July 7, 1994

Planning Division
Environmental Branch

Mr. David Ferrell
Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, Florida 32961-2676

Dear Mr. Ferrell:

This is in reference to Region III of the Coast of Florida Erosion and Storm Effects Study.

Enclosed for your use are 13 computer disks containing the results of the side scan sonar survey. Data files included on these disks are: hardground boundaries, the shoreline boundary, bathymetric contours, and the boundary of the area surveyed. The disks are DOS formatted ready for PC ARC/INFO import.

Sincerely,

A. J. Salem
Chief, Planning Division

Enclosures

January 19, 1995

Planning Division
Environmental Branch

Mr. Jim Miller
Bureau of Archeological Research
Division of Historical Resources
R. A. Gray Building
500 South Bronough Street
Tallahassee, Florida 32399-0250

Dear Mr. Miller:

The Jacksonville District, U.S. Army Corps of Engineers, is gathering information to help define issues and concerns that will be addressed in the Coast of Florida Erosion and Storm Effects Study (COFS). The study is a cooperative effort between the District and the Florida Department of Environmental Protection to investigate coastal processes on a regional basis for the purpose of recommending modifications for existing shore protection and navigation projects.

Enclosed are three reports which together comprise the Geographic Information System (GIS) database design for the subject study. These reports are being provided to you in response to a January 18, 1995, telephone conversation with Ms. Janice Adams, Corps of Engineers. So that potential impacts to cultural resources will be addressed in the COFS, the Jacksonville District will include information on these resources in the developed database.

In compliance with the National Historic Preservation Act, written coordination with the Florida State Historic Preservation Officer (SHPO) has been initiated for the Draft Environmental Impact Statement that is currently being prepared for Region III of the Coast of Florida. Studies required for each region of the Coast of Florida study will be coordinated with the SHPO.

Sincerely,

A. J. Salem
Chief, Planning Division

Enclosures

FLORIDA DEPARTMENT OF STATE
Jim Smith
Secretary of State
DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough
Tallahassee, Florida 32399-0250
Director's Office (904) 488-1480
Telecopier Number (FAX) (904) 488-3353

December 8, 1994

Mr. A. J. Salem
Planning Division
Environmental Branch
Department of the Army
Jacksonville District
Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

In Reply Refer To:
Laura A. Kammerer
Historic Sites
Specialist
(904) 487-2333
Project File No. 944131

RE: Region III of the Coast of Florida Erosion and
Storm Effects Study
Draft Environmental Impact Statement Preparation
Broward, Dade and Palm Beach Counties, Florida

Dear Mr. Salem:

This study region contains hundreds of shipwrecks. They are most frequently located in 20 feet or less of water, or in association with the first and second reef lines along the southeastern coast of Florida. We suggest that your office contact the following agencies regarding local shipwreck information:

Steve Higgins
Broward County Biological Resources Division
305/519-1265

Richard Curry
Biscayne National Park
305/247-2044

There are also hundreds of prehistoric and historic archaeological sites in this coastal region. Enclosed is the most current Florida Master Site File printouts of properties in Broward, Dade and Palm Beach Counties listed, or eligible for listing in the *National Register of Historic Places*.

The following proposed modifications for existing shore protection and navigation projects are likely to affect historic shipwrecks: sand bypassing at inlets using conventional

dredging, construction of groins and/or offshore breakwaters, construction of sand traps and offshore borrowing. The following activities are likely to affect upland prehistoric and historic properties: dune construction and upland sand borrow sources.

As you are aware, many of the proposed shore protection and navigation projects will have to be coordinated on a case-by-case basis with this office. We look forward to working with you and providing more specific concerns and information regarding important cultural resources as projects are developed and implemented.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

Laura A. Kammerer for

George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Klk
Enclosure

Department of Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

November 14, 1994

Mr. Scott Hoffeld
Gulf Engineers & Consultants
P.O. Box 84010
Baton Rouge, LA 70884-4010

RE: Coast of Florida Study Marine Turtle and Manatee Issues

Dear Mr. Hoffeld:

As we discussed on the phone, the federal projects in the area encompassed by the Coast of Florida do have a high probability of encountering manatees and marine turtles. In general, the projects you have listed are either on or near the beaches and inlets and do not include harbor projects. For this reason, our Office typically recommends standard manatee protection conditions be implemented during construction. These standard conditions are very familiar to the Corps and to construction contractors. In the areas you listed, manatees are occasionally sighted moving through inlets or more infrequently swimming in the open ocean within the limits of some of the project boundaries. No congregation areas of manatees have been reported in the nearshore ocean areas of Palm Beach, Broward and Dade counties. Manatees utilizing the inlets have been documented, however, no significant foraging habitat is reported within the limits of the inlet projects on your list. Manatees would be more likely encountered by support boats moving from marinas and dock areas through the channels and inlets towards dredge vessels. The standard manatee protection conditions I referenced earlier would require signs be posted on work boats informing crew of the possibility of manatees being sighted and notifying them of the appropriate responses should manatees be in the area.

