# SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY MARINE HABITAT ATLAS

CONTRACT NO. 14-12-0001-29036

VOLUME 2

2 JULY 1985

An addendum and update of the Southwest Florida Shelf Ecosystems Study Years I and 2 Marine Habitat Atlas

PREPARED FOR:

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

PREPARED BY:

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# 1.0 INTRODUCTION

## 1.1 Background

The continental shelf off southwestern Florida is an area of increasing interest to industry engaged in offshore petroleum exploration and development. However, until recently, little was known of the benthic habitats and biota of the shelf and the possible impacts of offshore petroleum-related activities on them. The Minerals Management Service (MMS), as the agency designated to lease submerged Federal lands and supervise oil and gas exploration, development, and production activities, has funded a multi-year series of studies of southwest Florida shelf benthic habitats under the MMS Environmental Studies Program. The objectives of the program are: (1) to obtain data concerning the environmental impacts of petroleum exploration and production activities on the outer continental shelf (OCS), and (2) to provide relevant information to MMS decisionmakers, who are charged with the prediction, assessment, and management of those impacts.

A major environmental concern in relation to proposed drilling on the west Florida shelf centers on the widespread occurrence of "live bottom" areas, which are defined as:

> "...seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna" [U.S. Department of the Interior (USDOI), MMS, 1984].*

Because of the possible sensitivity of these areas to drilling-related activities, a major goal of the MMS-funded southwest Florida shelf studies has been to map benthic habitats, including various types of live-bottom areas.

The first two years of the study series, entitled "Southwest Florida Shelf Ecosystems Study," included benthic habitat mapping in water depths of 20 to 200 m (Figure 1) using a combination of bathymetric and geophysical profiling and underwater television and still camera photography. The results have been presented in a Marine Habitat Atlas (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983a). In addition to the mapping, 39 discrete stations were visited in one or both years to characterize biota and substrate at soft- and live-bottom locations (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983b, 1985).

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*This definition differs from previous usage in the inclusion (at the request of the State of Florida) of seagrass communities as live bottom, regardless of substrate type.

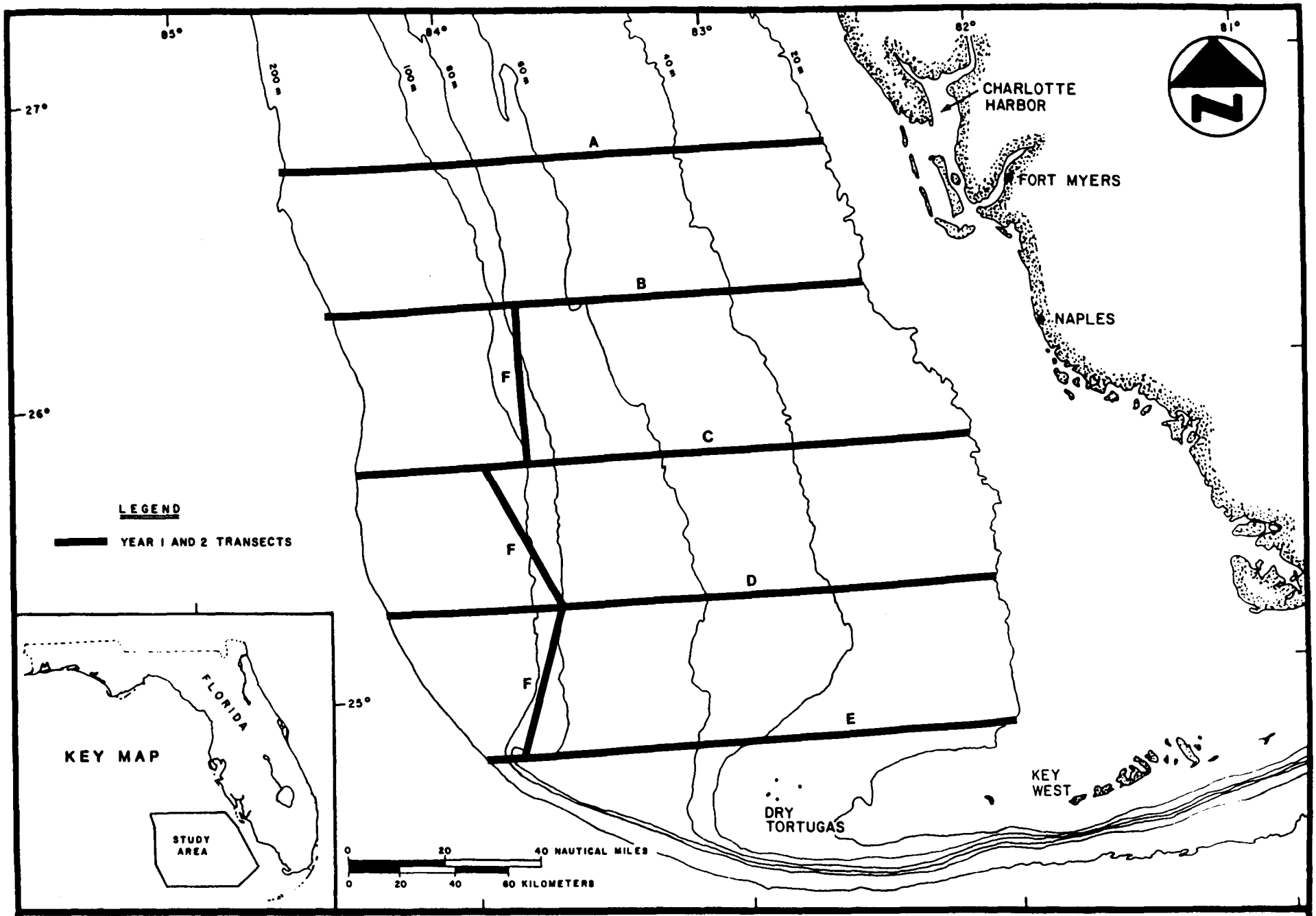



FIGURE 1. LOCATIONS OF "SOUTHWEST FLORIDA SHELF ECOSYSTEMS STUDY" (YEARS 1 AND 2) TRANSECTS.

The "Southwest Florida Shelf Regional Biological Communities Survey" was a third-year extension of the previous investigations. The goal was to map additional areas between and inshore of previous cross-shelf transects and to examine interesting features noted during the earlier surveys (Figure 2). As in the two previous years of study, both habitat mapping and sampling of discrete stations were involved. This report is intended to accompany the third year Marine Habitat Atlas. The results of the third year study, including station sampling and habitat mapping, will be summarized in the forthcoming Final Report (Continental Shelf Associates, Inc., in prep.).

## 1.2 Description of the Atlas

The "Southwest Florida Regional Biological Communities Survey" Marine Habitat Atlas comprises two volumes: the atlas itself and the accompanying volume of explanatory text (this volume). Volume 1 contains: (1) a Survey Locations Map (scale=1:500,000) showing the locations of all geophysical and underwater television/still camera transects; (2) an Index Map (scale=1:500,000), which serves as a key to other atlas maps; (3) two Regional Maps of Marine Habitats (scale=1:500,000) showing the broad distribution of biological communities along the survey transects; and (4) 23 detailed Habitat Maps (scale=1:48,000) summarizing navigational post-plot, side-scan, subbottom profiler, and television data. A legend is provided which clearly defines all symbols used on the maps. Volume 2 (this volume) provides more detailed discussions of each habitat and substrate type; and describes the field surveys, mapping procedures, and data analysis.

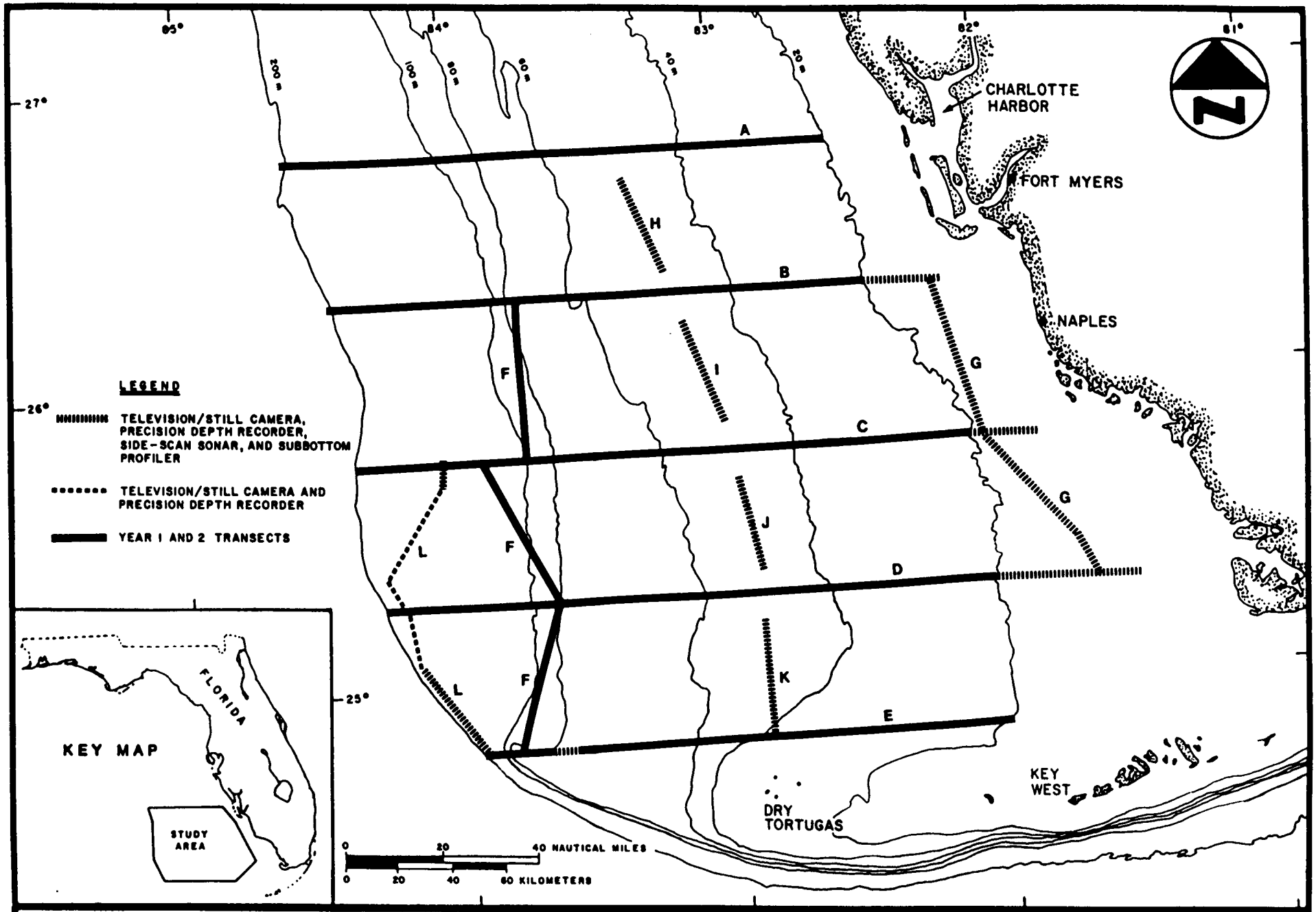



FIGURE 2. LOCATIONS OF "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY" (YEAR 3) TRANSECTS IN RELATION TO THE "SOUTHWEST FLORIDA SHELF ECOSYSTEMS STUDY" (YEAR 1 AND 2) TRANSECTS.

## 2.0 FIELD SURVEYS

The "Southwest Florida Shelf Regional Biological Communities Survey" entailed three cruises. Cruise I, conducted during October 1982, involved simultaneous geophysical and remote photographic surveys of MMS-selected transects for the purpose of habitat mapping and sampling station selection. Cruises II and III, conducted during December 1982 and May-June 1983, respectively, were primarily biological sampling cruises focusing on soft- and live-bottom stations inshore of the 20-m isobath. During Cruise III, some additional remote photographic footage of a deepwater transect (Transect L; see below for description of transect locations) was obtained (photographic coverage was incomplete due to the loss of the television/still camera sled during Cruise I).

### 2.1 Navigation

Navigation was accomplished using an EPSCO Loran-C system, which included a C-NAV XL receiver, a C-Plot-II 10-in. plotter, and an STM steer-to-meter. When used with proper calibration and signal averaging and filtering techniques, the Loran-C system has an accuracy of $\pm$30 to 60 m and a repeatability of $\pm$15 to 45 m. A Digitec 6410 alphanumeric printer was interfaced with the Loran-C system and recorded the time delays from all four available secondary stations at each navigational fix. A receiver at the navigation console displayed ship location as a pair of Loran-C time delays to a resolution of 0.1 $\mu$s. This information was transferred instantly to both the plotter and a steer-to-meter located on the ship's bridge. The steer-to-meter continuously displayed the ship's position relative to a preplotted transect line. Error increments were 30 m to the right or left of the transect line.

The Loran-C navigation system was calibrated immediately prior to Cruise I. All transect lines had been preplotted and the appropriate courses programed into the navigational system. The navigator conned the ship by observing the ship's progress along the preprogramed course plot and issuing instructions to the bridge whenever necessary. While study transects were actually in progress, primary navigational fixes were recorded every 375 m. Two supplementary fixes were taken between each set of primary fixes at intervals of approximately 125 m. All geophysical instrumentation (fathometers, side-scan recorder, and subbottom recorder) was connected to a remote "mark" button located at the navigator's station. Navigational fixes were simultaneously marked on all three recordings. Navigational fixes were also recorded verbally on the sound track generated to accompany video and still camera records. Review of these records and calculation of variances in set-back of the geophysical and video instrument packages allowed precise, "real time" comparison of photographs, videotapes, and sonographic records.

