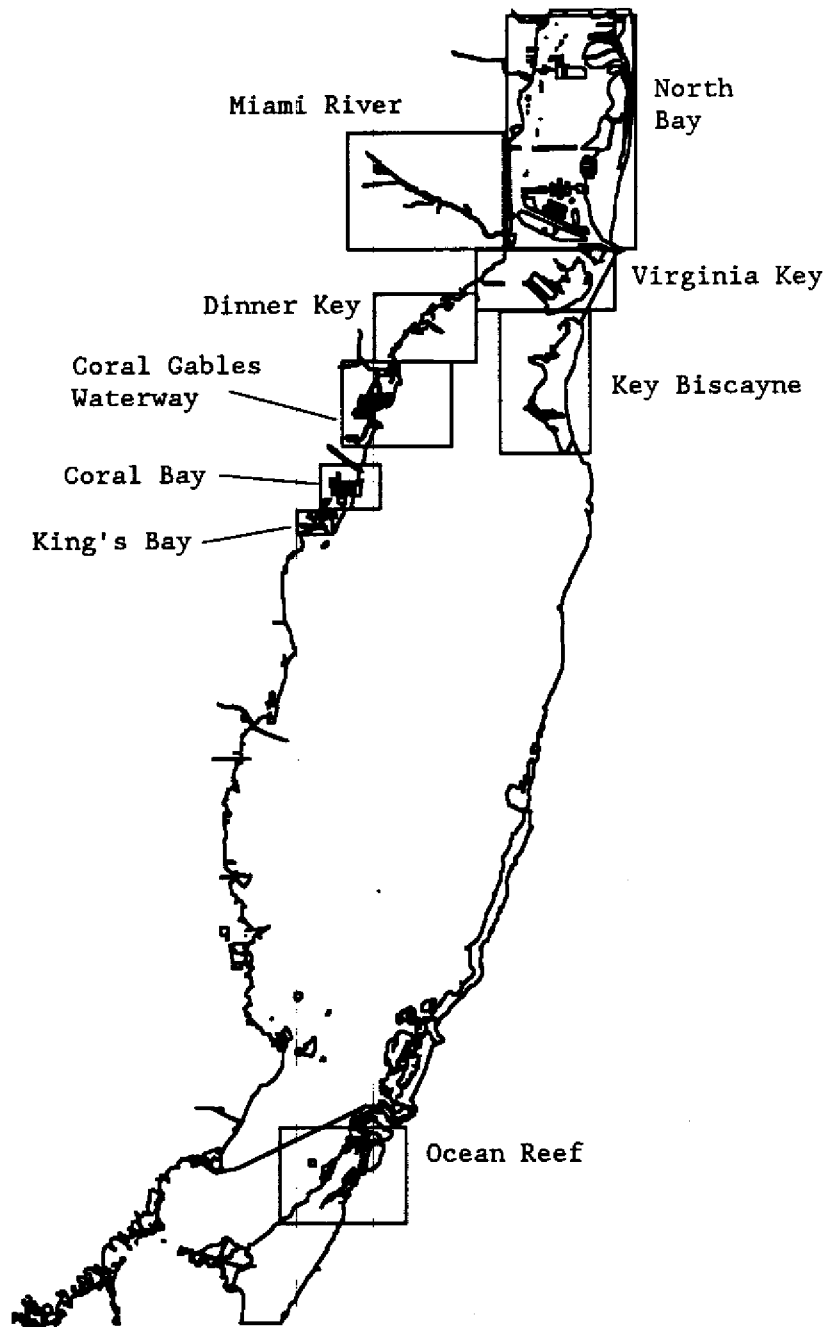


Figure 13: Principal Locations of Potential Impact by Damaged Vessels

Table 8: Area of Potential Impact Zones

Location	Potential Impact Zone (area in ha)
North Bay	102.54
Miami River	25.17
Virginia Key	29.50
Key Biscayne	38.09
Dinner Key	145.63
Coral Gables Waterway	53.23
Coral Bay	12.65
King's Bay	7.48
Ocean Reef	18.16
Other	43.51
Total	475.96

Table 9: Index of Potential Impact on Habitats at Selected Locations

Location	Seagrasses			Barren			Mangroves			Upland		
	L	M	H/V	L	M	H/V	L	M	H/V	L	M	H/VH
North Bay	-	-	-	1	3	-	-	-	-	1	6	-
Miami River	-	-	-	4	2	-	-	-	-	10	7	-
Virginia Key	4	2	-	5	4	-	-	-	-	5	1	-
Key Biscayne	5	3	-	2	5	-	-	-	-	4	-	-
Dinner Key	1	1	1	6	1	1	-	-	-	8	3	1
Coral Gables Waterway	2	-	-	3	-	2	1	-	-	2	-	2
Coral Bay	6	-	-	9	6	-	4	-	-	7	2	-
King's Bay	-	-	-	7	8	-	5	-	-	9	5	-
Ocean Reef	-	-	-	-	-	-	3	-	-	3	-	-
Other	3	-	-	8	7	3	2	-	-	6	4	3

(Index based on percent of scaled areal subtotals)
 (high and highest combined; 1 = highest, 10 = lowest)

storm's northwall and within the "dangerous semi-circle," account for high damaged vessel concentrations; about 325 cases were clustered in 4 (0.25 km²) locations (Figure 10).

Hurricane damaged vessels (Figure 4) were found onshore the mainland, nearshore within Biscayne Bay, and on the barrier islands. Fifty percent of the vessels were situated within the area bounded by Rickenbacker Causeway (north), King's Bay (south), including Virginia Key and Key Biscayne (Table 2, Figure 3). Vessels located in traditional storm havens ("hurricane holes"), as No Name Harbor and Hurricane Harbor (Key Biscayne), Miami River, Angelfish Creek (Key Largo), were sunken or damaged as were those at marinas and those docked in residential canals. The track of this Category 4 storm took aim at the area of highest concentration of floating recreational vessels in Dade County, Florida.

Hurricane Andrew's mainland landfall was near the Deering Estate and south of King's Bay. The 8 km open, shoal water area north of Soldier Key and south of Key Biscayne, known as Biscayne Flats and Safety Valve, left the floating recreational fleet completely exposed and vulnerable to the storm's most forceful winds and surge. The 3 m storm surge at Dinner Key washed over the spoil islands at Picnic Island Park where elevations are close to sea level (Rappaport, 1992). Entrance channels south of Dinner Key, at Coral Gables Waterway, Matheson Hammock Marina, Coral Bay, King's Bay, Black Point Marina, Homestead Bayfront Marina, oriented approximately east - west and open to Biscayne Bay, made access easy by storm surge. Much of the damage to vessels was caused by surge and resulted in sinkings at docks, empailments on pilings, pile-ups of vessels at canal junctures and termini (Figures 13-18).

2. Potential Impact Zones

While a majority of vessels were removed within two months, questions linger concerning the real and potential impact of 918 sunken and damaged vessels on public safety, navigation and environmental quality (USCGS, 1993). What types of baywater, tidal and shore habitats could have been impacted? Where might these potential impacts be found? Can a relative scale of impact be associated with location and habitat? Answers to these questions are found in the following section. The damaged/sunken vessel population used in this potential impact assessment includes the 918 hurricane damaged vessels, the derelict vessels existing prior the storm, and those found in January 1993 (Table 3, Figure 8).

The study region covers 874 km² (Table 4). An overlay of damaged vessels on habitat showed no vessels on "living" hardbottom (corals and sponges). Most vessels (59.14 percent) were on "non-living" barren substrate (dredged and undredged); 27.27 percent of vessels were on upland within 100 m of the shoreline; another 8.99 percent were on seagrasses. Only 2.30 percent of vessels were on mangroves.

The potentially impacted area is 2 orders of magnitude below the regional area. Five percent, 475.94 ha (100 ha = 1 km²), could have been

affected by vessel damage and sinkings (Table 5); 56.70 percent is at the low level, and the remainder is about equally divided in the medium and very high impact categories (Table 6).

Nine geographic areas of potential impact from hurricane and derelict vessel damage and sinkings were identified (Figure 13). Table 8 shows that Dinner Key covered the largest area (145.63 ha) followed by North Bay, Coral Gables Waterway, Key Biscayne, Virginia Key, Miami River.

When potential impact (low, medium, high, very high) on habitats (seagrasses, barren, mangrove, upland) was indexed to location, based on the percent of scaled areal subtotals with 1 = highest and 10 = lowest, (Table 9) the following results were obtained.

Dinner Key had the very highest potential impact on seagrasses (it scored first in all 3 levels - low, medium, high/very high); potential impact on barren was first in the medium and high/very high levels); potential impact on upland was first in the high/very high category, but third and eighth, respectively, in medium and low levels.

Table 9 shows, from another standpoint, that the potential impact of vessels on mangroves was low for several reasons: mangroves accounted for only 12.82 ha (2.69 percent) of the total potentially impacted area (this accounts for only low scaled readings); and mangroves were found underlying damaged vessels at only five sites. Coral Gables Waterway ranked first but at a low potential impact level.

A description of potential impacts at each of the 9 areas follows.

1- Dinner Key: very high potential impacts, on seagrasses south of the anchorage, on barren substrate at the marina and anchorage, and on upland along shore from Dinner Key Marina north to Biscayne Bay Yacht Club; medium potential impacts, in the lee of Fair Isle (south of Mercy Hospital), and in the nearshore zone from Sunrise Harbor north (Figure 14).

2- Key Biscayne: medium potential impacts on seagrasses and barren near Key Biscayne Yacht Club; low on barren substrate at No Name Harbor, Pines Canal, and Hurricane Harbor; low on seagrasses south of Crandon Marina, and, medium on barren substrate at Crandon Marina (Figure 15).

3- Virginia Key: medium potential impact on barren substrate and upland at Rickenbacker Marina; low on barren (dredged) in the Marine Stadium; low on upland along the spit west of the Stadium (Figure 16).

4- Miami River: medium potential impact on barren substrate downstream from the 7th Avenue Bridge and upstream halfway to and at the junction of South Fork; medium on upland at Nutta's Boat Yard and the Poland Yacht Basin (Figure 17).

5- Coral Gables Waterway: very high potential impact in the Waterway on barren (dredged) substrate and upland; low on upland and on barren in secondary canals principally at canal junctions and termini; very high potential impact on barren at Matheson Hammock Marina; low on seagrasses in the bay at isolated locations (Figure 18).