Marine turtles are far more likely to be encountered during operation, maintenance, and new construction activities within the Coast of Florida Study area. Nests of the threatened loggerhead (Caretta caretta) turtle are the most common in all three counties. Nesting numbers of the endangered leatherback (Dermochelys coriacea) turtle are very significant in Palm Beach county and occasionally reported from Broward and Dade counties. The endangered green (Chelonia mydas) turtle is a frequent nester in the project areas listed for Palm Beach and Broward counties and an occasional nester in Dade County. The endangered Hawksbill (Eretmocheyles imbricata) turtle has been recorded nesting in all three counties on an infrequent basis. Although there are no routine surveys of the open ocean waters, marine

turtles are present for much of the year in the region because of the water temperatures and nearshore rock habitat. It is likely that different special construction conditions would be needed to ensure protection of marine turtles for the various types of projects encompassed by the Coast of Florida Study. For example, beach restoration or renourishment projects should be planned to avoid the main portion of nesting season (March 1 to October 31 for Palm Beach and Broward, May 1 to October 31 for Dade). Each project might also have specific monitoring requirements to ensure that beach compaction and escarpments do not interfere with marine turtle nesting activity. Finally, open ocean borrow activities might disturb marine turtles and their habitat therefore special precautions might be needed for dredges operating around hardbottom habitat.

Within the time frame provided for these comments, we could not generate the actual historical nesting data for the areas identified. We are currently in press with a report covering the nesting data between 1979 and 1992. Unfortunately, the data is reported to us by survey areas which do not always correspond with federal project limits. For example, we have nesting data from 7 different segments of the Dade County shoreline. Our Golden Beach segment is 1.9 km long while the federal project length is 1.1 miles. The Sunny Isles, Bakers Haulover, Bal Harbour, Surfside and Miami Beach federal projects are all within our general segment of Miami Beaches. It is very similar for the other two counties. For this reason, we typically speak of nesting in terms of the average densities encountered in the County as well as more project specific densities if they are available. If in your continued work on this environmental review it is determined that nesting data for all three counties is desired, please let me know and we will try to generate that information for you.

I hope this general information is helpful. Should you have any other questions, please feel free to call me at (904)922-4330.

Sincerely,

David W. Arnold

David W. Arnold
Biological Administrator

DWA/da

November 9, 1994

Planning Division
Environmental Branch

Mr. George Percy
Division of Historical Resources
500 South Bronough
Tallahassee, Florida 32399

Dear Mr. Percy:

The Jacksonville District U.S. Army Corps of Engineers, is gathering information to help define issues and concerns that will be addressed in a Draft Environmental Impact Statement (DEIS) for Region III of the Coast of Florida Erosion and Storm Effects Study. The study is a cooperative effort between the Corps of Engineers and the Florida Department of Environmental Protection to investigate coastal processes on a regional basis for the purpose of recommending modifications for existing shore protection and navigation projects.

The study area includes most of the Atlantic and Gulf Coast of Florida and has been divided into five coastal regions. The focus of the DEIS is Region III which consists of 92 miles of Atlantic Ocean coastline within Palm Beach, Broward, and Dade counties. Refer to the enclosed location map. Several alternatives are being considered in the study and will be addressed in the DEIS. These include: 1) continued renourishment of existing projects, 2) design modifications to existing projects where needed, 3) sand bypassing at inlets using sand transfer plants and/or conventional dredging, 4) nearshore placement of suitable maintenance dredged material to feed adjacent beaches, 5) use of suitable maintenance dredged material as beach fill, 6) construction of groins and/or offshore breakwaters, 7) dune construction, 8) construction of sand traps at inlets to aid in sand bypassing, and 9) sand tightening existing jetties to where the need has been identified. Sources of sand that have been identified include offshore borrow areas, upland sand sources, suitable material from maintenance dredging, and the possible use of Bahamian aragonite. In addition to biological resources, it is anticipated that significant historic and archeological resources are located within the study area.