## 2.2 Geophysical Survey

### 2.2.1 Transects Surveyed

The survey pattern selected by the MMS for the 1982 survey (Figure 3) extended previously sampled transects as follows:

1) Transect B was extended from the 20-m isobath to the Florida three-league line.
2) Transect C was extended from the 20-m isobath to the 82°W meridian.
3) Transect D was extended from the 20-m isobath eastward a distance of 35 km (19 nmi).
4) A portion of Transect E characterized by an unusual algal nodule pavement substrate was surveyed again.
5) A north-south transect (G) connecting Transects B and D was run between the 10- and 20-m isobaths.
6) North-south transects (H, I, J, and K) were run along the 50-m isobath between Transects A and E.
7) A north-south transect (L) was run along the outer edge of the continental shelf in depths of approximately 150 m between Transects C and E.

### 2.2.2 Equipment and Procedures

The geophysical equipment employed during the surveys consisted of:

| | |
|---|---|
| Depth Sounders: | Raytheon DE-719 and DE-731 fathometers |
| Side-Scan Sonar: | Kline 421 with either the 4225-101F or 4225-101AF Kline towfish |
| Subbottom Profiler: | Kline 5325-101 with a Kline 611 digital processor and a Kline 431 recorder |

A brief description of each system is given below.

Depth Sounders: The Raytheon DE-719 fathometer was used along the nearshore transects of this survey. This instrument is extremely accurate in shallow water. Maximum depth range for the DE-719 is 122 m. For the deeper transects of this study, a Raytheon DE-731 fathometer was employed. The DE-731 fathometer has a maximum range of 732 m and an accuracy level well within the required 5% of total depth specified in the contract.

Side-Scan Sonar: The Kline 431 side-scan sonar recorder is a three-channel recorder. One channel displays sonic return from the

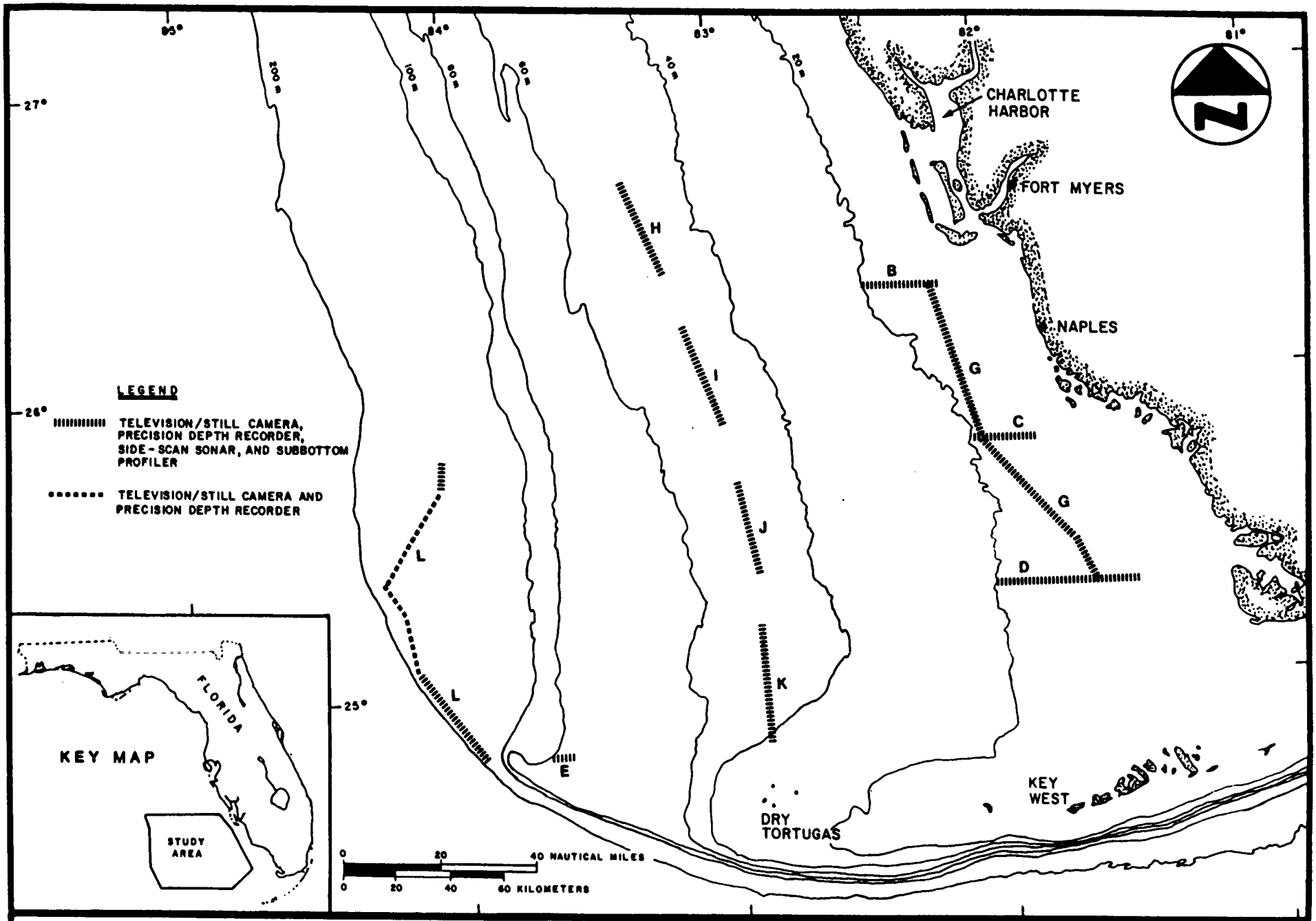



FIGURE 3. LOCATIONS OF "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY" (YEAR 3) TRANSECTS.

seafloor on the starboard, another displays sonic return on the port, and the third displays subbottom profiler data. Although this display pattern could be configured in a number of ways, the most practical display pattern was port signal displayed on port channel, starboard signal on starboard channel, and subbottom data on the remaining channel (Figure 4).

Two types of towed, dual beam transducers (towfish) were employed in attempting to resolve various types of biological signatures:

| Kline Towfish | Application | Horizontal Beam Width | Output Frequency | Pulse Length | Vertical Beam Width |
|---|---|---|---|---|---|
| 4225-101F | High Resolution | 0.75° | 100 kHz | 0.1 ms | 40° down<br>10° horizontal |
| 4225-101AF | General Purpose | 1.0° | 100 kHz | 0.1 ms | 40° down<br>10° horizontal |

The high resolution towfish was used in the areas of dense live bottom along the nearshore transects, and in the algal nodule-Agaricia coral community along Transect E. The general purpose towfish was used on the middle shelf transects and on Transect L along the shelf edge.

Subbottom Profiler: The Kline 5325-101 subbottom profiler has an output frequency of 3.5 kHz, pulse length of 0.4 ms, and a conical beam width of 50° angled straight down. Its calculated resolution is approximately 0.6 m in carbonate sand. The Kline 611 digital processor was used to expand the subbottom profiler's signal for display. The expanded signal contained only the top 25 m beneath the seafloor (Figure 4).

### 2.2.3 Data Collected

Table 1 summarizes the coverage of geophysical data collected along the transect lines surveyed during the "Southwest Florida Shelf Regional Biological Communities Survey." Nearly 500 km (270 nmi) of simultaneous geophysical and videotape data were recorded during Cruise I. Geophysical coverage of Transect L was not completed due to rough seas encountered at the end of Cruise I; about half of the transect length was traversed. All collected data including sonograms, profiles, fathometer traces, and scientific logs were catalogued and returned to the office for analysis. These data have been forwarded to the MMS Gulf of Mexico OCS Region, Metairie, LA.

## 2.3 Underwater Television and Still Camera Survey

### 2.3.1 Transects Surveyed

Photographic data were collected concurrently with geophysical data during Cruise I, and the same transects were surveyed.

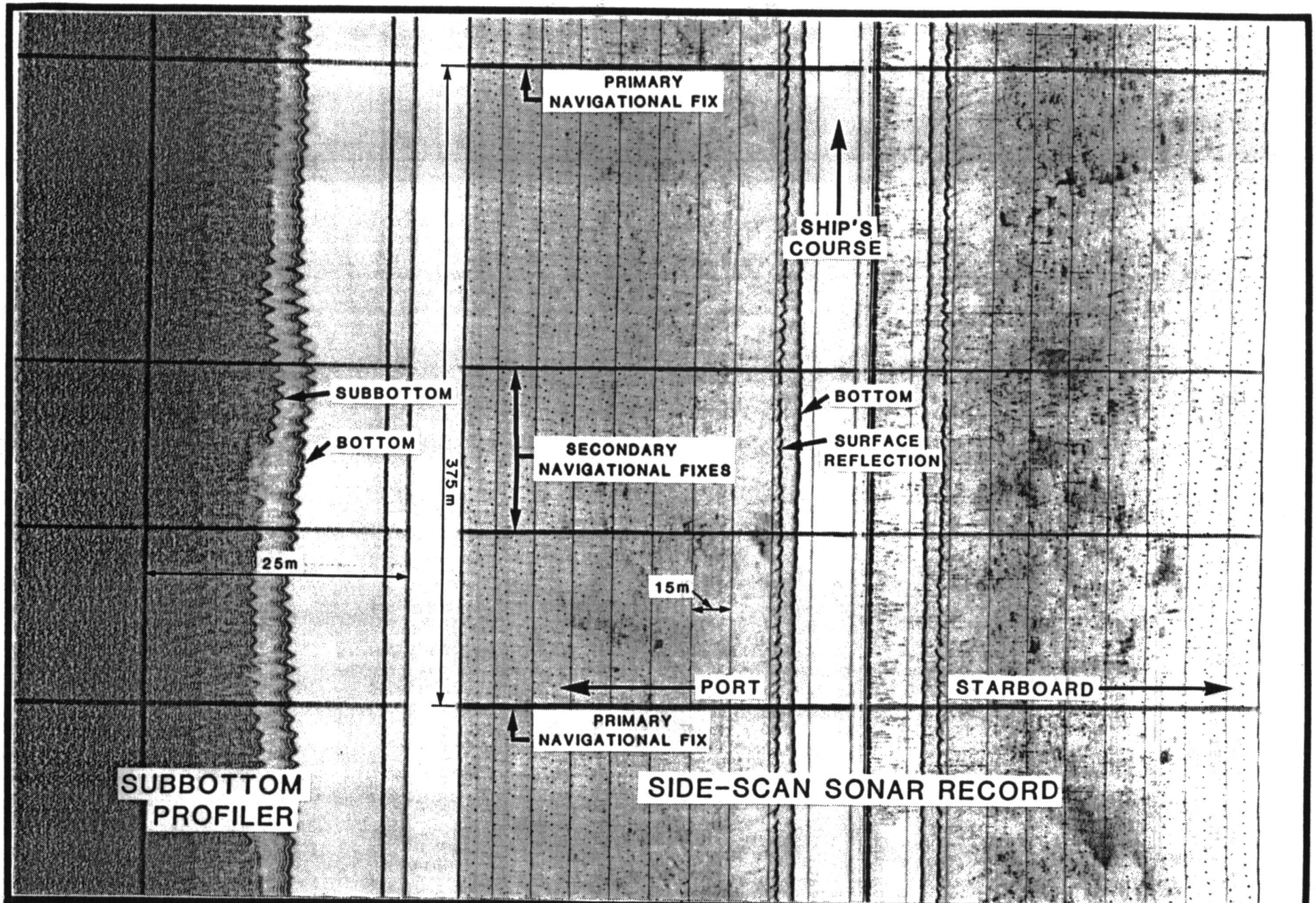



FIGURE 4. EXAMPLE OF THE OUTPUT FROM THE SIDE-SCAN SONAR AND SUBBOTTOM PROFILER SYSTEMS.

TABLE 1. SUMMARY OF GEOPHYSICAL AND TELEVISION/STILL CAMERA COVERAGE OF THE "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY" TRANSECTS.

| Transect | Geophysical Coverage | | Television/Still Camera Coverage | |
|---|---|---|---|---|
| | km | nmi | km | nmi |
| B (extension) | 26 | 14 | 26 | 14 |
| C (extension) | 24 | 13 | 27 | 14.5 |
| D (extension) | 56 | 30 | 56 | 30 |
| E (repeat) | 9 | 5 | 9 | 5 |
| G | 130 | 70 | 130 | 70 |
| H | 37 | 20 | 37 | 20 |
| I | 41 | 22 | 41 | 22 |
| J | 35 | 19 | 35 | 19 |
| K | 44 | 24 | 44 | 24 |
| L | 62 | 33.5 | 133 | 72 |
| Total | 464 | 250.5 | 538 | 290.5 |

Values are approximate and are expressed to the nearest kilometer or half nautical mile.

The television/still camera sled was lost along Transect L during Cruise I, but the remaining photographic footage of the transect was obtained during Cruise III.

### 2.3.2 Equipment and Procedures

Video footage of the seafloor and benthic biota was recorded using a Hydro Products TC-125 underwater television camera, an LT-7 underwater light with a 250-W thallium iodide lamp, an SC-303 television control unit, an Elgar 121 power source (frequency stabilizer), and a Sony VO 1800 videocassette recorder. The camera had an f/1.4 lens with remotely controlled focusing.

A Benthos 372, 35-mm deep-sea camera with data chamber, Benthos 382 deep-sea flash, and Ektachrome ASA 200, 35-mm color slide film were used to further verify substrate and benthic biotal types. Both television and still photograph camera systems were mounted on a Hydro Products RP-3 pan and tilt unit, which was attached to a television/still camera sled (Figure 5).

