



U.S. Army Corps
of Engineers®

AN ASSESSMENT OF THE NATION'S SHORELINE CHANGE:

*A Review of the
1971 National Shoreline Study*



NATIONAL SHORELINE MANAGEMENT STUDY

The National Shoreline Management Study, authorized in the Water Resources Development Act of 1999 under Section 215c, presents an opportunity to examine the status of the Nation's shoreline for the first time in 30 years. Results from the study will provide a basis for Federal actions regarding shoreline management for the foreseeable future. The study will provide a technical basis and analytical information useful in developing recommendations regarding shoreline management, including a systems approach to sand management, and roles for Federal and non-Federal participation in shoreline management.

The study will:

- summarize information about the shoreline changes (erosion and accretion) available from existing data sources and examine the causes and economic and environmental effects;
- identify and describe the Federal, state and local government programs and resources related to shore restoration and nourishment; and,
- explore ideas concerning a systems approach to sand management.

The assessment of the nation's shorelines will take into account the regional diversity of geology, geomorphology, oceanography, ecology, commerce, and development patterns.

The study will be undertaken through collaborative efforts with other agencies. Information and products will be scoped, developed, and reviewed by national technical and policy committees involving multiple agencies. The National Study team will also solicit input from other interested parties and in developing study recommendations.

The U.S. Army Corps of Engineers' Institute for Water Resources (IWR) is managing the study working closely with the Engineer Research and Development Center Coastal and Hydraulics Laboratory and Corps field experts. National technical and policy committees, which include other agency experts, will be assembled as integral components of the study.

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Or go to the study website at: <http://www.iwr.usace.army.mil/NSMS>. The website provides reports to date and study progress along with topical links to other related studies and relevant agency programs.

A limited number of reports are available and may be ordered by writing Arlene Nurthen, IWR Publications, at the above Institute for Water Resources address, by e-mail at: Arlene.nurthen@usace.army.mil, or by fax 703-488-8171.



**AN ASSESSMENT OF THE
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National Shoreline Study**

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P R E F A C E

This report was prepared as a product of the National Shoreline Management Study (NSMS). The NSMS, authorized by Section 215(C) of the Water Resources Development Act of 1999, is being managed by the U.S. Army Corps of Engineers' (Corps) Institute for Water Resources (IWR).

The NSMS authorization calls for a description of the state of the shoreline in terms of erosion and accretion. This report provides a first response to those charges by examining the results and methods of the last national study of the nation's shoreline erosion. This paper serves as starting point for developing the methodology by which the NSMS will be conducted.

A C K N O W L E D G E M E N T S

This report was prepared by Dr. Donald Stauble, of the Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL). Direct supervision and support for this effort was provided by Dr. Robert Brumbaugh, (IWR), manager of the NSMS. Mr. Robert Pietrowsky is Director of IWR. Study oversight and general direction was provided by Mr. Harry Shoudy, Senior Policy and Chief Economist, Headquarters, U.S. Army Corps of Engineers, at the time this report was prepared.

Ms. Joan Pope (CHL), Dr. Andrew Morang (CHL), L. Jean O'Neil (EL) and Ms. Lynn Martin (IWR) provided comments on draft versions of this report.

EXECUTIVE SUMMARY

The nation's shorelines and beaches are a vital resource for recreational, natural resources, seaport and maritime commerce, residential and commercial uses. With the growth of population in the coastal zone, more competing pressures are put on the shores and beaches. Beginning in 1968, the public and Congress recognized a growing erosion problem and authorized a national appraisal of shore erosion and protection needs. The National Shoreline Study of 1971 was the first study of its kind to examine on a national scale, the existing Federal shore protection program and document the magnitude of the shore erosion problem. The 1971 Study produced separate reports that addressed three topics: shore erosion, shore protection and shore management. Nine regional reports were produced that addressed the areas of critical erosion, non-critical erosion and stable shorelines along the U.S. Atlantic, Pacific, Gulf of Mexico and Great Lakes coasts, including Alaska, Hawaii and Puerto Rico. The study identified 4,344 km (2,700 miles) of shoreline to be critically eroding (about 3.2% of the total nations shoreline), almost all

of which were along extensively developed areas, most of which were in the densely populated North Atlantic Region.

This paper provides a review of the methodology and criteria from that study in determining critical and non-critical erosion of the shoreline to serve as background for a new study to update the status of the shores. The new National Shoreline Management Study (NSMS) will provide a basis to describe the extent of and economic and environmental effects of present shore erosion and accretion. Improvements in accurate shoreline position survey methodologies and global positioning tools, along with advances in geographic information systems have provided much more accurate shoreline change data sets. In updating the shoreline assessment, the new study will provide recommendations regarding levels of Federal and non-Federal participation in future shore protection and systematic sand management practices. "The Report on the National shoreline Study prepared in 1971 is available on the SNS study website at: <http://www.iwr.usace.army.mil/NSMS/nsmsframeset.html>.

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INTRODUCTION

The shoreline is a vital part of the coastal zone. In order to manage this resource, one must understand the scope and magnitude of shoreline erosion. The first comprehensive study on the condition of shorelines on a national level was the National Shoreline Study (NSS) of 1971. This paper is an assessment of the 1971 NSS methodology and criteria used for defining “critical erosion” along the Nation’s shorelines. Within the past thirty years, the nation’s shores have undergone much change due to natural processes, and commercial and engineering activities. A new assessment is now needed on the state of the nation’s shorelines that will be addressed by the new National Shoreline Management Study (NSMS). Before proceeding in an assessment of present shore erosion problems, a review was done on the earlier methods and criteria used to determine the state of the nation’s shores and identify the critically eroding areas that needed shore protection measures. With a better understanding of how to determine the extent and effects of erosion on a national scale, a more comprehensive basis can be made to recommend Federal actions regarding shoreline management in the future. The new study will provide a sound technical basis and analytical information to develop recommendations for coastal sediment management and the roles of Federal and non-Federal participation in shoreline management.

OVERVIEW OF THE NATIONAL SHORELINE STUDY 1971

The 1971, National Shoreline Study was authorized by Congress in the Rivers and Harbors Act of 1968 to appraise the National shoreline erosion problem (U.S. Army, 1971a). Coastal engineers and planners recognized that a determination of the scope and

magnitude of the erosion problem was needed before any long-range comprehensive planning could be done by Federal, State and local interests. The purpose of the 1971 study was further described in eight tasks:

1. To determine areas of the coast where significant erosion was occurring;
2. To identify areas where erosion presented a serious problem, due to rates of shoreline retreat that required action to protect the upland infrastructure;
3. To describe methods to protect against erosion;
4. To provide cost estimates for protecting these areas;
5. To recommend priorities to mitigate this erosion;
6. To provide State and local authorities with information and recommendations for action to stop erosion;
7. To develop land use guidelines; and
8. To identify coastal areas where ownership was uncertain.

Three specific topic areas were addressed, that of:

Shore Erosion
Shore Protection
Shore Management.

Under Shore Erosion, coastal areas with significant erosion were determined and serious erosion problems were identified (U.S. Army, 1971a). General descriptions of the most suitable types of remedial action were described in the Shore Protection focus area (U.S. Army, 1971b). Preliminary cost estimates of each type of shore protection remedial action was also given along with a recommendation of priorities in erosion

control actions to take among the serious erosion problem areas. Under Shore Management, information and recommendations were presented to assist State and local interests in creation and implementation of shore erosion control programs (U.S. Army, 1971c). Guidelines were also recommended for land use regulation, and areas where jurisdictions and land ownership were unclear were identified.

THE NATIONAL SHORELINE MANAGEMENT STUDY

The nation's coasts have undergone a great deal of change in the thirty years since the NSS. The U.S. Army Corps of Engineers (Corps) has initiated a new study called the National Shoreline Management Study (NSMS), authorized in the Water Resources Development Act of 1999 under Section 215c. The study will provide a technical basis and analytical information useful in developing recommendations regarding shoreline management, including a systems approach to sand management, and roles for Federal and non-Federal participation in shoreline management. The study results will provide a basis for Federal actions regarding shoreline management for the foreseeable future

The Corps' Institute for Water Resources (IWR) is managing the study, working closely with the Engineering Research and Development Center's (ERDC) Coastal Hydraulics Laboratory (CHL) and Environmental Laboratory (EL) and Corps coastal Division and District experts on the study team. The study team will work with other Federal, State and local agencies regarding shoreline data collection and will coordinate and collaborate with these agencies to assess the state of the nation's shores. Federal Agencies with a role in shoreline mapping and analysis involved with this study will include the Federal Emergency Management Agency (FEMA) with flood mapping responsibilities, the National Oceanic and Atmospheric Administration (NOAA) with nautical chart and shoreline surveying responsibilities and the United States Geological Survey (USGS) with coastal topographic mapping responsibilities. Additional Federal Agencies with coastal interests are also involved. Many coastal state agencies are also conducting

shoreline change assessment studies within their respective states and their involvement has been solicited and will be assisted by coordination through the Coastal States Organization (CSO). The National Study team will also solicit input from other interested parties.

