HANDBOOK FOR REMOTE SENSING

MID-ATLANTIC COAST NATIONAL SEASHORES
ASSATEAGUE ISLAND
CAPE HATTERAS
CAPE LOOKOUT

Sponsored Jointly

NASA/WALLOPS FLIGHT CENTER
WALLOPS ISLAND, VIRGINIA 23337

and

NATIONAL PARK SERVICE
WASHINGTON, D. C.

NATURAL RESOURCES
REPORT NO. 10
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PREFACE

Remote sensing is an efficient means of acquiring information for land management and environmental investigations. The literature on remote sensing is extensive; however, most papers are limited to either a single type of imagery or a single application. This report summarizes the use of several types of imagery in the investigation of coastal phenomena. It is not intended as an imagery-recognition key for coastal features, but rather as a guide to imagery selection and application in the coastal environment.

The National Aeronautics and Space Administration - Wallops Island Flight Center (Fig. 1) is the center for barrier-island and wetlands remote-sensing research in the mid-Atlantic area; therefore, this handbook contains a section describing the programs and facilities at the Wallops Flight Center. The three mid-Atlantic coast National Seashores are the special focus of this report; however, the National Park Service has a wide range of marine parks, including sites on the Arctic, the Pacific, and the Atlantic Oceans, the Great Lakes, the Gulf coast, and the Carribean Sea. For this reason, our inventory and analyses are as broad as possible to insure the widest applicability.

Various scales of aerial photography and LANDSAT imagery provide a solid data base for monitoring barrier-island

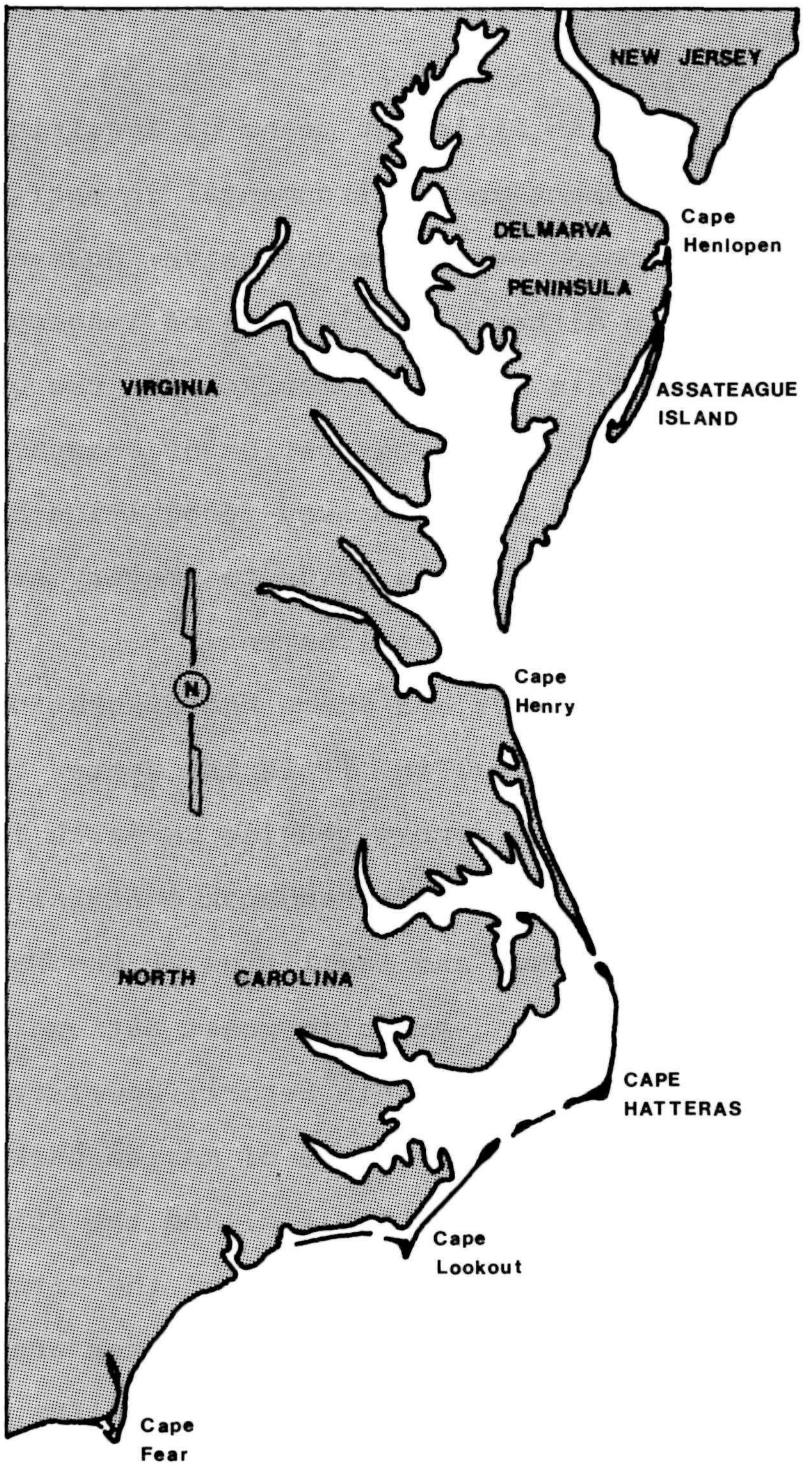

Figure 1: Barrier islands of the mid-Atlantic coast

dynamics. When used with carefully designed field studies, measurements from aerial photography can be accurate and relatively inexpensive. Within hours, one aircraft flight can record regional-scale conditions over an extensive stretch of the coast. More than two dozen sets of aerial photography of the mid-Atlantic barrier zone back to the 1930's are the best historical record of barrier-island dynamics.

The purpose of this report is to summarize for National Park Service research, planning, and administrative personnel how various types of remote-sensing imagery can be used to map and monitor barrier-island landscapes. This summary is based on more than ten years of research experience of members of the University of Virginia staff and of the Chesapeake Bay Regional Ecology Data Center. Information on imagery sources is also provided; and a tabulation of available imagery of the three mid-Atlantic coast barrier islands is included.

ACKNOWLEDGMENTS

This report summarizes information contained in a number of documents prepared by members of the coastal environments research team, Department of Environmental Sciences, University of Virginia.

Mary Vincent deserves special acknowledgment for her efforts in putting together the glossary and the advantages and disadvantages of remote-sensing imagery in coastal investigations.

We also thank Jeff Michel and Beth Burkhart for help in preparing the inventory of coastal imagery and Mary-Scott Marston for doing most of the really difficult work in assembling, typing and editing the manuscript, and, finally, in seeing everything through to printing and distribution.

INTRODUCTION

Barrier islands are among the most dynamic landscapes under the National Park Service's jurisdiction. The most important attribute of barrier islands is their dynamics; sometimes they move landward and sometimes seaward. In recent years, to the displeasure of many, this movement has been mostly landward.

Geologically and ecologically, barrier-island dynamics span time scales from hours to decades. The processes include beach-face changes during a single tidal cycle, periodic storm overwash, long-term sea level and climatic trends, and modification associated with man's activities.

Good information about barrier-island dynamics is a prerequisite to good management. Field investigations have provided base-line data; however, the number of systematic field investigations is modest and their geographic distribution is limited. Therefore, when questions concerning regional processes are asked, data from field studies is seldom available for analysis. The best source for regional-scale information is remote sensing.

ATLANTIC COAST BARRIER ISLANDS

The coastal zone along the mid-Atlantic is flat and extends across a wide continental shelf (80 km or more). The land/sea interface is a series of barrier islands from 1.5 to 32 km offshore. The islands are 1.5 to 5 km wide and low; the highest points are usually 3 to 6 m above sea level, with occasional unvegetated dunes 3 to 30 m high. Grasses and shrubs are the primary vegetation types, although there are oak and pine forests in older sheltered areas of the islands. Marshes are usually present on the lagoon side and shallow lagoons can contain tidal mud flats and marshes (Fig. 2).

Tides range from 1 to 1.5 m and wave heights average 0.5 to 1 m. Storms generate much larger waves and are, therefore, the principal agents of change; extratropical storms during the winter season can produce deep-water waves 4.5 m to 9 m high with 0.5- to 1.5-m storm surges. Less frequent hurricanes also cause major landscape changes.

The Imagery

Primary data available for mapping Atlantic coast barrier-island dynamics include: 1)LANDSAT satellite imagery; 2) high-altitude aircraft (U-2) color-infrared photography (about 1:120,000/1:130,000); 3) low-altitude aerial photography (1:20,000/1:30,000) produced by Wallops Flight Center; and 4) various sets of historical aerial photography. The following imagery has been used to successfully identify coastal processes, coastal zones, and regional patterns:

A. Photography

1. Black-and-white panchromatic
2. Black-and-white infrared
3. Color
4. Color infrared
5. Skylab

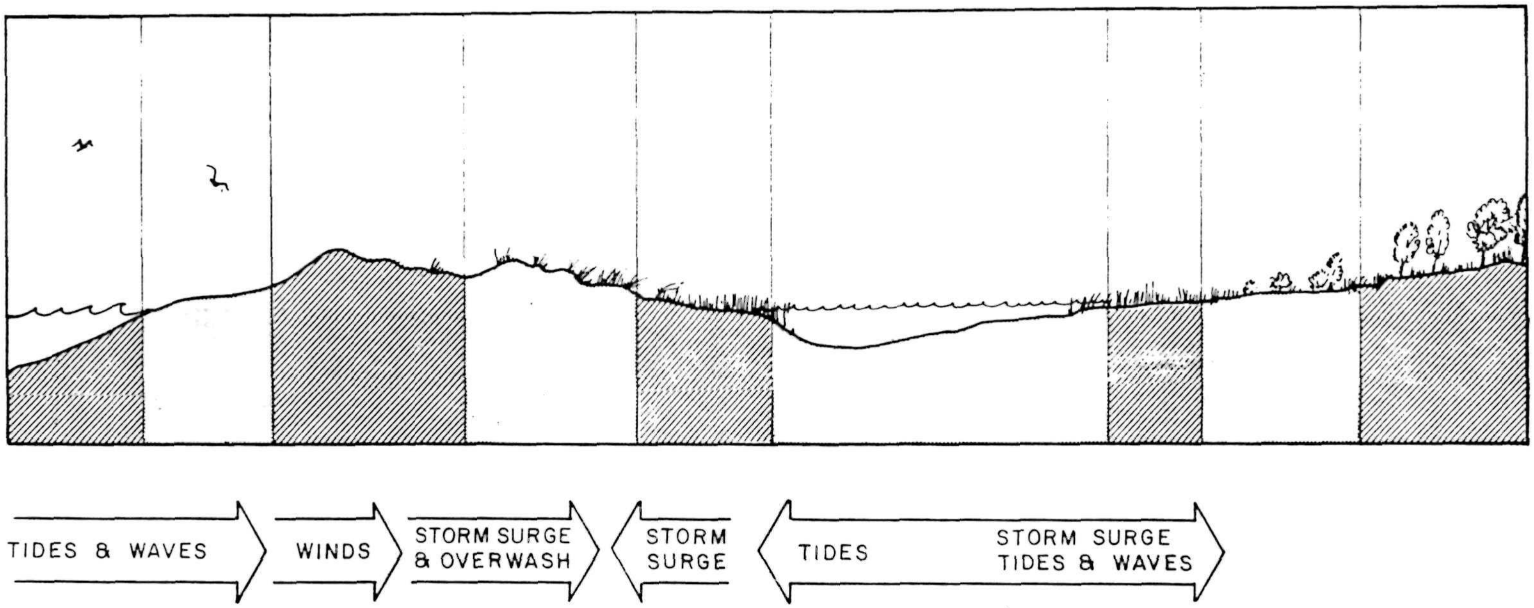

Figure 2: Natural barrier-island environments and associated processes.

B. Satellite imagery

1. LANDSAT, MSS bands 4, 5, 6, 7 (black and white)

2. LANDSAT, color composites

3. Satellite Scanning Radiometer (black and white)

Land Classification

Table 1 gives the geographic locations of each land class on a barrier island. The processes responsible for natural changes or for the origin and maintenance of these changes are listed in Tables 2 and 3 and illustrated in Figure 2. Table 3 gives the normal period of landscape response to these processes. An overriding factor for all classes responding on a daily basis is an extreme or episodic event which can cause catastrophic land alteration.

Table 1 also gives an assessment of the stability and vulnerability of each land class. Stability of the land classes provides a general indication of how moderate developmental stresses, such as construction of buildings and roads, would change the natural landscape. Vulnerability of the classes indicates how vulnerable unprotected structures would be to natural stresses from storms. In both cases, the assessments suggest the frequency and magnitude of natural stress or the fragile nature of a particular landscape type.

Coastal features are correlated on a matrix to land/sea interface types most common along the coasts of North America (Table 4). This permits organization of the coastal features into patterns which define interface types by the presence, absence, or association of attributes. The matrix also aids

TABLE 1

Geographic Locations of Land Classes

Primary Locations	Vulnerability*	Stability**
Barrier islands: Filled marshes	Moderate	Stable
Pleistocene islands: Adjacent mainland	Low	Stable
Barrier islands; Inland of barrier dunes	Moderate	Stable
Barrier dunes: Adjacent to beach on barrier islands	Low	Stable
Waters: Between islands and mainland	High	Unstable
Marsh: In estuaries and bays or inland edge of barrier islands	Moderate	Unstable
Mud flats: Primarily in estuaries, bays, more rarely in fringe islands	Moderate	Unstable
Beaches: Seaward edge of barrier islands, includes overwash fans if they are contingent to the beach	High	Unstable
Dunes: Interior of barrier islands, often denuded ancient dunes	Moderate	Stable
Sand flats: Interior of barrier islands or adjacent to tidal inlets	Moderate	Stable

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

*High - natural changes occur frequently, representing risk for development; moderate - danger from flood or surge; low - natural change low.

**Stable - relatively insensitive to activity; unstable - easy to move out of balance.

TABLE 2

Land Classes and Biophysical Processes

Land Classes	Biophysical Processes
Grassland	Surface runoff
Vegetated sand flat (grass)	Eolian; overwash
Vegetated dune system (grass)	Eolian; wave erosion (frontal)
Forest	Surface runoff
Estuary and bay	Tidal currents
Freshwater pond	Rainfall runoff
Marsh	Biological; tidal overwash
Mud flat	Tidal
Beach	Waves: tides; storm waves: surge
Unvegetated sand flat	Eolian; overwash
Unvegetated dune system	Eolian

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

TABLE 3

Altering Processes and Response Periods

Land Classes	Period of Response	Events Causing Alterations
Grassland	Slow trends	
Vegetated sand flat	Daily; extreme events	Storm depositon of sand; denudation
Vegetated dune system	Daily; extreme events	Storm erosion of dune mass; denudation
Forest	Slow trends	Denudation
Estuary and Bay	Daily	Pollution; alteration of flow patterns
Freshwater ponds	Daily	Siltation; saltwater intrusion
Marsh	Slow trends; extreme events; daily	Overwash; deposition of sand, man-made; land fill; restriction of water flux
Mud flat	Daily	Current erosion; revegetation
Beach	Daily (seasonally); extreme events	Storm-caused erosion; sea-level trend
Unvegetated sand flat	Daily	Overwash deposition; revegetation
Unvegetated dune system	Daily	Vegetation

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

TABLE 4

Definition of Coastal Interface Types by Characteristic Composition of Landscape Elements

Landscape elements	Sand beach	Barrier chain coast	Pocket beach coast	Sand beach with rock headlands	Shingle or cobble beach	Rocky coast	Delta shore-line	Estuary	Fjord coast	Coral-reef shoreline	Mangrove shore-line	Open coast, marsh, or mudflat
Relief												
High relief	o	+	+	+	+	+	o	+	+	o	o	o
Low relief	+	+	++	++	++	++	+	++	x	+	+	+
Coastal plain	++	++	x	x	x	x	++	+	x	++	++	++
Shore material												
Rocky, mainland	x	x	+	+	o	+	x	x	+	x	x	x
Rocky, skerry	x	x	●	o	●	+	x	o	●	x	x	x
Shingle	x	x	●	x	+	●	x	o	x	x	x	x
Sand, sandy	+	+	+	+	x	o	●	o	x	●	●	x
Siltage	x	x	x	x	o	●	+	+	x	x	●	●
Coral, fringing reef	●	●	o	o	x	x	x	x	x	+	●	x
Coral, barrier reef	●	●	o	o	x	x	x	x	x	+	●	x
Topographic forms												
Coastline	+	+	+	+	+	+	+	+	+	+	+	+
Promontory	o	x	+	+	o	+	x	o	+	x	x	x
Cliff	x	x	●	o	●	●	x	o	+	x	x	x
Truncated spur	x	x	x	x	x	x	x	x	+	x	x	x
Barrier	o	+	x	x	o	x	x	x	x	●	●	o
Alluvail plain	x	x	x	x	x	x	+	x	x	x	o	o
Natural levee	x	x	x	x	x	x	+	x	x	x	x	x
Dune, stable (vegetated)	●	+	x	x	x	x	x	x	x	x	x	x
Dune, unstable (unvegetated)	●	+	x	x	o	x	x	x	x	o	o	x
Tidal flat	o	●	o	x	o	o	o	+	x	o	o	+
Swash zone	+	+	+	+	+	+	o	o	o	x	o	o
Beach	+	+	x	+	+	x	x	x	x	o	x	o
Beach crest	+	+	x	●	+	x	x	x	x	x	x	x
Hydrographic forms												
Bathyorographic variance												
great	o	x	o	x	x	++	x	o	x	o	o	o
little	+	+	++	++	++	+	+	+	+[1]	++	++	++
flat	++	++	x	o	o	o	++	o	+[2]	+	+	+
Submarine bar	●	+	x	x	o	x	o	o	x	o	o	o
Shoals	o	●	x	x	o	x	o	o	x	o	o	o
Channel												
hanging valley	x	x	x	x	x	x	x	x	+	x	x	x
mouth (river)	o	o	o	o	o	o	+	+	+	o	o	o
inlet	o	+	x	x	o	x	x	x	x	●	●	o
tidal channel	o	+	x	x	o	x	x	x	x	●	●	o
distributary drainage pattern	x	x	x	x	x	x	+	x	x	x	x	x
Bay												
open bay or bight	+	x	x	+	+	o	x	x	x	o	o	o
bayhead beach	o	x	+	x	+	o	x	x	x	x	x	x
funnel sea	x	x	x	x	x	x	o	+	x	x	o	o
trough, u-shape valley	x	x	x	x	x	x	x	x	+	x	x	x
closed bay, lagoon	o	+	x	x	o	x	x	x	x	●	●	o
Site-specific features												
Berm	+	+	o	o	●	x	o	x	x	x	x	x
Beach ridge	o	o	x	o	o	x	o	x	x	x	o	o
Overwash mark	●	●	x	o	x	x	o	x	x	x	x	x
Spit	●	●	o	o	●	o	o	o	x	x	o	o
Cusp	●	●	●	●	●	x	x	x	x	x	x	x
Tidal delta	●	●	x	o	o	x	●	o	x	x	x	x
Process features												
Wave approach												
Wave breaking, breakers												
Water mass												
River plume												
Sediment, in suspension												

(Process features:) These features all occur universally, except for coral which does not occur in waters which have large amounts of suspended sediment.

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

[1]Outside channel

[2]Within channel

+ = occurs (++ most often occurs) as a defining characteristic;
● = associated with, typically occurs but not always;
o = can and does occur but not typically associated with;
x = occurs rarely, if ever.

in understanding coastal-form complexes and is a key to combinations and associations found in imagery interpretation.

The matrix of coastal features and the degree of certainty with which these features can be recognized on each image is listed in Table 5.

For a comparison of imagery with topographic maps, Table 6 provides estimates of the relative accuracy with which coastal features can be interpreted on various scales of maps and indicates the level of accuracy with which measurements can be made.

Discussion

The matrices and tables (Tables 5-9) show the results of an evaluation of several types of imagery used to obtain information on selected elements of the coastal landscape. The foremost problem in this study was the subjectivity inherent to remote-sensing interpretation. Levels of interpreter training, experience, and understanding of coastal environments often vary considerably. Although an objective presentation of subjectively obtained results is impossible, numerical ratings (Tables 7-9) do provide an effective relative evaluation of imagery types.

A second problem in studying the applicability of each type of imagery is the variability of imagery quality. Although atmospheric conditions, film exposure, and quality of sensor and film affect the quality of visual definition, calibration of these factors is difficult. The results presented here state what can be expected with good-to-excellent imagery.

TABLE 5

Recognition of Landscape Elements on Imagery of Various Types and Scales

Landscape Elements	Black and white			Black-and-white infrared			Color			Color Infrared			LANDSAT					
	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	4	5	6	7	Color Comp	Scanning radiometer
Relief																		
High	2	1	1	2	1	1	2	1	1	2	2	2	1	2	1	2	1	0
Low	2	1	1	2	1	1	2	1	1	2	2	2	1	2	1	2	1	0
Coastal Plain	2	1	1	2	1	1	2	1	1	2	2	2	1	2	1	2	1	0
Shore material																		
Rocky, mainland	3	3	1	3	2	1	3	2	1	3	2	1	0	0	0	0	0	0
Rocky, skeery	3	3	1	3	3	1	3	3	2	3	3	1	1	1	1	1	1	0
Sand, sandy	3	3	1	3	3	1	3	3	2	3	3	1	0	1	0	0	2	0
Siltage	3	3	1	3	3	1	3	3	1	3	3	1	0	1	1	1	0	0
Coral, fringing reef	3	2	1	3	2	1	3	2	1	3	2	1	1	1	0	0	0	0
Coral, barrier reef	3	2	1	3	2	1	3	2	1	3	2	2	1	1	0	0	0	0
Topographic forms																		
Coastline	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	2
Promontory	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	0
Cliff	2	1	0	2	1	0	2	1	0	2	1	0	0	0	0	0	0	0
Truncated spur	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Barrier	3	3	2	3	2	2	3	3	2	3	3	3	1	1	2	2	1	0
Alluvial plain	3	3	2	3	2	2	3	3	2	3	3	3	1	1	2	2	3	0
Natural levee	3	3	1	3	2	1	3	3	1	3	2	2	1	1	1	2	1	0
Dune, stable (vegetated)	3	3	0	3	3	0	3	3	2	3	3	2	1	1	0	0	0	0
Dune, unstable (unvegetated)	3	3	0	3	3	0	3	3	2	3	3	2	1	1	0	0	0	0
Tidal	3	3	1	3	3	2	3	3	3	3	1	1	1	1	1	1	1	0
Swash zone	3	3	0	3	3	0	3	2	0	3	2	0	0	0	0	0	0	0
Beach	3	3	0	3	2	0	3	3	1	3	2	1	0	0	0	0	0	0
Beach crest	3	3	0	3	3	0	3	3	1	3	2	1	0	0	0	0	0	0
Hydrographic forms																		
Bathyorographic variance																		
great	3	3	2	0	0	0	2	1	1	2	1	1	1	0	0	0	0	0
little	3	3	2	0	0	0	2	1	1	2	1	1	1	0	0	0	0	0
flat	3	3	2	0	0	0	2	1	1	2	1	1	1	0	0	0	0	0
Submarine bar	3	3	1	3	3	2	3	3	1	3	3	2	1	1	0	0	0	0
Shoals	3	3	1	3	3	2	3	3	2	3	3	3	1	1	0	0	0	0
Channel																		
hanging valley	3	1	0	2	1	0	3	1	0	2	1	0	0	0	0	0	0	0
mouth (river)	3	3	2	3	3	3	3	3	2	3	3	3	2	2	3	3	3	3
inlet	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	0
tidal channel	3	3	2	3	3	2	3	3	2	3	3	3	1	1	2	2	1	0
distributary	3	3	2	3	3	2	3	3	2	3	3	3	1	1	2	2	1	0
drainage pattern	3	2	1	3	3	2	3	2	2	3	3	2	1	2	2	3	1	0
Bay																		
open bay or bight	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
bayhead beach	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
funnel sea	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
trough, u-shape valley	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
closed bay, lagoon	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Site-specific features																		
Berm	2	2	0	3	2	0	3	1	0	3	1	0	0	0	0	0	0	0
Beach ridge	3	3	1	3	3	2	3	3	1	3	3	3	2	2	1	1	0	0
Overwash mark	3	3	0	3	3	1	3	3	0	3	1	1	0	0	0	0	0	0
Spit	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	0
Cusp	3	3	0	3	3	0	3	3	0	3	2	1	0	1	1	2	0	0
Tidal delta	3	3	0	3	3	0	3	3	0	3	1	1	0	0	0	0	0	0
Process features																		
Wave approach	3	3	1	0	0	0	3	2	1	3	3	3	0	0	0	0	0	0
Wave breaking, breakers	2	3	1	3	3	2	3	3	1	3	3	3	0	0	0	0	0	0
Water mass	0	1	1	0	0	0	0	1	1	1	1	1	2	1	0	0	0	2
River plume	3	3	3	0	0	0	3	3	3	3	3	3	3	2	0	0	1	1
Sediment, in suspension	3	3	3	0	0	0	3	3	3	3	3	3	3	2	0	0	1	1
Vegetative life-forms																		
Upland vegetation (moist soils)	2	2	0	3	3	1	3	2	2	3	3	3	3	2	2	2	2	0
wooded	2	2	0	3	3	1	3	2	1	3	3	3	0	0	0	0	0	0
shrubby	2	2	0	3	3	1	3	2	1	3	3	2	0	0	0	0	0	0
grass	2	2	0	3	3	1	3	2	1	3	3	2	0	0	0	0	0	0
Wetland vegetation (wet soils)	2	2	0	3	3	1	3	2	2	3	3	3	3	2	2	2	2	0
wooded swamp	2	2	0	3	3	1	3	2	1	3	3	2	1	1	1	1	1	0
shrub swamp	2	2	0	3	3	1	3	2	1	3	3	2	1	1	1	1	1	0
grass - tidal marsh	2	2	0	3	3	1	3	2	1	3	3	3	1	1	1	1	1	0
salt marsh	2	2	0	2	2	1	3	2	1	3	3	2	1	1	1	1	1	0
freshwater marsh	2	2	0	2	2	1	3	2	1	3	3	2	1	1	1	1	1	0
submerged aquatic plants	2	2	0	0	0	0	2	0	0	3	2	1	1	1	1	1	1	0
Desert vegetation (dry soils)	3	3	0	3	3	1	3	3	2	3	3	3	2	2	2	2	2	0
Vegetated/unvegetated differentiation	3	3	1	3	3	1	3	3	3	3	3	3	0	0	0	0	0	0
Upland/wetland differentiation	2	2	0	3	3	1	3	2	2	3	3	3	2	2	2	2	2	0

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903

Notes:

3 = element quickly and easily recognized;
2 = element fairly easily recognized;
1 = interpretation doubtful or recognition poor;
0 = element cannot be recognized.