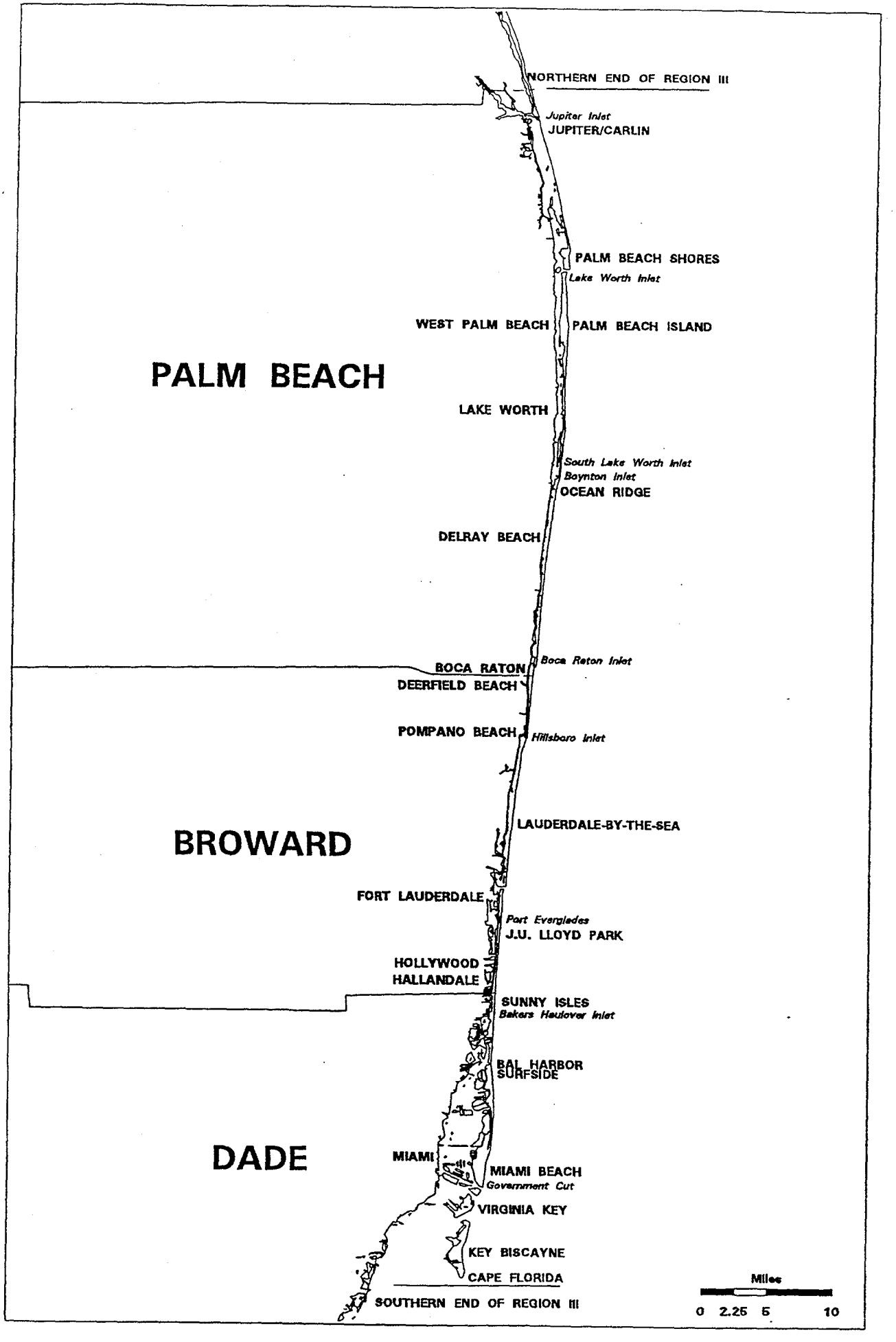
We request that your office provide comments and information about resources and important cultural features within the

described area. In compliance with the National Historic Preservation Act, as amended, and 36 CFR Part 800, your comments are requested within 30 calendar days of the date of this letter.

Sincerely,

A. J. Salem
Chief, Planning Division

Enclosure


NORTHERN END OF REGION III
Jupiter Inlet
JUPITER/CARLIN
PALM BEACH SHORES
Lake Worth Inlet
WEST PALM BEACH
PALM BEACH ISLAND
PALM BEACH
LAKE WORTH
South Lake Worth Inlet
Boynton Inlet
OCEAN RIDGE
DELRAY BEACH
BOCA RATON
Boca Raton Inlet
DEERFIELD BEACH
POMPANO BEACH
Hillsboro Inlet
LAUDERDALE-BY-THE-SEA
BROWARD
FORT LAUDERDALE
Port Everglades
J.U. LLOYD PARK
HOLLYWOOD
HALLANDALE
SUNNY ISLES
Bakers Haulover Inlet
BAL HARBOR
SURFSIDE
DADE
MIAMI
MIAMI BEACH
Government Cut
VIRGINIA KEY
KEY BISCAYNE
CAPE FLORIDA
SOUTHERN END OF REGION III
Miles
0 2.25 5 10

United States Department of the Interior
FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

September 30, 1994

Colonel Terry L. Rice
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

RE: Coast of Florida
Environmental Study Plan

Dear Colonel Rice:

The U.S. Fish and Wildlife Service (Service) provides the following Interim Fish and Wildlife Coordination Report on the Coast of Florida Study. This report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and Section 7(a)(2) of the Endangered Species Act, as amended (16 U.S.C. 1531 et seq.). This does not represent the Section 2(b) report of the Secretary of the Interior.

It is our understanding that the Coast of Florida Study may result in the authorization of as many as 13 new coastal construction projects. Little is currently known about the environmental consequences of these proposed actions. As agreed with your Planning Division staff, the Service will provide a separate Coordination Act report on each of the projects proposed as a result of the Coast of Florida Study. As the Coast of Florida Study continues, the Service will supplement this report regarding the environmental effects of proposed projects through further fish and wildlife investigations.

BACKGROUND

The Coast of Florida Study (Study) is a multi-year project to examine the entire developed east and west coast shorelines of Florida. The objective of the study is to develop a comprehensive database of relevant engineering, economic, and environmental parameters to aid in the development of shore protection projects while minimizing environmental impacts.

The Service has been involved in the Study since 1989. At that time, the Service recommended that subtidal habitats (reefs) within Region III of the Study (Dade, Broward and Palm Beach Counties) be mapped using side scan sonar. This mapping has recently been completed and the various reef areas found within the areas of influence of Coast of Florida Study Projects await assessment. Finding an efficient sampling method to survey the project area is necessary in order to thoroughly determine values of the extensive habitat potentially affected. Service biologists accompanied personnel from Seabyte, Inc. in August to observe the use of underwater video survey methods. The method provides an interface between the video and a Geographic Information System database which has been employed for the Study. Use of this methodology has been rejected by the Corps as being too costly. A new methodology has yet to be proposed.