Growth and development along the nation's coastal areas has increased extensively in recent decades and this trend is expected to continue. Federal, State and local policies and programs affecting coastal management have evolved independently, and there is growing confusion as to how the different programs and responsibilities interrelate, particularly with respect to problems with coastal erosion threatening the upland infrastructure. The public has expressed a desire for both infrastructure and services to support economic growth along the coast, and also to protect the environment and restore natural resource systems. Products from the NSMS will provide information useful for policy analysis, coastal shore protection and land-use planning, along with coastal resources management.

The new study will summarize information about the shoreline changes (erosion and accretion) available from several post-1971 data sources and examine the causes and economic and environmental effects of these changes. The improvements in survey methodologies (LIDAR) and positioning tools (Global Positioning Systems) along with advances in analysis (Geographic Information Systems) have provided much more accurate shoreline change data sets. An identification and description of the Federal, State and local government programs and resources related to shore restoration and nourishment will be compiled as a reference source. A systems approach to sand management will be identified to effectively deal with the regional nature of erosion problems. The assessment of the nation's shorelines will take into account the regional diversity of geology, geomorphology, oceanography, ecology, commerce, and man-made development patterns. As an initial step in the new program, a review of the methodology and findings of the 1971 study was done to understand the background methods and criteria used to identify critical erosion along the coasts of the US and provide a comparison with the present state of the nation's shorelines.



THE NATIONAL SHORELINE STUDY 1971

METHODOLOGY AND CRITERIA FOR DETERMINING “CRITICAL EROSION”

The 1971 study identified significant erosion through a survey of all 135,156 km (84,000 miles) of U.S. Atlantic, Pacific, Gulf of Mexico and Great Lakes shorelines. Of the total Nations shoreline, 54,706 km (34,000 miles) was identified as exposed shoreline on the open coast, while 80,450 km (50,000 miles) was sheltered shorelines in bays and estuaries. Data were based on available information, local knowledge and judgment of the investigators. Information was obtained from various sources including local authorities, review of aerial photography, maps and surveys, and review of previous studies in order to determine the extent of significant erosion. Significant erosion was identified along 32,985 km (20,500 miles) or about 25% of the nations shorelines. "The Report on the National Shoreline Study prepared in 1971 is available on the SNS study website at: <http://www.iwr.usace.army.mil/NSMS/nsmshomeframeset.html>.

Areas undergoing significant erosion were identified using criteria based on:

- Rate of erosion
- Economic factors
- Industrial use
- Recreational use
- Agricultural use
- Navigational needs
- Demographic distributions
- Ecological impacts

Significant erosion was further subdivided into “critical” and “non-critical” categories. “Critical” erosion

areas were defined as shores where erosion presents a serious problem and erosion control projects may be justified (U.S. Army, 1971a). Critical areas were further identified based on:

- Projected population and land use demands on that particular stretch of shoreline to the year 2020
- Effects of past and continued erosion on environmental values
- Ownership
- Constraints on land use regulations

These critical areas were designated based on experienced judgment that indicated that prospective damage prevented and benefits from tangible and intangible values may justify action to halt erosion (U.S. Army, 1971a). From the NSS, 4,344 km (2,700 miles) of shoreline was deemed to be critically eroding (about 3.2% of the total nations shoreline), almost all of which were along extensively developed areas. The North Atlantic Region had the largest percentage of critically eroding shoreline followed by the South Atlantic Region. There was a direct relationship between areas of extensive coastal development and the critical erosion designation. Heavy development of the coast for industrial and recreational purposes close to the shore has resulted in erosion pressures and therefore long reaches of the coast in these two regions fell into the critical category.

“Non-critical” erosion areas were judged to be areas that did not justify remedial action, but that erosion was still significant. In the NSS, another 28,640 km (17,800 miles) or 21.1% of the Nation’s shores were identified as non-critical erosion, meaning that these parts of the coast experienced erosion, but shore

protection was not economically justified at that time. If development had been placed closer to the shoreline, many areas in this category would likely be in the critical category. Land use controls and management techniques were thought to be able to control future development in these areas, without requiring erosion control projects.

Coasts with stable or accretionary change measurements were termed non-eroding. The rest of the 102,558 km (63,740 miles) or 75.7% of the Nation's shoreline was characterized as stable. Suggestions were provided on various types of both soft and hard shore protection structures that could be used to protect the shore from erosion. Guidelines were also developed to assist State and local interests in creation and implementation of shore erosion control programs. To insure the national best interest in use of the shore, recommendations were made to: improved methods of erosion control; and develop coordinated and comprehensive planning and management.

Excluding Alaska, for which there was relatively scant development along the coast, as well as scant information, approximately 42% of the Nation's shorelines were identified as undergoing significant erosion. Approximately 7% of the Nation's shorelines were characterized as critically eroding.

Shorelines were not explicitly defined by the 1971 NSS. In some coastal regions, the shorelines included those affected by tides. In other cases, not all estuarine areas were included. For example, in the Chesapeake Bay area, the study covered up to the Washington, D.C. area on the Potomac River. Bay, and estuarine shorelines appear to be included if they were urbanized. All shoreline maps used and presented were for descriptive purposes. Thus, the extent of shoreline identified in the 1971 NSS cannot be replicated using a uniform measure.

THE REGIONAL REPORTS

The Nation's shorelines were divided into nine regions to produce a more detailed inventory of shore conditions. The nine regions corresponded to the Corps coastal Divisions existing at that time:

1. North Atlantic and New England combined (Maine to Virginia)
2. South Atlantic (North Carolina to Mississippi, and Puerto Rico and US Virgin Islands)
3. Lower Mississippi Valley (Louisiana)
4. Southwest (Texas),
5. North Central (Great Lakes)
6. South Pacific (California)
7. North Pacific (Oregon and Washington)
8. Alaska
9. Pacific Ocean (Hawaii).

Findings were published in regional reports listed in Table 1. The largest percentage of critically eroding shore was found in the North Atlantic, followed by the South Atlantic-Gulf, Great Lakes, California and Texas Gulf regions (Figure 1). The lowest percentage of critical erosion was in the Lower Mississippi, North Pacific, Hawaii and Alaska. Corps District and Division personnel prepared the regional reports using available data. The judgment of experienced coastal engineers and planners was used as a major resource (U.S. Army 1971d).

Various other Federal and non-Federal government agencies as well as civic and conservation groups also provided information. In identifying the areas of critical and non-critical erosion, the regional reports considered the following (U.S. Army 1971e):

- Use demand history,
- Projections of future use demands (based on judgment and available information),
- General estimates of historic and future annual damages from property loss
- General estimates of historic and future annual damages from business and recreation forgone, and
- The effect of continued erosion on ecological values.

Excluding Alaska, the 1971 National Shoreline Study estimated 58% of the shoreline was stable

Each of the nine reports was further divided into smaller reaches to better cover the outer seacoast and estuaries or bay shorelines. These reaches were divided on geographic divisions (capes, inlets, etc...), coastal morphology (i.e. barrier islands, cusped forelands, rocky coasts, etc...), shoreline type (open coast or bay or estuary shoreline), and oceanographic and coastal processes. Areas of critical erosion were further divided into four priorities based on the time until erosion affects the life safety and property of coastal residents in the critical erosion areas (U.S.Army, 1971a).