TABLE 6

Recognition of Landscape Elements on Topographic Maps of Various Scales
(Degree Accuracy of Quantitative Extraction Indicated)

Landscape elements	1:24,000	1:50,000	1:62,500	1:100,000	1:250,000	1:500,000	1:1,000,000	1:5,000,000
Relief								
high	4A	4A	4A	4B	4C	3C	3C	2C
low	4A	4A	4A	4B	4C	3C	3C	2C
coastal plain	4A	4A	4A	4B	4C	3C	3C	2C
Shore material								
Rocky, mainland	3	3	3	2	2	2	2-1	1
Rocky, skerry	3	3	3	2	2	2	2-1	1
Shingle	3	3	3	2	2	2	2-1	1
Sand, sandy	3	3	3	2	2	2	2-1	1
Siltage	3	3	3	2	2	2	2-1	1
Coral, fringing reef	4	4	4	4	4	3	2-1	2-1
Coral, barrier reef	4	4	4	4	4	3	2-1	2-1
Topographic forms								
Coastline	4A	4A	4A	4A	4A	4A	4A	4B
Promontory	4A	4A	4A	4A	4B	3C	2C	2C
Cliff	4B	3B	3C	2C	2C	2C	2C	1
Truncated spur	4A	4A	4B	3B	3C	3C	1	1
Barrier	4A	4B	4B	4B	4C	4C	4C	3C
Alluvial plain	4A	4A	4A	4B	4C	3C	3C	2C
Natural levee	4B	4B	4B	4B	4C	1	1	1
Dune, stable (vegetated)	2C	2C	2C	1	1	1	1	1
Dune, unstable (unvegetated)	2C	2C	2C	1	1	1	1	1
Tidal flat	4A	4B	3B	2C	2C	2C-1	2C-1	1
Swash zone	1	1	1	1	1	1	1	1
Beach	1	1	1	1	1	1	1	1
Beach crest	3B	1	1	1	1	1	1	1
Hydrographic forms								
Bathyorographic variance								
great	4A	4A	4A	4A	4A	3A	3A	2B
little	4A	4A	4A	4A	4A	3A	3A	2B
flat	4A	4A	4A	4A	4A	3A	3A	2B
Submarine bar								
Shoals								
Channel								
hanging valley	4A	4B	4B	3C	2C	1	1	1
mouth (river)	4A	4B	4B	4B	4C	3C	3C	3C
inlet	4A	4B	4B	4B	3C	3C	2C	2C
tidal channel	4A	4B	4B	4C	4C	2C	1	1
distributary	4A	4B	4B	4C	4C	3C	2C	2C
drainage pattern	4A	4A	4A	4A	3B	3C	2C	2C
Bay								
open bay or bight	4A	4A	4A	4A	3B	3C	2C	1
bayhead beach	4A	4A	4B	4B	3C	2C	1	1
funnel sea	4A	4A	4A	4A	4B	3C	2C	2C
trough, u-shaped valley	4A	4A	4A	4A	4B	4C	3C	2C
closed bay, lagoon	4A	4A	4A	4B	4C	3C	3C	2C
Site-specific features								
Berm	2C	2C	2C	1	1	1	1	1
Beach ridge	4A	4B	4B	3C	1	1	1	1
Overwash mark	2C	1	1	1	1	1	1	1
Spit	4A	4B	4B	3	2C	2C	2C	2C
Cusp	1	1	1	1	1	1	1	1
Tidal delta	2C	1	1	1	1	1	1	1
Process features								
Wave approach	1	1	1	1	1	1	1	1
Wave breaking, breakers	1	1	1	1	1	1	1	1
Water mass	1	1	1	1	1	1	1	1
River plume	1	1	1	1	1	1	1	1
Sediment, in suspension	1	1	1	1	1	1	1	1

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903

Notes:

Recognition

4 = element clearly presented
3 = element fairly clearly presented
2 = interpretation doubtful
1 = element not presented

Accuracy of quantitative extraction

A = accurate measurements can be made
B = accuracy marginal, measurements can be taken depending on degrees of accuracy required
C = cannot or should not take measurements

TABLE 7

Recognition Rating of Landscape-Element Groups on Various Types and Scales of Imagery
(in percentages)

Landscape-element groups	Black-and-white panchromatic			Black-and-white infrared			Color			Color Infrared			LANDSAT					
	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	1:10,000 ±5,000	1:40,000 ±20,000	1:120,000 ±40,000	4	5	6	7	Color Comp	Scanning radiometer
Relief	66	33	33	66	33	33	66	33	33	66	66	66	33	66	33	66	33	0
Shore material	100	81	33	100	76	33	100	76	43	100	76	38	14	24	10	10	14	0
Topographic form	97	95	41	97	87	43	97	92	61	97	79	67	38	41	41	43	43	8
Hydrographic form (all)	100	94	67	79	77	63	94	81	67	92	83	77	58	54	56	58	50	6
Channel forms	100	83	50	94	89	61	100	83	61	94	89	78	44	50	66	72	50	0
Bay forms	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	20
Site-specific features	94	94	22	100	94	33	100	89	22	100	61	50	22	28	22	28	11	0
Process features	80	87	60	20	20	2	80	80	60	87	86	87	53	33	0	0	2	27
Vegetative life forms (all)	69	69	0	86	86	31	97	64	39	100	97	78	39	36	36	36	36	0
Upland	66	66	0	100	100	33	100	66	42	100	100	83	33	17	17	17	17	0
Wetland	66	66	0	76	76	29	95	57	33	100	95	71	43	39	39	39	39	0
Desert	100	100	0	100	100	33	100	100	66	100	100	100	66	66	66	66	66	0
Average percentage of recognition	95	81	34	85	78	41	94	77	52	95	86	76	45	46	41	46	38	5

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA, 22903.

Note:

$$\text{Rating} = \frac{\text{sum actual recognition of each element within group (from Table 2)}}{\text{sum possible recognition of each element within group}} \times 100$$

Table can be interpreted as giving the percentage of capability of a type and scale of imagery for study of a particular group of landscape elements.

TABLE 8

Landscape Elements Grouped by Scales of Dimensionality

Scale	Landscape Elements	
	1	2
Region: Gross scale (most variation approximately 160 - 800 km) of coastal form	Coastline Barrier	Relief Alluvial plain Bathyorographical variance (River) mouth channel form Trough, bay form Lagoon, bay form
	3	4
Area: Medium scale (most variation approximately 16 - 160 km) of differentiation within gross form	Coral reef Promontory Natural levee Tidal channel, channel form Distributary, channel form Funnel sea, bay form	Truncated spur Inlet, channel form Drainage pattern, channel form Open bay, bay form Bayhead beach, bay form
	5	6
Site: Small scale (most variation approximately 0 - 16 km) of local character	Hanging valley, channel form Beach ridge Spit	Shore material: rocky dune shingle beach crest sand berm siltage tidal delta cliff tidal flat

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

Note: Table 8 was constructed from Table 6 according to these criteria: 1 = elements clearly presented and 2 = elements fairly clearly presented on 1:1,000,000 topographic maps; 3 = elements clearly presented and 4 = elements fairly clearly presented on 1:250,000,000 topographic maps; 5 = elements clearly presented and 6 = elements fairly clearly presented on 1:62,500 topographic maps.

Process features, overwash marks, cusps, and beaches do not appear on topographic maps.

Vegetative life forms are not included because they are not describable by these scales and do not consistently appear on topographic maps.

TABLE 9

Recognition Rating of Landscape-Element Groupings of Scales of Dimensionality on Various Types and Scales of Imagery

Imagery (at approximate scale)	Regional Scale	Area Scale	Site Scale	Overall Capability
	Recognition Rate (in percentages)			
Black-and-white Panchromatic				78
1: 10,000	92	100	96	96
1: 40,000	83	92	80	85
1:120,000	69	67	22	53
Black-and-white IR				69
1: 10,000	67	100	96	79
1: 40,000	56	92	82	77
1:120,000	56	72	27	52
Color				78
1: 10,000	83	100	98	94
1: 40,000	67	92	80	80
1:120,000	61	78	42	60
LANDSAT				47
MSS 4	56	64	18	46
MSS 5	56	69	22	49
MSS 6	56	67	13	45
MSS 7	64	72	13	50
MSS 4, 5, 7 (color composite)	58	61	13	44
Satellite Scanning Radiometer	11	6	0	7

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA, 22903.

Imagery availability is a third problem. Since no single agency acts as a clearinghouse for aerial photography, it can take several weeks to locate the desired imagery at the desired scale. The delivery time on most orders is, at best, a month because prints or transparencies are made on request. Table 10 is a listing of the major United States agencies that maintain files of coastal aerial photography. Resolution varies with imagery type but improves as the scale increases. In cases where the desired scale is not available, commensurate resolution might be obtained on other types of imagery at the same or a different scale.

Several types of imagery have been evaluated for their usefulness as information sources for coastal investigations. The conclusions and observations are summarized as follows:

1. Much of the existing literature is of little value when investigating applications of various types of imagery.

2. Quality and scale coverage of imagery types are not consistent.

3. Locating and acquiring necessary imagery are difficult.

4. At least two interpreters should be employed in any study using imagery as a data base.

5. Each imagery type has characteristics which favor application to certain studies. Researchers can increase efficiency by choosing the imagery appropriate to their needs (Tables 4-6).

6. Color-infrared photography offers the best single choice; recognition ratings of landscape elements remain good despite scale reduction. Color IR suits most needs, particularly vegetation analyses. Scales are most effective at 1:130,000 or larger, with the most useful range being 1:20,000 to 1:60,000.

TABLE 10

Sources and Types of Coastal Aerial Photography

Source	Location	Type
Agricultural Stabilization & Conservation Service (801) 524-5856	Dept. of Agriculture 2505 Parleys Way Salt Lake City, UT 84109	Inland by county
American Air Surveys, Inc.	907 Pennsylvania Ave. Pittsburgh, PA 15222	Commercial
Bureau of Land Management	Dept. of the Interior Washington, DC 20242	
Carto-Photo Corp	520 Conger Street Eugene, OR 97402	
National Archives (GSA) (202) 523-3006	Cartographic Archives Division Room 2W Washington, DC 20408	Historical photography prior to 1940.
Chesapeake Bay Ecological Program Office (804) 824-3411	NASA - Wallops Building E105 Wallops Station, VA 23337	Chesapeake Bay and mid-Atlantic coast
Coastal Engineering Research Center (CERC) (703) 325-7135 or 7373	Kingman Building Ft. Belvoir, VA 22060	Index, by engineering district, of available U. S. photography.
EROS Data Center (605) 594-6511	Sioux Falls, SD 57198	Skylab, LANDSAT, NASA, USGS photography
US Forest Service	Dept. of Agriculture Washington, DC 20250	Inland
National Ocean Survey NOAA (301) 443-8601	Coastal Mapping Division C3415 Photo Map & Imagery Section Rockville, MD 20352	Historical to present
Soil Conservation Service	Dept. of Agriculture East-West Highway & Belcrest Road Hyattsville, MD 20781	Primarily inland by county
United States Geological Survey (USGS) (703) 860-6045	Map Information Office Stop 507 Reston, VA 22092	Primarily inland with indexes
Defense Intelligence Agency (DIA)	Att: DS-4A (FDIA) Washington, DC 30201	Military photography, historical to present
Defense Intelligence Agency (DIA) (202) 695-0311	Attention: DS-4A (FDIA) Washington, DC 30201	Military photography, historical to present
New Jersey Office of Shore Protection (609) 292-2630	Div. of Marine Services POBox 1889 Trenton, NJ 08625	New Jersey coast, historical to present
Aero Service Corp. (215) JE3-3900	4219 Van Kirk Street Philadelphia, PA 19135	Commercial
Highway Departments	Area of Location	Statewide

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA. 22903.

7. Satellite imagery has low recognition ratings but is suitable for viewing suspended sediment, river-effluent dispersion, and major landform variations.

8. Relief interpretation from imagery without the aid of stereo viewing is uncertain. However, clues to relief are given by fragmented patterns of landscape, drainage dissection, and land classes.

9. In any study, maps and imagery complement each other: Maps provide precise location, place names, and contours; imagery presents water-body characteristics, process features, terrain details and relationships, and accurate vegetational distributions.

A CASE STUDY
ASSATEAGUE ISLAND NATIONAL SEASHORE

During the more than thirty years in which the National Park Service has been managing coastal park areas, two basic generalizations have become obvious:

> *Management actions designed to control and stabilize the natural modifications of the landscape by marine forces usually result in unexpected side effects that in turn require additional management action.*
>
> *Management actions to control the landscape have been found to be site-specific. Therefore, procedures that were successful in one location are neither necessarily successful nor do they result in the same side effects when applied elsewhere because of the regional nature of the forcing processes.*

The recognition over ten years ago of these inherent management difficulties resulted in the development of intensive study and a program of research on behalf of the National Park Service. These investigations of the physical, ecological, and economic effects of the barrier-island stabilization policy provided a core of knowledge on which a reconsideration of the general policy of stabilization and an examination of alternate stategies were based. In 1972, the Office of the Chief Scientist of the National Park Service asked those who conducted the research investigations to summarize the findings and to propose guidelines for management.

One recommendation was that systematic, regional-scale environmental inventories of landscape dynamics be developed based on historical and current aerial photography. Over the last three years a research program, jointly sponsored by NPS and NASA, has been designed to provide such an information base for Assateague Island National Seashore.

Shoreline Processes: Natural Variations

Inshore and shoreline processes are the driving forces that control barrier-island dynamics, both physically and biologically. Therefore, an understanding of the natural variations (temporal and spatial) of the shoreline, or beach face, is fundamental to resource management.

Variations in shoreline form occur as organized patterns with features or curvatures ranging from beach cusps to very large shoreline meanders (see Glossary). Crescentic coastal landforms are dynamic and respond readily to varying sea state, tides, and sea level. Smaller forms appear, disappear, and migrate along the shoreline; larger ones establish the spatial context for along-the-shore distribution of erosion and storm-overwash processes. Landforms include: 1) Small cusps, or cusplets, only a meter across; 2) beach cusps up to tens of meters long; 3) giant beach cusps, or shoreline sand waves, from 100 to 3,000 m long; 4) secondary capes 25 to 50 km apart; and 5) capes 100 to 200 km apart.

If large-scale crescentic coastal landforms are associated in time and space with inshore processes of similar scale, then it is reasonable to assume that there is a measurable and predictable relationship between the spatial distribution of shoreline forms and manifestations of shoreline dynamics (Fig. 3). This investigation was designed to test if there is a significant correlation between coastal erosion and the orientation of relatively straight shoreline segments within larger sinuous features.

The investigation was based on the interpretation of imagery of Assateague Island from Ocean City Inlet to Chincoteague Inlet at three different scales: 1) Low-altitude photography at scales ranging from 1:5,000 to 1:40,000; 2) high-altitude photography at 1:120,000; and 3) LANDSAT imagery enlarged to 1:80,000 and 1:250,000.

Measuring Historical Change

Since the objective was to monitor changes in coastal landforms and to establish shoreline dynamics through time, a method was developed which enabled relatively rapid and accurate comparison of photographs taken of the same area at different times.

With varying scales of historical aerial photography and the need to measure relatively straight segments of otherwise curved shoreline, base maps at the scale of 1:5,000 were produced that divide the coastline into 3.6-km segments. The base maps were drawn from enlarged sections of the most recent 7.5-minute-series USGS topographic maps. The frame of each map was oriented with the long side parallel to the coastline and positioned over the barrier island so that the shoreline and

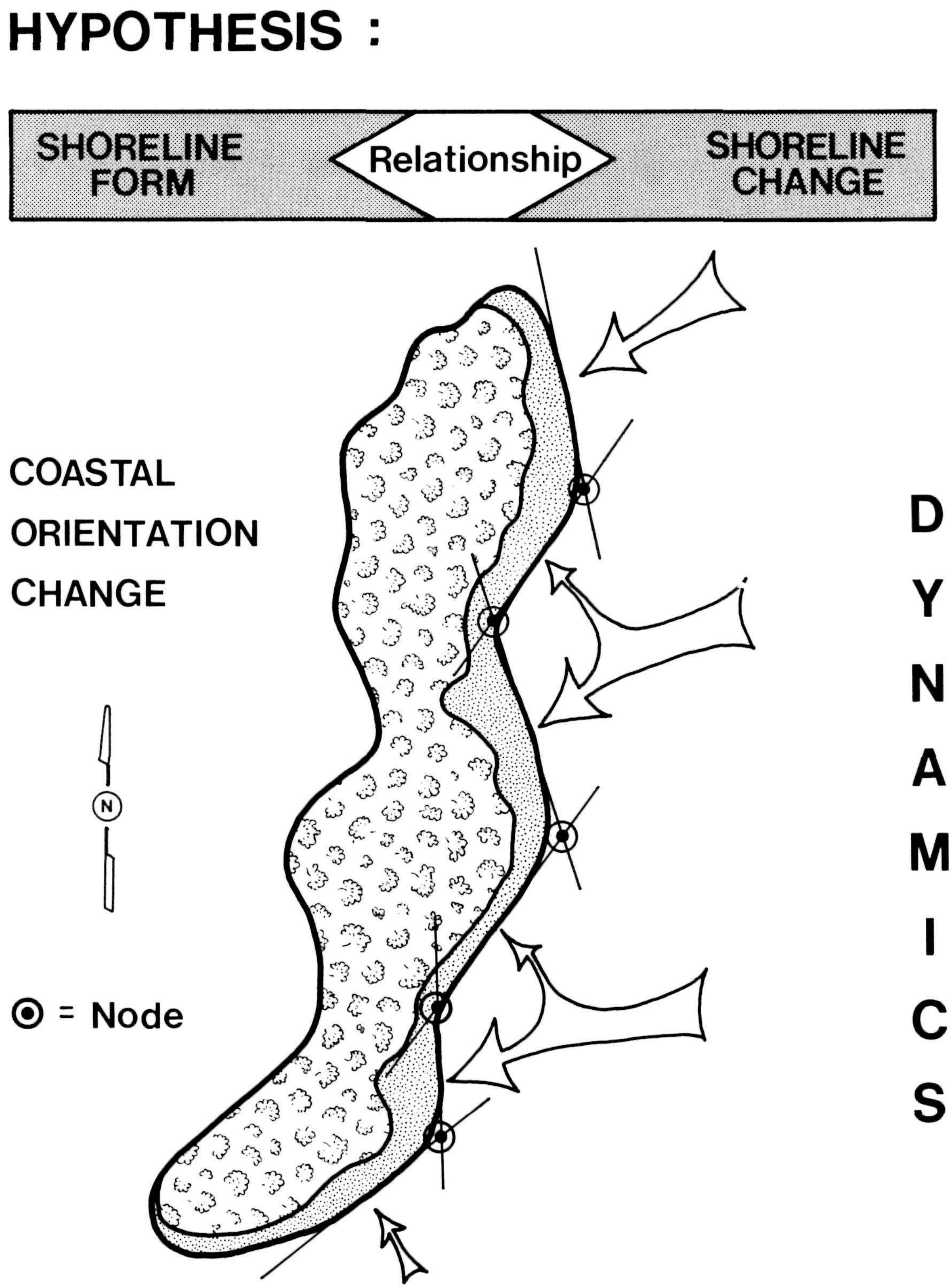

Figure 3: Shoreline form and shoreline dynamics

vegetation line fit within the frame. The long side of the frame, lying entirely over the ocean, served as the base line from which all measurements were made (Fig. 4).

For each base map, aerial photographs were enlarged until the best possible fit of natural and cultural features between photo and base map was obtained. The shoreline and storm-overwash penetration line or vegetation line were then drawn on an overlay map. This process was repeated for each historical photograph of the same area.

The shoreline was defined as the high-water mark. The storm-overwash penetration line was defined by a smoothed line that separates the beach and dune sand or lightly vegetated sand flats from the relatively contiguous stands of dense shrub and grass vegetation.

An orthogonal grid system with transects spaced at 100-m intervals along the coast was used to record, to the nearest 5 m, the points at which the shoreline and the vegetation line intersected each across-the-shore transect. The information was then transferred to computer cards.

A computer program was written which lists the following information for every base map (statistics include mean, variance, standard deviation, number of transects over which mean is calculated, maximum value, and minimum value).

1. Location of vegetation line (VL), shoreline (SL), and overwash-penetration distance (OP=VL-SL) for each of the 36 transects along the coast.

2. Line-printer graphs of VL, SL, and OP.

METHOD OF DATA COLLECTION

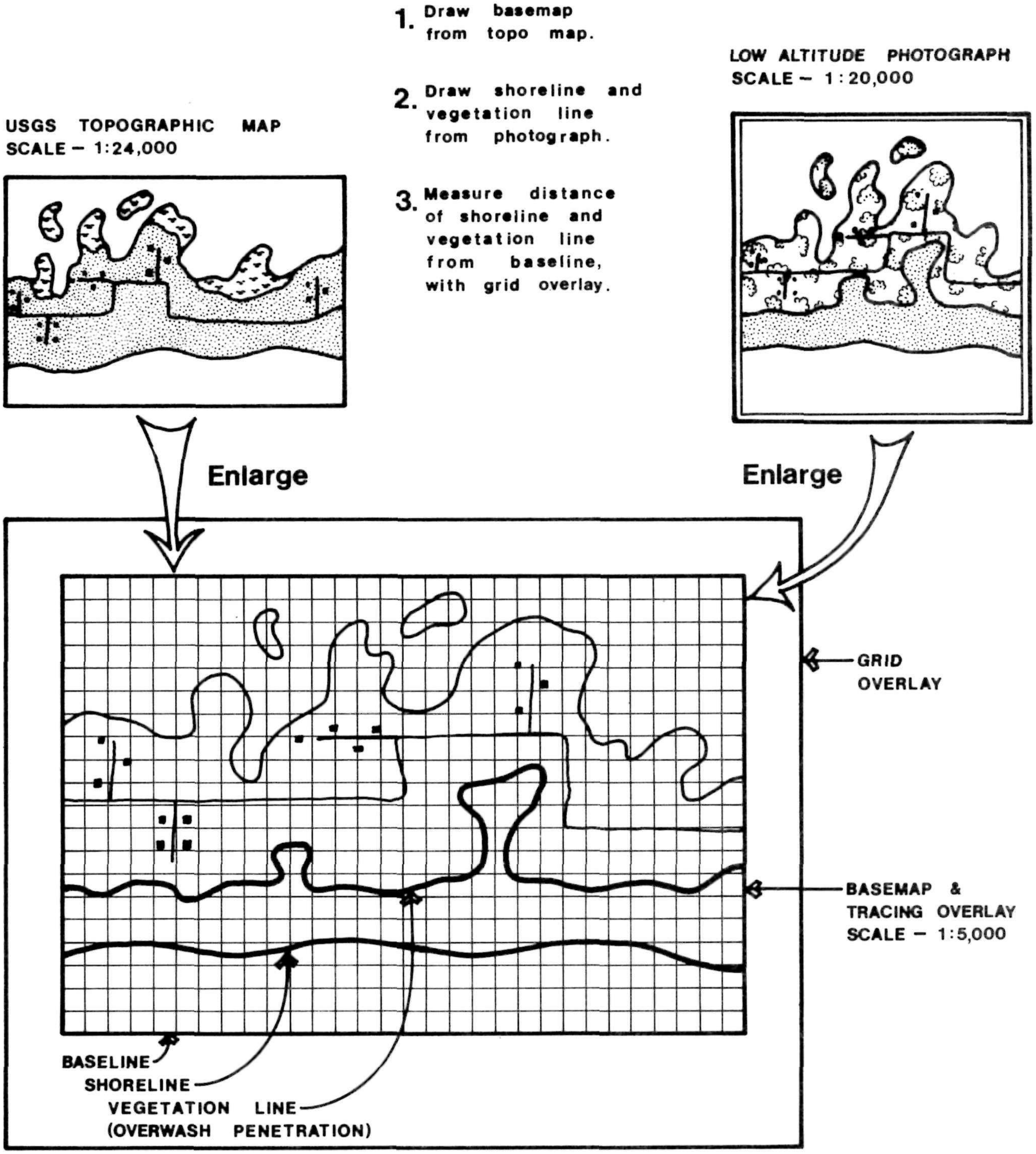

Figure 4: Method of data collection using historical photography, base maps, and a grid-address system.

3. Changes and rates of change in VL, SL, and OP between selected dates (erosion and accretion statistics).

4. Line-printer graphs of rates of change in VL, SL, and OP.

5. Line-printer graphs of the mean + one standard deviation of rate of change in VL, SL, and OP (Fig. 5).

In addition, the following information is provided for sections of any desired length of coast:

1. Statistics on OP for each year and statistics on changes and rates of change in VL, SL, and OP between any two years.

2. Frequency distributions of OP for each year and of rates of change of VL, SL, and OP between any two years.

Measuring Shoreline Form

To answer questions concerning the orientation and length of the shoreline segments within the larger crescentic forms, images of the coastline in the mesoscale range of 1:80,000 to 1:250,000 were needed. LANDSAT imagery is ideal for this purpose; and because the concern was with long stretches of coastline and large crescentic landforms, the relatively low resolution of the LANDSAT imagery was acceptable. The orthogonal accuracy of LANDSAT imagery and the large area of coverage within a single frame rendered it more valuable than high-altitude aerial photography.

By experimenting with various enlargements of the 70-mm LANDSAT negative transparencies, the amount of noise in angular orientation along the coast was controlled. The method used is simple and does not call for sophisticated equipment or digital processing of raw LANDSAT data. The steps are:

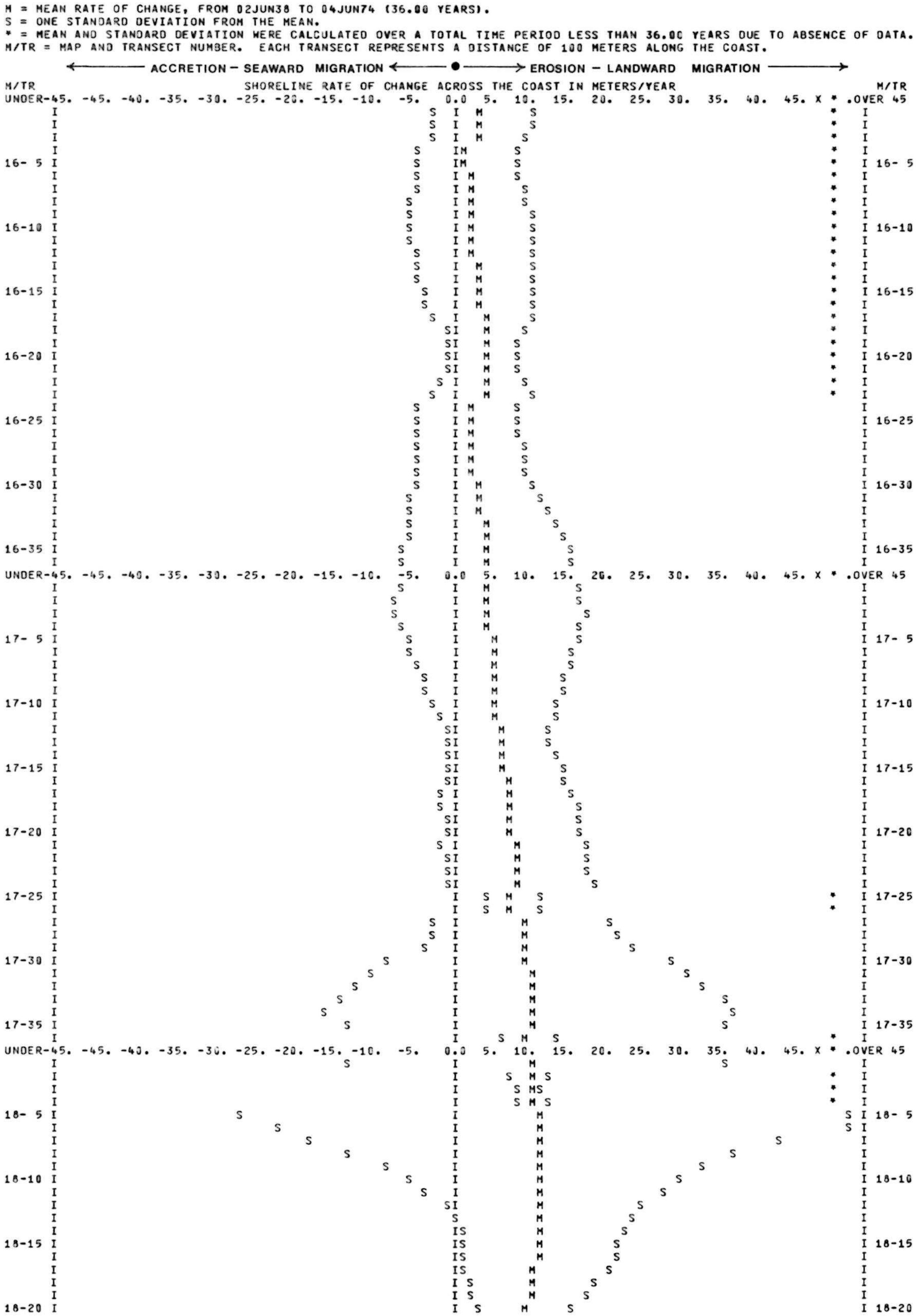

Figure 5: Computer output of historical shoreline change.

1. A photographic print is made from a 70-mm negative of Band 7 of a cloud-free LANDSAT image of the coastal area under study at a scale from 1:250,000 to 1:80:000.

2. A straight edge is placed along each straight-line segment of the coast as perceived by the mapper, and a line is drawn on an overlay. The point of intersection of adjacent lines is called a node and marks the location of change in angularity of the coastline (Fig. 3).

3. Lengths of these line segments are measured and their angular orientations with respect to the north/south line are recorded in degrees north of south or north of east.

4. Each node is located to the nearest 100-m transect previously defined in the discussion on historical data collection. The nodes then define the location of each straight-line segment along the coast.

A certain amount of subjectivity and user judgment is incorporated into this method; therefore, steps 2 through 4 representing one sample, were repeated a number of times to account for sampling error.

This data was then put into digital format compatible with the computer program written for the historical analysis, and mean values for segment length and orientation were calculated in the following manner. The length and orientation of each straight-line segment were assigned to each transect within that segment and the mean values of length and orientation for each transect, measured over all samples, were calculated. Each transect, representing a 100-m segment of coast, had a slightly different mean orientation than adjacent transects. There were, therefore, as many straight-line segments as there were transects--more than five hundred for Assateague Island. When orientation and erosion were compared on a transect-by-transect basis, correlation coefficients seldom exceeded .6. However, the hypothesis states that mesoscale rather than small-scale features reflect the long-term effects of coastal dynamics. Thus if the number of straight-line segments is reduced, the correlation between orientation and erosion should increase.

The computer program was designed to perform this segment reduction, or smoothing process, automatically based on a threshold of change in angular orientation. For example, if a threshold value of 1° is assigned, the program divides the island into segments whose change in angular orientation from one segment to the next is at least 1°. The program begins at one end of the island with the first transect and adds changes in orientation until the algebraic sum exceeds 1°. That particular transect marks the end of the new first segment, the length of which is easily calculated and the orientation of which is the mean of the orientations assigned to the transects within the segment. The process is repeated to the other end of the island to determine the length and orientation of all further segments.

The threshold is then increased by 1°, and the entire process repeated to define a new set of segments. This process is repeated, each time with an increased threshold, until the island is divided into three segments, the minimum allowable number to run a regression analysis with n-2 degrees of freedom. The smaller the initial threshold, the greater the number of initial segments and the greater the number of repetitions before three segments are reached.

Regression Analysis

For each repetition at a given threshold value, regression and correlation analyses were run between pairs of expressions for shoreline form and shoreline dynamics which are summarized below.

A - angular orientation of segment in degrees north of east;

B - length of segment in meters;

C - mean rate of erosion over entire segment in meters a year;

D - mean stadard deviation of rate of erosion in meters a year;

E - average of the mean + one standard deviation of rate of erosion in meters a year.

