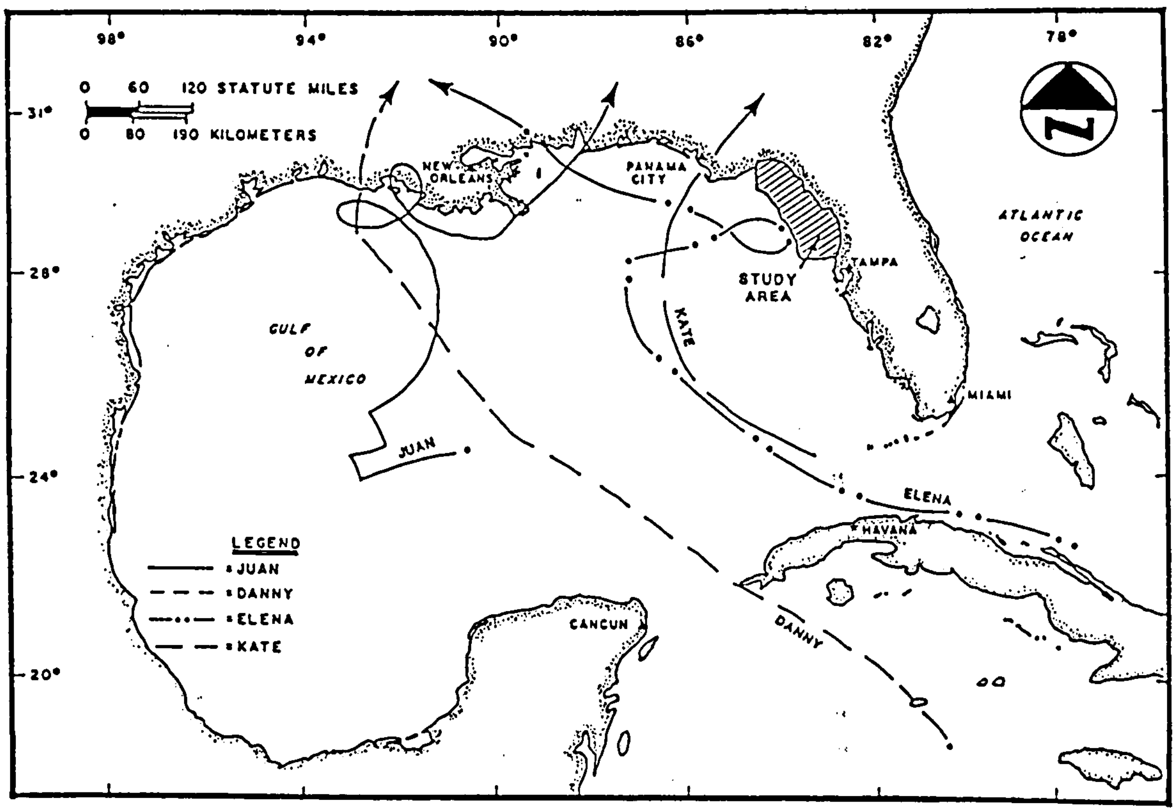
OCS Study
MMS 87-0001

Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

OCS Study
MMS 87-0001

Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds

Authors

M. John Thompson
Neal W. Phillips
Continental Shelf Associates, Inc.

Prepared under MMS Contract
14-12-0001-30188
by
Continental Shelf Associates, Inc.
759 Parkway Street
Jupiter, Florida 33477

Published by

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Regional Office

New Orleans
February 1987

DISCLAIMER

REPORT AVAILABILITY

Extra copies of this report may be obtained from the Public Information Unit (Mail Stop OPS-3-4) at the following address:

Minerals Management Service
Gulf of Mexico OCS Region
U.S. Department of the Interior
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394
Attn: Public Information Unit (OPS-3-4)
Telephone: (504) 736-2519

CITATION

This volume should be cited as:

Continental Shelf Associates, Inc. 1987. Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds. A final report by Continental Shelf Associates, Inc. submitted to the Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-30188.

ABSTRACT

A survey of the Florida Big Bend seagrass beds was conducted in August 1986 to assess long-term damage and recovery following the hurricanes of 1985. The Florida Big Bend Seagrass Habitat Study and a Monitoring Program conducted at the Gainesville OCS Area Block 707 were used as pre-hurricane data sets. The August 1986 survey reoccupied 20 of the original 50 Signature Control Stations established in October 1984. Using biomass data developed for *Halophila decipiens* and *H. engelmanni* during the Block 707 Monitoring Program, biomass and leaf counts were compared for these species before and after the hurricanes of 1985 at ten of the resampled stations. Three of the 14 television and diver transects sampled in 1984-85 were resurveyed and compared in terms of percentages of major habitat types. The live-bottom reference station established in the Block 707 Monitoring Program was also resampled and percentages of biotal cover compared among the June, August, and October 1985, and August 1986 data sets.

Comparisons of 1984 and 1986 data from the *H. decipiens* stations showed leaf densities and biomasses were higher at some stations and lower at others, but the mean values for 1984 and 1986 were comparable. No relationship between stations showing higher or lower standing stocks and their distance from hurricane tracks could be established. Stations dominated by *H. engelmanni* in the October 1984 sampling were completely barren of leaves when visited in August 1986. Roots and shoots were found at these stations, however, and the observed reduction in biomass is not felt to be a hurricane impact.

Stations and transects located in nearshore, dense, *Thalassia*-*Syringodium*-*Halodule* grass beds and live-bottom areas showed no observable changes following the 1985 hurricanes. Percentages of major habitat types remained similar on transects 1 and 4 between the 1984-85 surveys and the 1986 survey. Transect 9 showed a marked increase in seagrass coverage, but this is attributed to this transects covering a slightly different area in 1986.

Live-bottom biotic coverage in the reference station sampled showed marked reductions immediately after Hurricane "Elena" in 1985. This station had recovered somewhat by the 1986 sampling, but did not show the same levels of coverages as seen in August 1985. The octocorals, however, showed no reduction in area covered either immediately after the hurricane or when sampled in 1986. This particular

faunal group consistently made up the largest element of live-bottom biota seen in all sampling periods.

No long-term hurricane impacts could be documented in Florida's Big Bend seagrass beds. Data suggest that seagrass and live-bottom communities of the west Florida continental shelf are resilient to the periodic passage of major storms. At stations where seagrasses are known to have been completely destroyed by Hurricane "Elena," there were no overall differences in standing crop from 1984 levels. Standing stock in the dense, nearshore, seagrass beds on Florida's Big Bend shelf is estimated to be 448,325 t (494,054 tons), while the standing stock of *Halophila* in the sparse, offshore seagrass beds is estimated to be approximately 590 t (651 tons).

ACKNOWLEDGEMENTS

The Assessment of Hurricane Damage in the Florida Big Bend Seagrass Beds Final Report was written by M. John Thompson and Neal W. Phillips of Continental Shelf Associates, Inc. The authors wish to express their appreciation to the following individuals who have helped ensure the quality of this report:

Dr. Robert Rogers, Minerals Management Service, Gulf of Mexico Regional Office, New Orleans, Louisiana;

Mr. Cary W. Kerlin, Sohio Petroleum Campany, Lafayette, Louisiana;

Ms. Lorna Sicarello, U.S. Fish and Wildlife Service, Panama City, Florida;

Mr. Lynwood R. Powell, Continental Shelf Associates, Inc., Jupiter, Florida;

Mr. David B. Snyder, Continental Shelf Associates, Inc., Jupiter, Florida; and

Mr. Donald R. Deis, Continental Shelf Associates, Inc., Jupiter, Florida.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

During the 1985 hurricane season, four major storms passed through the Gulf of Mexico (Figure 1). Reports from coastal observers suggested that these hurricanes, particularly "Elena" and "Kate," severely damaged seagrass beds within the Florida Big Bend area. A seagrass monitoring program being conducted by Continental Shelf Associates, Inc. in the Big Bend area showed approximately 116,554 ha (288,000 acres) to be completely denuded of seagrasses following Hurricane "Elena" (Continental Shelf Associates, Inc., 1986).

During the fall and winter of 1984-1985, the Minerals Management Service (MMS) funded a seagrass mapping study in the Florida Big Bend area. Following the passage of the major hurricanes in summer 1985, the MMS decided to sponsor a follow-up study to assess hurricane impacts and seagrass recovery in the area. New field data were collected during a survey in August 1986, and all previously collected data on the seagrasses of the Big Bend area were reviewed and compared with the new data sets.

1.1 STUDY AREA

The sweeping curve of Florida's west coast between Ochlockonee Bay and Tarpon Springs (Figure 2) defines the Florida Big Bend area. This section of the west Florida continental shelf is extremely productive in terms of sport and commercial fisheries and is considered of importance by both environmentalists and commercial fishermen. In 1983, the Florida Big Bend area was nominated as a Marine Sanctuary (Chelsea International Corporation, 1983) and was placed on the Site Evaluation list for further consideration (48 *Federal Register* 35568-1983).

Extensive seagrass beds are found in the Florida Big Bend area (Phillips, 1960; Moore, 1963; Earle, 1972; McNulty et al., 1972; Enos and Perkins, 1977; Iverson and Bittaker, in press). Seagrass beds and associated macroalgal stands are important primary producers (Mann, 1973; McRoy and McMillan, 1977), and they provide nursery grounds for sport and commercial fish species as well as habitat for many of the larval and adult invertebrates critical to nearshore food chains (Zimmerman and Livingston 1976; Phillips, 1978; Dawes et al., 1979).

Seagrass species found in the Big Bend area include the climax species *Thalassia testudinum* and *Syringodium filiforme*, which grow in

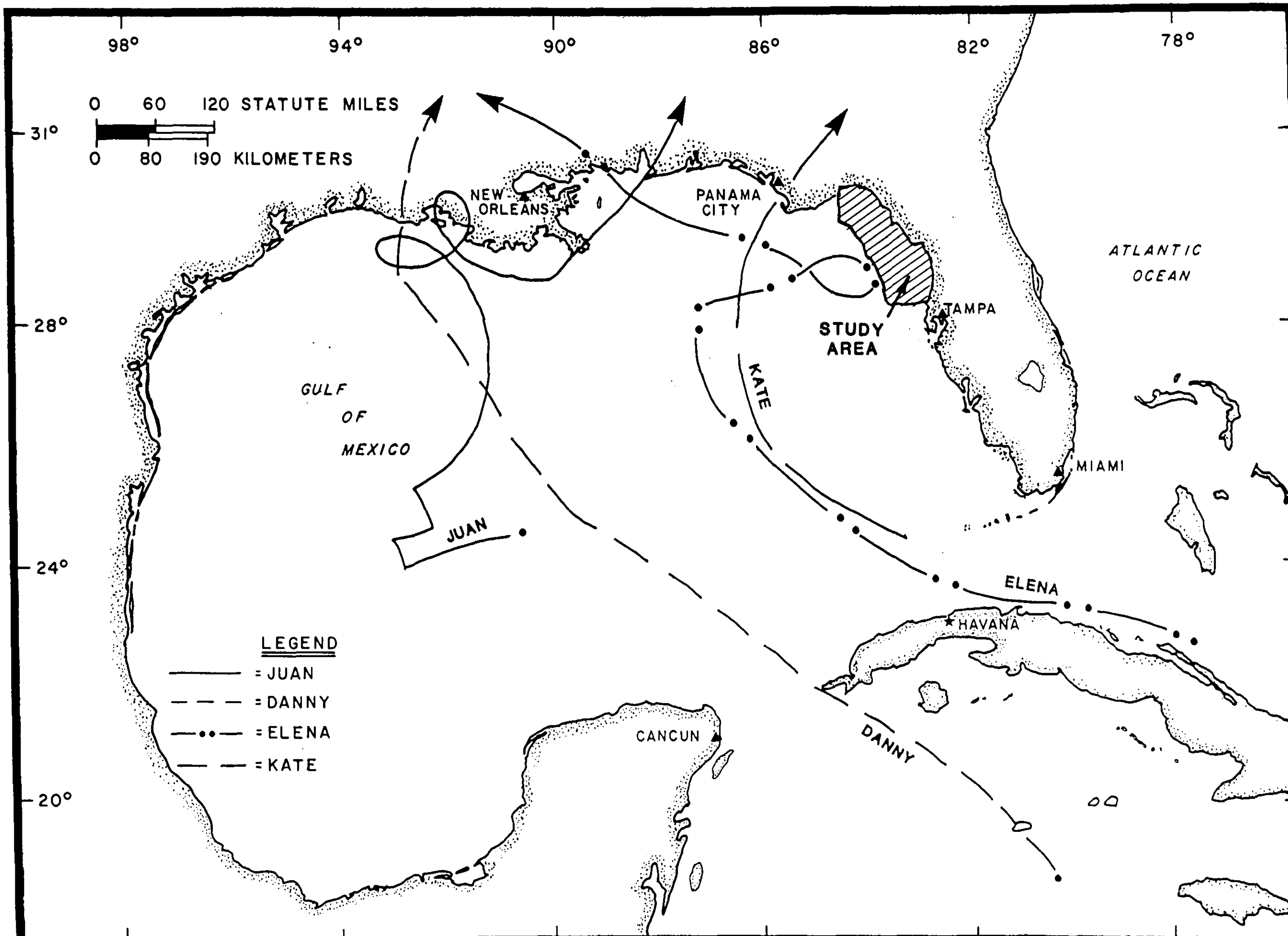


FIGURE 1. TRAJECTORIES OF MAJOR HURRICANES OF THE 1985 SEASON.