TABLE 1. REGIONAL ASSESSMENT OF SHORELINE EROSION, NATIONAL SHORELINE STUDY, 1971

Region	Total Shoreline (miles)	Critical Erosion (miles)	Non-Critical Erosion (miles)	Non-Eroding (miles)	Source
North Atlantic ME, NH, MA, RI, CT, NY, NJ, DE, MD, VA	8,620	1,090	6,370	1,160	U.S. Army (1971d)
South Atlantic/Gulf NC, SC, GA, FL, AL, MS, Puerto Rico, Virgin Islands	14,620	980	1,840	11,800	U.S. Army (1971c)
Lower Mississippi LA	1,940	30	1,550	360	U.S. Army (1971f)
Texas Gulf	2,500	100	260	2,140	U.S. Army (1971g)
Great Lakes MN, WI, IL, IN, MI, OH, PA, NY	3,680	220	1,040	2,420	U.S. Army (1971h)
California	1,810	80	1,470	260	U.S. Army (1971i)
North Pacific WA, OR	2,840	70	190	2,580	U.S. Army (1971j)
Alaska	47,300	100	5,000	42,200	U.S. Army (1971k)
Hawaii	930	30	80	820	U.S. Army (1971l)
Total	84,240	2,700	17,800	63,740	U.S. Army (1971a)

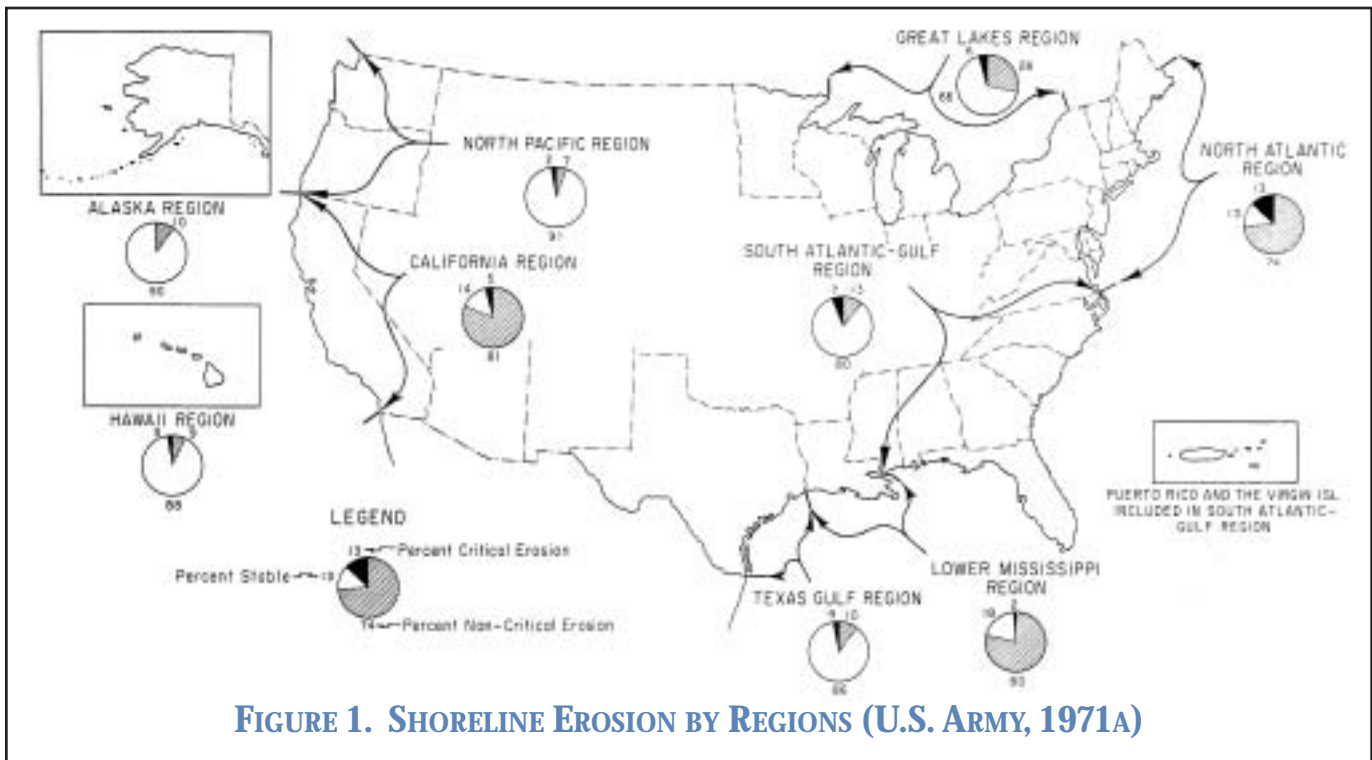


FIGURE 1. SHORELINE EROSION BY REGIONS (U.S. ARMY, 1971A)

By region, the highest percentage of critically eroding shoreline area was in the North Atlantic Region, most likely due to the large population centers near the coast and heavy development and shore use (Table 2). The four priorities are defined as:

- **Priority 1:** Areas where continued critical erosion is likely to endanger life or public safety within 5 years
- **Priority 2:** Areas where continued critical erosion is likely to endanger property, scarce wildlife habitats, or landmarks of historical or natural significance within 5 years
- **Priority 3:** Areas where continued critical erosion is likely to endanger life, public safety, property, scarce wildlife habitats, or landmarks of historical or natural significance within 5 to 15 years

1971 Study divided Shoreline into:

- Coast-sandy shores
- Open ocean rocky coasts
- Bay or estuarine shore

- **Priority 4:** All other areas undergoing critical erosion

Each regional report presented maps that depicted the areas of critical and non-critical erosion as well as the non-eroding shores for each section of coast. The maps however, had different formats in each of the reports. Some of the reports provided additional information on their maps or some even had additional maps with more information. In these maps, the symbols that signify critical erosion, non-critical erosion and no erosion were different depending on the regional report format. The shoreline was divided into three categories on most of the maps, which included open coast sandy shores, open ocean rocky coast and bay or estuarine shores.

TABLE 2. PRIORITIES FOR CRITICALLY ERODING SHORELINE BY REGION (U.S. ARMY 1971A)

Region	State	Priority 1 (miles)	Priority 2 (miles)	Priority 3 (miles)	Priority 4 (miles)	Total (miles)
North Atlantic	Maine	0	0	0	20	20
	New Hampshire	0	0	0	2	2
	Massachusetts	0	51	52	33	136
	Rhode Island	4	0	0	17	21
	Connecticut	3	0	0	22	25
	New York	101	115	84	0	300
	New Jersey	0	8	41	72	121
	Delaware	0	1	7	23	31
	Maryland	9	22	64	85	180
	Virginia	13	245	0	0	258
	Total		130	442	248	274
South Atlantic – Gulf	North Carolina	0	226	108	205	539
	South Carolina	0	35	22	0	57
	Georgia	0	0	7	0	7
	Florida	0	93	153	47	293
	Alabama	0	0	33	0	33
	Mississippi	0	0	6	37	43
	Puerto Rico	0	2	5	0	7
	Virgin Islands	0	0	0	2	2
	Total		0	356	334	291
L. Miss. Valley Texas Gulf Great Lakes	Louisiana	0	29	0	0	29
	Texas	2	13	47	33	95
	New York	0	0	0	17	17
	Pennsylvania	0	6	0	0	6
	Ohio	0	12	12	1	25
	Michigan	33	60	11	0	104
	Indiana	0	10	0	3	13
	Illinois	0	11	0	0	11
	Wisconsin	0	29	0	0	39
	Minnesota	0	1	0	0	1
	Total		33	139	23	21
California	California	21	23	23	14	81
North Pacific	Oregon	0	13	0	52	65
	Washington	0	3	3	2	8
	Total	0	16	3	54	73
Alaska	Alaska	0	0	0	95	95
Hawaii	Hawaii	4	12	13	2	31