Independent Variables	Dependent Variables B	C	D	E
A	x	x	x	x
B		x	x	x
C			X	

The analysis includes the correlation coefficient (r), the significance of r (s), the standard error of estimate of r (e), scatterplots, and the regression line (Fig. 6). Scatterplots were used to analyze the data for locating stray points and for discovering multiple populations and nonlinear relationships.

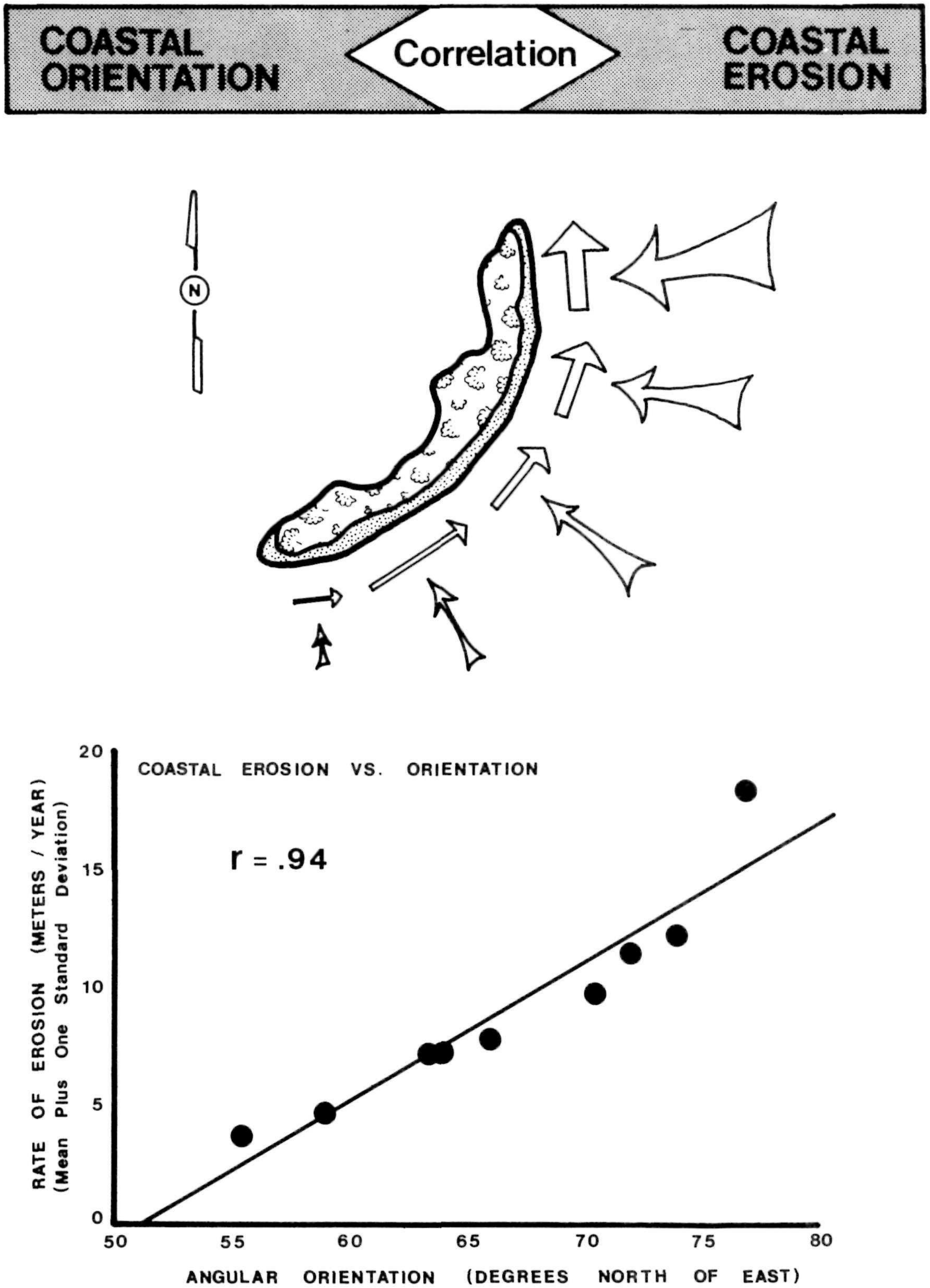

Figure 6: Analysis of coastal orientation versus coastal erosion for Assateague Island National Seashore.

Results

Seven sets of aerial photography were used to establish rates of erosion for Assateague Island: June 1938, May 1949, March 1955, October 1959, April 1961, December 1962, and June 1974. Five samples of shoreline orientation were used to produce the set of mean-transect segments. The southern 1 km and the northern 1.7 km of the island were not included due to obvious anomalistic effects of the adjacent inlets. A LANDSAT enlargement to 1:80,000 was used.

The results of the correlation analysis are shown in Table 11 for angular orientation of coastal segments in degrees north of east versus the mean standard deviation of rate of erosion of the segments in meters a year. It is the most important pairing related to the hypothesis because the standard deviation of rate of erosion best represents the variable nature of coastal dynamics. The graph in Figure 7 shows the relationship between r and the number of coastal segments.

The scatter plots of the regression analysis for the threshold of 1° (36 segments) show three points that are obviously outside of the dominant field (Fig. 8). These points represent three short segments in the northern .7 km of the island and reflect the influence of the jettied Ocean City Inlet. Scatterplots at other thresholds exhibit similar stray points, all of which represent segments within 1.3 km of the northern end of the site and are thus influenced by the inlet. Therefore, the correlations with these segments were rerun and the results summarized (Table 12, Fig. 9).

TABLE 11

Correlation* Statistics for Shoreline Form Versus Coastal Dynamics for Assateague Island

Before Removal of Anomalistic Segments (Fig. 7)

Orientation Change Threshold (degrees N of E)	Number of Segments	Mean Segment Length (km)	Correlation Coefficient (r)	Significance of r (s)	Standard Error of Estimate of r (e)
0.5**	59	0.9	.69	.00001	3.5
1.0**	36	1.5	.64	.00001	3.9
1.5**	27	2.0	.65	.00014	3.7
2.0**	19	2.9	.64	.00168	4.1
2.5**	15	3.7	.64	.00509	3.6
3.0**	15	3.7	.71	.00160	3.4
3.5**	11	5.0	.69	.00999	3.5
4.0***	9	6.1	.63	.03453	3.9
4.5***	9	6.1	.63	.03321	4.3
5.0	7	7.9	.58	.08536	4.4
5.5***	5	11.1	.92	.01291	1.3
6.0***	3	18.4	.99	.04161	0.6
6.5***	5	11.1	.92	.01247	1.4
7.0	3	18.4	.97	.08314	1.2
7.5	3	18.4	.97	.08134	1.2
8.0	3	18.4	.96	.09389	1.5

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

* Correlation of angular orientation (degrees north of east) versus standard deviation of rate of erosion (m/yr).

** Significant at the 1% level.

*** Significant at the 5% level.

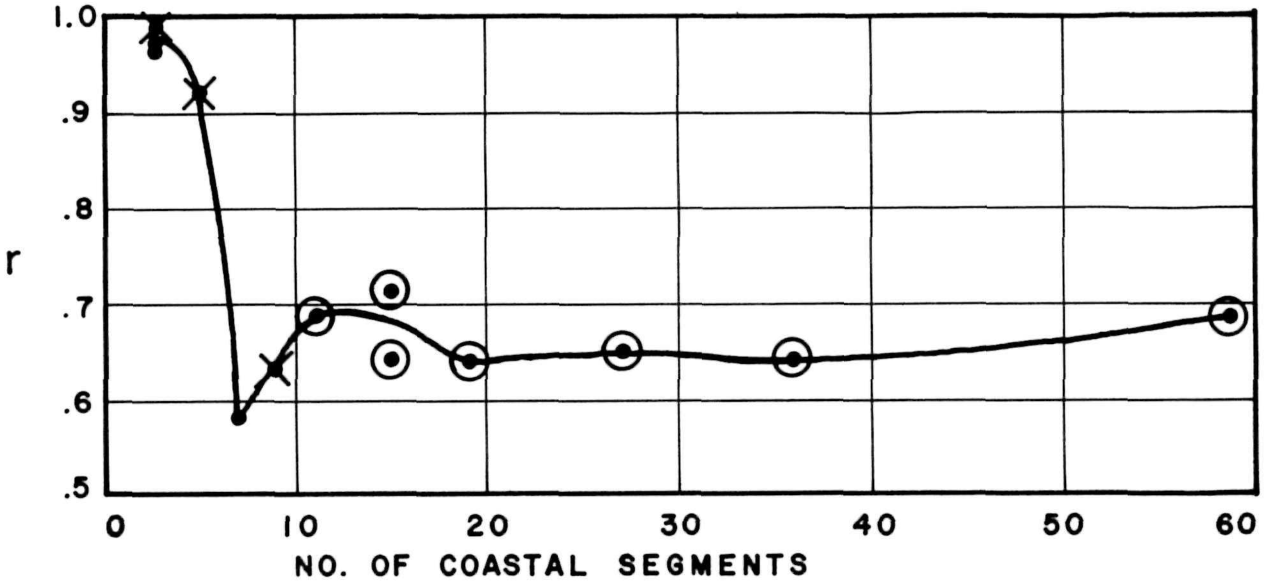

Figure 7: r versus the number of coastal segments for Assateague Island *before* removal of anomalistic segments (Table 11).

r - Correlation coefficient for coastal orientation versus coastal erosion.

⊙ - r is significant at 1% level.

✕ - r is significant at 5% level.

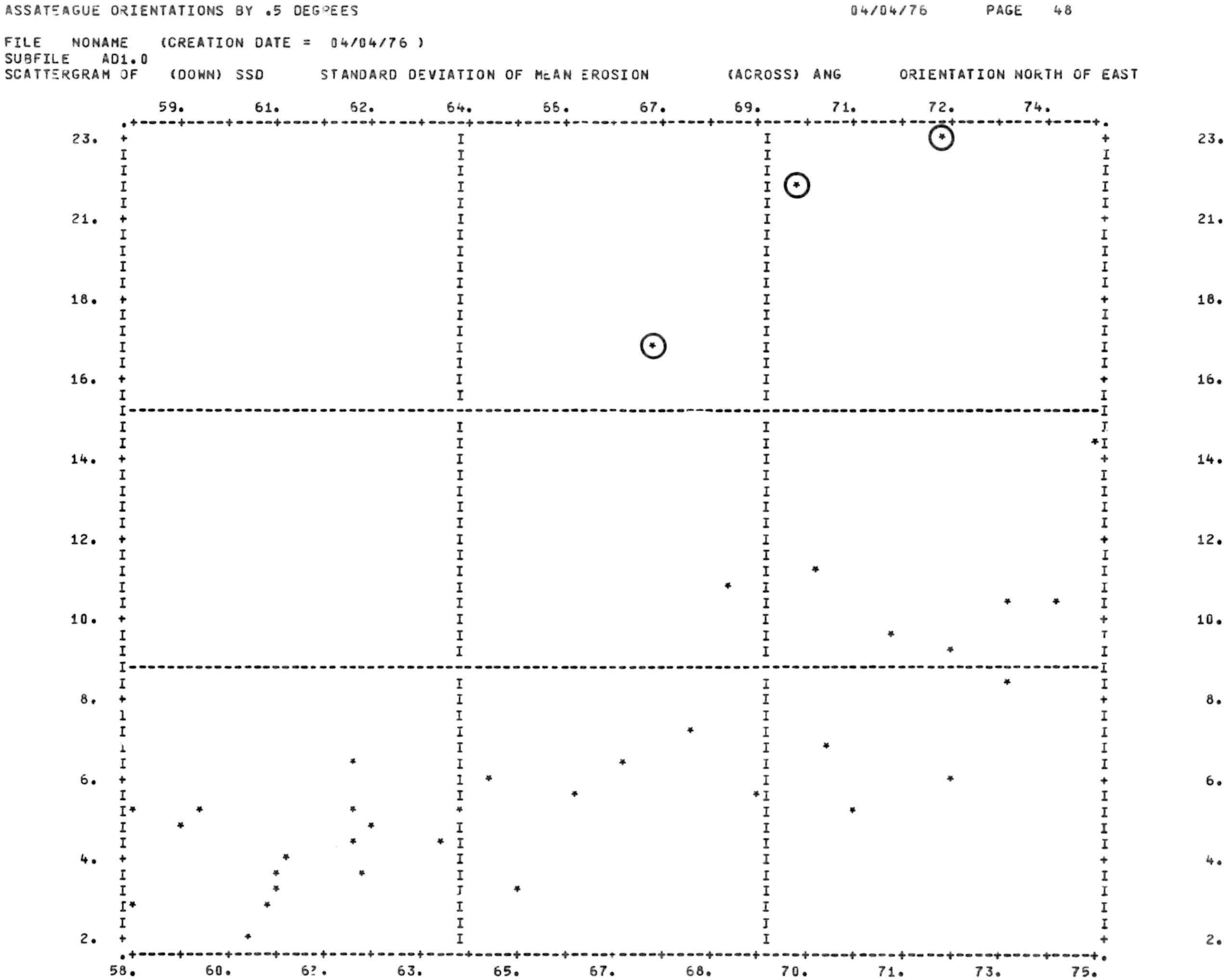

Figure 8: Scatterplot of coastal orientation (degrees) versus coastal erosion (m/yr) for 36 segments of Assateague Island.

TABLE 12

Correlation* Statistics for Shoreline Form Versus Coastal Dynamics for Assateague Island

After Removal of Anomalistic Segments (Fig. 9)

Orientation Change Threshold (degrees N of E)	Number of Segments	Mean Segment Length (km)	Correlation Coefficient (r)	Significance of r (s)	Standard Error of Estimate of r (e)
0.5**	55	1.0	.80	.00001	2.0
1.0**	33	1.7	.80	.00001	1.9
1.5**	25	2.2	.84	.00001	1.7
2.0**	17	3.3	.86	.00001	1.6
2.5**	14	3.9	.84	.00009	1.8
3.0**	15	3.7	.75	.00057	2.9
3.5**	10	5.5	.90	.00022	1.5
4.0**	8	6.9	.92	.00054	1.4
4.5**	8	6.9	.93	.00036	1.4
5.0**	6	9.2	.93	.00364	1.5
5.5***	5	11.1	.92	.01330	1.3
6.0	3	18.4	.99	.05143	0.7
6.5***	5	11.1	.92	.01290	1.4
7.0	3	18.4	.97	.08314	1.2
7.5	3	18.4	.97	.08134	1.2
8.0	3	18.4	.96	.09389	1.5

SOURCE: Coastal Environments Program, University of Virginia, Charlottesville, VA 22903.

* Correlation of angular orientation (degrees north of east) versus standard deviation of rate of erosion (m/yr).

** Significant at the 1% level.

*** Significant at the 5% level.

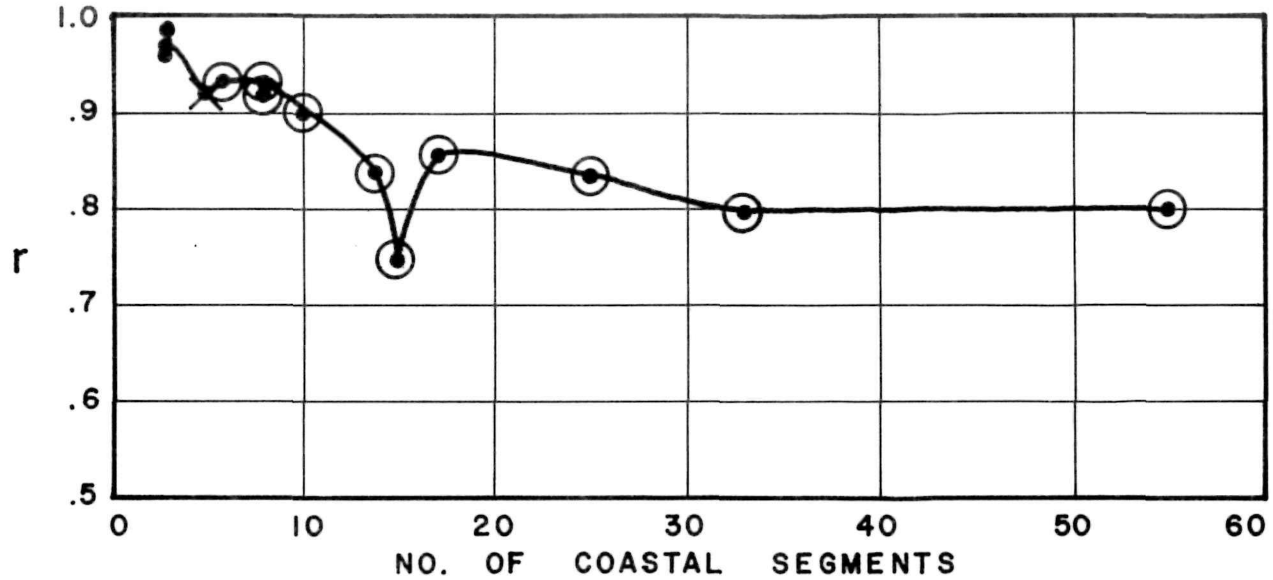

Figure 9: r versus the number of coastal segments for Assateague Island *after* removal of anomalistic segments (Table 12).

r - Correlation coefficient for coastal orientation versus coastal erosion.

⊙ - r is significant at 1% level.

✕ - r is significant at 5% level.

All correlation coefficients increased, most by more than 20%. The highest r's (greater than .9) that were significant at the 1% level occurred when the change in orientation thresholds produced between five and ten coastal segments in the mesoscale range of 5 km to 10 km a segment. It is of interest to note that in four previous samples of drawing coastal segments on a LANDSAT image enlarged to 1:250,000, an average of 9.5 segments was defined.

These results support the hypothesis that shoreline form is highly correlated with coastal dynamics, especially in the mesoscale range. Specifically, the orientation of relatively straight-line segments of the coast of Assateague Island, when measured in the mesoscale range of 5 to 10 km, is significantly correlated with erosion. As the orientation of the coast approaches north/south, the standard deviation of rate of erosion increases.

Conclusions

In the mesoscale range of 1:80,000 to 1:250,000, there is a highly significant (1% level) positive correlation (.9) between the orientation (with respect to an imaginary north/south line) of straight-line segments of the coast as measured from LANDSAT imagery and the mean standard deviation of rate of erosion of those segments on Assateague Island.

As the orientation of any segment of the Assateague coast (excluding the northern 2 km and southern 1 km of the island) approaches north/south, extremes in coastal erosion and storm-surge penetration caused by major storm events have increased in the past and will probably continue to do so in the future.

At the intersection point of two adjacent segments (turning point in the coast), if the point is seaward such as in a false-cape situation, the northern segment is more vulnerable to storm damage than the southern one; if the point is landward such as in an embayment situation, the southern segment is more vulnerable to storm damage.

The above responses to coastal dynamics can be explained by the fact that the major storm forces that strike the coast of Assateague Island arrive from a northeasterly direction.

By measuring coastal orientation, it is possible to determine solely from a recent LANDSAT image of Assateague Island at scales from 1:80,000 to 1:250,000 those sections of the coast which have historically proven to be most dynamic and most vulnerable to storm damage.

This kind of information is an essential part of the Resources Basic Inventory (RBI) which must be amassed before developing and finalizing master plans. The extensive geographical extent of park and seashore areas and the large number of NPS-administered areas preclude most high-density information acquisition other than that from aircraft and satellites.

Remote-sensing imagery provides the viewer with excellent perspectives of regional-scale barrier-island dynamics. When mapping regional boundaries, especially for land/sea interfaces, LANDSAT MSS Band 7 is superior to that of aerial photography. As LANDSAT enlargements approach 1:80,000, the poor resolution of site-specific features is apparent, and noise becomes a problem in image interpretation. Therefore, simple mechanical measurements from LANDSAT imagery should be confined to those features large enough to be measured in terms of kilometers. Features up to 10 or 15 km can be viewed and measured with more accuracy with high-altitude aerial photography (1:120,000). Low-altitude aerial photography (1:20,000) is best used for features ranging in size from a few meters to 1 or 2 km.

This investigation and case study stresses the importance of using three scales of remote-sensing imagery in attempting to use shoreline-form analysis to study erosional trends:

1. *Macroscale* - to determine the mean orientation of a major stretch of coast (LANDSAT);
2. *Mesoscale* - to determine relative degrees of variance in shoreline movement over shorter sections of the coast (LANDSAT and U-2);
3. *Microscale* - to measure absolute erosion rates at specific sites (low-altitude aerial photography).

RESEARCH AND DEVELOPMENT

WALLOPS ISLAND FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WALLOPS ISLAND, VIRGINIA

Wallops Flight Center conducts research in the utilization of practical applications of remote sensing for problems of concern to resource managers within the mid-Atlantic coast region. The program is also intended to develop new techniques which may be used to solve the unique problems of this region. In promoting the use of remote-sensing technology, Wallops Flight Center serves as a catalyst in bringing resource managers and scientists together and supplying them with aerospace tools to solve their ecologically oriented problems.

Investigators with projects underway in the mid-Atlantic region are welcome to submit proposals for cooperative studies to NASA - Wallops Island; however, it must be stressed that Wallops Flight Center is not a research-funding agency and that the Center was not established to provide free data--that is, aerial photography. The program is mainly experimental, with efforts to translate research and developmental results into user needs. Outside investigations are considered on a project-to-project basis. The initial step in establishing a cooperative relationship with Wallops Flight Center is to submit a short "Statement of the Problem," including a brief description of the support and facilites required.

The major thrust of the Wallops Flight Center is the use of multispectral instrumentation to measure a number of areas of the spectrum simultaneously and, from the differences in the responses in each area, to make deductions about objects or conditions which are being sensed. The multispectral approach has been brought to its present stage by researchers in a number of universities such as Purdue, Michigan, Kansas, and California. However, very little work has been done, comparatively speaking, on the remote-sensing problems of the eastern seaboard. The Atlantic coast and Chesapeake Bay offer a combination of environments ranging from the marshes and dunes of the coast to the highly urbanized areas at the head of the bay. Diversified agriculture, wild lands, and industry exist side by side. All of these environments impinge on each other and various types of pollution invade from one environment into another. Using the new multispectral tools, Wallops Flight Center sees this as an unique opportunity for studying these impinging influences.

Remote sensing may be accomplished from a wide range of altitudes--from just above the surface to deep space. In recent years, there has been a spirited debate going on in the reconnaissance community over the relative merits of using aircraft and spacecraft as remote-sensing platforms. Each has distinct advantages. Aircraft can be used for coverage of specific areas from specific altitudes at specific times with relative ease. High resolutions (both spatial and spectral) are possible to attain; areas which are closed to overflights can be avoided; costs for short flights are relatively low; and bad weather can generally be avoided. Imagery from spacecraft has the advantage of the synoptic or regional view. This makes it possible to make direct comparisons of conditions over wide areas at the same moment in time and under identical lighting and sensor-recording limitations. Coverage at the same time of day can be repeated at desired intervals from the same altitude and the same angle of view. This repetitive coverage can be distinctly advantageous for tracing the progress of changes, especially during periods of crisis. Actually, the two types of platforms are best used together to complement each other and to provide a system of multistage sampling which is superior to the use of only one type of platform.

The Chesapeake Bay Ecological Program Office is located at Wallops Flight Center with its excellent airfield and sensor platforms (Fig. 10). At the present time, instrumentation for these platforms consists of sensors dedicated to the visible, infrared, and microwave wavelengths.

AERIAL PHOTOGRAPHY

Aerial photography is the oldest and most widely used form of remote sensing. Its uses are continually growing as the realization of the complexity of the interrelationship of the environmental, commercial, cultural, and financial parameters of twentieth century life become more and more apparent. Within a few decades, it has grown from a scientific

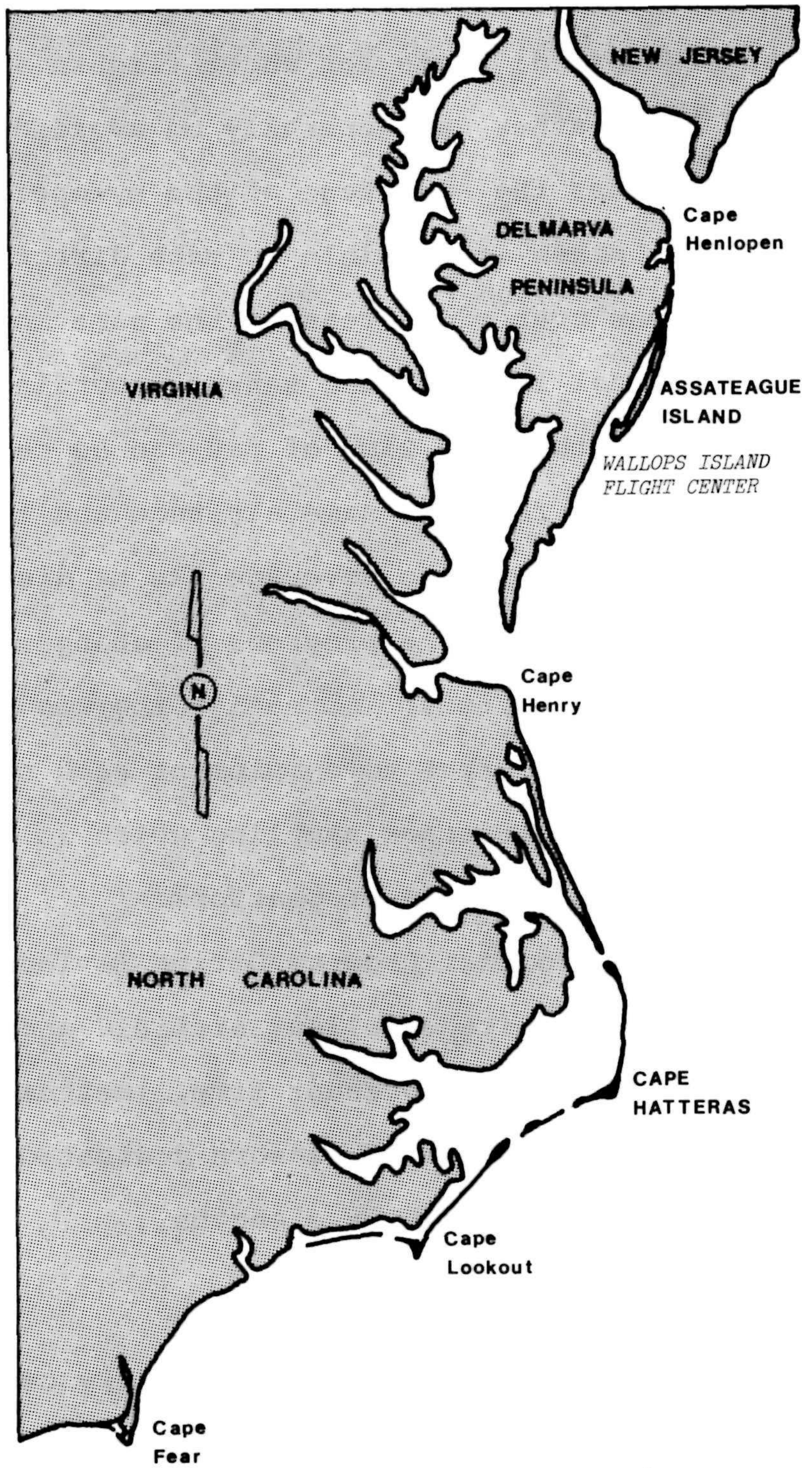

Figure 10: Mid-Atlantic coast with NASA/Wallops Flight Center

novelty to an economic necessity in photogrammetric mapping. Today, its use is being extended into the realm of spectral measurements of imaged phenomena. These measurements, combined with data collected from ground observation stations, are enabling analysts to identify and map vegetation species, polluted waters, soil types, forest boundaries, and diseased plants with a speed and accuracy previously unknown.

Wallops Flight Center has several types of aerial cameras now in use. They are flown on Douglas C-54's, a Bell UH-1H helicopter, and a Beechcraft Queen Air. In the following paragraphs each camera is described, including its most interesting characteristics to remote-sensing data users.

Cameras

Fairchild T-11

The Fairchild T-11 camera is a post-World War II mapping camera which is relatively unsophisticated. However, this lack of complexity makes it easy to operate and maintain.

The camera takes standard 9 1/2-in. (24-cm) roll film and produces 9-by-9-in. (23-by-23-cm) frames of imagery. The lens aperture is f/6.3, but "Waterhouse" stops are available which can be inserted to provide either f/8 or f/11. The aperture setting is part of the shutter mechanism and the camera must be partially disassembled to change settings. This is a distinct disadvantage, not only in the limited number of settings, but also in the lack of an external setting capability. Different targets occasionally require different f-stop settings, and it would be advantageous to make the changes in flight. The shutter is a between-the-lens Fairchild Rapidyne type with settings of 1/75 to 1/500th of a second which can be set externally.

The camera records data on the frame, outside the image area, showing the serial number, the calibrated focal length, the exposure number, time, and flight altitude. The camera does not have provisions for stabilizing its vertical position, for suppressing vibration, or for image motion compensation. These are features found in nearly all modern cameras.

