CORE BANKS: THE CROWN JEWELS OF NORTH CAROLINA'S BARRIER ISLANDS


CAPE LOOKOUT, 2007

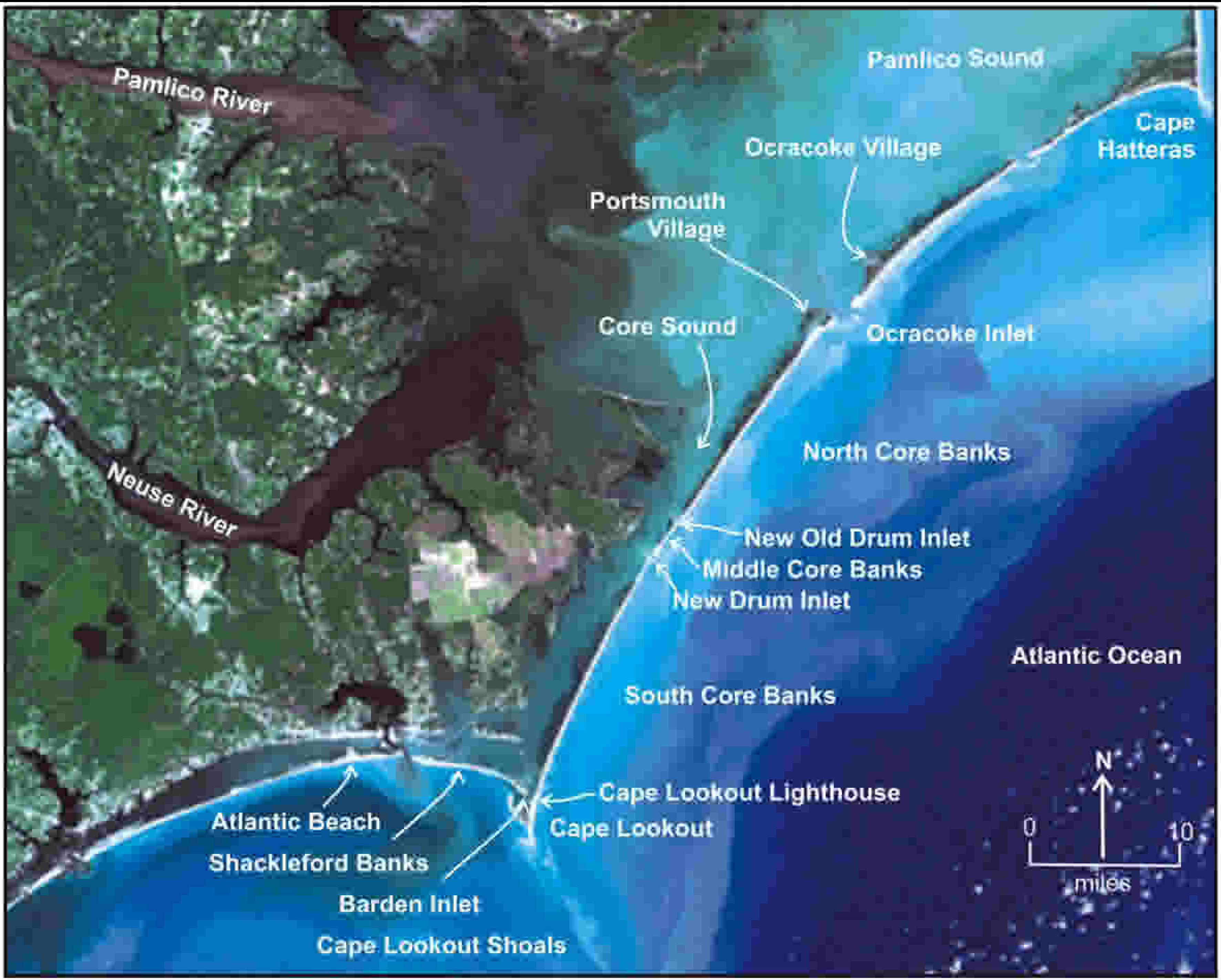

OLD DRUM INLET, 1943

STANLEY R. RIGGS
DOROTHEA V. AMES

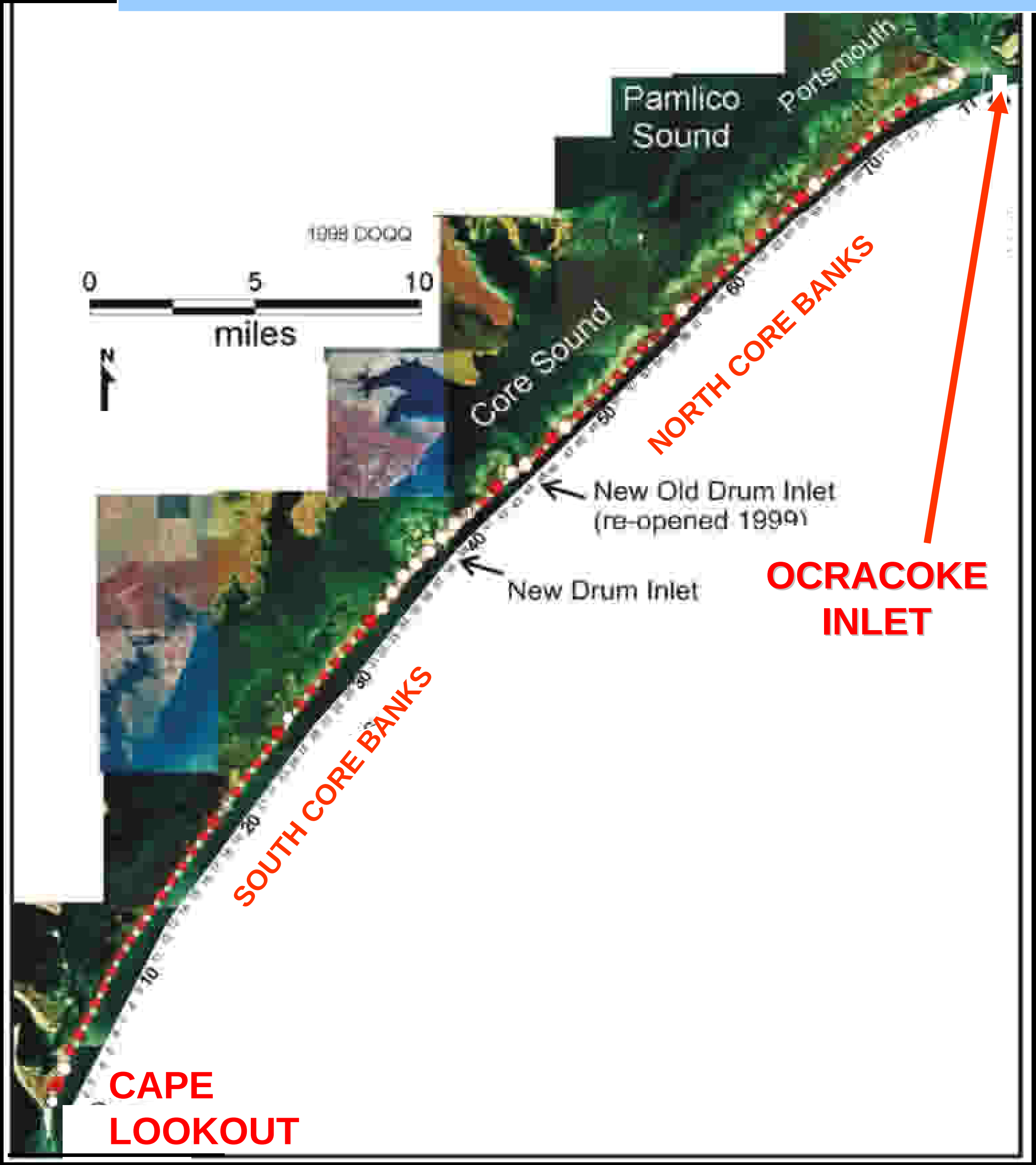
GEOLOGY DEPT.

EAST CAROLINA UNIV.

GREENVILLE, NC 27858


Pamlico Sound
Pamlico River
Cape Hatteras
Ocracoke Village
Portsmouth Village
Core Sound
Ocracoke Inlet
North Core Banks
Neuse River
New Old Drum Inlet
Middle Core Banks
New Drum Inlet
Atlantic Ocean
South Core Banks
N
Cape Lookout Lighthouse
Cape Lookout
0
10
miles
Atlantic Beach
Shackleford Banks
Barden Inlet
Cape Lookout Shoals