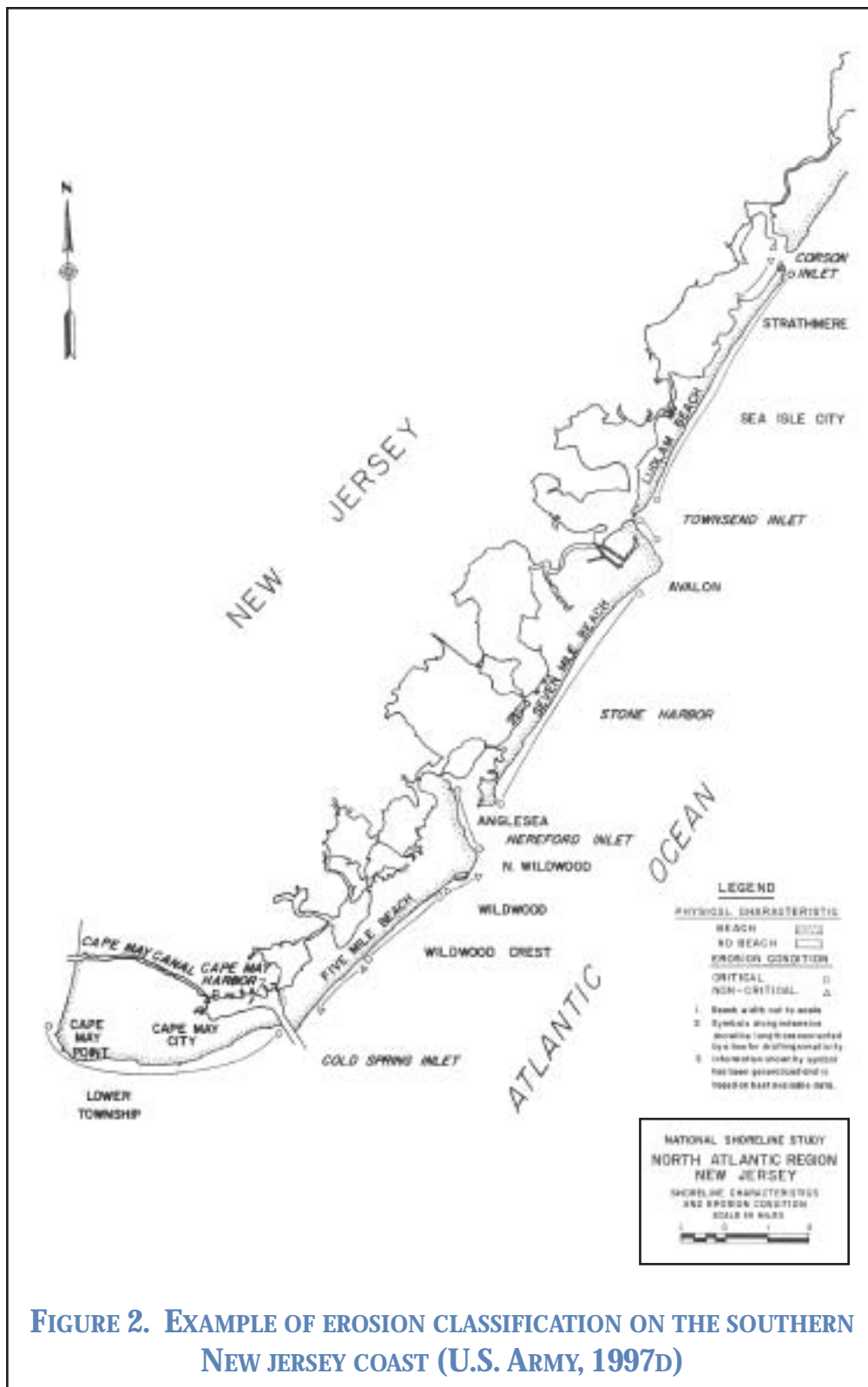


FIGURE 2. EXAMPLE OF EROSION CLASSIFICATION ON THE SOUTHERN NEW JERSEY COAST (U.S. ARMY, 1997D)

one showing land use and ownership (U.S. Army, 1971g). Critical erosion areas were signified as a red line, non-critical erosion by a green line and non-erosion by no color for the Texas Coast Shores (Figure 5).

For the North Atlantic Region (U.S. Army 1971d) and South Atlantic-Gulf Region (U.S. Army, 1971e), two maps were presented for each shoreline segment, one showing the shoreline characteristics and erosion condition and the other showing ownership and land use. On the erosion condition maps, the shoreline reach between the circles represented critical erosion, between the triangles represented non-critical erosion and no symbol areas were considered non-eroding (Figures 2 and 3).

Four separate maps were presented for the Lower Mississippi Region, showing physical characteristics, historical shoreline changes, shore ownership and shore use. Critical erosion was signified by a red line, non-critical erosion by a yellow line and non-erosion by a green line for the Lower Mississippi Region (U.S. Army, 1971f) on their historic shoreline change maps (Figure 4). Two maps were provided for the Texas coast, including one depicting the sandy beaches and areas of erosion and

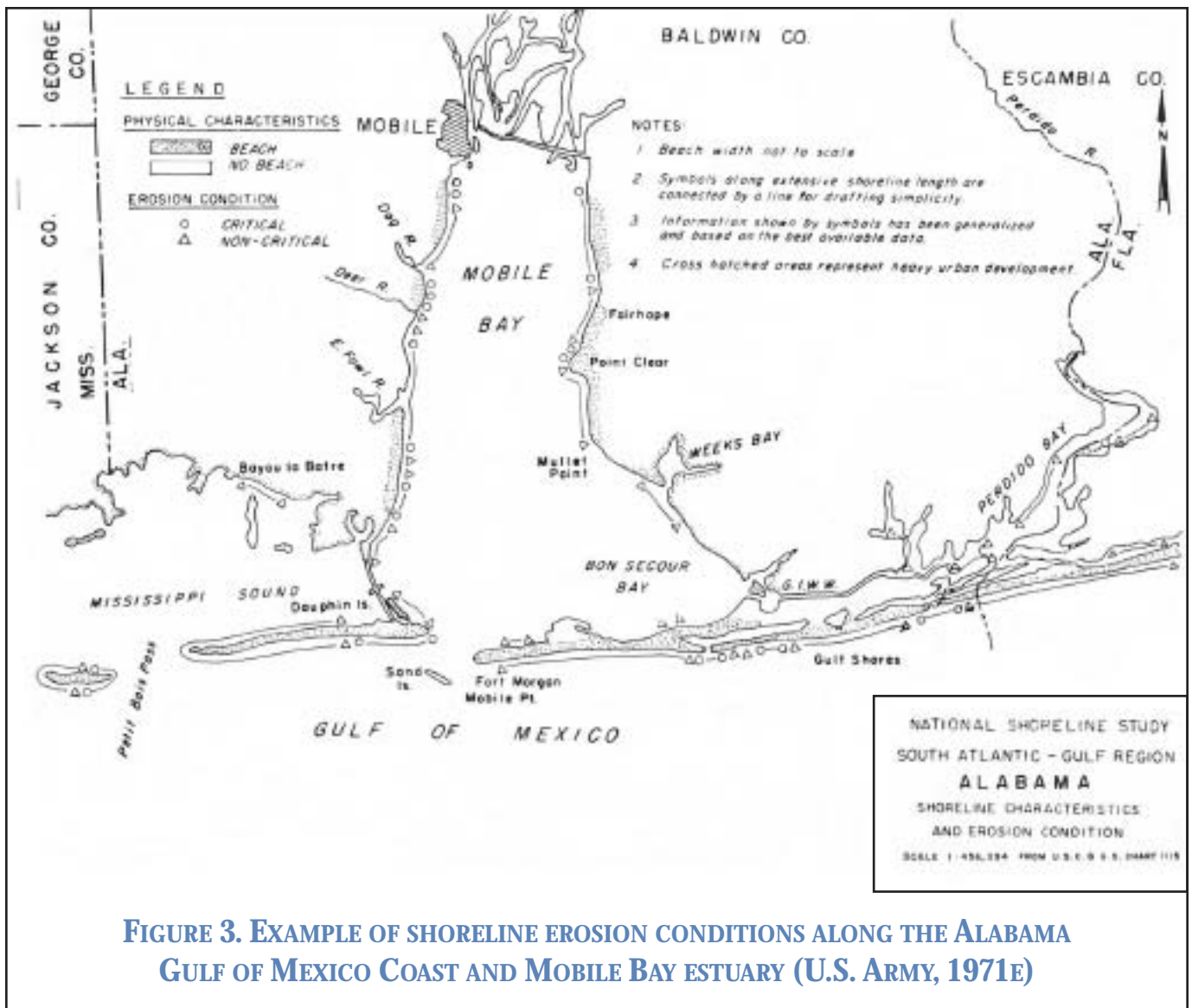


FIGURE 3. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE ALABAMA GULF OF MEXICO COAST AND MOBILE BAY ESTUARY (U.S. ARMY, 1971E)

The Great Lakes report used survey information on shore descriptions and other data collected for an International Joint Commission (IJC) study of the entire Great Lakes shoreline, including the Canadian coast (U.S. Army 1971h). These erosion maps included three maps for each reach. The reaches were selected on the basis of the Great Lakes Regional Study planning subareas (U.S. Army 1971h), which included one on shoreline use, one on environmental values, water

intakes and waste outfalls, and one on physical description, ownership, and erosion and flooding problems (Figure 6). Five categories of erosion areas were provided on the physical description maps indicating shorelines that are protected (black line), unprotected critical erosion (red line), unprotected non-critical erosion (brown line), shoreline subject to lake flooding (blue line) and shoreline not subject to flooding (white line).

