The Center for Marine and Coastal Studies — North Carolina State University

A SURVEY OF NORTH CAROLINA BEACH EROSION BY AIR PHOTO METHODS 1973

By
H. E. WAHLS

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H. E. Wahls
Professor of Civil Engineering

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Negatives of the aerial photographs for November, 1971, were made available by the U. S. Army Coastal Engineering Research Center, Washington, D. C. Prints were obtained from these negatives through the cooperation of the Photogrammetry Section, North Carolina State Highway Commission.

The detailed measurements and computations of erosion data were performed by Mr. Ralph Gordon, graduate assistant in civil engineering. Dr. Donald B. Stafford, Clemson University, who conducted the original 1968 study, assisted by providing useful advice and information at the start of the investigation

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

A beach is a transient feature which is continually eroding or building up as a result of the action of wind and waves. Knowledge of the patterns of coastal erosion is essential to the safe and orderly development of a coastal region. This is particularly true for coastal North Carolina which is currently undergoing rapid development. If this development is allowed to proceed without consideration of potential beach erosion, severe economic losses are likely to be incurred by both private owners and the public.

An indication of the potential future erosion of a beach can be gained from a study of the history of erosional patterns along that beach. Aerial photographs provide an ideal means for studying the erosional history of an area. Each aerial photograph records the location of the beach, as well as related cultural and natural features, at a specific time. Comparisons of the positions of the shoreline in photos taken at different times will indicate the amount of erosion for the time interval between the two photographs. Such investigations can be conducted for any time periods for which aerial photography is available.

Specific techniques for beach erosion studies from aerial photographs were developed and applied to the North Carolina coast by Stafford in 1968. The results of this study were presented in the report, "A Reconnaissance of Coastal Erosion in North Carolina", by Langfelder, Stafford, and Amein. Mean annual rates of erosion and accretion were presented for the entire time period of available photography and for each incremental time period between successive photos. For the southern coast from Brunswick to Beaufort Inlet, photography dating back to 1938 generally was available. North of Beaufort Inlet, the earliest available photos were made in 1945. The date of the most recent photography used in that investigation varied with the county and ranged from 1961 to 1966.

Because of the demonstrated value of the beach erosion data, in the summer of 1972, it was deemed advisable to update the survey. The work was jointly sponsored by the Office of Water and Air Resources, Department of Natural and Economic Resources of the State of North Carolina, and the Center for Marine and Coastal Studies, North Carolina State University. New aerial photographs were obtained of the entire North Carolina coast. For Brunswick, New Hanover, and Pender counties, excellent quality photos taken in January and February of 1972 were available from the U. S. Department of Agriculture. For the remainder of the coast, photos for November, 1971, were obtained from the U. S. Army Corps of Engineers. These photos were generally of small scale and poorer quality than the Department of Agriculture photos. Using these new photographs, the techniques of the original study were employed to compute a new increment of erosion data for the entire coast and to revise the data reported in the original study. Thus this report includes the results of the original study as well as new data for the time interval since the publication of the original report.

METHODOLOGY

The present study essentially used the methods presented by Langfelder, Stafford, and Amein (1968), and elsewhere, but eliminated some measurements and computations which had not proven meaningful in the initial study. These techniques and modifications will be reviewed briefly in the following paragraphs. In addition, some of the limitations of the method will be indicated.

To determine the rate of erosion for a specific time interval, fixed reference points, which can be clearly identified in aerial photographs at both the beginning and the end of the time period, were established at approximately 1000-foot intervals along the beach. Road intersections, utility poles, and corners of permanent structures were used as reference points. The distances from each reference point to the dune line and the high water line were measured in each photograph. The difference in the position of the dune line and the high water line at the beginning and end of the time interval is the amount of erosion or accretion during the interval. If the total change in position is divided by length of the time interval in years, the average rate of erosion or accretion in feet per year is obtained for the interval. This procedure was repeated at each reference point for each time interval for which erosion rates were to be calculated.

The data for a series of reference points were averaged for specific sections of beach between inlets or other locations for which significant changes in erosional characteristics were anticipated. These mean annual rates of erosion or accretion are reported for each section of beach for the new time interval for which photography was available. The results for the new time interval were then averaged with the results from the 1968 report to obtain a new composite mean annual rate of erosion or accretion for the entire time interval of the original and the new studies. All computations were done by computer using the computer program developed by Stafford for the original study.

The air photo method for measuring coastal erosion is limited by the availability of aerial photographs, the quality of the available photographs, and the ability of the interpreter to identify the position of the dune line and the water line in the photographs. Relatively new photographs were available for the entire coast for the current study. However, there was considerable variation in the quality of the photographs. Excellent quality photographs were available for Brunswick, New Hanover, and Pender counties. For these counties, rectified enlargements to a scale of 1" = 400' were obtained. These enlargements have been corrected for various photogrammetric errors so that the scale is accurate and uniform for all photographs. For the remainder of the coast, the photographs were of poorer quality. The approximate scale of these photographs was 1" = 1000" and the scales varied by as much as 10% from one photograph to another. Smaller scale variations were present within an individual photograph because of the tilt of the camera. Finally, the imagery was not always clear; and in a few photographs, the beach line was partially obscured by cloud cover. Fortunately, all portions of the coast were visible in at least one photograph.

Measurements on the individual photographs were made to the nearest 0.001 inches, using a patented microrule. However, the actual field distance represented by the measurement on the photograph is significantly affected by the reliability of the scale. For example, if the scale of the photograph is 1" = 1000' plus or minus 10%, a one inch distance on the photograph could represent a real distance of 900' to 1100'. Such variability was not acceptable and the scale of each individual photograph was determined to a greater accuracy. The scale of individual photographs was established by measuring the distance between the fixed reference points in the new photographs and relating this distance to the distance between the same points in a previous photo of known scale.

Human error is introduced by the need to interpret the position of the dune line and the high water line. Usually the high water line can be identified by the distinctive change in color tone. However, the dune line frequently was subject to more interpretation. The dune line generally represents a point of abrupt change in slope which can be observed best by using stereo pairs. In some areas, the dune lines are very distinct, while in other areas, the dunes may have been removed by development or the dunes may be quite low. In these cases, considerable judgment was involved. In all cases, the position of the dune line in the new photograph was compared with the position in the earlier photographs to minimize errors due to differences in interpretation of the dune line by different individuals.

SUMMARY OF RESULTS

The significant results of the new study are combined with the results of the original study and presented in Figures 1-6. For purposes of presentation, the coast has been divided into six sections which are indicated on the index map in Figure I-1. Section 1 starts at the South Carolina line and succeeding sections progress northward with Section 6 ending at the Virginia line.

All results for each section are presented together in a series of four figures. For example, the results for Section 1, Brunswick County, are presented in Figures 1-a, b, c and d. Figure 1-a presents the composite data for the entire period of both studies, 1938 - 1972. Mean annual rates of erosion or accretion, in feet per year, are presented for both the dune line and the high water line. Figure 1-b presents the mean annual rates of erosion or accretion, in feet per year, for both the dune line and the high water line for the time interval of the new study, 1966-1972, for Brunswick County. Figures 1-c and 1-d are reprinted from the original 1968 report. Figure 1-c presents the data for the dune line for each time increment between successive photographs which were used in the original study. Figure 1-d shows similar data for each time interval for the high water line.

A similar set of 4 figures is presented for each of the six sections of the coast line. All results are presented in units of feet per year of erosion or accretion for the time intervals specified on the figures. In Figures 3b, 4b, 5b and 6b, the data for the most recent time interval are composites of the results of the new study and the data for the most recent time interval of the original study. This was done to minimize potential effects of the poor quality of the new aerial photographs, which were used for these sections.

The first figure for each section, e. g., Figure 1-a, for Brunswick County, provides the best indication of long term erosion or accretion trends. The second figure of each set, e. g., Figure 1-b for Brunswick County, can be compared with the first figure of the set to determine whether the behavior for the most recent time interval is significantly different from the long-term average for the section. The third and fourth figures of each set provide additional historical data on the consistency of the erosion or accretion patterns at a specific location.

Finally, it should be noted that the data presented in this report are indicative of long-term trends. However, short-term effects of severe storms are not indicated. Such short-terms effects could be studied by aerial photography if sufficient aerial photographs were available. This could be accomplished by having aerial photographs of the coast line made on an annual basis during a non-storm period. These photographs would provide base data on long-term trends, such as have been presented in this report. When the effect of an individual severe storm is to be studied, another set of aerial photographs would be made immediately after the storm and compared with the existing base photos. The monitoring of coastal erosion patterns on an annual basis would seem to be a highly desirable project for those agencies concerned with the control and the protection of the coastal regions.

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2. Stafford, D. B. (1968). "Development and Evaluation of a Procedure for Using Aerial Photographs to Conduct a Survey of Coastal Erosion", Unpublished Ph.D. thesis, North Carolina State University, Raleigh, N. C.

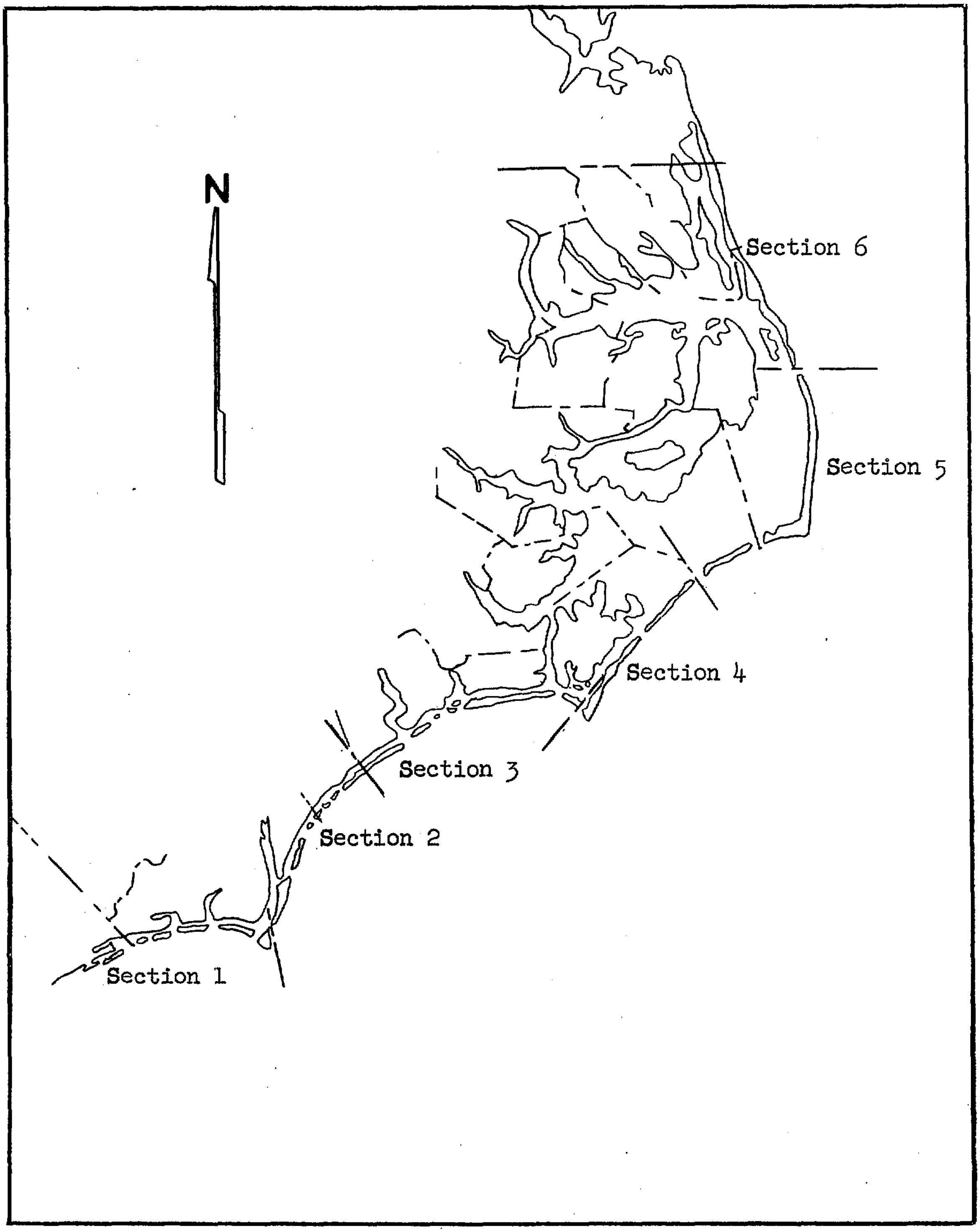

Figure I-1. Index map of sections used for presentation of erosion data.