LOCATION OF 77 PROFILES ALONG CORE BANKS



USACE

1960 SURVEYED 77 PROFILES 3,000 FT APART

1961 SURVEYED 231 RM 100 FT APART PERPENDIC TO SHORE + CROSS ISLAND TOPO SURVEYS

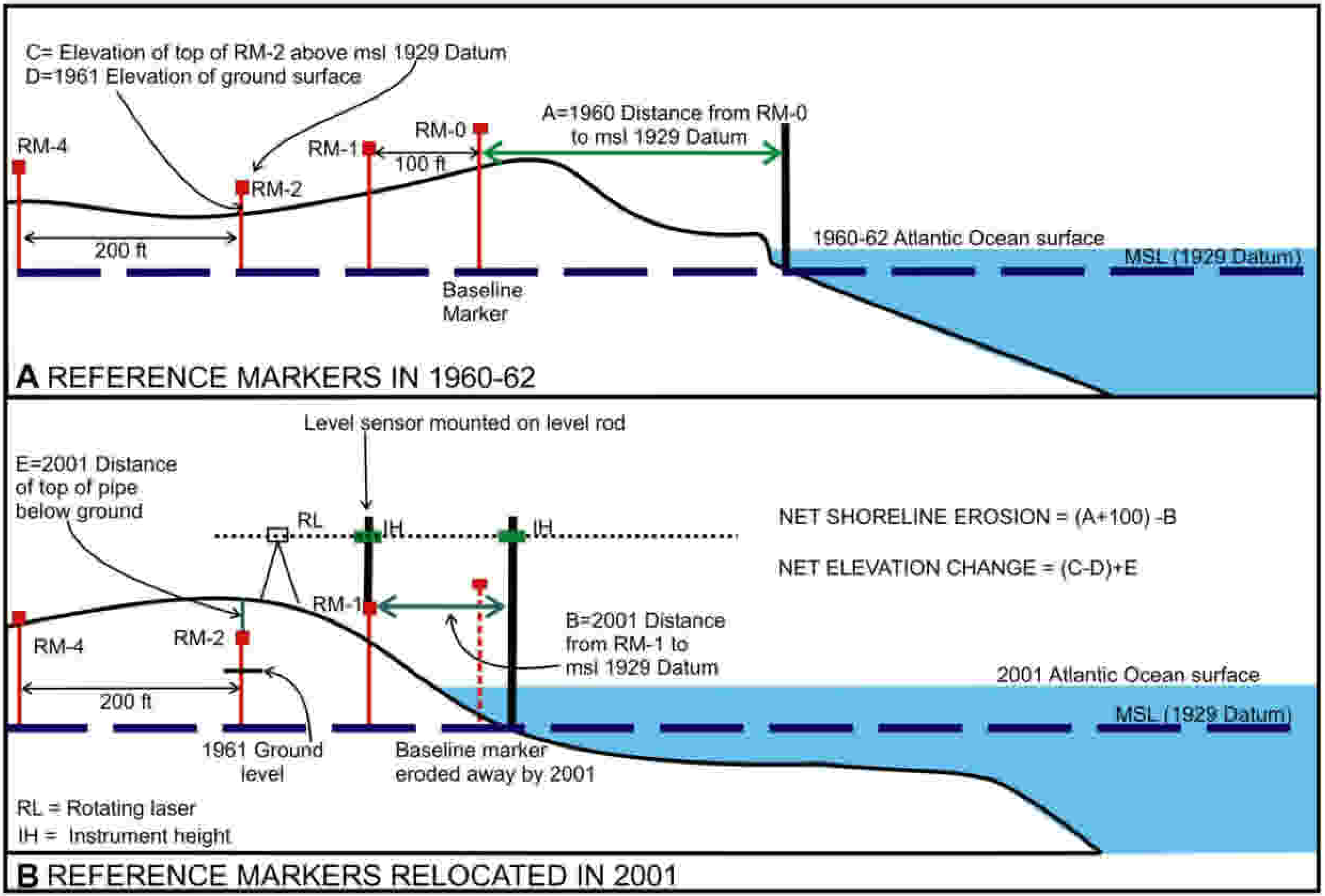
1962 REPLACED RMs & RESURVEYED 77 PROFILES