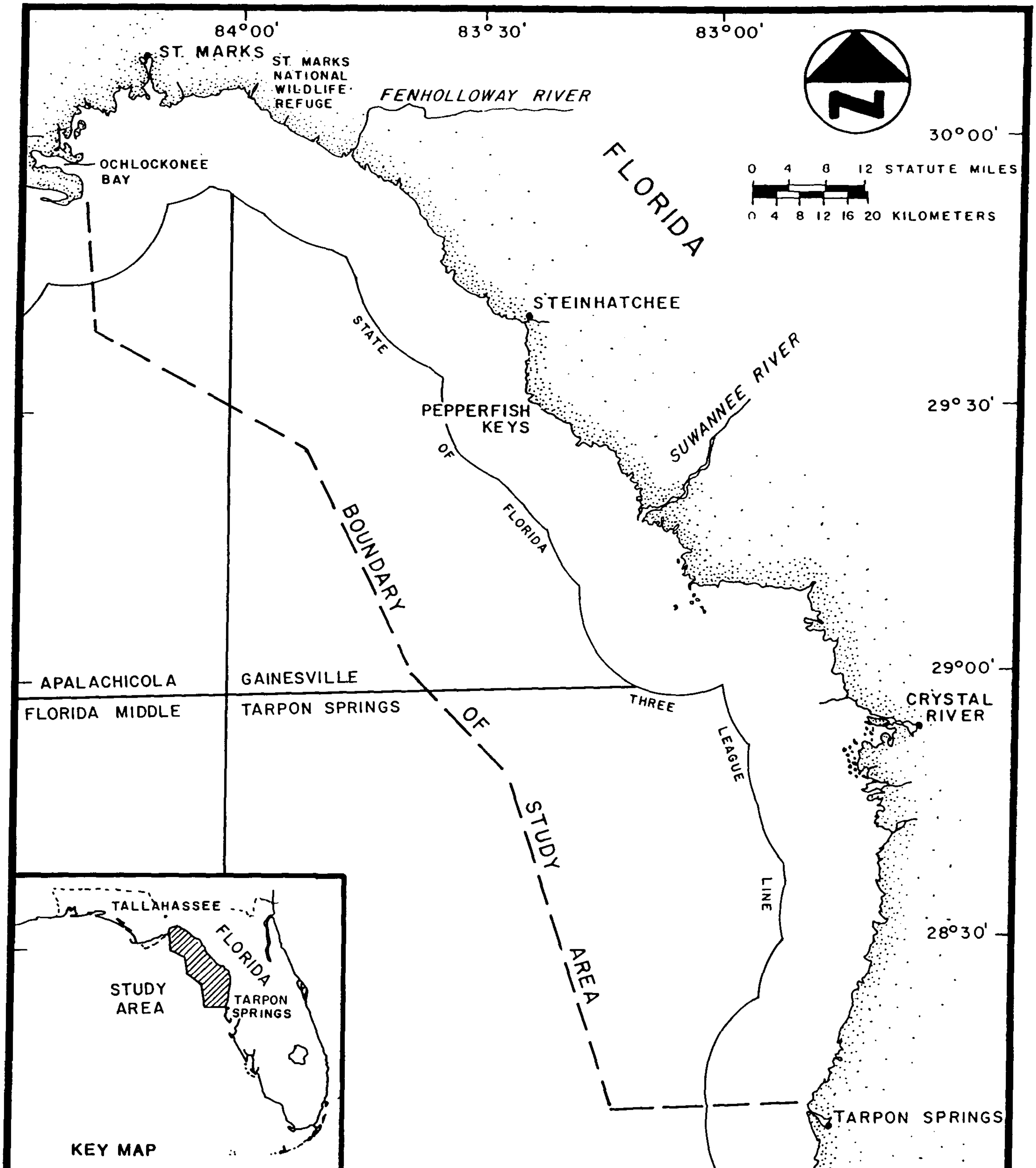


FIGURE 2. LOCATION OF THE STUDY AREA.

dense seagrass beds in the nearshore area (<10 m [<33 ft]); and the pioneering species Halodule wrightii, Halophila decipiens, and H. engelmanni, which cover large portions of the shelf offshore of the major seagrass beds (Williams and McRoy, 1982; Thompson and Phillips, 1986). Macroalgal species common in Big Bend seagrass beds include Caulerpa, Udotea, Penicillus, Halimeda, and Sargassum (Continental Shelf Associates, Inc. and Martel Laboratories, Inc., 1985).

1.2 PREVIOUS RESEARCH

Early studies in the area summmarized seagrass distributional patterns and estimated the acreage of seagrass and hard-bottom type communities found in the eastern Gulf based on reports and field observations at specific sites (Phillips, 1960; Moore, 1963; Earle, 1972; Parker et al., 1983). Between 1974 and 1980, Iverson and Bittaker (in press) used teams of scuba divers to map the outlines of major nearshore seagrass beds in the Big Bend area. Several limited seagrass mapping studies were also conducted using various combinations of aerial imagery and ground truth surveys at specific nearshore locations along Florida's west coast (Withlacoochee Regional Planning Council, 1982; Continental Shelf Associates, Inc., 1983, 1984a). However, the overall structure and distributional patterns of the Florida Big Bend area seagrass beds were poorly documented on the basis of these studies. In particular, almost no information was available on the deep seagrass and algal beds known or presumed to occur in water depths greater than 10 m (33 ft).

Recent interest in offshore oil and gas exploration in the Big Bend area raised concerns of possible environmental impacts to seagrasses and their associated biota. In response, the MMS, as the Federal agency responsible for prediction and management of oil- and gas-related environmental impacts, initiated the Florida Big Bend Seagrass Habitat Study in September 1984. The study involved both aerial photography and two field sampling cruises (October 1984 and February 1985). The objective was to map seagrasses in both nearshore (<10 m [33 ft]) and offshore (10 to 20 m [35 to 66 ft]) regions of the continental shelf. The study area, shown in Figure 2, covered approximately 1.5 million ha (3.7 million acres or 5,830 mi^2) of seafloor.

The results of the Florida Big Bend Seagrass Habitat Study were reported by Continental Shelf Associates, Inc. and Martel Laboratories, Inc. (1985). Mapping delineated 232,893 ha (575,479 acres) of dense seagrass beds, 498,034 ha (1,230,643 acres) of sparse seagrass beds, and

279,722 ha (691,195 acres) of patchy seagrass beds (Figure 3). Two major groupings or plant species associations were reported: 1) a nearshore association of T. testudinum, S. filiforme, and Halodule wrightii; and 2) an offshore association of Halophila decipiens, H. engelmanni, and various macroalgal species (Thompson and Phillips, 1986). Thalassia testudinum and S. filiforme formed dense permanent seagrass beds in nearshore areas where conditions were suitable for their growth. Halodule wrightii stands fringed these major beds, occurring both on their inner (shallow) and outer (deep) sides. Farther offshore, vast areas of the continental shelf were found to be covered by a sparse seagrass, algal, and hard-bottom community in which Halophila decipiens and H. engelmanni were the only two vascular plants present. Extending beyond the 20 m (66 ft) depth contour, these seagrasses were present at least to the 23 m (75 ft) contour (Continental Shelf Associates, Inc. and Martel Laboratories, Inc., 1985). Over one million acres of this assemblage was mapped. Field surveys indicated that the macroalgal component of this community accounted for 21% of the blade densities seen in seagrass areas. Also, of the total area mapped on the basis of aerial photography as sparse or patchy seagrass beds, 44% was determined to consist of low-relief live-bottom areas where the vascular plant species H. decipiens and H. engelmanni were not necessarily present (Thompson and Phillips, 1986).

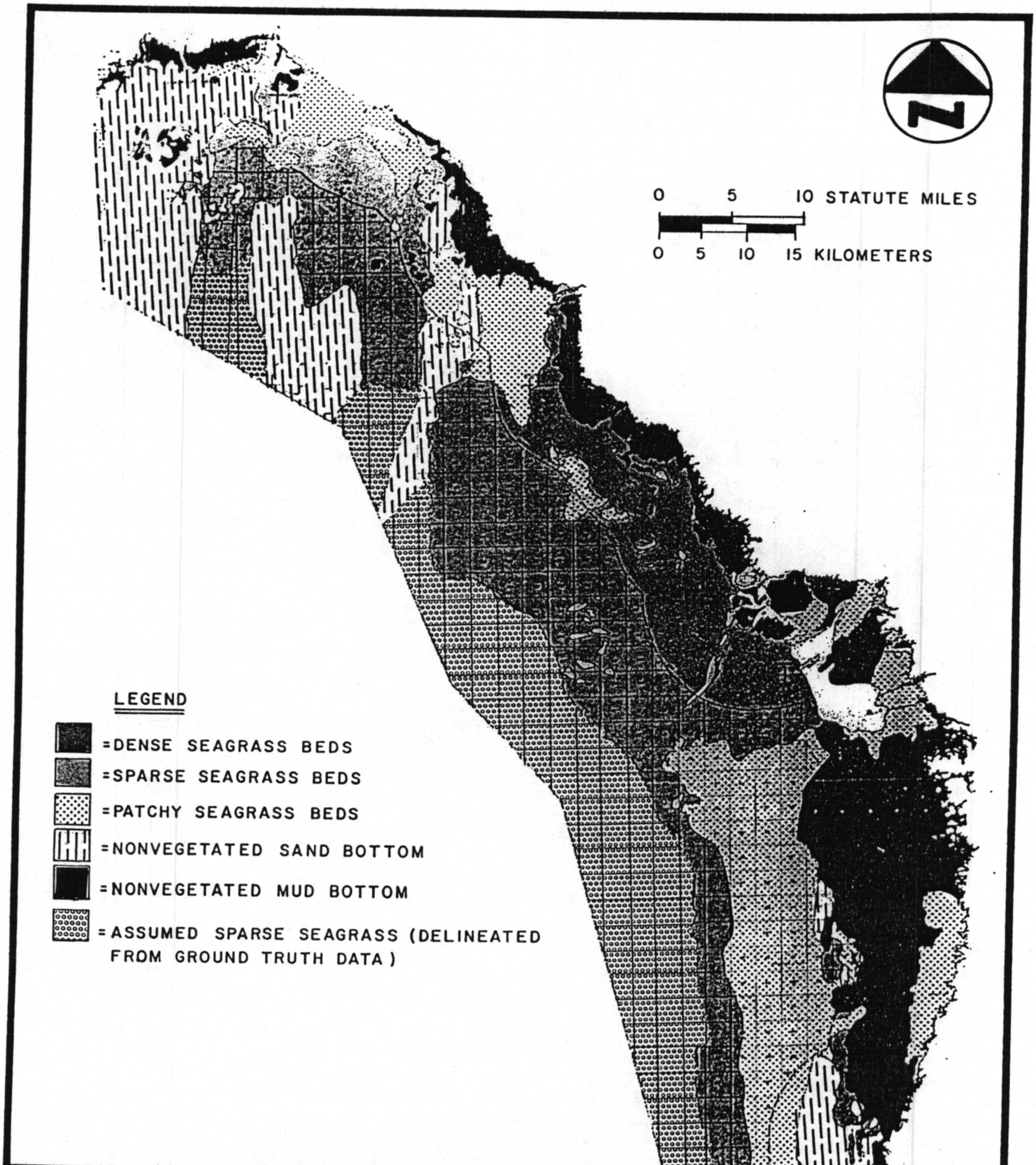


FIGURE 3. FLORIDA BIG BEND SEAGRASS DISTRIBUTION BASED ON AERIAL AND GROUND TRUTH DATA.

2.0 MATERIALS AND METHODS

The present study was designed to provide follow-up data to those collected in October 1984 and February 1985 during the Florida Big Bend Seagrass Habitat study. Two approaches used during the previous study were to be repeated approximately one year after the passage of the major hurricanes. The first involved qualitative observations made along transects surveyed by divers and/or television. The second involved photographic sampling at selected stations in the area. A review of sampling conducted during the earlier study is presented below, followed by a description of new sampling conducted during the August 1986 field survey.

2.1 BACKGROUND

The Florida Big Bend Seagrass Habitat Study was conducted in the fall and winter of 1984-1985. Between 25 and 28 October 1984, six television transects encompassing 232 km (144 mi) of the seafloor were surveyed (Figure 4). Between 28 October and 2 November 1984, 50 Signature Control Stations (Figure 5) were established along the transects to aid in interpreting aerial photographs that were obtained during another phase of the study. The seafloor at these stations was quantitatively photographed using a Nikonos 35-mm underwater camera and a 0.03 m^2 framer; ten photographs were taken at each station. Of the 50 signature control stations established in 1984, 25 were in seagrass beds. Seagrass blades were counted in each photograph to estimate blade density.

Of the 50 stations established during October 1984, 11 were sampled again in February 1985. Methods were the same as those used on the earlier survey. Also, nine additional transects were surveyed by towed divers and/or television (Figure 4).

From June through October 1985, Continental Shelf Associates, Inc. conducted a seagrass monitoring program in Gainesville OCS Area Block 707 (Figure 6). The purpose of this study, conducted for Sohio Petroleum Company, was to monitor possible impacts of discharged drilling muds on live-bottom areas and deep seagrass communities found there. Twenty-four permanent seagrass monitoring stations, each with six replicate photographic quadrats, were established. All replicate photographic quadrats were staked, allowing photographic coverage to be exactly duplicated on subsequent surveys. At each seagrass station, collections

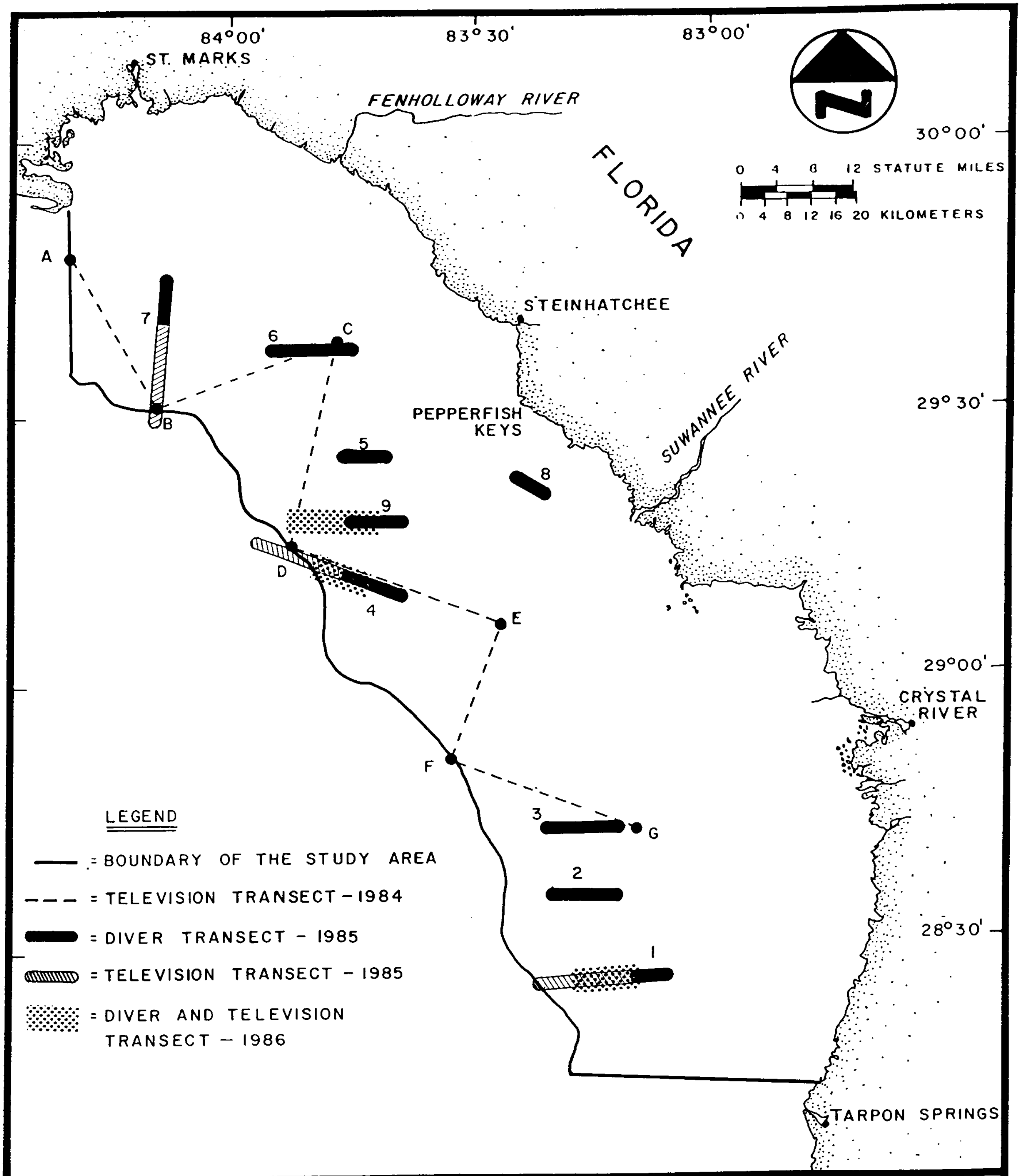


FIGURE 4. DIVER AND TELEVISION TRANSECTS SURVEYED.