6- North Bay: medium potential impact on barren substrate at Normandy Isle and at the western end of Venetian Causeway; low on barren and upland on the north shore of North Bay Causeway; low on barren in Indian Creek and along Venetian Causeway; low on barren and upland at City Yacht Basin.

7- Coral Bay: medium to low potential impact on barren substrate and upland in the residential canal system; low on seagrasses on shore at the mouth of Snapper Creek.

8- King's Bay: medium on barren substrate at King's Bay Yacht and Country Club; low on upland adjoining the Club; low in canals west of Paradise Point.

9- Ocean Reef: low potential impact on isolated upland areas and within canals and basins (habitat undetermined), at Ocean Reef Club, Crayvik, and Key Largo Club.

VIII.

CONCLUSIONS

This mapping and assessment project of hurricane damaged vessels provides insights for boaters faced with imminent hurricane threat as well as for coastal managers concerned with post-storm recovery.

The message for boaters, marina managers and the marine insurance industry is somber. Expect significant boat damage if your vessel lies in the track of a Category 4 storm. The fate of Miami's moored recreational fleet was sealed when a storm, such as Andrew, with a 3 m storm surge, took aim at the Coral Gables - Dinner Key area on 24 August 1992.

Significant boat damage was related to several factors. Waterway entrances, open to seaward, allowed a rapidly rising dome of water to push unimpeded into the canal systems; this surge was 2 m at Homestead Bay Front, 4 m at Black Point, 5 m south of King's Bay, and 3 m at Dinner Key (Rappaport, 1992). The outer anchorage at Dinner Key was completely exposed to open water fetch as the hurricane moved westward across Biscayne Bay. The Picnic Islands offered little, if any, protection to the inner anchorage and to vessels docked at Dinner Key Marina, Grove Key Marina, Merrill-Stevens Dry Dock, Biscayne Bay Yacht Club, and Coral Reef Yacht Club. Only a diked basin and hurricane gate system would have guaranteed their protection.

The storm, furthermore, debunked the myth that "hurricane holes" provide adequate shelter for small-craft under such conditions. Most of these safe havens are dredged sites, with silt-mud soft bottoms. Stormwater runoff and deposition of fine textured flocculated sediments contribute to poor holding ground conditions at many of these sites.

A panel of experts concluded that the loss of life among the boating population would have been significantly higher during Hurricane Andrew had marinas exercised their lease requirement and forced boat owners to remove their vessels at Hurricane Watch time (IMI, 1993). Many more vessels would have sought shelter in so-called "safe havens." Dade County, subsequent to Hurricane Andrew, eliminated the forced evacuation clause from lease agreements at county marinas.

The results, also, raise a number of intriguing questions - why was there more damage to vessels at some locations than at other locations? And, at a particular location, why were some vessels spared while others were totally or partially wrecked? Is a vessel's vulnerability to storm damage a function of site (probability of storm occurrence, fetch, aspect, water depth), presence of a protective barrier, mooring (dock, davits, anchor), type of vessel, vigilance, experience, pre-storm preparation? In all likelihood, all of the above impinge on a vessel's survival, but how? And, to what degree

is one factor more important than another? A review of the historic record of localized impacts of storm events would provide invaluable insights.

The study offers coastal managers a method for defining the potential impact of damaged and sunken vessels on marine and shore habitats. Vessel locations were mapped and degree of damage was identified, as completely submerged, partially submerged, wrecked floating, wrecked aground. The study methodology provides a way of focusing scarce resources, during post-hurricane recovery, on potentially impacted zones by eliminating from further consideration areas where no apparent impact occurred. In the case of Hurricane Andrew and Biscayne Bay, application of this methodology narrowed the search area to 5.4 percent (4.75 km²) of the total region (874 km²).

Segmentation into discrete habitat zones, as shore upland, mangroves, seagrasses, barren substrate, provides further areal discrimination by revealing potential remediation needs, since vessel damage and sinking may affect each habitat in unique ways. Groundings may damage or destroy seagrasses and mangroves; debris may remain unnoticed in barren channels and obstruct navigation; wreckage may accumulate on uplands adjoining the shore and pose safety hazards. Categorizing damaged vessels by habitat and location, further, may assist post-hurricane mitigation by enabling recovery teams to task specific potentially impacted zones with specialized cleanup equipment and personnel: upland wreckage accessible by road; vessels and debris lying in mangroves and seagrasses reachable over shallow water; damaged vessels in navigable channels and deep water.

In the days following Hurricane Andrew's landfall, questions raised repeatedly were: how many vessels are damaged or destroyed? where are they situated? what threat do they pose to public safety, navigation, and the environment?

Answers to these questions required timely access to high resolution aerial photography and cloud penetrating satellite imagery. Unfortunately, the remote sensing products available after the storm were of marginally acceptable quality. Satellite imagery (SPOT, LANDSAT), available to the general public, was unapplicable because low resolution (10 m and 30 m, respectively) made vessel identification impossible. Aerial photo coverage was piecemeal and large segments of Biscayne Bay were not photographed, as the Safety Valve, Ragged Keys, and Monroe County portion.

Two private firms, specializing in cadastral surveys and land development, photographed segments of the disaster zone. Florida Department of Transportation (FDOT) photographed the barrier islands from Cape Florida (Key Biscayne) north to Ft. Lauderdale. The National Aeronautical and Space Administration (NASA) photographed the bay and adjoining shore but did not provide complete coverage. These missions were conducted within 2 weeks of Hurricane Andrew's landfall. National Ocean Service (NOS) photographed the entire area 4 months after the storm. The most useful imagery for this mapping and damage assessment project was 3"x5", hand-held oblique color photographs taken by a private firm.

Timely receipt of the photography was hampered by several factors. EROS Data Center and the National Cartographic Information Center (NCIC), primary sources for identifying existing photo coverages in the US, had no mechanism for placing users in contact with suppliers in cases requiring immediate photo missions following natural disasters. Determining photographic sources relied on an informal network.

Weather conditions, in the days following the storm, did not meet photo mission standards of private firms, state or federal agencies. Their mission standards, however, were based on the firm or agency's "normal" mission activities (e.g., cadastral, hydrographic, road surveys), not response to disaster relief requests. Private firms were inundated with orders for photography. Prints were received, in some cases, 4 to 10 weeks after orders were placed. Acquisition of aerial photography proved to be the most vexing task on this vessel damage assessment project.

Geographic information systems (GIS) technology made feasible mapping and analyzing the project's large relational data bases. However, a number of problems surfaced. Initial compilation tasks were performed on pc ARC/INFO. Since GIS applications on this project required large memory (RAM), data providers were asked to eliminate nonessential attribute data from source files. This caused some time delays. Shoreline matching from 4 source files -- TIGER (roads), NOS (benthic communities), USGS (vessel locations), NWI (mangroves) -- required extensive editing time. Overlay of roads (1:24,000 source) and shoreline (1:40,000 source) from different files placed roads in the water and proved unsuccessful. Only major arteries were included for general orientation. The digital NOS bathymetry file contained truncated contours at channel cuts, spoil bank and shoreline, which made its incorporation impractical. As the GIS task proceeded, work was transferred to a workstation ARC/INFO environment. This facilitated final plot production.

IX.

RECOMMENDATIONS

This report summarizes the application of remote sensing and GIS technology for siting hurricane damaged vessels and assessing their potential impact on nearshore ecosystems.

The critical factor in disaster assessment is the timely receipt of information upon which relief and recovery efforts can be executed. Massive destruction of roads and communications associated with hurricanes makes on-the-water and land surveys impractical.

State-of-the-art remote sensing systems, as thermal infrared, cloud penetrating radar, multi-channel imaging, high resolution photography, mounted on airborne and satellite platforms, and operated by Department of Defense (DOD) for military surveillance and intelligence gathering purposes, should be directed to provide federal, state, and local agencies with image products for disaster relief. DOD has the demonstrated capability to offer immediate delivery of imagery and photography.

Timely receipt of such information can only happen if a national system is in place, one that will automatically initiate aerial sorties and data gathering missions once hurricane landfall has been determined. As is the case of the national airborne weather reconnaissance system, that tracks hurricane movements prior to landfall, the creation of a national remote sensing system should be considered to image pre- and post-storm conditions.

The boating public needs to have addressed a number of key lessons from Hurricane Andrew. The results of this research provide a baseline of information on post-storm vessel location and damage. This information should be linked to pre-storm vessel location, condition and storm preparation, to explain why some vessels were damaged and others were not.

A more fundamental issue is whether a method can be developed to construct a vulnerability scale of the relative hazard potential of mooring sites to a range of storm events. This would permit a potential hazard ranking of boating facilities, private and public, marina and residential, docks and anchorages. Results of such follow-up research would provide boaters and the recreational marine industry with guidelines to better prepare for future similar storm events.

Boaters need to know bottom-holding characteristics and controlling entrance channel depths for storm havens. Some sites may or may not provide adequate protection under hurricane force conditions. The U.S. Navy provides information on "hurricane havens," for large vessel operators (Turpin and Brand, 1982). Recreational vessel owners' needs, similarly, should be addressed. Current efforts, by Florida Sea Grant and the (Florida) West Coast

Inland Navigation District, to map at large-scale selected recreational boat anchorages in southwest Florida is a step in this direction (Antonini and Zabler, 1992).

The threat of a hurricane landfall places some boaters in triple jeopardy: forced eviction from a marina facility under the eye of an advancing storm; adequate storm protection provision for their vessel; safe removal of the ship's crew to an inland location. The International Marina Institute initiated a dialogue between marina owners, vessel owners, and coastal managers to find an alternate strategy to forced vessel removals in times of approaching storms. There is consensus on the need to satisfactorily resolve this issue in a way that safeguards marina property, recreational vessels, and individuals alike.