1970-71 GODFREY & GODFREY RESURVEYED 141 RMs FOUND

2001 ECU GEOLOGY RESURVEYED 83 RMs FOUND


US ACE BENCH
MARKS: 1960-1962

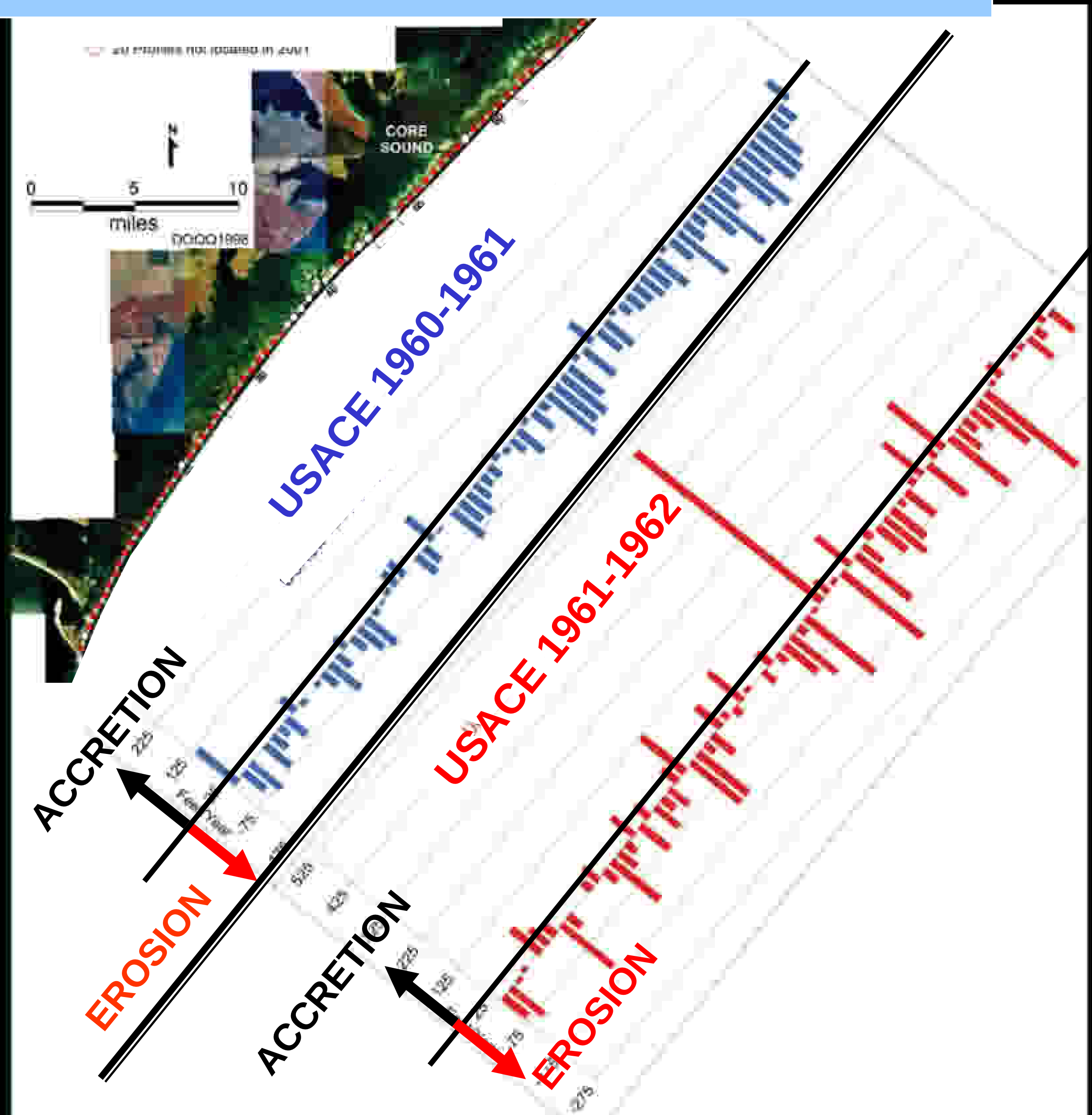

ECU 2001 SURVEY
OF US ACE
BENCH MARKS


C= Elevation of top of RM-2 above msl 1929 Datum
D=1961 Elevation of ground surface
RM-4
RM-2
RM-1
RM-0
100 ft
A=1960 Distance from RM-0 to msl 1929 Datum
200 ft
Baseline Marker
1960-62 Atlantic Ocean surface
MSL (1929 Datum)
A REFERENCE MARKERS IN 1960-62
Level sensor mounted on level rod
E=2001 Distance of top of pipe below ground
RL
IH
IH
NET SHORELINE EROSION = (A+100) -B
NET ELEVATION CHANGE = (C-D)+E
RM-1
RM-4
RM-2
B=2001 Distance from RM-1 to msl 1929 Datum
2001 Atlantic Ocean surface
200 ft
MSL (1929 Datum)
1961 Ground level
Baseline marker eroded away by 2001
RL = Rotating laser
IH = Instrument height
B REFERENCE MARKERS RELOCATED IN 2001