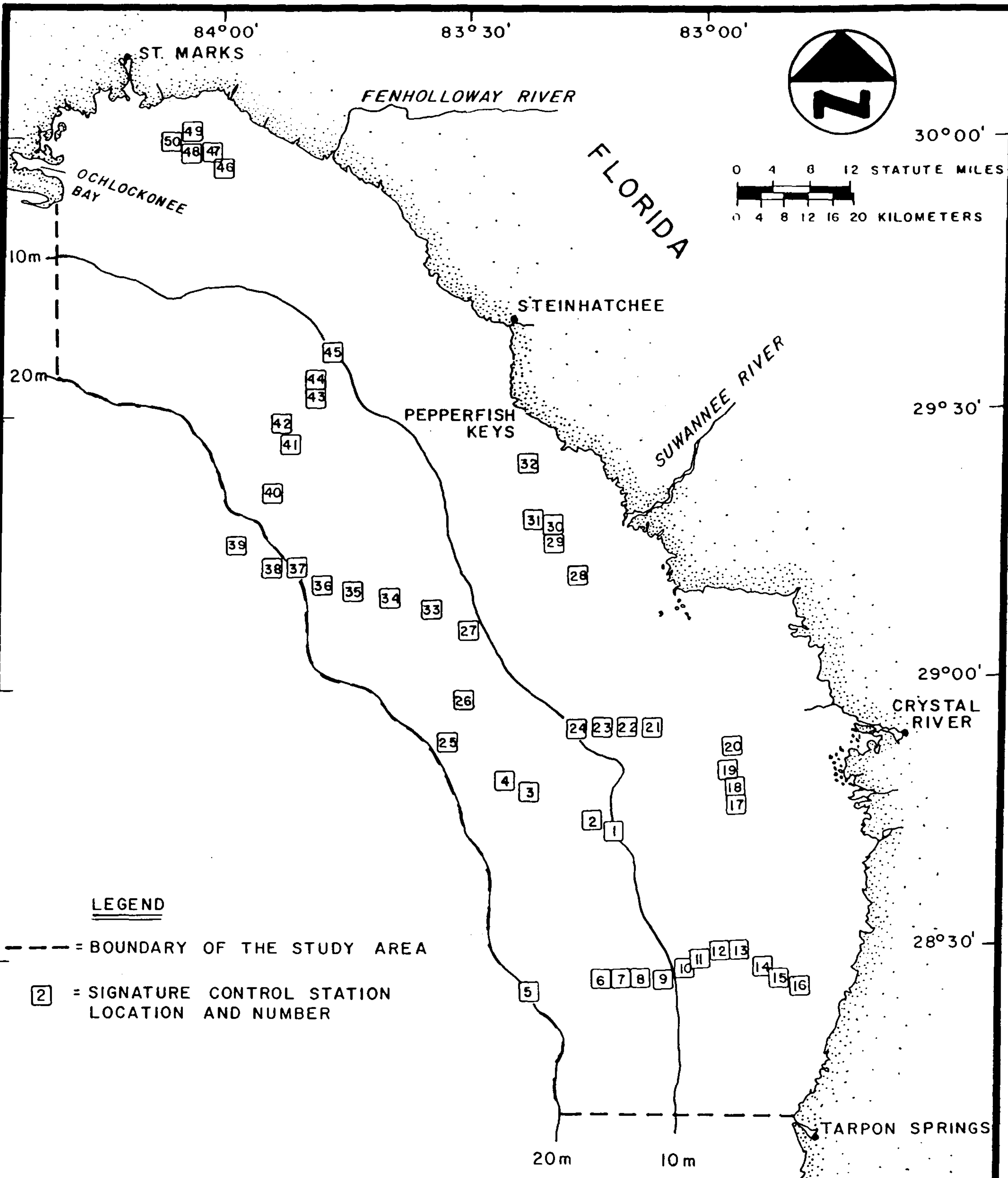


FIGURE 5. SIGNATURE CONTROL STATIONS ESTABLISHED 24 OCTOBER TO 1 NOVEMBER 1984.

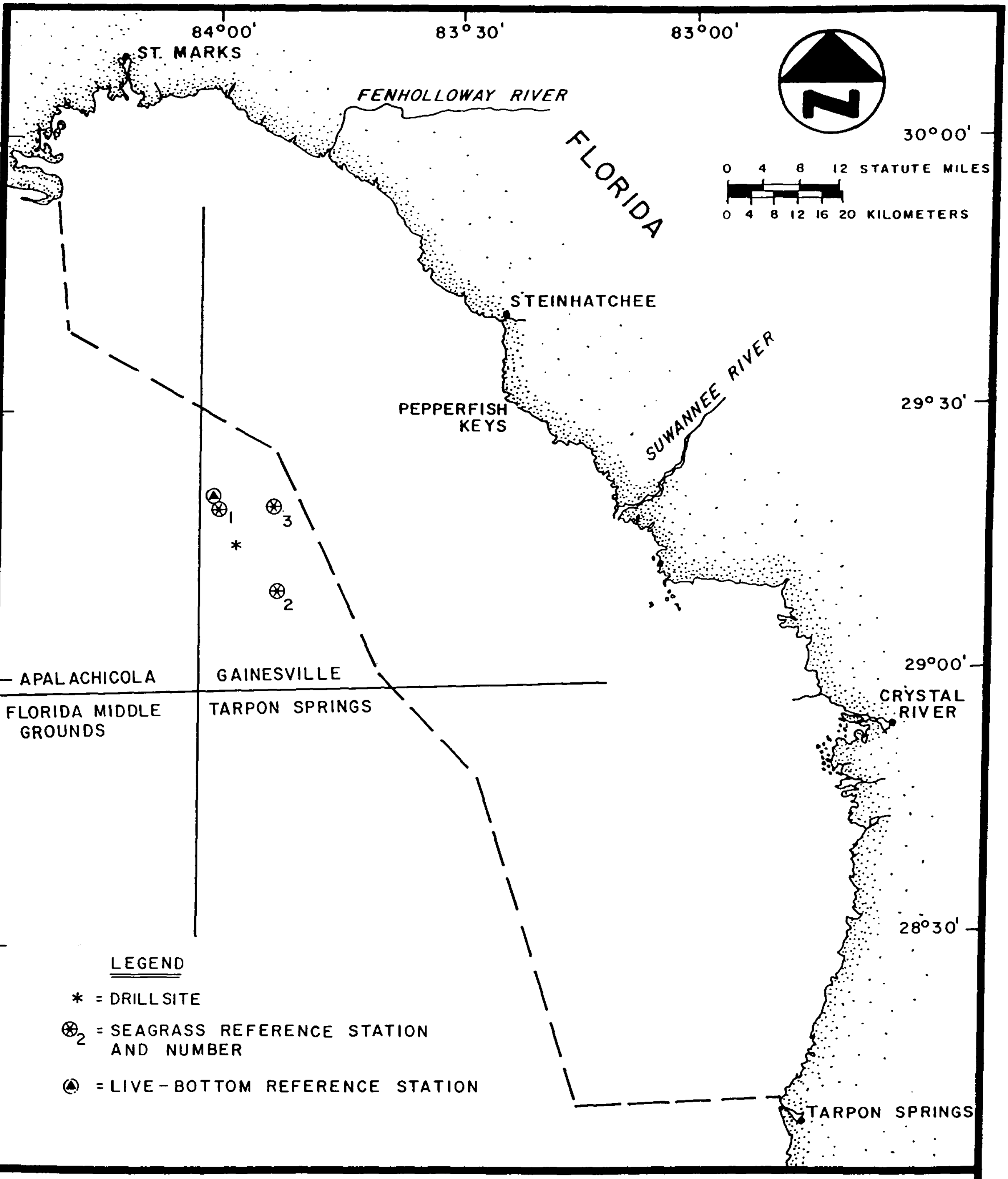


FIGURE 6. LOCATION OF THE SOHIO MONITORING PROGRAM, GAINESVILLE OCS AREA, BLOCK 707.

of seagrass leaves were made from areas outside the repetitive photographic quadrats for dry weight biomass determination. Prior to the destruction of all seagrasses present in this area by Hurricane "Elena" in September 1985, two complete data sets had been gathered from these stations (Continental Shelf Associates, Inc., 1987).

Data collected during the Sohio monitoring program are to be reported elsewhere (Thompson and Hart, in prep.). For the purposes of the present study, measurement and weighing of seagrass leaves collected at the Sohio monitoring site allowed calculation of dry weight biomass from photographic data for _H. decipiens_ and _H. engelmanni_, the numerically dominant species seen at depths greater than 10 m (33 ft) (Continental Shelf Associates, Inc. and Martel Laboratories, Inc., 1985). Photographs from the Florida Big Bend Seagrass Habitat Study stations occupied during 1984, 1985, and 1986 were analyzed, and dry weight biomass for stations located in _H. decipiens_ and _H. engelmanni_ beds was calculated (Appendix A).

2.2 FIELD OPERATIONS

New field surveys were carried out between 14 and 19 August 1986. All photography was performed with a Nikonos 35-mm underwater camera and color transparency film that was processed in the field to ensure the film had been exposed properly. Days of sampling Signature Control Stations were alternated with days of television/diver transect surveys.

2.2.1 Diver/Television Transect Surveys

Figure 4 shows the diver/television transects surveyed during 1984-1985 and the portions that were resurveyed in August 1986. Observational and recording techniques along these transects were the same as those applied in both previous surveys (Continental Shelf Associates, Inc. and Martel Laboratories, Inc., 1985).

All transect surveys were begun with both divers and television in the water. The diver, riding a towed sled, was able to get a much broader picture of the seafloor than the fixed-view television camera. Divers used full face masks with hard-wired communications to their surface tenders. Each diver verbally described bottom features over the communications link. Surface observers recorded the diver's seafloor descriptions while watching the television monitor and were able to discuss and compare what they were seeing with the impressions of the diver. The television pictures and the observer comments were recorded on videotapes with an audio track.

On some of the longer transects, divers became saturated with nitrogen and were unable to complete the entire transect. These transects were completed using underwater television alone.

During the diver/television surveys, navigational fixes and seafloor classifications were recorded at 5-min intervals, with the diver stating the overall bottom classification. A written log was maintained by the surface observers and was compared with the video and audio tape records when the data were later reviewed in the laboratory.

2.2.2 Station Sampling

Figure 5 shows the locations of the 50 Signature Control Stations that were established in October 1984. Twenty of these stations were resampled in August 1986 (Figure 7). Table 1 gives the sampling date and seafloor classification for each resampled station.

Of the 20 Signature Control Stations selected from those sampled during the original Big Bend Seagrass Habitat Study, four (Stations 9, 11, 13, and 39) were live-bottom stations (Table 1). To gain additional information about changes in live bottom since the 1985 hurricane season, one live-bottom reference station established during the Sohio monitoring program was also resampled during the August 1986 survey. The station was located 9.65 km (6 mi) from the drilling site, far enough to ensure that any changes in the epibiota would be attributable to the hurricanes or other natural factors rather than drilling activities. At this station, ten permanently staked quadrats were sampled photographically with a 0.1 m^2 framer.

2.3 DATA ANALYSIS

2.3.1 Records from Diver/Television Surveys

Video and audio records of all the diver tow and television transects resampled in August 1986 were reviewed and compared with transect records from both October 1984 and February 1985. Percentages of bottom habitat coverage were calculated primarily from the bottom classification at each navigational fix (Appendix B). All bottom classifications were reviewed in the laboratory, and some were changed based upon the overall area between navigational fixes rather than one

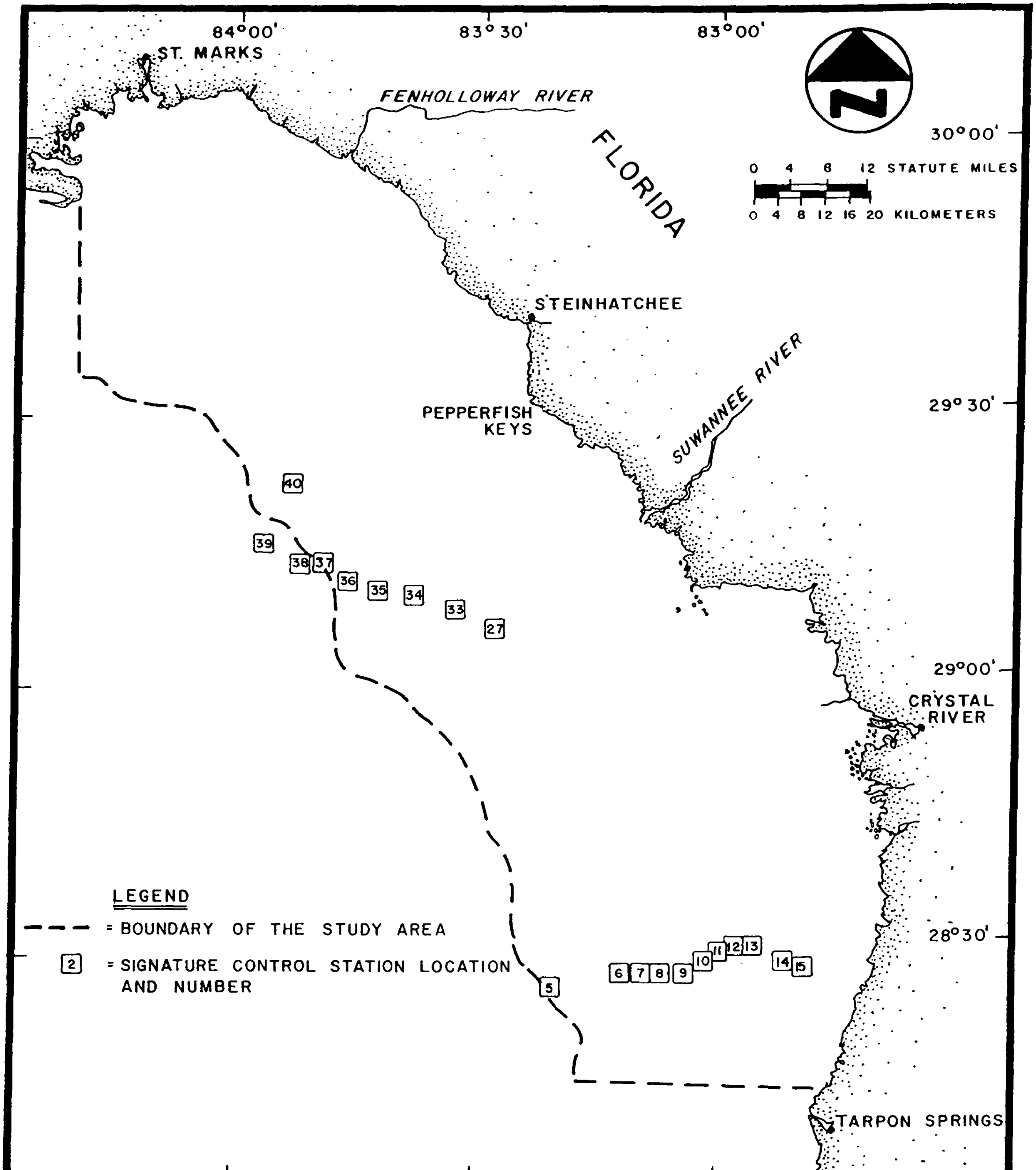


FIGURE 7. SIGNATURE CONTROL STATIONS SAMPLED 14 TO 19 AUGUST 1986.