STATUS OF CURRENT PLANNING

The Study proposes construction at 24 different areas encompassing over 54 miles of shoreline. Of these projects, 11 are already existing or approved and 13 are new. These include:

Project Name	Project Type	Project Status
Pompano\Lauderdale by the Sea	5.3 Mile Renourishment	Authorized Project
Fort Lauderdale	2.1 Mile Renourishment	New Project
Port Everglades	0.18 Mile Sand Transfer	New Project
Port Everglades	Spur and Breakwater	New Project
John U. Lloyd	2.3 Mile Renourishment	Authorized Project
Dania Beach	0.6 Mile Renourishment	New Project
Hollywood\Hallandale	5.3 Mile Renourishment	Authorized Project
Golden Beach	1.1 Mile Renourishment	New Project
Sunny Isles	2.5 Mile Renourishment	Authorized Project
Bakers Haulover Inlet	0.08 Mile Sand Transfer	New Project
Bal Harbour, Surfside, Miami Beach	8.9 Mile Renourishment	Authorized Project
Government Cut	0.19 Jetty Tightening	New Project
Key Biscayne	3.2 Mile Renourishment	Authorized Project
Jupiter Inlet	0.13 Mile Sand Trap	New Project
Jupiter\Juno Beach	3.0 Mile Renourishment	Authorized Project
Riviera Beach	0.38 mile Groin or Breakwater	New Project
Riviera Beach	1.7 Mile Dune	New Project
Lake Worth Inlet	0.57 Mile Sand Transfer	New Project
Palm Beach Island	5.6 Mile Renourishment	Authorized Project
So. Lake Worth Inlet	0.25 Mile Sand Transfer	New Project
Ocean Ridge	1.46 Mile Renourishment	Authorized Project
Delray Beach	2.65 Mile Renourishment	Authorized Project
Highland Beach	3.2 Mile Renourishment	New Project
Boca Raton	1.45 Mile Renourishment	Authorized Project

Projects include inlet bypassing, new and old beach renourishment, sand tightening, spur and breakwaters, etc. Due to the enormity of area to cover and the variability in projects, field work for environmental surveys needs to be developed and an Environmental Study Plan developed for the entire Coast of Florida, Region III. The Service needs to be provided with the opportunity to conduct reconnaissance visits to each study area in order to develop the Environmental Study Plan. The uniqueness of each project needs to be recognized and may require special design requirements specific to the area, impacts and the timing of the project. This approach has the advantage of resulting in more timely reports due to changes in environmental conditions over time.

RECOMMENDATIONS

The Service recommends the following be included in future project planning to clearly identify habitat resources and minimize project impacts. It is impossible to predict what methodologies will be required for all potential biological characterizations since the possible varieties of communities are diverse.

1. Service and Corps biologists/divers jointly develop an Environmental Study Plan for Coast of Florida, Region III.

2. The latitude and longitude of all corners of the borrow area, the percent silt and clay at each boring location, and a chart showing the location of all reefs within a mile of the borrow area should be provided to the Service.

3. The Service should be notified of the Corps' intention to propose a SOW at least 6 months prior to preparation of the first draft of the SOW. This will enable the Service to make a preparatory visit to the project area and to assist the Corps in developing a biologically sound study plan suited for that area.

4. During the six month preparatory period mentioned in #3 above, the Service should be funded for not only preparation of the SOW, but also to obtain aerial photographs showing the ocean bottom seaward of the fill area or any nearshore dredge area.

5. At a minimum, the SOW should read that the Draft FWCA Report is due 90 days after the Service receives all project information with Final FWCA due 30 days prior to distribution of the Final EIS. The 90 day timeframe should include spring and summer diving seasons (May through September). As some SCUBA diving is possible in winter, an extended Fall\Winter review period may be acceptable in Region III which is prone to favorable diving conditions.

Field investigations are necessary to locate potential resources at risk. The goal is to not simply generate species lists, but to evaluate impacts to affected organisms and interpret potential habitat responses. It is important to monitor both pre- and post-project conditions in order to evaluate project impacts and to develop adequate mitigation plans if necessary. Fish and Wildlife Service field studies should include the following:

1. video transects perpendicular to the shore every 500 feet or every 1/2 Florida Department of Environmental Protection (FDEP) monument;

2. video transects parallel to the shoreline every 50' seaward to identify vulnerable habitat. The location and lengths of transects will be determined by aerials and reconnaissance visits;

3. photographic quadrates may be needed if seagrasses, corals, worm rock or other sensitive species are present; and,

4. depth recording transects to identify topographic features with significant relief.

ENDANGERED SPECIES

The Service will continue to conduct consultation for threatened and endangered sea turtles under Section 7 of the Endangered Species Act. All sea turtle nesting data available through the FDEP should be added to the Corps' GIS database. The information should be updated annually. This will allow the Corps to provide the Service with sea turtle nesting data on short notice, streamlining the Section 7 Consultation process to threatened and endangered sea turtles.