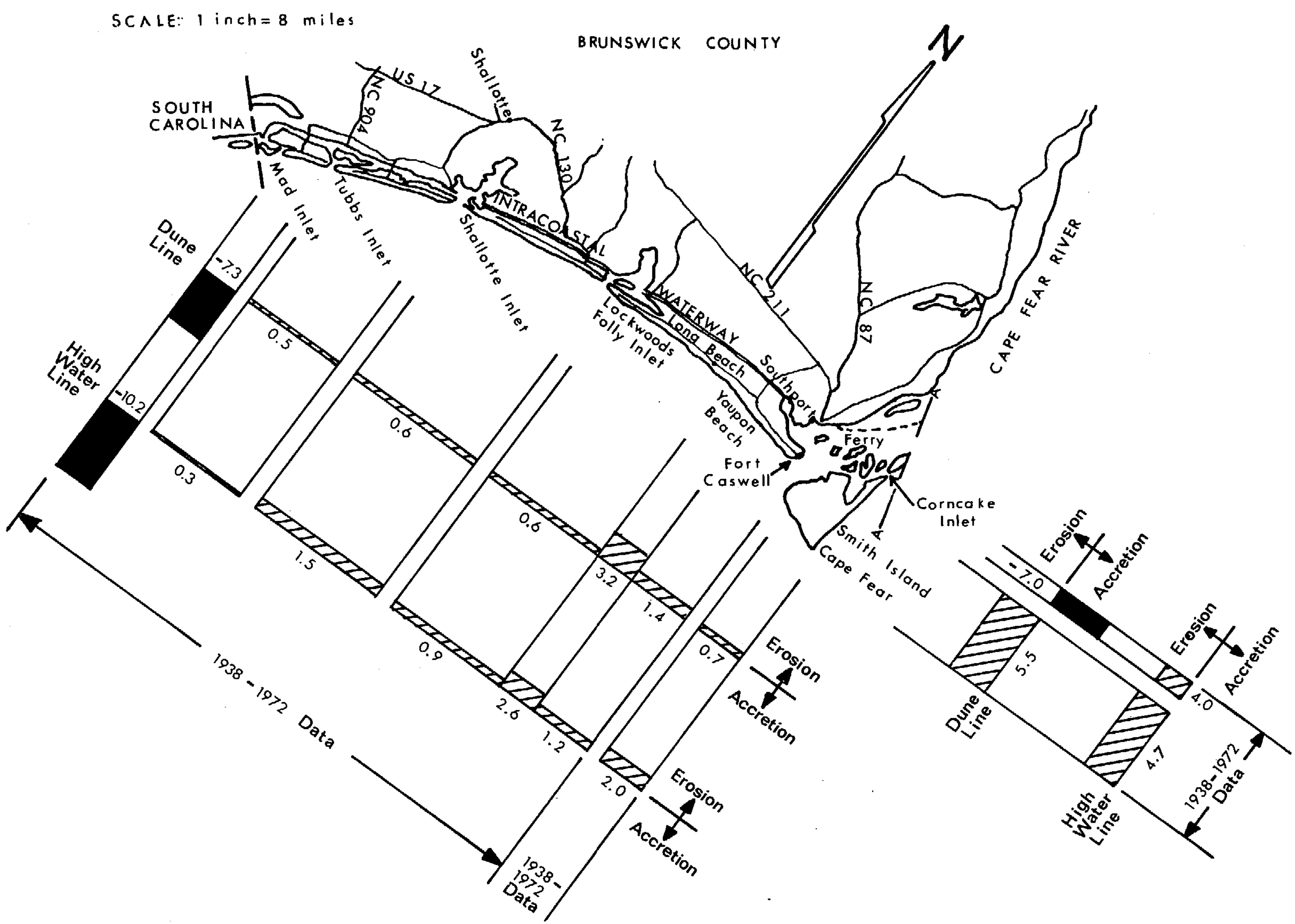

Figure 1. Brunswick County
(a) Dune line and high water line. Composite mean annual rates of change (feet per year) 1938-1972.

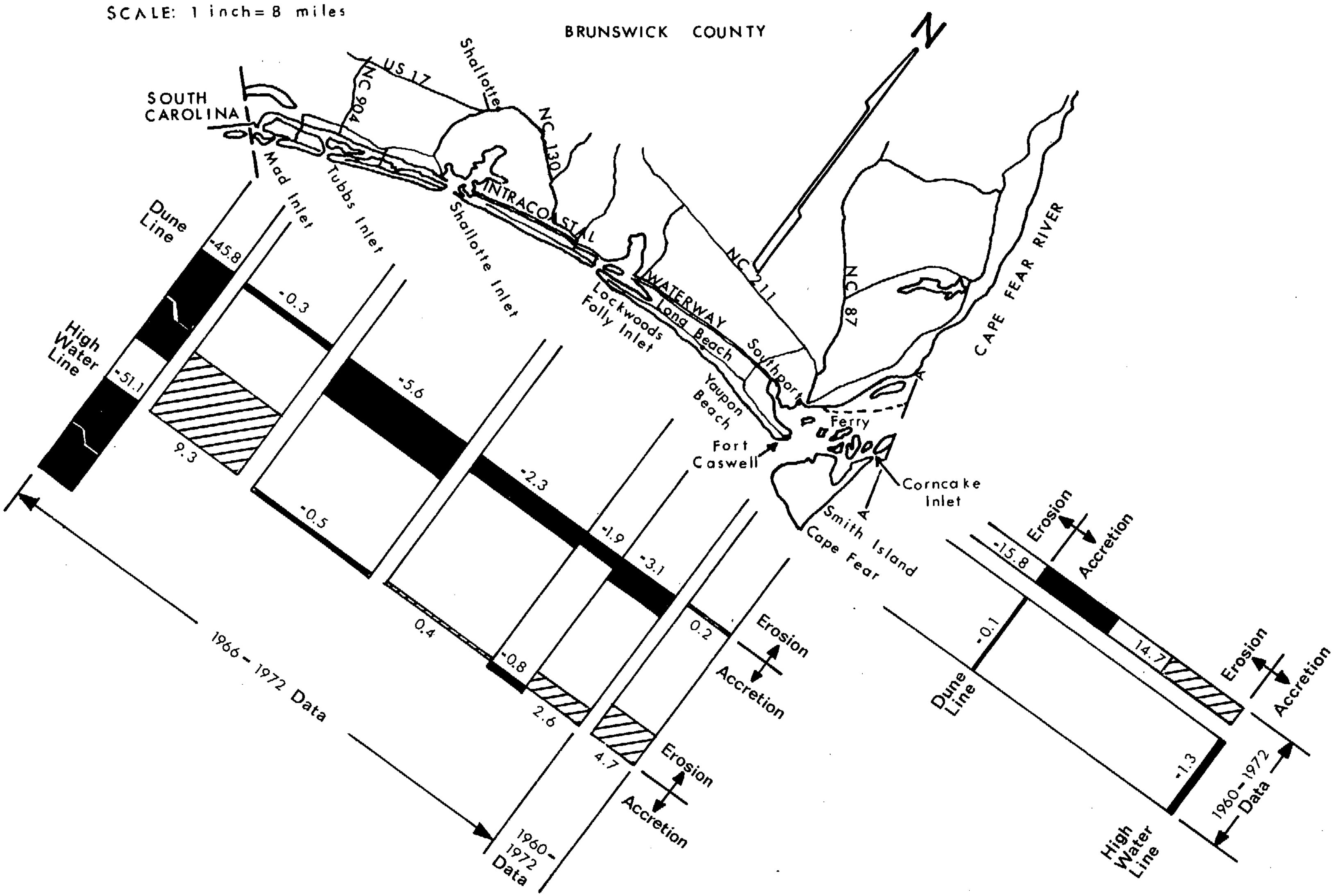

Figure 1. Brunswick County
(b) Dune line and high water line. Mean annual rates of change (feet per year) for most recent time interval, 1966-1972.