TABLE 1. STATIONS SAMPLED IN AUGUST 1986.

Station No.	Date Sampled	Seafloor Characterization
5	14 Aug 1986	*H. decipiens*
6	14 Aug 1986	*H. decipiens* and live bottom*
7	14 Aug 1986	*H. decipiens*
8	14 Aug 1986	Coarse-grained sand and algae
9	14 Aug 1986	Live bottom
10	14 Aug 1986	Medium-grained sand and drift algae
11	14 Aug 1986	Live bottom
12	14 Aug 1986	*Halodule wrightii*
13	14 Aug 1986	*Halodule wrightii* and live bottom
14	14 Aug 1986	*Thalassia testudinum*
15	14 Aug 1986	*Thalassia testudinum*
27	16 Aug 1986	Bare sand
33	16 Aug 1986	Bare sand
34	16 Aug 1986	Bare sand
35	16 Aug 1986	Very sparse *H. engelmanni*
36	16 Aug 1986	Very sparse *H. decipiens*
37	16 Aug 1986	*H. decipiens* and *H. engelmanni*
38	16 Aug 1986	*H. decipiens* and *H. engelmanni*
39	16 Aug 1986	Live bottom
40	16 Aug 1986	*H. decipiens*

*The term live bottom refers to areas colonized by sessile epifauna such as sponges, hard corals, and gorgonians or soft corals.

specific point visible to the diver or television at the time the original field classification was made.

2.3.2 Quantitative Photographic Data

Exposed film was viewed in the laboratory with a Vanguard Motion Analyzer (Figure 8). With this instrument, individual frames could be enlarged to any desired size (up to approximately 0.5 m^2). A scale mounted in the photographic framer was always visible on the right hand corner of the individual transparency, allowing exact measurement of seagrass blades seen in the individual frames.

Seagrass blades at *Halophila* dominated stations were counted in each photograph. Biomass for these stations was calculated by measuring individual leaves and applying a relationship between leaf length and biomass. The length/weight relationship was estimated on the basis of seagrass (*H. decipiens* and *H. engelmanni*) collections made at the Sohio Reference Station 1 during June and August 1985. Collected leaves of each species were grouped into seven length categories: 0-5 mm, 6-10 mm, 11-15 mm, 16-20 mm, 21-25 mm, 26-30 mm, and >30 mm. All leaves in each length class were counted, dried, and weighed as a group, yielding a mean weight for each size of leaf; values determined for *H. decipiens* for June 1985 and August 1985 are shown in Table 2. In the photographs from each Signature Control Station, the number of leaves within each size category was noted, and total leaf biomass was calculated by multiplying this number by the mean weight for the length class and summing over length classes. For the calculations, mean weights for *H. decipiens* leaves of various sizes were taken from the August 1985 data, which encompassed a greater range of leaf sizes than the June data (Table 2). Mean weights for *H. engelmanni* leaves were taken from June 1985 data because the leaves collected during August 1985 were coated by a filamentous red alga.

Not all of the *Halophila* blades seen in any given photograph could be measured accurately; some were folded over or turned sideways. To correct for this, the investigator first counted all seagrass blades, then measured the length and width of all blades that were oriented in such a way as to allow measurement. The measured leaves were classified into length categories as described above, and the percentage of leaves in each length category was calculated. The assumption was made that the size distribution of leaves that could not be measured was the same as that of the leaves that could be measured. For example, if 60% of the

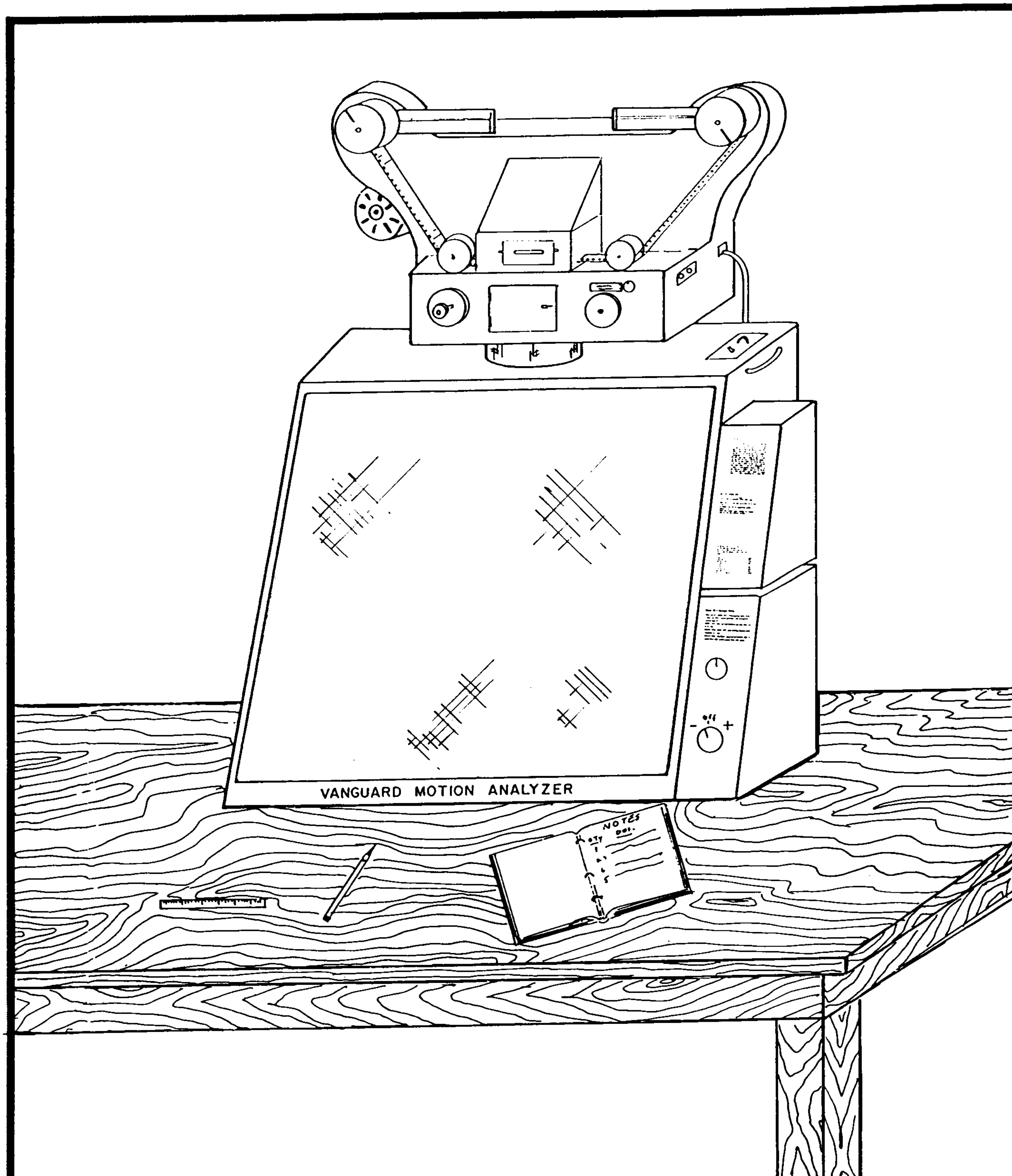


FIGURE 8. VANGUARD MOTION ANALYZER.

TABLE 2. DRY WEIGHTS OF SIZE CLASSES OF HALOPHILA DECIPIENS LEAVES COLLECTED FROM THE SOHIO SEAGRASS REFERENCE STATION 1.

Length Class (mm)	Jun 1985			Aug 1986		
	No. Leaves	Dry Wt (mg)	Dry Wt/Leaf (μg)	No. Leaves	Dry Wt (mg)	Dry Wt/Leaf (μg)
0-5	22	0.1	5	0	-	-
6-10	279	19.2	69	19	2.5	132
11-15	69	7.2	104	101	30.7	304
16-20	2	0.1	50	308	60.0	519
21-25	0	-	-	46	34.6	752
26-30	0	-	-	1	1.4	1,400

measured leaves were 16 to 20 mm in length, then it was assumed that 60% of the total counted leaves in a photographic replicate would fall into the 16 to 20 mm category. In this manner, a total biomass based on the actual leaf count in each photographic replicate was calculated. The ten replicates photographed at each station were summed to get a biomass per station, which was then standardized to a square meter basis (Appendix A).

Hurricane impacts to sessile epibiota other than seagrasses were assessed both qualitatively and quantitatively. Qualitative comparisons were made by examining seafloor photographs taken on successive surveys at the four Signature Control Stations that were characterized as live bottom. Quantitative comparisons were made by analyzing photographs from the live-bottom reference station established during the Sohio monitoring program. The station was sampled during June, August, and October 1985 as part of the monitoring program and in August 1986 as part of the present study. Ten replicate photographs from each sampling of this station were analyzed for percent biotic cover through the use of a random point overlay method developed by Bohnsack (1979) and employed previously by Continental Shelf Associates, Inc. (1983, 1984b,c). For this analysis, the slide from each replicate photographic quadrat was enlarged on the Vanguard Motion Analyzer, and a clear acetate overlay with 100 randomly selected points was superimposed on the image. The number of points covered by each type of biota (coral, sponge, etc.) or substrate (sand, rock, rubble, etc.) was recorded from each replicate. All biota was identified to the lowest possible taxonomic level, and the percentage coverage of each type of biota or substrate was calculated for each replicate. These percentages were combined to determine the percent coverage of each type of biota at the station before and after the hurricanes of 1985.

3.0 RESULTS

3.1 DIVER/TELEVISION SURVEYS

Portions of diver/television transects 1, 4, and 9 were resurveyed (Figure 4). The records from these transects were compared on a point-by-point basis and in terms of overall percent coverage of specific bottom types (Table 3). Transects 1 and 9 were originally surveyed in February 1985, and transect 4 corresponds to the D to E leg of the original TV survey in October 1984 (Figure 4). Relatively minor changes were seen in the percentage of bottom covered by the major habitat types along transects 1 and 4 (Table 3). Along transect 9, there appears to be a dramatic increase in seagrass coverage; however, the 1986 survey extended transect 9 farther offshore (Figure 4) and the observed increase in seagrass coverage is felt to result from this difference in location rather than an actual increase in the extent of seagrass beds.

3.2 STATION SAMPLING

3.2.1 Nearshore Seagrass Beds

Qualitative observations in the dense nearshore *Thalassia-Syringodium-Halodule* seagrass beds (stations 13, 14, and 15) off Tarpon Springs showed no noticeable changes between the 1984 and 1986 surveys. Seagrass growth in these beds appeared to be lush in August of 1986, indicative of the high point of the growing season.

3.2.2 Offshore Seagrass Beds

Table 4 presents leaf density and leaf biomass data from 10 *Halophila* stations that were sampled during October 1984 and August 1986. These data show considerable variation in leaf density and biomass both seasonally and geographically. There is no indication that August 1986 *H. decipiens* values were consistently higher or lower than those of October 1984, and their grand mean leaf counts and biomass values from October 1984 and August 1986 appear comparable. One might expect a slightly higher standing crop during August because this is closer to the peak of the growing season for *H. decipiens*.

During the Sohio monitoring program, *Halophila* was collected during early June and late August 1985 for leaf length and biomass determinations. The data for *H. decipiens* are shown in Figure 9. The size-frequency histograms indicate that the June sampling occurred early in the growth season of the *H. decipiens*; the percentage of small leaves

TABLE 3. PERCENT OCCURRENCE OF MAJOR HABITAT TYPES ALONG THE TELEVISION/DIVER TRANSECTS.

	Percent Incidence of Bottom Types		
	Oct 1984	Feb 1985	Aug 1986
Transect 1			
Live-bottom	--	22	29
Bare Sand	--	31	29
Seagrass and Algae	--	49	42
Transect 4			
Live-bottom	20	--	25
Bare Sand	20	--	20
Seagrass and Algae	60	--	55
Transect 9			
Live-bottom	--	22	31
Bare Sand	--	47	22
Seagrass and Algae	--	16	53

TABLE 4. LEAF DENSITY AND BIOMASS OF *HALOPHILA* AT STATIONS SAMPLED IN OCTOBER 1984 AND AUGUST 1986.

Station No.	Species	Mean Leaf Density (no./m^2)		Mean Biomass (g dry wt/m^2)	
		Oct 1984	Aug 1986	Oct 1984	Aug 1986
5	*H. decipiens*	100	855	0.050	0.272
6	*H. decipiens*	763	116	0.299	0.029
7	*H. decipiens*	559	1,666	0.223	0.522
9	*H. decipiens*	1,627	0	0.467	0
34	*H. engelmanni*	2,029	0	1.973	0
35	*H. engelmanni*	754	ND*	0.875	ND*
36	*H. decipiens*	67	ND*	0.028	ND*
	H. engelmanni	644	ND*	0.829	ND*
37	*H. decipiens*	326	277	0.103	0.123
38	*H. decipiens*	1,018	755	0.313	0.369
40	*H. decipiens*	24	398	0.006	0.209
Grand Mean	*H. decipiens*	560	581	0.1861	0.2177
Grand Mean	*H. engelmanni*	1,142	ND*	1.2257	ND*

*No data - At these stations, sparse shoots and rhizomes of *Halophila* sp. were seen, but attached leaves were not photographed.