Appendix 1: Sample FDNR Derelict Vessel Report

Derelict Vessel # _____
Date _____

FMP District _____ County _____ Chart Code No. _____

I. Description of Vessel

Registry Number _____
Vessel's Owner _____ Vessel's Name _____
Address _____ Approx. Length _____ Approx. Width _____
City _____ Hull Material _____
Motor: Yes _____ No _____ Type: Inboard _____ Outboard _____

II. Condition and Location of Vessel

Vessel Condition: Stored _____ Wrecked _____ Junked _____ Abandoned _____ Dismantled _____
Water Depth _____ ft. Permit granted for abandonment? Yes _____ No _____
By Whom? _____
Degree Submerged _____ at _____ tide level *
Vessel Location: (a) Upon public waters at _____ (b) at a port which is located at _____
If at a port, has the agency having jurisdiction given consent? _____ (c) at a private dock which is located at _____
If docked at private property, has the owner given consent? _____ Name/Address of Owner _____

III. Vessel's Effect on Environment/Navigation

- A. Obstructs or threatens to obstruct navigation? Yes _____ No _____ How? _____
- B. Contributes to air pollution? Yes _____ No _____ How? _____
- C. Contributes to water pollution? Yes _____ No _____ How? _____
- D. Constitutes a danger or a potential danger to the environment? Yes _____ No _____ In what way? _____
- E. Constitutes a potential health hazard? Yes _____ No _____ Type or nature of hazard? _____

IV. Vessel's Removal

Can it be towed without repair? Yes _____ No _____ Recommend Disposition: (a) Landfill _____
(b) Artificial Reef _____ (c) Leave as is for marine habitat _____ Estimated cost of removal _____

V. ***NOTE: TAKE AT LEAST TWO (2) COLOR PHOTOGRAPHS OF VESSEL FOR SUBMISSION ALONG WITH THIS REPORT. MARK THE PHOTOGRAPHS WITH THE DATE, TIME, PLACE AND SIGNATURE/TITLE OF THE PHOTOGRAPHER.

VI. COMMENTS (Use additional page if necessary) _____

Investing Officer & ID # _____

District Captain _____

Date _____

FLORIDA DEPARTMENT OF NATURAL RESOURCES
Division of Law Enforcement

01 Page of Pages

1. Date

2. Originating Office

3. 10-29 CHECK 4. OTHER AGENCY CASE NUMBERS 5. FMP CASE/COMPLAINT NUMBER

POS NEG

6. INFORMATION TOPIC

7. INFORMATION HAS BEEN RECEIVED THAT:

ADMINISTRATIVE INFORMATION BELOW FOR FLORIDA MARINE PATROL USE ONLY

8. SOURCE NAME OR NUMBER

9. DATE AND TIME INFORMATION RECEIVED

10. SOURCE ADDRESS

11. SIGNATURE OF OFFICER RECEIVING INFORMATION

12. REVIEWING OFFICER(S) DATE

13. INFORMATION EVALUATION

14. INVESTIGATION RECOMMENDATION

RELIABLE PLAUSIBLE IMPROBABLE

IMMEDIATE NORMAL OPEN

CLOSE INDEX

15. CASE ASSIGNED TO:

16. ASSIGNED BY: DATE

THIS REPORT IS THE PROPERTY OF THE FLORIDA MARINE PATROL, NEITHER IT NOR ITS CONTENTS MAY BE DISSEMINATED OUTSIDE THE AGENCY TO WHICH LOANED.



Date _____ Time _____
USGS Quad. _____
On Photo # _____
Derelict Vessel FMP # _____
Photo Roll # _____ Slide # _____
Field Observer _____

Appendix 2: Sample Field Data Form

1. Description Of Vessel:

Vessel Name _____
Registry # _____

Length (actual) (approx) _____
Width (actual) (approx) _____

Hull Material: fiberglass; wood; unknown; other _____
Motor: No Yes

2. Condition and Location of Vessel:

Vessel Condition:
Stored; Wrecked; Junked; Abandoned; Dismantled:
Comments: _____

Photo-Inspection Designation: Field Inspection Designation:

- | | |
|---------------------------------|----------|
| 1. - sunken fully submerged | 1. |
| 2. - sunken partially submerged | 2. |
| 3. - damaged but floating | 3. |
| 4. - damaged aground | 4. |
| 5. - unknown/other | 5. _____ |

Location: Private; Public; Protected Zone; Other _____
Specify _____

Accessible By Land; Water; Other _____

Water Depth _____ feet
Tide _____

3. Vessel's Effect on Environment / Navigation

1. Obstructs or threatens to obstruct navigation? N Y
2. Contributes to air pollution? N Y
3. Contributes to water pollution? N Y
Fuel; Flotsam; Waste; Other _____
4. Constitutes a danger or potential danger to public safety?

5. Constitutes a potential danger to the environment? N Y
6. Scenic Impairment? N Y

4. Additional Comments:

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
875	566049.8	2816706	Arsenicker Keys				X	
876	566916.9	2816392	Arsenicker Keys				X	
877	566880.3	2816296	Arsenicker Keys				X	
878	566896.8	2816366	Arsenicker Keys		X			
879	566177.8	2816165	Arsenicker Keys				X	
880	566220.9	2816167	Arsenicker Keys				X	
881	566215.2	2816167	Arsenicker Keys				X	
882	566273.8	2816168	Arsenicker Keys				X	
883	566316.9	2816172	Arsenicker Keys				X	
884	566277.6	2816065	Arsenicker Keys		X			
885	566271.8	2816126	Arsenicker Keys		X			
886	566232.4	2816050	Arsenicker Keys		X			
887	566229.6	2816062	Arsenicker Keys		X			
888	566226.7	2816128	Arsenicker Keys		X			
889	566216.1	2816071	Arsenicker Keys		X			
890	566189.3	2816060	Arsenicker Keys		X			
891	566189.3	2816113	Arsenicker Keys		X			
892	566274.7	2816104	Arsenicker Keys			X		
893	566230.6	2816054	Arsenicker Keys			X		
894	566227.7	2816085	Arsenicker Keys			X		
895	566227.7	2816081	Arsenicker Keys			X		
896	566226.7	2816108	Arsenicker Keys			X		
897	566192.2	2816067	Arsenicker Keys			X		
898	566174.9	2816119	Arsenicker Keys			X		
899	566268.9	2816138	Arsenicker Keys	X				
900	566189.3	2816107	Arsenicker Keys	X				
901	566175.9	2816111	Arsenicker Keys	X				
902	566161.5	2816086	Arsenicker Keys					X
903	566220.0	2816136	Arsenicker Keys					X
907	574421.6	2801683	Card Sound					X
908	574406.1	2801048	Card Sound				X	
909	574320.1	2801058	Card Sound				X	
910	574288.8	2801336	Card Sound				X	
911	574320.1	2801375	Card Sound				X	
912	572961.1	2800531	Card Sound			X		
913	573203.3	2800720	Card Sound			X		
914	573336.0	2801077	Card Sound			X		
915	573015.8	2800253	Card Sound			X		
916	571836.5	2800263	Card Sound			X		
917	571828.8	2800214	Card Sound			X		
918	572109.9	2800928	Card Sound			X		
919	573211.1	2800760	Card Sound				X	
920	573304.8	2801067	Card Sound				X	
921	573297.0	2801048	Card Sound				X	
922	573414.1	2801127	Card Sound				X	
923	572492.5	2800045	Card Sound					X
924	572102.0	2801127	Card Sound					X
925	571297.7	2799737	Card Sound					X
926	571836.5	2800243	Card Sound		X			

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
927	571735.0	2800233	Card Sound	X				
928	573172.1	2800710	Card Sound		X			
929	570989.8	2799600	Card Sound		X			
930	572493.0	2799540	Card Sound		X			
931	572426.8	2799540	Card Sound		X			
932	572459.9	2799540	Card Sound			X		
933	570696.8	2799017	Card Sound					X
934	571958.8	2799125	Card Sound					X
872	577343.1	2808795	Elliott Key				X	
873	581019.3	2815829	Elliott Key				X	
124	584072.3	2838785	Key Biscayne					X
125	583793.8	2839989	Key Biscayne				X	
126	584055.3	2839972	Key Biscayne				X	
127	584038.3	2839989	Key Biscayne				X	
128	584007.7	2839855	Key Biscayne		X			
129	584058.6	2839812	Key Biscayne		X			
130	583833.1	2840585	Key Biscayne			X		
131	583476.8	2840779	Key Biscayne			X		
132	583905.1	2840580	Key Biscayne		X			
133	583893.1	2840733	Key Biscayne		X			
134	583765.0	2840860	Key Biscayne					X
135	583821.1	2840865	Key Biscayne					X
136	583708.9	2840789	Key Biscayne					X
137	583608.9	2840753	Key Biscayne					X
138	583532.9	2840764	Key Biscayne					X
139	583676.9	2840768	Key Biscayne			X		
140	583924.4	2843806	Key Biscayne					X
141	584574.8	2844962	Key Biscayne	X				
142	584318.6	2845345	Key Biscayne	X				
143	584603.7	2845288	Key Biscayne		X			
144	584640.9	2845335	Key Biscayne		X			
145	584698.7	2845377	Key Biscayne		X			
146	584393.0	2845109	Key Biscayne			X		
147	584298.0	2845156	Key Biscayne				X	
148	584298.0	2845167	Key Biscayne				X	
149	584298.0	2845288	Key Biscayne			X		
150	584673.9	2845340	Key Biscayne			X		
151	584632.6	2845466	Key Biscayne			X		
152	584620.3	2845277	Key Biscayne			X		
153	584074.0	2846058	Key Biscayne		X			
154	584001.4	2846864	Key Biscayne				X	
155	583309.9	2847174	Key Biscayne				X	
156	583349.4	2847107	Key Biscayne				X	
160	582719.3	2847807	Key Biscayne		X			
161	582602.6	2847771	Key Biscayne		X			
162	582667.1	2847725	Key Biscayne		X			
163	582719.3	2847817	Key Biscayne				X	
164	582709.3	2847829	Key Biscayne	X				
165	582783.8	2847632	Key Biscayne			X		