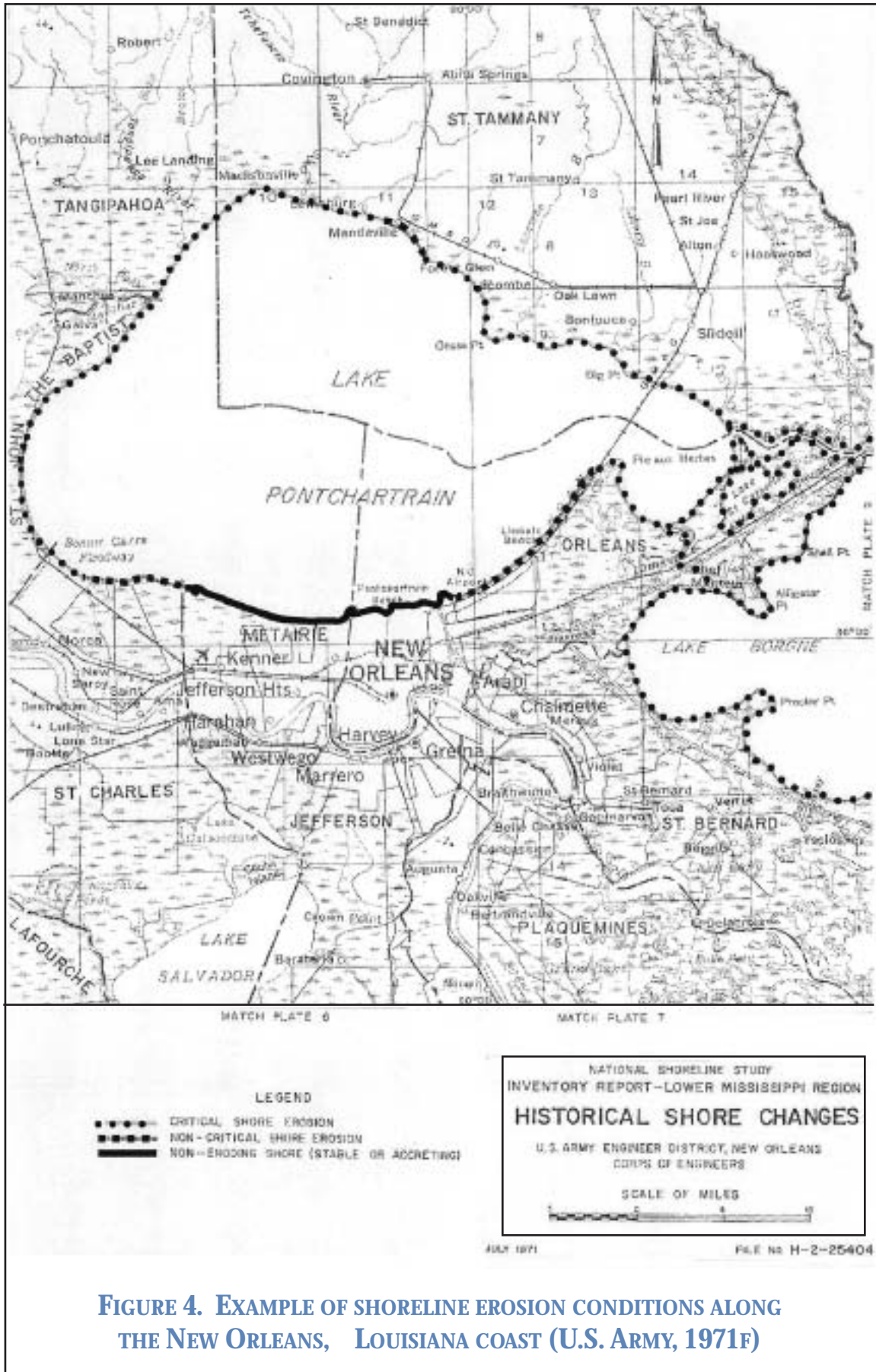


FIGURE 4. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE NEW ORLEANS, LOUISIANA COAST (U.S. ARMY, 1971F)

No definite rules or quantifiable criteria were developed to identify and evaluate the critical erosion areas along the California coast (U.S. Army 1971i). This can also be said for all the other regional reports. Three separate maps were presented for each of 21 segments of the California coast. The maps showed ownership and use, parks and shore protection, and what might be termed, shoreline and classifications (Figure 7). Much of the critical area designation on

erosion effects was identified from records of requests for shore protection by cities, counties and other groups and existing authorized Federal projects. The symbols were different on these maps such that the critical erosion was designated by triangles, an unfilled box designated sections of coast that were classified as non-critical erosion and circles were used for areas of non-eroding shorelines.

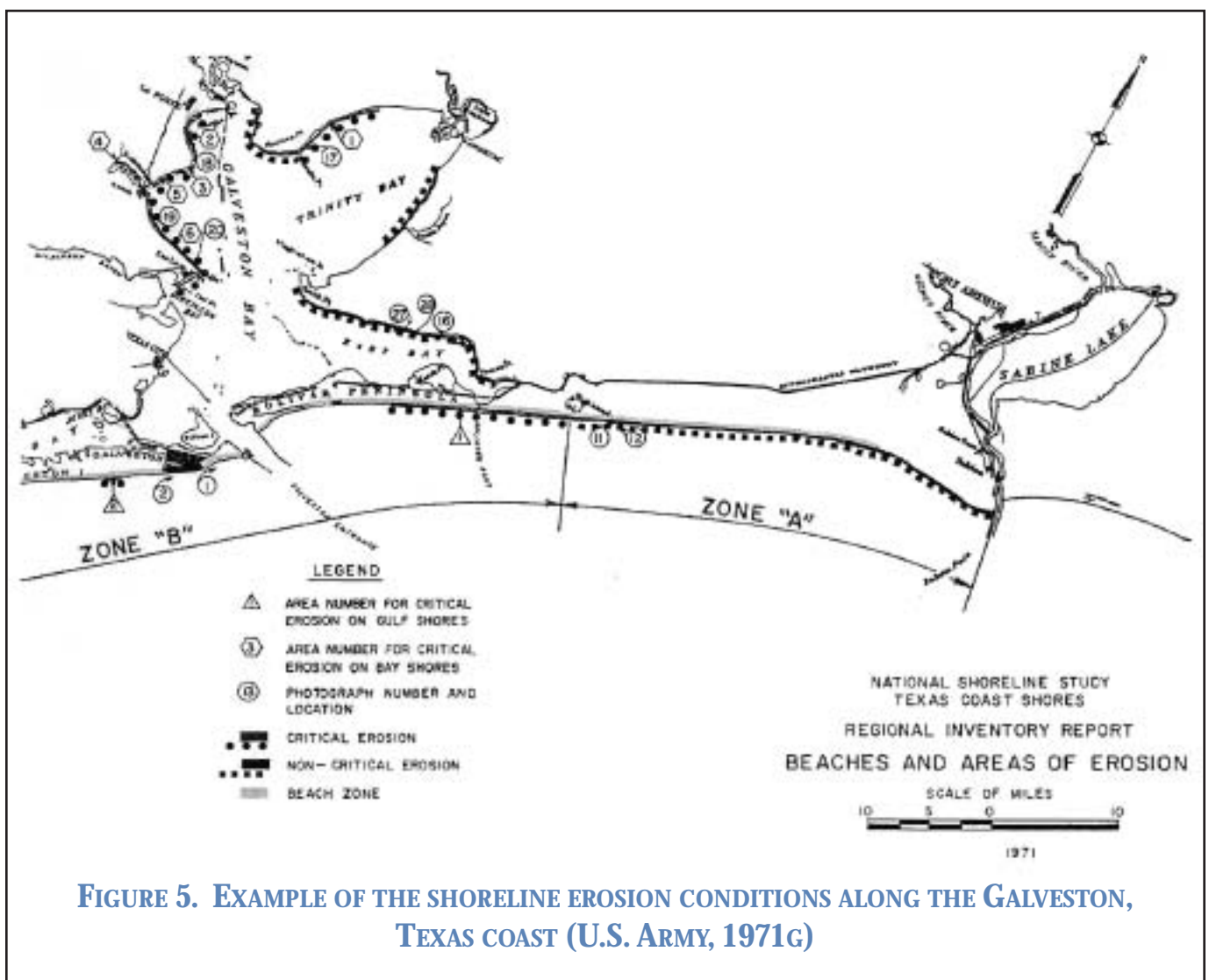
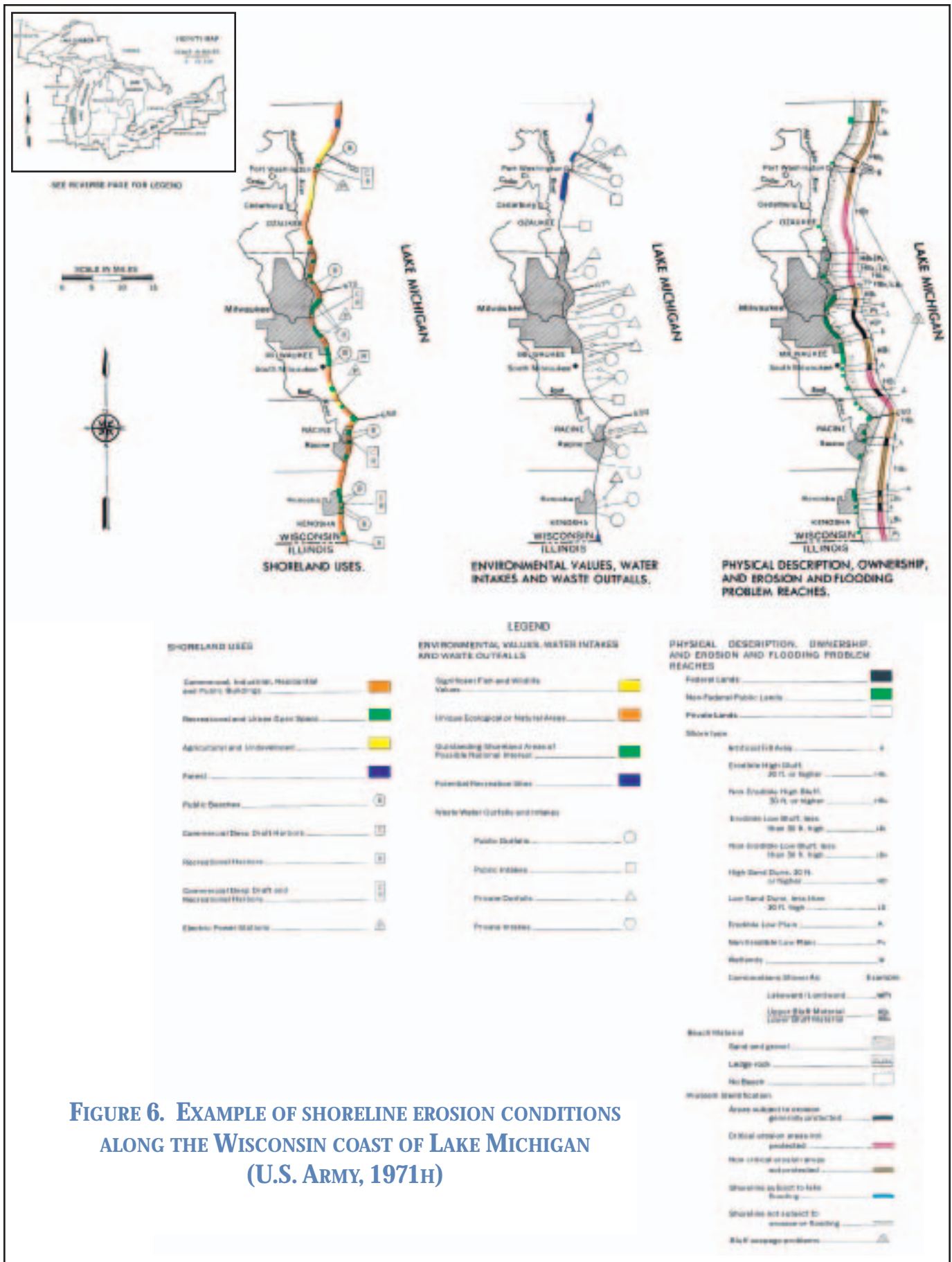