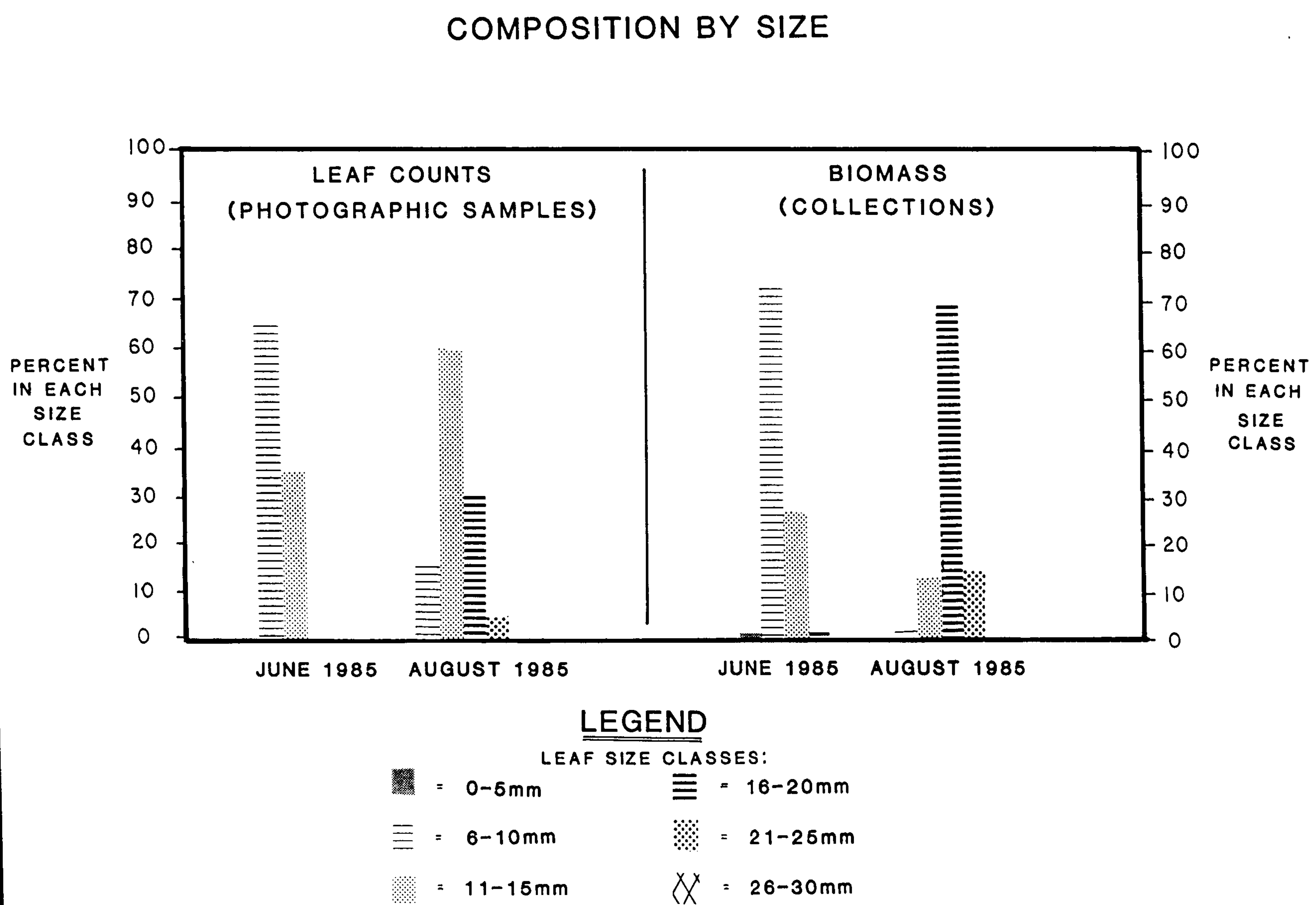


FIGURE 9. SIZE FREQUENCY DISTRIBUTION OF H. DECIPIENS LEAVES, SEAGRASS REFERENCE STATION 1, JUNE AND AUGUST 1985.

was much greater in June than in August. In August, the sampled leaf size ranges approximated the bell curve of a normally distributed population (Figure 9). The biomass data indicate that a few large leaves can account for a large proportion of total leaf biomass.

Signature Control Stations 34, 35, and 36 were dominated by *H. engelmanni* in October 1984 (Table 4). In August of 1986, these stations showed either bare sand or extremely sparse clusters of *Halophila* sp. shoots and rhizomes. What has occurred at these stations is unknown, but the presence of attached shoots and rhizomes indicates there were seagrasses present earlier in the growing season.

Information about the growth of *H. engelmanni* is available from two of the Sohio monitoring program reference stations located in the same general area as Signature Control Stations 38 and 40. When the Seagrass Reference Stations were sampled in June 1985, they appeared to have reached their growth peak for the year. When these stations were resampled in August 1985, the seagrasses present were found to have been decimated by a red filamentous alga that coated their leaves and destroyed the plant. Biomass from these stations was drastically reduced in the August sampling (Continental Shelf Associates, Inc., 1986).

3.2.3 Live Bottom Stations

Signature Control Stations 9, 11, 13, and 39 were located in live-bottom areas. These stations were reoccupied, and photographs from 1984 were compared with photographs from 1986. No obvious changes in species present or growth form could be detected.

Quantitative photographic data from the Sohio live-bottom reference station show a reduction in biota and an increase in sand cover immediately after Hurricane "Elena" (Table 5). Total percent biota coverage in 1986 was 26.5, up from the 17.2 recorded in October of 1985, but considerably below the 43.55 seen in August 1985. Of the four major live-bottom groups, algae, sponges, octocorals, and hard corals, only the octocorals showed coverage equal to pre-storm levels. The octocorals were consistently the single most abundant faunal element. They showed no reduction in coverage either immediately after Hurricane "Elena" in October 1985 or in the August 1986 survey (Table 5).

TABLE 5. BIOTIC COVER DATA FROM THE SOHIO LIVE-BOTTOM REFERENCE STATION.

Biota/Substrate Type	Percent Coverage* Jun 1985	Aug 1985	Oct 1985	Aug 1986
BIOTA TYPE				
Unid. Biota	7.65	5.30	1.75	2.33
Algae				
Halimeda sp.	3.15	3.10		
Unid. Rhodophycophyta	1.15	10.65	0.30	0.56
Unid. Corallinacea	0.75	2.20	0.85	1.44
Unid. Chlorophycophyta	0.35			
Gracilaria sp.	0.20		0.15	
Udotea sp.	0.05	0.20		0.11
Botryocladia occidentalis		1.60	0.05	0.67
Caulerpa sp.		1.00		
Gracilaria mammilaris		0.20		
Codium sp.		0.15		
Spyridium sp.				8.67
Sponges				
Unid. Porifera	2.45	0.75	0.40	0.22
Cinachyra alloclada	0.45	0.05		0.11
Ircinia campana	0.40	0.50		
Cinachyra kuekenthali	0.25	0.10		
Cinachyra sp.	0.15		0.10	
Igernella notabilis	0.10			
Pseudaxinella lunaecharta	0.10			
Axinella sp.	0.05	0.05		
Spirastrella sp.	0.05	0.05	0.05	0.11
Unid. Microcionidae	0.05	0.10		
Haliclona sp. on *Geodia gibberosa*		1.25	1.00	1.33
Ircinia sp.		0.80	0.80	
Placospongia melobesioides		0.25		
Homaxinella sp.		0.10		
Phakellia folium		0.05		
Octocorals				
Muricea elongata	8.80	7.35	9.05	8.00
Unid. Plexauri	2.70	4.85	1.80	1.78
Pseudopterogorgia acerosa		0.65	0.25	0.56
Scleractinian Corals				
Cladocora arbuscula	1.45	1.15	0.05	0.22
Scolymia lacera	1.00	0.45	0.30	0.11
Siderastrea radians	0.40	0.15		
Stephanocoenia michelinii	0.20	0.10		

TABLE 5. (CONTINUED).

Biota/Substrate Type	Percent Coverage* Jun 1985	Aug 1985	Oct 1985	Aug 1986
Phyllangia americana	0.05	0.05		
Solenastrea hyades		0.05		
Molluscs				
Arca zebra		0.10		
Bryozoans				
Celleporaria sp.	0.10			
Celleporaria magnifica			0.05	
Hippoporidra edax				0.05
Echinoderms				
Diadema antillarum	0.15			
Echinaster sp.		0.10		
Astrophyton muricatum			0.05	
Ascidians				
Polycarpa circumarata	1.00			0.22
Polyandrocarpa floridana	0.20			
Clavelina picta	0.10			
Didemnum sp.		0.05		0.11
Clavelina gigantea			0.20	
Fishes				
Diplectrum formosum	0.10			
TOTAL BIOTA	33.60	43.50	17.20	26.60
SUBSTRATE TYPE				
Sand	64.00	52.35	80.50	73.40
Tag**	1.80	2.20	1.35	
Rock	0.60	1.05	0.65	
Algal Rubble		0.90		
Shell Rubble			0.30	
TOTAL SUBSTRATE	66.40	56.50	82.80	73.40

*Based on quantitative slide analysis of photographs from 10 quadrats on each survey (except Aug 1986--9 quadrats).

**Sample points which fell on the quadrat marker.

4.0 DISCUSSION

4.1 HURRICANE IMPACTS

In 1961, aerial photographs taken following the passage of Hurricane "Donna" illustrated the potential importance of hurricanes in shaping the *Thalassia testudinum* beds of Biscayne Bay (Thomas et al., 1961). Review of aerial photographs taken following the passage of Hurricanes "David" (1979) and "Allen" (1980) across Cayo Enrique, La Parguera, Puerto Rico, showed that the mangrove community sustained the bulk of damage from those storms; the dense *T. testudinum* beds present near the Cay showed no detectable impacts (Armstrong, 1981). In a related study from the same general area, Ballantine (1984) reported that although hurricanes "Allen" and "David" caused massive destruction in a deep [17 m (55 ft)] algal flat assemblage he was studying off Puerto Rico, recovery was complete within one year. Similarly, Morgan and Kitting (1984) reported the 93-mph winds of Hurricane "Allen" had no major impacts on the shallow water beds of *Halodule wrightii*. Kirby-Smith and Ustach (1985) studied the effects of Hurricane "Diana" on live-bottom communities off North Carolina. They reported some immediate impacts in the form of mortalities among mussels, sponges, and corals, but were unable to detect any long-term, significant damage to these communities. Their conclusions were that continental shelf live-bottom communities are not significantly affected by either the wave energy or sediment scour associated with the passage of major storms. Recently, a report from the Northern Gulf of Mexico stated that both Hurricanes "Elena" and "Kate" produced changes in the standing stock biomass, sediment structure, and infauna associated with a mixed nearshore seagrass bed being studied there (Phillips, 1986).

In 1985, when Continental Shelf Associates, Inc. divers visited the area in the Big Bend where Hurricane "Elena" had passed through eight days earlier, they found evidence of tremendous destruction of seagrasses, macroalgae, and sessile invertebrates. Large quantities of organic material were suspended in the water column, and thick mats of uprooted vegetation and fragmented sessile invertebrates covered the seafloor. Four Endeco propeller-type current meters located in the area were completely jammed with organic debris composed mainly of *Halophila*, algae, sponge, and gorgonian fragments. A subsequent visit one month after the passage of "Elena" showed that most of the organic debris was gone from the area. The bottom had been completely stripped of attached algal and seagrass cover, and substantial shifts in sediment cover were noted in some areas. Attached hard corals appeared relatively intact, but white spots indicative of zooxanthellae expulsion (a reaction associated with environmental stress) were noted in many colonies (Continental Shelf Associates, Inc., 1987).

The August 1986 survey, conducted approximately one year after the passage of Hurricane "Elena," showed that seagrasses were again present in portions of the Big Bend area known to have been completely denuded. The elimination of *H. engelmanni* seen at Stations 34, 35, and 36 is not interpreted as a hurricane impact. Total areal coverage by seagrass beds and overall zonation patterns were similar to those observed during the October 1984 survey. Direct comparison of leaf densities and biomass values for *Halophila decipiens* is not conclusive with regard to hurricane impacts, because the degree of seasonal and interannual variation in these parameters is not well known. However, the values from 1984 and 1986 were of the same general magnitude. Biotic coverage and gross taxonomic composition of the epifaunal communities at the live-bottom stations also were comparable between the 1984 and 1986 surveys. Although the immediate impacts of hurricanes are extensive in terms of uprooted plants and animals, seagrass/algal beds and live-bottom communities on the Florida Big Bend continental shelf appear to be resilient to the occasional passage of major hurricanes.

4.2 STRUCTURE OF THE BIG BEND SEAGRASS BEDS

Worldwide, there are two families, 12 genera, and 45 species of vascular marine plants. In Florida, the family Hydrocharitaceae is represented by *T. testudinum*, *Halophila decipiens*, *H. engelmanni*, and *H. johnsonii* and the family Potamogetonaceae is represented by *S. filiforme* and *Halodule wrightii* (Zieman, 1982). Zonation along the Big Bend continental shelf approximates the idealized pattern described by den Hartog (1977). *Halophila* species are found in all habitats where they are not outcompeted by larger seagrasses (*Thalassia*, *Syringodium*, or *Halodule*). *Syringodium* in the shallow sublittoral and *Thalassia* in slightly deeper areas occupy a variety of substrates along the coastline. *Halodule wrightii* is seen both inside the climax species stands in the very shallow sublittoral and eulittoral, then again outside the major beds in the lower sublittoral.

Of the three colonizing or fringing species seen in the Big Bend area, *Halodule wrightii* and *Halophila engelmanni* appear to be the most tolerant to fluctuating environmental conditions (Zimmerman and Livingston, 1976). The third species, *Halophila decipiens*, which is the only seagrass species distributed pantropically (McMillan and Williams, 1980), appears to be the most stenohaline (Zieman, 1982). Halophila species predominate only in areas where Halodule does not grow (den Hartog, 1977). In the Big Bend area, both H. decipiens and H. engelmanni are found to depths exceeding 22 m (72 ft). They can also be found growing near the low- water mark and in areas shaded by other seagrasses or mangroves. The response of H. engelmanni to light is typical for a colonizing plant species. Its linear C uptake and Pmax are two to four times higher than those of T. testudinum (Williams and McRoy, 1982) indicating the plant can better utilize whatever photosynthetically active radiation (PAR) to which it is exposed. This in turn, allows H. engelmanni to survive in a wider variety of habitats. Both H. decipiens and H. engelmanni show more sensitivity to high irradiance than climax species and are inhibited photosynthetically by ultraviolet light (Trocine et al., 1982).

The Halophila-dominated seagrass beds that cover a large portion of the Big Bend continental shelf are simple communities in which a single vascular plant, either H. decipiens or H. engelmanni, is the main structural element. The fauna associated with these seagrass beds typically are similar to those seen on nearby areas of unvegetated seafloor. Such communities repopulate rapidly after a seafloor disturbance (den Hartog, 1977).

4.3 BIOMASS COMPARISONS

Biomass estimates for H. decipiens in the present study ranged from 0.006 to 0.522 g/m^2. For H. engelmanni, the range was 0.829 to 1.973 g/m^2, which are generally comparable to those reported previously by Buesa (1975) for the north coast of Cuba and by Zieman and Wetzel (1980) for the Texas coast.

Biomass in Halophila seagrass beds is always small when compared with that of a climax species seagrass bed (Zieman, 1982). Buesa (1975) calculated the mean biomass for H. decipiens growing between 0 and 24 m (77 ft) off the north coast of Cuba at 0.14 g/m^2. His figures for H. engelmanni growing between 0 and 14 m (46 ft) were 0.25 g/m^2, whereas for Thalassia (0 to 12 m or 40 ft) they were 350 g/m^2. By abundance, Thalassia accounted for 97.5% of the measured seagrass biomass, Syringodium for 2.2%, H. engelmanni for 0.2%, and H. decipiens for 0.1% on the north Cuban shelf. Off the Texas coast, Halophila engelmanni biomass was measured at 1.6 g/m^2, whereas the biomass of

Thalassia off the southeast coast of Florida ranged from 500 to 3,100 g/m^2 (Zieman and Wetzel, 1980). In the Big Bend area off Cedar Key, biomass in a Thalassia-dominated nearshore seagrass bed was estimated at 385 g/m^2, with seagrass making up about 45% of the total (Dawes et al., 1985).

Applying the mean biomass figures obtained during this study for H. decipiens (0.2116 g/m^2) to the 498,034 ha (1.2 million acres) of sparse offshore seagrass beds mapped in the 1985 Florida Big Bend Seagrass Habitat Study, and allowing that 44% of the area mapped as seagrass beds may actually consist of live-bottom rather than seagrass beds, the estimated standing crop is 590 t (651 tons). Utilizing Dawes (1986) biomass figure of 385 g/m^2, 50% of which is produced by the seagrass themselves, as typical of the 232,893 ha (0.5 million acres) of dense nearshore seagrass beds mapped yields a standing crop of 448,325 t (494,054 tons) for those seagrass beds.