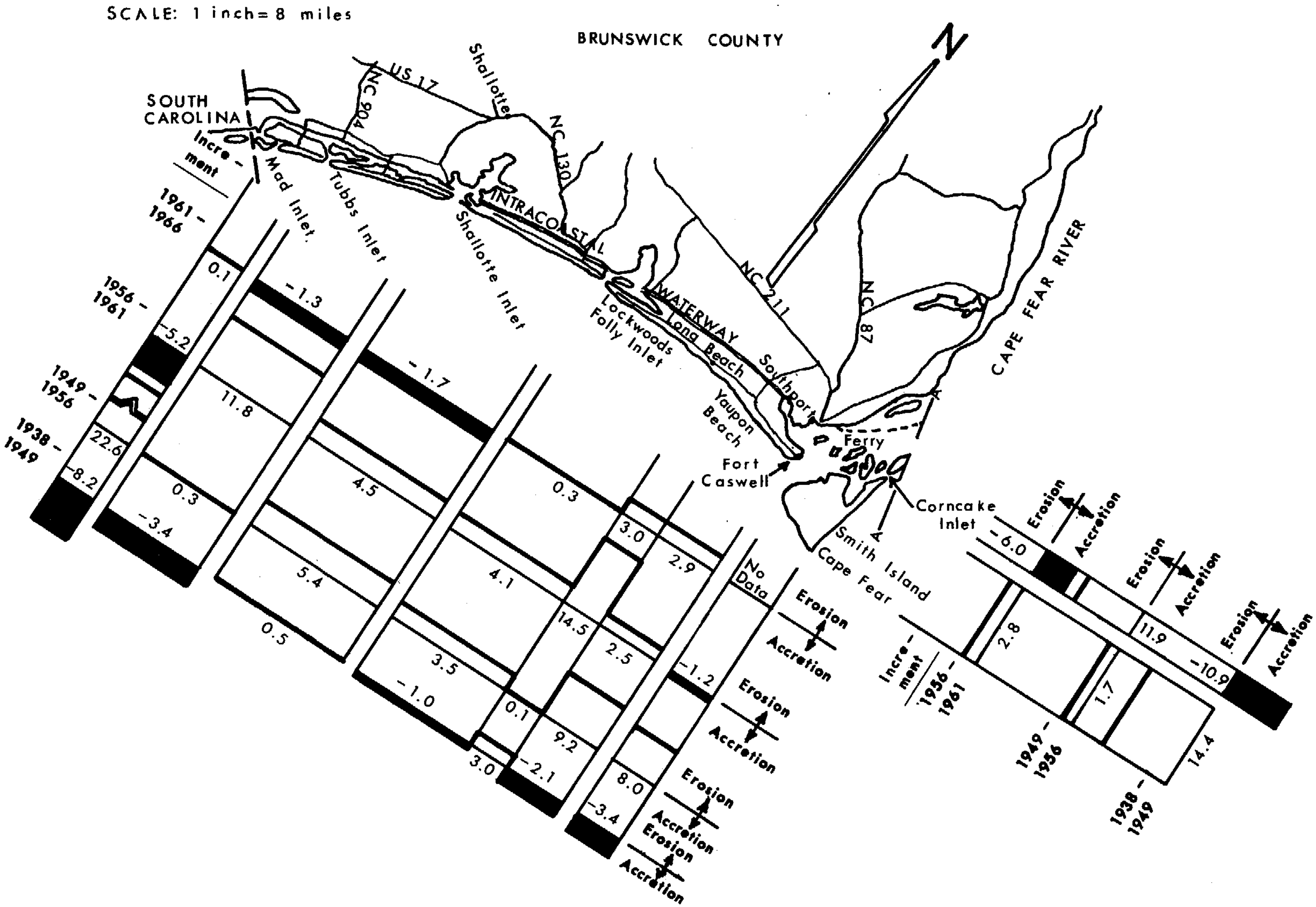

Figure 1. Brunswick County
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

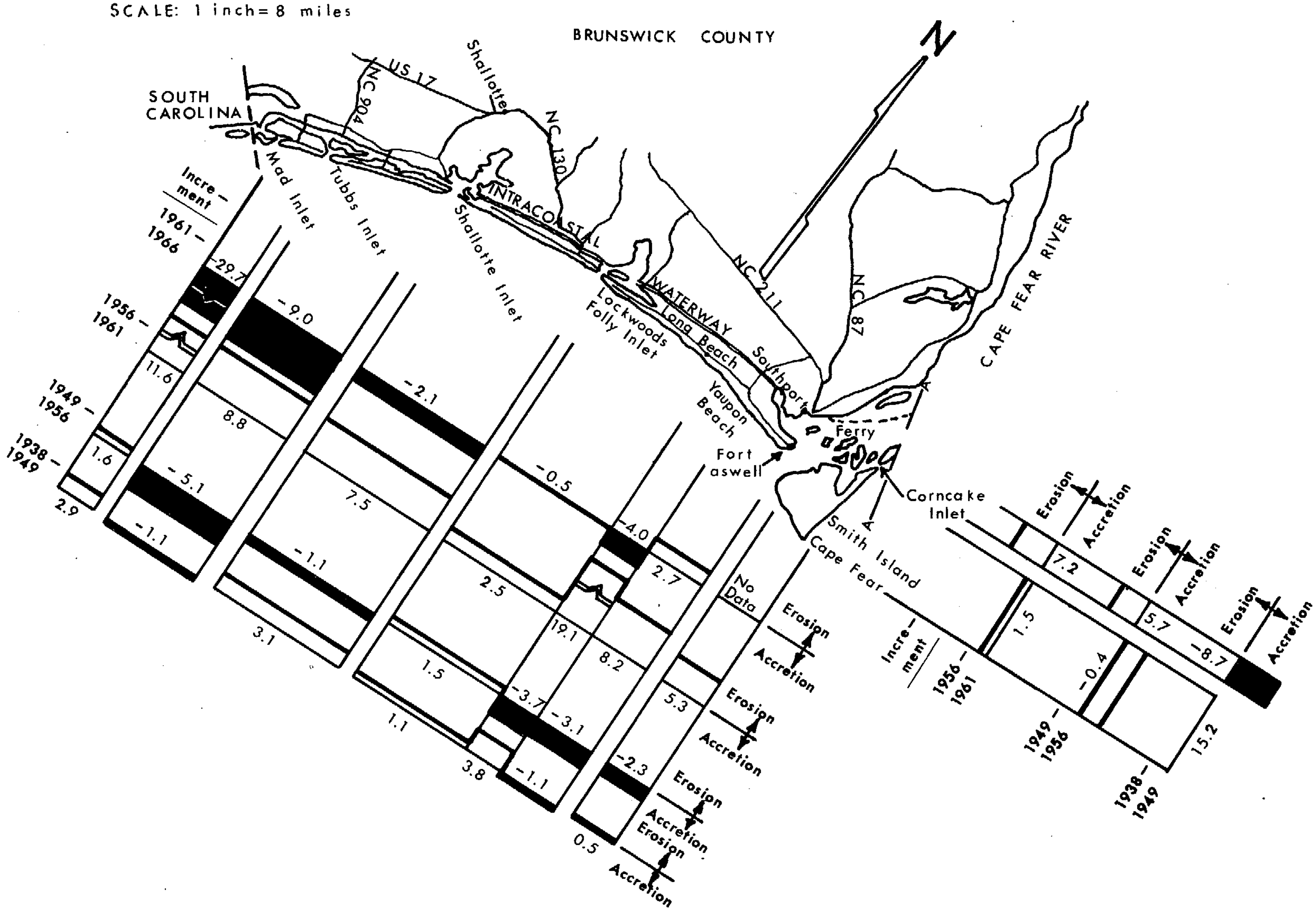

Figure 1. Brunswick County
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

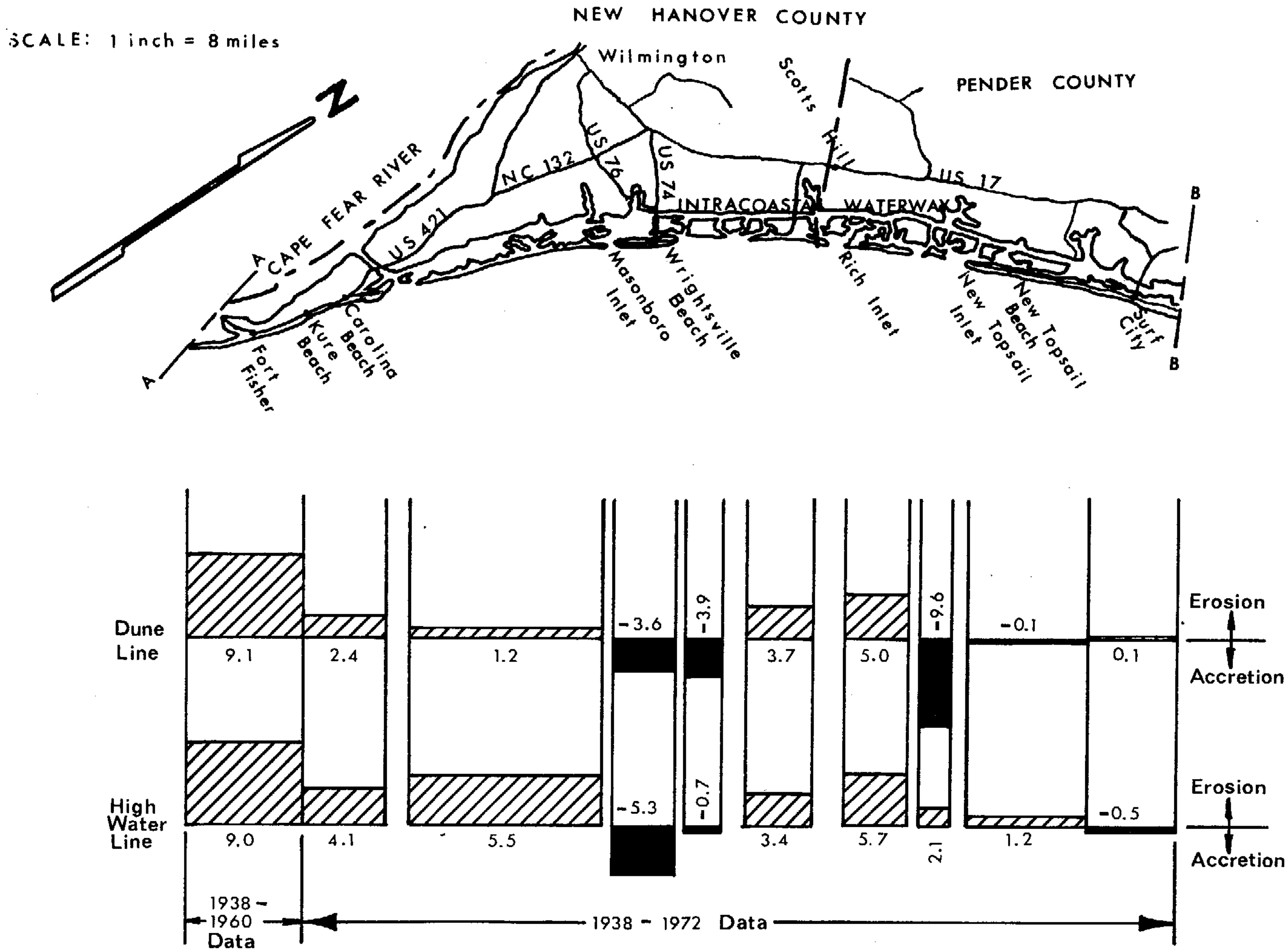

Figure 2. New Hanover and Pender Counties
(a) Dune line and high water line. Composite mean annual rates of change (feet per year), 1938-1972.

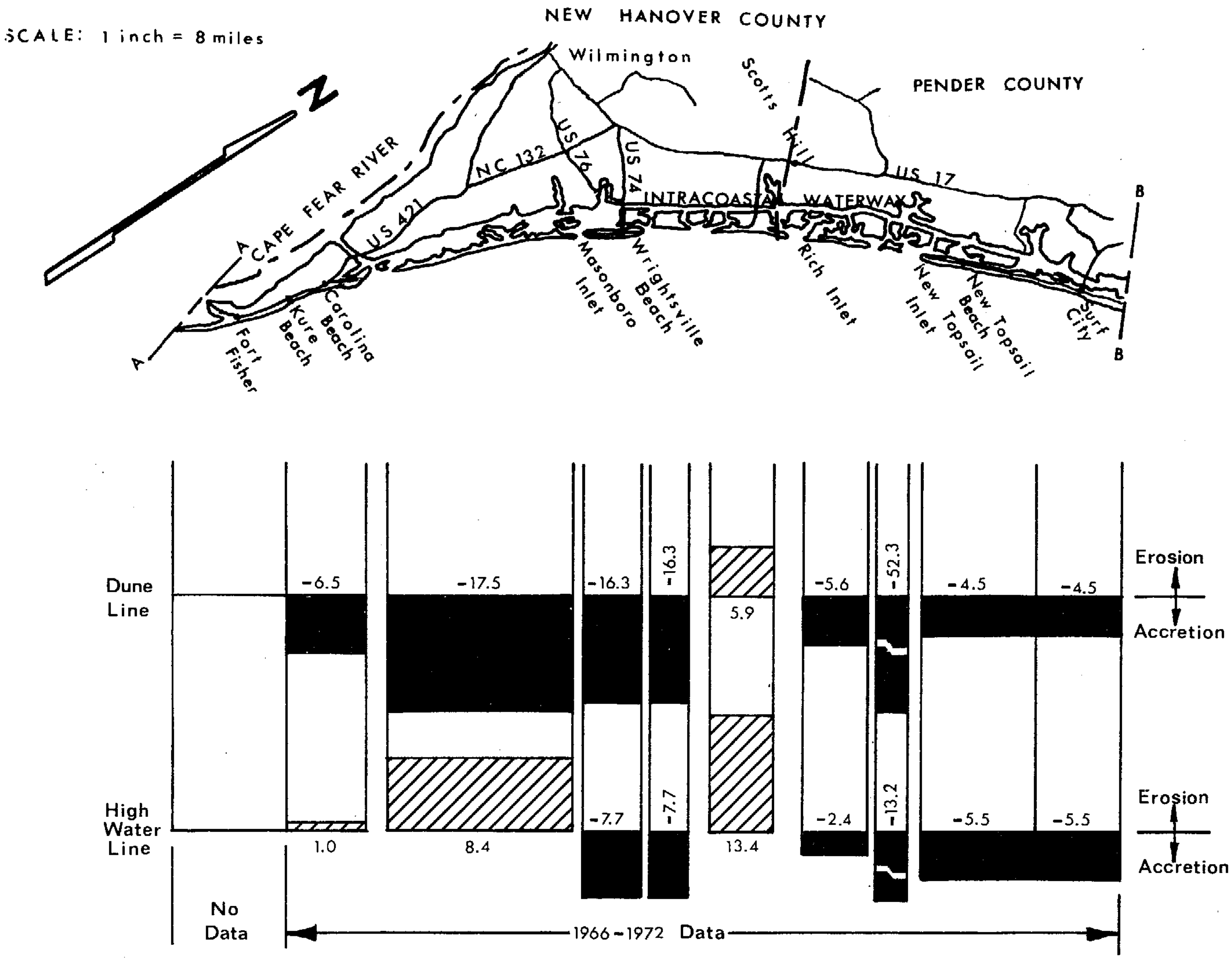

Figure 2. New Hanover and Pender Counties
(b) Dune line and high water line. Mean annual rates of change (feet per year) for most recent time interval, 1966-1972.

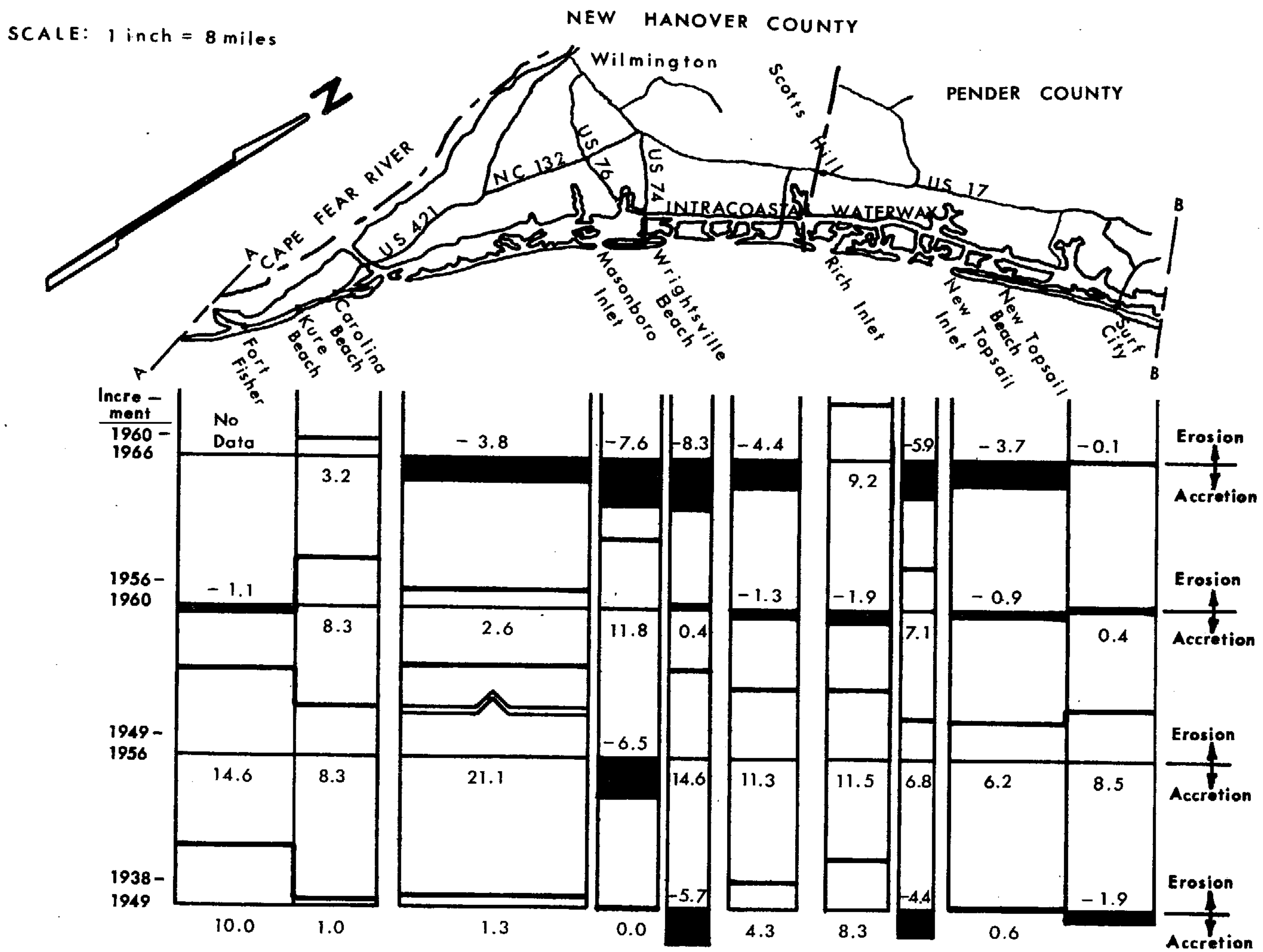

Figure 2. New Hanover and Pender Counties
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