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
166	582787.1	2847638	Key Biscayne			X		
167	582490.3	2847687	Key Biscayne				X	
168	581311.3	2847592	Key Biscayne			X		
169	580459.4	2847569	Key Biscayne				X	
170	580749.3	2847566	Key Biscayne				X	
171	581086.9	2847556	Key Biscayne				X	
172	580052.9	2847880	Key Biscayne				X	
173	580065.9	2847869	Key Biscayne				X	
174	580022.0	2847855	Key Biscayne				X	
175	580049.6	2847865	Key Biscayne		X			
176	579367.8	2847548	Key Biscayne				X	
177	579438.6	2847581	Key Biscayne				X	
178	579522.6	2847652	Key Biscayne				X	
179	579779.3	2847792	Key Biscayne				X	
180	579056.0	2847217	Key Biscayne					X
181	579139.2	2847220	Key Biscayne					X
182	579300.8	2847462	Key Biscayne					X
183	579092.8	2847001	Key Biscayne				X	
184	578079.9	2846849	Key Biscayne				X	
185	578138.0	2846861	Key Biscayne				X	
186	578129.1	2846811	Key Biscayne					X
187	578349.3	2846847	Key Biscayne					X
188	578484.6	2846844	Key Biscayne					X
189	578173.4	2846730	Key Biscayne			X		
190	577936.9	2846749	Key Biscayne			X		
191	578097.6	2846586	Key Biscayne	X				
192	578140.6	2846636	Key Biscayne	X				
193	578196.2	2846739	Key Biscayne	X				
194	578393.6	2846850	Key Biscayne	X				
195	578465.6	2846850	Key Biscayne	X				
196	578451.7	2846849	Key Biscayne		X			
197	578211.8	2846420	Key Biscayne				X	
198	578217.4	2846450	Key Biscayne			X		
199	578220.2	2846466	Key Biscayne			X		
200	578334.4	2846580	Key Biscayne		X			
201	577929.8	2846472	Key Biscayne				X	
202	577790.4	2846417	Key Biscayne				X	
203	577660.8	2846377	Key Biscayne				X	
204	577730.4	2846374	Key Biscayne					X
205	577541.1	2846343	Key Biscayne			X		
206	577536.7	2846351	Key Biscayne			X		
207	577536.7	2846366	Key Biscayne					X
208	577392.8	2846215	Key Biscayne					X
209	577265.3	2846244	Key Biscayne				X	
210	577311.3	2846232	Key Biscayne				X	
211	577411.3	2846005	Key Biscayne				X	
212	577492.5	2845886	Key Biscayne					X
213	577411.3	2845967	Key Biscayne					X
214	577264.6	2846094	Key Biscayne		X			

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
215	577197.5	2846050	Key Biscayne					X
216	577069.6	2846040	Key Biscayne				X	
217	577064.9	2845935	Key Biscayne		X			
218	577055.5	2845943	Key Biscayne	X				
219	577064.9	2845925	Key Biscayne	X				
220	577033.6	2845975	Key Biscayne		X			
221	577043.0	2845965	Key Biscayne		X			
222	577024.3	2845973	Key Biscayne			X		
223	577030.5	2845967	Key Biscayne			X		
224	576933.8	2846003	Key Biscayne					X
225	576982.2	2845953	Key Biscayne					X
226	577024.3	2845911	Key Biscayne					X
227	577038.3	2845884	Key Biscayne					X
228	577022.8	2845894	Key Biscayne					X
229	576975.9	2845945	Key Biscayne					X
230	576929.1	2846001	Key Biscayne			X		
231	576921.3	2845997	Key Biscayne			X		
232	576930.7	2845989	Key Biscayne			X		
233	576996.2	2845939	Key Biscayne			X		
234	577004.0	2845917	Key Biscayne			X		
235	576888.5	2845949	Key Biscayne				X	
236	576891.6	2845981	Key Biscayne				X	
237	576901.0	2845993	Key Biscayne				X	
238	576955.6	2845971	Key Biscayne		X			
239	576999.3	2845921	Key Biscayne		X			
240	577008.7	2845913	Key Biscayne		X			
241	576926.0	2845782	Key Biscayne		X			
242	576947.9	2845798	Key Biscayne		X			
243	576916.6	2845794	Key Biscayne	X				
244	576936.9	2845802	Key Biscayne	X				
245	577007.1	2845907	Key Biscayne	X				
246	577207.9	2846295	Key Biscayne				X	
247	576852.9	2845791	Key Biscayne				X	
248	576866.9	2845782	Key Biscayne				X	
249	576859.9	2845791	Key Biscayne				X	
250	576891.6	2845777	Key Biscayne					X
251	577037.9	2845311	Key Biscayne	X				
252	577027.0	2845323	Key Biscayne	X				
253	577021.6	2845334	Key Biscayne	X				
254	576919.7	2845450	Key Biscayne	X				
255	576921.5	2845471	Key Biscayne	X				
256	576968.8	2845591	Key Biscayne	X				
257	577007.0	2845552	Key Biscayne	X				
258	577028.8	2845535	Key Biscayne	X				
259	577019.7	2845566	Key Biscayne	X				
260	576841.4	2845445	Key Biscayne	X				
261	576854.3	2845431	Key Biscayne	X				
262	576890.6	2845392	Key Biscayne	X				
263	576928.8	2845341	Key Biscayne	X				

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
264	576936.1	2845323	Key Biscayne	X				
265	576968.8	2845279	Key Biscayne	X				
266	576912.4	2845318	Key Biscayne	X				
267	576903.3	2845272	Key Biscayne	X				
268	576717.8	2845397	Key Biscayne	X				
269	576801.5	2845311	Key Biscayne	X				
270	576852.4	2845235	Key Biscayne	X				
271	576816.1	2845216	Key Biscayne	X				
272	576763.3	2845318	Key Biscayne	X				
273	576725.1	2845351	Key Biscayne	X				
274	576712.3	2845371	Key Biscayne	X				
275	576750.5	2845228	Key Biscayne	X				
276	576668.7	2845316	Key Biscayne	X				
277	576694.2	2845279	Key Biscayne	X				
278	576746.9	2845195	Key Biscayne	X				
279	576916.5	2845565	Key Biscayne		X			
280	576966.9	2845520	Key Biscayne		X			
281	576985.3	2845487	Key Biscayne		X			
282	576968.4	2845396	Key Biscayne		X			
283	576983.8	2845409	Key Biscayne		X			
284	576983.8	2845372	Key Biscayne		X			
285	577015.9	2845341	Key Biscayne		X			
286	577025.1	2845365	Key Biscayne		X			
287	576833.9	2845435	Key Biscayne		X			
288	576838.4	2845427	Key Biscayne		X			
289	576858.3	2845407	Key Biscayne		X			
290	576881.3	2845382	Key Biscayne		X			
291	576887.4	2845374	Key Biscayne		X			
292	576945.5	2845316	Key Biscayne		X			
293	576983.8	2845269	Key Biscayne		X			
294	576965.4	2845273	Key Biscayne		X			
295	576957.8	2845300	Key Biscayne		X			
296	576965.4	2845291	Key Biscayne		X			
297	576942.5	2845293	Key Biscayne		X			
298	576795.6	2845491	Key Biscayne		X			
299	576754.3	2845440	Key Biscayne		X			
300	576752.8	2845427	Key Biscayne		X			
301	576769.6	2845413	Key Biscayne		X			
302	576777.3	2845382	Key Biscayne		X			
303	576810.9	2845372	Key Biscayne		X			
304	576829.3	2845357	Key Biscayne		X			
305	576846.1	2845339	Key Biscayne		X			
306	576858.3	2845324	Key Biscayne		X			
308	576833.9	2845326	Key Biscayne		X			
309	576893.6	2845275	Key Biscayne		X			
310	576905.8	2845261	Key Biscayne		X			
311	576921.1	2845273	Key Biscayne		X			
312	576910.4	2845281	Key Biscayne		X			
315	576872.1	2845314	Key Biscayne		X			

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
316	576890.4	2845297	Key Biscayne		X			
317	576878.3	2845289	Key Biscayne		X			
318	576872.1	2845293	Key Biscayne		X			
319	576719.1	2845435	Key Biscayne		X			
320	576745.1	2845359	Key Biscayne		X			
321	576757.4	2845341	Key Biscayne		X			
322	576734.4	2845343	Key Biscayne		X			
323	576838.4	2845269	Key Biscayne		X			
324	576827.8	2845277	Key Biscayne		X			
325	576815.5	2845263	Key Biscayne		X			
326	576800.3	2845275	Key Biscayne		X			
327	576795.6	2845285	Key Biscayne		X			
328	576813.9	2845294	Key Biscayne		X			
329	576654.9	2845374	Key Biscayne		X			
330	576657.9	2845333	Key Biscayne		X			
331	576679.4	2845308	Key Biscayne		X			
332	576703.8	2845271	Key Biscayne		X			
333	576711.4	2845263	Key Biscayne		X			
334	576729.9	2845273	Key Biscayne		X			
335	576763.5	2845205	Key Biscayne		X			
336	576737.5	2845217	Key Biscayne		X			
337	576723.8	2845244	Key Biscayne		X			
338	576743.6	2845203	Key Biscayne		X			
339	576517.2	2845472	Key Biscayne		X			
340	576982.3	2845520	Key Biscayne			X		
341	576979.2	2845510	Key Biscayne			X		
342	576979.2	2845378	Key Biscayne			X		
343	576976.2	2845386	Key Biscayne			X		
344	576989.9	2845396	Key Biscayne			X		
345	576996.1	2845386	Key Biscayne			X		
346	577018.9	2845370	Key Biscayne			X		
347	576996.1	2845359	Key Biscayne			X		
348	576847.6	2845438	Key Biscayne			X		
349	576869.0	2845413	Key Biscayne			X		
350	576896.6	2845384	Key Biscayne			X		
351	576902.7	2845378	Key Biscayne			X		
352	576953.2	2845310	Key Biscayne			X		
353	576959.3	2845310	Key Biscayne			X		
354	576974.6	2845285	Key Biscayne			X		
355	576985.3	2845256	Key Biscayne			X		
356	576974.6	2845263	Key Biscayne			X		
357	576968.4	2845256	Key Biscayne			X		
358	576960.9	2845279	Key Biscayne			X		
359	576948.6	2845297	Key Biscayne			X		
360	576933.3	2845302	Key Biscayne			X		
361	576927.2	2845308	Key Biscayne			X		
362	576922.6	2845314	Key Biscayne			X		
363	576901.2	2845324	Key Biscayne			X		
364	576896.6	2845330	Key Biscayne			X		