4.4 TROPHIC IMPORTANCE OF SEAGRASS BEDS

Seagrasses provide food for other organisms in three ways: 1) via direct herbivory; 2) via the detrital food web within seagrass beds; and 3) via export of plant material and detritus. In climax species beds, the detrital food web is the primary pathway of trophic energy transfer (Zieman, 1982). Within these dense nearshore seagrass beds, biomass is significantly correlated with both species number and abundance of associated invertebrate fauna, but this correlation is thought to result from habitat complexity (the ability to provide protection), rather than primary production (Heck and Wetstone, 1977).

Of the 66 species reported to eat Florida seagrasses (Zieman, 1982), only eight fish species are listed as feeding on Halophila leaves. These fish are all generalist feeders (Randall, 1965) and it is unlikely that Halophila makes up a significant portion of their diet.

Wolff (1976, 1980) demonstrated the importance of seagrasses as an energy source on the deep sea floor; however, Halophila leaves were not reported in the material collected from abyssal depths. Josselyn et al. (1983) documented the transfer of seagrass biomass off the Virgin Islands shelf and listed H. decipiens leaves as seasonally dominant in the drift material transported down a submarine canyon. Exported carbon and nitrogen from seagrass productivity can be important to benthic, midwater, and surface feeders considerable distances from the continental shelves (Zieman, 1982).

Biomass calculations derived from data collected during the Big Bend Seagrass Habitat Study suggest that as much as 590 t (651 tons) of *H. decipiens* may be released on the outer Big Bend shelf annually between October and February. The importance of this production in the ecosystem of Florida's western continental shelf remains unclear. However, the extensive *Halophila* beds could be an important detrital food source, a possibility that should be investigated in further research.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This study, as well as previously published research, supports the contention that seagrass, algal, and live-bottom communities on the continental shelf are resilient to storm impacts. *Halophila* sp. areas denuded by Hurricane "Elena" in 1985 appeared fully recovered after the 1986 growing season, supporting den Hartog's (1977) statement that *Halophila* sp. rapidly repopulate disturbed bottom. Live-bottom assessments in this study, particularly with respect to the octocorals, support Kirby-Smith and Ustach's (1985) conclusion that continental shelf live-bottom assemblages are adapted to withstand both the wave energy and sand scouring associated with storms.

Although climax species seagrass beds have long been studied the world over, very little research effort has been devoted to sparse offshore halophilid communities. The long, gentle slope and relatively clear water of the west Florida shelf have allowed extensive seagrass, algal, and live-bottom communities to develop. Trophic energy transfer has not been well studied in these extended sparse seagrass, algal, and live-bottom communities, which may play an important role in the shelf's overall productivity. Future studies of these outer continental shelf seagrass communities should concentrate on: 1) the floral and faunal components of these communities; 2) their indigenous food webs; and 3) mechanisms of trophic energy transfer.

6.0 REFERENCES CITED

Armstrong, R. A. 1981. Changes in Cayo Enrique, LaParguera, Puerto Rico, from 1936-1980 using aerial photo analysis. M.S. thesis, Puerto Rico Univ. 69 pp.

Ballantine, D. L. 1984. Hurricane-induced mass mortalities to a tropical subtidal algal community and subsequent recoveries. Mar. Ecol. Prog. Ser. 20:75-83.

Bohnsack, J. A. 1979. Photographic quantitative sampling of hard-bottom communities. Bull. Mar. Sci. 29(2):242-252.

Buesa, R. J. 1975. Population biomass and metabolic rates of marine angiosperms on the northwestern Cuban shelf. Aquat. Bot. 1:11-23.

Chelsea International Corporation. 1983. National Marine Sanctuary Site Evaluations Recommendations and Final Reports. A report for the National Oceanic and Atmospheric Administrative, Office of Ocean and Coastal Resource Management Sanctuary Program Division. Contract No. NA82-SAC-00647.

Continental Shelf Associates, Inc. 1981. Survey of Potential Live-Bottom Areas in Tarpon Springs Block 277 off the Western Coast of Florida. A report for Mobil Oil Exploration and Producing Southeast Inc.

Continental Shelf Associates, Inc. 1983. Annotated bibliography of published research dealing with light/seagrass relationships. A report for the Florida Department of Environmental Regulation, Tallahassee, FL. 13 pp.

Continental Shelf Associates, Inc. 1984a. Seagrass beds and surficial sediment types found in Clearwater Harbor-St. Joseph Sound, Florida. A report for the U.S. Army Corps of Engineers, Mobile District, Mobile, AL.

Continental Shelf Associates, Inc. 1984b. Live-Bottom Survey of Drillsite Locations in Destin Dome Area Blocks 160, 204, and 205 off the Northwest Coast of Florida. A report for Shell Offshore Inc. and Amoco Production Company.

Continental Shelf Associates, Inc. 1984c. Live-Bottom Survey of Drillsite Locations in Gainesville Area Block 707 off the Northwest Coast of Florida. A report for Sohio Petroleum Company, Lafayette, LA.

Continental Shelf Associates, Inc. 1987. Monitoring of Drillsite A in the Gainesville OCS Area Block 707. A report for Sohio Petroleum Company, Lafayette, LA.

Continental Shelf Associates, Inc. and Martel Laboratories, Inc. 1985. Florida Big Bend Seagrass Habitat Study Narrative Report. A final report for the Minerals Management Service, Metairie, LA. Contract No. 14-12-0001-30188.

Dawes, C. J., K. Bird, M. Durako, R. Gooddard, W. Hoffman, and R. McIntosh. 1979. Chemical fluctuations due to seasonal cropping effects on an algal seagrass community. Aquat. Bot. 6(1):79-86.

Dawes, C. J., M. O. Hall, and R. K. Riechert. 1985. Seasonal biomass and energy content in seagrass communities on the west coast of Florida. J. Coast. Res. 1(3):255-262.

Dawes, C. J. 1986. Seasonal proximate constituents and caloric values in seagrasses and algae on the west coast of Florida. J. Coast. Res. (2)1:25-32.

den Hartog, C. 1977. Structure, function, and classification in seagrass communities, pp. 89-121. In: C. P. McRoy and C. Helfferich (eds.), Seagrass Ecosystems: A Scientific Perspective.

Earle, S. A. 1972. Benthic algae and seagrasses, pp. 15-18. In: C. V. Bushnell (ed.), Chemistry, Primary Productivity, and Benthic Algae of the Gulf of Mexico. Serial Atlas of the Marine Environment. Folio 22.

Enos, P. and R. D. Perkins. 1977. Quaternary sedimentation in south Florida. Geol. Soc. Am. Mem. 147:1-198.

Heck, K. L. Jr., and G. S. Wetstone. 1977. Habitat complexity and invertebrate species richness and abundance in tropical seagrass meadows. J. Biog. 4:1135-1142.

Iverson R. L. and H. F. Bittaker (in press). Seagrass distribution and abundance in eastern Gulf of Mexico coastal waters. Est. Coast. Shelf Sci.

Josselyn M. N., G. M. Cailliet, T. M. Niesen, R. Cowen, A. C. Harley, J. Connor, and S. Hawes. 1983. Composition, export and faunal utilization of drift vegetation in the Salt River submersible canyon. Est. Coast. Shelf Sci. 17:447-465.

Kirby-Smith, W. W. and J. Ustach. 1985. Effects of a Natural Disturbance on a Continental Shelf Live-Bottom Community off North Carolina. A final report for Atlantic OCS Region Minerals Management Service, USDOI, Washington, D.C. 17 pp.

Mann, K. H. 1973. Seaweeds: Their productivity and strategy for growth. Science 182:975-981.

McMillan, S. and S. C. Williams. 1980. Systematic implications of isozymes in Halophila section Halophila. Aquat. Bot. 9:21-31.

McNulty, J. K., W. N. Lindall, Jr., and J. E. Sykes. 1972. Cooperative Gulf of Mexico Estuarine Inventory and Study, Florida. Phase 1, Area Description. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Circ. No. 368. 126 pp.

McRoy, C. P. and C. McMillan. 1977. Production Ecology and Physiology of Seagrasses, pp. 53-87. In: C. P. McRoy and C. Helfferich (eds.), A Scientific Perspective. Marcel Dekker, New York, NY.

Moore, D. R. 1963. Distribution of the seagrass, Thalassia. Bull. Mar. Sci. 13(2):329-342.

Morgan, M. D. and C. L. Kitting. 1984. Productivity and utilization of the seagrass Halodule wrightii and its attached epiphytes. Limnol. Oceanogr. 29(5)1066-1076.

Parker, R. O., Jr., D. R. Colby, and T. D. Willis. 1983. Estimated amount of reef habitat on a portion of the U.S. South Atlantic and Gulf of Mexico continental shelf. Bull. Mar. Sci. 33(4):935-942.

Phillips, R. C. 1960. Observations on the ecology and distribution of the Florida seagrasses. Florida State Board of Conservation. Prof. Paper Ser. No. 2. 72 pp.

Phillips, R. C. 1978. Seagrasses and the coastal marine environment. Oceanus 3:30-40.

Phillips, C. 1986. The Effects of Hurricanes Elena and Kate on the infauna of a seagrass meadow. Abstract from 1986 Benthic Ecology Meetings, University of Massachusetts at Boston.

Randall, J. E. 1965. Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. Miami. 5:665-847.

Thomas, L. P., D. R. Moore, and R. C. Work. 1961. Effects of Hurricane Donna on the turtle grass beds of Biscayne Bay, Florida. Bull. Mar. Sci. 11:191-197.

Thompson, M. J. and N. W. Phillips. 1986. Resource Inventory of the Florida Big Bend Region. In: Proceedings of the Tenth National Conference of the Coastal Society. 12-15 October 1986, New Orleans, LA.

Trocine, B. P., J. D. Rice, and G. N. Wells. 1982. Photosynthetic response of seagrasses to UV-A radiation and the influence of visible light intensity. Plant Physiol. 69:341-344.

Williams, S. L. and P. C. McRoy. 1982. Seagrass productivity: The effect of light on carbon uptake. Aquat. Bot. 12:321-344.

Withlacoochee Regional Planning Council. 1982. Withlacoochee marine biology study. 45 pp.

Wolff, T. 1976. Utilization of seagrass in the deep sea. Aquat. Bot. 2:161-174.

Wolff, T. 1980. Animals associated with seagrass in the deep sea, pp. 199-224. In: R. C. Phillips and C. P. McRay (eds.), Handbook of Seagrass Biology: An Ecosystem Perspective. Garland STMP Press, New York, NY.

Zieman, J. C. 1982. The ecology of seagrasses of south Florida: A community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82/25. 158 pp.

Zieman, J. C. and R. G. Wetzel. 1980. Productivity in seagrass: methods and rates, pp. 87-116. In: R. C. Phillips and C. P. McRoy (eds.), Handbook of Seagrass Biology: An Ecosystem Perspective. Garland STMP Press, New York, NY.

Zieman, J. C., G. W. Thager, M. B. Robblee and R. T. Zieman. 1979. Production and export of seagrasses from a tropical bay, pp. 21-33. In: R. J. Livingston (ed.), Ecological Processes in Coastal and Marine Systems. Plenum Press, New York, NY.

Zimmerman, M. S. and R. J. Livingston. 1976. Seasonality and physico-chemical ranges of benthic macrophytes from a north Florida estuary (Apalachee Bay). Contrib. Mar. Sci. 20:33-45.

7.0 APPENDICES

APPENDIX A

LEAF COUNTS AND BIOMASS CALCULATIONS FROM ALL *HALOPHILA DECIPIENS* AND *H. ENGELMANNI* SIGNATURE CONTROL STATIONS

CRUISE I

OCTOBER 1984

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 2

DATE SAMPLED 28 October 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 205

NO. OF LEAVES MEASURED 113

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	2	1.77	3.62	5	0.02
6-10	30	26.55	54.42	132	7.18
11-15	62	54.87	112.47	304	34.19
16-20	17	15.04	30.84	519	16.01
21-25	2	1.77	3.62	752	2.72
26-30	0	0.00	0.00	1,400	0.00
Total	113	100.00	204.97	--	60.12

LEAF DENSITY (No. of Leaves/m^2) 663

ESTIMATED LEAF BIOMASS (g/m^2) 0.194

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 4

DATE SAMPLED 28 October 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 109

NO. OF LEAVES MEASURED 71

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	11	15.48	16.88	0.20	3.37
11-15	28	39.44	42.98	0.59	25.36
16-20	28	39.44	42.98	1.00	42.98
21-25	1	1.41	1.53	1.51	2.31
26-30	1	1.41	1.53	1.96	3.00
>30	2	2.82	3.07	2.16	6.63
Total	71	100.00	108.97	--	83.65

LEAF DENSITY (No. of Leaves/m^2) 453

ESTIMATED LEAF BIOMASS (g/m^2) 0.348

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 5

DATE SAMPLED 28 October 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 31

NO. OF LEAVES MEASURED 17

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	0	0.00	0.00	132	0.00
11-15	3	17.65	5.47	304	1.66
16-20	13	76.47	23.70	519	12.30
21-25	1	5.88	1.82	752	1.37
26-30	0	0.00	0.00	1,400	0.00
Total	17	100.00	30.99	--	15.33

LEAF DENSITY (No. of Leaves/m^2) 100

ESTIMATED LEAF BIOMASS (g/m^2) 0.050

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 6

DATE SAMPLED 28 October 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 236

NO. OF LEAVES MEASURED 113

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	8	7.08	16.70	132	2.20
11-15	60	53.10	125.30	304	38.09
16-20	38	33.63	79.36	519	41.19
21-25	7	6.19	14.61	752	10.99
26-30	0	0.00	0.00	1,400	0.00
Total	113	100.00	235.97	--	92.47

LEAF DENSITY (No. of Leaves/m^2) 763

ESTIMATED LEAF BIOMASS (g/m^2) 0.299

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 7

DATE SAMPLED 28 October 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 192

NO. OF LEAVES MEASURED 61

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	0	0.00	0.00	132	0.00
11-15	35	57.38	110.16	304	33.49
16-20	25	40.98	78.68	519	40.83
21-25	1	1.64	3.14	752	2.36
26-30	0	0.00	0.00	1,400	0.00
Total	61	100.00	191.98	--	76.68

LEAF DENSITY (No. of Leaves/m^2) 559

ESTIMATED LEAF BIOMASS (g/m^2) 0.223

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 9

DATE SAMPLED 29 October 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 503

NO. OF LEAVES MEASURED 287

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	6	2.09	10.51	5	0.05
6-10	80	27.88	140.24	132	18.51
11-15	152	52.96	266.39	304	80.98
16-20	48	16.72	84.10	519	43.65
21-25	1	0.35	1.76	752	1.32
26-30	0	0.00	0.00	1,400	0.00
Total	287	100.00	503.00	--	144.51

LEAF DENSITY (No. of Leaves/m^2) 1627

ESTIMATED LEAF BIOMASS (g/m^2) 0.467

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 25

DATE SAMPLED 31 October 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 248

NO. OF LEAVES MEASURED 194

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	39	20.10	49.85	132	6.58
11-15	77	39.69	98.43	304	29.92
16-20	75	38.6	95.87	519	49.76
21-25	3	1.55	3.83	752	2.88
26-30	0	0.00	0.00	1,400	0.00
Total	194	100.00	247.98	--	89.14