The television/still camera system was towed at a height of 1 to 3 m above the bottom at a speed of 2 kn. The still camera and synchronized flash were surface activated by the scientific personnel monitoring the television screen. During the synchronous collection of photographic and geophysical data, the television and still cameras were oriented in such a way that the fields of view of the television and still cameras were the same.

During the surveys, photographs were taken on an average of one per minute. Additional photographs of biological assemblages, geologic features, and any other specific items of interest were taken at the discretion of the scientific observer.

### 2.3.3 Data Collected

A total of 120 videotape cassettes and 8,500 still photographs were taken along the transects surveyed during Cruises I and III. The remote photographic coverage is summarized in Table 1. Videotapes and still photographs collected during the surveys have been forwarded to the MMS Gulf of Mexico OCS Region, Metairie, LA.

## 2.4 Biological Station Sampling

Cruises II and III focused primarily on biological sampling at selected stations inshore of the 20-m isobath. Eleven soft-bottom and five live-bottom stations (Figure 6) were sampled during both Cruises II and III. Remote photographic surveys (television and still camera) were conducted and dredge, trawl, and diver collections of epibiota were made at each live-bottom station. Descriptions of methods and results of station sampling are presented in the third year Final Report. Although the station-specific data are not presented here, it is important to note that identification of characteristic biota from remote photographs taken

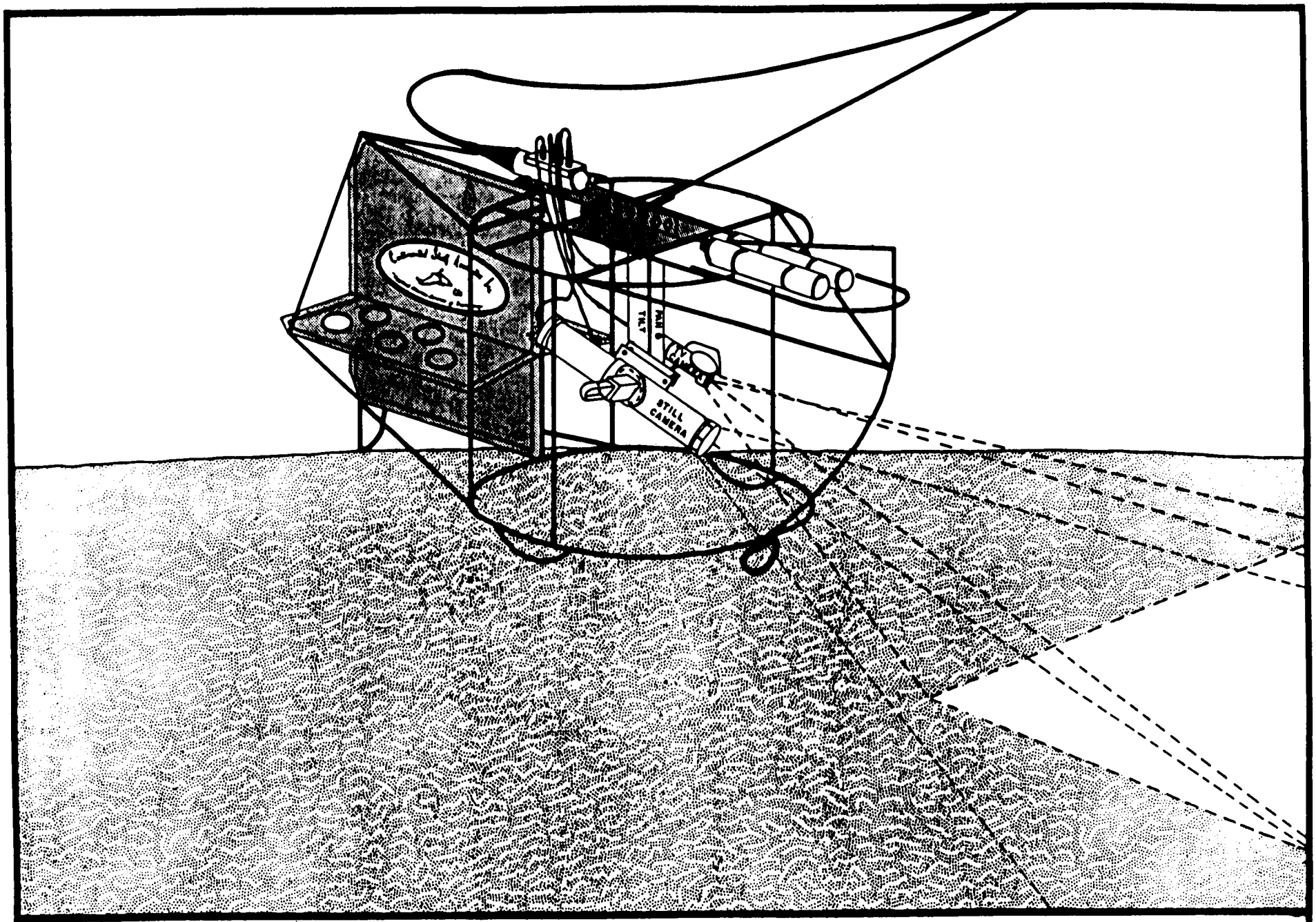



FIGURE 5. UNDERWATERWATER TELEVISION/STILL CAMERA SYSTEM.

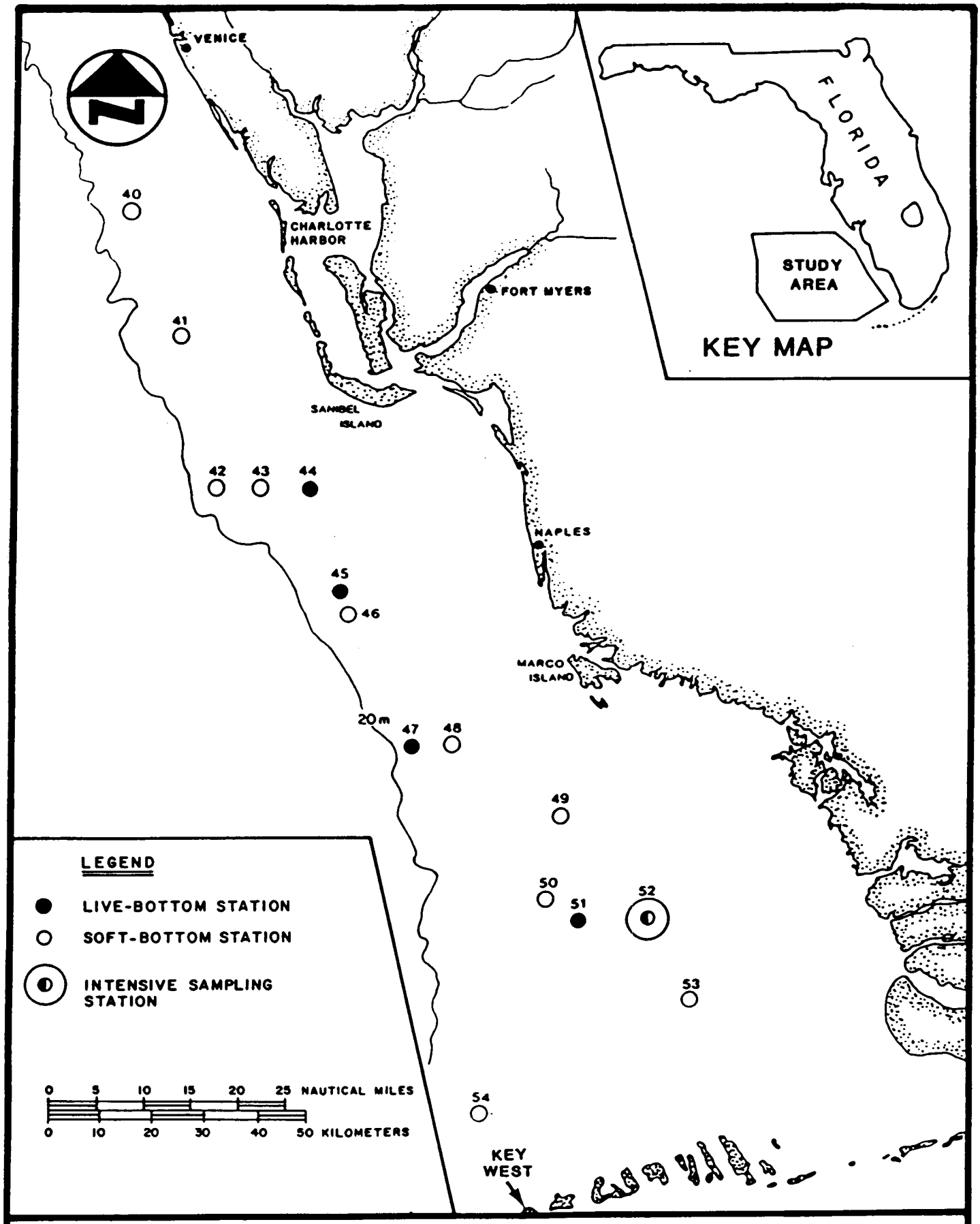



FIGURE 6. LOCATIONS OF BIOLOGICAL SAMPLING STATIONS FOR CRUISES II AND III OF THE "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY."

along the survey transects depended on collection of the same taxa in dredge and trawl samples during this or the two previous years of study.

# 3.0 DATA BASE AND MAPS

## 3.1 Survey Locations Map, Index Map, and Regional Maps of Marine Habitats

Base maps at the 1:500,000 scale for the Survey Locations Map, the Index Map, and the two Regional Maps of Marine Habitats were provided by the MMS. The maps are presented on protraction diagram bases showing the location of the transects surveyed relative to OCS lease blocks.

The Survey Locations Map shows the locations of all survey transects. The Index Map is a key map on which all of the 1:48,000 Habitat Maps are indicated (Figure 7). Each Habitat Map is referenced by sheet number.

The two Regional Maps of Marine Habitats summarize the geophysical and biological interpretation of the survey data. The first sheet (Figure 8) summarizes biological assemblage data from the east-west survey transects (B, C, D, and E). The second sheet (Figure 9) summarizes data from the north-south transects (G, H, I, J, K, and L).

## 3.2 Habitat Maps

Twenty-three maps, at a scale of 1:48,000, present the substrate, biological assemblage, and subbottom data obtained during this survey. The habitat maps each cover approximately six OCS lease blocks. Map generation is based on the Universal Transverse Mercator Projection (UTM) using the Clarke 1866 spheroid. Lease block boundaries were drawn from the official OCS protraction diagram furnished by the MMS. Latitude and longitude coordinates were obtained by computer conversion of the Loran-C navigational fixes. All data were rectified so that the northern or eastern end of the surveyed transects always appears to the right. Rectification was required in order that the atlas from the "Southwest Florida Shelf Regional Biological Communities Survey" would conform to the one previously produced during the "Southwest Florida Shelf Ecosystems Study" (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983a).

Base maps at the 1:48,000 scale were hand generated in the following manner:

1) UTM coordinates received from the Loran-C time delay conversions were hand plotted on 1:250,000 scale OCS Resource Maps provided by the MMS (on these maps individual lease blocks are approximately 19 mm on a side).
2) These post-plot maps were then enlarged to the 1:48,000 scale and became the base maps on which substrate and biological community data were represented.

Each of the 1:48,000 habitat maps is divided into three sections. The top section shows the lease block boundaries, UTM and

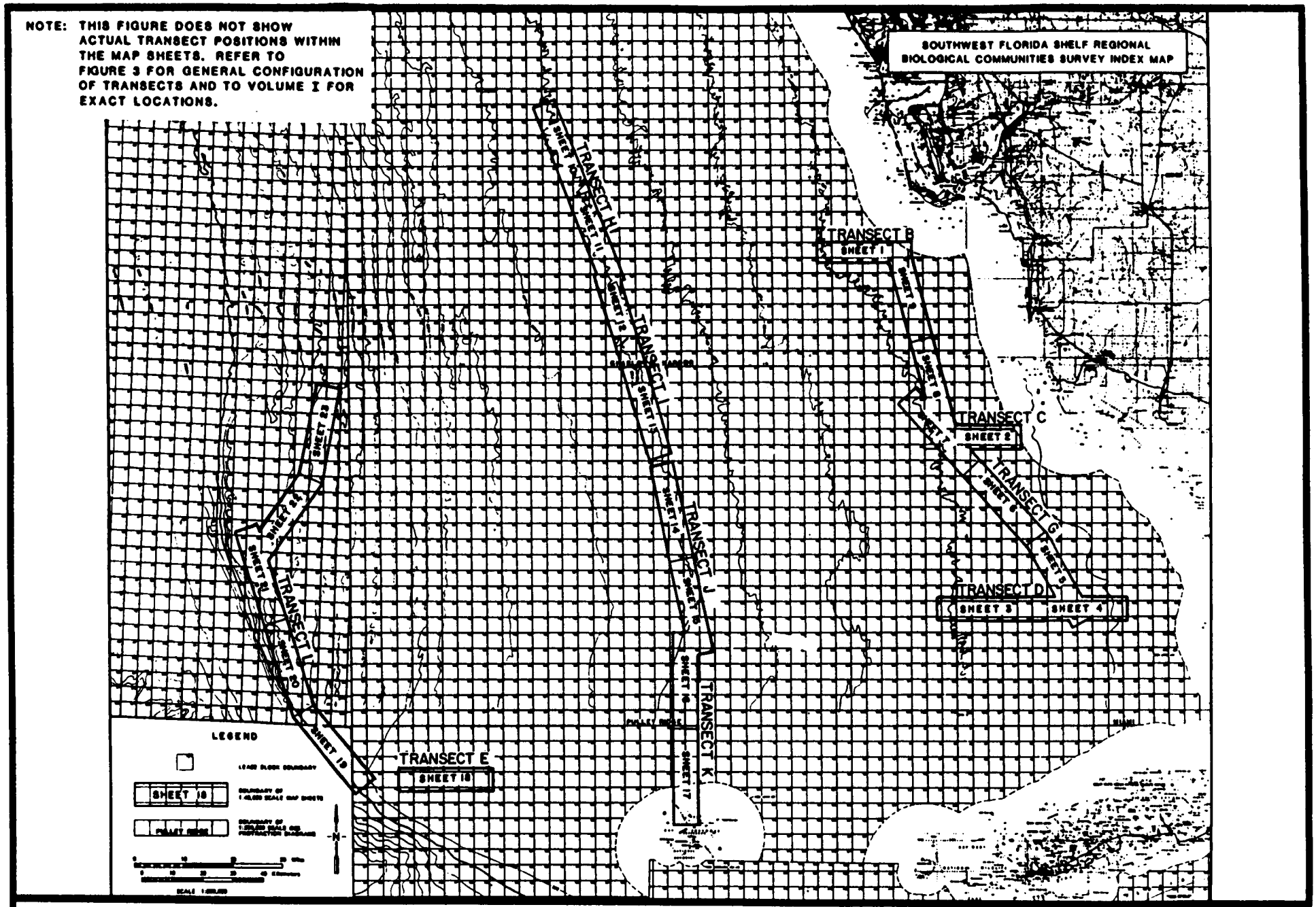



FIGURE 7. THE INDEX MAP FROM VOLUME 1 OF THIS ATLAS (GREATLY REDUCED).