FIGURE 5. EXAMPLE OF THE SHORELINE EROSION CONDITIONS ALONG THE GALVESTON, TEXAS COAST (U.S. ARMY, 1971G)



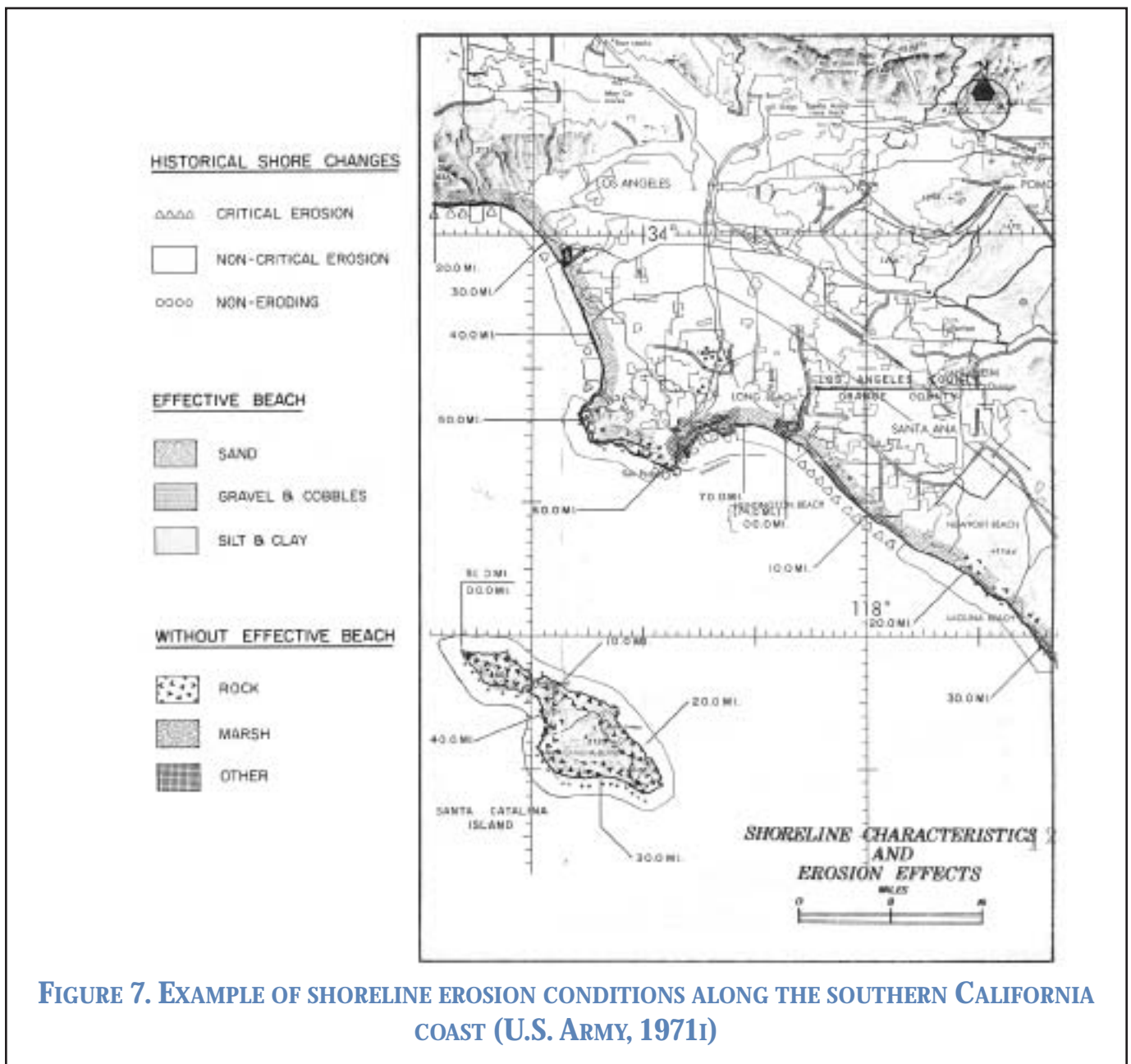


FIGURE 7. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE SOUTHERN CALIFORNIA COAST (U.S. ARMY, 1971i)

For the Report on the Columbia-North Pacific Region of Washington and Oregon, the Corps used aerial photography, reports from State and local agencies, information from local requests for erosion control projects and District reports in its determination of erosion areas (U.S. Army, 1971j). Two maps were provided for each segment of shoreline, one covering the physical characteristics and historic shore changes and one showing shore ownership and use. As shown in Figure 8, they used a dashed line to identify critical erosion areas, a wavy line to show non-critical shorelines and no symbol for non-eroding coastal areas.

The coastline of Alaska was discussed in general terms due to the large extent of the coast, much of which limited information is available. The report focused on the details around populated areas only (U.S. Army, 1971k). Shore ownership was presented in a single map and five regional maps were presented to show the erosion areas (Figure 9). They did not identify individual stretches of the shoreline as in the other regional reports, but listed city names of areas that have reported erosion problems, based on a questionnaire that was mailed to the towns. Most of the erosion problems were listed as individual homes threatened by erosion. The homes ranged from little

fishing shacks in villages to large shorefront homes in the few urban coastal areas of the state






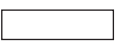


An inventory of the coastal areas was reported for six of the eight principal islands of the State of Hawaii. Two of the islands had a majority of their shoreline not accessible to the general public and these were not included in the inventory. Only the shores in developed areas were presented (U.S. Army 1971). Five types of maps were presented for each of the six islands. One map showed the shoreline physical characteristics (type of sediment or rock), one presented shoreline land use, one showed land ownership, one showed coral reef locations exposed at mean lower low water and one depicted erosion areas along with the type of sediment, rock or artificial structure (Figure 10). Critical erosion was identified as a triangle with a number of feet of shoreline affected, while non-critical erosion was identified by a circle with a number of feet of shoreline included in this classification.