LEAF DENSITY (No. of Leaves/m^2) 802

ESTIMATED LEAF BIOMASS (g/m^2) 0.288

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 26

DATE SAMPLED 31 October 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 49

NO. OF LEAVES MEASURED 44

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	11	25.00	12.25	132	1.62
11-15	22	50.00	24.50	304	7.45
16-20	11	25.00	12.25	519	6.36
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	44	100.00	49.00	--	15.43

LEAF DENSITY (No. of Leaves/m^2) 204

ESTIMATED LEAF BIOMASS (g/m^2) 0.064

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 26

DATE SAMPLED 31 October 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 194

NO. OF LEAVES MEASURED 148

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	0	0.00	0.00	0.20	0.00
11-15	22	14.86	28.83	0.59	17.01
16-20	64	43.24	83.89	1.00	83.89
21-25	51	34.46	66.85	1.51	100.94
26-30	10	6.76	13.10	1.96	25.68
>30	1	0.68	1.31	2.16	2.83
Total	148	100.00	193.98	--	230.35

LEAF DENSITY (No. of Leaves/m^2) 807

ESTIMATED LEAF BIOMASS (g/m^2) 0.958

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 25

DATE SAMPLED 31 October 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 107

NO. OF LEAVES MEASURED 76

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	0	0.00	0.00	0.20	0.00
11-15	17	22.37	23.93	0.59	14.12
16-20	14	18.42	19.71	1.00	19.71
21-25	24	31.58	33.78	1.51	51.01
26-30	17	22.37	23.93	1.96	46.90
>30	4	5.26	5.63	2.16	12.16
Total	76	100.00	106.98	--	143.90

LEAF DENSITY (No. of Leaves/m^2) 346

ESTIMATED LEAF BIOMASS (g/m^2) 0.465

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 34

DATE SAMPLED 31 October 1984

SPECIES PRESENT *H. engelmanni*

NO. OF LEAVES COUNTED 488

NO. OF LEAVES MEASURED 337

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	24	7.12	34.75	0.20	6.95
11-15	86	25.52	124.53	0.59	73.47
16-20	149	44.22	215.76	1.00	215.76
21-25	66	19.58	95.57	1.51	144.31
26-30	12	3.56	17.37	1.96	34.05
>30	0	0.00	0.00	2.16	0.00
Total	337	100.00	487.98	--	474.54

LEAF DENSITY (No. of Leaves/m^2) 2,029

ESTIMATED LEAF BIOMASS (g/m^2) 1.973

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 35

DATE SAMPLED 31 October 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 259

NO. OF LEAVES MEASURED 182

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	4	2.20	5.69	0.20	1.14
11-15	35	19.23	49.80	0.59	29.38
16-20	76	41.76	108.15	1.00	108.15
21-25	42	23.08	59.76	1.51	90.24
26-30	18	3.85	25.61	1.96	50.20
>30	7	3.85	9.96	2.16	21.51
Total	182	100.00	258.97	--	300.62

LEAF DENSITY (No. of Leaves/m^2) 754

ESTIMATED LEAF BIOMASS (g/m^2) 0.875

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 36

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 16

NO. OF LEAVES MEASURED 16

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	0	0.00	0.00	132	0.00
11-15	7	43.75	7.00	304	2.13
16-20	9	56.25	9.00	519	4.67
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	16	100.00	16.00	--	6.80

LEAF DENSITY (No. of Leaves/m^2) 67

ESTIMATED LEAF BIOMASS (g/m^2) 0.028

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 36

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. engelmanni*

NO. OF LEAVES COUNTED 155

NO. OF LEAVES MEASURED 114

AREA SAMPLED (m^2) 0.2405

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	2	1.75	2.71	0.20	0.54
11-15	13	11.40	17.67	0.59	10.43
16-20	38	33.33	51.66	1.00	51.66
21-25	42	36.85	57.10	1.51	86.22
26-30	19	16.67	25.83	1.96	50.63
>30	0	0.00	0.00	2.16	0.00
Total	114	100.00	154.97	--	199.48

LEAF DENSITY (No. of Leaves/m^2) 644

ESTIMATED LEAF BIOMASS (g/m^2) 0.829

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 37

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 112

NO. OF LEAVES MEASURED 44

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	8	18.18	20.36	132	2.69
11-15	28	63.64	71.27	304	21.67
16-20	7	15.91	17.81	519	9.24
21-25	1	2.27	2.54	752	1.91
26-30	0	0.00	0.00	1,400	0.00
Total	44	100.00	111.98	--	35.51

LEAF DENSITY (No. of Leaves/m^2) 326

ESTIMATED LEAF BIOMASS (g/m^2) 0.103

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 38

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 350

NO. OF LEAVES MEASURED 103

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	31	30.10	105.33	132	13.90
11-15	51	49.52	173.30	304	52.68
16-20	16	15.53	54.36	519	28.21
21-25	5	4.85	16.99	752	12.78
26-30	0	0.00	0.00	1,400	0.00
Total	103	100.00	349.98	--	107.57

LEAF DENSITY (No. of Leaves/m^2) 1,019

ESTIMATED LEAF BIOMASS (g/m^2) 0.313

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 40

DATE SAMPLED 1 November 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 10

NO. OF LEAVES MEASURED 5

AREA SAMPLED (m^2) 0.4123

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	1	20.00	2.00	132	0.26
11-15	4	80.00	8.00	304	2.43
16-20	0	0.00	0.00	519	0.00
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	5	100.00	10.00	--	2.69

LEAF DENSITY (No. of Leaves/m^2) 24

ESTIMATED LEAF BIOMASS (g/m^2) 0.006

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 41

DATE SAMPLED 1 November 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 136

NO. OF LEAVES MEASURED 107

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	4	3.74	5.08	5	0.03
6-10	57	53.27	72.44	132	9.56
11-15	42	39.25	53.38	304	16.23
16-20	4	3.74	5.08	519	2.63
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	107	100.00	135.98	--	28.45

LEAF DENSITY (No. of Leaves/m^2) 440

ESTIMATED LEAF BIOMASS (g/m^2) 0.092

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 41

DATE SAMPLED 1 November 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 46

NO. OF LEAVES MEASURED 33

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	1	3.03	1.39	0.20	0.28
11-15	8	24.24	11.15	0.59	6.57
16-20	19	57.58	26.48	26.48	26.48
21-25	3	9.09	4.18	1.51	6.31
26-30	2	6.06	2.78	1.96	5.45
>30	0	0.00	0.00	2.16	0.00
Total	33	100.00	45.98	--	45.09

LEAF DENSITY (No. of Leaves/m^2) 149

ESTIMATED LEAF BIOMASS (g/m^2) 0.146

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 42

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 109

NO. OF LEAVES MEASURED 92

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	2	2.17	2.37	5	0.01
6-10	39	42.39	46.20	132	6.10
11-15	42	45.66	49.77	304	15.13
16-20	9	9.78	10.66	519	5.53
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	92	100.00	109.00	--	26.77

LEAF DENSITY (No. of Leaves/m^2) 317

ESTIMATED LEAF BIOMASS (g/m^2) 0.078

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 43

DATE SAMPLED 1 November 1984

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 57

NO. OF LEAVES MEASURED 45

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	17	37.78	21.53	132	2.84
11-15	24	53.33	30.40	304	9.24
16-20	3	6.67	3.80	519	1.97
21-25	1	2.22	1.27	752	0.95
26-30	0	0.00	0.00	1,400	0.00
Total	45	100.00	57.00	--	15.00

LEAF DENSITY (No. of Leaves/m^2) 184

ESTIMATED LEAF BIOMASS (g/m^2) 0.048

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 44

DATE SAMPLED 1 November 1984

SPECIES PRESENT *H. engelmanni*

NO. OF LEAVES COUNTED 195

NO. OF LEAVES MEASURED 167

AREA SAMPLED (m^2) 0.378

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	17	10.18	19.85	0.20	3.97
11-15	76	45.51	88.74	0.59	52.36
16-20	50	29.94	58.38	1.00	58.38
21-25	22	13.17	25.68	1.51	38.78
26-30	2	1.20	2.33	1.96	4.57
>30	0	0.00	0.00	2.16	0.00
Total	167	100.00	194.98	--	158.06

LEAF DENSITY (No. of Leaves/m^2) 516

ESTIMATED LEAF BIOMASS (g/m^2) 0.418

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 45

DATE SAMPLED 1 November 1984

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 109

NO. OF LEAVES MEASURED 90

AREA SAMPLED (m^2) 0.3092

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	21	23.33	25.43	0.20	5.09
11-15	47	52.23	56.92	0.59	33.58
16-20	21	23.33	25.43	1.00	25.43
21-25	1	1.11	1.21	1.51	1.83
26-30	0	0.00	0.00	1.96	0.00
>30	0	0.00	0.00	2.16	0.00
Total	90	100.00	108.99	--	65.93

LEAF DENSITY (No. of Leaves/m^2) 353

ESTIMATED LEAF BIOMASS (g/m^2) 0.213

CRUISE II

FEBRUARY 1985

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 13

DATE SAMPLED 26 February 1985

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 79

NO. OF LEAVES MEASURED 70

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	37	52.86	41.75	0.20	8.35
11-15	23	32.86	25.95	0.59	15.31
16-20	8	11.42	9.02	1.00	9.02
21-25	2	2.86	2.25	1.51	3.40
26-30	0	0.00	0.00	1.96	0.00
>30	0	0.00	0.00	2.16	0.00
Total	70	100.00	78.97	--	36.08

LEAF DENSITY (No. of Leaves/m^2) 230

ESTIMATED LEAF BIOMASS (g/m^2) 0.105

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 26

DATE SAMPLED 26 February 1985

SPECIES PRESENT *H. engelmanni*

NO. OF LEAVES COUNTED 243

NO. OF LEAVES MEASURED 208

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	85	40.87	99.31	0.20	19.86
11-15	83	39.90	96.96	0.59	57.21
16-20	37	17.79	43.22	1.00	43.22
21-25	3	1.44	3.50	1.51	5.28
26-30	0	0.00	0.00	1.96	0.00
>30	0	0.00	0.00	2.16	0.00
Total	208	100.00	242.99	--	125.57

LEAF DENSITY (No. of Leaves/m^2) 707

ESTIMATED LEAF BIOMASS (g/m^2) 0.366

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 34

DATE SAMPLED 22 February 1985

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 178

NO. OF LEAVES MEASURED 154

AREA SAMPLED (m^2) 0.3436

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	75	48.70	86.69	0.20	17.34
11-15	66	42.86	76.29	0.59	45.01
16-20	13	8.44	15.02	1.00	15.02
21-25	0	0.00	0.00	1.51	0.00
26-30	0	0.00	0.00	1.96	0.00
>30	0	0.00	0.00	2.16	0.00
Total	154	100.00	178.00	--	77.37

LEAF DENSITY (No. of Leaves/m^2) 518

ESTIMATED LEAF BIOMASS (g/m^2) 0.225

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 45

DATE SAMPLED 23 February 1985

SPECIES PRESENT H. engelmanni

NO. OF LEAVES COUNTED 78

NO. OF LEAVES MEASURED 69

AREA SAMPLED (m^2) 0.2749

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (mg)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	--	0.00
6-10	16	23.19	18.08	0.20	3.61
11-15	32	46.38	36.17	0.59	21.34
16-20	20	28.99	22.60	1.00	22.60
21-25	1	1.45	1.13	1.51	1.71
26-30	0	0.00	0.00	1.96	0.00
>30	0	0.00	0.00	2.16	0.00
Total	69	100.00	77.98	--	49.26

LEAF DENSITY (No. of Leaves/m^2) 284

ESTIMATED LEAF BIOMASS (g/m^2) 0.179

CRUISE III

AUGUST 1986

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 40

DATE SAMPLED August 1986

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 433

NO. OF LEAVES MEASURED 116

AREA SAMPLED (m^2) 1.088

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	3	2.59	11.21	132	1.48
11-15	30	25.86	111.97	304	34.04
16-20	53	45.69	197.84	519	102.68
21-25	28	24.14	104.53	752	78.61
26-30	2	1.72	7.45	1,400	10.43
Total	116	100.00	432.97	--	227.24

LEAF DENSITY (No. of Leaves/m^2) 398

ESTIMATED LEAF BIOMASS (g/m^2) 0.209

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 38

DATE SAMPLED August 1986

SPECIES PRESENT *H. decipiens*

NO. OF LEAVES COUNTED 821

NO. OF LEAVES MEASURED 171

AREA SAMPLED (m^2) 1.088

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	6	3.51	28.81	132	3.80
11-15	56	32.75	268.88	304	81.74
16-20	78	45.62	374.54	519	194.39
21-25	28	16.37	134.40	752	101.07
26-30	3	1.75	14.37	1,400	20.12
Total	171	100.00	821.00	--	401.12

LEAF DENSITY (No. of Leaves/m^2) 755

ESTIMATED LEAF BIOMASS (g/m^2) 0.369

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 37

DATE SAMPLED August 1986

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 225

NO. OF LEAVES MEASURED 79

AREA SAMPLED (m^2) 0.989

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	3	3.80	8.55	132	1.13
11-15	20	25.32	56.97	304	17.32
16-20	34	43.02	96.80	519	50.24
21-25	19	24.06	54.14	752	40.71
26-30	3	3.80	8.55	1,400	11.97
Total	79	100.00	255.01	--	121.37

LEAF DENSITY (No. of Leaves/m^2) 228

ESTIMATED LEAF BIOMASS (g/m^2) 0.123

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 7

DATE SAMPLED August 1986

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 630

NO. OF LEAVES MEASURED 128

AREA SAMPLED (m^2) 0.378

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	24	18.75	118.12	132	15.59
11-15	79	61.72	388.84	304	118.21
16-20	25	19.53	123.04	519	63.86
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	128	100.00	630.00	--	197.66

LEAF DENSITY (No. of Leaves/m^2) 1,667

ESTIMATED LEAF BIOMASS (g/m^2) 0.522

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 6

DATE SAMPLED August 1986

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 32

NO. OF LEAVES MEASURED 13

AREA SAMPLED (m^2) 0.2749

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	2	15.38	4.92	5	0.02
6-10	3	23.08	7.39	132	0.98
11-15	6	46.16	14.77	304	4.49
16-20	2	15.38	4.92	519	2.55
21-25	0	0.00	0.00	752	0.00
26-30	0	0.00	0.00	1,400	0.00
Total	13	100.00	32.00	--	8.04

LEAF DENSITY (No. of Leaves/m^2) 116

ESTIMATED LEAF BIOMASS (g/m^2) 0.029

LEAF COUNT AND BIOMASS DATA

SIGNATURE CONTROL STATION 5

DATE SAMPLED August 1986

SPECIES PRESENT H. decipiens

NO. OF LEAVES COUNTED 235

NO. OF LEAVES MEASURED 90

AREA SAMPLED (m^2) 0.2749

Size Range (mm)	No. of Leaves	Percent of Measured Leaves in Size Range	Estimated No. of Leaves in Counted Sample	Mean Weight of Leaf in Size Range (ug)	Estimated Biomass in Size Range (mg)
0-5	0	0.00	0.00	5	0.00
6-10	23	25.56	60.06	132	7.93
11-15	47	52.22	122.72	304	37.31
16-20	16	17.78	41.78	519	21.68
21-25	4	4.44	10.43	752	7.84
26-30	0	0.00	0.00	1,400	0.00
Total	90	100.00	234.99	--	74.76