AVERAGE ANNUAL RATE OF SHORELINE CHANGE (FT/YR) FOR STORM-DOMINATED PERIOD 1960-62

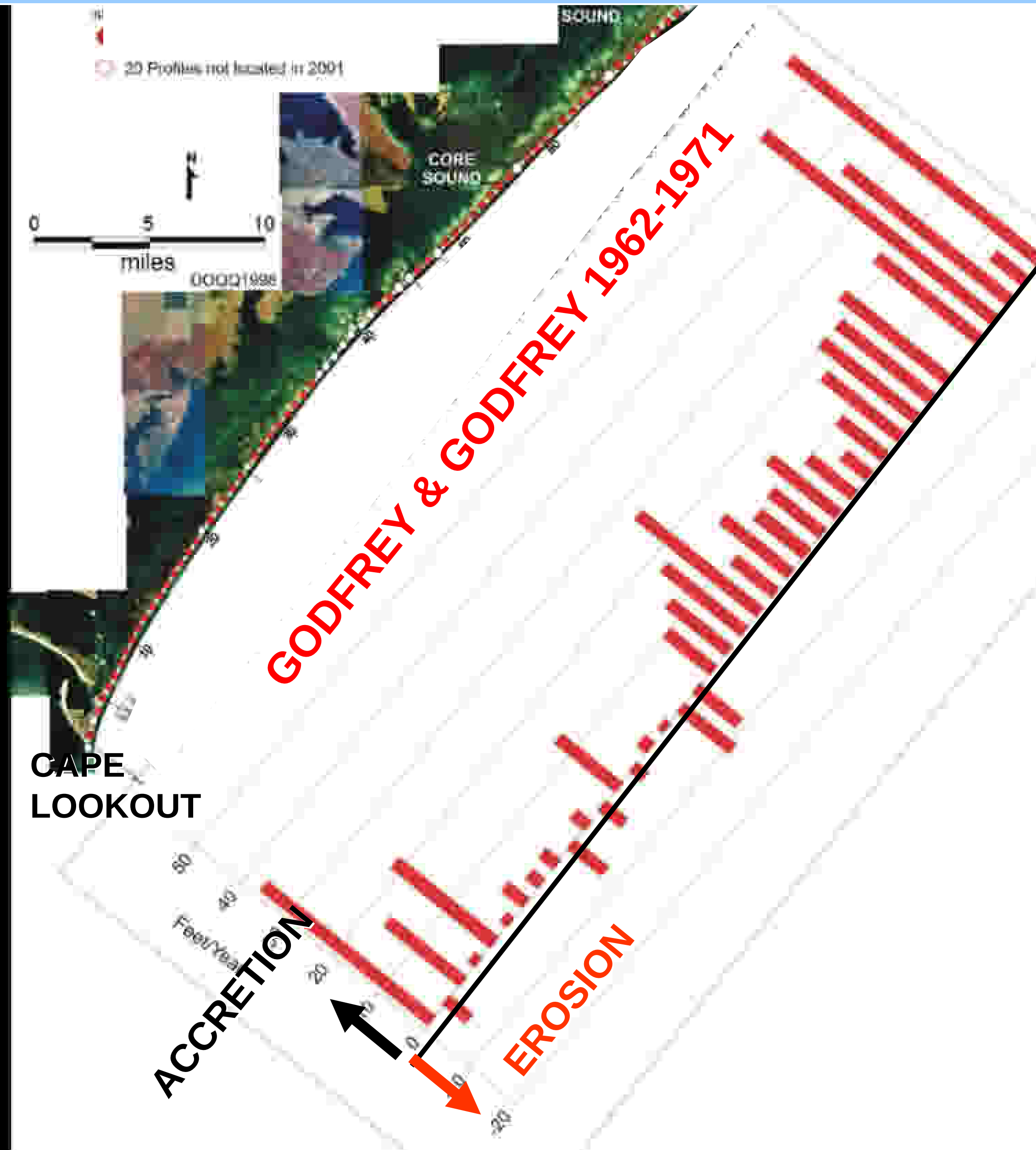
1960 to 1961 AVERAGE ANNUAL EROSION RATE = - 40 FT/YR