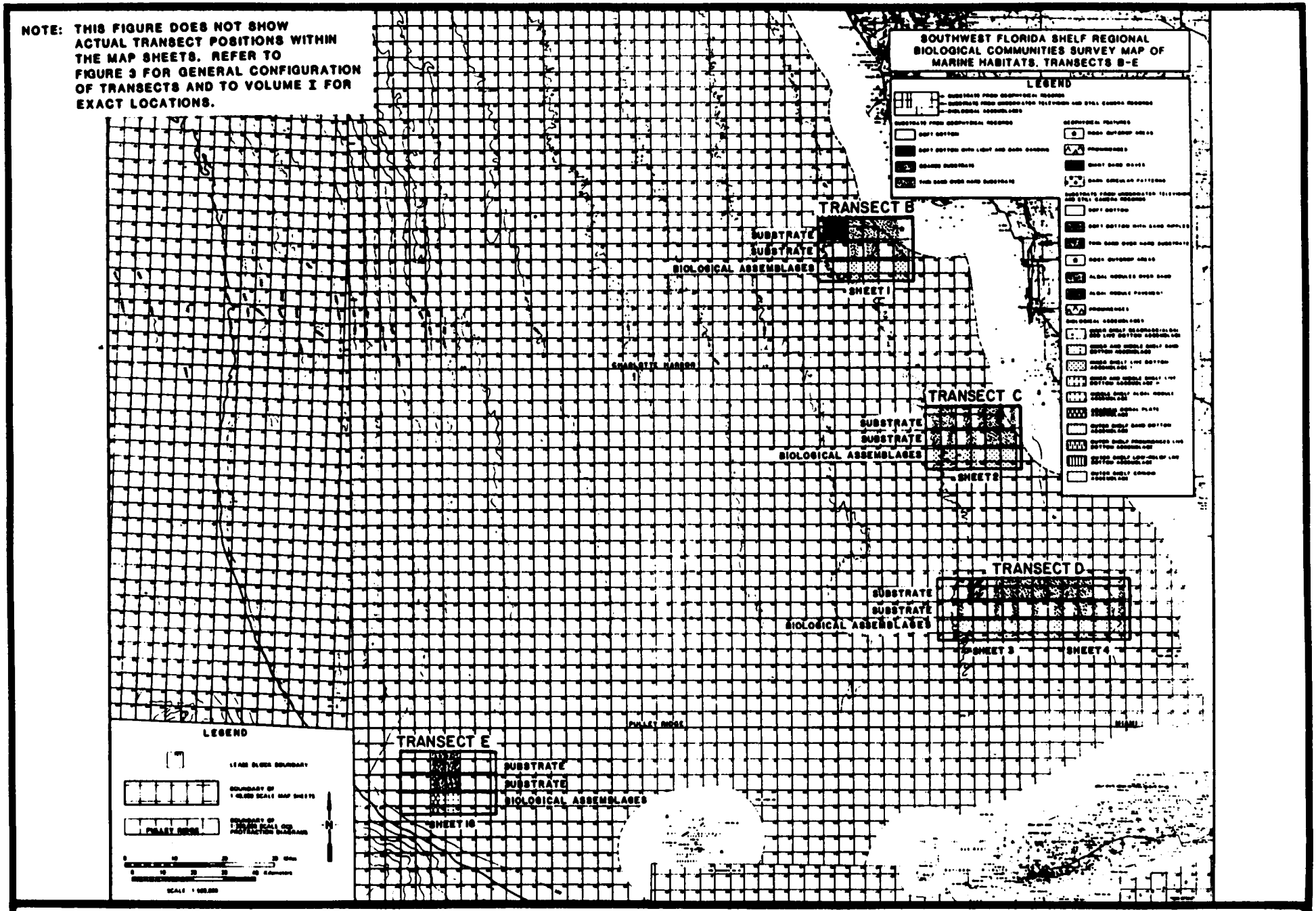



FIGURE 8. FIRST SHEET OF REGIONAL MAPS OF MARINE HABITATS FROM VOLUME 1 OF THIS ATLAS (GREATLY REDUCED).

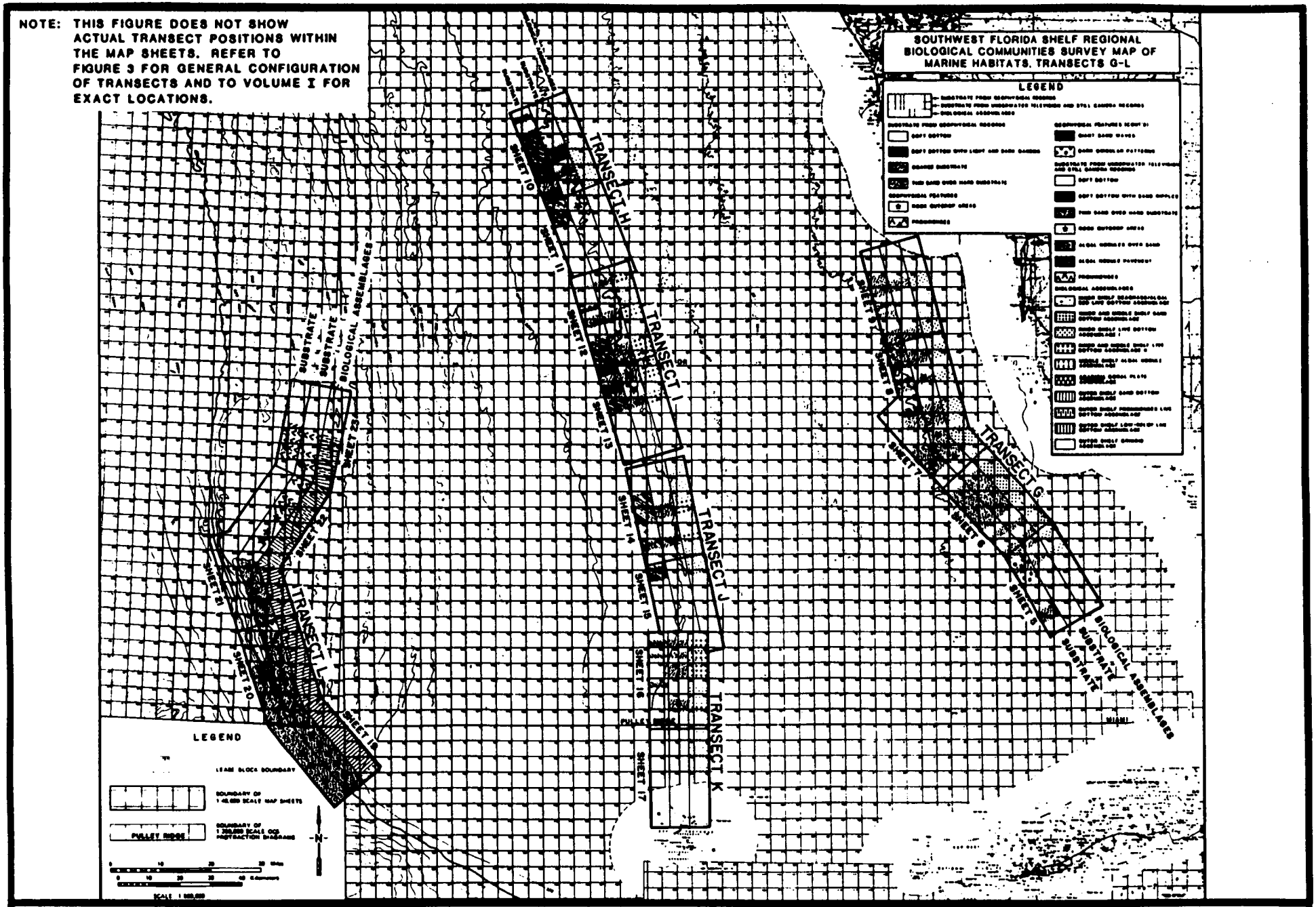



FIGURE 9. SECOND SHEET OF REGIONAL MAPS OF MARINE HABITATS FROM VOLUME 1 OF THIS ATLAS (GREATLY REDUCED).

longitude/latitude coordinates, post-plot cruise navigational data, videotape code numbers, and still photograph roll numbers corresponding to the position of the bottom photographs taken in the lease blocks traversed. The second section shows the substrate and biological assemblage information. This information is presented in three strips: (1) the top strip shows the substrate type and geophysical features defined from geophysical records alone; (2) the middle strip shows the substrate type identified from television and still camera records; and (3) the bottom strip indicates the linear extent of the biological assemblages identified from the television and still camera records (Figure 10). The bottom section of each map is a geological profile showing the shallow geological characteristics as determined from subbottom profiler data and bathymetry as indicated by precision fathometer.

On the navigational post-plot chart shown at the top of each of the Habitat Maps, the arrows indicate the direction of ship's travel. The navigational fix point interval is 375 m; every 2nd fix point is shown on the chart as a solid triangle (interval = 750 m), and every 10th fix point is annotated. A triangle with a solid dot in it indicates the location of stations sampled during Cruises II and III (and any of the Year 1 and 2 stations encountered along the transects).

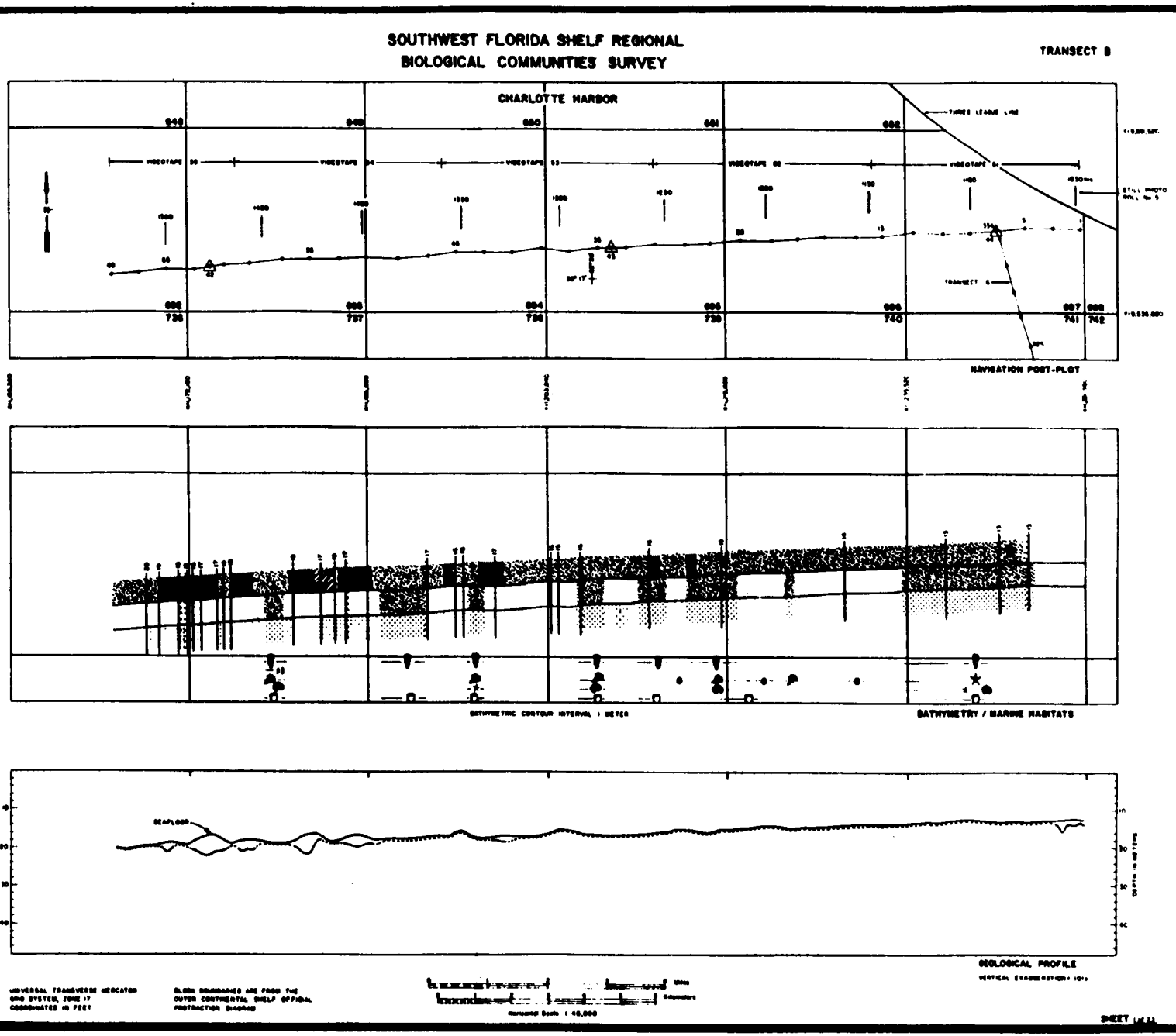



**FIGURE 10. AN EXAMPLE HABITAT MAP FROM VOLUME 1 OF THIS ATLAS (GREATLY REDUCED).**

# 4.0 SUBSTRATE MAPPING

## 4.1 Technical Approach

Substrate mapping employed two techniques. One utilized only side-scan sonar and subbottom profiler data, whereas the other was based entirely on analysis of the underwater television and still camera data. Side-scan sonar and subbottom profiler data have in the past been the principal information sources used to detect the presence of hard- or live-bottom areas on the continental shelf, but recently, the concept of using geophysical data alone to detect low-relief live-bottom areas has been questioned (Continental Shelf Associates, Inc., 1979; Henry et al., 1981; Gettleson et al., 1983). During two previous years of geophysical investigations on the southwest Florida shelf, questions arose concerning the ability of side-scan sonar and subbottom profilers to detect or differentiate specific types of biological communities seen there. Some of these communities were either not detected using geophysical techniques or produced signatures that were difficult to interpret (Woodward Clyde Consultants and Continental Shelf Associates, Inc., 1983b).