LEAF DENSITY (No. of Leaves/m^2) 855

ESTIMATED LEAF BIOMASS (g/m^2) 0.272

APPENDIX B

DIVER AND TELEVISION TRANSECT DATA FROM AUGUST 1986

TRANSECT NO. 1

DATE: 15 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
1	ND	ND	ND	--
2	28°28.09'	83°02.12'	Patchy Live Bottom	T.V.
3	28°27.91'	83°02.42'	Sand Waves	T.V.
4	28°27.72'	83°02.77'	Sand Waves	T.V.
5	28°27.60'	83°03.02'	Patchy Live Bottom	T.V.
6	28°27.44'	83°03.37'	Bare Sand Botom	T.V.
7	28°27.33'	83°03.68'	Scattered Live Bottom	T.V.
8	28°27.19'	83°03.99'	Scattered Live Bottom with *Caulerpa*	T.V.
9	28°27.06'	83°04.30'	Patchy Live Bottom with Seagrass and Algae	T.V.
10	28°26.96'	83°04.06'	Sand Bottom with Waves and Patchy Algae or *Halophila*	T.V.
11	28°26.83'	83°04.91'	Sand Bottom with Scattered Algae	T.V.
12	28°26.73'	83°05.22'	Scattered Hard Bottom	T.V.
13	28°26.66	83°05.54'	Scattered Live Bottom	T.V.
14	28°26.55'	83°05.86'	Patchy Live Bottom	T.V.
15	ND	ND	Bare Sand, Red Algae	Diver
16	28°25.93'	83°06.44'	Bare Sand, Red Algae	Diver
17	28°25.81'	83°06.97'	Bare Sand with Shell Hash	Diver
18	28°25.75'	83°07.27'	Dense *Halophila*	Diver
19	28°25.70'	83°07.60'	Sparse Live Bottom	Diver

TRANSECT NO. 1

DATE: 15 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
20	28°25.65'	83°07.90'	Dense Halophila	Diver
21	28°25.59'	83°08.22'	Live Bottom	Diver
22	28°25.51'	83°08.65'	Dense Halophila	Diver
23	28°25.47'	83°08.82'	Open Sand with Medium Dense Halophila	Diver
24	28°25.45'	83°09.09'	Halophila	Diver
25	28°25.17'	83°09.46'	Sparse Halophila and Algae	Diver
26	28°25.13'	83°10.72'	Sandy, Sparse Halophila	Diver
27	28°25.15'	83°10.03'	Sand Bottom, Sparse Vegetation	Diver
28	28°25.16'	83°10.36'	Sand with Shell, Some Algae	Diver
29	28°25.20'	83°10.66'	Hard Bottom, Patch Algae with Relief	Diver
30	28°25.23'	83°11.00'	Hard Bottom	Diver
31	28°25.28'	83°11.31'	Sparse Live Bottom	Diver
32	28°25.35'	83°11.60'	Live Bottom, Attached Algae	Diver
33	28°25.45'	83°11.86'	Live Bottom with Relief	Diver
34	28°25.62'	83°11.33'	Halophila with Patches of Sand, Caulerpa	Diver
35	28°25.69'	83°12.55'	Sand with Caulerpa	Diver
36	28°25.89'	83°12.75'	Patchy Halophila With Algae	Diver

TRANSECT NO. 1

DATE: 15 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
37	28°25.86'	83°13.06'	Sand with Drift Algae	Diver
38	28°25.94'	83°13.33'	Sand with Drift Algae	Diver
39	28°25.90'	83°13.64'	Drift Algae *Caulerpa*, Shell Hash, *Halophila*	Diver
40	28°25.77'	83°13.86'	Level Sand Bottom, *Encope*, Drift Algae, *Halophila*	Diver
41	28°25.65'	83°14.14'	Coarse Sand, Emergent Hard Bottom, Soft Corals Algae, Bioturbation	Diver
42	28°25.53'	83°14.43'	Patchy Emergent Rock, Attached Algae and *Halophila*	Diver
43	28°25.45'	83°14.73'	Patches of Emergent Rock, *Caulerpa*, *Halophila*, Algae	Diver
44	28°25.38'	83°15.03'	Attached Algae, *Halophila*, Med-Fine Grain Sand	Diver
45	28°25.31'	83°15.27'	Scattered Sponges, Algae and *Halophila*	Diver
46	28°25.24'	83°15.54'	Attached Algae, *Halophila*, Emergent Hard Bottom	Diver
47	28°25.10'	83°15.66'	Sparse *Halophila*	Diver
48	28°25.04'	83°15.93'	Bare Sand Bottom, Drift Algae	Diver
49	28°25.02'	83°16.17'	Bare Sand, Intermittent Clumps of *Halophila*	Diver

TRANSECT NO. 1

DATE: 15 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
50	28°25.00'	83°16.45'	Shell Hash, Drift Algae	Diver
51	28°24.98'	83°16.73'	Bare Sand, Fine Grain	Diver
52	28°24.95'	83°16.98'	Bare Sand, Fine Grain, Some _Halophila_	Diver
53	28°24.93'	83°17.25'	Bare Sand Bottom, Fine Hard-Packed Sediments	Diver

TRANSECT NO. 4

DATE: 18 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
1	29°11.48'	83°45.85'	Bare Sand Bottom	
2	29°11.54'	83°45.71'	Bare Sand Bottom-Drift Algae with Wind Rows	Diver
3	29°11.46'	83°45.42'	Sand Flats and Sparse *Halophila*-Patchy	Diver
4	29°11.27'	83°45.47'	Bare Sand Bottom-Waves and Ripples	Diver
5	29°11.32'	83°45.52'	Sea Stars, Patchy *Halophila*	Diver
6	29°11.42'	83°45.61'	Bare Sand Bottom, Drift Algae	Diver
7	29°11.48'	83°45.76'	Bare Sand Bottom with Shell, Drift Algae	Diver
8	29°11.52'	83°46.89'	Bare Sand Bottom with Drift Algae	Diver
9	29°11.57'	83°46.11'	Sparse *Halophila*	Diver
10	29°11.60'	83°46.31'	Dense Patches of *Halophila*	Diver
11	29°11.59'	83°46.28'	Patchy Rock Outcrop, *Halophila*, Med. Sand, Drift Algae	Diver
12	29°11.48'	83°46.41'	Level Sand with Med.-Sparse Density *H. engelmanni*, *H. decipiens*	Diver
13	29°11.50'	83°46.59'	Drift Algae, Sparse *H. engelmanni*, *H. decipiens*	Diver
14	29°11.52'	83°46 75'	Level Sand, Sparse *Halophila*, Starfish	Diver

TRANSECT NO. 4

DATE: 18 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
15	29°11.51'	83°46.94'	Drift Algae, Caulerpa H. decipiens	Diver
16	29°11.53'	83°47.12'	Level Sand, Patchy Emergent Rock, Stony Coral, Halophila	Diver
17	29°11.54'	83°47.28'	Emergent Rock-Patchy; Attached Biota, Halophila	Diver
18	29°11.40'	83°48.90'	Bare Bottom-Drift Algae	T.V.
19	29°11.44'	83°48.20'	Bare Sand with Ripples	T.V.
20	29°11.50'	83°48.51'	Bare Sand with Drift Algae	T.V.
21	29°11.55'	83°48.82'	Dense Live Bottom	T.V.
22	29°11.63'	83°49.11'	Patchy Halophila	T.V.
23	29°11.66'	83°49.46'	Patchy Live Bottom	T.V.
24	29°11.73'	83°49.77'	Patchy Live Bottom, Sparse Halophila	T.V.
25	29°11.78'	83°50.08'	Patchy Live Bottom	T.V.
26	29°11.83'	83°50.38'	Bare Sand, Patchy Halophila	T.V.
27	29°11.89'	83°50.71'	Patchy Halophila	T.V
28	29°11.94'	83°51.00'	Dense to Patchy Live Bottom	T.V.
29	29°11.99'	83°51.29'	Patchy to Dense Live Bottom	T.V.
30	29°12.06'	83°51.62'	Patchy Halophila	T.V.
31	29°12.15'	83°51.90'	Sparse Live Bottom	T.V.

TRANSECT NO. 4

DATE: 18 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
32	29°12.26'	83°52.15'	Patchy Live Bottom	T.V.
33	29°12.36'	83°52.45'	Patchy Sparse *Halophila*	T.V.
34	29°12.47'	83°52.72'	Sparse Live Bottom	T.V.
35	29°12.59'	83°53.01'	Patchy Live Bottom	T.V.
36	29°12.69	83°53.27'	Sparse Live Bottom	T.V.
37	29°12.81'	83°53.54'	Patchy Live Bottom	T.V.
38	29°12.91'	83°53.83'	Patchy Live Bottom	T.V.
39	29°13.03'	83°54.11'	Scatered Live Bottom with *Halophila*	T.V.
40	29°13.15'	83°54.40'	Sparse Live Bottom with Algae and *Halophila*	T.V.
41	29°13.26'	83°54.68'	Sparse Live Bottom	T.V.
42	29°13.39'	83°54.96'	Sparse Live Bottom with *Halophila*	T.V.
43	29°13.52'	83°55.23'	Sparse Live Bottom	T.V.
44	29°13.64'	83°55.51'	Sparse-Patchy *Halophila*	T.V.
45	29°13.77'	83°55.77'	Patchy *Halophila* and Live Bottom	T.V.
46	29°13.95'	83°56.01'	Patchy Live Bottom	T.V.
47	29°14.11'	83°56.27'	Sparse Live Bottom	T.V.
48	29°14.27'	83°56.33'	Dense Live Bottom	T.V.
49	29°14.43'	83°56.75'	Sparse Live Bottom	T.V.
50	29°14.60'	83°56.98'	Sparse Live Bottom	T.V.
51	29°14.77'	83°57.22'	Bare Sand	T.V.

TRANSECT NO. 9

DATE: 19 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
1	ND	ND	Bare Sand Bottom	Diver
2	ND	ND	NE/SW Gully, 10'-20' Width Depression; 5 ft Emergent Rock	Diver
3	ND	ND	Sparse and Patchy Algae and Halophila	Diver
4	29°15.30'	83°35.17'	Live Bottom	Diver
5	29°15.30'	83°35.48'	Dense Algae, Sparse Seagrass	Diver
6	29°15.29'	83°35.81'	Caulerpa with Some Drift Algae	Diver
7	29°15.36'	83°36.09'	Bare Sand-Live Bottom	Diver
8	29°15.35'	83°36.31'	Bare Sand, Drift Algae	Diver
9	29°15.39'	83°36.60'	Bare Sand with Waves, Some Drift Algae	Diver
10	29°15.42'	83°36.89'	Bare Sand with Drift Algae	Diver
11	29°15.45'	83°37.18'	Bare Sand with Waves and Drift Algae	Diver
12	29°15.48'	83°37.50'	Bare Sand, Patchy Halophila	Diver
13	29°15.52'	83°37.81'	Bare Sand, Drift Algae	Diver
14	29°15.56'	83°38.10'	Bare Sand, Drift Algae	Diver
15	29°15.92'	83°38.64'	Bare Sand, Drift Algae	Diver
16	29°15.99'	83°38.96'	Bare Sand with Drift Algae, Small Patches of Halophila	Diver
17	29°16.02'	83°39.27'	Emergent Rock with Halophila	Diver

TRANSECT NO. 9

DATE: 19 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
18	29°16.07'	83°39.58'	Bare Sand with Drift Algae, Emergent Rock, Patchy <u>Halophila</u>	Diver
19	29°16.11'	83°39.86'	Bare Bottom, Patchy <u>Halophila</u>	Diver
20	29°16.17'	83°40.12'	Bare Sand	Diver
21	29°16.23'	83°40.39'	Bare Sand, Patchy <u>Halophila</u>	Diver
22	29°16.36'	83°40.61'	Level Sand Bottom, Patchy <u>Halophila</u>	Diver
23	29°16.48'	83°40.85'	Level Sand Bottom Patchy <u>Halophila</u>	Diver
24	29°16.55'	83°41.13'	Mixed Coarse to Medium Grain Sand, <u>Halophila</u>	Diver
25	29°16.59'	83°41.40'	Emergent Rock, Attached Algae	Diver
26	29°16.66'	83°41.71'	Level Sand, Emergent Rock, Patchy <u>Halophila</u>	Diver
27	29°16.72'	83°42.01'	Level Sand, Sparse and Uniform <u>Halophila</u>, <u>H. engelmanni</u>, Stony Corals	Diver
28	29°16.78'	83°42.29'	Level Sand <u>H. engelmanni</u>, <u>H. decipiens</u>, <u>Caulerpa</u> <u>H. engelmanni</u> Drift	Diver
29	29°16.84'	83°42.57'	Drift Algae, Level, Sparse <u>H. engelmanni</u>	Diver
30	29°16.92'	83°42.93'	Hard Bottom, Sparse Epibiota	Diver
31	29°16.97'	83°43.15'	Hard Bottom, Coarse Grain Sand	Diver

TRANSECT NO. 9

DATE: 19 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
32	29°17.34'	83°43.56'	Bare Sand	Diver
33	29°17.41'	83°43.83'	Sparse Live Bottom	Diver
34	29°17.49'	83°44.12'	Live Bottom	Diver
35	29°17.58'	83°44.40'	Live Bottom-Dense	Diver
36	29°17.66'	83°44.70'	Live Bottom-Dense	Diver
37	29°17.75'	83°45.00'	Sparse Live Bottom	Diver
38	29°17.82'	83°45.29'	Dense Live Bottom	Diver
39	29°18.16'	83°45.69'	Sparse Live Bottom, *Caulerpa*	Diver
40	29°18.36'	83°46.25'	Patchy Live Bottom	Diver
41	29°18.47'	83°46.53'	Sparse Live Bottom, Mostly Sand with *Halophila*	Diver
42	29°18.59'	83°46.84'	Open Sand	Diver
43	29°18.70'	83°47.12'	Open Sand with Algae, Sponges, Gorgonians	Diver
44	29°19.14'	83°47.43'	Patchy *Caulerpa*, Gorgonians, *Halophila*	Diver
45	29°19.25'	83°47.72'	Sparse Live Bottom	Diver
46	29°19.38'	83°48.00'	Dense Live Bottom	Diver
47	29°19.46'	83°48.30'	Patchy Live Bottom	Diver
48	29°19.58'	83°48.57'	Sand Bottom, Shell Hash, Sparse *Halophila*	Diver
49	29°19.91'	83°49.01'	Coarse Sand, *Caulerpa*	Diver
50	29°20.01'	83°49.34'	Sand Bottom	Diver
51	29°20.09'	83°49.65'	Scattered Gorgonians	Diver

TRANSECT NO. 9

DATE: 19 August 1986

Fix No.	Latitude	Longitude	Bottom Description	Source
52	29°20.17'	83°49.96'	Thin Sand Veneer, Emergent Rock, Caulerpa Algae	Diver
53	29°20.24'	83°50.27'	Dense Halophila	Diver
54	29°20.42'	83°50.50'	Sparse H. decipiens	Diver
55	29°20.47'	83°50.78'	Sparse Live Bottom, Halophila and Algae	Diver
56	29°20.54'	83°51.09'	Bare Sand, Thin Veneer Over Hard Substrate	Diver
57	29°20.58'	83°51.40'	Dense Live Bottom	Diver
58	29°20.62'	85°51.70'	Patchy Live Bottom	Diver

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. The includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.