The lens is a Type II Metrogon lens, meaning that it was designed for its metric or mapping qualities. It has a field of view of 74°, which rates it as a wide-angle lens. It has a 15-cm focal length; a short focal length designed to provide strong vertical exaggeration in stereoscopic models to aid map makers in the production of contour maps. The lens is not color corrected. Of the three critical factors in judging the color capabilities of a lens--1) chromatic aberration, 2) spectral transmission, and 3) distribution of light--the first and second factors are not serious for this lens. However, the third factor (light distribution) presents problems because too much light is concentrated into the center of the frame. Antivignetting filters correct this condition. The resolution of the lens is rated at 20 lines/mm.

Hasselblad 500EL Camera

This camera was designed as a hand-held instrument, not for aerial use. It was selected for use by astronauts because of the simplicity of its operation. For Apollo 9, four of these cameras were clustered together and used with different films and filters so that a multispectral experiment could be conducted. Similar camera clusters were made up for a number of aircraft which flew along the Apollo 9 flight path at the same time. As a result of this experiment, the same camera clusters have been distributed to NASA field stations for further experimentation.

The Hasselblad 500EL is a battery driven single-lens reflex camera. The Hasselblads at Wallops have two interchangeable lenses: a 40-mm lens (a relatively short focal length) and an 80-mm lens (a moderately long focal length). The lens is color corrected and will produce color photos of excellent quality. The 80-mm lens has an f-3.8 aperture and it can be stopped down through intermediate stages to f-22. The shutter is a between-the-lens type which can be set from 1 second to 1/500th of a second. In its present configuration, the film magazine takes 12-exposure commercially packaged rolls or it can be loaded with 4.5 m of 70-mm film. The exposures are 2 1/4 by 2 1/4 in. (5.5 by 5.5 cm) and there are no data indicators on the margin.

I^2S "A" Camera

International Imaging Systems (I^2S) has been a forerunner in multispectral imaging systems. These systems employ a principle that allows multiple images of the same area to be taken simultaneously. By changing film and filter combinations, it is possible to obtain multiple spectral exposures of the same area and thus present differences in spectral returns of all of the objects viewed.

The I^2S "A" camera system has four individual lenses and filters attached to a single camera mount which uses one 23-cm magazine. The exposures for all four lenses are made simultaneously with a focal plane shutter. The optical axis of the four lenses are parallel and their focal lengths matched, thus insuring exposures of the same area at the same scale. Black-and-white 2424 infrared film is used in most instances which makes available at least one channel for near infrared recordings; however, any type film and any filter configuration can be adapted to the system. All four lenses have a focal length of 100 mm and each of the four frames has a 3.7-by-3.7-in. (9 by 9 cm) format. The filters that come with the camera were designed to produce either a composite-color or false-color infrared image. They are Wratten 25-red, 57A-green, 47B-blue, and 88A near infrared.

Film positives of the four scenes are reconstituted by using an additative color projector which is also an I^2S product. Color balance and hue can be altered for each channel enabling the user to get the maximum enhancement of the desired object.

I^2S "B" Camera

The "B" version of the I^2S multispectral camera system encompasses several changes employed to better match the LANDSAT MSS (multispectral scanner) spectral bands. Two 70-mm films are used in the place of a single 9 1/2-in. (24-cm) roll and consequently the format for each frame is altered to 2.3 by 2.6 in. (5.8 by 6.6 cm). The focal length is 100 mm and both films are exposed with a focal plane shutter. For LANDSAT-type exposures, black-and-white 2424 infrared film and 2405 panchromatic films are used with filters having spectral band passes of 480-560 nm, 600-700 nm, 725-800 nm, and 800-920 nm.

Fairchild KC-6A Camera

The Fairchild KC-6A camera is a 15-cm focal length aerial camera with a high-resolution wide-angle lens. It has image-motion-control capabilities and an automatic exposure control. The camera has a Geocon IV lens with a 74° field of view, a maximum aperature of f/5.0 and shutter speeds of 1/50 and 1/800 second.

Fairchild K-170 Camera

The Fairchild K-170 is a very versatile reconnaissance camera which has been used for many years in a wide variety of applications. It has a 30-cm focal-length lens with an f/5.0 aperture, with shutter speeds of 1/75 to 1/225 second. The lens is rated at 15 lines/mm. The camera takes 9 1/2-in. (24-cm) roll film and takes 9-by-9-in. (24-by-24-cm) exposures.

Filters

The key to multispectral photography is knowing what to look for and how to record it on film. Once the object or phenomena that is to be recorded is isolated and its spectral response determined, it is necessary to plan a film/filter combination that will produce the subject on film in such a manner as to isolate it from its surroundings. For many instances, this is simply a case of obtaining imagery of sufficient resolution and contrast to recognize the object. However, if the problem is one of isolating diseased trees or discriminating between plant species, it becomes necessary to match film and filter spectral responses to those of the subject matter. It is not unusual to study an imaging problem and realize a need for a special narrow-band filter not offered as an off-the-shelf item. This has led to an extensive assortment of filters available for remote-sensing missions. The filters, the film with which they are used, and their band widths are listed in Table 13.

Film

There are three general types of film used in aerial-reconnaissance cameras: the panchromatic film, the black-and-white IR film, and color film. Technical manuals and tables of characteristics are available for those who wish them.

Panchromatic Film

The name means literally "all color" film because of its even distribution of densities throughout the visible spectrum.

TABLE 13

Filters

Cameras	Designation	Band Pass (nm)	Peak (nm)
Fairchild T-11, KC-6A, and K-170	2A	410-950	Flat
	2E	430-950	Flat
	HF-3	410-950	Flat
	WR3	460-950	Flat
	WR12	310-330, 520-950	318, Flat
	WR15	310-330, 530-950	320, Flat
	WR25	600-950	Flat
	WR47	410-490, 790-950	442, Flat
	WR57	490-590, 760-950	522, Flat
	WR58	500-570, 740-950	530, Flat
	WR61	500-570, 770-950	530, Flat
I^2S "A"	WR88A+4	740-950	780
	WR25A+3	580-700	640
	WR57A+2	480-590	540
	WR47B+1	410-460	460
I^2S "B"		400-500	450
		475-525	500
		575-625	600
		600-700	650
		650-700	680
		630-730	680
		675-725	700
		725-800	760
		400-800	Flat
		800-920	860

SOURCE: Wallops Island Flight Center, NASA, Wallops Island, VA.

There are three Kodak panchromatic films on standard, thick-base stock in general use: Plus-X Aerographic, Double-X Aerographic, and Tri-X Aerographic. These are generally high-speed films with medium resolution. Two other panchromatic films are made on thin-base stock and have slower speeds and higher resolution: Panatomic-X Aerial and Plus-X Aerial. A recently developed ultrathin-base film called High Definition Aerial has a slow speed but extremely high resolution. This group of film can be used with filters to procure the narrow-spectral-band recordings needed in multispectral work.

Black-and-White IR Film

This film records in both visible wavelengths and the near infrared from 0.4 to 1.2 microns. If desired, filters can be used to confine the recordings to the infrared band only. Kodak produces only one black-and-white IR film, Infrared Aerographic, on standard base. When multispectral clusters of cameras are employed, this film is used in combination with panchromatic films; this provides a near-IR spectral band to supplement the visible-light spectral bands. For studies of vegetation and agriculture, IR film can also be used alone to record loss of vigor in vegetation.

Color Films

These three-layer films are coated on standard, thin, and ultra-thin bases and generally fall into two groups: natural-color films and IR-color films. The natural-color effect is produced by the subtractive combination of dyes from the three complementary colors--magenta, yellow, and cyan--in the three layers coated on the film. IR color is produced by shifting these colors so that cyan records the near-infrared band, magenta records the normal-red part of the spectrum, and yellow records the green part of the spectrum. This film was developed for camouflage detection because it gives a different return for vegetation which is cut and used for concealment purposes than the normal return for healthy vegetation.

IR Scanners

IR scanners record only in the infrared band; however, the use of various filtering devices can usually break incoming energy into several narrow bands, if desired. For example, if the scanning is done in daylight, the shorter wavelengths produced by solar reflections may be filtered out so that the resulting recording shows only the emitted energy of the heat within the object imaged. IR scanners have the distinct advantage of being able to record at night and through light haze. However, their low spatial resolution limits them to low elevations. Scanners of this type have a wide variety of applications including the study of thermal pollution from power plants and the study of ground water and ocean currents. Wallops Flight Center has at the present time only one IR scanner, an H. R. B. Singer Incorporated instrument. It is designed for reconnaissance at an altitude of 305 m at a maximum speed of 556 kmh. It has two aperture settings, 1/2 mm which produces a spatial resolution of 3 milliradians (1 m on the ground at 305 m altitude), and 2.5 mm which produces a resolution of 18 milliradians. The instrument senses in the 4 to 14 micron range of wavelengths with a rated sensitivity of 0.1° C. The angle of view is 120°. The recordings are made by photographing a glow tube in flight. The film used is 70 mm in width and the resulting imagery is orthographic only in a narrow strip in the center of the film. On the edges it is distorted by the obliquity of the angle of view and by the scan rate, which is uniform whether sweeping short distances close to the plane or the longer distances at an oblique angle. The imagery has a photographic-like quality with objects emitting high temperatures appearing light in tone and lower temperature objects appearing dark. The imagery produces some surprising results with underground pipelines and the wakes of ships often visible and clearly defined.

Microwave Sensors

Radars operating in the microwave bands are an old and well-tested multispectral tool. However, recent improvements in spatial resolution and in the use of polarized beams have greatly increased their effectiveness. Radar requires a transmitter as well as a receiver and it consumes relatively large amounts of power. The transmitted signal is directed toward the target by an antenna that serves as a collector as well as a transmitter. The interval between the transmission of the pulse and its reflected return is a a measure of distance to the various objects in the scene, and the antenna angle gives the angular position of the objects with respect to the ground track. A smooth road, an angular building, or a power-line tower all reflect signals at different intensities. Probably the feature of most importance is the day and night, fair- or foul-weather capability of microwave radar. The use of polarized beams enables the differentiation of moist soils from dry soils, a feature of interest to the agricultural analyst. Recent work by researchers at the University of Kansas has shown that radar has capabilities for discriminating many land-use patterns and some crop types. Radar is also useful in mapping surface geology because microwaves penetrate forest foilage and give a return representing the mineralized surface.

Some of the most recent remote-sensing instruments to be developed are the laser radars. These instruments operate in many wavelengths from the visible through the microwave. Laser radars using the IR band are reported to be excellent for the study of oil spills. Laser altimeters are so accurate that the heights of ocean swells and tides can be measured. Much is expected of this group of instruments in the future.

Passive microwave recorders are also a group of instruments still in a developmental stage. They record the natural microwave emissions which are similar to thermal emissions but longer in wavelength. They show promise of being capable of measuring surface textures, such as soil types and wave actions at sea. They also show promise for detecting materials several feet below the surface, such as bodies of rock or sand.

GROUND TRUTH

Those who have not been intimately involved in the interpretation of remotely sensed data rarely appreciate the extent to which ground truth must be used. Virtually all information recovered from this type of data has its origin in the experience of people on the ground. The experienced interpreter carries with him in his memory bank a series of mental keys built on experience. These memory keys permit him to extract qualitative but not quantitative data. Even the qualitative data may need additional inputs to make his assessment accurate. For example, a road may appear smooth and an agricultural field may appear fertile, but how smooth and how fertile? The answers to such questions will augment both the quality and the credibility of his information. He can get quantitative information only indirectly. For example, he may recognize the make of an automobile and know from this its length and width, or he may recognize color panels on the ground and know the spectral characteristics of the sensor. As we progress into the multispectral area, the necessity for measuring many of the observed features has become not only important but indispensable. It is no longer sufficient to say that an object in a scene is red. We must know how red, or what is the spectral curve of this image, or to what standard can it be compared. The next question is, "Does the object really have these spectral characteristics or has the optical chain through which the reflected light from the object has passed deformed the observed spectral characteristics?" To determine this we must measure the actual reflected light directly above the object under time and space parameters which are identical or analagous to those under which the imagery was sensed. Some investigators have built computer programs which make it possible to obtain this information indirectly. By including all the appropriate influencing facts (i.e., the sun angle, the latitude, the altitude, etc.), a computer can correct a spectral curve from a deformed curve to the ground-truth approximation of what it should have been.

Another type of ground-truth data other than the observations of man are the recordings of automatic instruments. These may vary from conventional weather recordings to the recordings of some of the new and advanced instruments now under development. For example, a number of new automatic instruments are being developed to record water quality. Some of the new instrumentation, such as the Data Buoy, will telemeter its data to satellites for relay back to earth. This program opens up many new and challenging opportunities for the environmental scientist who works with remote sensing.

Experimentation with ground-truth techniques has led to an important development, the multistage sampling technique. Attempts to compile data on resources of an entire geographical region have demonstrated the problem of handling the immense amount of data that must be processed. The logical alternative was to take a statistical sample of the data population and estimate the total population. Foresters making timber estimates have been doing this type of statistical estimation for years, so it was natural to use this general approach in the first test of a new multistage sampling technique. This test was conducted by Philip Langley of the U. S. Forest Service over Louisiana and Mississippi by flying an aircraft mission simultaneously with Apollo 9 coverage. The aircraft and spacecraft were equipped with identical cameras, filters, and films. First-stage samples were then selected at random from space and aircraft imagery with a probability proportional to a prior prediction as to the relative resource quantity contained in the population units. Increasingly higher resolution imagery was selected on subsamples within subsequent stages. Finally, sampling was undertaken on the ground to obtain the necessary ground-truth data. These ground measurements were expanded through the system to obtain estimates that were valid over the entire area of interest. The sampling error depended solely on the accuracy of the predictions made at each stage. With only ten ground plots totaling only 2 1/2 ha out of the 2 1/2 million ha covered by the Apollo 9 photographs, Langley obtained an estimate of 62 million gross m^3 of timber, with an estimated sampling error of 13%. As better techniques are developed for extracting more reliable information from remote-sensor data, by either manual or automatic methods, investigators will be able to inventory from space vast forested areas, as well as agricultural and land-use values for large regions, with greater precision and with less ground work.

Ground-Truth Van

One of the major problems in acquiring ground-truth data is the necessity of making measurements in areas away from conventional power supplies due to the remote locations of the phenomena studied such as wetlands, forests, seashores, etc. One answer to this would be to have light portable instruments that could be carried in the field. Such systems are in use but they are severely limited due to the lack of adequate recording capabilities. The approach that the Chesapeake Bay Ecological Program Office (CBEPO) has taken is to outfit a Dodge van with a portable 3 KW AC electrical power unit and an extension ladder capable of reaching up to 10 m above ground level. Special racks and fittings have been installed in the van permitting the use of the telespectroradiometer system (TSR) with its computer and its teletypewriter. A video camera system has been installed allowing the TSR operator to view the target he is taking readings on from a video screen inside the van.

The TSR sensor head and the video camera are attached to a gimbaled head on the upper end of the van extension ladder. The operator has the option of operating the extension ladder from either end of the ladder; however, the gimbaled head and the TSR must be operated from within the van.

Wallops Flight Center also has an instrument for skimming the surface of a water body. It is mounted on a boat and skims off a very thin layer of the surface for later analysis in the laboratory. It will be a powerful tool for securing ground truth about water pollution.

Ground-Truth Equipment

Radiometers

Radiation measurements are one of the most important tasks of the ground-truth team. Measurements are made of the total solar energy received at ground level, the spectral reflectance of the substances being studied, and the infrared radiation of these objects. To do this, several radiometers of varying bandwidths are employed. The measurements from these radiometers are used to define the sensor and filter combinations to be used for the remote-sensing missions.

Spectral Data Series 30 Telespectroradiometer

This system consists of a sensor, a minicomputer, and a teletypewriter. Radiant energy is passed through a telescopic optical system to a circular variable interference filter. After passing through the interference filter, the light ray is focused onto a visible or infrared photomultiplier detector. Light energy striking the detector is converted from analog to digital signals. The computer receives the digital signals, computes the ratio of reflected illumination to incident illumination, and prints this information in graphic form for each 12.5 nanometers of wavelength.

This system is also capable of performing statistical tests of previously recorded runs such as regression analysis, multiple-scan averaging, nonparametric statistical classification and computing tristimulus coordinate values.

Instrumentation Specialties Company SR Spectrometer

An ISCO spectroradiometer with a programmed scanning recorder and a calibrated spectral calibration lamp and power supply are also available for field or laboratory use. Although the instrument was not made for field use, it is light enough for one person to carry and has been used as such. When attached to the recording unit, it prints a spectral distribution graph in light energy per unit area per wavelength. This graph must first be corrected with a calibration graph before a true curve is obtained.

The sensor has fittings for a fiber optics head which allows readings to be taken from any angle. Both the fixed and the fiber optics head are made of a teflon diffusing screen which provides a cosine response. The light entering the sensor is divided into monochromatic bands by a wedge interference filter and detected on a planar photodiode. Before reaching the photodiode, the light beam passes an electro-mechanical chopper which permits the use of a lock-in type AC amplifier with a coherent detector.

Barnes PRT-5 Precision Radiation Thermometer

IR radiometers operate in much the same way as the previously described instruments. The only exception is that they do not scan or produce imagery. They are frequently used as ground-truth instruments, but when they are airborne, they are pointed directly downward and they produce a trace of temperatures directly below the flight line. These readings can be used to calibrate the recordings of an IR scanner which is flown in the same aircraft. Since a radiometer covers a relatively large area on the ground, the recordings are best adapted to reading temperatures of large homogeneous surfaces such as water areas, although small objects can sometimes be pinpointed. Wallops Flight Center has one IR radiometer, a Barnes PRT-5. It has a battery pack so that it can be handcarried for ground-truth readings, or it can be airborne and receive its power from the aircraft. It has a meter for direct temperature readings or a temperature trace can be recorded for later evaluation. The spectral range is 8 to 14 microns and the thermal resolution is rated at better than 0.1° C. The field of view is 2° of arc.

Star Pyranometer

A thermopile of 72 CrnI Constantan junctions is in thermal contact with 12 alternating black-and-white painted Cu segments. The temperature difference of the black-and-white segments creates a thermopower of approximately 8 mv per gm-cal/cm^2/min. The detecting surface is mounted on a white plate with a ground-crystal-glass hemispherical cover. This design allows solar direct and scattered radiation plus surface albedo to be measured in the detector's 0.3 to 3.3u range.

Data General Reflectivity Panels

These panels consist of a tricolor red, green, and blue set and a series of five gray-scale panels from white to black.

The tricolor panels have spectral reflectance peaks at 650, 550, and 450 nanometers. The gray-scale panels have reflectance values of 64%, 32%, 16%, 8%, and 4%. All panels are made of Army Duct or vinyl, are 50 by 50 cm, and have corner and side hold-down gromets on 5 cm centers.

Hydrology Equipment

Weighted water-sample bottles and resolution targets are available for providing ground-truth status to project investigators.

Water-Surface Vehicle

A 5-m Boston Whaler with a 50 hp engine is available for acquiring ground-truth samples and making ISCO or PRT-5 spectral measurements.

CHESAPEAKE BAY REGIONAL DATA CENTER

As the amount of imagery, magnetic tapes, flight plans, mission summary reports, and associated documentation grew, along with user request for duplicate data and viewing facilities, it became apparent that a separate facility was needed to provide these services. This facility is the Chesapeake Bay Regional Data Center on the third floor of Building E-105.

In an atmospherically controlled storage area the Data Center retains the original mission film of all remote-sensing missions originating from Wallops Flight Center and film positives of all NASA/AMES and Johnson Spacecraft Center missions over the Chesapeake Bay region. This data is documented, catalogued, and placed in storage for user requests. A 35-mm brouse file with projection viewers is maintained as a quick-reference service to potential users.

Data-analysis rooms with specialized film viewing and data-extraction equipment are provided to investigators. A map file containing USGS and Naval Hydrographic charts is used by mission planners, analysts, and data documentors.

Data Storage and Retrieval

All films magnetic tapes, and 35-mm slides are kept in a limited-access atmospherically controlled storage area. Data handlers receive, catalogue, file, retrieve, and transmit the remote-sensing data to approved users. All data records and data-control operations are handled from this office.

Mission Planning and Analysis

The Chesapeake Bay Ecological Program Office assists principal investigators in acquiring the maximum usable data for their projects with the equipment and instrumentation available for their operations. This consists of planning sensor and filter combinations, flight parameters, and ground-truth instrumentation.

All data from all sensors is analyzed after each mission as an operational check of the remote-sensing systems and to insure that all areas of interest are covered.

Viewing Facilities

There are six viewing areas available to users of Chesapeake Bay Regional Data Center.

Viewing Equipment

Light Tables

A variety of Richards direct-viewing manual- and motorized-reeling light tables are available for data analysis. These include the standard desk type and seated model GFL-9-40, a drafting table with included light source, and a motorized microscopic-carriage multiple-track table.

Itek Viewer - Model AM-6

This viewer has a variable-width rear-projection film viewer and can also accommodate processed panoramic film in widths of 35 and 70 mm and 5.0, 6.6, 8.0, and 9.5 in. (12.5, 17, 20, and 24 cm). Film can be transported in forward or reverse in both scan and slew modes. Film motion is controlled by a joystick on the main control panel. The film platen is mounted on a motor-driven carriage in such a manner that it may be translated in a direction perpendicular to the direction of film travel. The platen, platen carriage, and film transport are mounted on a revolving motor-driven stage that can be rotated slightly more than $\pm$ 180°.

International Imaging Systems Multispectral Mini-Addcol Color Additative Viewer

The Model 6040 International Imaging Systems (I^2S) Mini-Addcol Viewer is a compact four-channel optical projector. Its function is to facilitate the interpretation of multispectral imagery.

Light originating with a lamp is collected by the condenser system which incorporates an IR-reflecting glass to prevent thermal energy from impinging on the film. The visible radiant light then illuminates the film held in the glass platen. The light passes through the film, progresses through the filter and lens, and is reflected by the mirror onto the screen.

All four channels work in an identical manner. Registration in X and Y on the screen is accomplished by moving the lens. The viewer has no capability of scale change for magnification. Each individual channel has its own illumination controls for On/Off, intensity and filter selection, registration controls in X and Y, and film-load and -unload controls. Thus, an operator can project single images or superimpose two or more spectral images in registration on a high-quality rear-projection screen at a fixed magnification for viewing a 9-by-9-in. (23-by-23-cm) image in black and white, monochrome color, natural or false color.

Data-Extraction Equipment

More often than not image data will have to be altered before it is useful to the investigator. These changes may be spatial, as in scale revisions, or spectral, as in density slicing and image enhancement. Several special instruments are provided for these needs.

Bausch and Lomb Zoom Transfer Scope

This is a simple portable binocular instrument used for transferring detail from photography to maps. It uses the "camera lucida" principle of superimposing an image of the photograph onto a map by using a beam splitter inserted into the optical train. Magnifications from .25X to 14X are achieved by using either 10X or 20X eye pieces in combination with the map lens of .1X or .4X and the sliding easel which has a .25X to 1.75X range. Minor rectifications in scale can be accommodated by using an anamarphic system which enlarges in only one direction. This should be useful in reducing the slant-range distortion in radar imagery.

The photo easel can be either back-lighted with a cold cathode-light grid for transparencies or illuminated with two 30W swivel-mounted lamps. The map is lighted with three 1.8-amp 12-volt adjustable lamps. An illumination-control unit is provided to give continuous variable light levels for both the photograph and the map.

Kargl Map Projector

This is a rapid scale-change instrument specifically designed to make reductions ranging to 1/4 size and enlargements up to 4X. Suitable for graphic-arts application as well as mapping compilation and revision, this all-purpose projector features an X-Y tilt easel (slants up to ± 4°) open at three sides which is capable of accommodating large copy or roll material.

Focusing is completely automatic throughout the entire scale range. Copy is evenly illuminated by brilliant tungsten-iodide bulbs and projected through a precision-engineered optical system onto a 60-by-97-cm glass tracing table of convenient working height (107 cm from the floor).

All mechanical components, including lights and lenses, are located beneath the tracing area to allow uninhibited movement around the table without interference from shadows.

Map-O-Graph Reflecting Projector

This instrument has the capability of enlarging or reducing paper-print images to fit base maps. As in the Kargl and Zoom Transfer Scope, the primary use of this instrument is in transferring detail from late-date remote-sensing imagery to base maps.

Bausch and Lomb Zoom 240 Stereoscope

This instrument is available for stereoscopic viewing of photographic roll film. It has a continuously variable magnification capability from 3.5X to 120X. The pod is attached to a Richards variable-intensity-illumination light table. The pod can be used in either a monoscopic or stereoscopic mode. Rhomboid arms extend the light-table viewing range to approximately 38 cm. The in-focus zoom magnification has a range from .7X to 3.0X and there is a scale-matching capability of 4:1.

Photomation System P-1700 Microdensitometer

The Photomation System P-1700 Microdensitometer is manufactured by Optronics International, Incorporated. This system is a combination of a scanning digital microdensitometer - film writer interfaced to a minicomputer, a magnetic tape recorder, and a teletype machine. This equipment belongs to the Wallops' Applied Science Directorate but can be used by range users to convert pictorial information on film into digital form suitable for HW625 computer processing.

The film to be scanned is placed over an opening in a cylindrical drum which rotates at high speed. The density data is read by an incoherent optical system which is always on axis to guarantee both linearity and stationarity. After each circumferential record has been scanned, the entire optical system (illumination and detection) is then stepped along the axis of the drum in preparation for the next record. The illuminating and detecting optical apertures and the spacing between density samples in both the axial (X) and circumferential (Y) direction are all variable. The system electronically corrects for zero density with each revolution of the drum by introducing an open slit into the light path.

The sampled density is amplified in a logarithmic amplifier and fed to an analog-to-digital converter. The digital data is transferred to the computer through the interface and control circuits. Each density point uses eight bits allowing the density range to be divided into 255 equal parts.

In the writing section, the unexposed film is mounted on a rotating drum which is contained in a detachable cassette. A modulated-light source (light-emitting diode) exposes spots on the film via an aperture and lens system, the exposure time being much shorter than the time between spots. The exposure of the film is performed on a point-by-point basis with each separate spot being exposed to a density level between zero and 3.0 D. As the drum rotates, a continuous sequence of spots is produced on the film around the circumference of the drum (Y direction). The optical carriage is then advanced axially (X direction) ready for the next scan line. A truly orthogonal grid is generated by a rotary-shaft encoder and a ball screw driven by a stepping motor.

Macbeth TD-404 Digital Readout Transmission Densitometer

This is a single-unit transmission densitometer equipped with four spectral filters for color and gray-scale density measurements within a 0 to 4.0 density range.

IMAGERY: ADVANTAGES, DISADVANTAGES, BEST USES

Black-and-White Panchromatic Photography

Advantages

Resolution is excellent; topographic forms, including beach features and beach zones, are easily distinguishable. Hydrographic forms are clear and submarine features are visible in greater depths of water than on infrared photography. Vegetation forms are fairly easy to distinguish.

Disadvantages

This photography is less clear than either infrared or color. Tonal range decreases as the scale decreases; identification of features is more difficult. Elevation changes are not apparent; cliffs are hard to recognize without a stereoviewer. The scale is usually too large to view regional patterns and large spatial relationships without splicing; thus drainage patterns, bar systems, river plumes, etc., can be identified but not seen in their spatial perspective.

Best Uses

This imagery provides the best detailed resolution of small features, especially along the shoreline. It is also good for identifying vegetation.

Recommended Scale

1:20,000 because of tonal-range decrease.

Infrared Black-and-White Photography

Advantages

Resolution of detail is excellent; definition is considerably better than on black-and-white panchromatic. Clarity is better than on color prints, but color provides a wider range of tones. Vegetation forms (broadleaf and coniferous types differentiated) and beach features (even to aeolian drifts behind dunes) are clearly defined. Wet and dry areas are shown in high contrast; drainage, shoreline, wetlands, and tidal stages are clearly demarcated.

Disadvantages

Prints cannot be enlarged and still retain the same resolution and brightness as transparencies. Suspended sediment and submerged deposits are not visible. Wave patterns are not visible unless sun reflects into the camera.

Best Uses

This imagery provides the highest contrast between wet and dry areas and shows good discrimination of vegetation. Identification is improved when used in conjunction with black-and-white panchromatic imagery.

Recommended Scale

1:20,000 or larger

Color Photography

Advantages

A wider range of tone is available on color imagery than on black and white permitting easier identification of features at smaller scales. Shoreline composition is fairly easy to detect, especially at larger scales. Vegetation forms and elevation changes appear clearly; at 1:10,000 and larger, cliffs can be identified without stereoscopic aid. Suspended sediment appears very clearly and shallow bathymetric variations can usually be discerned. Reolution of detail is excellent but better on transparencies than on prints.

Disadvantages

There is considerably less coverage for higher altitudes. Variations from true color can confuse identification.

Best Uses

This imagery form would be best used in studies concerned with elevation variation (including cliffs), shoreline composition, sediment suspension, and bathymetric variation. It would also be good for discriminatory studies of water indicators and for topographic variation studies (without the aid of a stereoviewer).

Recommended Scale

1:12,000 or larger

Color-Infrared Photography

Advantages

Color IR combines the advantages of a wide tonal range of color, the sensitivity of detail, and wet/dry contrast of infrared. Vegetation forms are more clearly defined than on color and drainage channels and land/water interfaces are clearly seen. Soil moisture differences, wetland-vegetation types, and high- and low-water marks are clearly demarcated. Shoreline composition can be interpreted on larger scales. Mangrove shorelines and brackish water marshes show sharp delineation at scales of 1:10,000 and up.

Disadvantages

Color IR does not penetrate water very far and is not suitable for studying bathymetry or sedimentation plumes.