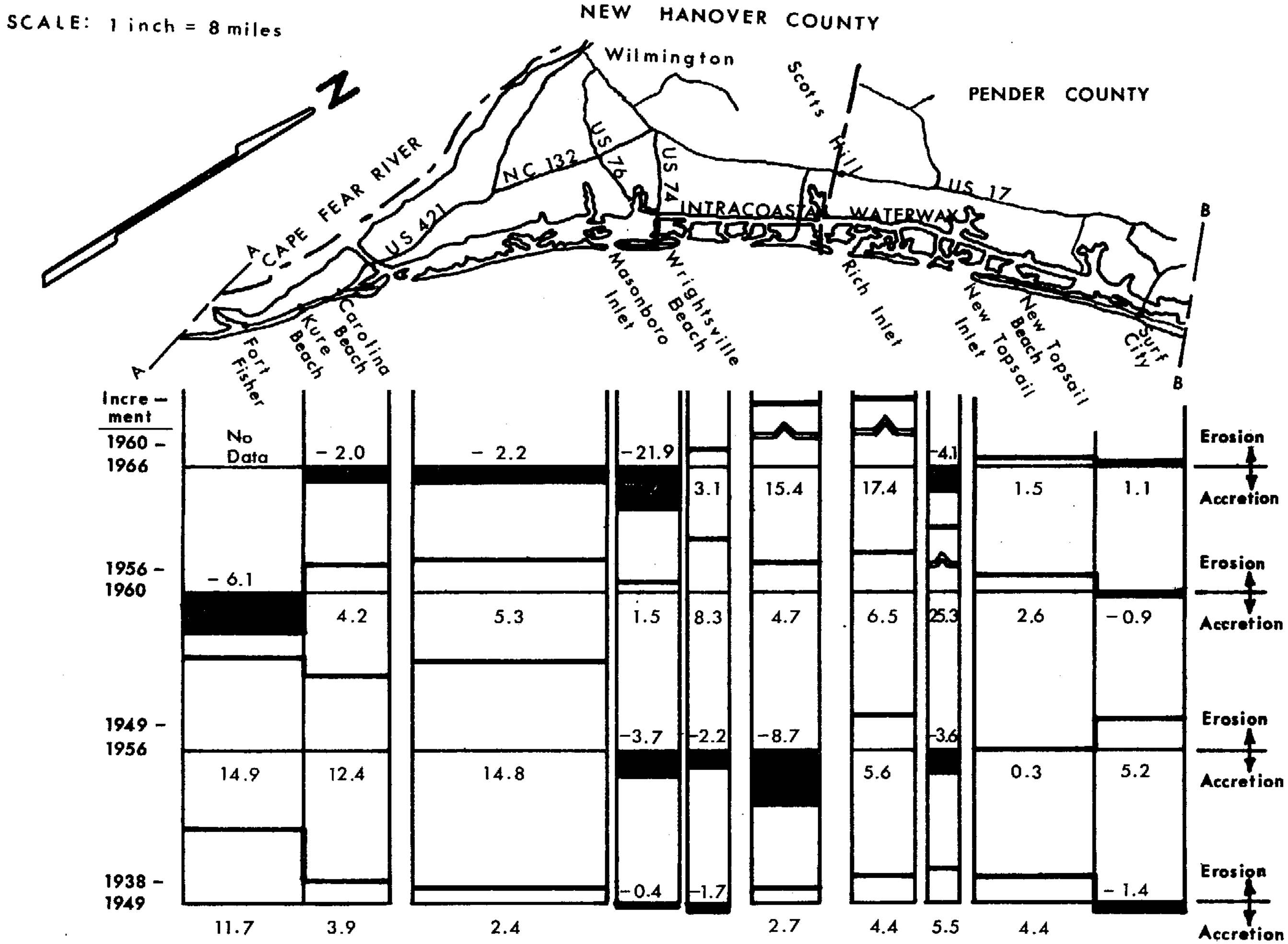

Figure 2. New Hanover and Pender Counties
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

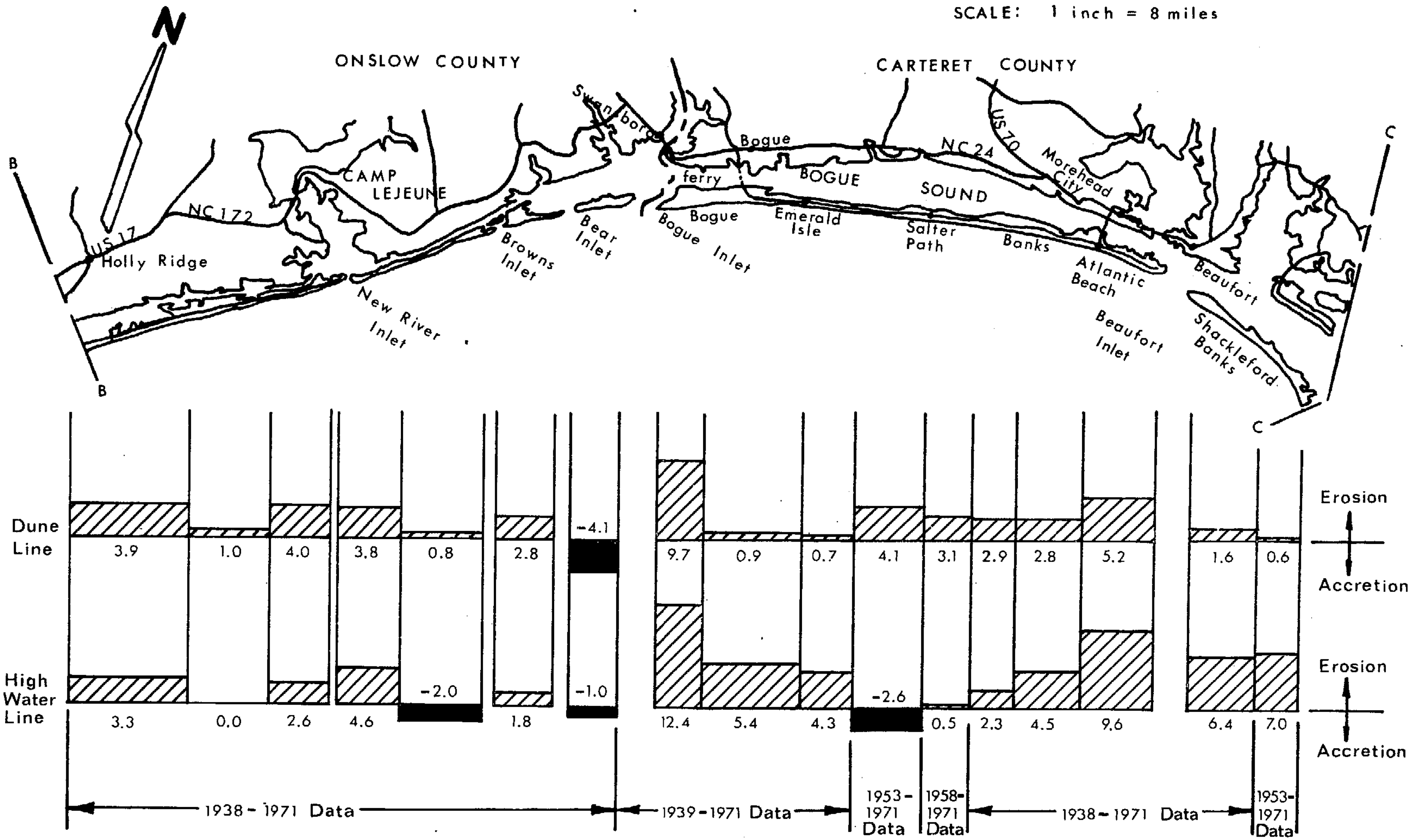

Figure 3. Onslow and southern Carteret Counties
(a) Dune line and high water line. Composite mean annual rates of change (feet per year), 1938-1971

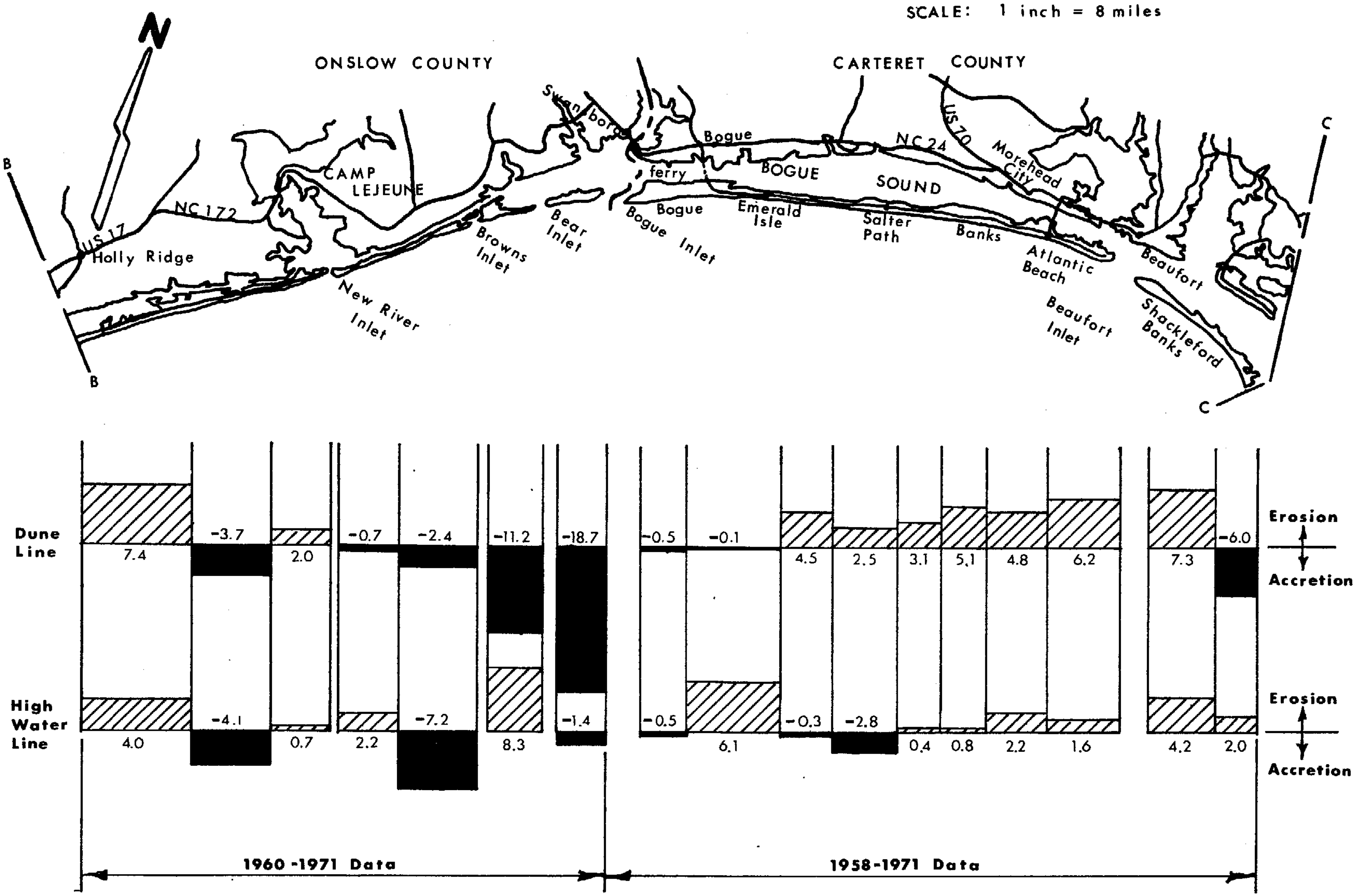

Figure 3. Onslow and southern Carteret Counties
(b) Dune line and high water line. Mean annual rates of change (feet per year) for most recent time interval, 1958-1971