SUMMARY

The Corps of Engineers has proposed 13 new projects as a result of the Coast of Florida Study, Region III. The Corps provided a SOW for Service involvement in the review of the new projects as well as 11 previously authorized projects. No suggested method for assessing environmental impacts to 54 miles of South Florida Shoreline has been agreed upon by the Corps, Service or Project Sponsor.

The Service has proposed that a contractor survey affected habitat with underwater video which could interface with the Corps and Service GIS systems. This method was deemed too costly by the Corps. Without knowledge of the potential environmental consequences of the newly proposed beach and inlet projects, the Service cannot render a judgement on the advisability of implementing those projects. No new projects should be initiated until adequate biological surveys (assessments) are accomplished to evaluate mitigation needs and associated project costs.

The Service has provided the Corps with this Interim Fish and Wildlife Coordination Act Report which outlines Scoping needs for adequate biological surveys. If future SOW's are to be contracted, the consulting firm and SOW should first be approved by the Service in accordance with our National Transfer Fund Agreement.

Thank you for the opportunity to provide this input. Please contact Mr. Charles Sultzman at 407-562-3909 if you have any questions.

Sincerely,

David L. Ferrell
Field Supervisor

cc:

NMFS, Panama City, FL
FDEP, Tallahassee, FL
FGFWFC, Tallahassee, FL

December 22, 1993

Planning Division
Environmental Branch

Mr. Alexander Stone
Director, Project Reefkeeper
2809 Bird Avenue, Suite 162
Miami, Florida 33133

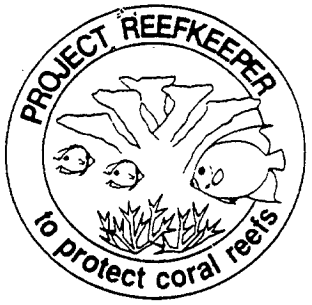
Dear Mr. Stone:

This is in response to your October 15, 1993 letter concerning the Coast of Florida Study (COFS). As requested, your organization has been added to the COFS mailing list. The draft feasibility report and environmental impact statement will be available in October 1994 for public review and comment. We will ensure that you receive a copy.

The hardbottom communities offshore of Region III (Dade Broward, and Palm Beach Counties) have been surveyed and mapped using side scan sonar. At this time only general physical descriptors have been used to define reef types (i.e. high/low relief, patch reef, artificial reef, etc.) based on interpretation of the side scan data. Some groundtruthing was performed during this past fall and more is planned for the spring and summer of 1994. We will BE working with the U.S. Fish and Wildlife Service and the Florida Department of Environmental Protection to develop habitat quality descriptors/indices for hardbottom communities. This work will begin early in 1994. Any information you would like to provide that would help us in this effort will be appreciated.

Sincerely,

A. J. Salem
Chief, Planning Division



Project ReefKeeper

OPERATIONS CENTER
Suite 162
2809 Bird Ave
Miami, Florida 33133

CARIBBEAN REGION
Suite 1271
Castillo Del Mar
Isla Verde, Puerto Rico 00913

PACIFIC REGION
Suite 106-542
350 Ward Avenue
Honolulu, Hawaii 96814

LATIN AMERICAN REGION
Calle 60 No. 387-C
Merida, Yucatan
Mexico 97000

Operations Center
October 15, 1993

Mr. Mitch Granat
Army Corps of Engineers
Jacksonville District
P.O. Box 4970 -- CESAJ-PD-PC
Jacksonville, FL 32232-0019

re.: Coast of Florida Study

Dear Mr. Granat:

We are a non profit organization dedicated to the conservation of coral reefs in the United States and internationally. We have been involved in beach renourishment environmental issues for years. In the past we were included in the Coast of Florida Study and attended working group meetings as a non-government organization observer. We intend to continue to be involved in the Coast of Florida Study via pre-draft comments and input, and would like to once again be placed on the mailing list for the **Update Report**, and for working group meeting notices.

We would also like to know what the Army Corps of Engineers is specifically using as descriptor definitions for hardbottom and as quality indices for hardbottom quality. If you have not gotten that far, please inform us who will be developing the definitions and quality indices for hardbottom, so that we may provide input.

Sincerely,

Alexander Stone

ALEXANDER STONE
Director

Project ReefKeeper

Fact Sheet

Description

- a membership organization dedicated to worldwide coral reef conservation via policy analysis, public information, advocacy and grassroots organization
- an affiliate of the American Littoral Society, a non-profit marine conservation organization founded in 1961.

Objectives

- to achieve and foster worldwide protection of coral habitats and preservation of their biological diversity

Priority Issue Areas

- offshore oil impacts and contamination
- dredging and siltation impacts
- marine pollution impacts from land-based sources
- depletion of reef fish populations
- creation of coral reef habitat preserves

Current Campaigns

- creation of coral reef protected areas — Texas, Florida, Hawaii, Puerto Rico, Japan, Thailand, Jamaica, USVI
- offshore oil leasing exclusions for coral reef areas — Florida Straits, Gulf of Mexico, U.S. Caribbean
- wire mesh fish trap ban — Florida, Texas USVI, Micronesia.
- coral habitat protection from dredging and beach renourishment smothering — Florida, Hawaii, St. Lucia
- coral collection prohibition — Pto. Rico, USVI, Jamaica, Malaysia, Thailand
- nutrient pollution reduction — Florida, Pto. Rico, Hawaii
- live rock collection ban — Fla., USVI, Hawaii, Pto. Rico