1961 to 1962 AVERAGE ANNUAL EROSION RATE = - 26 FT/YR

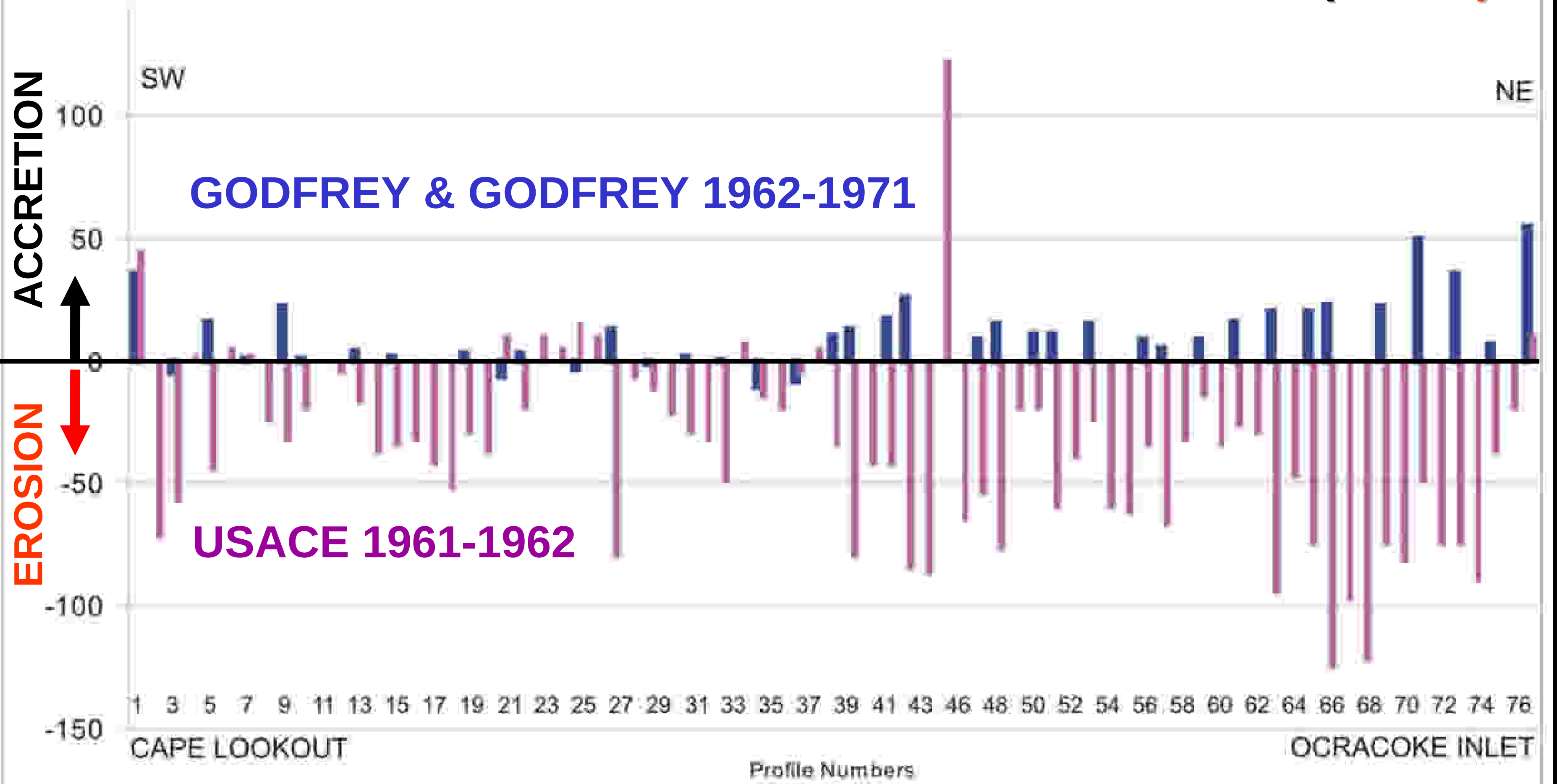


AVERAGE ANNUAL RATE OF SHORELINE CHANGE (FT/YR) FOR LOW-STORM DOMINATED PERIOD 1962-71

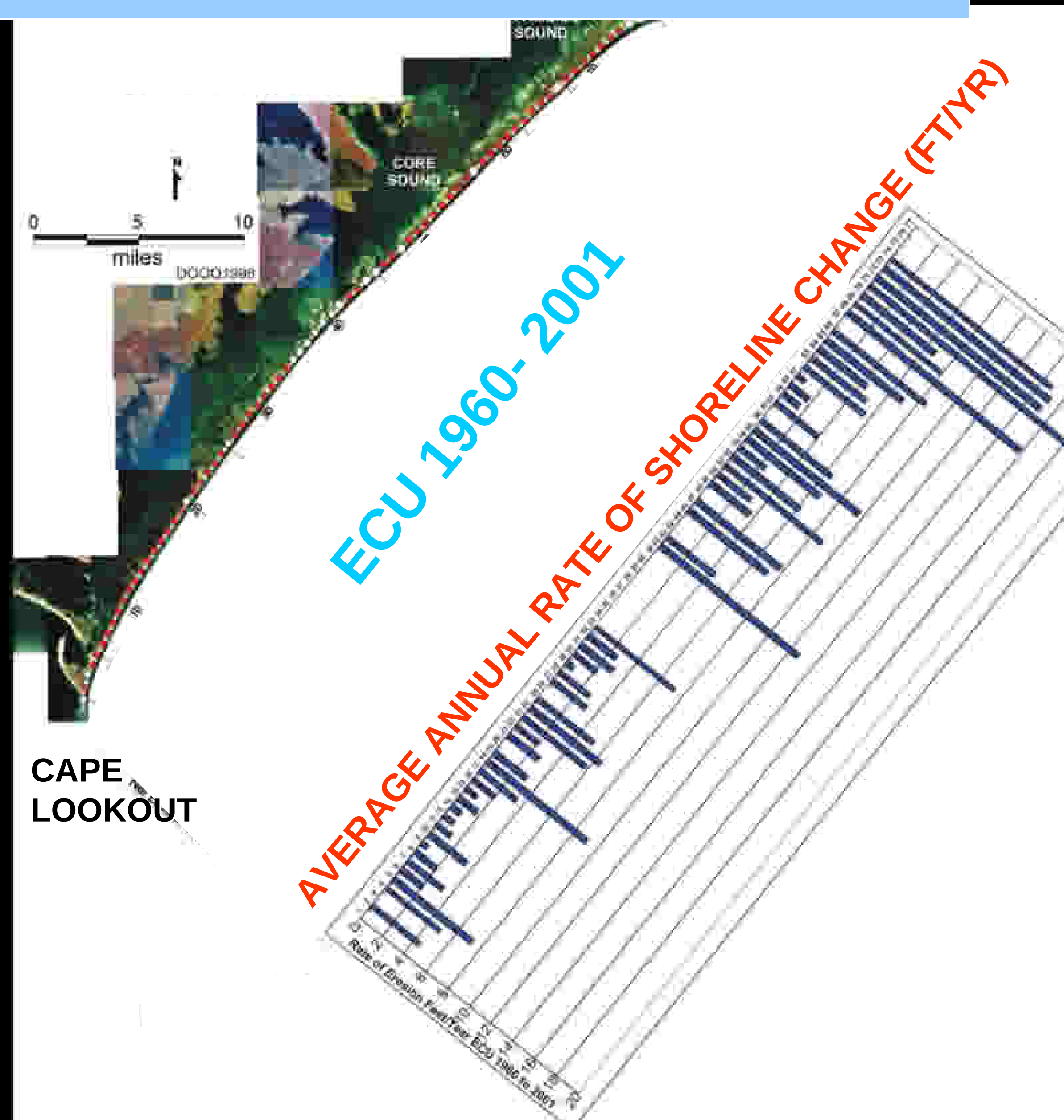
1962 to 1971 AVERAGE ANNUAL ACCRETION RATE = +12 FT/YR