One objective of the "Southwest Florida Shelf Regional Biological Communities Survey" was the thorough investigation and comparison of side-scan sonar and subbottom profiler techniques vs. underwater photographic methods of detecting hard- and/or live-bottom areas. During the "Southwest Florida Shelf Ecosystems Study," the primary objective of the geophysical investigations had been to define geologic structure. During this study, the main purpose of geophysical investigations was to help differentiate biological communities. Substrate maps were prepared showing the two types of substrate interpretations side-by-side to facilitate comparisons of the two techniques.

## 4.2 Substrates and Geologic Features

### 4.2.1 Substrates and Geologic Features Identified from Geophysical Data

#### 4.2.1.1 Substrates

Four substrate types were identified from the geophysical data: (1) soft bottom; (2) soft bottom with light and dark banding; (3) coarse substrate; and (4) thin sand over hard bottom.

The substrate types include three textures of soft-bottom substrates. Soft-bottom areas were defined as those having a distinct subbottom layer at some depth below the seafloor, and they characteristically showed reduced backscatter (that is, light shading) in side-scan sonar records. Textural interpretations generally rest on three levels of intensity of backscatter recorded on the side-scan sonar records: weak, moderate, and strong. The signals produce light, moderate, and dark signatures, respectively, on the sonograms and

correspond roughly to fine, medium, and coarse sediment textures. Other variables, such as particle shape and packing, angle of sonic incidence, slant range, and machine settings, can affect the apparent texture of a sonogram record, but experienced interpreters can minimize false interpretation by taking these other variables into account. Differentiation of the fourth category, thin sand over hard substrate, was based on loss of a distinct subbottom trace accompanied by a general darkening (intensification) of the side-scan sonar signature. The characteristics of each geophysically defined substrate type are summarized below.

Soft Bottom: Soft bottom consists of sand and/or silt underlain at some depth by hard substratum (as indicated by the subbottom profiler data). Soft bottom may be planar, or it may exhibit sand ripples or sand waves (see Geologic Features below).

Soft Bottom with Light and Dark Banding: In some areas (e.g., along Transects H, I, J, and K), bands or ribbons of fine sediments (which have a light appearance in side-scan sonar records) were interspersed with areas of darker, coarse sediments. These "sand ribbon" formations are characteristic of the middle west Florida shelf and reflect sorting of sediments during lower stands of sea level. Figure 11 illustrates this type of pattern seen on side-scan sonar records.

Coarse Substrate: The coarse substrate designation generally applies to areas of coarse shell hash, calcareous algal rubble, or algal nodules. Coarse substrate was differentiated from finer soft-bottom substrates on the basis of the darker and rougher side-scan sonar signature of the former. Subbottom profiler penetration in areas of coarse substrate, especially those characterized by coralline algal nodules or an algal nodule pavement with Agaricia (coral) accumulations (Transect E), was sporadic, leaving the interpretation to be based primarily on side-scan sonar records.

Thin Sand over Hard Substrate: The signature for this widespread substrate type was the most difficult to assign. Generally, thin sand over hard bottom was inferred from the loss of a distinctive subbottom trace and a concurrent intensification (darkening) of the side-scan sonar signature.

#### 4.2.1.2 Geologic Features

Four geologic features were identified from the geophysical data: (1) rock outcrop areas; (2) prominences; (3) giant sand waves; and (4) dark circular patterns. The characteristics of these features are summarized below.

Rock Outcrop Areas: Rock outcrops were easily identifiable from the side-scan sonar records. Generally, the outcrops ranged up to 1 m in relief.

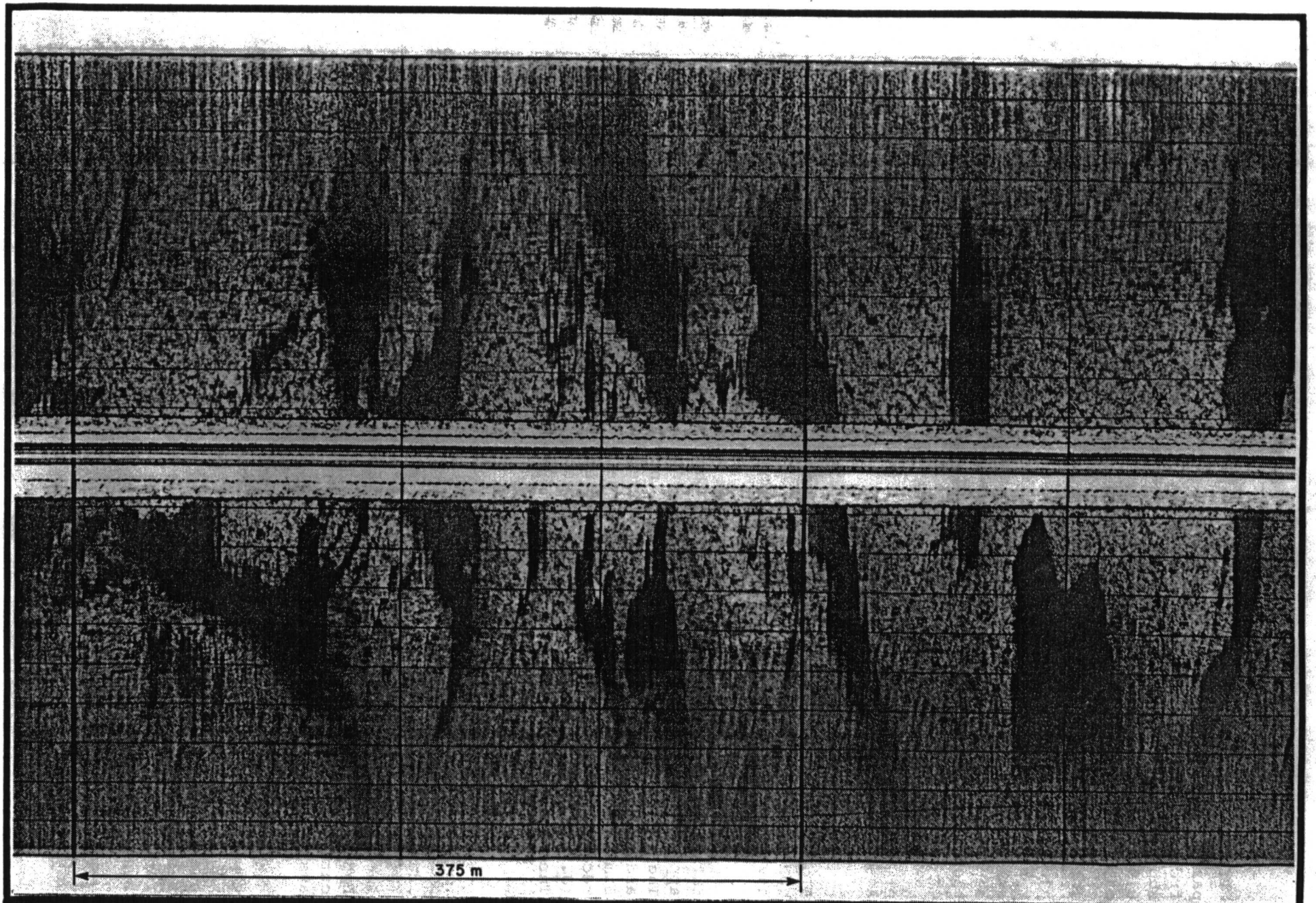



FIGURE 11. SIDE-SCAN SONAR RECORD SHOWING SOFT BOTTOM WITH LIGHT AND DARK BANDING.

Prominences: Prominences (also referred to as pinnacles) are a particular kind of high-relief outcrop identified in geophysical records from the shelf edge (Transect L). The prominences rise from a hard substrate some distance beneath the seafloor to an exposed relief of 0.5 to 3 m (Figure 12). The features may be remnants of an ancient carbonate reef complex (Holmes, 1981).

Giant Sand Waves: Giant sand waves (bedforms with wavelengths >100 m and a height of 1 to 3 m; ripple index 30 to 100) were noted along the inshore portion of Transect B. These features may represent old, submerged dune lines, or they may reflect sculpturing of surficial sediments associated with fluctuations in the subbottom contours seen there. Such sculpturing might be due to persistent circulation patterns or to storm events. The features were not seen along the deeper (>20 m) portions of Transect B surveyed during the "Southwest Florida Shelf Ecosystems Study" (Woodward-Clyde Consultants Continental Shelf Associates, Inc., 1983a).

Similar giant scale bedforms have been noted on the inner west Florida shelf by Neurauter (1979). These giant sand waves should not be confused with small-scale features such as sand ripples, which generally have wavelengths <1 m and a ripple index of 5 to 15 (Neurauter, 1979).

Dark Circular Patterns: The dark, circular patterns noted during this survey were a unique feature of the sonographic record. They appeared in clusters, lending a polka-dot appearance to the sonograms. The patterns were seen only near the intersection of Transects D and G and appeared to be associated exclusively with live-bottom areas. Similar, though less distinct, patterns have been noted in side-scan records from live-bottom areas on the shelf off northwest Florida (J. Thompson, Continental Shelf Associates, Inc., personal observation). The cause of this unusual side-scan signature is not known.

### 4.2.2 Substrates Identified from Underwater Television/Still Camera Photography

Seven types of substrates or geological features were identified from the remote television/still camera data: (1) soft bottom; (2) soft bottom with sand ripples; (3) thin sand over hard substrate; (4) rock outcrop areas; (5) algal nodule layer over sand; (6) algal nodule pavement; and (7) prominences. The identification of rock outcrops and prominences was straightforward and requires no elaboration; assignment of the other designations deserves further explanation.

In areas where little or no exposed rock was visible, the substrate could be categorized as soft bottom, soft bottom with sand ripples (if they were present), or thin sand over hard substrate. The presence of hard bottom under the sand in an area was inferred from the presence of sessile epibiota (e.g., gorgonians, sponges) that require hard substrate for attachment. Patches of exposed, low-relief hard bottom were usually seen in such areas, and their presence helped to confirm the designation of thin sand over hard substrate.

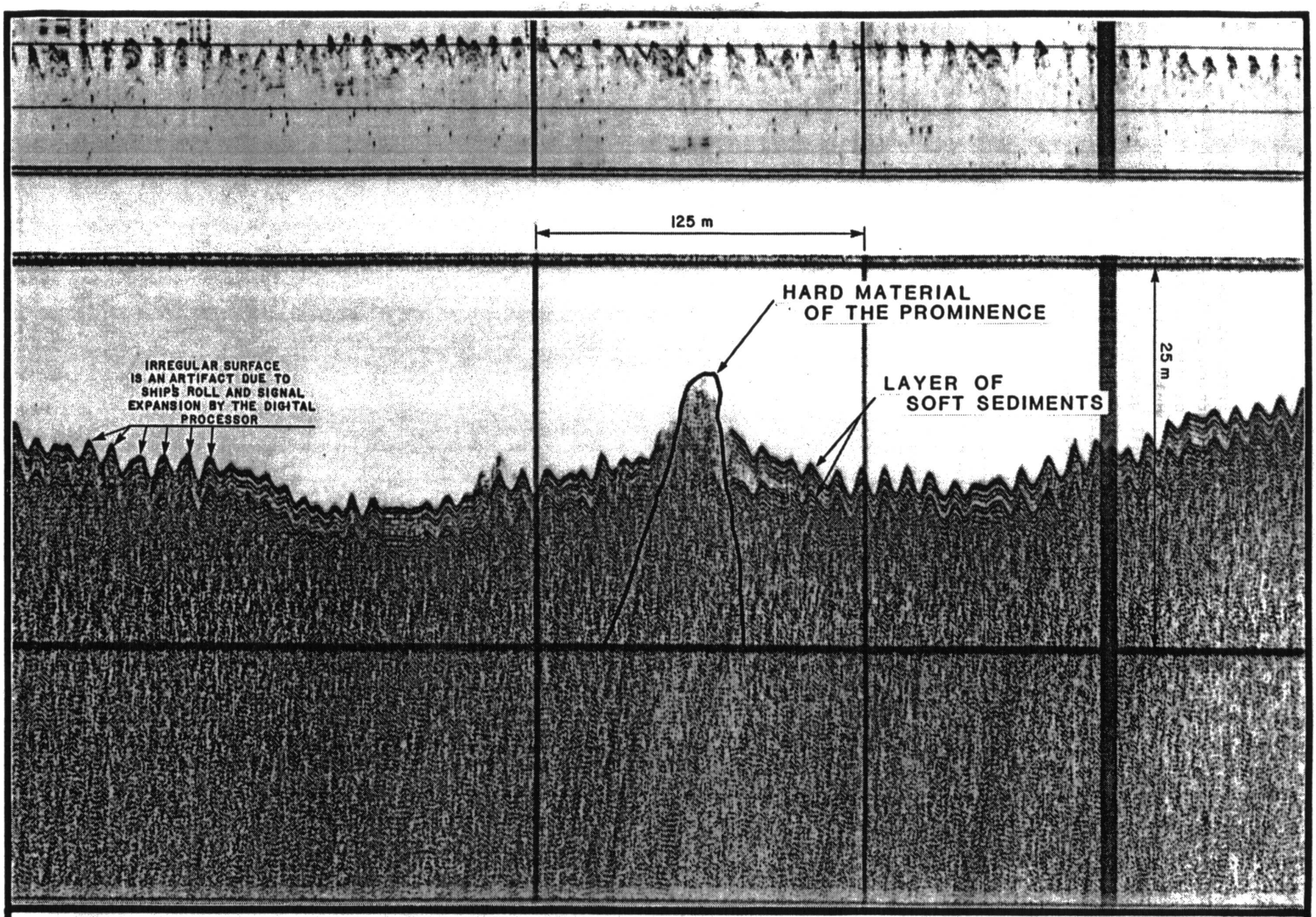



FIGURE 12. SUBBOTTOM PROFILER RECORD SHOWING PROMINENCES SEEN ALONG TRANSECT L.