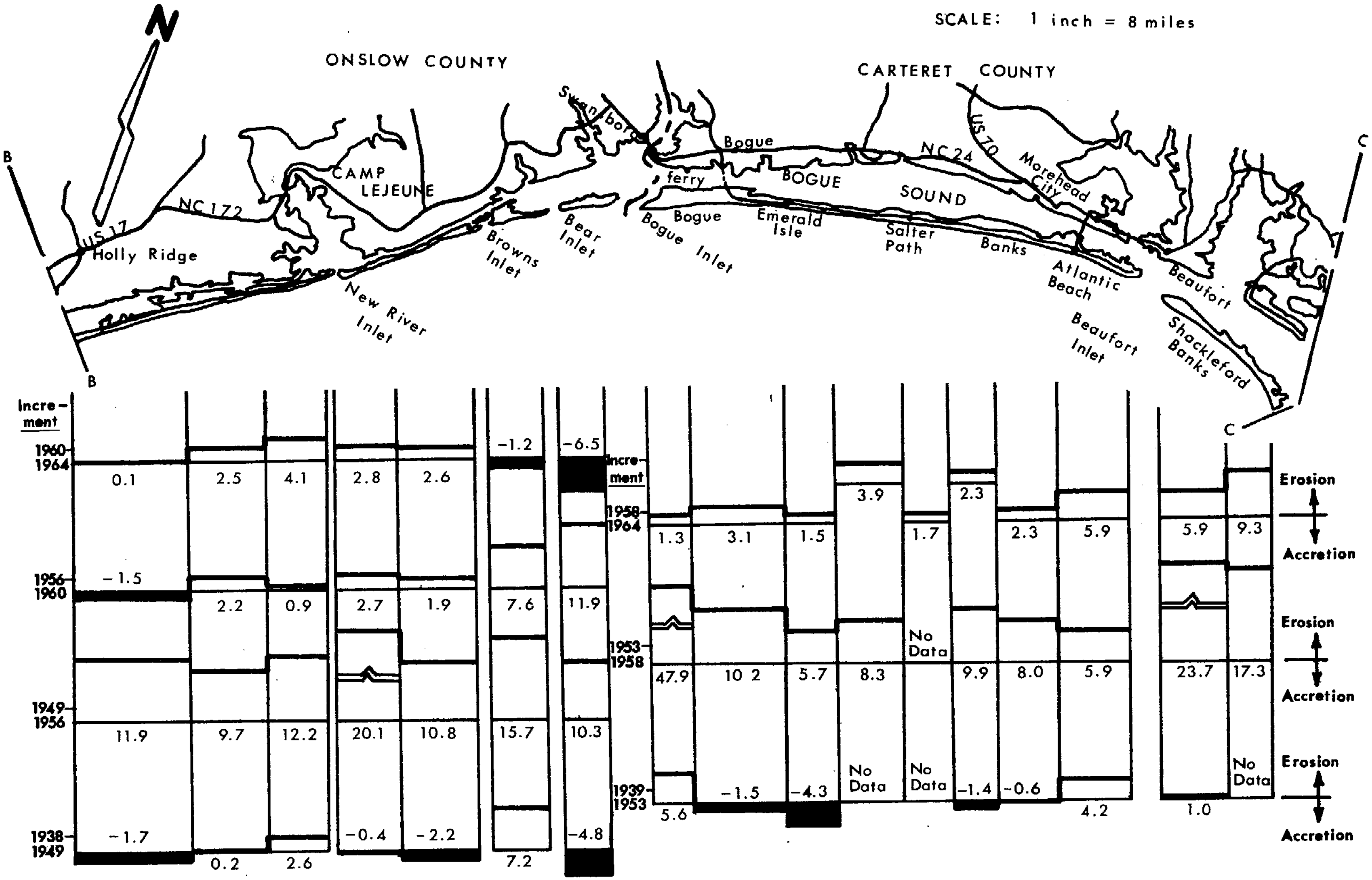

Figure 3. Onslow and southern Carteret Counties
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

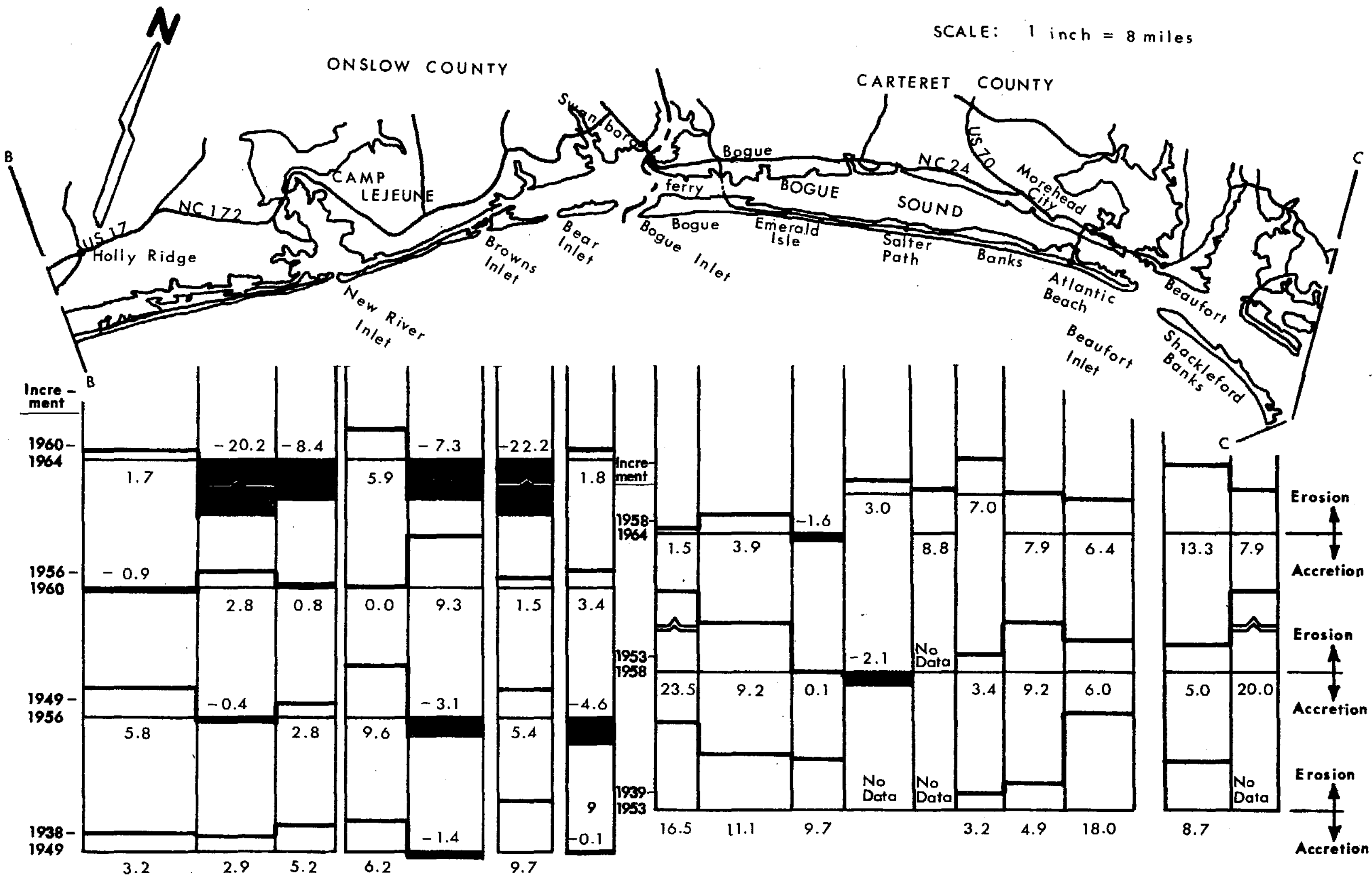

Figure 3. Onslow and southern Carteret Counties
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

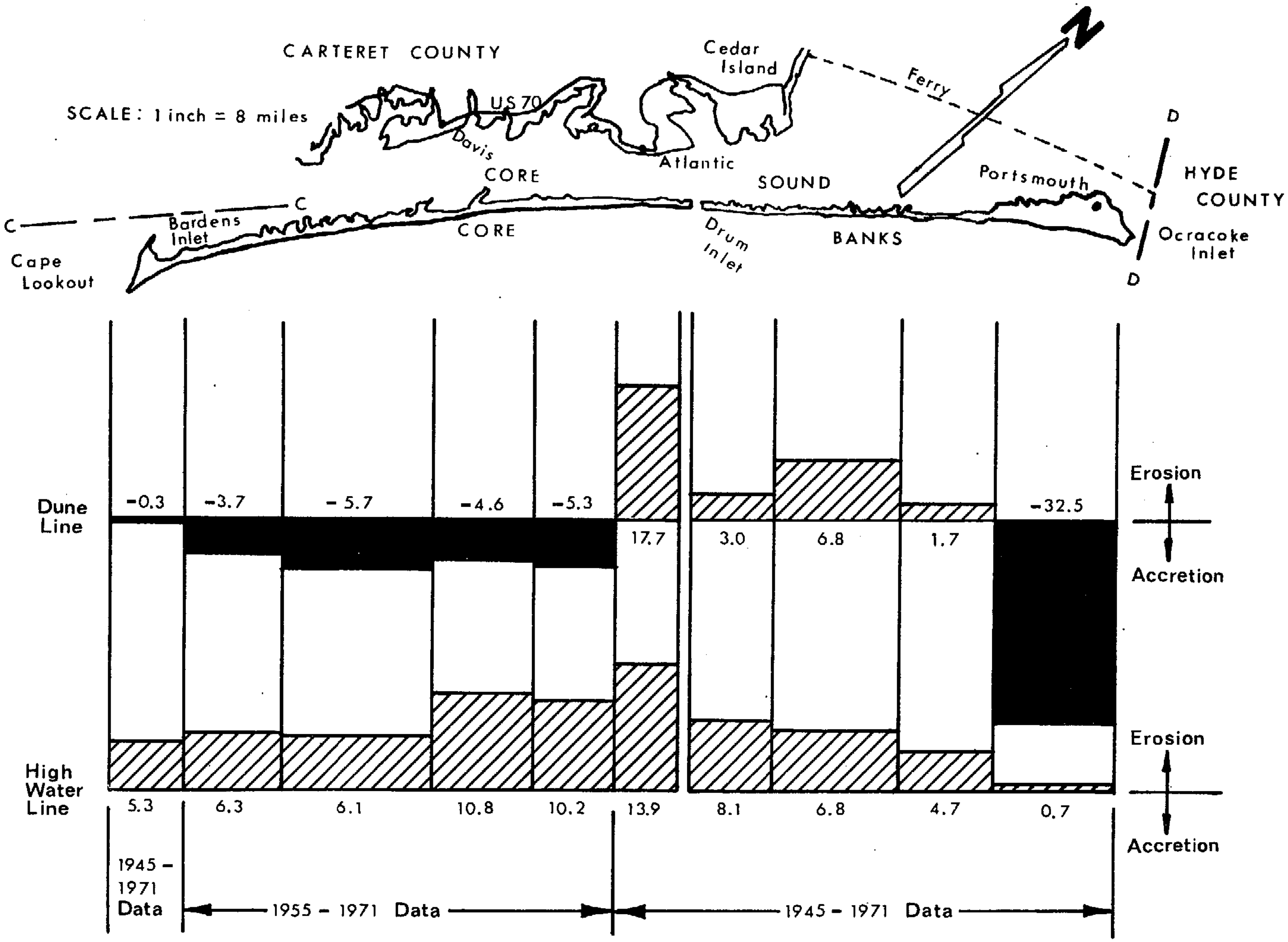

Figure 4. Eastern Carteret County
(a) Dune line and high water line. Composite mean annual rates of change (feet per year), 1945-1971.

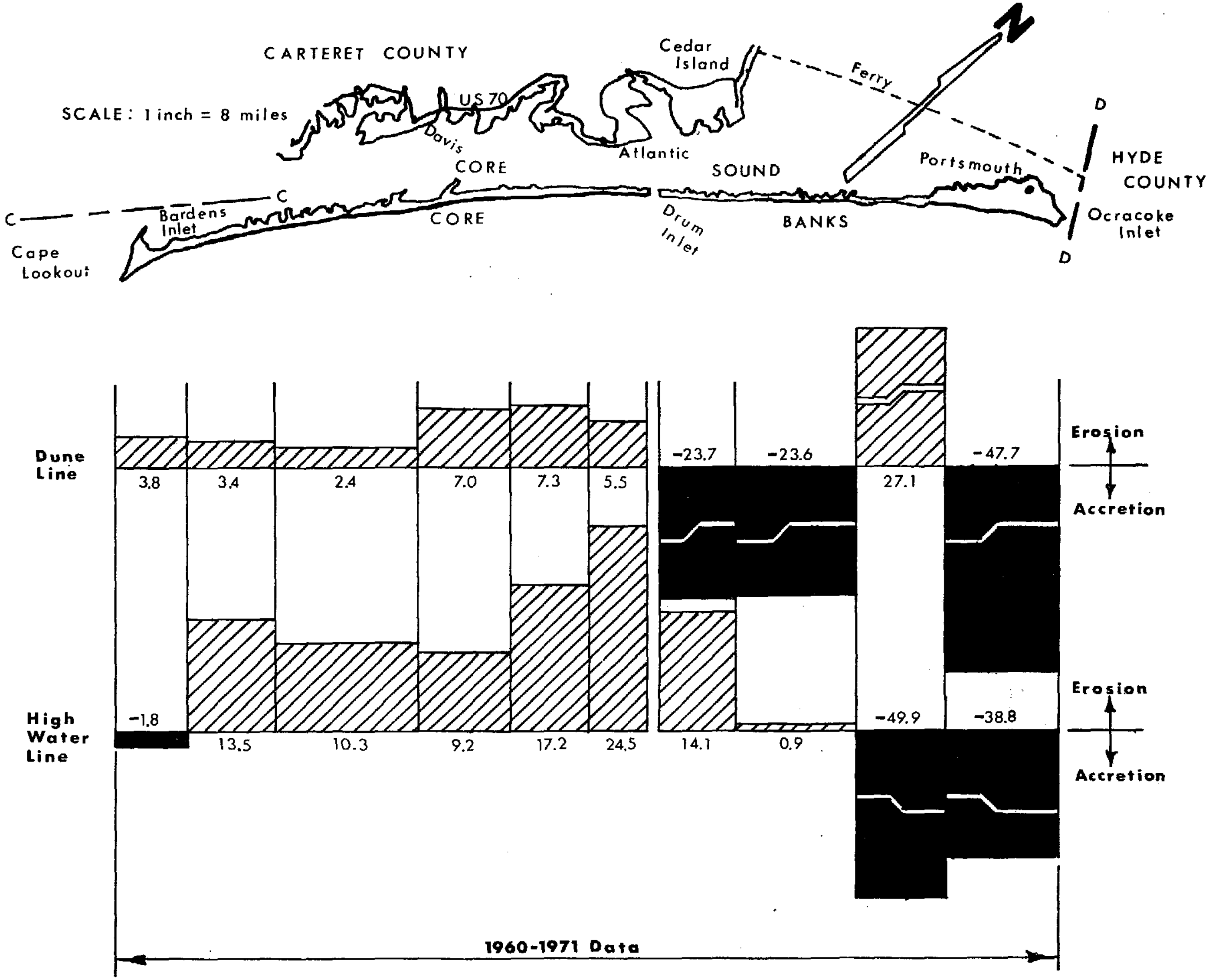

Figure 4. Eastern Carteret County
(b) Dune line and high water line. Mean annual rates of charge (feet per year) for most recent time interval, 1960-1971.