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
365	576893.6	2845361	Key Biscayne			X		
366	576872.1	2845394	Key Biscayne			X		
367	576748.2	2845419	Key Biscayne			X		
368	576728.3	2845384	Key Biscayne			X		
369	576806.4	2845314	Key Biscayne			X		
370	576795.6	2845293	Key Biscayne			X		
371	576787.9	2845294	Key Biscayne			X		
372	576809.4	2845294	Key Biscayne			X		
373	576815.5	2845302	Key Biscayne			X		
374	576821.6	2845289	Key Biscayne			X		
375	576673.3	2845310	Key Biscayne			X		
376	576737.5	2845234	Key Biscayne			X		
377	576743.6	2845197	Key Biscayne			X		
378	576478.9	2845464	Key Biscayne			X		
379	576488.1	2845464	Key Biscayne			X		
380	576546.3	2845452	Key Biscayne			X		
381	576549.3	2845448	Key Biscayne			X		
382	576553.9	2845442	Key Biscayne			X		
383	576560.0	2845436	Key Biscayne			X		
384	576563.1	2845433	Key Biscayne			X		
385	576547.8	2845438	Key Biscayne			X		
386	576552.4	2845431	Key Biscayne			X		
387	576977.7	2845602	Key Biscayne				X	
388	576973.1	2845514	Key Biscayne				X	
389	576937.9	2845448	Key Biscayne				X	
390	577003.7	2845366	Key Biscayne				X	
391	576852.3	2845411	Key Biscayne				X	
392	576881.3	2845404	Key Biscayne				X	
393	576907.3	2845332	Key Biscayne				X	
394	576940.9	2845302	Key Biscayne				X	
395	576749.8	2845483	Key Biscayne				X	
396	576847.6	2845326	Key Biscayne				X	
397	576893.6	2845287	Key Biscayne				X	
398	576578.4	2845440	Key Biscayne				X	
399	576677.8	2845316	Key Biscayne				X	
400	576762.0	2845221	Key Biscayne				X	
401	576766.6	2845213	Key Biscayne				X	
402	577040.4	2845551	Key Biscayne					X
403	576852.3	2845310	Key Biscayne					X
404	576340.9	2845358	Key Biscayne		X			
405	576488.9	2845505	Key Biscayne		X			
406	576449.3	2845498	Key Biscayne			X		
407	576342.4	2845429	Key Biscayne				X	
408	576307.3	2845423	Key Biscayne				X	
409	576444.9	2845509	Key Biscayne				X	
410	576481.5	2845526	Key Biscayne				X	
411	576433.2	2845507	Key Biscayne				X	
412	576411.3	2845501	Key Biscayne				X	
413	576875.8	2845546	Key Biscayne				X	

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
414	577086.3	2845536	Key Biscayne				X	
415	577117.4	2845516	Key Biscayne				X	
416	577125.3	2845437	Key Biscayne				X	
417	577082.4	2845516	Key Biscayne				X	
418	577140.8	2845427	Key Biscayne				X	
419	577117.4	2845407	Key Biscayne				X	
420	577105.8	2845432	Key Biscayne				X	
421	577094.1	2845452	Key Biscayne				X	
422	577098.0	2845471	Key Biscayne				X	
423	577098.0	2845486	Key Biscayne				X	
424	577129.1	2845466	Key Biscayne				X	
425	576847.0	2845182	Key Biscayne	X				
426	576889.1	2845198	Key Biscayne	X				
427	576939.4	2845230	Key Biscayne	X				
428	576424.8	2845137	Key Biscayne	X				
429	576960.4	2845225	Key Biscayne		X			
430	576918.4	2845134	Key Biscayne		X			
431	576414.3	2845043	Key Biscayne	X				
432	576424.8	2844953	Key Biscayne	X				
433	577013.0	2845124	Key Biscayne					X
434	576338.7	2845083	Key Biscayne			X		
435	576321.9	2845105	Key Biscayne			X		
436	576345.0	2845102	Key Biscayne			X		
437	576391.2	2844931	Key Biscayne			X		
438	576353.4	2844905	Key Biscayne			X		
439	576414.3	2844899	Key Biscayne			X		
440	576473.1	2845145	Key Biscayne				X	
441	576510.9	2845164	Key Biscayne				X	
442	576725.2	2845110	Key Biscayne				X	
443	576811.3	2845027	Key Biscayne					X
444	576447.9	2845129	Key Biscayne					X
445	576117.9	2845194	Key Biscayne				X	
446	576089.4	2845225	Key Biscayne				X	
447	576030.6	2845103	Key Biscayne				X	
448	576025.8	2845113	Key Biscayne				X	
449	576011.6	2845049	Key Biscayne				X	
450	576017.9	2845037	Key Biscayne				X	
451	576008.4	2845071	Key Biscayne				X	
452	576017.9	2844964	Key Biscayne				X	
453	575917.8	2844851	Key Biscayne				X	
454	575889.3	2844881	Key Biscayne				X	
455	576127.5	2845275	Key Biscayne					X
456	576097.3	2845115	Key Biscayne					X
457	576021.1	2845097	Key Biscayne					X
458	576111.6	2845105	Key Biscayne	X				
459	576041.8	2845057	Key Biscayne			X		
460	575757.9	2844696	Key Biscayne				X	
461	575591.6	2844537	Key Biscayne				X	
462	575666.4	2844452	Key Biscayne				X	

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
464	575764.2	2844555	Key Biscayne			X		
465	575631.1	2844508	Key Biscayne			X		
466	575516.6	2844389	Key Biscayne			X		
467	575708.1	2844529	Key Biscayne		X			
468	575772.5	2844402	Key Biscayne	X				
469	575793.4	2844381	Key Biscayne	X				
470	575531.2	2844384	Key Biscayne				X	
472	575624.9	2844331	Key Biscayne			X		
473	575572.8	2844357	Key Biscayne			X		
474	575568.6	2844347	Key Biscayne			X		
475	575562.4	2844354	Key Biscayne			X		
486	575629.3	2843049	Key Biscayne				X	
487	575618.4	2843125	Key Biscayne				X	
491	575506.6	2843070	Key Biscayne	X				
492	577487.6	2845438	Key Biscayne		X			
493	577205.8	2845373	Key Biscayne		X			
494	577231.4	2845326	Key Biscayne		X			
495	577227.8	2845363	Key Biscayne		X			
496	577253.3	2845322	Key Biscayne		X			
497	577246.1	2845396	Key Biscayne		X			
498	577366.8	2845298	Key Biscayne		X			
499	577462.0	2845122	Key Biscayne		X			
500	577542.5	2845122	Key Biscayne		X			
501	577586.4	2844982	Key Biscayne		X			
502	577681.6	2844870	Key Biscayne		X			
503	576605.6	2845019	Key Biscayne		X			
504	576784.9	2844940	Key Biscayne		X			
505	576784.9	2844870	Key Biscayne		X			
506	576839.8	2844959	Key Biscayne		X			
507	576880.1	2844922	Key Biscayne		X			
508	576927.7	2844889	Key Biscayne		X			
509	576934.9	2844870	Key Biscayne		X			
510	576836.2	2844880	Key Biscayne		X			
511	576960.6	2845080	Key Biscayne		X			
512	576986.2	2845103	Key Biscayne		X			
513	577044.8	2845136	Key Biscayne		X			
514	577044.8	2845168	Key Biscayne		X			
515	577103.3	2845187	Key Biscayne		X			
516	577008.1	2845042	Key Biscayne		X			
517	577044.8	2845042	Key Biscayne		X			
518	577055.7	2845080	Key Biscayne		X			
519	577106.9	2845154	Key Biscayne		X			
520	577117.9	2845126	Key Biscayne		X			
521	577110.7	2845098	Key Biscayne		X			
522	577121.6	2845075	Key Biscayne		X			
523	577180.2	2845047	Key Biscayne		X			
524	577205.8	2845108	Key Biscayne		X			
525	577191.1	2845159	Key Biscayne		X			
526	577235.1	2845112	Key Biscayne		X			

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
527	577366.8	2845052	Key Biscayne		X			
528	577026.4	2844931	Key Biscayne		X			
529	577132.6	2844945	Key Biscayne		X			
530	577128.9	2844898	Key Biscayne		X			
531	577158.2	2844898	Key Biscayne		X			
532	577319.3	2844898	Key Biscayne		X			
533	577326.6	2844968	Key Biscayne		X			
534	577392.4	2844884	Key Biscayne		X			
535	577385.2	2844866	Key Biscayne		X			
536	576814.2	2845145	Key Biscayne		X			
537	576590.9	2845284	Key Biscayne		X			
538	576609.2	2845261	Key Biscayne		X			
539	576572.6	2845280	Key Biscayne		X			
540	577088.7	2845052	Key Biscayne		X			
541	577081.3	2845122	Key Biscayne		X			
542	577030.1	2845080	Key Biscayne		X			
543	577059.4	2845187	Key Biscayne		X			
544	577088.7	2845210	Key Biscayne		X			
545	577070.4	2845164	Key Biscayne		X			
546	576971.6	2845010	Key Biscayne		X			
547	576982.6	2845131	Key Biscayne		X			
548	577213.1	2845382	Key Biscayne	X				
549	577315.6	2845359	Key Biscayne	X				
550	577224.1	2845415	Key Biscayne			X		
551	577348.6	2845387	Key Biscayne			X		
552	577399.8	2845233	Key Biscayne			X		
553	577359.6	2845177	Key Biscayne			X		
554	577308.3	2845173	Key Biscayne			X		
555	577074.1	2845010	Key Biscayne			X		
556	577187.5	2845001	Key Biscayne			X		
557	577191.1	2845015	Key Biscayne			X		
558	577392.4	2845070	Key Biscayne			X		
559	577377.8	2844959	Key Biscayne			X		
560	576623.9	2845196	Key Biscayne			X		
562	582902.3	2841527	Key Biscayne			X		
563	582902.3	2841521	Key Biscayne			X		
564	582851.1	2841527	Key Biscayne			X		
565	582744.3	2841126	Key Biscayne		X			
566	583287.8	2842384	Key Biscayne			X		
567	583296.6	2842406	Key Biscayne			X		
568	583287.8	2842406	Key Biscayne			X		
569	583281.2	2842403	Key Biscayne			X		
570	583276.8	2842409	Key Biscayne			X		
571	583239.5	2842406	Key Biscayne			X		
572	583250.5	2842428	Key Biscayne			X		
573	583329.5	2842451	Key Biscayne			X		
574	583340.5	2842470	Key Biscayne			X		
575	583329.5	2842476	Key Biscayne			X		
576	583309.8	2842490	Key Biscayne			X		