Publications

- ReefKeeper Report

Project ReefKeeper

OPERATIONS CENTER
Suite 162
2809 Bird Ave
Miami, Florida 33133

CARIBBEAN REGION
Suite 1271
Castillo Del Mar
Isla Verde, Puerto Rico 00913

PACIFIC REGION
Suite 106-542
350 Ward Avenue
Honolulu, Hawaii 96814

LATIN AMERICAN REGION
Calle 60 No. 387-C
Merida, Yucatan
Mexico 97000

December 6, 1993

Planning Division
Environmental Branch

Mr. David L. Ferrell
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, Florida 32961-2676

Dear Mr. Ferrell:

The Region III portion of the Florida Erosion and Storm Effects Study (Dade, Broward, and Palm Beach Counties) is in its final year of study. The draft feasibility report is scheduled for transmittal to the U.S. Army Corps of Engineers, South Atlantic Division Office in June 1994. We have scheduled a plan formulation technical review conference (TRC) for December 14, 1993 to review the study efforts to date and to discuss alternative plans that are under consideration.

The enclosed provides additional information related to the TRC. You and your staff are invited to attend this conference. The meeting will begin at 0800 in room 104 at the Prime F. Osborn Convention Center, 1000 Waters Street. An agenda and a list of probable attendees are included in the enclosed packet.

I look forward to seeing you at the conference.

Sincerely,

A. J. Salem
Chief, Planning Division

Enclosures

August 10, 1993

Planning Division
Environmental Branch

Mr. David L. Ferrell
Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, Florida 32961-2676

Dear Mr. Ferrell:

Enclosed is a Scope of Work (SOW) and Cost Estimate for your office's participation in ground truthing hardbottom/reef communities mapped by side scan sonar surveys within Region III of the Coast of Florida Erosion and Storm Effects Study. Other agencies that will be involved in this effort will be the Florida Department of Environmental Protection and possibly Palm Beach, Broward and Dade Counties. We plan to use the Survey Boat Sable, which has differential GPS navigation, as a dive boat and have tentatively scheduled the field work for the last two weeks in September.

Please sign the enclosed SOW, providing a copy to this office, and process the enclosed MIPR. We request that you expedite processing the MIPR so that we can obligate funds this fiscal year. If you have any questions concerning this, please feel free to contact Mr. Mike Dupes at 904-232-1689.

Sincerely,

Mann G. Davis
Acting Chief, Planning Division

Enclosures

United States Department of the Interior
FISH AND WILDLIFE SERVICE
P.O. BOX 2676
VERO BEACH, FLORIDA 32961-2676

January 8, 1993

Colonel Terrence Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Att: Planning Division

RE: Coast of Florida Study

Dear Colonel Salt:

In accordance with the Fiscal Year 1992 Transfer Fund Agreement between the U.S. Fish and Wildlife Service (Service) and the Jacksonville District Corps of Engineers (Corps), this represents a Technical Assistance Report on a method for characterizing the physical attributes of reefs offshore of Dade, Broward, and Palm Beach Counties (Region III) for the Coast of Florida Study. The method involves gathering high resolution digital depth recordings of distinct reef sub areas. The recordings, thus obtained, would then be manipulated mathematically to derive an index of the relative rugosity (ruggedness) of the hard substrate. Increasing rugosity is believed to increase habitat value by offering increasingly numerous hiding places for fishes and invertebrates and by increasing surface area for the attachment of sessile organisms.

The method may also be used to estimate reef height from the surrounding bottom and could be refined to discriminate between rugosity and that resulting from large scale features such as cliffs and boulders resulting from small scale features as rock rubble. This report will first discuss collection of the depth profile data, then will discuss the treatment of those data.

INTRODUCTION

Reef rugosity for small areas has been measured in some studies by forcing a chain (Risk, 1972; Carpenter, et. al., 1981) or a rope (Luckhurst and Luckhurst, 1978) to conform to the irregularities of the reef surface. As a result, the straight-line distance between ends of the chain becomes shortened. The more sinuous the path over the reef surface, the greater the reduction in straight line distance from end to end. This shortening has been treated mathematically in different ways by different researchers. Risk (1972) generated values for "T" (topographic complexity) and Carpenter (1981) used values of "SR" (substrate rugosity). All researchers have found that whatever the resulting term, reefs with more complex, rugged surfaces are inhabited by more fish species and invertebrates.

reefs with more complex, rugged surfaces are inhabited by more fish species and invertebrates.

A similar method can be applied to large areas in measuring reef surface rugosity for the Coast of Florida Study. A depth recorder produces a line which conforms approximately to the shape of reef surfaces. North-south and east-west depth recording transects could be run on reef areas mapped by side scan sonar (This was done by Continental Shelf Associates for Region III). The ratio of the straight-line distance to the over-all distance of the convoluted line of the recording could then be used as an index of ruggedness, surface area, and height of relief ("T" and "SR" have been found to be highly correlated with reef height). This index would, in turn, could be used as an indicator of reef habitat quality.

DATA COLLECTION

Ideally, the equipment used should be able to detect features which are one inch or greater in diameter. Reef surface convolutions of this size could contribute significant surface area and cover for small motile species. As we will explain later, this resolution may not be obtainable with equipment currently available on the market.