Best Uses

Color IR is the best choice of imagery for general use or if only one choice of imagery is available. It excels when used in studies requiring differentiation of wetland vegetation forms.

Recommended Scale

All scales from 1:130,000 to 1:5,000

LANDSAT Imagery

Satellite data provides nonphotographic imagery by converting electronic signals to photographic negatives. Images are available as 70 mm negatives (1:3,369,000) or as enlarged prints at scales of 1:1,000,000, 1:500,000, and 1:250,000. The multispectral scanner (MSS), one of two types of LANDSAT sensors, produces images at four different wave bands (4, 5, 6, 7). Because LANDSAT imagery was not intended for highly detailed studies or large-scale precision, it is best suited for regional studies involving the distributions and relationships of small- to medium-scaled features.

Band 7

Advantages

High contrast between wet and dry areas provides sharp delineation of shoreline configuration drainage patterns. Tidal flats, marsh/water interfaces, upper wetland boundaries, and large plant communities are clearly visible in spatial perspective.

Disadvantages

Landscape elements not associated with shoreline configuration (bay form, barriers, etc.) are nearly impossible to identify. Differentiation within wetland types is difficult. This MSS band provides the poorest view of sediment drift of all.

Best Uses

This imagery will benefit any study requiring a distinction between wet and dry areas, an analysis of regional patterns, or an identification of gross elements in spatial perspective, such as drainage patterns, barrier chains, etc.

Recommended Scale

1:250,000 - if enlarging capabilities are available, 70 mm negatives are good for producing prints up to 1:100,000.

Band 6

Advantages

Topograghic variations are better distinguished than on Band 7 because of more grey tones; for example, patches of agricultural land and beaches appear. Shoreline configuration forms (bays, headlands, islands, etc.), marsh/water interfaces, and upper wetland boundaries are clearly seen. However, land/water definition which is very clear here is clearer on Band 7.

Disadvantages

Because of the narrow tonal range, many land features are difficult to interpret. Small details, if they appear at all, are not recognizable; resolution is poor except for land/water interfaces. Wetland boundaries are fuzzy.

Best Uses

Studies involving land/water contrast or land-use practices can take the most advantage of Band 6 imagery.

Recommended Scale

1:250,000 - if enlarging capabilities are available, 70 mm negatives are good for producing prints up to 1:100,000.

Band 5

Advantages

Band 5 gives the best general image of all the MSS bands. Sediment patterns are clearly seen and not as affected by haze as Band 4. Land features are clearer than on Bands 6 or 7, with vegetated areas apparent. Shallow-water batymetric variations (15-20 m), water masses, and tidal flats are visible.

Disadvantages

Land/water interface is only clear where the shoreline is sand. Relief is almost impossible to interpret because of poor tonal definition. Vegetative life forms cannot be distinguished although vegetated versus nonvegetated areas are clear.

Best Uses

This band can be used to advantage in studies of gross topographic features and relationships (mountain ranges, flood plains, etc.) and in identifying regional patterns of sediment drift.

Recommended Scale

1:250,000 - if enlarging capabilities are available, 70 mm negatives are good for producing prints up to 1:100,000.

Band 4

Advantages

Band 4 gives the best view of topographic forms when they are not obscured by atmospheric haze. Relative depth and turbidity of water bodies and sediment drift are clear; water masses can be seen.

Disadvantages

Land/water interfaces are difficult to discern and Band 4 imagery is the most affected by atmospheric conditions.

Best Uses

This imagery provides good coverage of regional views of topographic forms and sediment drift.

Recommended Scale

1:250,000 - if enlarging capabilities are available, 70 mm negatives are good for producing prints up to 1:100,000.

Color Composite: Bands 4, 5, and 7

Advantages

Wetland vegetation is fairly easy to identify because the water-table level is interpretable. Shoreline configuration, associated forms, and drainage patterns are well defined and land features are enhanced. Large plant communities can also be seen.

Disadvantages

This imagery gives poorer resolution than on black- and white bands with fuzzy boundaries between vegetative forms and water interfaces. Sediment drift is ill-defined; relief and bathymetric variation are not interpretable.

Best Uses

This imagery clearly covers regional relationships and patterns of major land forms, shoreline configuration, and river mouths, and drainage patterns.

Recommended Scale

1:250,000

Satellite Scanning Radiometer

Advantages

Because this black-and-white imagery is thermal, the edge of the Gulf Stream and approximate location of the continental shelf may be identified. Weather patterns are very clear and river mouths and rough outlines of large land masses and bodies of water are visible.

Disadvantages

A very narrow tonal range permits recognition of gross features only: sumbarine features and barrier islands less than about 8 km wide cannot be seen. Clouds frequently obscure the coastline.

Best Uses

This form is best used in studies involving weather patterns and their relation to continental position.

Recommended Scale

Scale is standard: approximately 1:20,000,000 to 1:25,000,000.

INVENTORY OF AERIAL PHOTOGRAPHY COVERING THE MID-ATLANTIC BARRIER ISLANDS

Many different government agencies provide aerial photography for the general public. Unfortunately, no single agency lists all the photography ever flown. The EROS Data Center, Sioux Falls, South Dakota, has most of the photography flown by NASA, USGS, and other federal agencies. The National Ocean Survey, NOAA, Rockville, Maryland, has the most comprehensive coverage of the coastal United States. The U. S. Army Corps of Engineers, Soil Conservation Service, and various state highway departments are other major depositories of aerial photos. No agency has an updated easy-to-read index of photography listed by geographical area; however, EROS will supply a computer listing in coded form.

To facilitate the collection of historical data covering the National Seashores, a list of all known coastal aerial photography of Assateague Island, Cape Hatteras, and Cape Lookout National Seashores has been compiled. The information is in computer format with flight lines located by geographical or cultural names. Each entry represents a continuous flight line, is fed to the computer on a single card, and contains the following information if available at the time of compilation: start and finish of flight line, date, scale, film type, number of frames, first and last frame numbers, stereo or not, source, and identification number. In some cases an entry represents a partial flight line; the source agency should be contacted (Table 13) to determine the full extent of coverage represented by a segmented listing.

Flights are categorized by major geographical locations, such as Assateague Island. Within each area, the lines are first listed chronologically and then by scale. The 15th of the month was assigned where the flight day was unknown and June was assigned where the flight month was unknown. The heading has an abbreviation key.

ASSATEAGUE ISLAND AERIAL PHOTOGRAPHY.

KEY TO ABBREVIATIONS.

FILM. COL=COLOR CIR=COLOR INFRA-RED PAN=PANCHROMATIC (BLACK AND WHITE) BIR=BLACK AND WHITE INFRA-RED.
MUL=MORE THAN ONE OF THE ABOVE AVAILABLE.
FRM=TOTAL NUMBER OF FRAMES IN FLIGHT LINE. FIRST=FIRST FRAME NUMBER. LAST=LAST FRAME NUMBER.
IF ABOVE=0, INFORMATION WAS NOT IMMEDIATELY AVAILABLE AT TIME OF COMPILATION.
S=STEREO COVERAGE = X IF OVERLAP IS 50 PERCENT OR GREATER.
SOURCE. ASCS=AGRIC.STABIL.AND CONS.SERVICE. NASA=EROS DATA CENTER.
CENG=CORPS OF ENGINEERS. NOAA=NATIONAL OCEAN SURVEY, NOAA, ROCKVILLE, MD.
COMM=COMMERCIAL. OTHR=OTHER.
DIA=DEFENSE INTELLIGENCE AGENCY. USAF=AIR FORCE.
EROS=EROS DATA CENTER, SIOUX FALLS, S.D. USGS=USGS, RESTON, VA. OR EROS DATA CENTER.
NARC=NATIONAL ARCHIVES. USN=NAVY.
NAS=NAVAL AIR STATION. WALL=NASA/WALLOPS,VA. OR EROS DATA CENTER.
I.D.=MISSION, ROLL, FLIGHT, ACCESSION, OR OTHER IDENTIFYING NUMBER.
NOTE. FLIGHTS FLOWN WITH SCALES GREATER THAN 1/200,000 HAVE A 2.2-INCH FORMAT. ALL OTHERS HAVE A 9-INCH FORMAT.
MILITARY FLIGHTS CAN BE OBTAINED THROUGH THE DIA.

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
1	OCEAN CITY INLET	TO OCEAN CITY INLET	18-SEP-33	1/ 4,000	PAN	1	0	TO	0		CENG	
2	OCEAN CITY INLET	TO OCEAN CITY INLET	1-JUL-34	1/ 8,000	PAN	1	0	TO	0		CENG	
3	OCEAN CITY INLET	TO OCEAN CITY INLET	6-DEC-35	1/ 5,000	PAN	1	0	TO	0		CENG	
4	OCEAN CITY INLET	TO OCEAN CITY INLET	6-DEC-35	1/ 12,000	PAN	1	0	TO	0		CENG	
5	OCEAN CITY INLET	TO MCCABES ESTATE	7-MAY-38	1/ 20,000	PAN	6	0	TO	0		NARC	ANN24
6	OCEAN CITY INLET	TO MCCABES ESTATE	7-MAY-38	1/ 20,000	PAN	6	0	TO	0		NARC	ANN21
7	OCEAN CITY INLET	TO OCEAN CITY INLET	15-OCT-44	1/ 21,000	PAN	1	97	TO	97		USAF	4M 777
8	CAPE HENLOPEN	TO ASSATEAGUE ST PARK	31-OCT-44	1/ 21,000	PAN	48	55	TO	102	X	DIA	16PS ROLL1
9	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-45	1/ 11,000	PAN	1	8	TO	8		USAF	
10	*N OF OCEAN CITY*	*TO N END OF ASSATEAGUE*	21-FEB-46	1/ 11,000	PAN	18	1	*TO*	18	X	*DIA*	16PS
11	OCEAN CITY	TO NORTHERN ASSATEAGUE	21-FEB-46	1/ 11,000	PAN	6	6	TO	11	X	DIA	6P121
12	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAY-48	1/ 8,000	PAN	4	83	TO	86		USGS	AMS59 VV
13	OCEAN CITY INLET	TO MCCABES ESTATE	3-MAY-49	1/ 20,000	PAN	7	580	TO	586	X	NOAA	490
14	MD/VA BORDER	TO CHINCOTEAGUE INLET	3-MAY-49	1/ 40,000	PAN	11	580	TO	590	X	NOAA	490
15	ACCOMACK COUNTY,VA	TO ACCOMACK COUNTY,VA	15-JUN-49	1/ 20,000	PAN	0	0	TO	0	X	ASCS	AN051001
16	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-NOV-49	1/ 20,000	PAN	1	74	TO	74		ASCS	ANO 5E
17	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-NOV-49	1/ 20,000	PAN	1	81	TO	81		ASCS	ANO 5E
18	WORCESTER COUNTY,MD	TO WORCESTER COUNTY,MD	15-JUN-52	1/ 20,000	PAN	0	0	TO	0	X	ASCS	ANN24047
19	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-52	1/ 20,000	PAN	2	17	TO	18		ASCS	ANN 1K
20	CHINCOTEAGUE ISLAND	TO OCEAN CITY INLET	14-MAR-55	1/ 20,000	PAN	27	4626	TO	4652	X	NOAA	55W
21	ACCOMACK COUNTY,VA	TO ACCOMACK COUNTY,VA	15-JUN-57	1/ 20,000	PAN	0	0	TO	0	X	ASCS	AN051001
22	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-OCT-57	1/ 20,000	PAN	1	13	TO	13		ASCS	ANO 2T
23	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-OCT-57	1/ 20,000	PAN	1	18	TO	18		ASCS	ANO 2T
24	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAY-58	1/ 20,000	PAN	2	197	TO	198		ASCS	ANN 2T
25	WORCESTER COUNTY,MD	TO WORCESTER COUNTY,MD	15-JUN-58	1/ 20,000	PAN	0	0	TO	0	X	ASCS	ANN24047
26	S OF MD/VA BORDER	TO FISHING POINT	5-OCT-59	1/ 25,000	PAN	9	9393	TO	9401	X	NOAA	59W
27	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	5-OCT-59	1/ 25,000	PAN	2	9403	TO	9404	X	NOAA	59W
28	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-60	1/ 60,000	PAN	1	4001	TO	4001		USGS	AF59 35
29	MD STATE PARK	TO CHINCOTEAGUE ISLAND	21-APR-61	1/ 15,000	PAN	20	6244	TO	6263	X	NOAA	61W
30	NAT WILDLIFE REFUGE	TO NAT WILDLIFE REFUGE	21-APR-61	1/ 15,000	PAN	4	6260	TO	6263	X	NOAA	61W

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
31	S OF OCEAN CTY INLT	TO CHINCOTEAGUE ISLAND	21-APR-61	1/ 15,000	PAN	25	6265	TO 6289	X	NOAA	61W
32	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-61	1/ 30,000	PAN	1	9305	TO 9305	X	NOAA	60S
33	OCEAN CITY INLET	TO MD/VA BORDER	28-NOV-61	1/ 15,000	PAN	30	9067	TO 9096	X	NOAA	61S
34	ASSATEAGUE	TO ASSATEAGUE	17-JAN-62	1/ 0,000	PAN	69	0	TO 0	X	COMM	ASS.NAT.SS.
35	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAR-62	1/ 5,000	PAN	5	2073	TO 2077		USGS	MATS62 1
36	CHINCOTEAGUE INLET	TO FISHING POINT	15-MAR-62	1/ 10,000	PAN	10	2081	TO 2090	X	NOAA	62S
37	OCEAN CITY INLET	TO N OF MD/VA BORDER	15-MAR-62	1/ 15,000	PAN	16	2290	TO 2305	X	NOAA	62S
38	N OF MD/VA BORDER	TO CHINCOTEAGUE ISLAND	15-MAR-62	1/ 15,000	PAN	17	2318	TO 2334	X	NOAA	62S
39	FISHERMANS POINT	TO ASSATEAGUE ST PARK	17-MAR-62	1/ 5,000	PAN	91	1582	TO 1672	X	DIA	USAF/1375MCS
40	ASSATEAGUE LIGHT	TO CHINCOTEAGJE INLET	23-MAR-62	1/ 5,000	PAN	29	2121	TO 2149	X	DIA	USAF/1375MCS
41	OCEAN CITY INLET	TO FISHING POINT	24-MAR-62	1/ 15,000	PAN	54	3159	TO 3212	X	NOAA	62S
42	TINGLES ISLAND	TO FISHERMANS POINT	28-MAR-62	1/ 5,000	PAN	143	1978	TO 2120	X	DIA	USAF/1375MCS
43	OCEAN CITY INLET	TO N OF MD/VA BORDER	28-APR-62	1/ 15,000	PAN	25	3809	TO 3833	X	NOAA	62W
44	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	28-APR-62	1/ 20,000	PAN	1	3773	TO 3773	X	NOAA	62W
45	FISHING POINT	TO ASSATEAGUE NAT PARK	28-APR-62	1/ 20,000	PAN	24	3776	TO 3799	X	NOAA	62W
46	ASSATEAGUE	TO ASSATEAGUE	6-MAY-62	1/ 0,000	PAN	0	0	TO 0	X	OTHR	ASS.NAT.SS.
47	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-62	1/ 10,000	COL	3	1869	TO 1871	X	NOAA	62S(C)
48	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-62	1/ 14,000	PAN	2	2652	TO 2653	X	NOAA	62L
49	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-62	1/ 20,000	COL	1	1872	TO 1872	X	NOAA	62S(C)
50	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-62	1/ 20,000	COL	1	1874	TO 1874	X	NOAA	62S(C)
51	CHINCOTEAGUE INLET	TO CHINCOTEAGJE INLET	15-JUN-62	1/ 20,000	COL	1	1903	TO 1903	X	NOAA	62S(C)
52	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-62	1/ 20,000	COL	1	2054	TO 2054	X	NOAA	62S(C)
53	CHINCOTEAGUE INLET	TO CHINCOTEAGJE INLET	15-JUN-62	1/ 20,000	COL	1	2087	TO 2087	X	NOAA	62S(C)
54	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-62	1/ 20,000	PAN	1	2613	TO 2613	X	NOAA	62L
55	CHINCOTEAGUE INLET	TO CHINCOTEAGJE INLET	15-JUN-62	1/ 20,000	PAN	1	2618	TO 2618	X	NOAA	62L
56	CHINCOTEAGUE INLET	TO CHINCOTEAGJE INLET	15-JUN-62	1/ 20,000	PAN	1	2685	TO 2685	X	NOAA	62L
57	N SINEPUXENT BAY	TO FOX HILL LEVEL	3-DEC-62	1/ 5,000	PAN	45	1208	TO 1252	X	USAF	62-7/11A
58	FENWICK ISLAND	TO N SINEPUXENT BAY	3-DEC-62	1/ 5,000	PAN	39	1253	TO 1291	X	USAF	62-7/11B
59	OCEAN CITY INLET	TO OCEAN CITY INLET	3-DEC-62	1/ 5,000	PAN	3	1267	TO 1269		USAF	AF62
60	FOX HILL LEVEL	TO POPE BAY	3-DEC-62	1/ 5,000	PAN	26	1889	TO 1914	X	USAF	62-7/10A
61	MIDDLEMOORE MARSH	TO CHINCOTEAGUE INLET	3-DEC-62	1/ 5,000	PAN	54	1915	TO 1968	X	USAF	62-7/10B
62	TINGLES ISLAND	TO FISHERMANS POINT	17-JAN-63	1/ 5,000	PAN	182	1208	TO 1389	X	DIA	1370PMW
63	S OF MD/VA BORDER	TO OCEAN CITY	15-MAR-63	1/ 11,000	PAN	7	159	TO 165	X	USGS	CMU
64	CHINCOTEAGUE INLET	TO S OF MD/VA BORDER	15-MAR-63	1/ 11,000	PAN	3	169	TO 171	X	USGS	CMU 5
65	S OF MD/VA BORDER	TO OCEAN CITY	8-APR-63	1/ 8,000	PAN	24	39	TO 62	X	USGS	VAQA
66	CHINCOTEAGUE INLET	TO CHINCOTEAGJE BAY	8-APR-63	1/ 24,000	PAN	2	398	TO 399		USGS	VAQA
67	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAY-64	1/ 20,000	PAN	2	12	TO 13		ASCS	ANN 3EE
68	OCEAN CITY INLET	TO NORTH END OF ASSATE	12-JUN-64	1/ 24,000	BIR	3	102	TO 104	X	NOAA	64RY
69	WORCESTER COUNTY,MD	TO WORCESTER COUNTY,MD	15-JUN-64	1/ 20,000	PAN	0	0	TO 0	X	ASCS	ANN24047
70	ASSATEAGUE	TO ASSATEAGUE	7-JUL-64	1/ 0,000	PAN	68	0	TO 0	X	OTHR	ASS.NAT.SS.
71	ASSATEAGUE	TO ASSATEAGUE	5-DEC-64	1/ 0,000	PAN	20	0	TO 0	X	OTHR	ASS.NAT.SS.
72	ACCOMACK COUNTY,VA	TO ACCOMACK COUNTY,VA	15-JUN-66	1/ 20,000	PAN	0	0	TO 0	X	ASCS	AN051001
73	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-66	1/ 20,000	COL	1	3828	TO 3828	X	NOAA	66W(C)
74	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-66	1/ 20,000	COL	1	3830	TO 3830	X	NOAA	66W(C)
75	ASSATEAGUE	TO ASSATEAGUE	6-SEP-66	1/ 6,000	PAN	0	0	TO 0	X	OTHR	ASS.NAT.SS.
76	ASSATEAGUE	TO ASSATEAGUE	7-SEP-66	1/ 6,000	PAN	0	0	TO 0	X	OTHR	ASS.NAT.SS.
77	A/SATEAGUE	TO ASSATEAGUE	9-SEP-66	1/ 6,000	PAN	0	0	TO 0	X	OTHR	ASS.NAT.SS.
78	A/SATEAGUE	TO ASSATEAGUE	7-OCT-66	1/ 48,000	PAN	35	0	TO 0	X	OTHR	ASS.NAT.SS.
79	FISHING POINT	TO MCCABES ESTATE	4-APR-67	1/ 60,000	PAN	12	39	TO 50	X	NOAA	67M
80	MCCABES ESTATE	TO FISHING POINT	4-APR-67	1/ 60,000	PAN	12	51	TO 62	X	NOAA	67M
81	CHINCOTEAGUE ISLAND	TO FISHING POINT	2-APR-68	1/ 20,000	COL	7	3008	TO 3014	X	NOAA	68E
82	FISHING POINT	TO CHINCOTEAGUE ISLAND	5-OCT-68	1/ 40,000	COL	7	3015	TO 3021	X	NOAA	68L

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
83	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-69	1/ 12,000	COL	6	8543	TO	8548		NASA	104/174
84	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-69	1/ 12,000	COL	5	8572	TO	8576		NASA	104/174
85	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-69	1/ 12,000	COL	2	8681	TO	8682		NASA	104/174
86	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-69	1/120,000	CIR	10	18	TO	27		NASA	104/174
87	FISHING POINT	TO FISHING POINT	24-OCT-69	1/ 20,000	COL	5	3095	TO	3099	X	NOAA	69E
88	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	20-APR-70	1/ 20,000	MUL	0	0	TO	0	X	WALL	MSN12 FLT1
89	OCEAN CITY INLET	TO OCEAN CITY INLET	15-SEP-70	1/ 60,000	CIR	1	395	TO	395		NASA	144 21
90	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-70	1/ 60,000	CIR	1	404	TO	404		NASA	21
91	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-70	1/120,000	PAN	1	14	TO	14		NASA	22
92	OCEAN CITY INLET	TO OCEAN CITY INLET	15-SEP-70	1/120,000	COL	1	7240	TO	7240		NASA	144 19
93	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-70	1/120,000	COL	1	7245	TO	7245		NASA	19
94	FISHERMANS POINT	TO CAPE HENLOPEN	23-SEP-70	1/120,000	COL	9	7245	TO	7253	X	EROS	JSC144 19
95	S OF DEL/MD BORDER	TO FISHERMANS POINT	23-SEP-70	1/122,000	COL	5	7240	TO	7244	X	EROS	JSC144 19
96	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	19-OCT-70	1/ 10,000	MUL	0	0	TO	0	X	WALL	MSN29 FLT3
97	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	15-DEC-70	1/ 1,000	MUL	0	0	TO	0	X	WALL	MSN38 FLT2
98	ASSATEAGUE	TO FISHERMANS ISLAND	15-APR-71	1/ 10,000	MUL	0	0	TO	0	X	WALL	MSN52 FLT1
99	CAPE HENLOPEN	TO MD/VA BORDER	23-APR-71	1/ 2,000	MUL	0	0	TO	0	X	WALL	MSN53 FLT1
100	CAPE HENLOPEN	TO MD/VA BORDER	23-APR-71	1/ 20,000	MUL	0	0	TO	0	X	WALL	MSN53 FLT1
101	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-MAY-71	1/120,000	PAN	1	6	TO	6		NASA	166 18
102	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAY-71	1/120,000	PAN	1	8	TO	8		NASA	166 18
103	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-MAY-71	1/120,000	COL	1	5437	TO	5437		NASA	166 24
104	OCEAN CITY INLET	TO OCEAN CITY INLET	15-MAY-71	1/120,000	COL	1	5443	TO	5443		NASA	166 24
105	N OF MD/VA BORDER	TO N OF DEL/MD BORDER	18-MAY-71	1/ 63,000	CIR	5	15	TO	19	X	EROS	JSC166 25
106	S OF DEL/MD BORDER	TO CAPE CHARLES	18-MAY-71	1/ 64,000	CIR	16	59	TO	74	X	EROS	JSC166 25
107	DEL/MD BORDER	TO MD/VA BORDER	8-JUN-71	1/ 20,000	COL	14	97	TO	110	X	EROS	JSC210 100
108	INDIAN RIV INLET	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	13	391	TO	403	X	EROS	JSC144 210
109	CHINCOTEAGUE INLET	TO OCEAN CITY	8-JUN-71	1/ 20,000	CIR	10	404	TO	413	X	EROS	JSC144 210
110	OCEAN CITY INLET	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	24	1726	TO	1749	X	EROS	JSC181 1
111	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	16	1897	TO	1912	X	EROS	JSC181 2
112	CHINCOTEAGUE	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	4	1913	TO	1916	X	EROS	JSC181 1
113	OCEAN CITY INLET	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	27	1936	TO	1962	X	EROS	JSC181 80
114	MD/VA BORDER	TO DEL/MD BORDER	8-JUN-71	1/ 20,000	COL	35	2038	TO	2072	X	EROS	JSC181 80
115	DEL/MD BORDER	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	30	2073	TO	2102	X	EROS	JSC181 80
116	S OF MD/VA BORDER	TO REHOBOTH BEACH	8-JUN-71	1/ 20,000	COL	50	2212	TO	2261	X	EROS	JSC181 100
117	CAPE HENLOPEN	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	COL	53	2262	TO	2314	X	EROS	JSC181 100
118	OCEAN CITY INLET	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	24	6832	TO	6855	X	EROS	JSC181 20
119	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	16	7003	TO	7018	X	EROS	JSC181 20
120	S OF DEL/MD BORDER	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	27	7041	TO	7067	X	EROS	JSC181 90
121	CHINCOTEAGUE	TO BETHANY BEACH	8-JUN-71	1/ 20,000	CIR	35	7143	TO	7177	X	EROS	JSC181 90
122	DEL/MD BORDER	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	30	7178	TO	7207	X	EROS	JSC181 90
123	CHINCOTEAGUE	TO CAPE HENLOPEN	8-JUN-71	1/ 20,000	CIR	50	7317	TO	7366	X	EROS	JSC181 110
124	CAPE HENLOPEN	TO CHINCOTEAGUE	8-JUN-71	1/ 20,000	CIR	53	7367	TO	7419	X	EROS	JSC181 110
125	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 20,000	COL	1	1921	TO	1921		NASA	JSC181 1
126	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-71	1/ 20,000	PAN	1	1941	TO	1941		NASA	JSC181 1
127	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 20,000	COL	1	1970	TO	1970		NASA	JSC181 1
128	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 40,000	PAN	1	494	TO	494		NASA	JSC181 4
129	OCEAN CITY INLET	TO OCEAN CITY INLET	15-JUN-71	1/ 40,000	PAN	1	500	TO	500		NASA	JSC181 4
130	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 40,000	PAN	1	528	TO	528		NASA	JSC181 4
131	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 48,000	PAN	1	2	TO	2		NASA	JSC187 21
132	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUN-71	1/ 48,000	COL	1	9434	TO	9434		NASA	JSC187 19
133	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	3-AUG-71	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN84 FLT1
134	OCEAN CITY	TO WACHAPREAGUE	15-AUG-71	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN84 FLT2