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
577	583287.8	2842503	Key Biscayne			X		
578	583283.4	2842509	Key Biscayne			X		
579	583259.3	2842442	Key Biscayne		X			
580	575989.9	2843240	Key Biscayne					X
581	576318.6	2842359	Key Biscayne		X			
582	575949.4	2841113	Key Biscayne		X			
3	583444.9	2859123	Miami	X				
4	582140.6	2857397	Miami	X				
5	582140.6	2857382	Miami	X				
6	582154.3	2857391	Miami	X				
7	582152.4	2857399	Miami		X			
8	582158.1	2857367	Miami		X			
9	582142.6	2857365	Miami		X			
10	582110.1	2857403	Miami				X	
11	582104.4	2857392	Miami				X	
12	582213.3	2857661	Miami				X	
13	582201.9	2857650	Miami				X	
14	587642.4	2858658	Miami					X
15	587872.8	2857758	Miami					X
16	587798.4	2857056	Miami					X
17	587840.9	2857333	Miami				X	
18	587927.4	2856957	Miami	X				
19	587757.3	2855994	Miami			X		
20	587873.3	2856102	Miami		X			
21	587142.5	2855835	Miami					X
22	587743.9	2855906	Miami			X		
23	587861.9	2855826	Miami		X			
24	587825.0	2855521	Miami		X			
26	587676.3	2854687	Miami					X
27	587608.7	2854466	Miami				X	
28	586412.0	2850056	Miami			X		
29	586325.1	2850222	Miami			X		
30a	586298.9	2850271	Miami		X			
30b	583132.9	2858921	Miami		X			
30c	583132.9	2858921	Miami		X			
30d	586298.9	2850271	Miami		X			
31	582912.1	2858978	Miami		X			
32	582818.5	2859168	Miami					X
33	582138.1	2858763	Miami				X	
34	581932.7	2858804	Miami				X	
35	581941.6	2858809	Miami				X	
36	581955.9	2858815	Miami				X	
37	582082.8	2858799	Miami		X			
38	581859.4	2858759	Miami		X			
39	581696.8	2858713	Miami	X				
40	581798.7	2858720	Miami					X
41	582772.5	2858515	Miami				X	
42	582256.8	2858659	Miami				X	
43	582282.0	2858635	Miami				X	

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
44	582759.8	2858543	Miami		X			
45	582157.3	2856953	Miami				X	
46	581964.3	2855921	Miami			X		
47	581624.6	2855154	Miami				X	
48	581505.1	2854006	Miami				X	
49	581513.4	2853980	Miami	X				
50	581536.0	2853998	Miami			X		
51	581658.4	2852371	Miami				X	
52	581644.1	2852528	Miami			X		
53	581647.0	2852471	Miami			X		
54	581719.9	2852430	Miami			X		
55	581711.4	2852573	Miami			X		
56	581760.0	2852471	Miami					X
57	581580.8	2851311	Miami			X		
58	581576.3	2851210	Miami			X		
59	581749.0	2851030	Miami				X	
60	580125.9	2850569	Miami			X		
61	580093.1	2850625	Miami					X
62	579954.8	2850894	Miami					X
63	579849.3	2850868	Miami					X
64	579730.5	2851037	Miami			X		
65	579537.3	2851160	Miami			X		
66	579545.1	2851160	Miami			X		
67	579048.8	2851518	Miami					X
68	578898.8	2851540	Miami					X
70	578706.9	2851601	Miami				X	
71	578387.0	2851784	Miami					X
72	577485.9	2852009	Miami					X
74	577474.2	2852156	Miami					X
75	577782.3	2852099	Miami			X		
76	577356.6	2851872	Miami				X	
77	577394.2	2852153	Miami		X			
78	577039.1	2852440	Miami					X
79	576965.1	2852457	Miami				X	
80	576938.3	2852382	Miami			X		
81	576959.8	2852419	Miami			X		
82	575742.1	2853009	Miami				X	
83	576106.8	2852828	Miami				X	
84	581660.7	2852652	Miami		X			
85	585160.5	2848785	Miami				X	
86	581373.7	2849657	Miami			X		
87	581378.6	2849707	Miami			X		
88	581373.7	2849608	Miami			X		
89	581354.3	2849589	Miami					X
90	580888.8	2848631	Miami					X
92	580286.9	2848214	Miami				X	
93	580358.1	2848292	Miami				X	
94	580533.8	2848389	Miami				X	
95	580267.9	2848216	Miami					X

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
96	580381.8	2848304	Miami					X
97	580470.4	2848306	Miami					X
98	580604.9	2848415	Miami					X
99	580475.2	2848316	Miami		X			
100	580549.6	2848379	Miami		X			
101	580568.5	2848365	Miami		X			
102	580467.3	2848320	Miami			X		
103	580560.6	2848387	Miami			X		
104	580565.3	2848383	Miami			X		
105	580554.3	2848393	Miami			X		
106	580601.8	2848403	Miami			X		
107	580593.8	2848407	Miami				X	
108	582954.3	2852633	Miami			X		
109	582908.6	2852629	Miami			X		
110	582638.5	2852616	Miami			X		
111	582895.7	2852393	Miami			X		
112	583133.3	2852625	Miami			X		
113	583025.9	2851540	Miami			X		
114	582335.8	2851925	Miami			X		
115	583012.8	2851503	Miami				X	
116	583035.6	2851557	Miami				X	
117	583006.3	2851569	Miami				X	
118	582937.9	2851826	Miami				X	
119	582950.9	2851797	Miami				X	
120	582762.2	2852157	Miami				X	
121	582690.6	2852633	Miami					X
122	582563.6	2852616	Miami					X
157	583036.5	2848201	Miami	X				
158	583007.4	2848127	Miami				X	
159	582832.6	2848049	Miami				X	
813	567001.4	2824400	Perrine			X		
814	567012.1	2824398	Perrine			X		
815	567021.0	2824389	Perrine			X		
816	567074.5	2824398	Perrine			X		
817	567083.4	2824405	Perrine			X		
818	567090.6	2824396	Perrine			X		
819	567097.7	2824403	Perrine			X		
820	567220.8	2824521	Perrine			X		
821	567236.9	2824523	Perrine			X		
822	567238.6	2824596	Perrine			X		
823	567308.2	2824514	Perrine			X		
824	567286.8	2824596	Perrine			X		
825	567286.8	2824625	Perrine			X		
826	567304.6	2824568	Perrine			X		
827	567374.2	2824541	Perrine			X		
828	567354.6	2824593	Perrine			X		
829	567359.9	2824600	Perrine			X		
830	567352.8	2824605	Perrine			X		
831	567418.8	2824528	Perrine			X		

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
832	567417.0	2824543	Perrine			X		
833	567413.5	2824593	Perrine			X		
834	567411.7	2824586	Perrine			X		
835	567417.0	2824580	Perrine			X		
836	567417.0	2824623	Perrine			X		
837	567413.5	2824648	Perrine			X		
838	566910.4	2824478	Perrine				X	
839	566940.7	2824471	Perrine				X	
840	567574.0	2824453	Perrine				X	
841	567297.6	2824534	Perrine				X	
842	567297.6	2824589	Perrine				X	
843	567297.6	2824616	Perrine				X	
844	567376.1	2824525	Perrine				X	
845	567374.2	2824618	Perrine				X	
846	567433.1	2824543	Perrine				X	
847	567433.1	2824530	Perrine				X	
848	567422.4	2824571	Perrine				X	
849	567424.1	2824555	Perrine				X	
850	567422.4	2824589	Perrine				X	
851	567420.6	2824618	Perrine				X	
852	567425.9	2824612	Perrine				X	
853	567424.1	2824609	Perrine				X	
854	567422.4	2824600	Perrine				X	
855	567429.6	2824596	Perrine				X	
856	567424.1	2824593	Perrine				X	
857	567415.3	2824641	Perrine				X	
858	567422.4	2824648	Perrine				X	
859	567220.8	2824502	Perrine		X			
860	567236.9	2824505	Perrine		X			
861	567302.8	2824607	Perrine		X			
862	567290.4	2824650	Perrine		X			
863	567381.4	2824534	Perrine		X			
864	567377.8	2824514	Perrine		X			
865	567376.1	2824591	Perrine		X			
866	567376.1	2824568	Perrine		X			
867	567358.2	2824627	Perrine		X			
868	567420.6	2824680	Perrine		X			
869	567449.1	2824725	Perrine					X
870	567558.3	2824484	Perrine				X	
806	584173.6	2830356	Soldier Key		X			
807	584155.1	2830346	Soldier Key		X			
808	582937.3	2823311	Soldier Key					X
809	582820.5	2823076	Soldier Key			X		
810	582348.3	2820735	Soldier Key				X	
811	582242.1	2820846	Soldier Key				X	
463	575456.3	2844405	South Miami				X	
471	575344.0	2844193	South Miami				X	
476	575354.8	2844081	South Miami		X			
477	575237.3	2843753	South Miami		X			

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
478	575416.1	2843779	South Miami	X				
479	575224.4	2844100	South Miami					X
480	575308.8	2843857	South Miami					X
481	575319.0	2843918	South Miami			X		
482	575296.0	2843756	South Miami			X		
483	575232.1	2843756	South Miami			X		
484	575216.8	2843753	South Miami			X		
485	575278.1	2843769	South Miami				X	
488	575479.4	2843025	South Miami				X	
489	575364.9	2842917	South Miami				X	
490	575473.9	2843090	South Miami				X	
583	575201.3	2843060	South Miami				X	
585	575214.1	2843096	South Miami				X	
586	575134.5	2843066	South Miami				X	
587	574230.2	2843118	South Miami				X	
588	574808.2	2842749	South Miami				X	
589	575142.9	2842813	South Miami	X				
590	575073.2	2842962	South Miami		X			
591	575073.2	2842938	South Miami		X			
592	574964.7	2842860	South Miami		X			
593	574690.9	2843070	South Miami		X			
594	574634.1	2842801	South Miami		X			
595	574597.9	2843067	South Miami			X		
596	574605.7	2843067	South Miami			X		
597	574644.4	2842801	South Miami			X		
598	574672.8	2843067	South Miami					X
599	574417.2	2842998	South Miami					X
600	574920.8	2842882	South Miami					X
601	574605.3	2842238	South Miami					X
602	574352.8	2842320	South Miami					X
603	574568.6	2842396	South Miami				X	
604	574196.8	2842256	South Miami				X	
605	574541.1	2842268	South Miami			X		
606	573985.5	2841835	South Miami			X		
607	575172.7	2841465	South Miami				X	
608	574723.7	2841755	South Miami				X	
609	573825.7	2841695	South Miami				X	
610	573847.4	2841714	South Miami				X	
611	573811.3	2841603	South Miami				X	
612	575031.4	2841428	South Miami			X		
613	574035.7	2841410	South Miami			X		
614	573782.2	2841677	South Miami			X		
615	575220.9	2841340	South Miami				X	
616	574855.7	2841370	South Miami				X	
617	574821.5	2841422	South Miami				X	
618	574797.6	2841427	South Miami				X	
619	574732.8	2841427	South Miami				X	
620	574207.1	2841236	South Miami				X	
621	574439.2	2840997	South Miami				X	