AVERAGE ANNUAL RATE OF SHORELINE CHANGE (FT/YR)

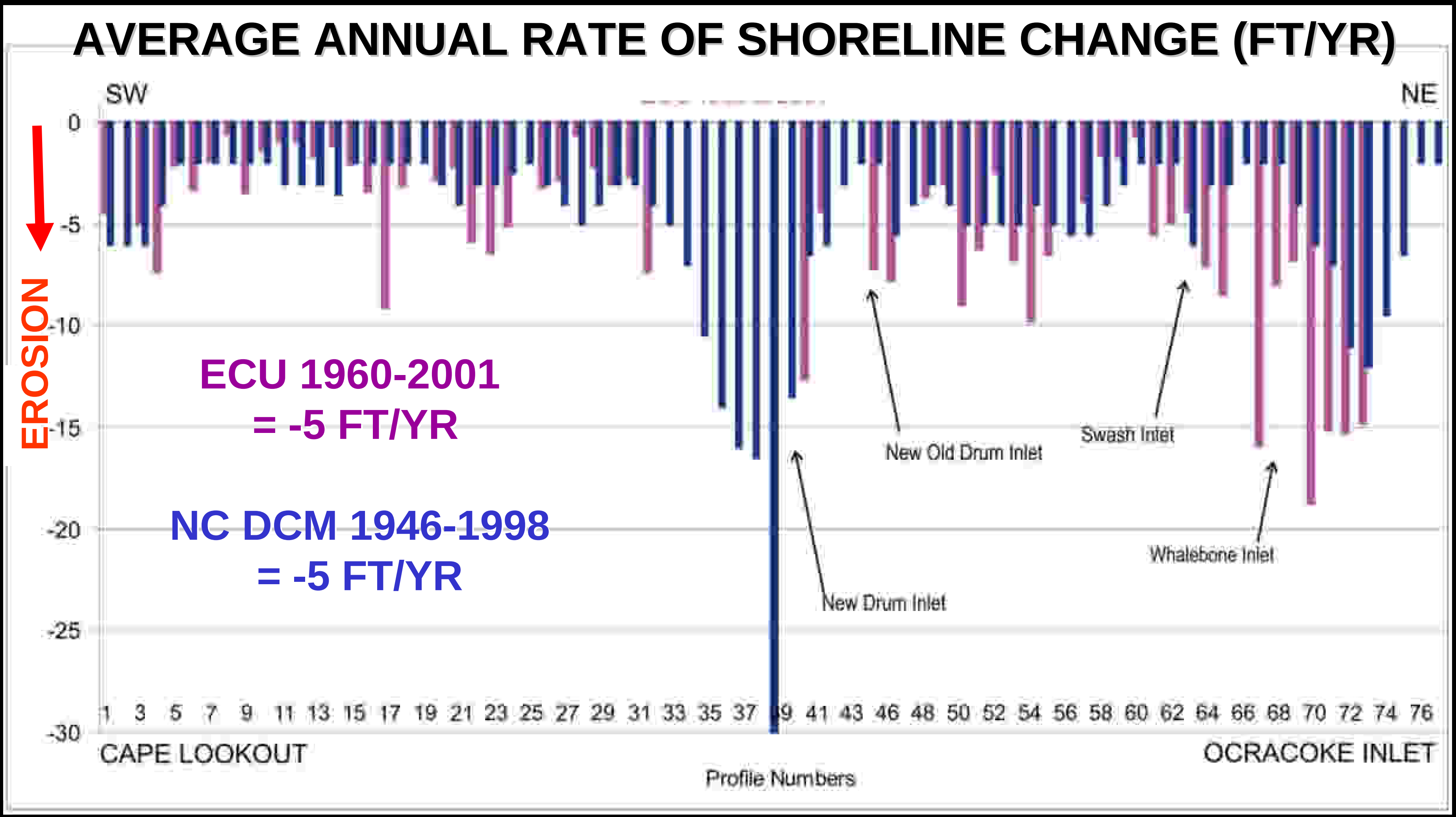


AVERAGE ANNUAL RATE OF SHORELINE CHANGE (FT/YR) FOR ENTIRE STUDY PERIOD 1960-2001