In some portions of the middle shelf (Transects B, C, D, E, and F from the previous years' studies and the portion of Transect E surveyed during this study), the substrate consists of sand covered by a dense layer of loose coralline algal rubble or nodules (algal nodule layer over sand). On Transect E, the coralline algal growth occurs in places as a fused crust or pavement, usually in association with accumulations of the plate-like coral Agaricia (algal nodule pavement). These substrate types were readily distinguishable in the television videotapes and still photographs.

# 5.0 BIOLOGICAL ASSEMBLAGE MAPPING

## 5.1 Technical Approach

Black-and-white television videotapes and color still camera photographs from the survey transects were viewed in the laboratory to delineate benthic biological assemblages. Identification of epibiota from the videotapes and photographs was facilitated by identification of specimens from dredge, trawl, and diver collections made during Cruises II and III and dredge and trawl collections made during the two previous study years.

The assignment of assemblage designations from remote photographic data is necessarily somewhat subjective; the classification scheme tends to exaggerate the importance of visually conspicuous and/or readily identifiable organisms. Other means of classification of shelf benthos, such as cluster analysis of the dredge and trawl collections, have been presented for Years 1 and 2 data (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983b, 1985), and similar analyses of all three years of data are presented in the third year Final Report.

## 5.2 Description of the Biological Assemblages

Nine distinct biological assemblages were recognized along the "Southwest Florida Shelf Regional Biological Communities Survey" transects. Eight of these had been delineated during the two previous years' study, and one new assemblage, the Inner Shelf Seagrass/Algal Bed Live Bottom Assemblage, was recognized during Year 3. A 10th designation recognized during the previous years' study, the Outer Shelf Crinoid Assemblage, was not seen during Year 3 but is described here for use in the overview provided in Section 6.0. Representative photographs of all 10 biological assemblages are provided in the Appendix.

### 5.2.1 Inner Shelf Seagrass/Algal Bed Live Bottom Assemblage

This assemblage was noted only on the nearshore transects in water depths of 11 to 20 m. It was typified by abundant seagrasses (*Halophila decipiens*) and various algae, including *Caulerpa mexicana*, *C. sertularioides*, *Dictyopteris jamaicensis*, *Halimeda incrassata*, and *Laurencia intricata*. In some areas, the seagrasses and algae were interspersed with patches of sessile epifauna typical of other live-bottom areas; however, by the definition presented in Section 1.0, seagrass beds constitute live bottom whether or not hard-bottom epifauna are present.

### 5.2.2 Inner and Middle Shelf Sand Bottom Assemblage

This biological assemblage predominated on sand bottom substrates with an attached macroepifaunal density of less than approximately one individual $m^{-2}$. Associated biota consisted of algae

(Caulerpa spp., Halimeda spp., Udotea spp., and coralline algae), asteroids (Astropecten spp., Goniaster tessellatus, Luidia spp., Narcissia trigonaria, and Oreaster reticulatus), bryozoans (Celleporaria spp. and Stylopoma spongites), hard corals (Scolymia lacera), echinoids (Clypeaster spp., Diadema antillarum, and Lytechinus spp.), holothuroids, sea pens, and sponges (Geodia gibberosa). Algae covered up to 75% of the seafloor in certain photographs taken in this assemblage, whereas epifauna were found in widely scattered patches. The sponges and solitary hard corals may have been attached to a hard substrate, but their occurrence was so limited that these areas could not be differentiated as "live bottom" assemblages. Sand waves, ripple marks, and evidence of bioturbation were sometimes present. This assemblage was found in water depths of 10 to 90 m, where it was interspersed in sand bottom areas among the Inner Shelf Live Bottom Assemblage I, Inner and Middle Shelf Live Bottom Assemblage II, and the Middle Shelf Algal Nodule Assemblage.

### 5.2.3 Inner Shelf Live Bottom Assemblage I

This live-bottom biological assemblage consisted of patches of various algae (Caulerpa spp., Halimeda spp., and Udotea spp.), ascidians, hard corals (Siderastrea spp.), large gorgonians (Eunicea spp., Muricea spp., Pseudoplexaura spp., and Pseudopterogorgia spp.), hydrozoans, and sponges (Geodia gibberosa, Haliclona spp., Ircinia campana, and Spheciospongia vesparium). Individual organisms were generally larger, and the fauna appeared to exhibit a higher biomass per unit area, than in the Inner and Middle Shelf Live Bottom Assemblage II. This assemblage was found in water depths of 10 to 27 m.

### 5.2.4 Inner and Middle Shelf Live Bottom Assemblage II

This assemblage consisted of algae (Cystodictyon pavonium, Halimeda spp., and Udotea spp.), ascidians (Clavelina gigantea), bryozoans (Celleporaria spp. and Stylopoma spongites), hard corals (Cladocora arbuscula, Scolymia lacera, Siderastrea spp., and Solenastrea hyades), small gorgonians, hydrozoans, and several sponges (Cinachyra alloclada, Geodia gibberosa, G. neptuni, Ircinia spp., Placospongia melobesioides, and Spheciospongia vesparium). It occurred in water depths of 25 to 71 m and appeared to have both a higher number of sponge species and a lower biomass per unit area than the Inner Shelf Live Bottom Assemblage I.

### 5.2.5 Middle Shelf Algal Nodule Assemblage

This live-bottom biological assemblage consisted of coralline algal nodules (fused into a crust or "pavement" at certain locations) formed by two genera of algae, Lithophyllum spp. and Lithothamnium spp., combined with sand, silt, and clay particles. Algae (Halimeda spp., Peyssonnelia spp., and Udotea spp.), hard corals, and small sponges (Cinachyra alloclada and Ircinia spp.) were also present. During the Year 3 survey, this assemblage was seen only on Transects E and L. The depth range for the assemblage is 62 to 108 m.

### 5.2.6 Agaricia Coral Plate Assemblage

This biotal assemblage consisted of a dead, hard coral-coralline algae substrate covered with living algae (Anadyomene menziesii and Peyssonnelia spp.), live hard corals (Agaricia spp. and Madracis spp.), gorgonians, and sponges. The coral plate assemblage was seen only on a portion of Transect E (64 to 80 m water depth) during Year 1, 2, and 3 surveys.

### 5.2.7 Outer Shelf Sand Bottom Assemblage

The deepwater (74 to 200 m) sand-bottom biological assemblage was distinguished by an apparent lack of macroalgae. Characteristically, the macroepifauna consisted of asteroids (Echinaster spp.), crinoids (Comactinia meridionalis, Leptonemaster venustus, and Neocomatella pulchella), echinoids (including Clypeaster ravenelli, Echinolampas depressa, and Stylocidaris affinis), ophiuroids, sea pens, and various anemones, crustaceans, and occasional hexactinellid sponges. This biological assemblage was interspersed with the Outer Shelf Crinoid Assemblage, the Outer Shelf Low-Relief Live Bottom Assemblage, and the Outer Shelf Prominences Live Bottom Assemblage seen along Transect L.

### 5.2.8 Outer Shelf Prominences Live Bottom Assemblage

This biological assemblage seen along portions of Transect C during Years 1 and 2 and Transect L during Year 3 consisted of the gorgonian Nicella guadalupensis, the antipatharian corals Antipathes spp., Aphanipathes abietina, A. filix, and A. humilis, the hard coral Madrepora carolina, crinoids, hydrozoans (Stylaster sp.), and medium to large hexactinellid sponges in the Order Dictyonina. All of these organisms were attached to "rock" prominences, which typically emerged from a sand covered bottom in water depths of 135 to 170 m and had a vertical relief of up to 3 m. These prominences are most likely remnants of an ancient reef complex (Holmes, 1981).

### 5.2.9 Outer Shelf Low-Relief Live Bottom Assemblage

This live-bottom biological assemblage consisted of various octocorals (including Nicella guadalupensis), the antipatharian corals Antipathes spp., Aphanipathes abietina, A. filix, and A. humilis, occasional hard corals (including Madrepora carolina), crinoids, the hydrozoan Stylaster sp., and small sponges in the Order Dictyonina. It was found in water depths of 105 to 200 m along portions of Transect L in conjunction with low-relief rock surfaces with a thin sand veneer.

### 5.2.10 Outer Shelf Crinoid Assemblage

This biological assemblage delineated during Year 1 and 2 surveys consisted of large numbers of crinoids (primarily Comactinia meridionalis, Neocomatella pulchella, and Leptonemaster venustus) living on a coarse sand or rock rubble substrate. Small hexactinellid sponges were also typically associated with this assemblage. During Years 1

and 2, this assemblage was noted in water depths of 118 to 168 m on Transects B, C, and D. The crinoid assemblage was not seen on any of the Year 3 transects.

# 6.0 SHELFWIDE DISTRIBUTION OF MARINE HABITATS

The Habitat Maps in Volume 1 summarize the distribution of substrates and biological assemblages along the transects surveyed during the "Southwest Florida Shelf Regional Biological Communities Survey" (Year 3). These maps and those produced during the "Southwest Florida Shelf Ecosystems Study" (Years 1 and 2) (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983a,b) together provide extensive coverage of southwest Florida shelf benthic habitats in water depths ranging from 10 to 200 m.

Generalized shelfwide distributions of substrate types and biological assemblages from all three study years are portrayed in Figures 13 and 14, respectively. The maps omit some detail due to the great scale reduction from the Habitat Maps. In addition, the generalized maps show substrate designations derived from remote photographic data only [these are from the middle strip of the Volume 1 Habitat Maps (Year 3) and from Figures 3-4 and 3-5 presented in the Year 1 Final Report (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983b)].

Discussions of shelfwide distribution patterns of substrate types and biological assemblages are presented in the Year 3 Final Report, along with a comparative evaluation of geophysical and remote photographic mapping techniques for detection of live bottom.

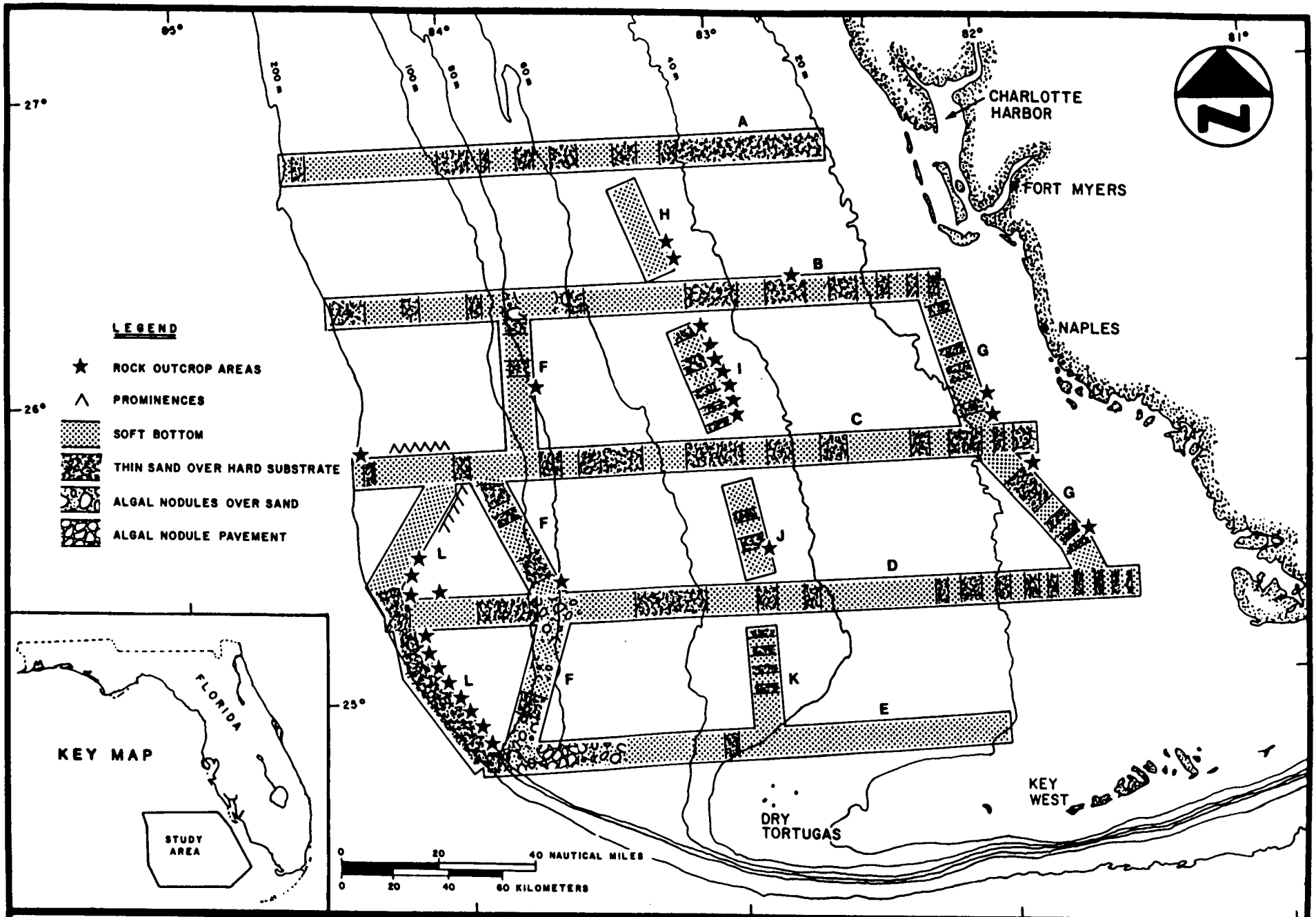



**FIGURE 13. SHELFWIDE DISTRIBUTION OF SUBSTRATE TYPES IDENTIFIED FROM TELEVISION/STILL CAMERA SURVEYS DURING THE "SOUTHWEST FLORIDA SHELF ECOSYSTEMS STUDY" AND THE "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY."**