SUMMARY

At a primary level, the 1971 National Shoreline Study provided a general assessment of the state of the

Nation's shorelines in terms of erosion and areas in need of protection. The nine regional reports all followed the basic shoreline erosion identification scheme using the three criteria of critical erosion, non-critical erosion and non-erosion. However, the methods of presentation varied between the nine reports, as seen in examples of each map that depicted erosion and the lack of definitive rules or quantifiable criteria to choose the three categories may have lead to the variations in the presentation of the different shore types. Table 3 summarizes the variability between the nine reports on how they reported shoreline erosion and shoreline types. The limited historic shoreline change studies at the time of the National Shoreline Study limited any quantifiable assessment of comparable rates of shoreline retreat. As stated in all of the reports, the main criteria to pick a critically erosion classification was based on degree of shoreline development and threat to property, infrastructure or significant resources. With more development, more pressure is placed on maintaining the shoreline position and protecting the upland infrastructure. Non-critical erosion areas were listed as also being important, particularly for predicting future development and need to protect the shoreline.

TABLE 3. INFORMATION PRESENTED AND CRITERIA AND SYMBOLS USED IN THE SHORELINE INVENTORY REPORTS

	Maps Prepared	Critical Eroding	Non-Critical Eroding	Non-Eroding	Sources of Info
NORTH ATLANTIC	2 maps for each 33 reaches *Shoreline Char + Erosion *Ownership + land use	○-----○	△-----△	No Symbol	District and Divisions State review, local and other Federal, state agency coord.
SOUTH ATLANTIC	2 Maps for each reach *Shoreline Char + Erosion *Ownership + land use	○-----○	△-----△	No Symbol	Contribution and review from Districts, other Federal, state, local agencies and institutions.
LOWER MISSISSIPPI REGION	4 maps each of 7 zones *Phys. Char. * Hist. Shoreline Change *Shoreline Ownership *Shoreline Use				Federal, state, parish and local agency data and review
TEXAS	2 Maps each of 3 segments *Beaches + areas of erosion *Landuse + ownership			No Color	Interviews w/Federal, state, county, city officials, and private land owners
GREAT LAKES	3 maps for each reach *Shoreline Use *Env. Values, water intakes + outfalls	Protected—Black Unprotected—Red	Subject to flooding—blue Unprotected—Brown	No Color	Aerial photographs, USGS quad sheets and IJC, Federal, State, local agencies and university reports
CALIFORNIA	3 maps each of 21 Segments: *Ownership + use * Parks + Shore Protection *Shoreline Char. + "erosion effects"	△△△△△△		o o o o o o	Records of requests for SP by cities, counties & others; locations of Federal projects districts, Division, state and local data sources
NORTH PACIFIC	2 maps each of 8 segments *Phys. Char. + historic shorelines *Shore Ownership + Use	-----	~~~~~	No Symbol	Aerial photocopy State and local reports Records of SP requests Distance Info
ALASKA	*Shore Ownership *5 regional maps showing erosion areas	-/-/-/ Listed city w/ erosion problem			Details only around populated areas. Erosion based on local request for SP
HAWAII	For each island: *Shoreline Characteristics *Land Use *Ownership *Coral reef exposed *Erosion areas w/type of sediment, rock, or artificial structure			No Symbol	Previous reports by District, State and local agencies and universities for 6 of 8 principal islands.

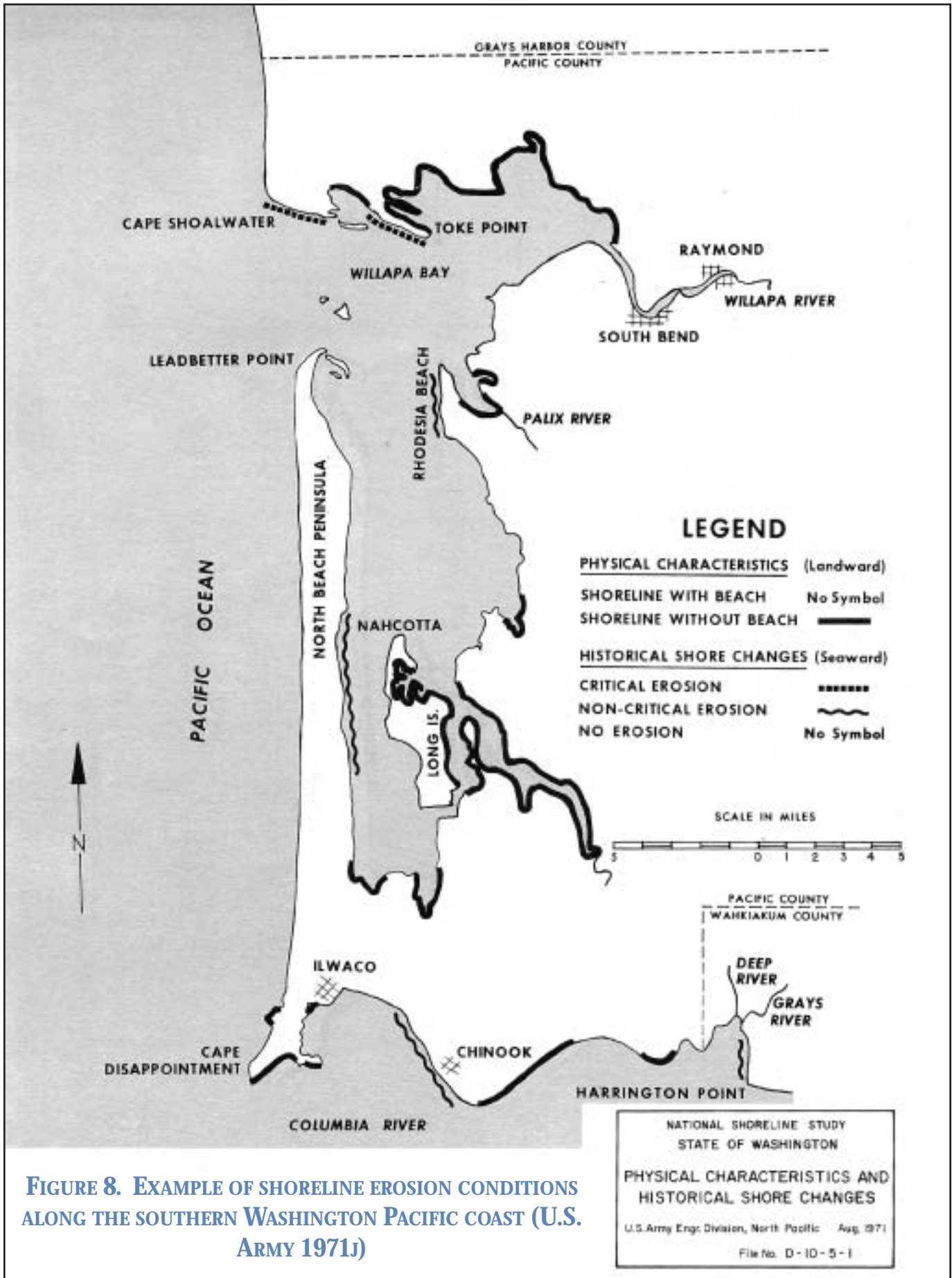


FIGURE 8. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE SOUTHERN WASHINGTON PACIFIC COAST (U.S. ARMY 1971j)



FIGURE 9. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE SOUTHERN ALASKAN COAST (U.S. ARMY, 1971k)