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST TO LAST	S	SOURCE	I.D.
135	N OF MD/VA BORDER	TO BETHANY BEACH	15-SEP-71	1/446,000	PAN	2	13 TO 14	X	EROS	AMES25
136	MD/VA BORDER	TO DEL/MD BORDER	4-NOV-71	1/449,000	PAN	2	20 TO 21	X	EROS	AMES93
137	MD/VA BORDER	TO DEL/MD BORDER	4-NOV-71	1/449,000	CIR	2	20 TO 21	X	EROS	AMES95
138	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	17-NOV-71	1/ 20,000	MUL	0	0 TO 0	X	WALL	MSN94 FLT2
139	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	1-DEC-71	1/ 71,000	PAN	1	179 TO 179		EROS	AMES120
140	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	1-DEC-71	1/415,000	PAN	1	1 TO 1		EROS	AMES120
141	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	1-DEC-71	1/415,000	PAN	1	1 TO 1		EROS	AMES122
142	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	1-DEC-71	1/415,000	PAN	1	1 TO 1		EROS	AMES121
143	CHINCOTEAGUE ISLAND	TO CHINCOTEAGUE ISLAND	1-DEC-71	1/429,000	PAN	1	177 TO 177		EROS	AMES120
144	DEL/MD BORDER	TO CHINCOTEAGUE	1-DEC-71	1/450,000	PAN	3	12 TO 14		EROS	AMES120
145	DEL/MD BORDER	TO CHINCOTEAGUE	1-DEC-71	1/450,000	PAN	3	12 TO 14		EROS	AMES121
146	DEL/MD BORDER	TO CHINCOTEAGUE	1-DEC-71	1/450,000	PAN	3	12 TO 14	X	EROS	AMES122
147	FISHERMANS POINT	TO FISHERMANS POINT	1-DEC-71	1/564,000	PAN	1	176 TO 176		EROS	AMES120
148	WALLOPS ISLAND	TO ASSATEAGUE ST PARK	2-DEC-71	1/423,000	PAN	2	3 TO 4	X	EROS	AMES124
149	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	1-FEB-72	1/ 10,000	CIR	0	0 TO 0	X	WALL	MSN106 FLT4
150	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	4-FEB-72	1/ 10,000	CIR	0	0 TO 0	X	WALL	MSN107 FLT3
151	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	2-MAR-72	1/ 4,000	MUL	0	0 TO 0	X	WALL	MSN110 FLT1
152	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	5-APR-72	1/ 10,000	MUL	0	0 TO 0	X	WALL	MSN117 FLT1
153	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	5-APR-72	1/ 20,000	MUL	0	0 TO 0	X	WALL	MSN117 FLT1
154	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	25-APR-72	1/ 6,000	MUL	0	0 TO 0	X	WALL	MSN123 FLT2
155	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	27-APR-72	1/ 14,000	COL	0	0 TO 0	X	WALL	MSN124 FLT2
156	CHINCOTEAGUE BAY	TO CHINCOTEAGUE BAY	27-APR-72	1/ 14,000	COL	0	0 TO 0	X	WALL	MSN124 FLT2
157	MD STATE PARK	TO MD/VA BORDER	29-APR-72	1/ 6,000	PAN	65	0 TO 0	X	COMM	72 71
158	MD STATE PARK	TO MD/VA BORDER	6-MAY-72	1/ 2,000	PAN	215	0 TO 0	X	COMM	72 71
159	DEL/MD BORDER	TO FISHERMANS POINT	7-JUN-72	1/448,000	PAN	9	247 TO 255	X	EROS	AMES423
160	DEL/MD BORDER	TO FISHERMANS POINT	7-JUN-72	1/448,000	PAN	9	247 TO 255	X	EROS	AMES424
161	DEL/MD BORDER	TO FISHERMANS POINT	7-JUN-72	1/448,000	CIR	9	247 TO 255	X	EROS	AMES425
162	WORCESTER COUNTY,MD	TO WORCESTER COUNTY,MD	15-JUN-72	1/ 40,000	PAN	0	0 TO 0	X	ASCS	ANN24047
163	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JUL-72	1/130,000	CIR	1	3852 TO 3852		NASA	AMES121
164	MD/VA BORDER	TO CHINCOTEAGUE	24-JUL-72	1/ 48,000	CIR	3	101 TO 103	X	EROS	JSC207 55
165	FISHERMANS POINT	TO DEL/MD BORDER	26-JUL-72	1/440,000	PAN	5	1 TO 5	X	EROS	AMES543
166	FISHERMANS POINT	TO DEL/MD BORDER	26-JUL-72	1/440,000	PAN	5	1 TO 5	X	EROS	AMES544
167	FISHERMANS POINT	TO DEL/MD BORDER	26-JUL-72	1/440,000	PAN	5	1 TO 5	X	EROS	AMES545
168	FISHERMANS POINT	TO DEL/MD BORDER	26-JUL-72	1/440,000	CIR	5	1 TO 5	X	EROS	AMES546
169	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-AUG-72	1/130,000	CIR	1	3693 TO 3693		NASA	AMES147
170	OCEAN CITY INLET	TO OCEAN CITY INLET	22-AUG-72	1/130,000	PAN	1	3641 TO 3641		NASA	AMES642
171	FISHERMANS POINT	TO S OF MD/VA BORDER	22-AUG-72	1/434,000	CIR	1	205 TO 205		EROS	AMES646
172	FISHERMANS POINT	TO S OF MD/VA BORDER	22-AUG-72	1/434,000	CIR	1	205 TO 205		EROS	AMES645
173	FISHERMANS POINT	TO S OF MD/VA BORDER	22-AUG-72	1/434,000	PAN	1	205 TO 205		EROS	AMES644
174	FISHERMANS POINT	TO S OF MD/VA BORDER	22-AUG-72	1/434,000	PAN	1	205 TO 205		EROS	AMES643
175	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-SEP-72	1/130,000	COL	1	1 TO 1		NASA	AMES169
176	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-OCT-72	1/130,000	COL	1	5081 TO 5081		NASA	AMES179A
177	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	15-JAN-73	1/130,000	COL	1	5081 TO 5081		NASA	AMES014C
178	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	26-JAN-73	1/416,000	CIR	1	214 TO 214		EROS	AMES901
179	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	26-JAN-73	1/416,000	PAN	1	214 TO 214		EROS	AMES898
180	S OF ASSA ST PARK	TO CHINCOTEAGUE	31-JAN-73	1/132,000	CIR	1	8481 TO 8481		EROS	AMES947
181	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	31-JAN-73	1/433,000	CIR	1	39 TO 39		EROS	AMES946
182	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	31-JAN-73	1/433,000	PAN	1	39 TO 39		EROS	AMES945
183	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	31-JAN-73	1/433,000	PAN	1	39 TO 39		EROS	AMES944
184	ASSATEAGUE ST PARK	TO CHINCOTEAGUE	31-JAN-73	1/433,000	PAN	1	39 TO 39		EROS	AMES943
185	N OF OCEAN CITY	TO ASSATEAGUE ST PARK	6-APR-73	1/ 40,000	CIR	4	204 TO 207	X	EROS	JSC230 47
186	ASSATEAGUE ST PARK	TO ASSATEAGUE ST PARK	6-APR-73	1/ 41,000	CIR	1	208 TO 208		EROS	JSC230 47

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
187	OCEAN CITY INLET	TO OCEAN CITY INLET	22-APR-73	1/130,000	CIR	1	9411	TO 9411		NASA	AMES1117
188	S OF MD/VA BORDER	TO OCEAN CITY	29-APR-73	1/ 76,000	PAN	1	572	TO 572		USGS	VDEY
189	FISHERMANS POINT	TO S OF MD/VA BORDER	29-APR-73	1/ 76,000	PAN	1	584	TO 584		USGS	VDEY
190	ASSATEAGUE ST PARK	TO MD/VA BORDER	29-APR-73	1/443,000	PAN	1	209	TO 209		EROS	AMES1113
191	ASSATEAGUE ST PARK	TO MD/VA BORDER	29-APR-73	1/443,000	PAN	1	209	TO 209		EROS	AMES1115
192	ASSATEAGUE ST PARK	TO MD/VA BORDER	29-APR-73	1/443,000	PAN	1	209	TO 209		EROS	AMES1114
193	ASSATEAGUE ST PARK	TO MD/VA BORDER	29-APR-73	1/443,000	COL	1	209	TO 209		EROS	AMES1116
194	FISHERMANS POINT	TO S OF ASSA ST PARK	29-APR-73	1/446,000	COL	2	210	TO 211	X	EROS	AMES1116
195	FISHERMANS POINT	TO S OF ASSA ST PARK	29-APR-73	1/446,000	PAN	2	210	TO 211	X	EROS	AMES1115
196	FISHERMANS POINT	TO S OF ASSA ST PARK	29-APR-73	1/446,000	PAN	2	210	TO 211	X	EROS	AMES1114
197	FISHERMANS POINT	TO S OF ASSA ST PARK	29-APR-73	1/446,000	PAN	2	210	TO 211	X	EROS	AMES1113
198	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	17-MAY-73	1/ 19,000	MUL	0	0	TO 0	X	WALL	MSN214 FLT1
199	CHINCOTEAGUE INLET	TO CHINCOTEAGUE INLET	21-OCT-73	1/ 7,000	CIR	2	6767	TO 6768	X	EROS	AMES1567
200	FISHERMANS POINT	TO FISHERMANS POINT	27-OCT-73	1/134,000	CIR	1	5368	TO 5368		EROS	AMES1525
201	OCEAN CITY INLET	TO FOX HILL LEVEL	27-OCT-73	1/456,000	PAN	1	176	TO 176		EROS	AMES1521
202	OCEAN CITY INLET	TO FOX HILL LEVEL	27-OCT-73	1/456,000	PAN	1	176	TO 176		EROS	AMES1523
203	OCEAN CITY INLET	TO FOX HILL LEVEL	27-OCT-73	1/456,000	PAN	1	176	TO 176		EROS	AMES1522
204	OCEAN CITY INLET	TO FOX HILL LEVEL	27-OCT-73	1/456,000	CIR	1	176	TO 176		EROS	AMES1524
205	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	1-NOV-73	1/ 19,000	MUL	0	0	TO 0	X	WALL	MSN245 FLT1
206	OCEAN CITY INLET	TO N OF MD/VA BORDER	1-DEC-73	1/445,000	CIR	1	175	TO 175		EROS	AMES1566
207	OCEAN CITY INLET	TO N OF MD/VA BORDER	1-DEC-73	1/445,000	PAN	1	175	TO 175		EROS	AMES1563
208	OCEAN CITY INLET	TO N OF MD/VA BORDER	1-DEC-73	1/445,000	PAN	1	175	TO 175		EROS	AMES1565
209	OCEAN CITY INLET	TO N OF MD/VA BORDER	1-DEC-73	1/445,000	PAN	1	175	TO 175		EROS	AMES1564
210	ASSATEAGUE ST PARK	TO CHINCOTEAGUE INLET	27-APR-74	1/442,000	PAN	2	77	TO 78	X	EROS	AMES1714
211	ASSATEAGUE ST PARK	TO CHINCOTEAGUE INLET	27-APR-74	1/442,000	COL	2	77	TO 78	X	EROS	AMES1717
212	ASSATEAGUE ST PARK	TO CHINCOTEAGUE INLET	27-APR-74	1/442,000	PAN	2	77	TO 78	X	EROS	AMES1716
213	ASSATEAGUE ST PARK	TO CHINCOTEAGUE INLET	27-APR-74	1/442,000	PAN	2	77	TO 78	X	EROS	AMES1715
214	S OF MD/VA BORDER	TO CHINCOTEAGUE INLET	27-APR-74	1/443,000	PAN	1	79	TO 79	X	EROS	AMES1715
215	S OF MD/VA BORDER	TO CHINCOTEAGUE INLET	27-APR-74	1/443,000	COL	1	79	TO 79	X	EROS	AMES1717
216	S OF MD/VA BORDER	TO CHINCOTEAGUE INLET	27-APR-74	1/443,000	PAN	1	79	TO 79	X	EROS	AMES1716
217	S OF MD/VA BORDER	TO CHINCOTEAGUE INLET	27-APR-74	1/443,000	PAN	1	79	TO 79		EROS	AMES1714
218	CAPE HENLOPEN	TO CORE BANKS	4-JUN-74	1/ 20,000	CIR	0	0	TO 0	X	WALL	MSN271 FLT1
219	ACCOMACK COUNTY,VA	TO ACCOMACK COUNTY,VA	15-JUN-74	1/ 40,000	PAN	0	0	TO 0	X	ASCS	AN051001
220	ASSATEAGUE ST PARK	TO CEDAR ISLAND	22-JUL-74	1/443,000	PAN	6	50	TO 55	X	EROS	AMES1879
221	ASSATEAGUE ST PARK	TO CEDAR ISLAND	22-JUL-74	1/443,000	CIR	6	50	TO 55	X	EROS	AMES1881
222	ASSATEAGUE ST PARK	TO CEDAR ISLAND	22-JUL-74	1/443,000	PAN	6	50	TO 55	X	EROS	AMES1880
223	DEL/MD BORDER	TO N OF MD/VA BORDER	22-JUL-74	1/449,000	PAN	2	48	TO 49	X	EROS	AMES1879
224	DEL/MD BORDER	TO N OF MD/VA BORDER	22-JUL-74	1/449,000	CIR	2	48	TO 49	X	EROS	AMES1881
225	DEL/MD BORDER	TO N OF MD/VA BORDER	22-JUL-74	1/449,000	PAN	2	48	TO 49	X	EROS	AMES1880
226	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	10-OCT-74	1/ 11,000	MUL	0	0	TO 0	X	WALL	MSN312 FLT1
227	COBB ISLAND VA	TO CAPE HENLOPEN	4-DEC-74	1/ 20,000	MUL	0	0	TO 0	X	WALL	MSN317 FLT1
228	CAPE LOOKOUT	TO CAPE HENLOPEN	17-APR-75	1/ 12,000	CIR	0	0	TO 0	X	WALL	MSN322 FLT1
229	METOMPKIN ISLAND	TO MD/VA BORDER	8-MAY-75	1/133,000	CIR	2	4231	TO 4232	X	EROS	AMES2092
230	DEL COAST	TO NC COAST	5-SEP-75	1/ 20,000	MUL	0	0	TO 0	X	WALL	MSN345 FLT1
231	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	15-OCT-75	1/ 6,000	CIR	0	0	TO 0	X	WALL	MSN351 FLT1
232	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	15-OCT-75	1/ 16,000	CIR	0	0	TO 0	X	WALL	MSN351 FLT1
233	CAPE HENLPOEN	TO WALLOPS ISLAND	19-FEB-76	1/ 20,000	CIR	0	0	TO 0	X	WALL	MSN357 FLT1
234	MD/VA BORDER	TO CHINCOTEAGUE INLET	25-FEB-76	1/120,000	PAN	5	0	TO 0	X	NASA	AMES2299
235	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	14-MAR-76	1/ 20,000	CIR	0	0	TO 0	X	WALL	MSN360 FLT1
236	OCEAN CITY INLET	TO CHINCOTEAGUE INLET	22-MAY-76	1/130,000	PAN	5	0	TO 0	X	NASA	2325
237	CAPE CHARLES	TO CAPE HENLOPEN	30-JUL-76	1/ 20,000	CIR	131	7	TO 137	X	WALL	MSN388 FLT1
238	CAPE HENLOPEN	TO CAPE CHARLES	11-AUG-76	1/ 20,000	CIR	128	8	TO 135	X	WALL	MSN383 FLT1
239	LONG ISLAND	TO LOOKOUT POINT	30-AUG-76	1/130,000	CIR	87	453	TO 539	X	EROS	76-142

CAPE HATTERAS AERIAL PHOTOGRAPHY.

KEY TO ABBREVIATIONS.

FILM. COL=COLOR CIR=COLOR INFRA-RED PAN=PANCHROMATIC (BLACK AND WHITE) BIR=BLACK AND WHITE INFRA-RED.
MUL=MORE THAN ONE OF THE ABOVE AVAILABLE.
FRM=TOTAL NUMBER OF FRAMES IN FLIGHT LINE. FIRST=FIRST FRAME NUMBER. LAST=LAST FRAME NUMBER.
IF ABOVE=0, INFORMATION WAS NOT IMMEDIATELY AVAILABLE AT TIME OF COMPILATION.
S=STEREO COVERAGE = X IF OVERLAP IS 50 PERCENT OR GREATER.
SOURCE. ASCS=AGRIC.STABIL.AND CONS.SERVICE.
CENG=CORPS OF ENGINEERS.
COMM=COMMERCIAL.
DIA=DEFENSE INTELLIGENCE AGENCY.
EROS=EROS DATA CENTER, SIOUX FALLS, S.D.
NARC=NATIONAL ARCHIVES.
NAS=NAVAL AIR STATION.
NASA=EROS DATA CENTER.
NOAA=NATIONAL OCEAN SURVEY, NOAA, ROCKVILLE, MD.
OTHR=OTHER.
USAF=AIR FORCE.
USGS=USGS, RESTON, VA. OR EROS DATA CENTER.
USN=NAVY.
WALL=NASA/WALLOPS,VA. OR EROS DATA CENTER.
I.D.=MISSION, ROLL, FLIGHT, ACCESSION, OR OTHER IDENTIFYING NUMBER.
NOTE. FLIGHTS FLOWN WITH SCALES GREATER THAN 1/200,000 HAVE A 2.2-INCH FORMAT. ALL OTHERS HAVE A 9-INCH FORMAT.
MILITARY FLIGHTS CAN BE OBTAINED THROUGH THE DIA.

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
1	OREGON INLET	TO OREGON INLET	15-OCT-40	1/ 24,000	PAN	2	38 TO	39		USGS	BARRIER REEF
2	HATTERAS INLET	TO HATTERAS INLET	15-OCT-40	1/ 24,000	PAN	2	54 TO	55		USGS	BARRIER REEF
3	OCRACOKE INLET	TO OCRACOKE INLET	15-OCT-40	1/ 24,000	PAN	6	73 TO	78		USGS	BARRIER REEF
4	OCRACOKE INLET	TO OCRACOKE INLET	15-OCT-40	1/ 24,000	PAN	6	80 TO	85		USGS	BARRIER REEF
5	COROLLA,NC	TO LOOKOUT POINT	21-OCT-40	1/ 24,000	PAN	139	1 TO	139	X	CENG	V
6	WRIGHT BRIDGE	TO OCRACOKE INLET	21-OCT-40	1/ 24,000	PAN	51	23 TO	73	X	DIA	BARRIOR REEF
7	ROANOKE BRIDGE	TO RODANTHE	21-OCT-40	1/ 24,000	PAN	16	28 TO	43	X	CENG	V
8	BUXTON	TO OCRACOKE INLET	21-OCT-40	1/ 24,000	PAN	31	44 TO	74	X	CENG	V
9	HATTERAS POINT	TO OLD NEW INLET	21-OCT-40	1/ 24,000	PAN	25	115 TO	139	X	CENG	V
10	HATTERAS POINT	TO N OF RODANTHE	21-OCT-40	1/ 24,000	PAN	25	115 TO	139	X	DIA	BARRIOR REEF
11	WRIGHT BRIDGE	TO N OF AVON	1-APR-42	1/ 40,000	PAN	20	656 TO	675	X	DIA	US 2 1030
12	WRIGHT BRIDGE	TO BUXTON	15-JUN-42	1/ 30,000	PAN	19	662 TO	680	X	DIA	PROJ ROLL-5
13	HATTERAS POINT	TO HATTERAS POINT	1-NOV-42	1/ 40,000	PAN	1	0 TO	0	X	DIA	RMP 2
14	HATTERAS INLET	TO HATTERAS INLET	15-FEB-43	1/ 40,000	PAN	3	77 TO	79		USGS	27
15	RODANTHE	TO OCRACOKE INLET	23-FEB-43	1/ 40,000	PAN	30	56 TO	85	X	DIA	PROJECT 27
16	SALVO	TO HATTERAS POINT	23-FEB-43	1/ 40,000	PAN	35	57 TO	91	X	CENG	PROJECT 27
17	OCRACOKE INLET	TO OCRACOKE INLET	15-JUN-43	1/ 60,000	PAN	1	86 TO	86		USGS	27
18	OCRACOKE INLET	TO MID OCRACOKE	24-JAN-45	1/ 20,000	PAN	7	884 TO	890	X	NOAA	45C
19	S OF HATTERAS INLET	TO N OF HATTERAS INLET	24-JAN-45	1/ 20,000	PAN	4	891 TO	894	X	NOAA	45C
20	HATTERAS POINT	TO N OF AVON	24-JAN-45	1/ 20,000	PAN	14	895 TO	908	X	NOAA	45C
21	RODANTHE	TO ROANOKE BRIDGE	24-JAN-45	1/ 20,000	PAN	19	909 TO	927	X	NOAA	45C
22	ROANOKE BRIDGE	TO ROANOKE BRIDGE	24-OCT-45	1/ 15,000	PAN	3	1 TO	3	X	DIA	3539AA4M3935
23	S OF WRIGHT BRIDGE	TO S OF OREGON INLET	27-APR-47	1/ 14,000	PAN	32	3642 TO	3673	X	DIA	AMS AV 32 20
24	ROANOKE BRIDGE	TO RODANTHE	5-DEC-49	1/ 40,000	PAN	14	1800 TO	1813	X	NOAA	490
25	ROANOKE BRIDGE	TO HATTERAS POINT	31-MAR-53	1/ 20,000	PAN	53	37 TO	89	X	NOAA	530
26	N OF HATTERAS INLET	TO S OF HATTERAS INLET	31-MAR-53	1/ 20,000	PAN	6	79 TO	84	X	NOAA	530
27	N OF OCRACOKE INLET	TO OCRACOKE INLET	31-MAR-53	1/ 20,000	PAN	7	85 TO	91	X	NOAA	530
28	BUXTON	TO HATTERAS POINT	31-APR-53	1/ 20,000	PAN	3	0 TO	0		NOAA	530
29	S END OF OCRACOKE	TO S END OF OCRACOKE	29-MAR-55	1/ 17,000	PAN	6	5569 TO	5574	X	NOAA	55W
30	OCRACOKE INLET	TO OCRACOKE INLET	29-MAR-55	1/ 20,000	PAN	3	5567 TO	5569	X	NOAA	55W

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
31	OCRACOKE INLET	TO OCRACOKE INLET	29-MAR-55	1/ 20,000	PAN	3	5578	TO 5580	X	NOAA	55W
32	OCRACOKE INLET	TO ROANOKE BRIDGE	29-MAR-55	1/ 20,000	PAN	77	5581	TO 5657	X	NOAA	55W
33	OREGON INLET	TO OREGON INLET	15-JUN-55	1/ 24,000	PAN	3	26	TO 28	X	NOAA	55S
34	HATTERAS INLET	TO HATTERAS INLET	15-JUN-55	1/ 24,000	PAN	3	2730	TO 2732	X	NOAA	55S
35	OCRACOKE INLET	TO NAGS HEAD	9-MAR-56	1/ 56,000	PAN	1	843	TO 843		USGS	AMS55055
36	HATTERAS INLET	TO HATTERAS INLET	15-MAR-56	1/ 20,000	PAN	2	106	TO 107		ASCS	A00
37	N OF HATTERAS INLET	TO S OF HATTERAS INLET	4-MAY-58	1/ 24,000	PAN	4	2730	TO 2733	X	NOAA	58S
38	N OF OREGON INLET	TO S OF OREGON INLET	4-MAY-58	1/ 25,000	PAN	5	2724	TO 2728	X	NOAA	58S
39	OCRACOKE INLET	TO OCRACOKE INLET	15-JUN-58	1/ 25,000	PAN	4	5735	TO 5738	X	NOAA	58S
40	N OF OREGON INLET	TO SALVO	10-OCT-58	1/ 18,000	PAN	18	1457	TO 1474	X	NOAA	58W
41	OREGON INLET	TO OREGON INLET	10-OCT-58	1/ 18,000	PAN	3	1460	TO 1462	X	NOAA	58W
42	AVON	TO OCRACOKE INLET	10-OCT-58	1/ 18,000	PAN	75	1476	TO 1550	X	NOAA	58W
43	OCRACOKE INLET	TO HATTERAS POINT	16-AUG-59	1/ 25,000	PAN	31	7505	TO 7535	X	NOAA	59W
44	SALVO	TO S OF ROANOKE BRIDGE	16-AUG-59	1/ 25,000	PAN	16	7537	TO 7552	X	NOAA	59W
45	OCRACOKE INLET	TO OCRACOKE INLET	15-SEP-60	1/ 10,000	PAN	3	1	TO 3		USGS	PMG58/7/1
46	OCRACOKE INLET	TO OCRACOKE INLET	15-SEP-60	1/ 10,000	PAN	9	76	TO 84		USGS	PMG58/7/2A
47	OCRACOKE INLET	TO OCRACOKE INLET	15-SEP-60	1/ 10,000	PAN	10	85	TO 94		USGS	PMG58/7/3A
48	HATTERAS INLET	TO HATTERAS INLET	15-SEP-60	1/ 10,000	PAN	6	105	TO 110		USGS	PGM58 7
49	OCRACOKE INLET	TO OCRACOKE INLET	15-SEP-60	1/ 10,000	PAN	5	119	TO 123		USGS	PMG58/7/4
50	OCRACOKE INLET	TO OCRACOKE INLET	15-SEP-60	1/ 10,000	PAN	1	124	TO 124		USGS	PMG58/7/2B
51	OCRACOKE INLET	TO HATTERAS VILLAGE	22-SEP-60	1/ 10,000	PAN	76	1	TO 76	X	DIA	1375 MAP
52	RODANTHE	TO GULL ISLAND	25-NOV-60	1/ 50,000	PAN	2	18	TO 19	X	DIA	20TRS
53	GULL ISLAND	TO AVON	25-NOV-60	1/ 50,000	PAN	2	53	TO 54	X	DIA	20TRS
54	GULL ISLAND	TO HATTERAS POINT	13-MAR-62	1/ 5,000	PAN	63	1	TO 63	X	DIA	USAF/1375MCS
55	N OF AVON	TO S OF WRIGHT BRIDGE	13-MAR-62	1/ 10,000	PAN	151	63	TO 213	X	DIA	USAF/1375MCS
56	ROANOKE BRIDGE	TO OREGON INLET	13-MAR-62	1/ 10,000	COL	16	1823	TO 1838	X	NOAA	62S
57	OCRACOKE INLET	TO W OF BUXTON	13-MAR-62	1/ 24,000	PAN	21	1684	TO 1704	X	NOAA	62S
58	HATTERAS POINT	TO N OF BUXTON	13-MAR-62	1/ 24,000	PAN	5	1707	TO 1711	X	NOAA	62S
59	N OF BUXTON	TO ROANOKE BRIDGE	13-MAR-62	1/ 24,000	PAN	36	1713	TO 1748	X	NOAA	62S
60	HATTERAS POINT	TO HATTERAS INLET	17-MAR-62	1/ 5,000	PAN	48	1172	TO 1219	X	DIA	USAF/1375MCS
61	OCRACOKE INLET	TO OCRACOKE INLET	4-APR-62	1/ 10,000	COL	8	4978	TO 4985	X	NOAA	62S
62	N END OF OCRACOKE	TO HATTERAS INLET	4-APR-62	1/ 10,000	COL	10	4996	TO 5005	X	NOAA	62S
63	E OF OREGON INLET	TO W OF OREGON INLET	4-APR-62	1/ 10,000	COL	8	5006	TO 5013	X	NOAA	62S
64	W OF OREGON INLET	TO E OF OREGON INLET	4-APR-62	1/ 10,000	COL	8	5014	TO 5021	X	NOAA	62S
65	OREGON INLET	TO OREGON INLET	3-MAY-62	1/ 15,000	PAN	3	3034	TO 3036	X	NOAA	62L
66	ROANOKE BRIDGE	TO S OF OREGON INLET	3-MAY-62	1/ 15,000	PAN	15	4165	TO 4179	X	NOAA	62W
67	N OF OREGON INLET	TO S OF SALVO	3-MAY-62	1/ 15,000	PAN	21	4181	TO 4201	X	NOAA	62W
68	MID PEA ISLAND	TO S OF SALVO	3-MAY-62	1/ 15,000	PAN	14	4203	TO 4216	X	NOAA	62W
69	ROANOKE BRIDGE	TO RODANTHE	3-MAY-62	1/ 20,000	BIR	19	2987	TO 3005	X	NOAA	62L
70	N OF OREGON INLET	TO SALVO	3-MAY-62	1/ 20,000	BIR	21	3036	TO 3056	X	NOAA	62L
71	MID PEA ISLAND	TO S OF SALVO	3-MAY-62	1/ 20,000	BIR	14	3058	TO 3071	X	NOAA	62L
72	SALVO	TO HATTERAS POINT	3-MAY-62	1/ 20,000	BIR	27	3073	TO 3099	X	NOAA	62L
73	HATTERAS POINT	TO HATTERAS INLET	3-MAY-62	1/ 20,000	BIR	13	3101	TO 3113	X	NOAA	62L
74	HATTERAS VILLAGE	TO OCRACOKE INLET	3-MAY-62	1/ 20,000	BIR	22	3115	TO 3136	X	NOAA	62L
75	ROANOKE BRIDGE	TO RODANTHE	3-MAY-62	1/ 20,000	PAN	20	4130	TO 4149	X	NOAA	62W
76	S OF SALVO	TO HATTERAS INLET	3-MAY-62	1/ 20,000	PAN	41	4218	TO 4258	X	NOAA	62W
77	HATTERAS VILLAGE	TO OCRACOKE INLET	3-MAY-62	1/ 20,000	PAN	21	4260	TO 4280	X	NOAA	62W
78	OCRACOKE INLET	TO OCRACOKE INLET	3-JUN-62	1/ 20,000	PAN	3	4282	TO 4284	X	NOAA	62W
79	OCRACOKE INLET	TO OCRACOKE INLET	15-JUN-62	1/ 19,000	PAN	8	1238	TO 1245	X	NOAA	62S
80	OREGON INLET	TO OREGON INLET	15-JUN-62	1/ 24,000	PAN	3	1740	TO 1742	X	NOAA	62S
81	OCRACOKE INLET	TO OCRACOKE INLET	15-JUN-62	1/ 60,000	PAN	1	3029	TO 3029	X	NOAA	62M
82	HATTERAS INLET	TO HATTERAS INLET	15-JUN-62	1/ 60,000	PAN	1	3035	TO 3035	X	NOAA	62M