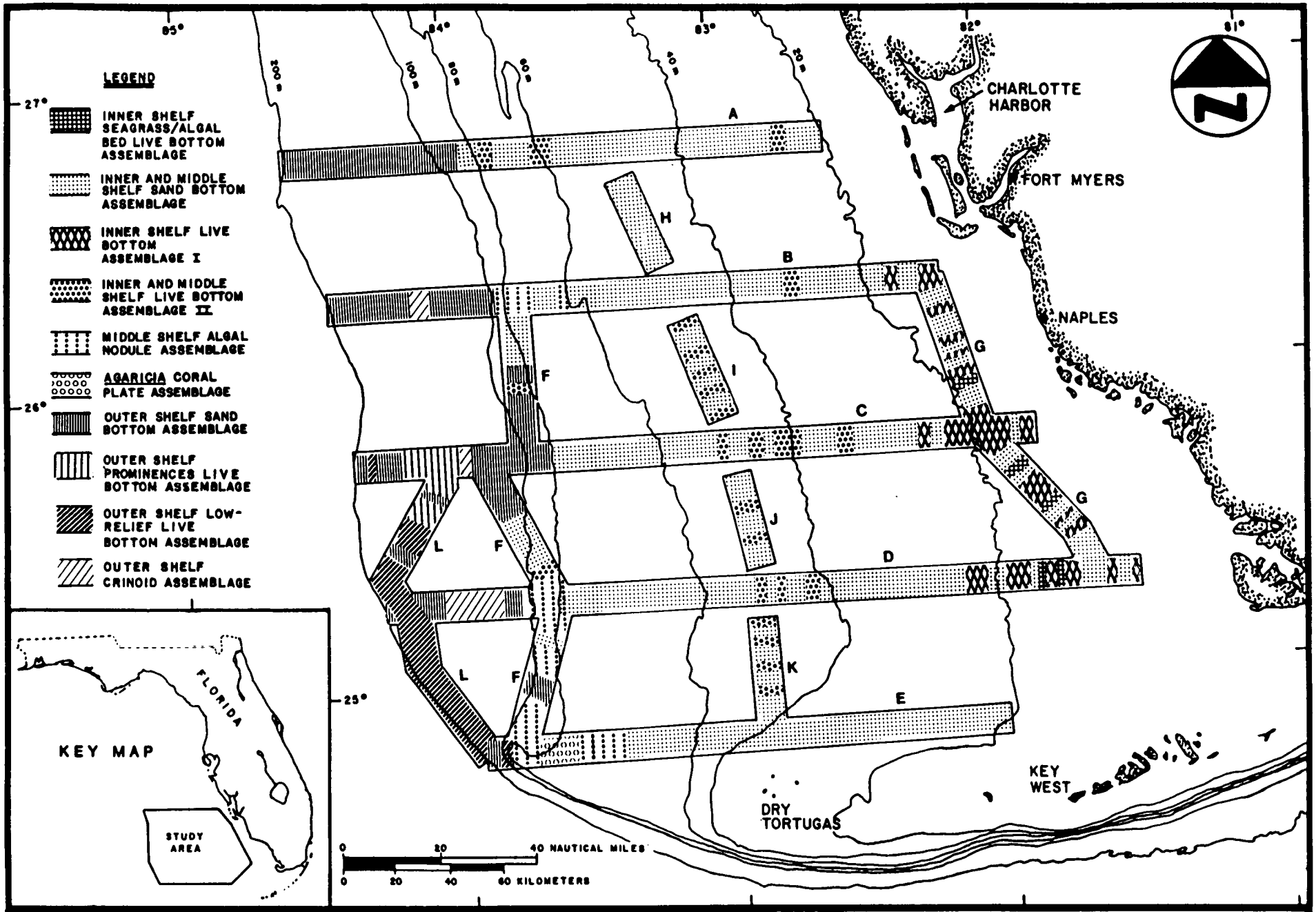



FIGURE 14. SHELFWIDE DISTRIBUTION OF BIOLOGICAL ASSEMBLAGES IDENTIFIED FROM TELEVISION/STILL CAMERA SURVEYS DURING THE "SOUTHWEST FLORIDA SHELF ECOSYSTEMS STUDY" AND THE "SOUTHWEST FLORIDA SHELF REGIONAL BIOLOGICAL COMMUNITIES SURVEY."

## 7.0 REFERENCES CITED


Continental Shelf Associates, Inc. 1979. South Atlantic Hard Bottom Study. A report for the U.S. Department of the Interior, Bureau of Land Management. Contract No. AA551-CT8-25. 356 pp.

Gettleson D. A., K. D. Spring, R. M. Hammer, and R. E. Putt. 1983. Comparison of geophysically defined hard bottom and visually detected live bottom in the Charlotte Harbor Area of the southwest Florida shelf. In: OCEANS '83 Conference Record.

Henry, V. J., Jr., L. J. Doyle, and P. J. Popone. 1981. Reefs and hardgrounds of the Georgia Bight. In: Reefs and Hardgrounds Workshop. U.S Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA.

Holmes, C. W. 1981. Late Neocene and Quaternary geology of the southwestern Florida shelf and slope. U.S. Geological Survey Open File Report No. 81-1029. 27 pp.

Neurauter, T. W. 1979. Bed forms on the west Florida shelf as detected with side-scan sonar. M.S. thesis, University of South Florida. 144 pp.

U.S. Department of the Interior, Minerals Management Service. 1984. Final Environmental Impact Statement, Proposed Oil and Gas Lease Sales 94, 98, and 102. Outer Continental Shelf Environmental Impact Statement No. MMS-84-0057.

Woodward-Clyde Consultants and Continental Shelf Associates, Inc. 1983a. Southwest Florida Shelf Ecosystems Study Marine Habitat Atlas. Prepared for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract Nos. 14-12-0001-29142 and 14-12-0001-29144. 2 volumes.

Woodward-Clyde Consultants and Continental Shelf Associates, Inc. 1983b. Southwest Florida Shelf Ecosystems Study--Year 1. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract No. 14-12-0001-29142. 4 volumes.

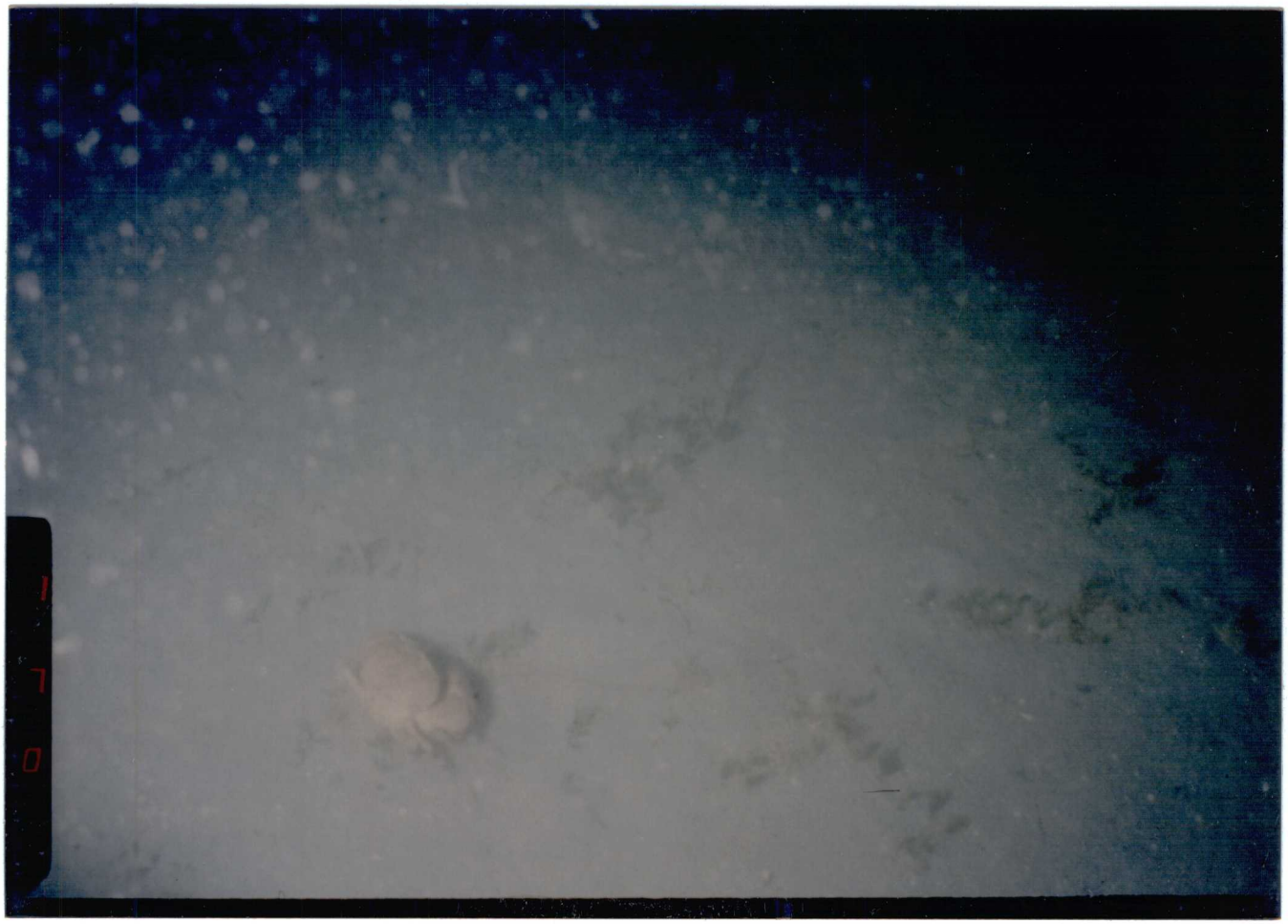
Woodward-Clyde Consultants and Continental Shelf Associates, Inc. 1985. Southwest Florida Shelf Ecosystems Study--Year 2. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, Metairie, LA. Contract No. 14-12-0001-29144. 7 volumes.

# 8.0 APPENDIX

## REPRESENTATIVE PHOTOGRAPHS OF BENTHIC BIOLOGICAL ASSEMBLAGES

**Inner Shelf Seagrass/Algal Bed Live Bottom Assemblage**

Shown here is a dense aggregation of seagrasses, probably including Halodule wrightii, Syringodium filiforme, and Thalassia testudinum, and green algae (Caulerpa sp.), on sand bottom. Location: Map sheet 6, Miami Area Block 443, Transect G, navigation fix point 71. Water depth: 13 m.