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
622	573715.5	2840915	South Miami				X	
623	573517.5	2840958	South Miami				X	
624	573520.9	2840893	South Miami				X	
625	573520.9	2840875	South Miami				X	
626	575190.2	2841392	South Miami					X
627	574691.8	2841105	South Miami					X
628	574172.9	2841010	South Miami					X
629	574370.9	2841036	South Miami					X
630	573537.9	2840828	South Miami			X		
631	573766.7	2840862	South Miami			X		
632	573749.7	2840884	South Miami		X			
633	574180.9	2840542	South Miami				X	
634	574166.1	2840551	South Miami				X	
635	574158.8	2840548	South Miami				X	
636	573813.5	2840539	South Miami				X	
637	573875.2	2840542	South Miami				X	
638	574422.6	2840253	South Miami				X	
639	574388.1	2840310	South Miami				X	
640	574343.7	2840335	South Miami				X	
641	573973.8	2840244	South Miami				X	
642	573949.1	2840272	South Miami				X	
643	573959.1	2840291	South Miami				X	
644	573944.2	2840259	South Miami				X	
645	573902.3	2840294	South Miami				X	
646	574040.4	2840363	South Miami				X	
647	574030.6	2840313	South Miami				X	
648	574033.0	2840303	South Miami				X	
649	573362.3	2840535	South Miami					X
650	573391.8	2840661	South Miami		X			
651	574309.2	2840043	South Miami		X			
652	574057.6	2840272	South Miami		X			
653	574074.9	2840325	South Miami		X			
654	574097.1	2840281	South Miami		X			
655	574119.3	2840291	South Miami			X		
656	574092.2	2840294	South Miami			X		
657	574084.8	2840306	South Miami			X		
658	574065.1	2840291	South Miami			X		
659	574018.2	2840272	South Miami			X		
660	574037.9	2840247	South Miami			X		
661	574025.6	2840262	South Miami	X				
662	574074.9	2840275	South Miami	X				
663	574288.6	2839467	South Miami		X			
664	573972.1	2839012	South Miami					X
665	573917.1	2838837	South Miami					X
666	573752.1	2838697	South Miami				X	
667	573669.5	2838557	South Miami				X	
668	572894.6	2839306	South Miami					X
669	572810.0	2838316	South Miami				X	
670	573470.5	2837827	South Miami					X

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
671	573435.8	2837636	South Miami					X
672	573470.5	2837915	South Miami				X	
673	572403.2	2837546	South Miami		X			
674	572424.8	2837091	South Miami		X			
675	572400.8	2837338	South Miami				X	
676	572321.6	2837320	South Miami				X	
677	572271.2	2837335	South Miami				X	
678	572364.8	2837161	South Miami				X	
679	572307.1	2837122	South Miami				X	
680	572540.1	2837021	South Miami				X	
681	572609.8	2837152	South Miami				X	
682	572662.6	2837109	South Miami				X	
683	572415.2	2837238	South Miami		X			
684	572314.4	2837259	South Miami		X			
685	572432.1	2837372	South Miami			X		
686	572347.9	2837271	South Miami			X		
687	572626.6	2837143	South Miami			X		
688	572604.9	2836835	South Miami					X
689	573597.8	2837214	South Miami				X	
690	573406.5	2837227	South Miami				X	
691	573382.9	2837278	South Miami				X	
692	573285.6	2837111	South Miami				X	
693	572787.9	2837039	South Miami				X	
694	572829.4	2836888	South Miami				X	
695	572829.4	2836915	South Miami				X	
696	572865.3	2837046	South Miami				X	
697	572859.6	2837039	South Miami				X	
698	572931.3	2836982	South Miami				X	
699	572931.3	2836967	South Miami				X	
700	572982.2	2836967	South Miami				X	
701	572867.2	2837118	South Miami				X	
702	573027.5	2836962	South Miami				X	
703	573042.6	2836799	South Miami				X	
704	573163.3	2837171	South Miami				X	
705	573197.2	2837166	South Miami				X	
706	573212.3	2837111	South Miami				X	
707	573138.7	2836728	South Miami				X	
708	573138.7	2837171	South Miami			X		
709	573285.8	2837157	South Miami			X		
710	573214.1	2836819	South Miami			X		
711	573072.7	2836869	South Miami			X		
712	572863.4	2836821	South Miami					X
713	572921.8	2836814	South Miami					X
714	572938.9	2836802	South Miami					X
715	572967.1	2836948	South Miami					X
716	572737.0	2837118	South Miami					X
717	573131.2	2837109	South Miami					X
718	573225.4	2837123	South Miami					X
719	573249.9	2837174	South Miami					X

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
720	574109.3	2840302	South Miami	X				
721	574102.0	2840307	South Miami	X				
722	574084.3	2840322	South Miami	X				
723	574057.7	2840223	South Miami	X				
724	574044.5	2840243	South Miami	X				
725	574239.2	2840326	South Miami	X				
726	574190.4	2840281	South Miami	X				
727	574203.8	2840272	South Miami	X				
728	574219.9	2840290	South Miami	X				
729	574255.4	2840255	South Miami	X				
730	574261.3	2840260	South Miami	X				
731	574354.1	2840238	South Miami	X				
732	574317.3	2840187	South Miami	X				
733	574376.3	2840185	South Miami	X				
734	574355.6	2840165	South Miami	X				
735	574326.1	2840146	South Miami	X				
736	574379.3	2840150	South Miami	X				
737	574357.1	2840125	South Miami		X			
738	574382.2	2840133	South Miami		X			
739	574388.1	2840140	South Miami		X			
740	574395.4	2840148	South Miami		X			
741	574414.7	2840163	South Miami		X			
742	574405.8	2840174	South Miami		X			
743	574395.4	2840200	South Miami		X			
744	574394.0	2840217	South Miami		X			
745	574293.7	2840287	South Miami		X			
746	574261.3	2840326	South Miami		X			
747	574224.4	2840296	South Miami		X			
748	574079.9	2840266	South Miami		X			
749	574045.9	2840298	South Miami		X			
750	574015.0	2840275	South Miami		X			
751	574059.2	2840230	South Miami			X		
752	574234.7	2840318	South Miami			X		
753	574239.2	2840307	South Miami			X		
754	574246.5	2840315	South Miami			X		
755	574286.3	2840281	South Miami			X		
756	574259.8	2840256	South Miami			X		
757	574283.4	2840238	South Miami			X		
758	574367.4	2840240	South Miami			X		
759	574358.6	2840232	South Miami			X		
760	574349.8	2840234	South Miami			X		
761	574321.7	2840193	South Miami			X		
762	574314.4	2840197	South Miami			X		
763	574299.6	2840174	South Miami			X		
764	574307.0	2840200	South Miami			X		
765	574312.9	2840210	South Miami			X		
766	574401.3	2840221	South Miami			X		
767	574388.1	2840213	South Miami			X		
768	574380.8	2840208	South Miami			X		

Appendix 3: Location and Condition of Hurricane Damaged Vessels

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
769	574343.9	2840174	South Miami			X		
770	574382.2	2840198	South Miami			X		
771	574391.1	2840206	South Miami			X		
772	574401.3	2840213	South Miami			X		
773	574413.2	2840182	South Miami			X		
774	574422.0	2840185	South Miami			X		
775	574128.5	2840197	South Miami				X	
776	574156.6	2840320	South Miami				X	
777	571371.4	2834719	South Miami				X	
778	571280.4	2834708	South Miami				X	
779	571215.4	2834713	South Miami				X	
780	571011.8	2834812	South Miami				X	
781	570730.3	2834752	South Miami				X	
782	570470.5	2834774	South Miami				X	
783	570492.1	2834763	South Miami				X	
784	570513.7	2834862	South Miami				X	
785	571055.1	2835154	South Miami				X	
786	571029.2	2835154	South Miami				X	
787	570929.5	2835225	South Miami				X	
788	570834.3	2835401	South Miami				X	
789	570803.9	2835401	South Miami				X	
790	570691.3	2835407	South Miami				X	
791	570717.3	2835363	South Miami				X	
792	570708.6	2835330	South Miami				X	
793	570695.6	2835324	South Miami				X	
794	570699.9	2835319	South Miami				X	
795	570682.6	2835269	South Miami				X	
796	571198.0	2834730	South Miami		X			
797	570544.0	2834840	South Miami		X			
798	570812.6	2835319	South Miami		X			
799	570725.9	2835253	South Miami		X			
800	570760.6	2835286	South Miami	X				
801	570855.9	2835275	South Miami	X				
802	570994.5	2834955	South Miami					X
803	570738.9	2835220	South Miami					X
804	571081.1	2835154	South Miami					X

Appendix 4: Location and Condition of Derelict Vessels Existing Prior to Hurricane Andrew