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
83	OREGON INLET	TO OREGON INLET	15-JUN-62	1/ 60,000	PAN	1	3050	TO	3050	X	NOAA	62M
84	OCRACOKE INLET	TO OCRACOKE INLET	2-SEP-62	1/ 19,000	COL	7	1246	TO	1252	X	NOAA	62S
85	N END OF OCRACOKE	TO OCRACOKE INLET	18-SEP-62	1/ 30,000	PAN	8	1833	TO	1840	X	NOAA	62S
86	OCRACOKE INLET	TO OREGON INLET	7-DEC-62	1/ 60,000	PAN	22	3029	TO	3050	X	NOAA	62W
87	RODANTHE	TO HATTERAS POINT	13-DEC-62	1/ 5,000	PAN	101	1390	TO	1490	X	USAF	62-7/2
88	HATTERAS POINT	TO S OF OREGON INLET	13-DEC-62	1/ 5,000	PAN	122	1390	TO	1511	X	DIA	1375MCS
89	G0AT ISLAND	TO N OF RODANTHE	13-DEC-62	1/ 5,000	PAN	22	1491	TO	1512	X	USAF	62-7/26
90	HATTERAS INLET	TO HATTERAS INLET	15-DEC-62	1/ 5,000	PAN	6	1513	TO	1518		USGS	AF62 7
91	CAPE HATTERAS	TO HATTERAS INLET	18-DEC-62	1/ 5,000	PAN	50	1513	TO	1562	X	USAF	62-7/1
92	HATTERAS INLET	TO HATTERAS POINT	18-DEC-62	1/ 5,000	PAN	114	1513	TO	1626	X	DIA	1370PMW
93	BUXTON	TO HATTERAS INLET	18-DEC-62	1/ 5,000	PAN	54	1563	TO	1616	X	USAF	62-7/25
94	OREGON INLET	TO S OF RODANTHE	18-DEC-62	1/ 5,000	PAN	65	1617	TO	1681	X	USAF	62-7/3
95	OREGON INLET	TO WRIGHT BRIDGE	18-DEC-62	1/ 5,000	PAN	125	1617	TO	1741	X	DIA	1370PMW
96	ROANOKE BRIDGE	TO JEANETTES PIER	18-DEC-62	1/ 5,000	PAN	36	1682	TO	1717	X	USAF	62-7/4
97	SALVO	TO HATTERAS POINT	5-JUL-63	1/ 20,000	COL	31	7007	TO	7037	X	NOAA	63S
98	FRISCO	TO BUXTON	5-JUL-63	1/ 20,000	COL	7	7038	TO	7044	X	NOAA	63S
99	FRISCO	TO HATTERAS POINT	5-JUL-63	1/ 20,000	COL	9	7046	TO	7054	X	NOAA	63S
100	BUXTON	TO HATTERAS POINT	1-OCT-63	1/ 6,000	PAN	11	0	TO	0	X	COMM	AAS A937
101	BUXTON	TO HATTERAS POINT	1-OCT-63	1/ 12,000	PAN	4	0	TO	0		COMM	AAS A937
102	S OF SALVO	TO S END OF PEA ISLAND	15-OCT-63	1/ 20,000	COL	10	2212	TO	2221	X	NOAA	63W
103	OREGON INLET	TO OREGON INLET	15-JUN-64	1/ 50,000	PAN	0	0	TO	0		USGS	AF64 12
104	OCRACOKE INLET	TO RODANTHE	22-JUL-65	1/ 6,000	BIR	143	0	TO	0		COMM	AAS 1419 1
105	HATTERAS POINT	TO S OF AVON	23-JUL-65	1/ 6,000	COL	9	0	TO	0		COMM	AAS 1419 4
106	OREGON INLET	TO OREGON INLET	24-JUL-65	1/ 12,000	COL	7	0	TO	0	X	COMM	AAS 1419 5
107	HATTERAS POINT	TO HATTERAS POINT	21-AUG-65	1/ 25,000	COL	1	0	TO	0		COMM	AAS 1419 9
108	ROANOKE BRIDGE	TO SALVO	25-OCT-65	1/ 20,000	COL	22	256	TO	277	X	NOAA	65S
109	HATTERAS POINT	TO BUXTON	17-NOV-66	1/ 5,000	PAN	11	0	TO	0	X	NAS	
110	HATTERAS POINT	TO GREAT ISLE OVERWASH	23-NOV-66	1/ 5,000	PAN	24	0	TO	0	X	NAS	
111	HATTERAS POINT	TO GREAT ISLE OVERWASH	15-APR-67	1/ 5,000	PAN	28	0	TO	0	X	NAS	
112	HATTERAS POINT	TO AVON	15-JUN-67	1/ 5,000	PAN	31	0	TO	0	X	NAS	
113	HATTERAS POINT	TO AVON	14-SEP-67	1/ 5,000	PAN	44	0	TO	0	X	NAS	
114	OCRACOKE INLET	TO W OF BUXTON	7-APR-68	1/ 20,000	COL	26	3386	TO	3411	X	NOAA	68E
115	NW OF BUXTON	TO OCRACOKE INLET	25-APR-68	1/ 20,000	COL	32	4658	TO	4689	X	NOAA	68E
116	OCRACOKE INLET	TO OCRACOKE INLET	25-APR-68	1/ 20,000	COL	1	4695	TO	4695	X	NOAA	68E
117	OCRACOKE INLET	TO KITTY HAWK	3-OCT-68	1/ 10,000	PAN	132	0	TO	0		DIA	USMC
118	HATTERAS POINT	TO AVON	14-NOV-68	1/ 5,000	PAN	26	0	TO	0	X	NAS	
119	HATTERAS POINT	TO KITTY HAWK	12-FEB-69	1/ 20,000	PAN	54	0	TO	0	X	USN	
120	HATTERAS POINT	TO AVON	13-FEB-69	1/ 5,000	PAN	35	0	TO	0	X	NAS	
121	HATTERAS POINT	TO AVON	29-MAR-69	1/ 5,000	PAN	39	0	TO	0	X	NAS	
122	NAGS HEAD	TO OCRACOKE INLET	4-APR-69	1/ 20,000	PAN	106	0	TO	0	X	USN	
123	OCRACOKE INLET	TO NAGS HEAD	4-APR-69	1/ 20,000	PAN	106	0	TO	0	X	USN	
124	NAGS HEAD	TO OCRACOKE INLET	4-JUN-69	1/ 20,000	PAN	129	0	TO	0	X	USN	VAP 62
125	OCRACOKE INLET	TO NAGS HEAD	4-JUN-69	1/ 20,000	PAN	129	0	TO	0	X	USN	VAP 62
126	OCRACOKE INLET	TO NAGS HEAD	7-AUG-69	1/ 20,000	PAN	139	0	TO	0	X	USN	
127	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/ 60,000	CIR	1	200	TO	200		NASA	MSN144FLT244
128	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/ 60,000	CIR	1	409	TO	409		NASA	MSN144FLT244
129	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/120,000	PAN	1	25	TO	25		NASA	MSN144FLT244
130	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/120,000	PAN	1	39	TO	39		NASA	MSN144FLT244
131	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/120,000	COL	1	7450	TO	7450		NASA	MSN144FLT244
132	HATTERAS INLET	TO HATTERAS INLET	15-SEP-70	1/120,000	COL	1	7709	TO	7709		NASA	MSN144FLT244
133	NAGS HEAD	TO BUXTON	24-SEP-70	1/ 60,000	CIR	19	0	TO	0	X	NASA	MSN144FLT244
134	WRIGHT BRIDGE	TO RODANTHE	24-SEP-70	1/ 60,000	CIR	38	0	TO	0	X	NASA	MSN144FLT244

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
135	OCRACOKE INLET	TO OCRACOKE VILLAGE	24-SEP-70	1/120,000	CIR	3	0	TO	0	X	NASA	MSN144FLT244
136	VA COASTAL PLAIN	TO NC COASTAL PLAIN	24-SEP-70	1/120,000	CIR	22	0	TO	0	X	EROS	
137	OREGON INLET	TO OREGON INLET	24-SEP-70	1/120,000	PAN	1	10	TO	10		NASA	MSN144FLT244
138	OCRACOKE	TO AVON	29-SEP-70	1/ 60,000	CIR	12	0	TO	0	X	NASA	MSN144FLT244
139	AVON	TO WAVES	29-SEP-70	1/121,000	CIR	2	7360	TO	7361	X	EROS	AMES470
140	S END OF OCRACOKE	TO SALVO	29-SEP-70	1/122,000	CIR	6	7354	TO	7359	X	EROS	AMES470
141	OCRACOKE INLET	TO OCRACOKE INLET	15-OCT-70	1/ 60,000	COL	1	44	TO	44		NASA	MSN145FLT244
142	HATTERAS INLET	TO HATTERAS INLET	15-OCT-70	1/120,000	PAN	1	44	TO	44		NASA	MSN145FLT244
143	OCRACOKE INLET	TO OCRACOKE INLET	15-OCT-70	1/120,000	PAN	1	45	TO	45		NASA	MSN145FLT244
144	OCRACOKE INLET	TO OCRACOKE INLET	15-OCT-70	1/120,000	COL	1	8312	TO	8312		NASA	MSN145FLT244
145	HATTERAS INLET	TO HATTERAS INLET	15-OCT-70	1/120,000	COL	1	8313	TO	8313		NASA	MSN145FLT244
146	OCRACOKE	TO OCRACOKE	18-OCT-70	1/ 60,000	COL	3	0	TO	0		NASA	MSN144FLT244
147	OCRACOKE INLET	TO OCRACOKE INLET	15-NOV-70	1/ 32,000	CIR	1	5	TO	5		NASA	MSN147FLT248
148	HATTERAS INLET	TO HATTERAS INLET	15-NOV-70	1/ 32,000	BIR	1	7	TO	7		NASA	MSN147FLT248
149	OCRACOKE INLET	TO OCRACOKE INLET	15-NOV-70	1/120,000	COL	1	9673	TO	9673		NASA	MSN147FLT248
150	HATTERAS INLET	TO HATTERAS INLET	15-NOV-70	1/120,000	COL	1	9675	TO	9675		NASA	MSN147FLT248
151	SALVO	TO AVON	6-DEC-70	1/ 20,000	COL	7	8763	TO	8769	X	NOAA	70E
152	RODANTHE	TO ROANOKE BRIDGE	21-MAR-71	1/ 20,000	COL	21	93	TO	113	X	NOAA	71E
153	NC COAST	TO NC COAST	25-AUG-71	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN83 FLT1
154	NC COAST	TO NC COAST	25-AUG-71	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN83 FLT1
155	NC COAST	TO NC COAST	7-OCT-71	1/ 12,000	CIR	0	0	TO	0	X	WALL	MSN88 FLT1
156	N OF OREGON INLET	TO S OF OREGON INLET	11-NOV-71	1/ 20,000	COL	7	9225	TO	9231	X	NOAA	71E
157	N OF SALVO	TO SALVO	11-NOV-71	1/ 40,000	COL	3	9224	TO	9226	X	NOAA	71E
158	NC COAST	TO NC COAST	4-FEB-72	1/ 5,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
159	NC COAST	TO NC COAST	4-FEB-72	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
160	NC COAST	TO NC COAST	4-FEB-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
161	NC OUTER BANKS	TO VA OUTER BANKS	19-APR-72	1/ 12,000	CIR	0	0	TO	0	X	WALL	MSN120 FLT1
162	NC OUTER BANKS	TO VA OUTER BANKS	19-APR-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN120 FLT1
163	NC COAST	TO VA COAST	9-AUG-72	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN155 FLT1
164	NC COAST	TO VA COAST	9-AUG-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN155 FLT1
165	NC COAST	TO NC COAST	7-NOV-72	1/ 12,000	MUL	0	0	TO	0	X	WALL	MSN179 FLT1
166	LOOKOUT POINT	TO CAPE HENRY	30-JAN-73	1/120,000	CIR	29	0	TO	0	X	NASA	73 13C
167	OREGON INLET	TO NAGS HEAD	30-JAN-73	1/127,000	CIR	2	8262	TO	8263	X	EROS	AMES937
168	OCRACOKE INLET	TO N OF RODANTHE	30-JAN-73	1/130,000	CIR	7	8253	TO	8259	X	EROS	AMES937
169	OREGON INLET	TO OREGON INLET	30-JAN-73	1/130,000	CIR	1	8261	TO	8261		EROS	AMES937
170	OCRACOKE INLET	TO RODANTHE	30-JAN-73	1/478,000	PAN	7	9	TO	15	X	EROS	AMES935
171	OCRACOKE INLET	TO RODANTHE	30-JAN-73	1/478,000	PAN	7	9	TO	15	X	EROS	AMES934
172	OCRACOKE INLET	TO RODANTHE	30-JAN-73	1/478,000	PAN	7	9	TO	15	X	EROS	AMES933
173	NC COAST	TO NC COAST	13-FEB-73	1/ 3,000	MUL	0	0	TO	0	X	WALL	MSN187 FLT1
174	NC COAST	TO NC COAST	13-FEB-73	1/ 13,000	MUL	0	0	TO	0	X	WALL	MSN187 FLT1
175	NC COAST	TO NC COAST	11-MAY-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN195 FLT1
176	NC COAST	TO NC COAST	11-MAY-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN195 FLT1
177	NC COAST	TO NC COAST	15-JUN-73	1/ 10,000	MUL	0	0	TO	0	X	WALL	MSN222 FLT2
178	NC COAST	TO NC COAST	15-JUN-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN222 FLT1
179	NC COAST	TO NC COAST	15-JUN-73	1/ 19,000	MUL	0	0	TO	0	X	WALL	MSN222 FLT2
180	NC COAST	TO NC COAST	15-JUN-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN222 FLT1
181	NC COAST	TO NC COAST	14-AUG-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN242 FLT1
182	NC COAST	TO NC COAST	14-AUG-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN242 FLT1
183	BUXTON	TO OCRACOKE VILLAGE	12-OCT-73	1/ 40,000	COL	12	748	TO	759	X	NOAA	73E
184	MID OCRACOKE	TO HATTERAS VILLAGE	13-OCT-73	1/ 10,000	COL	21	823	TO	843	X	NOAA	73E
185	NC COAST	TO NC COAST	18-NOV-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN182 FLT1
186	NC COAST	TO NC COAST	18-NOV-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN182 FLT1

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
187	CAPE HENLOPEN	TO CORE BANKS	4-JUN-74	1/ 20,000	CIR	0	0	TO 0	X	WALL	MSN271 FLT1
188	ROANOKE BRIDGE	TO HATTERAS POINT	18-JUL-74	1/442,000	COL	9	1	TO 9	X	EROS	AMES1867
189	CAPE HATTERAS	TO CAPE HATTERAS	18-OCT-74	1/ 20,000	COL	0	0	TO 0	X	WALL	MSN313 FLT1
190	NC COAST	TO NC COAST	3-DEC-74	1/ 20,000	MUL	0	0	TO 0	X	WALL	MSN316 FLT1
191	CAPE LOOKOUT	TO CAPE HENLOPEN	17-APR-75	1/ 12,000	CIR	0	0	TO 0	X	WALL	MSN322 FLT1
192	N OF KITTY HAWK	TO SHASH INLET	11-MAY-75	1/130,000	CIR	15	4486	TO 4500	X	EROS	AMES2112
193	NC COAST	TO NC COAST	20-JUN-75	1/ 23,000	CIR	0	0	TO 0	X	WALL	MSN329 FLT1
194	NC COAST	TO FISHERMANS ISLAND	2-JUL-75	1/ 24,000	CIR	0	0	TO 0	X	WALL	MSN331 FLT1
195	DEL COAST	TO NC COAST	5-SEP-75	1/ 20,000	MUL	0	0	TO 0	X	WALL	MSN345 FLT1
196	NC COASTS	TO VA COASTS	2-DEC-75	1/ 20,000	CIR	0	0	TO 0	X	WALL	MSN354 FLT1
197	NAGS HEAD	TO OCRACOKE INLET	23-DEC-75	1/ 21,000	CIR	0	0	TO 0	X	WALL	MSN355 FLT1
198	NAGS HEAD	TO OREGON INLET	25-FEB-76	1/120,000	CIR	5	0	TO 0		NASA	2299/76 23
199	CAPE HENRY	TO BEAUFORT INLET	20-JUL-76	1/ 20,000	CIR	170	8	TO 177	X	WALL	MSN376 FLT1
200	BACK BAY	TO BEAUFORT INLET	12-AUG-76	1/ 20,000	CIR	151	21	TO 171	X	WALL	MSN383 FLT3
201	HATTERAS INLET	TO FRISCO	12-AUG-76	1/ 20,000	CIR	11	172	TO 182	X	WALL	MSN383 FLT3
202	LONG ISLAND	TO LOOKOUT POINT	30-AUG-76	1/130,000	CIR	87	453	TO 539	X	EROS	76-142

CAPE LOOKOUT AERIAL PHOTOGRAPHY.

KEY TO ABBREVIATIONS.

FILM. COL=COLOR CIR=COLOR INFRA-RED PAN=PANCHROMATIC (BLACK AND WHITE) BIR=BLACK AND WHITE INFRA-RED.
MUL=MORE THAN ONE OF THE ABOVE AVAILABLE.
FRM=TOTAL NUMBER OF FRAMES IN FLIGHT LINE. FIRST=FIRST FRAME NUMBER. LAST=LAST FRAME NUMBER.
IF ABOVE=0, INFORMATION WAS NOT IMMEDIATELY AVAILABLE AT TIME OF COMPILATION.
S=STEREO COVERAGE = X IF OVERLAP IS 50 PERCENT OR GREATER.
SOURCE. ASCS=AGRIC.STABIL.AND CONS.SERVICE.
CENG=CORPS OF ENGINEERS.
COMM=COMMERCIAL.
DIA=DEFENSE INTELLIGENCE AGENCY.
EROS=EROS DATA CENTER, SIOUX FALLS, S.D.
NARC=NATIONAL ARCHIVES.
NAS=NAVAL AIR STATION.
NASA=EROS DATA CENTER.
NOAA=NATIONAL OCEAN SURVEY, NOAA, ROCKVILLE, MD.
OTHR=OTHER.
USAF=AIR FORCE.
USGS=USGS, RESTON, VA. OR EROS DATA CENTER.
USN=NAVY.
WALL=NASA/WALLOPS,VA. OR EROS DATA CENTER.
I.D.=MISSION, ROLL, FLIGHT, ACCESSION, OR OTHER IDENTIFYING NUMBER.
NOTE. FLIGHTS FLOWN WITH SCALES GREATER THAN 1/200,000 HAVE A 2.2-INCH FORMAT. ALL OTHERS HAVE A 9-INCH FORMAT.
MILITARY FLIGHTS CAN BE OBTAINED THROUGH THE DIA.

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST	LAST	S	SOURCE	I.D.
1	BARDEN INLET	TO BARDEN INLET	15-JUN-38	1/ 20,000	PAN	1	45 TO	45		NARC	AOR 39R
2	BEAUFORT INLET	TO CORE BANKS(PARTIAL)	2-JAN-39	1/ 20,000	PAN	4	0 TO	0		NARC	BUS102
3	WHALEBONE INLET	TO WHALEBONE INLET	15-OCT-40	1/ 24,000	PAN	1	87 TO	87		USGS	BARRIER REEF
4	SAND ISLAND INLET	TO SAND ISLAND INLET	15-OCT-40	1/ 24,000	PAN	1	92 TO	92		USGS	BARRIER REEF
5	COROLLA,NC	TO LOOKOUT POINT	21-OCT-40	1/ 24,000	PAN	139	1 TO	139	X	CENG	V
6	OCRACOKE INLET	TO WHALEBONE INLET	21-OCT-40	1/ 24,000	PAN	5	75 TO	79	X	CENG	V
7	OCRACOKE VILLAGE	TO LOOKOUT POINT	21-OCT-40	1/ 24,000	PAN	35	80 TO	114	X	CENG	V
8	SAND ISLAND INLET	TO SAND ISLAND INLET	15-FEB-43	1/ 40,000	PAN	1	89 TO	89		USGS	27VV
9	SWASH INLET	TO LOOKOUT POINT	23-FEB-43	1/ 40,000	PAN	18	91 TO	108	X	CENG	3P-3-62
10	BOGUE BANKS	TO DRUM INLET	30-MAR-43	1/ 40,000	PAN	33	0 TO	0	X	CENG	PROJECT 27
11	WHALEBONE INLET	TO WHALEBONE INLET	15-JUN-43	1/ 60,000	PAN	1	89 TO	89		USGS	27 62
12	LOOKOUT POINT	TO LOOKOUT POINT	24-JAN-45	1/ 20,000	PAN	4	848 TO	851	X	NOAA	45C
13	DRUM INLET	TO OCRACOKE INLET	24-JAN-45	1/ 20,000	PAN	19	867 TO	885	X	NOAA	45C
14	SAND ISLAND INLET	TO SAND ISLAND INLET	15-JUN-45	1/ 20,000	COL	3	872 TO	874	X	NOAA	45E
15	WHALEBONE INLET	TO WHALEBONE INLET	15-JUN-45	1/ 20,000	PAN	1	879 TO	879		NOAA	45C
16	BEAUFORT INLET	TO BEAUFORT INLET	15-MAR-51	1/ 24,000	PAN	2	3208 TO	3209	X	NOAA	510
17	BEAUFORT INLET	TO LOOKOUT POINT	10-JUN-53	1/ 20,000	PAN	18	224 TO	241	X	NOAA	530
18	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-53	1/ 20,000	PAN	3	224 TO	226	X	NOAA	530
19	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-53	1/ 20,000	PAN	2	3208 TO	3209	X	ASCS	BUS
20	MOREHEAD CITY	TO HARKERS ISLAND	30-NOV-54	1/ 24,000	PAN	9	3854 TO	3862	X	NOAA	54W
21	S OF DRUM INLET	TO LOOKOUT POINT	30-NOV-54	1/ 24,000	PAN	10	3863 TO	3872	X	NOAA	54W
22	DARDEN INLET	TO BEAUFORT INLET	30-NOV-54	1/ 24,000	PAN	11	3873 TO	3883	X	NOAA	54W
23	W OF DARDEN INLET	TO BEAUFORT INLET	30-NOV-54	1/ 24,000	PAN	5	3908 TO	3912	X	NOAA	54W
24	LOOKOUT POINT	TO OCRACOKE INLET	29-MAR-55	1/ 18,000	PAN	41	5529 TO	5569	X	NOAA	55W
25	LOOKOUT POINT	TO LOOKOUT POINT	29-MAR-55	1/ 24,000	PAN	3	5520 TO	5522	X	NOAA	55W
26	BEAUFORT INLET	TO BEAUFORT INLET	4-MAY-58	1/ 24,000	PAN	3	2756 TO	2758	X	NOAA	58S
27	DRUM INLET	TO DRUM INLET	4-MAY-58	1/ 25,000	PAN	2	2741 TO	2742	X	NOAA	58S
28	DARDEN INLET	TO LOOKOUT POINT	4-MAY-58	1/ 25,000	PAN	5	2745 TO	2749	X	NOAA	58S
29	BARDEN INLET	TO BARDEN INLET	4-MAY-58	1/ 25,000	PAN	2	2762 TO	2763	X	NOAA	58S
30	CARTERSET COUNTY,NC	TO CARTERSET COUNTY,NC	15-JUN-58	1/ 20,000	PAN	0	0 TO	0	X	ASCS	BUS37031

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
31	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-58	1/ 20,000	PAN	2	60	TO	61		ASCS	BUS 3H
32	OCRACOKE INLET	TO BOGUE BANKS	10-OCT-58	1/ 18,000	PAN	34	0	TO	0		NOAA	58W
33	SWASH INLET	TO LOOKOUT POINT	10-OCT-58	1/ 18,000	PAN	41	1559	TO	1599	X	NOAA	58W
34	E OF LOOKOUT POINT	TO E OF BEAUFORT INLET	10-OCT-58	1/ 18,000	PAN	11	1600	TO	1610	X	NOAA	58W
35	BARDEN INLET	TO BARDEN INLET	10-OCT-58	1/ 18,000	PAN	2	1643	TO	1644	X	NOAA	58W
36	BEAUFORT INLET	TO BEAUFORT INLET	15-OCT-58	1/ 18,000	PAN	2	1611	TO	1612	X	NOAA	58W
37	BARDEN INLET	TO BARDEN INLET	15-JUN-59	1/ 25,000	PAN	3	7385	TO	7387	X	NOAA	59W
38	BEAUFORT INLET	TO N OF LOOKOUT POINT	16-AUG-59	1/ 25,000	PAN	9	7409	TO	7417	X	NOAA	59W
39	S OF LOOKOUT POINT	TO SWASH INLET	16-AUG-59	1/ 25,000	PAN	33	7419	TO	7451	X	NOAA	59W
40	WHALEBONE INLET	TO WHALEBONE INLET	16-SEP-59	1/ 25,000	PAN	1	7501	TO	7501		NOAA	59W
41	E OF SWASH INLET	TO E OF N CORE BANKS	13-OCT-59	1/ 4,000	PAN	9	8402	TO	8410	X	NOAA	59S
42	BARDEN INLET	TO BARDEN INLET	15-NOV-60	1/ 20,000	PAN	1	22	TO	22		ASCS	AOR 1AA
43	BEAUFORT	TO E OF LOOKOUT POINT	25-NOV-61	1/ 36,000	PAN	7	8929	TO	8935	X	NOAA	61S
44	BARDEN INLET	TO BARDEN INLET	13-MAR-62	1/ 20,000	PAN	1	1640	TO	1640		NOAA	62S
45	BEAUFORT INLET	TO E OF BEAUFORT INLET	13-MAR-62	1/ 24,000	PAN	4	1648	TO	1651	X	NOAA	62S
46	LOOKOUT POINT	TO OCRACOKE INLET	13-MAR-62	1/ 24,000	PAN	30	1653	TO	1682	X	NOAA	62S
47	BACK SOUND	TO BEAUFORT INLET	4-APR-62	1/ 10,000	COL	6	4945	TO	4950	X	NOAA	62S
48	FORT MACON	TO BEAUFORT	4-APR-62	1/ 10,000	COL	5	4951	TO	4955	X	NOAA	62S
49	LOOKOUT POINT	TO N OF DARDEN INLET	4-APR-62	1/ 10,000	COL	10	4956	TO	4965	X	NOAA	62S
50	DARDEN INLET	TO W OF LOOKOUT POINT	4-APR-62	1/ 10,000	COL	10	4968	TO	4977	X	NOAA	62S
51	OCRACOKE INLET	TO N OF LOOKOUT POINT	3-MAY-62	1/ 20,000	BIR	35	3133	TO	3167	X	NOAA	62L
52	N OF LOOKOUT POINT	TO BEAUFORT INLET	3-MAY-62	1/ 20,000	BIR	13	3169	TO	3181	X	NOAA	62L
53	LOOKOUT POINT	TO S OF DRUM INLET	3-MAY-62	1/ 20,000	BIR	19	3183	TO	3201	X	NOAA	62L
54	BEAUFORT INLET	TO BEAUFORT INLET	15-MAY-62	1/ 20,000	PAN	1	4325	TO	4325		NOAA	62W
55	BARDEN INLET	TO BARDEN INLET	15-JUN-62	1/ 20,000	PAN	1	3429	TO	3429		NOAA	62L
56	WHALEBONE INLET	TO WHALEBONE INLET	15-JUN-62	1/ 20,000	PAN	1	4289	TO	4289		NOAA	62W
57	SWASH INLET	TO SWASH INLET	15-JUN-62	1/ 20,000	PAN	1	4291	TO	4291		NOAA	62W
58	SAND ISLAND INLET	TO SAND ISLAND INLET	15-JUN-62	1/ 20,000	PAN	1	4295	TO	4295		NOAA	62W
59	DRUM INLET	TO DRUM INLET	15-JUN-62	1/ 20,000	PAN	1	4300	TO	4300		NOAA	62W
60	SAND ISLAND INLET	TO SAND ISLAND INLET	15-JUN-62	1/ 30,000	PAN	1	1848	TO	1848		NOAA	62S
61	SWASH INLET	TO SWASH INLET	15-JUN-62	1/ 30,000	PAN	1	1848	TO	1848		NOAA	62S
62	WHALEBONE INLET	TO WHALEBONE INLET	15-JUN-62	1/ 60,000	PAN	1	3026	TO	3026		NOAA	62M
63	CARTERSET COUNTY,NC	TO CARTERSET COUNTY,NC	15-JUN-64	1/ 20,000	PAN	0	0	TO	0	X	ASCS	BUS37031
64	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-64	1/ 20,000	PAN	2	26	TO	27		ASCS	BUS 3EE
65	BARDEN INLET	TO BARDEN INLET	15-JUN-64	1/ 20,000	PAN	1	217	TO	217		ASCS	AOR 3EE
66	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-64	1/ 30,000	PAN	2	1356	TO	1357	X	NOAA	64S
67	PORTSMOUTH ISLAND	TO PORTSMOUTH ISLAND	23-JUL-65	1/ 6,000	BIR	14	0	TO	0		AAS	1419 Z
68	BEAUFORT INLET	TO DARDEN INLET	27-OCT-65	1/ 20,000	PAN	13	700	TO	712	X	NOAA	65S
69	LOOKOUT POINT	TO N OF LOOKOUT POINT	27-OCT-65	1/ 20,000	PAN	11	713	TO	723	X	NOAA	65S
70	BEAUFORT	TO HARKERS ISLAND	25-NOV-65	1/ 20,000	PAN	10	9521	TO	9530	X	NOAA	65L
71	JARRETT BAY	TO HOG ISLAND	8-MAY-67	1/ 30,000	COL	15	1987	TO	2001	X	NOAA	67L
72	WHALEBONE INLET	TO WHALEBONE INLET	8-MAY-67	1/ 30,000	COL	1	2007	TO	2007		NOAA	67L
73	E OF HOG ISLAND	TO E OF DAVIS	8-MAY-67	1/ 30,000	COL	13	2010	TO	2022	X	NOAA	67L
74	HOG ISLAND	TO SWASH INLET	8-MAY-67	1/ 30,000	COL	9	2032	TO	2040	X	NOAA	67L
75	BEAUFORT INLET	TO DARDEN INLET	7-APR-68	1/ 20,000	PAN	12	3336	TO	3347	X	NOAA	68E
76	N OF LOOKOUT POINT	TO SWASH INLET	7-APR-68	1/ 20,000	PAN	22	3346	TO	3367	X	NOAA	68E
77	N OF LOOKOUT POINT	TO LOOKOUT POINT	12-APR-68	1/ 20,000	PAN	9	3600	TO	3608	X	NOAA	68E
78	LOOKOUT POINT	TO DRUM INLET	12-APR-68	1/ 20,000	PAN	22	3610	TO	3631	X	NOAA	68E
79	SWASH INLET	TO N OF LOOKOUT POINT	25-APR-68	1/ 20,000	COL	25	4702	TO	4726	X	NOAA	68E
80	LOOKOUT POINT	TO S OF SWASH INLET	25-APR-68	1/ 20,000	COL	23	4728	TO	4750	X	NOAA	68E
81	OCRACOKE INLET	TO BOGUE BANKS	12-FEB-69	1/ 22,000	PAN	40	0	TO	0	X	USN	
82	OCRACOKE INLET	TO BOGUE BANKS	1-APR-69	1/ 20,000	PAN	80	0	TO	0	X	USN	