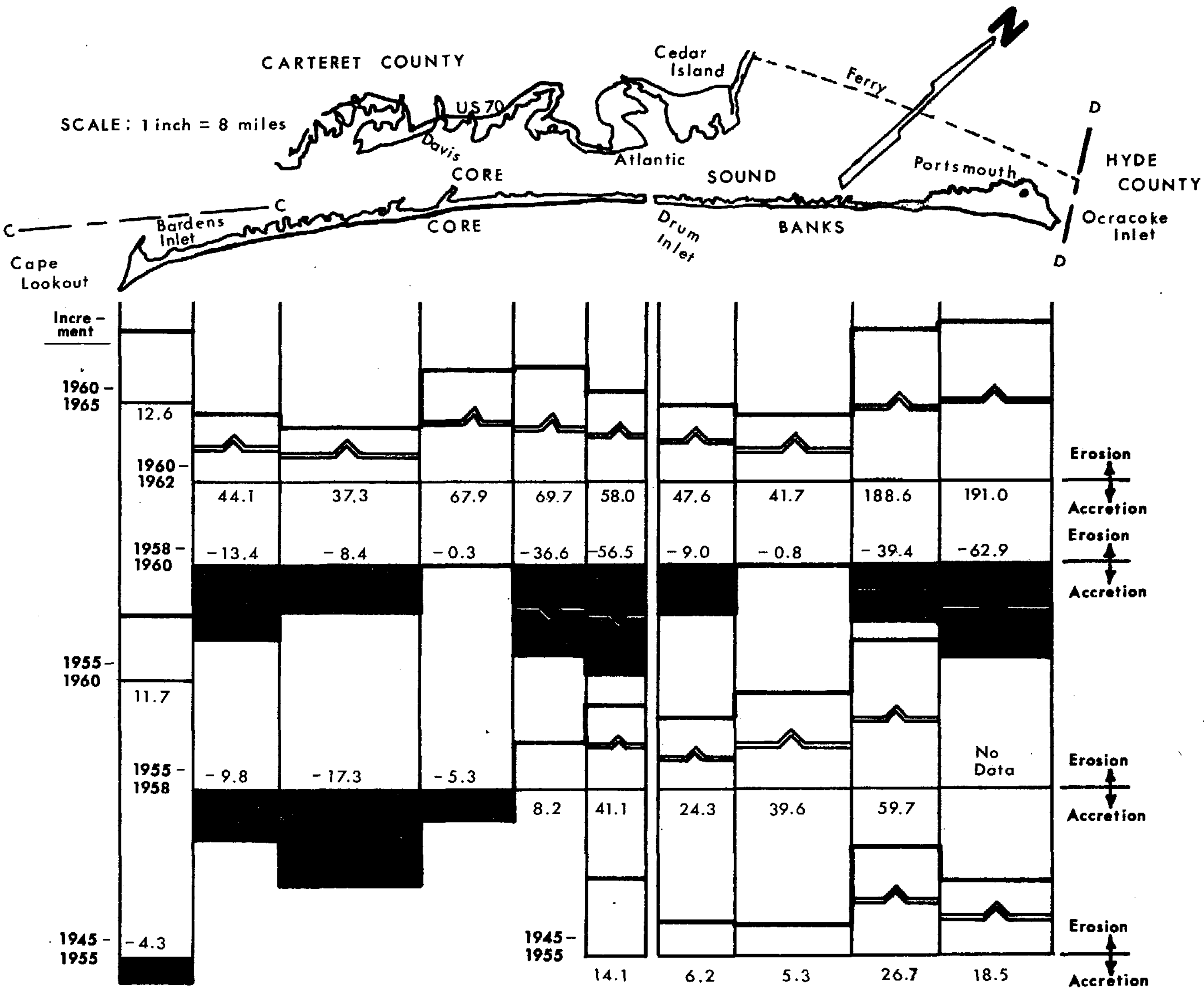

Figure 4. Eastern Carteret County
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

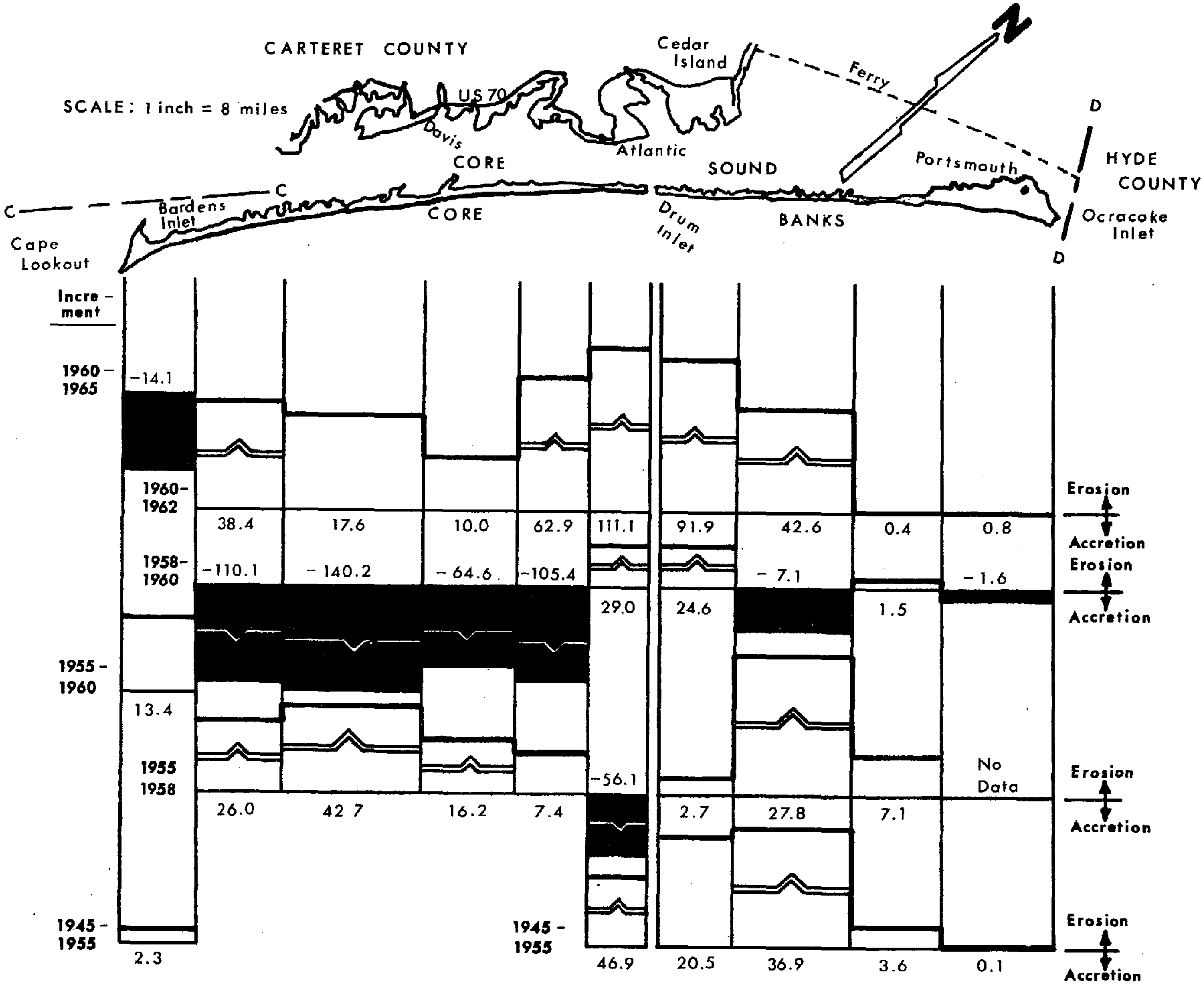

Figure 4. Eastern Carteret County
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

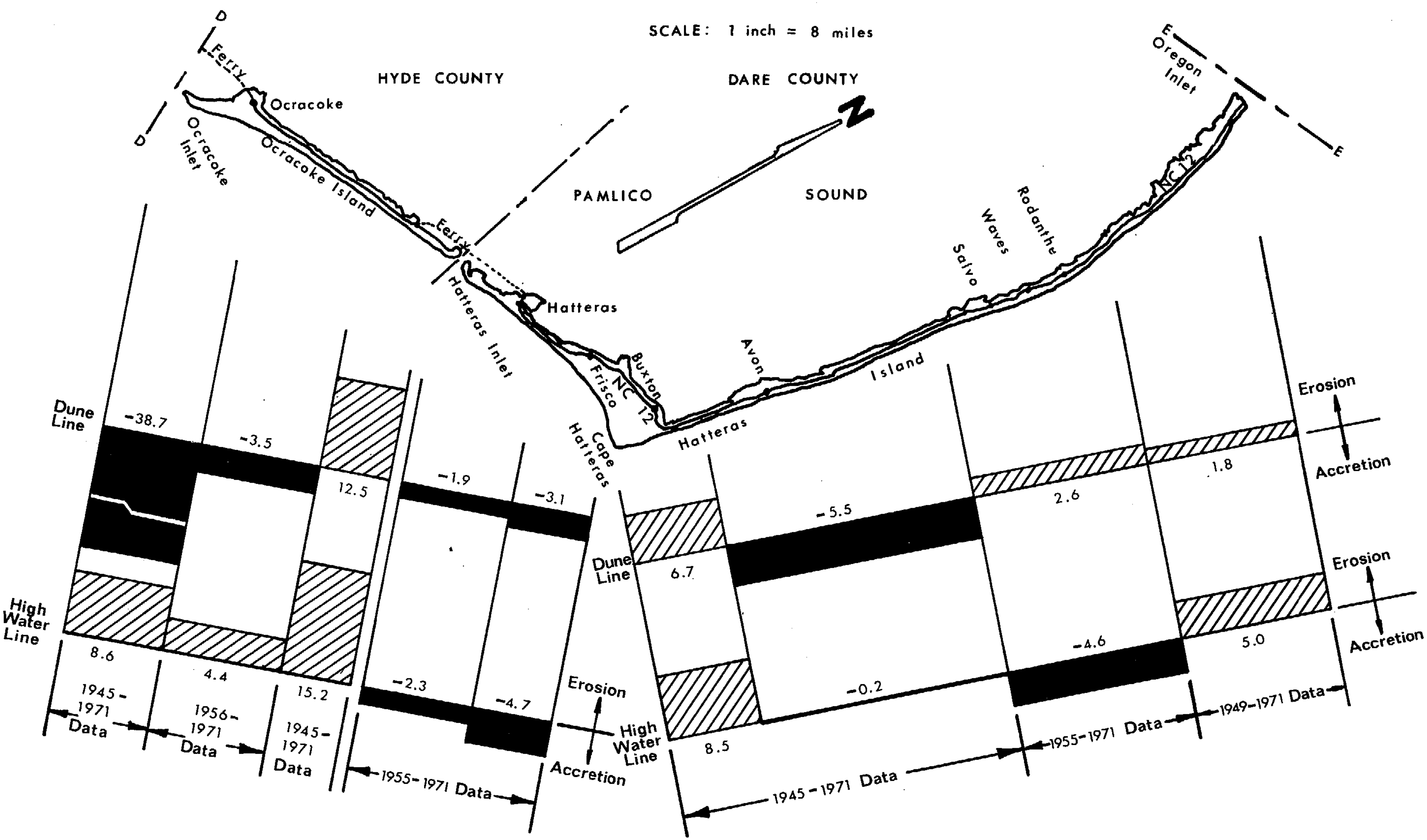

Figure 5. Hyde and southern Dare Counties
(a) Dune line and high water line. Composite mean annual rates of change (feet per year), 1945-1971.