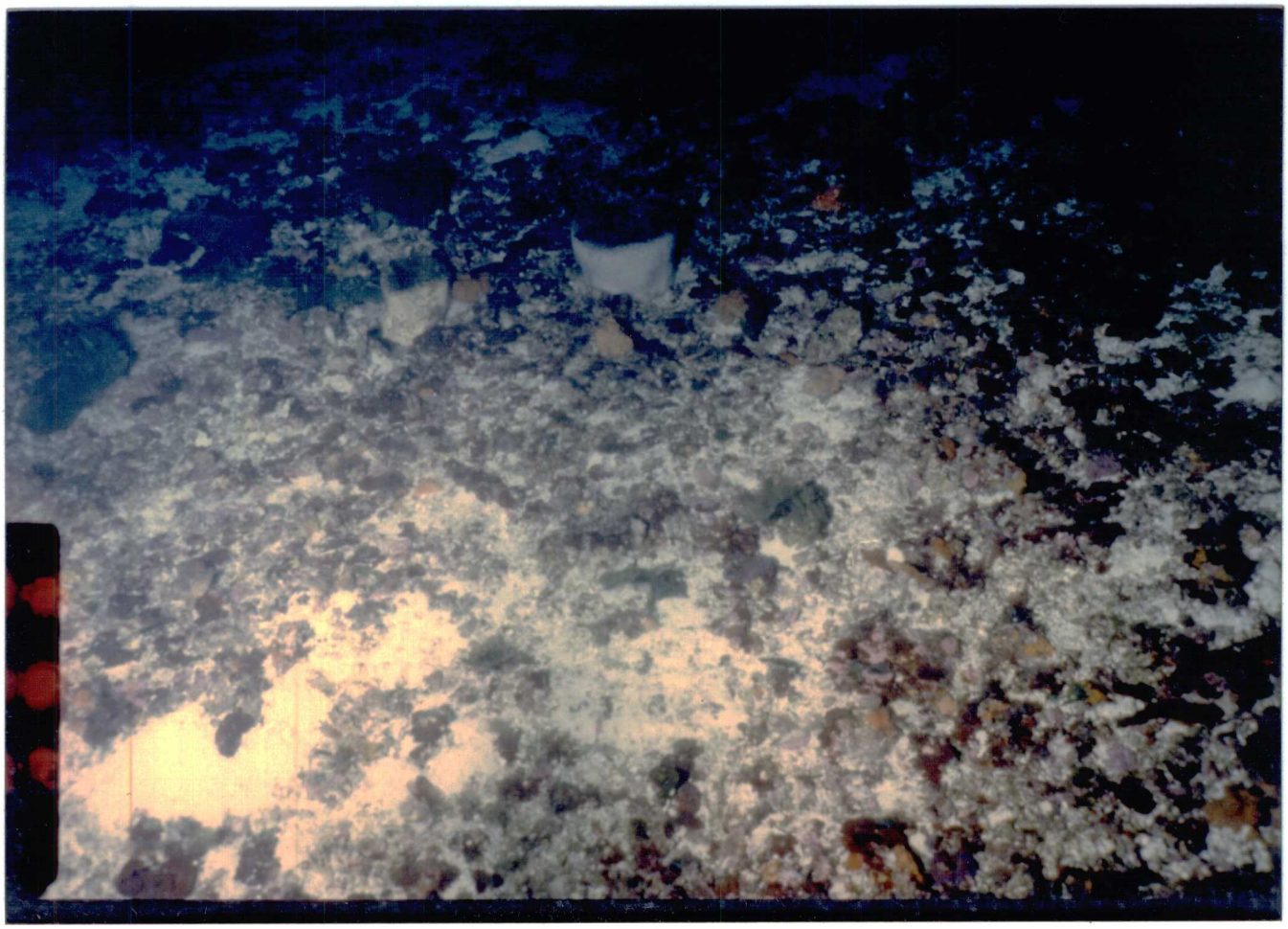


**Inner and Middle Shelf Sand Bottom Assemblage**

The photograph shows a stone crab (Menippe mercenaria) and small amounts of the seagrass Halophila decipiens on sand bottom. The high near-bottom turbidity is typical of inner shelf areas. Location: Map sheet 2, Pulley Ridge Area Block 218, Transect C, navigation fix point 27. Water depth: 15 m.

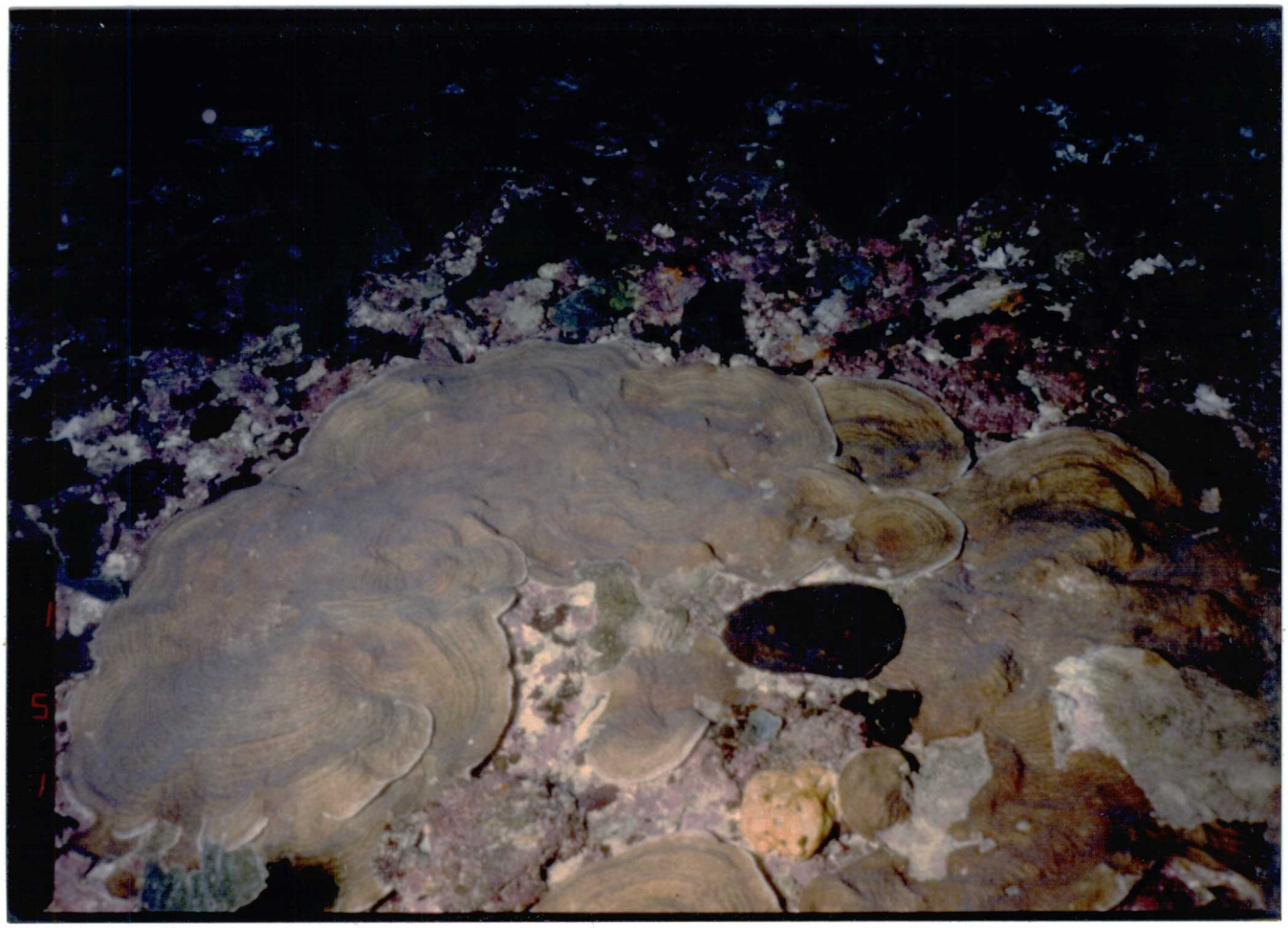
**Inner and Middle Shelf Live Bottom Assemblage II**

The photograph shows exposed rock bottom covered by coralline algae and various sponges, including Ircinia campana (vase sponge, upper left), Ircinia strobilina, Cinachyra alloclada, Chondrilla nucula, and Spirastrella sp. Also seen are a red grouper (Epinephelus morio) (behind the sponge in the foreground), a scrawled cowfish (Lactophrys quadricornis) (center), and a blue angelfish (Holacanthus bermudensis) (upper left). Location: Map sheet 13, Pulley Ridge Area Block 108, Transect I, navigation fix point 103. Water depth: 50.5 m.



**Middle Shelf Algal Nodule Assemblage**

The photograph shows a dense area of small coralline algal nodules. Also seen are the leafy green alga Anadyomene menziesii (center and upper left), the crustose green alga Halimeda sp., and the red alga Peyssonnelia rubra. Two keratose sponges (Ircinia ?campana) are visible in the upper left. Location: Map sheet 39 in the Southwest Florida Shelf Ecosystems Study (Year 1) Marine Habitat Atlas, Pulley Ridge Area Block 754, Transect F, navigation fix point 350. Water depth: 79 m.



**Agaricia Coral Plate Assemblage**

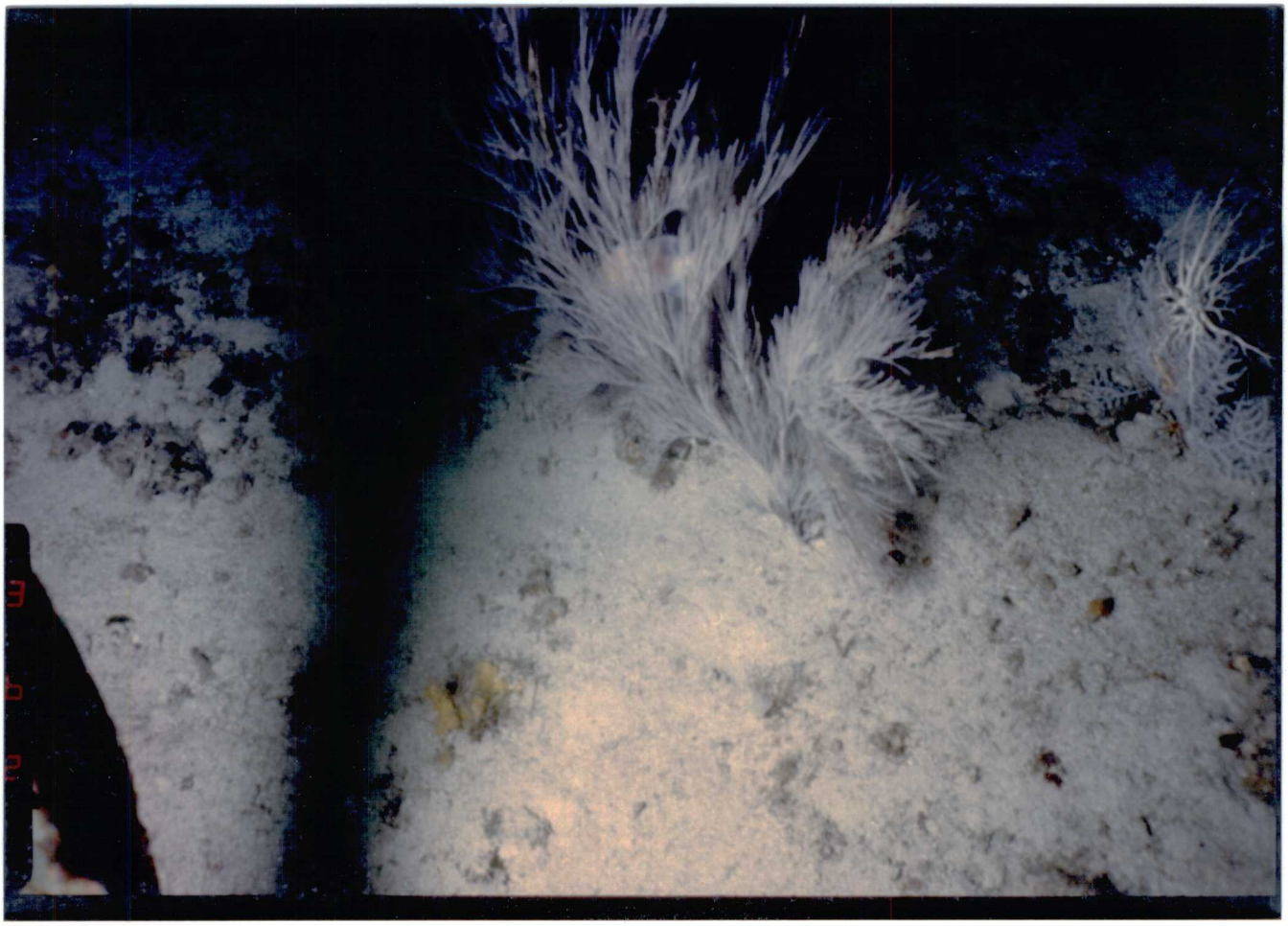
In this photograph, extensive colonies of the plate-forming coral Agaricia agaricites are seen in the foreground overlying a fused coralline algal pavement substrate. The leafy green alga Anadyomene menziesii and the red alga Peyssonnelia rubra are present in the background. Location: Map sheet 18, Dry Tortugas Area Block 138, Transect E, navigation fix point 25a. Water depth: 73.5 m.

**Outer Shelf Sand Bottom Assemblage**

The photograph shows the echinoid Conolampus sigsbei (center) and an unidentified crustacean (lower right) on coarse sand bottom. Location: Map sheet 21, Howell Hook Area Block 575, Transect L, navigation fix point 231. Water depth: 159 m.

**Outer Shelf Prominences Live Bottom Assemblage**

Vase-shaped hexactinellid sponges (upper left and right), antipatharians (lower right), octocoral sea fans (center and right background), and small hard corals (Madrepora carolina and Oculina sp.) cover a striking rock outcrop in this photograph. Location: Map sheet 23, Howell Hook Area Block 219, Transect L, navigation fix point 348. Water depth: 147 m.



**Outer Shelf Low-Relief Live Bottom Assemblage**

A roughtongue bass (Holanthias martinicensis) is behind the antipatharian in the center of this photograph. On the right, an unidentified basket star extends its arms. Location: Map sheet 19, NG 16-12 Block 85, Transect L, navigation fix point B. Water depth: 124 m.

**Outer Shelf Crinoid Assemblage**

A group of crinoids is shown here on a substrate of coarse sand and rubble. Crinoids typically found in this area include Comactinia meridionalis, Crinometra brevipinna, Leptonemaster venustus, and Neocomatella pulchella. Location: Map sheet 13 in the Southwest Florida Shelf Ecosystems Study (Year 1) Marine Habitat Atlas, Vernon Basin Area Block 699, Transect B, navigation fix point 731. Water depth: 139 m.


**The Department of the Interior Mission**

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. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; 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 ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.


**The Minerals Management Service Mission**

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.