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
83	OCRACOKE INLET	TO BOGUE BANKS	4-JUN-69	1/ 20,000	PAN	65	0	TO	0	X	USN	VAP62
84	OCRACOKE INLET	TO BOGUE BANKS	7-AUG-69	1/ 20,000	PAN	106	0	TO	0	X	USN	
85	BEAUFORT INLET	TO BEAUFORT INLET	15-SEP-70	1/ 60,000	CIR	1	392	TO	392		NASA	MSN144FLT244
86	BARDEN INLET	TO BARDEN INLET	15-SEP-70	1/120,000	PAN	1	8	TO	8		NASA	MSN144FLT244
87	BEAUFORT INLET	TO BEAUFORT INLET	15-SEP-70	1/120,000	PAN	1	21	TO	21		NASA	MSN144FLT244
88	DRUM INLET	TO DRUM INLET	15-SEP-70	1/120,000	PAN	1	23	TO	23		NASA	MSN144FLT244
89	SAND ISLAND INLET	TO SAND ISLAND INLET	15-SEP-70	1/120,000	PAN	1	23	TO	23		NASA	MSN144FLT244
90	BARDEN INLET	TO BARDEN INLET	15-SEP-70	1/120,000	COL	1	7669	TO	7669		NASA	MSN144FLT244
91	BEAUFORT INLET	TO BEAUFORT INLET	15-SEP-70	1/120,000	COL	1	7700	TO	7700		NASA	MSN144FLT244
92	DRUM INLET	TO DRUM INLET	15-SEP-70	1/120,000	COL	1	7703	TO	7703		NASA	MSN144FLT244
93	SAND ISLAND INLET	TO SAND ISLAND INLET	15-SEP-70	1/120,000	COL	1	7704	TO	7704		NASA	MSN144FLT244
94	VA COASTAL PLAIN	TO NC COASTAL PLAIN	24-SEP-70	1/120,000	CIR	14	0	TO	0	X	EROS	
95	LOOKOUT POINT	TO CORE BANKS	29-SEP-70	1/ 60,000	CIR	10	0	TO	0	X	NASA	MSN144FLT244
96	SWASH INLET	TO SWASH INLET	29-SEP-70	1/120,000	PAN	1	23	TO	23		NASA	MSN144FLT244
97	SWASH INLET	TO SWASH INLET	29-SEP-70	1/120,000	COL	1	7705	TO	7705		NASA	MSN144FLT244
98	SWASH INLET	TO BEAUFORT INLET	29-SEP-70	1/122,000	CIR	5	7313	TO	7317	X	EROS	AMES470
99	S OF NEW RIV INLET	TO OCRACOKE INLET	29-SEP-70	1/124,000	CIR	12	7342	TO	7353	X	EROS	AMES470
100	BARDEN INLET	TO BARDEN INLET	15-OCT-70	1/ 20,000	PAN	1	15	TO	15		ASCS	AOR 2LL
101	DRUM INLET	TO DRUM INLET	15-OCT-70	1/ 32,000	CIR	1	22	TO	22		NASA	MSN147FLT248
102	SWASH INLET	TO SWASH INLET	15-OCT-70	1/ 60,000	COL	1	40	TO	40		NASA	MSN145FLT244
103	SWASH INLET	TO SWASH INLET	15-OCT-70	1/120,000	PAN	1	46	TO	46		NASA	MSN145FLT244
104	SAND ISLAND INLET	TO SAND ISLAND INLET	15-OCT-70	1/120,000	PAN	1	46	TO	46		NASA	MSN145FLT244
105	DRUM INLET	TO DRUM INLET	15-OCT-70	1/120,000	PAN	1	47	TO	47		NASA	MSN145FLT244
106	BEAUFORT INLET	TO BEAUFORT INLET	15-OCT-70	1/120,000	PAN	1	51	TO	51		NASA	MSN145FLT244
107	BEAUFORT INLET	TO BEAUFORT INLET	15-OCT-70	1/120,000	COL	1	8306	TO	8306		NASA	MSN145FLT244
108	DRUM INLET	TO DRUM INLET	15-OCT-70	1/120,000	COL	1	8309	TO	8309		NASA	MSN145FLT244
109	SAND ISLAND INLET	TO SAND ISLAND INLET	15-OCT-70	1/120,000	COL	1	8310	TO	8310		NASA	MSN145FLT244
110	SWASH INLET	TO SWASH INLET	15-OCT-70	1/120,000	COL	1	8310	TO	8310		NASA	MSN145FLT244
111	DRUM INLET	TO DRUM INLET	15-OCT-70	1/120,000	COL	1	9691	TO	9691		NASA	MSN147FLT248
112	DELAWARE COAST	TO MARYLAND COAST	18-OCT-70	1/ 20,000	MUL	0	0	TO	0	X	WALL	MSN28 FLT3
113	CORE BANKS	TO CORE BANKS	18-OCT-70	1/ 60,000	COL	4	0	TO	0	X	NASA	MSN144FLT244
114	CAPE FEAR	TO OCRACOKE INLET	18-OCT-70	1/ 60,000	CIR	42	1	TO	42	X	EROS	AMES420
115	BEAUFORT INLET	TO BEAUFORT INLET	15-NOV-70	1/ 32,000	CIR	1	25	TO	25		NASA	MSN147FLT248
116	SWASH INLET	TO SWASH INLET	15-NOV-70	1/120,000	COL	1	9671	TO	9671		NASA	MSN147FLT248
117	BEAUFORT INLET	TO BEAUFORT INLET	15-NOV-70	1/120,000	COL	1	9695	TO	9695		NASA	MSN147FLT248
118	BARDEN INLET	TO BARDEN INLET	15-NOV-70	1/120,000	COL	1	9753	TO	9753		NASA	MSN147FLT248
119	HARKERS ISLAND	TO HARKERS ISLAND	6-DEC-70	1/ 20,000	COL	6	8757	TO	8762	X	NOAA	70E
120	CARTERSET COUNTY,NC	TO CARTERSET COUNTY,NC	15-JUN-71	1/ 20,000	PAN	0	0	TO	0	X	ASCS	BUS37031
121	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-71	1/ 20,000	PAN	1	25	TO	25		ASCS	BUS 3MM
122	BEAUFORT INLET	TO BEAUFORT INLET	15-JUN-71	1/ 20,000	PAN	1	61	TO	61		ASCS	BUS 3MM
123	NC COAST	TO NC COAST	25-AUG-71	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN83 FLT1
124	NC COAST	TO NC COAST	25-AUG-71	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN83 FLT1
125	NC COAST	TO NC COAST	7-OCT-71	1/ 12,000	CIR	0	0	TO	0	X	WALL	MSN88 FLT1
126	NC COAST	TO NC COAST	4-FEB-72	1/ 5,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
127	NC COAST	TO NC COAST	4-FEB-72	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
128	NC COAST	TO NC COAST	4-FEB-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN107 FLT1
129	NC OUTER BANKS	TO VA OUTER BANKS	19-APR-72	1/ 12,000	CIR	0	0	TO	0	X	WALL	MSN120 FLT1
130	NC OUTER BANKS	TO VA OUTER BANKS	19-APR-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN120 FLT1
131	LOOKOUT POINT	TO BEAUFORT INLET	27-APR-72	1/450,000	PAN	1	18	TO	18		EROS	AMES308
132	LOOKOUT POINT	TO BEAUFORT INLET	27-APR-72	1/450,000	PAN	1	18	TO	18		EROS	AMES307
133	LOOKOUT POINT	TO BEAUFORT INLET	27-APR-72	1/450,000	PAN	1	18	TO	18		EROS	AMES306
134	NC COAST	TO VA COAST	9-AUG-72	1/ 10,000	CIR	0	0	TO	0	X	WALL	MSN155 FLT1

LINE	START FLIGHT LINE	END FLIGHT LINE	DATE	SCALE	FILM	FRM	FIRST		LAST	S	SOURCE	I.D.
135	NC COAST	TO VA COAST	9-AUG-72	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN155 FLT1
136	E OF HARKERS ISLAND	TO DARDENS INLET	21-OCT-72	1/ 10,000	COL	9	6929	TO	6937	X	NOAA	72E
137	NC COAST	TO NC COAST	7-NOV-72	1/ 12,000	MUL	0	0	TO	0	X	WALL	MSN179 FLT1
138	BEAUFORT INLET	TO BEAUFORT INLET	15-JAN-73	1/ 10,000	CIR	0	0	TO	0		NASA	W/182 102
139	BEAUFORT INLET	TO E OF BEAUFORT INLET	30-JAN-73	1/ 20,000	COL	14	8240	TO	8253	X	NOAA	73E
140	E OF BEAUFORT INLET	TO BEAUFORT INLET	30-JAN-73	1/ 20,000	COL	10	8254	TO	8263	X	NOAA	73E
141	LOOKOUT POINT	TO OCRACOKE INLET	30-JAN-73	1/126,000	CIR	6	8247	TO	8252	X	EROS	AMES937
142	LOOKOUT POINT	TO SWASH INLET	30-JAN-73	1/440,000	PAN	1	1	TO	1		EROS	AMES935
143	LOOKOUT POINT	TO SWASH INLET	30-JAN-73	1/440,000	PAN	1	1	TO	1		EROS	AMES934
144	LOOKOUT POINT	TO SWASH INLET	30-JAN-73	1/440,000	PAN	1	1	TO	1		EROS	AMES933
145	NC COAST	TO NC COAST	13-FEB-73	1/ 3,000	MUL	0	0	TO	0	X	WALL	MSN187 FLT1
146	NC COAST	TO NC COAST	13-FEB-73	1/ 13,000	MUL	0	0	TO	0	X	WALL	MSN187 FLT1
147	BEAUFORT INLET	TO BEAUFORT INLET	15-APR-73	1/130,000	CIR	1	9312	TO	9312		NASA	AMES1102
148	NC COAST	TO NC COAST	11-MAY-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN195 FLT1
149	NC COAST	TO NC COAST	11-MAY-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN195 FLT1
150	NC COAST	TO NC COAST	15-JUN-73	1/ 10,000	MUL	0	0	TO	0	X	WALL	MSN222 FLT2
151	NC COAST	TO NC COAST	15-JUN-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN222 FLT1
152	NC COAST	TO NC COAST	15-JUN-73	1/ 19,000	MUL	0	0	TO	0	X	WALL	MSN222 FLT2
153	NC COAST	TO NC COAST	15-JUN-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN222 FLT1
154	NC COAST	TO NC COAST	14-AUG-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN242 FLT1
155	NC COAST	TO NC COAST	14-AUG-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN242 FLT1
156	LOOKOUT POINT	TO N OF LOOKOUT POINT	12-OCT-73	1/ 40,000	COL	7	725	TO	731	X	NOAA	73E
157	SWASH INLET	TO N OF LOOKOUT POINT	12-OCT-73	1/ 40,000	COL	11	760	TO	770	X	NOAA	73E
158	DARDENS INLET	TO BEAUFORT INLET	13-OCT-73	1/ 60,000	CIR	6	4685	TO	4690	X	NOAA	73C
159	DARDENS INLET	TO BEAUFORT INLET	13-OCT-73	1/ 60,000	CIR	5	4746	TO	4750	X	NOAA	73C
160	DARDENS INLET	TO BEAUFORT INLET	15-OCT-73	1/ 60,000	CIR	5	4779	TO	4783	X	NOAA	73C
161	NC COAST	TO NC COAST	18-NOV-73	1/ 11,000	CIR	0	0	TO	0	X	WALL	MSN182 FLT1
162	NC COAST	TO NC COAST	18-NOV-73	1/ 19,000	CIR	0	0	TO	0	X	WALL	MSN182 FLT1
163	SHACKLEFORD BANKS	TO BEAUFORT INLET	28-APR-74	1/131,000	CIR	2	8335	TO	8336	X	EROS	AMES1722
164	SHACKLEFORD BANKS	TO SHACKLEFORD BANKS	28-APR-74	1/447,000	CIR	1	16	TO	16		EROS	AMES1721
165	SHACKLEFORD BANKS	TO SHACKLEFORD BANKS	28-APR-74	1/447,000	PAN	1	16	TO	16		EROS	AMES1720
166	SHACKLEFORD BANKS	TO SHACKLEFORD BANKS	28-APR-74	1/447,000	PAN	1	16	TO	16		EROS	AMES1719
167	SHACKLEFORD BANKS	TO SHACKLEFORD BANKS	28-APR-74	1/447,000	PAN	1	16	TO	16		EROS	AMES1718
168	CAPE HENLOPEN	TO CORE BANKS	4-JUN-74	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN271 FLT1
169	NC COAST	TO NC COAST	3-DEC-74	1/ 20,000	MUL	0	0	TO	0	X	WALL	MSN316 FLT1
170	CAPE LOOKOUT	TO CAPE HENLOPEN	17-APR-75	1/ 12,000	CIR	0	0	TO	0	X	WALL	MSN322 FLT1
171	OCRACOKE INLET	TO BEAUFORT INLET	11-MAY-75	1/127,000	CIR	7	4501	TO	4507	X	EROS	AMES2112
172	NC COAST	TO NC COAST	20-JUN-75	1/ 23,000	CIR	0	0	TO	0	X	WALL	MSN329 FLT1
173	NC COAST	TO FISHERMANS ISLAND	2-JUL-75	1/ 24,000	CIR	0	0	TO	0	X	WALL	MSN331 FLT1
174	DEL COAST	TO NC COAST	5-SEP-75	1/ 20,000	MUL	0	0	TO	0	X	WALL	MSN345 FLT1
175	NC COASTS	TO VA COASTS	2-DEC-75	1/ 20,000	CIR	0	0	TO	0	X	WALL	MSN354 FLT1
176	OCRACOKE INLET	TO BEAUFORT INLET	25-FEB-76	1/120,000	CIR	4	0	TO	0	X	NASA	AMES2299
177	CAPE HENRY	TO BEAUFORT INLET	20-JUL-76	1/ 20,000	CIR	170	8	TO	177	X	WALL	MSN376 FLT1
178	BACK BAY	TO BEAUFORT INLET	12-AUG-76	1/ 20,000	CIR	151	21	TO	171	X	WALL	MSN383 FLT3
179	LONG ISLAND	TO LOOKOUT POINT	30-AUG-76	1/130,000	CIR	87	453	TO	539	X	EROS	76-142

GLOSSARY

Words in this glossary represent those most commonly found when using remote-sensing as a research tool for identifying coastal landscape elements and interface types. Definitions were collected from various sources including the 1972 edition of the *Glossary of Geology* published by the American Geological Institute.

ALLUVIAL PLAIN. A level or gently sloping tract or slightly undulating land surface produced by extensive deposition of alluvium, usually adjacent to a river that periodically overflows its banks; it may be situated on a flood plain, a delta, or an alluvial fan.

BARRIER. An elongated offshore ridge or mass usually of sand rising above the high-tide level, generally extending parallel to, and at some distance from, the shore and built up by the action of waves and currents. Examples: barrier beach, barrier island.

BARRIER BEACH. A single narrow, elongated sand ridge rising slightly above the high-tide level and extending generally parallel with the shore but separated from it by a lagoon or marsh; it is extended by longshore drifting and is rarely more than several kilometers long.

BARRIER CHAIN. A series of barrier islands, barrier spits, and barrier beaches extending a considerable distance along a coast.

BARRIER ISLAND. A long, low, narrow, wave-built sandy island representing a broadened barrier beach that is sufficiently above high tide and parallel to the shore and that commonly has dunes, vegetated zones, and swampy terrains extending lagoonward from the beach. Also a long series of barrier beaches as a barrier chain.

BARRIER REEF. A long, narrow coral reef roughly parallel to the shore and separated from it at some distance by a lagoon of considerable depth and width.

BATHYOROGRAPHICAL. Pertaining to the description of the ocean floor.

BAY. A large tract of water that penetrates into the land and around which the land forms a broad curve. By international agreement, a bay is a water body having a baymouth less than 24 nautical miles wide and an area that is equal to or greater than the area of a semicircle whose diameter is equal to the width of the baymouth.

BAYHEAD BEACH. A small crescentic beach formed at the head of a bay by materials eroded from adjacent headlands and carried to the bayhead by longshore currents or storm waves.

BEACH. A gently sloping zone, typically with a concave profile, of unconsolidated material that extends to the place where there is a definite change in material or physiographic form (such as a cliff) or to the line of permanent vegetation (usually of the effective limit of the highest storm waves); a shore of a body of water, formed and washed by waves or tides, usually covered by sandy or pebbly material, and lacking a bare rocky surface.

BEACH CREST. A temporary ridge or berm marking the landward limit of normal wave activity.

BEACH RIDGE. A low, essentially continuous mound of beach-and-dune material (sand, gravel, shingle) heaped up by the action of waves and currents on the backshore of a beach beyond the present limit of storm waves or the reach of ordinary tides and occurring singly as one of a series of approximately parallel deposits. The ridges are roughly parallel to the shoreline and represent successive positions of an advancing shoreline.

BERM. A low, impermanent, nearly horizontal or landward sloping beach, shelf, ledge, or narrow terrace on the backshore of a beach, formed of material thrown up and deposited by storm waves; it is generally bounded on one side or the other by a beach ridge.

BIGHT. A long, gradual bend or gentle curve, or slight, crescent-shaped indentation, in the shoreline of an open coast or of a bay; it may be larger than a bay, or it may be a segment of a feature smaller than a bay.

BREAKER. A sea-surface wave that has become too steep so that the crest outraces the body of the wave and collapses into a turbulent mass on shore or over a reef or rock; a breaking wave.

CHANNEL. The hollow bed where a natural body of surface water flows or may flow; a natural passageway or depression of perceptible extent containing continuously or periodically flowing water or forming a connecting link between two bodies of water; a watercourse.

CLIFF. Any high, very steep to perpendicular, or overhanging face of rock (sometimes earth or ice) occurring in the mountains or rising above the shore of a lake or river; a precipice. A cliff is usually produced by erosion, less commonly by faulting.

CLOSED BAY. A bay indirectly connected with the sea through a narrow pass.

COASTAL PLAIN. Any lowland area bordering a sea or ocean, extending inland to the nearest elevated land and sloping very gently seaward.

COASTLINE. Commonly, the line that forms the boundary between the land and the water, especially the water of a sea or ocean. A general term to describe the appearance or configuration of the land along a coast, especially as viewed from the sea; it includes bays but crosses narrow inlets and river mouths. Coastline, a limit fixed in position for a relatively long time; shoreline, a limit constantly moving across the beach.

CORAL-REEF SHORELINE. A shoreline formed by deposits of coral and algae, partly exposed at low tide and characterized by reefs built upward from a submarine floor or outward from the margin of a land area.

CUSP. Any of a series of low, crescent-shaped mounds or ridges of beach material built by wave action and separated by smoothly curved shallow depressions spaced at more or less regular intervals along and generally at right angles to the shoreline and varying in length across their seaward-pointing apexes from less than a meter to many kilometers; a beach cusp, a storm cusp, a giant cusp, a cuspate.

DELTA. The low, nearly flat, alluvial tract of land deposited at or near the mouth of a river, commonly forming a triangular or fan-shaped plain of considerable area enclosed and crossed by many distributaries of the main river, perhaps extending beyond the general trend of the coast and resulting from the accumulation in a wider body of water of sediment supplied by a river in such quantities that it is not removed by tides, waves, and currents. Most deltas are partly subaerial and partly below water.

DELTA SHORELINE. A prograding shoreline produced by the advancing of a delta into a lake or sea.

DESERT. An area of low moisture due to low rainfall; i.e., less than ten inches annually, high evaporation, or extreme cold and which supports only specialized vegetation, not that typical of the latitudes and is generally unsuitable for human habitation under natural conditions.

DISTRIBUTARY. An irregular, divergent stream flowing away from the main stream and not returning to it, as in a delta or on an alluvial plain.

DRAINAGE PATTERN. The configuration or arrangement in plan view of the natural stream courses in an area. It is related to local geologic and geomorphic features.

DRY SOILS. Soil lacking enough moisture for plant growth over extended time periods.

DUNE. A low mound, ridge, bank, or hill of loose, wind-blown granular material (generally sand, sometimes volcanic ash), either bare or covered with vegetation, capable of movement form place to place but always retaining its own characteristic shape.

ESTUARY. 1. The seaward end or the widened funnel-shaped tidal mouth of a river valley where freshwater mixes with and measurably dilutes seawater and where tidal effects are evident (a tidal river) or a partially enclosed coastal body of water where the tide meets the current of a stream. 2. A portion of the ocean, as a firth or an arm of the sea, affected by freshwater. 3. A drowned river mouth formed by the subsidence of land near the coast or by the drowning of the lower portion of a nonglaciated valley due to the rise of sea level.

FJORD COAST. A deeply indented, glaciated coast characterized by a partial submergence of glacial troughs and by the presence of steep parallel walls, truncated spurs, and hanging valleys.

FRESHWATER MARSH. A marsh that depends on nontidal freshwater as a source rather than salt water.

FRINGING REEF. A coral reef that is directly attached to or borders the shore of an island or continent, having a rough, table-like surface that is exposed at low tide; it may be more than 1 kilometer wide and its seaward edge slopes sharply down to the sea floor. There may be a shallow channel or lagoon between the reef and the mainland, although strictly there is no body of water between the reef and the land to which it is attached.

FUNNEL SEA. A gulf or bay that is narrow at its head and wide at its mouth and that deepens rapidly from head to mouth, thus resembling one half of a funnel split leghtwise.

GRASS. Grass-covered ground.

HANGING VALLEY. A coastal valley whose lower end is notably higher than the shore to which it leads, produced where betrunking or rapid cliff recession causes the mouths of streams to "hang" along the cliff front.

HIGH RELIEF. A region showing a great variation in relief has "high relief." (See relief). For this project, high relief was defined as relief greater than 100 feet within 4 miles of the coastline.

INLET. A short, narrow waterway running between islands or connecting a bay, lagoon, or similar body of water with a larger body of water, such as a sea or lake; for example, a waterway through a coastal obstruction (such as a reef or barrier island) leading to a bay or lagoon.

LAGOON A shallow stretch of seawater such as a sound, channel, bay, or salt-water lake, near or communicating with the sea and partly or completely separated from it by a low, narrow elongated strip of land, such as a reef, barrier island, sandbank, or spit; especially the sheet of water between an offshore coral reef and the mainland. It often extends roughly parallel to the coast and it may be stagnant.

LIFE FORM. The vegetative form of an organism such as tree, shrub, annual, liana, bunchgrass, broad-leafed sclerophyll, etc; growth form.

LONGSHORE BAR. A low, elongated sand ridge, built chiefly by wave action, occurring at some distance from, and extending generally parallel with, the shoreline, being submerged at least by high tides and typically separated from the beach by an intervening trough.

LOW RELIEF. A region showing little variation in elevation has "low relief." In this project low relief was defined as relief less than 100 feet (30 m) within 4 miles (6.5 km) of the coastline (see relief).

MANGROVE COAST. A tropical or subtropical low-energy coast whose shoreline is overgrown by mangrove vegetation; such as in southern Florida.

MOIST SOILS. Usually not saturated with water but for long periods have enough moisture for plant growth.

MOUTH. The place of discharge of a body of water into a larger body of water as where a tributary enters the main stream or where a river enters a sea or lake.

MUDFLAT. See open-coast marsh.

MUDFLAT COASTLINE. A mudflat formed along an open coast; a relatively flat foreshore composed of fine silt.

NATURAL LEVEE. A long, broad, low ridge or embankment of sand and coarse silt, built by a stream on its flood plain and along both banks of its channel, especially in time of flood when water overflowing the normal banks is forced to deposit the coarsest part of its load. It has a gentle slope away from the river and toward the surrounding flood plain and its highest elevation is closest to the river bank, at or near normal flood level.

OPEN BAY. An indentation between two capes or headlands, so broad and open that waves coming directly into it are nearly as high near its center as on adjacent parts of the open sea; a bight.

OPEN-COAST MARSH. A salt marsh formed along an open coast (i.e., a coast exposed to the full action of waves and currents). A coastal marsh is defined as a marsh bordering a sea coast, generally formed under the protection of a barrier beach or enclosed in the sheltered part of an estuary.

OVERWASH MARK. A narrow, tongue-like ridge of sand formed by overwash on the landward side of a berm.

POCKET BEACH. A small narrow beach formed in an enclosed or sheltered place along a coast (such as a reentrant between rocky, cliffed headlands or a bight on a lee shore), commonly crescentic in plan and concave toward the sea and generally displaying well-sorted sands; a bayhead beach.

PROMONTORY. A high, prominent projection or point of land, or cliff of rock, jutting out boldly into a body of water beyond the coastline; a headland.

RELIEF. The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given region. A region showing a great variation in elevation has "high relief;" one showing little variation has "low relief."

ROCK COAST. A jagged rocky coastline, especially where dangerous to shipping.

ROCKY. 1. Any notable, usually bare peak, cliff, promontory, or hill considered as one mass. 2. A rocky mass lying at, near, or projecting above the surface of a body of water.

SALT MARSH. Flat, poorly drained land that is subject to periodic or occasional overflow by salt water, containing water that is brackish to strongly saline and usually covered with a thick mat of grassy halophytic plants (e.g., a coastal marsh periodically flooded by the sea).

SAND. A tract or region of sand such as a sandy beach along the seashore or a desert land.

SAND BEACH. A straight or gently curving broad beach of sandy material formed on the mainland and possessing many of the characteristics of a barrier-chain coast except the lagoon.

SAND BEACH WITH ROCK HEADLANDS. A narrow beach formed in an open bay or bight between rocky cliffed headlands, commonly broadly crescentic in plan and concave toward the sea.

SANDY. Pertaining to or containing sand or consisting of, abounding in, or covered with sand.

SHINGLE. Coarse, loose, well-rounded, and waterworn detritus or alluvial material of various sizes, especially beach gravel composed of smooth and spheroidal or flattened fragments relatively free from fine material. Strictly, the term refers to beach pebbles and cobble of roughly the same size; more commonly, it includes any beach material coarser than ordinary gravel.

SHINGLE BEACH. A narrow beach, usually the first to form on a coastline having resistant bedrock and cliffs, composed of shingle, and commonly having a very steep slope on both its landward and seaward sides.

SHOAL. An elevation, or an area of such elevations, at a depth of 10 fathoms or less, composed of material other than rock or coral. It may be exposed at low water.

SHORE MATERIAL. The characteristic or dominant compositional substance of the beach.

SHRUB. A low, usually several-stemmed woody plant; a bush.

SHRUBBERY. A growth of shrubs; shrubs collectively.

SILTAGE. A mass of silt.

SKEERY. A low, small, rugged, and rocky island or reef; an isolated rock detached from the mainland, rising above sea level from a shallow strandflat, and covered by the sea during high tides or stormy weather.

SPIT. A small point or low tongue or narrow embankment of land commonly consisting of sand or gravel deposited by longshore drifting and having one end attached to the mainland and the other terminating in open water, usually the sea; a finger-like extension of the beach.

SUBMARINE BAR. A longshore bar that is always submerged, or never exposed above the water level even by low tides.

SUBMERGED AQUATIC PLANT. A hydrophyte, the main part of which grows below the surface of the water.

SWAMP. A water-saturated area, intermittently or permanently covered with water, having shrub- and tree-type vegetation.

SWASH ZONE. The sloping part of the beach that is alternately covered and uncovered by the uprush of waves and where longshore movement of water occurs in a zigzag (upslope, downslope) manner.

TIDAL CHANNEL. A major channel followed by the tidal currents, extending from offshore well into a tidal marsh or tidal flat.

TIDAL DELTA. A delta formed at the mouth of a tidal inlet on both the seaward and lagoon sides of a barrier island or baymouth bary by changing tidal currents that sweep sand in and out of the inlet.

TIDAL FLAT. An extensive, nearly horizontal, marshy or barren tract of land that is alternately covered and uncovered by the rise and fall of the tide and consisting of unconsolidated sediment (mostly mud and sand). It may form the top surface of a deltaic deposit. Includes sand flat and mudflat.

TIDAL MARSH. A low, flat marsh bordering a coast (as in a shallow lagoon or a sheltered bay), formed of mud and of resistant mat of roots of salt-tolerant plants, and regularly inundated during high tides.

TOPOGRAPHIC FORM. A landform considered without regard to its origin, cause, or history. A landform is defined as any physically recognizable form or feature of the Earth's surface, having a characteristic shape and produced by natural causes; it includes major forms such as a plain, plateau or mountain, and minor forms such as a hill, valley, slope, esker, or dune.

TROUGH. Any long and narrow depression in the Earth's surface, such as one between hills or with no surface outlet for drainage; especially a broad, elongated, U-shaped valley such as a glacial trough or a trench.

TRUNCATED SPUR. A spur that formerly projected into a preglacial valley and that was partially worn away or leveled by a moving glacier that widened and straightened the valley.

U-SHAPED VALLEY. A valley having a pronounced parabolic cross profile suggesting the form of a broad letter U, with steep parallel walls and a broad nearly flat floor.

WETLAND. Lowlands covered with shallow and sometimes temporary or intermittent waters.

WET SOIL. Seasonally or permanently water-saturated soil.

WOODED. Covered with trees.

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