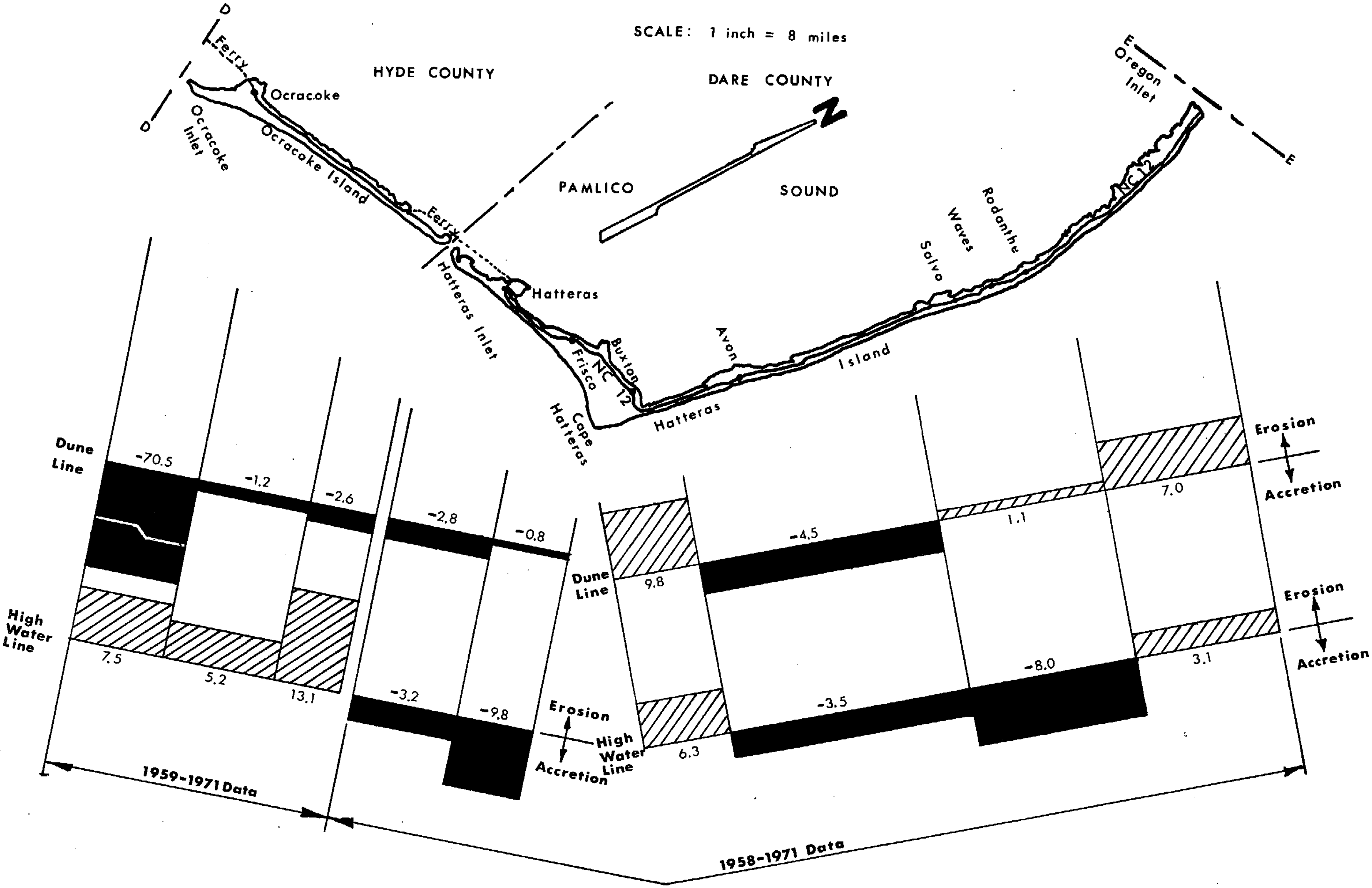

Figure 5. Hyde and southern Dare Counties
(b) Dune line and high water line. Mean annual rates of change (feet per year) for most recent time interval, 1958-1971.

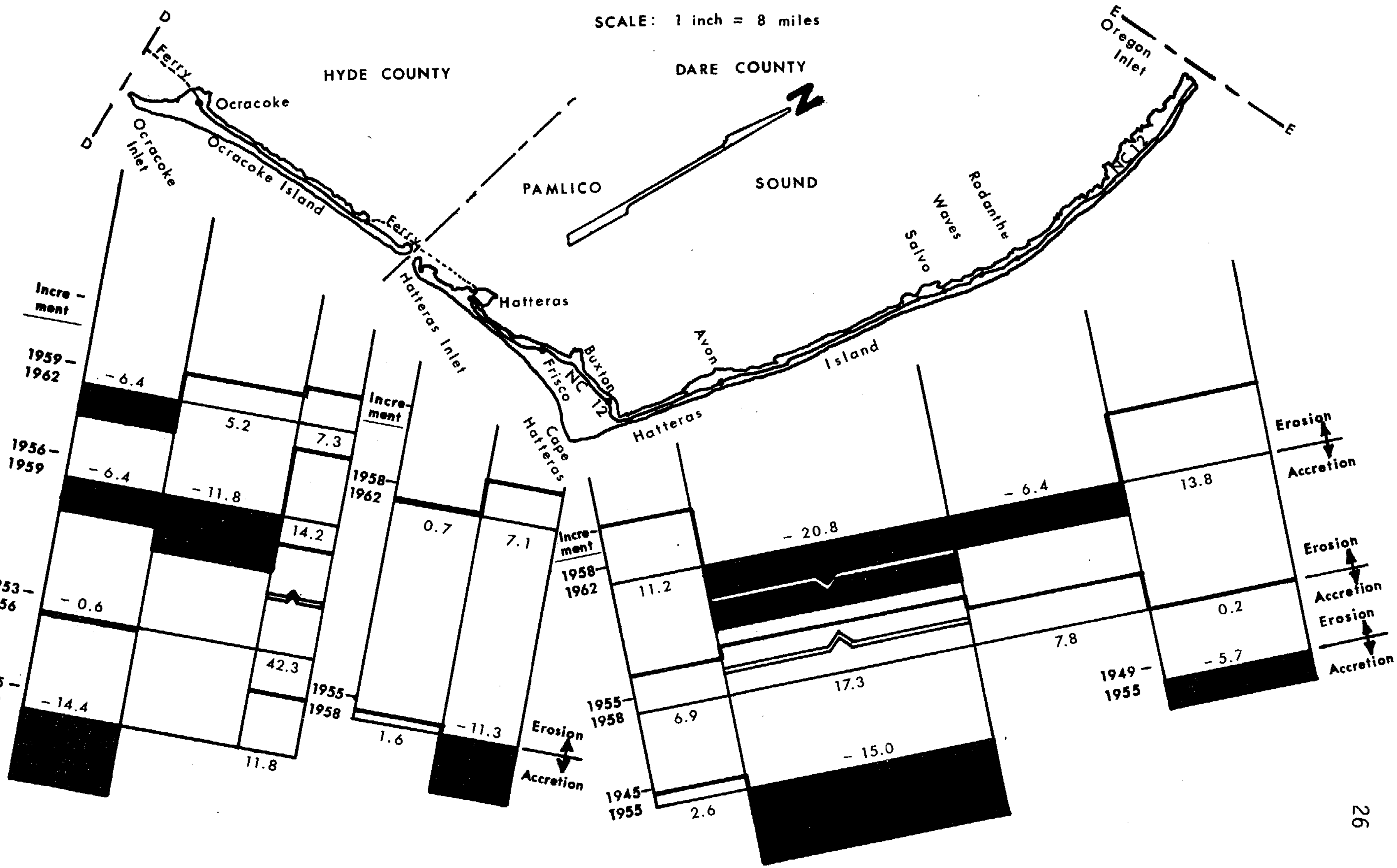

Figure 5. Hyde and southern Dare Counties
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

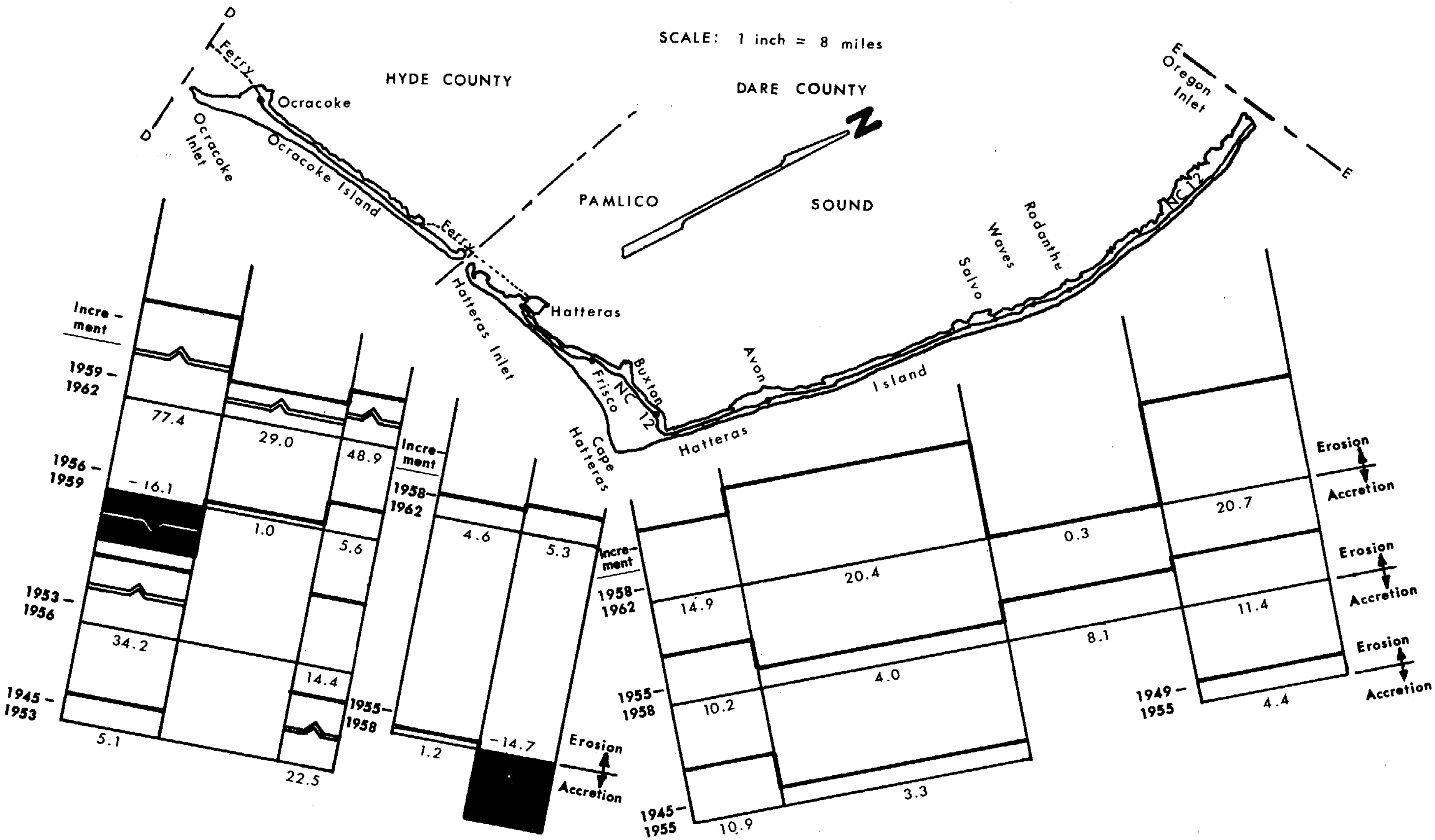

Figure 5. Hyde and southern Dare Counties
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

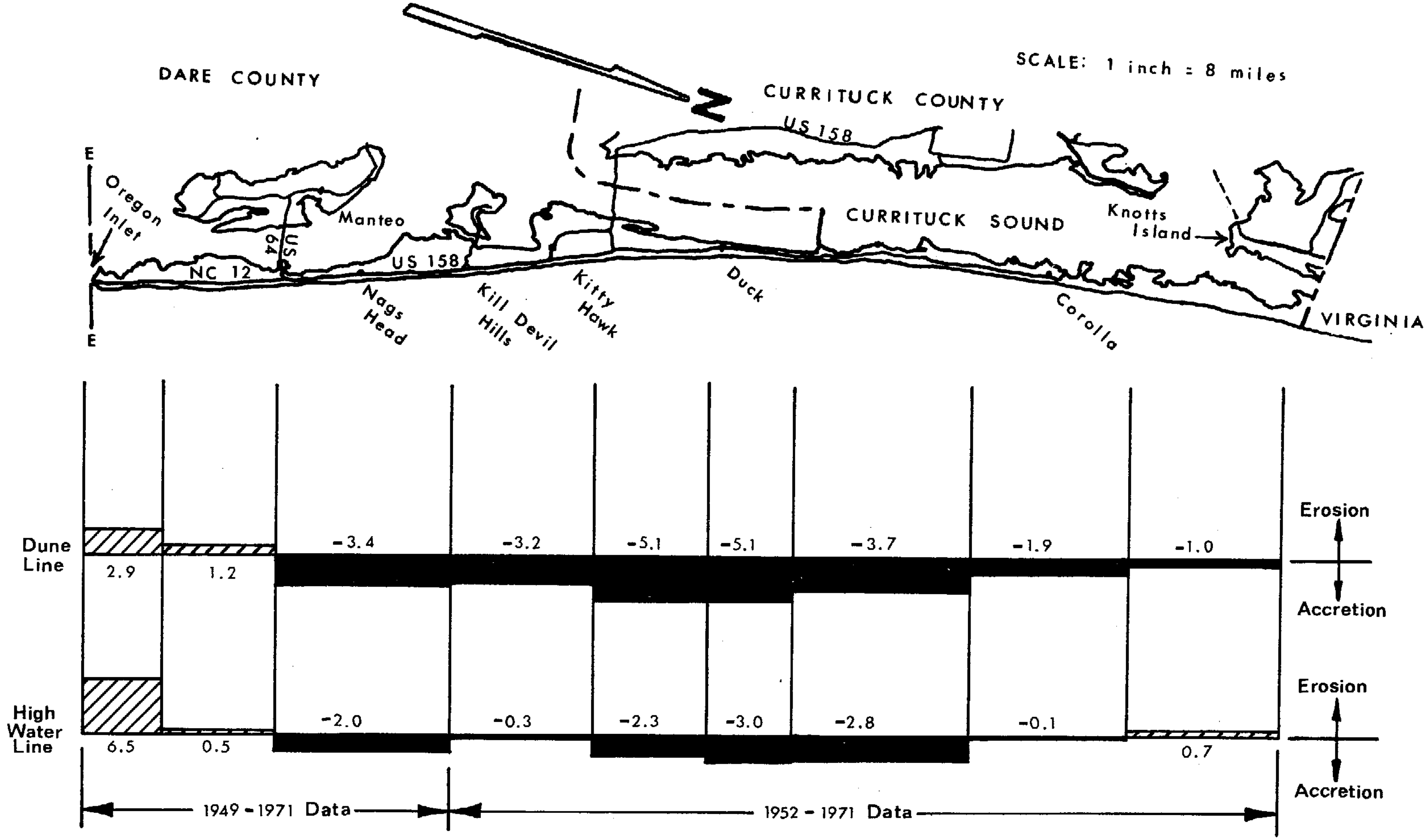

Figure 6. Northern Dare and Currituck Counties
(a) Dune line and high water line. Composite mean annual rates of change (feet per year), 1949-1971.