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
1	586339.4	2867505	North Miami		X			
2	586745.4	2863315	North Miami	X				
43	562228.3	2797205	Glades		X			
44	562444.6	2797080	Glades	X				
45	562640.9	2797006	Glades		X			
46	562739.4	2796856	Glades		X			
47	562877.1	2796705	Glades		X			
39	574629.0	2852913	Hialeah	X				
40	574828.6	2853789	Hialeah		X			
41	574257.2	2854297	Hialeah		X			
42	573975.9	2854550	Hialeah		X			
26	577969.2	2842908	Key Biscayne	X				
27	575945.3	2844208	Key Biscayne		X			
28	576023.8	2844632	Key Biscayne		X			
29	576515.1	2844283	Key Biscayne		X			
30	576652.8	2844183	Key Biscayne		X			
31	576986.6	2844782	Key Biscayne	X				
32	576416.7	2844982	Key Biscayne		X			
33	576986.6	2845107	Key Biscayne		X			
34	577085.1	2845157	Key Biscayne		X			
35	577379.8	2845232	Key Biscayne		X			
36	577320.8	2845332	Key Biscayne		X			
37	577242.2	2845532	Key Biscayne		X			
38	583339.5	2847932	Key Biscayne		X			
4	581261.2	2859074	Miami		X			
5	583250.9	2858939	Miami		X			
7	583949.4	2859249	Miami		X			
8	583990.1	2859497	Miami		X			
9	585950.2	2859598	Miami		X			
10	583239.4	2851888	Miami	X				
11	585619.3	2852087	Miami		X			
12	580078.4	2850658	Miami			X		
13	580044.4	2850696	Miami		X			
14	579950.7	2850810	Miami		X			
16	579465.3	2851281	Miami		X			
17	579069.4	2851492	Miami		X			
18	578728.8	2851654	Miami		X			
19	578380.8	2851740	Miami			X		
20	578292.1	2851767	Miami		X			
21	578262.5	2851778	Miami		X			
22	577508.6	2852132	Miami		X			
23	577050.3	2852300	Miami		X			
24	576816.4	2852437	Miami		X			
25	575587.6	2853002	Miami		X			
3	583500.9	2828530	Soldier Key		X			

Appendix 5: Location and Condition of Damaged Vessels Existing in January 1993

boat id	UTM Coordinates		USGS Quad	Submerged		Floating	Aground	Undetermined
	X	Y		Completely	Partially			
105	563052.9	2797028	Card Sound		X			
106	562739.4	2796856	Glades		X			
107	562877.1	2796705	Glades		X			
108	562444.6	2797080	Glades	X				
100	583339.5	2847932	Key Biscayne		X			
101	582617.1	2847874	Key Biscayne		X			
102	583274.9	2847327	Key Biscayne		X			
103	583940.2	2839888	Key Biscayne		X			
104	583643.5	2840852	Key Biscayne	X				
121	575517.4	2843151	Key Biscayne			X		
124	577529.1	2845213	Key Biscayne				X	
125	576128.2	2845024	Key Biscayne	X				
126	576071.4	2844963	Key Biscayne		X			
127	577341.4	2845402	Key Biscayne				X	
128	577367.5	2845379	Key Biscayne				X	
129	577415.5	2845368	Key Biscayne		X			
1	577526.8	2852107	Miami		X			
2	577502.1	2852124	Miami		X			
3	577560.1	2852098	Miami		X			
4	576853.3	2852421	Miami			X		
5	579982.8	2850830	Miami		X			
6	580035.8	2850773	Miami		X			
7	579876.8	2850861	Miami		X			
8	579365.1	2851605	Miami	X				
9	582142.6	2857365	Miami		X			
10	585774.8	2851847	Miami		X			
11	587357.4	2856111	Miami		X			
12	587922.8	2856974	Miami			X		
13	587965.0	2857988	Miami		X			
14	583253.8	2858961	Miami				X	
15	584066.5	2859187	Miami			X		
16	583981.4	2859866	Miami		X			
17	583008.9	2851869	Miami		X			
18	578423.9	2851783	Miami		X			
69	578750.6	2851646	Miami		X			
77	577394.2	2852153	Miami		X			
80	576938.3	2852382	Miami		X			
122	587813.0	2856223	Miami	X				
123	578532.1	2851719	Miami		X			
109	573237.3	2837098	South Miami			X		
110	573346.3	2837179	South Miami			X		
111	573374.4	2837112	South Miami				X	
112	573033.3	2836951	South Miami				X	
113	572899.7	2837045	South Miami				X	
114	572963.1	2836928	South Miami			X		
115	573340.3	2840819	South Miami				X	
116	574256.0	2840579	South Miami				X	
117	574278.8	2840550	South Miami		X			
118	573892.7	2840540	South Miami				X	
119	573590.1	2840800	South Miami			X		
120	575331.9	2843196	South Miami				X	

Appendix 6: Area Measurements for Potential Impact Locations

North Bay (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	0.00	0.00	0.00	0.00	0.00
Barren	72.74	10.40	0.00	0.00	83.14
Mangrove	0.00	0.00	0.00	0.00	0.00
Upland	19.31	0.10	0.00	0.00	19.41
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	92.05	10.50	0.00	0.00	102.55

Virginia Key (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	4.78	3.92	0.00	0.00	8.70
Barren	7.30	8.92	0.00	0.00	16.22
Mangrove	0.00	0.00	0.00	0.00	0.00
Upland	2.74	1.83	0.00	0.00	4.57
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	14.82	14.67	0.00	0.00	29.49

Miami River (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	0.00	0.00	0.00	0.00	0.00
Barren	9.87	15.16	0.00	0.00	25.03
Mangrove	0.00	0.00	0.00	0.00	0.00
Upland	0.07	0.06	0.00	0.00	0.13
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	9.94	15.22	0.00	0.00	25.16

Dinner Key (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	12.98	5.40	0.00	40.35	58.73
Barren	5.35	18.43	0.00	55.90	79.68
Mangrove	0.00	0.00	0.00	0.00	0.00
Upland	0.67	0.26	0.00	6.30	7.23
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	19.00	24.09	0.00	102.55	145.64

Key Biscayne (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	4.69	1.77	0.00	0.00	6.46
Barren	19.51	8.44	0.00	0.00	27.95
Mangrove	0.00	0.00	0.00	0.00	0.00
Upland	3.69	0.00	0.00	0.00	3.69
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	27.89	10.21	0.00	0.00	38.10

Coral Gables Waterway (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	12.79	0.00	0.00	0.00	12.79
Barren	18.86	0.00	0.00	9.39	28.25
Mangrove	3.95	0.00	0.00	0.00	3.95
Upland	8.14	0.00	0.00	0.10	8.24
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	43.74	0.00	0.00	9.49	53.23

Coral Bay (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	0.28	0.00	0.00	0.00	0.28
Barren	1.17	7.52	0.00	0.00	8.69
Mangrove	2.22	0.00	0.00	0.00	2.22
Upland	1.13	0.34	0.00	0.00	1.47
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	4.80	7.86	0.00	0.00	12.66

King's Bay (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	0.00	0.00	0.00	0.00	0.00
Barren	3.29	3.24	0.00	0.00	6.53
Mangrove	0.25	0.00	0.00	0.00	0.25
Upland	0.57	0.13	0.00	0.00	0.70
Undetermined (Monroe County)	0.00	0.00	0.00	0.00	0.00
Total	4.11	3.37	0.00	0.00	7.48

Ocean Reef (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	0.00	0.00	0.00	0.00	0.00
Barren	0.00	0.00	0.00	0.00	0.00
Mangrove	3.02	0.00	0.00	0.00	3.02
Upland	3.79	0.00	0.00	0.00	3.79
Undetermined (Monroe County)	11.36	0.00	0.00	0.00	11.36
Total	18.17	0.00	0.00	0.00	18.17

Other (area in ha)					
Habitat	Low	Medium	High	Very High	Subtotal
Seagrasses	10.24	0.00	0.00	0.00	10.24
Barren	2.01	4.51	3.37	0.00	9.89
Mangrove	3.38	0.00	0.00	0.00	3.38
Upland	1.27	0.15	0.09	0.00	1.51
Undetermined (Monroe County)	18.48	0.00	0.00	0.00	18.48
Total	35.38	4.66	3.46	0.00	43.50

Appendix 7: Low, Medium, High, and Very High Potentially Impacted Habitats, by Location

Low Potentially Impacted Locations (area in ha) (ranked in descending order by location impact area)						
Location	Seagrasses	Barren	Mangroves	Upland	Undetermined	Subtotal
North Bay	0.00	72.74	0.00	19.31	0.00	92.05
Coral Gables Waterway	12.79	18.86	3.95	8.14	0.00	43.74
Other	10.24	2.01	3.38	1.27	18.48	35.38
Key Biscayne	4.69	19.51	0.00	3.69	0.00	27.89
Dinner Key	12.98	5.35	0.00	0.67	0.00	19.00
Ocean Reef	0.00	0.00	3.02	3.79	11.36	18.17
Virginia Key	4.78	7.30	0.00	2.74	0.00	14.82
Miami River	0.00	9.87	0.00	0.07	0.00	9.94
Coral Bay	0.28	1.17	2.22	1.13	0.00	4.80
King's Bay	0.00	3.29	0.25	0.57	0.00	4.11
Total	45.76	140.10	12.82	41.38	29.84	296.90

Medium Potentially Impacted Locations (area in ha) (ranked in descending order by location impact area)						
Location	Seagrasses	Barren	Mangroves	Upland	Undetermined	Subtotal
Dinner Key	5.40	18.43	0.00	0.26	0.00	24.09
Miami River	0.00	15.16	0.00	0.06	0.00	15.22
Virginia Key	3.92	8.92	0.00	1.83	0.00	14.67
North Bay	0.00	10.40	0.00	0.10	0.00	10.50
Key Biscayne	1.77	8.44	0.00	0.00	0.00	10.21
Coral Bay	0.00	7.52	0.00	0.34	0.00	7.86
Other	0.00	4.51	0.00	0.15	0.00	4.66
King's Bay	0.00	3.24	0.00	0.13	0.00	3.37
Total	11.09	76.62	0.00	2.87	0.00	90.58

High Potentially Impacted Locations (subtotal in ha)						
Location	Seagrasses	Barren	Mangroves	Upland	Undetermined	Subtotal
Other	0.00	3.37	0.00	0.09	0.00	3.46
Total	0.00	3.37	0.00	0.09	0.00	3.46

Very High Potentially Impacted Locations (area in ha) (ranked in descending order by location impact area)						
Location	Seagrasses	Barren	Mangroves	Upland	Undetermined	Subtotal
Dinner Key	40.35	55.90	0.00	6.30	0.00	102.55
Coral Gables Waterway	0.00	9.39	0.00	0.10	0.00	9.49
Total	40.35	65.29	0.00	6.40	0.00	112.04

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