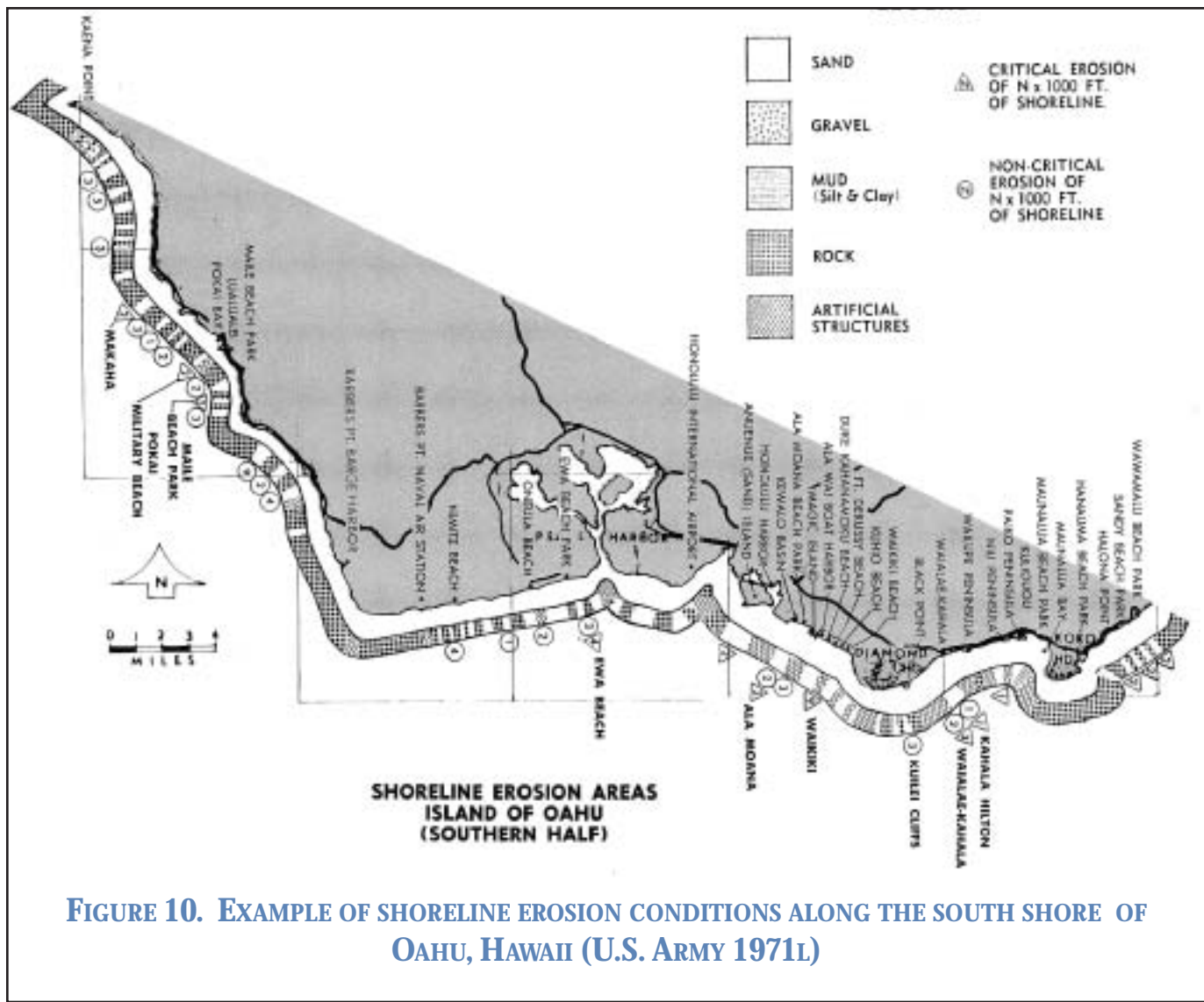
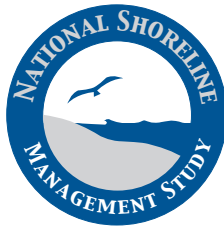


FIGURE 10. EXAMPLE OF SHORELINE EROSION CONDITIONS ALONG THE SOUTH SHORE OF OAHU, HAWAII (U.S. ARMY 1971L)



ASSESSMENT OF RELEVANCE TO NSMS

The criteria used in the NSS were applied in a non-quantitative manner subject to interpretation by each regional group. Critical erosion was identified by judgment and was subject to interpretation. These maps were produced without the benefit of shoreline change maps that are readily available for most areas of the U.S. coast today. More recent large-area studies on shoreline change include an assessment of all U.S. coastal erosion and accretion (Dolan, et al., 1985) and coastal hazards (Anders, et al. 1985), historical shoreline change along the Gulf of Mexico coast (Westphal, et al., 1991), and a compilation of shoreline types and erosion and accretion patterns for the Great Lakes (Pope et al., 1999). Many coastal states have compiled measurements of erosion and accretion and shoreline change patterns on a statewide basis. Most of these present studies on shoreline change were completed well after the 1971 study. The National Shoreline Management Study can conduct a more comprehensive analysis and apply uniform and specific criteria to determine extent of erosion and accretion.

The criteria used in the 1971 National Shoreline Study were subject to interpretation by each regional group

Erosion is a function of several factors including shore type, geology, coastal processes, proximity to inlets, storm frequency, sediment supply and wave energy. The highest variability both temporally and spatially in shoreline change was associated with unconsolidated coasts adjacent to inlets as found in a study of four areas of the U.S. shoreline in the 1980's—the NOAA/National Ocean Survey-Corps Coastal Engineering Research Center Cooperative Shoreline Movements Study (Everts, et al., 1983; May and Barwin, 1985; Anders, et al., 1990). Stable shores were related to consolidated rocky coasts and sandy areas away from inlet influence. The influence of development on the coast was an important part in the determination of critical erosion in the NSS. But, even on coasts with relatively stable natural shorelines, slight erosion of the beach can place intense pressure on authorities to protect heavy development that was placed too close to the shore. The rate of shoreline recession may be lower than on an undeveloped shore, but require a higher priority in providing storm protection and erosion control. New initiatives in environmental restoration may also change the concept of critical erosion.



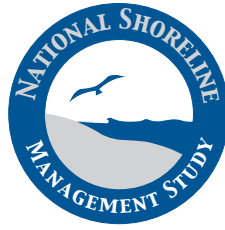
CONCLUSIONS

There is much more interest in the coastal engineering and coastal zone management community for understanding shoreline change and its effects on the upland infrastructure today. Coordination among Federal agencies is an important issue with new responsibilities being placed on several government agencies to preserve and protect the coast. The 1971 National Shoreline Study provided information on Shore Erosion, Shore Protection and Shore Management. Within its nine regional reports it identified areas of critical erosion, non-critical erosion and stable shorelines. Based on a complex criteria of rate of erosion, economic factors, industrial use, recreational use, agricultural use, navigational needs, demographic distributions, and ecological impacts as well as projected population and land use demands on that particular stretch of shoreline to the year 2020, effects of past and continued erosion on environmental values, ownership, and constraints on land use regulations about 3.2% of the total nation's shoreline was identified as "critically eroding". Another 21.1% of the Nation's shores were identified as non-critical erosion, meaning that these parts of the coast experienced erosion but shore protection was not economically justified at that time, based on the above criteria. The remaining 75.7% of the Nation's shoreline was characterized as stable.

Much has changed since the 1971 National Shoreline Study, with continued growth and development pressures on the Nation's coastal areas. Many hard and soft shore protection projects have been constructed since 1971 along the critically eroding shorelines. Storm processes have impacted the coast and formed or modified the geomorphology of the

shore, with new inlets, breaches and overwash areas. Construction of dams has limited the sediment supply to the coast and has created new erosion or accretion patterns along the shoreline. A new set of national guidelines is needed to identify the extent and causes of shoreline change (erosion and accretion) on a more quantitative basis. The National Shoreline Management Study will benefit from a close working relationship among the Federal agencies and coastal States. Several states have developed extensive programs with shoreline change maps, erosion rates and even designations of "critically eroding" shoreline segments. Erosion rates are now available for most of the coast and a value can be picked to represent recession at a critical level.

Coastal development and other criteria will need to be identified to differentiate the potential economic and environmental implications of shoreline change. The goal is to improve the identification of the extent of and economic and environmental effects of shoreline erosion and to describe the systematic movement of sand along the shorelines. The 1971 National Shoreline Study collected much needed data on the state of the nation's shoreline. Many of the processes and areas of erosion and accretion are still active today but new information and data processing techniques are now available to update and better quantify the shoreline change processes. With this new information, better recommendations can be made regarding the level of Federal and non-Federal participation in shore protection and improve our ability to better manage sand resources along the nation's coasts.



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13. ABSTRACT (Maximum 200 words) This report reviews the 1971 National Shoreline Study (NNS) for methodology and criteria in determining critical, non-critical and stable shorelines. The NSS was the first nationwide study to examine existing Federal shore protection programs and document the magnitude of erosion. Three reports were produced on shore erosion, shore protection and shore management. Nine regional reports identified areas of critical or non-critical erosion, and stable shorelines along the U.S. Atlantic, Pacific, Gulf of Mexico and Great Lakes coasts, including Alaska, Hawaii and Puerto Rico. The study identified 4,344 km (2,700 miles) of critically eroding shores (about 3.2% of the total shoreline), located along mostly extensively developed areas, especially in the densely populated North Atlantic Region. The regional reports all followed basic erosion identification schemes using the three criteria, but methods of presentation varied due to lack of definitive rules or quantifiable methods. Limited shoreline change studies at the time, restricted any quantifiable assessment of shoreline retreat. The main criteria to pick a critical erosion classification were based on degree of shoreline development and threat to property, infrastructure or significant resources. Criteria used in the NSS were applied in a non-quantitative manner, subject to interpretation by each regional group.

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