Transducers for depth recorders are selected for their beam angle. Wider beam angles (typically 20°) are chosen to search larger areas for fish. Beams of smaller angles cover a narrower swath but give a more detailed representation of bottom features. For the purposes of this study, a high resolution profile of the bottom is desired. Therefore, a transducer with the narrowest beam angle obtainable should be used. To the best of our knowledge, this would be the 1° beam of Odom Hydrographic System's "Echotrac" depth recorder (See enclosed letter, Odom Hydrographics, May 12, 1989).

The subject system has been said to be capable of detecting changes in bottom contours as small as 8 millimeters (.3 inches). However, this claim probably refers to detection of uniform changes in shallow water. Over a depth distance of 10 feet, a beam with angle of 1° would spread to .17 feet (10 sin 1°) or approximately 2 inches. Therefore, a reef feature of 1 inch diameter falling within this sonic cone would not completely fill the detection area. As the return signal would be reflected first by higher objects within the cone, smaller features can be obscured. The resolution capability of this system would, however, yield much valuable information about the presence and frequency of features 2 inches in diameter or greater.

The increase in beam width with distance traveled (i.e., increasing depth) reduces resolution. It would be necessary, therefore, to maintain as constant a transducer height above to bottom as possible. In addition, when a transducer is mounted on the transom of a boat, wave action causes

distortion of bottom bathymetry by alternately increasing and decreasing the effective depth. Both of these difficulties can be surmounted by decoupling the transducer from the boat. With the transducer mounted on a towed, submerged vehicle (see enclosure), transducer height can be held at a constant short distance and, if towed with an elastic cable, short wave distortion can be virtually eliminated.

Boat speed over the bottom, chart paper speed, and sonic pulses per second would have to be held constant throughout the recording. These details can easily be worked out by a qualified marine surveyor.

DATA INTERPRETATION

A. A Simple System

Once a chart recording is obtained for a particular reef area, each transect can then be analyzed for rugosity simply by dividing total length of the convoluted line delineating the bottom into the length of paper used during that transect. For example, in Figure 1, two possible tracings are shown. Figure 1.a. depicts a relatively smooth surface; figure 1.b.depicts a very rugged one. This difference can be quantified by comparing ratios of line length AB ÷ CD and lengths EF ÷ GH. Suppose the paper used during both transects (lengths AB and EF) is 10 inches and the smooth reef generated a line (CD) of length 12 inches, the rugged reef produced a recorded line (GH) of 18 inches. The ratio for Figure 1.a. would be 10/12 or .83; for Figure 1.b. it is 10/18 or .55.

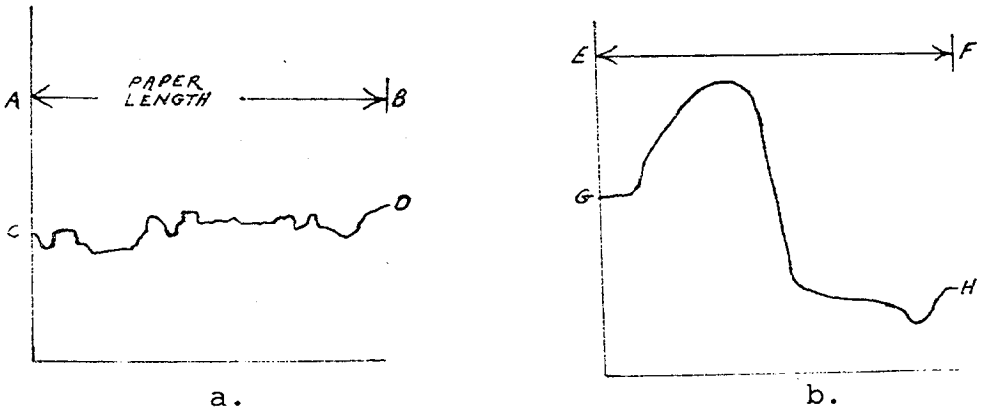


Figure 1. Hypothetical Depth Recordings.

This result could lead to confusion because the less rugged surface has produced a larger fraction. To make the result more comprehensible, these ratios should be subtracted from 1 to yield an index which increases with increasing rugosity. Finally, then, the index for recording 1.a. would be 1 - .83 or .17; that for recording 1.b. would be 1 - .55 or 0.45.

This also makes sense at the extremes of the indexing system. Look at Figure 1.a.. As the sea floor becomes flatter, the index (1-AB/CD) tends toward 0 because AB/CD tends toward unity. Conversely, as the surface becomes increasingly complex, the index tends toward 1 because CD $\rightarrow \infty$ and AB/CD $\rightarrow$ 0. Note however that the index can never = 1, but approaches 1 asymptotically.

All that is needed for this simple system to be made workable is a means by which to measure the length of the line produced by the depth recorder. If the depth data are gathered in digitized form or can be precisely digitized from a chart recording, calculation of the length of the convoluted line should be a fairly simple matter. This aspect is currently being explored by the Fish and Wildlife Service.

B. A Better System

The above method does not discriminate among reef features of different scales. Large scale features such as boulders and cliffs would have habitat value for larger fishes and invertebrates while features of smaller scale such as solution holes and cracks would be equally valuable but for smaller organisms. The methods of fractile geometry allow one to distinguish between topographic complexity attributable to small scale features versus large scale features.