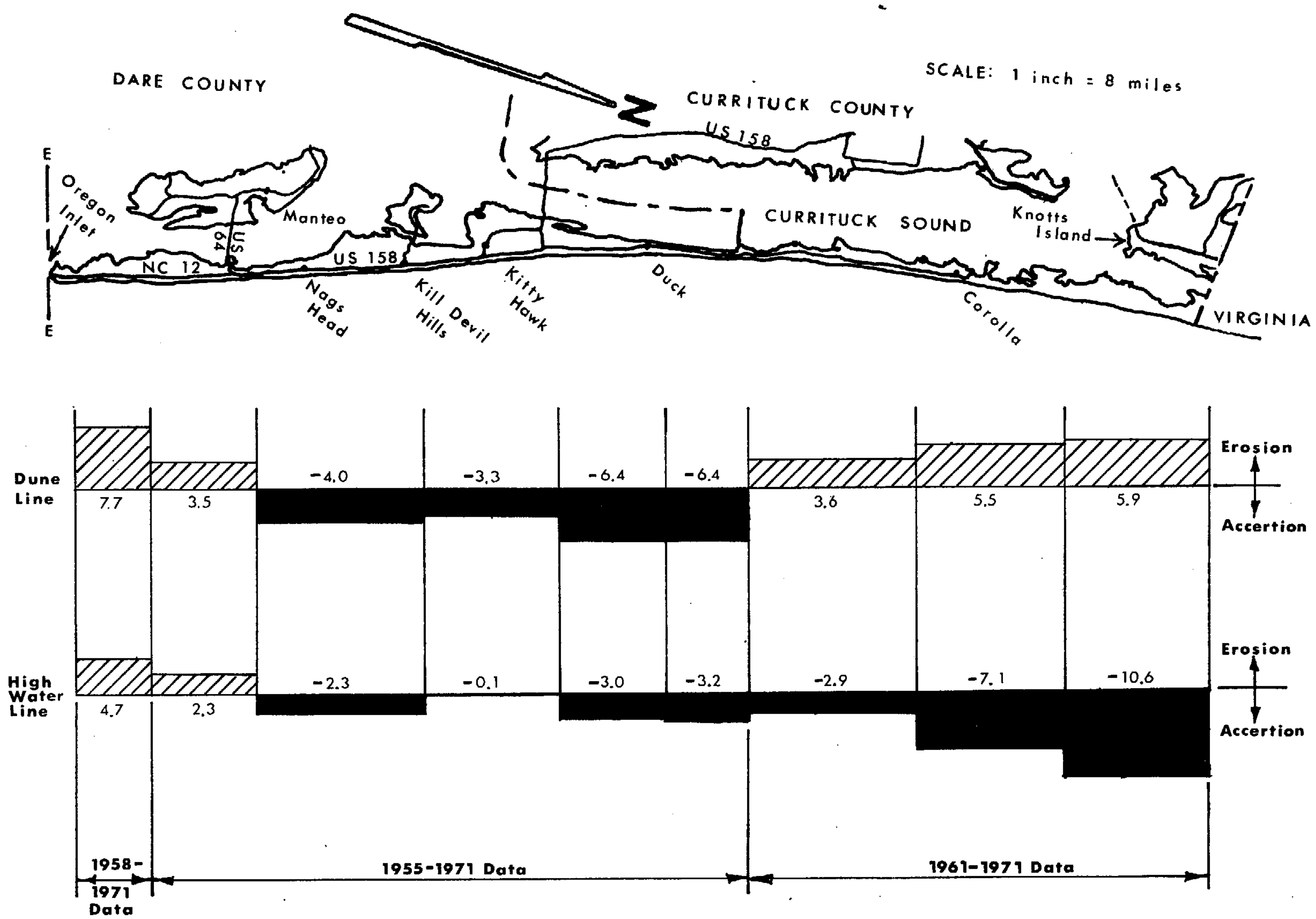

Figure 6. Northern Dare and Currituck Counties
(b) Dune line and high water line. Mean annual rates of change (feet per year) for most recent time interval, 1955-1971.

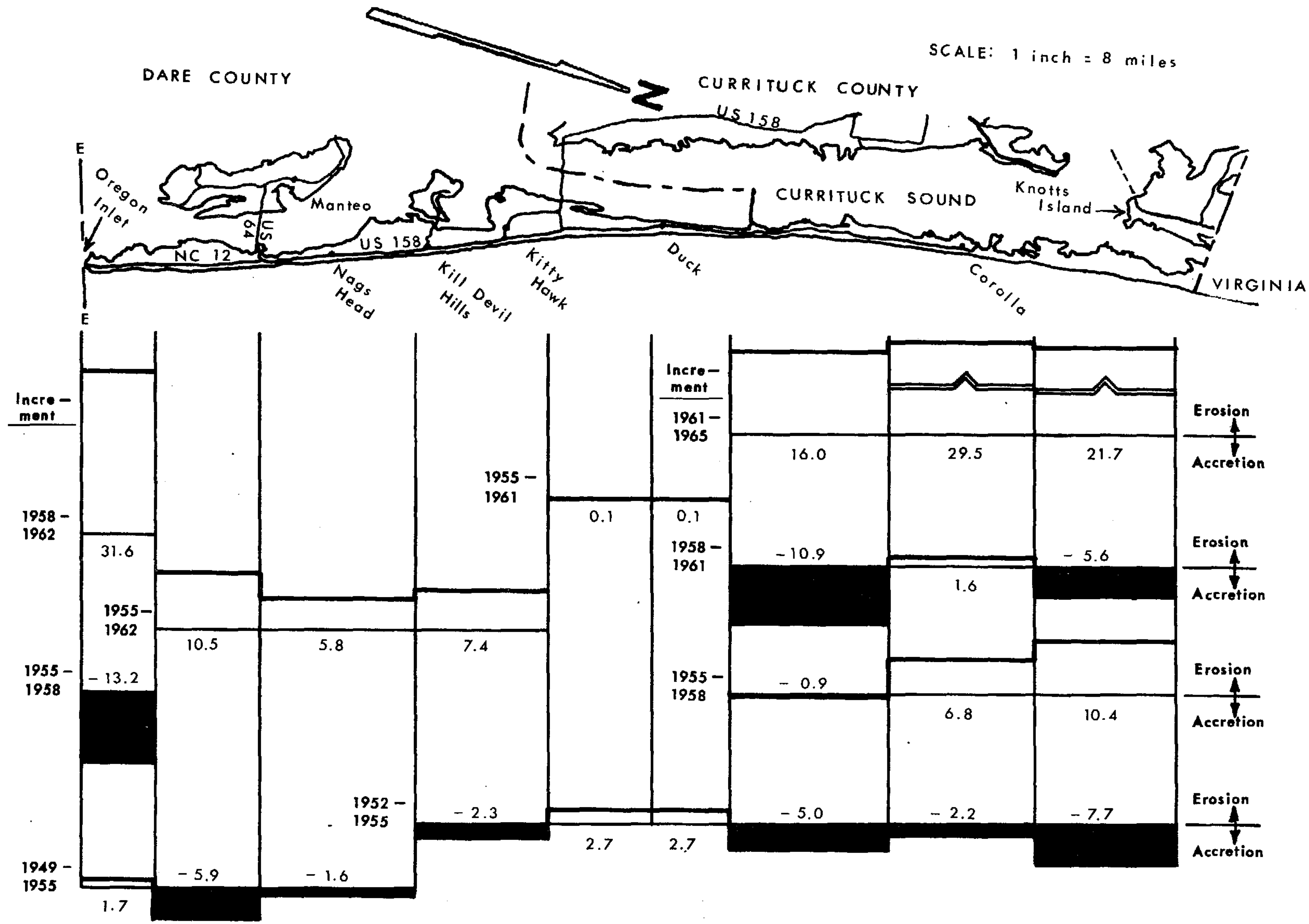

Figure 6. Northern Dare and Currituck Counties
(c) Dune line. Mean annual rates of change (feet per year) for previous time intervals.

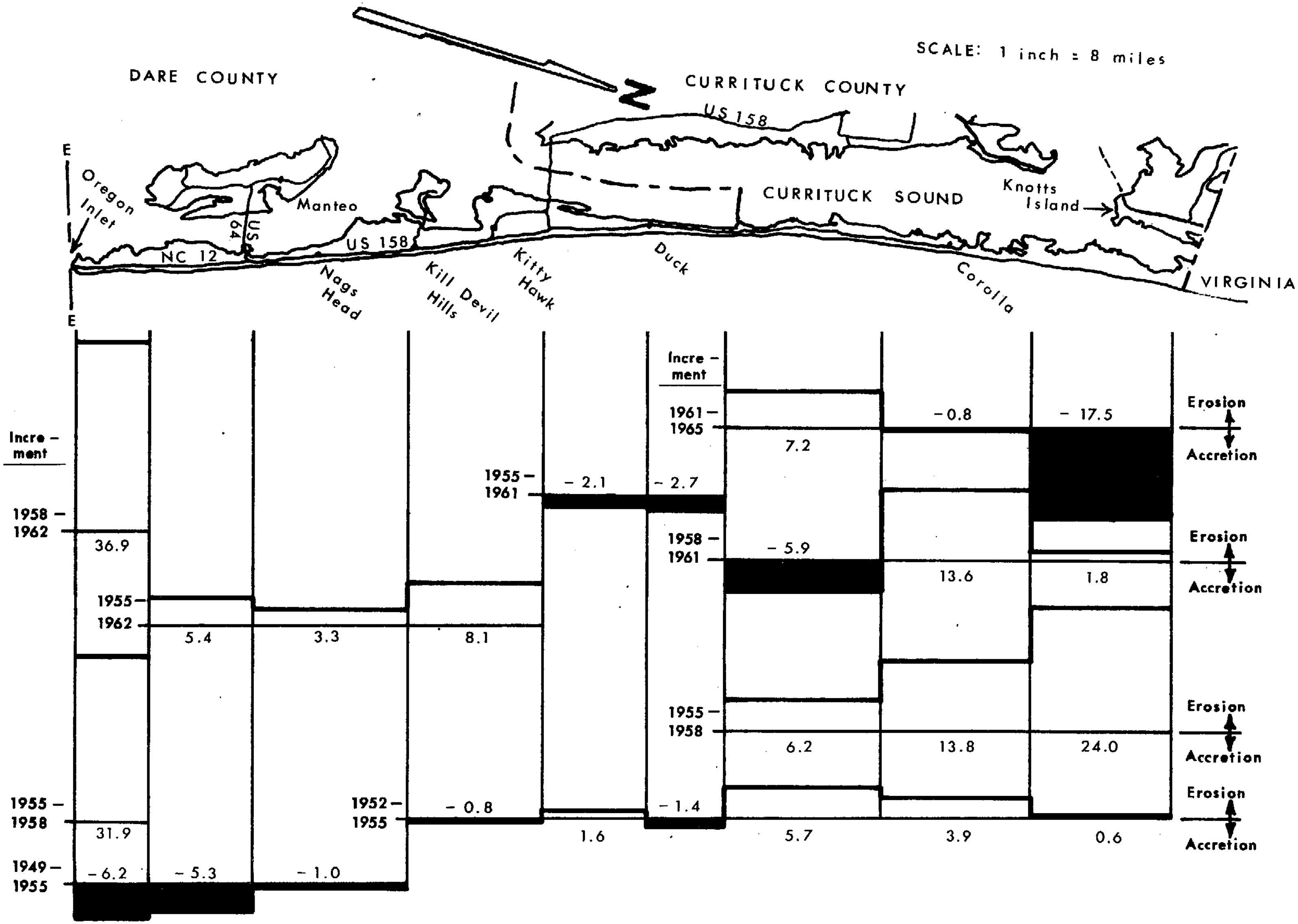

Figure 6. Northern Dare and Currituck Counties
(d) High water line. Mean annual rates of change (feet per year) for previous time intervals.

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