Consider Figure 1 again. The bottom depicted by tracing 1.a. has been calculated to have rugosity index equal to 0.17 while that of tracing 1.b. is 0.45. According to this system, 1.b. is nearly 3 times better than 1.a.. This ignores the fact that 1.a. has numerous small crevices which may be just as important to small species and juveniles for cover as the large cliff in 1.b. is to large fishes and invertebrates.

To make up for this shortcoming, the lines can be measured using methods of increasing resolution. Computer programs are available which automatically perform this analysis (Shelberg, et. al., 1982; Kennedy and Lin, 1986). For the sake of this discussion, the process can be most readily understood by comparing the analysis to repeated measurement of the line by walking a pair of dividers along it. At each measurement, the spacing between ends of the dividers is decreased, thereby increasing the resolution of the measurement.

With dividers widely spaced, only the most prominent features are detected. The presence of prominent features results in a lengthening of the recorded line over the distance from end to end. Figure 2 shows the measurements of the 10 inch depth recordings from Figure 1 after being measured by a pair of dividers spread 2 inches apart (coarse resolution). Only the large hump and sharp drop off of 2.b. are detected. This lengthens the distance traversed to 16 inches. Virtually no

increase over 10 inches was required to traverse the depth profile of Figure 1.a. at this level of resolution.

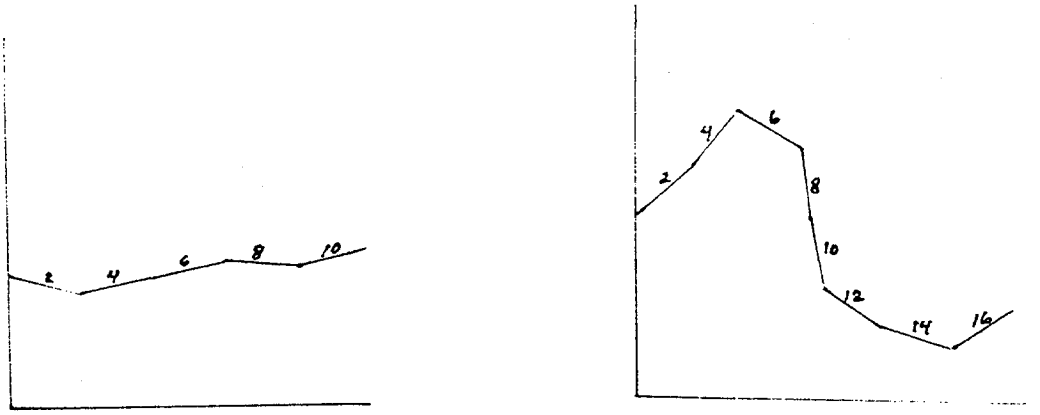


Figure 2. Depth Recordings measurements in 2" increments.

The rugosity index of topographic complexity due to large features for Figure 2.a. is 0, (1 - 10/10). The rugosity index for large features as derived from Figure 2.b. is .375. If the lines are then measured with the highest resolution possible (as in the preceding section) in very small increments, say .001 inches, an approximation of the actual length results. Recall that for Figure 1.a. the resulting index for the 12 inch recorded profile was .17 and in Figure 1.b. the result was a line of 18 inches and index equal to .45. Table 1 below organizes this information more clearly.

Table 1. Rugosity indices at coarse and fine resolution.

Transect	Coarse	Fine	Total
1	0.000	0.17	0.17
2	0.375	0.075	0.45

The above results give a more complete description of the reef areas depicted in Figure 1. One can see that the vast majority of the features on the reef of transect 1 are small features while in transect 2, most of the rugosity is due to large features. By subtracting the rugosity index detected at coarse resolution from that detected at fine resolution, ruggedness due to small features in transect 2 can be approximated. That is, some of the total rugosity of each is also due to small scale features. For transect 2, this would be 0.075, (0.45 - 0.375) or approximately 16.6%.

RECOMMENDATIONS

The application of fractal geometry to depth recording technology would result in the creation of a system capable of estimating surface area and rugosity of large reef areas. Considering the vast area encompassed by the Coast of Florida Study, remote sensing and automated data analysis would be the most cost effective means to evaluate physical attributes of reef habitat. While the use of fractal geometry is more technical and would require more effort to develop a program which would produce the kind of results illustrated in the example above, additional expense would be incurred one time - in the start-up. Once a program is written which will accept digital depth recordings, perform the mathematics, and print the results, no additional expense over a simpler system would be required for operation.

In our opinion, the potential benefits out weigh this expense. As already mentioned, there are programs available which perform most of the functions described in this report. We have enclosed a copy of a paper by Shelberg, et. al. (1986) which presents one such program. As of 1982, Mark Shelberg was employed by the Defense Mapping Agency of the Federal Government. He may be available to assist the Corps and the Service in developing a custom program which will best address our needs for the Coast of Florida Study.

Sincerely Yours,

David L. Ferrell

David L. Ferrell
Field Supervisor

cc:
DER, Tallahassee, FL
DNR, Tallahassee, FL(Attn: Fritz Wettstein)
FWS, Jacksonville, FL

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