1960-2001 AVERAGE ANNUAL EROSION RATE = - 5 FT/YR

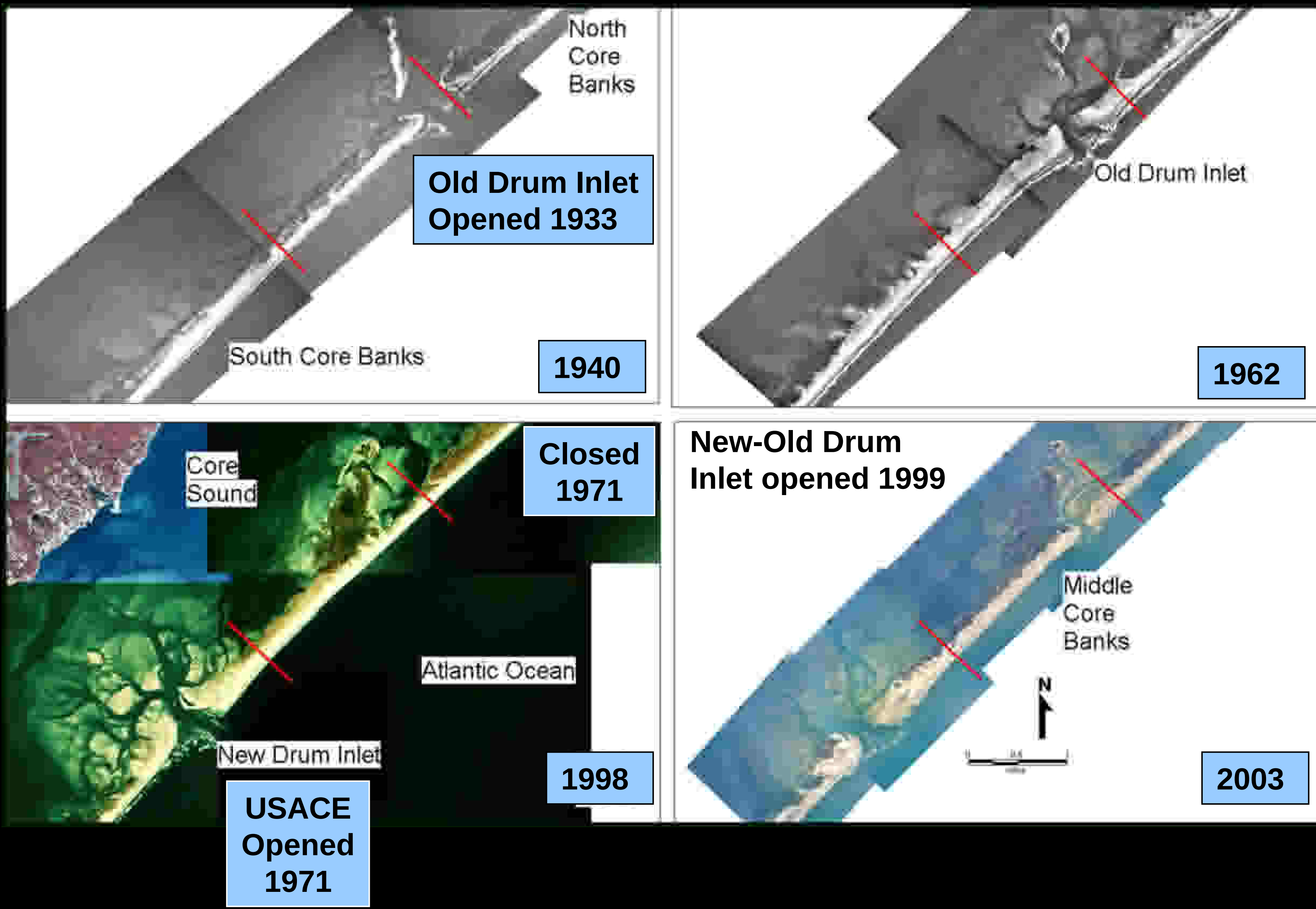
BOTH METHODS PRODUCED SIMILAR AVERAGE ANNUAL EROSION RATES



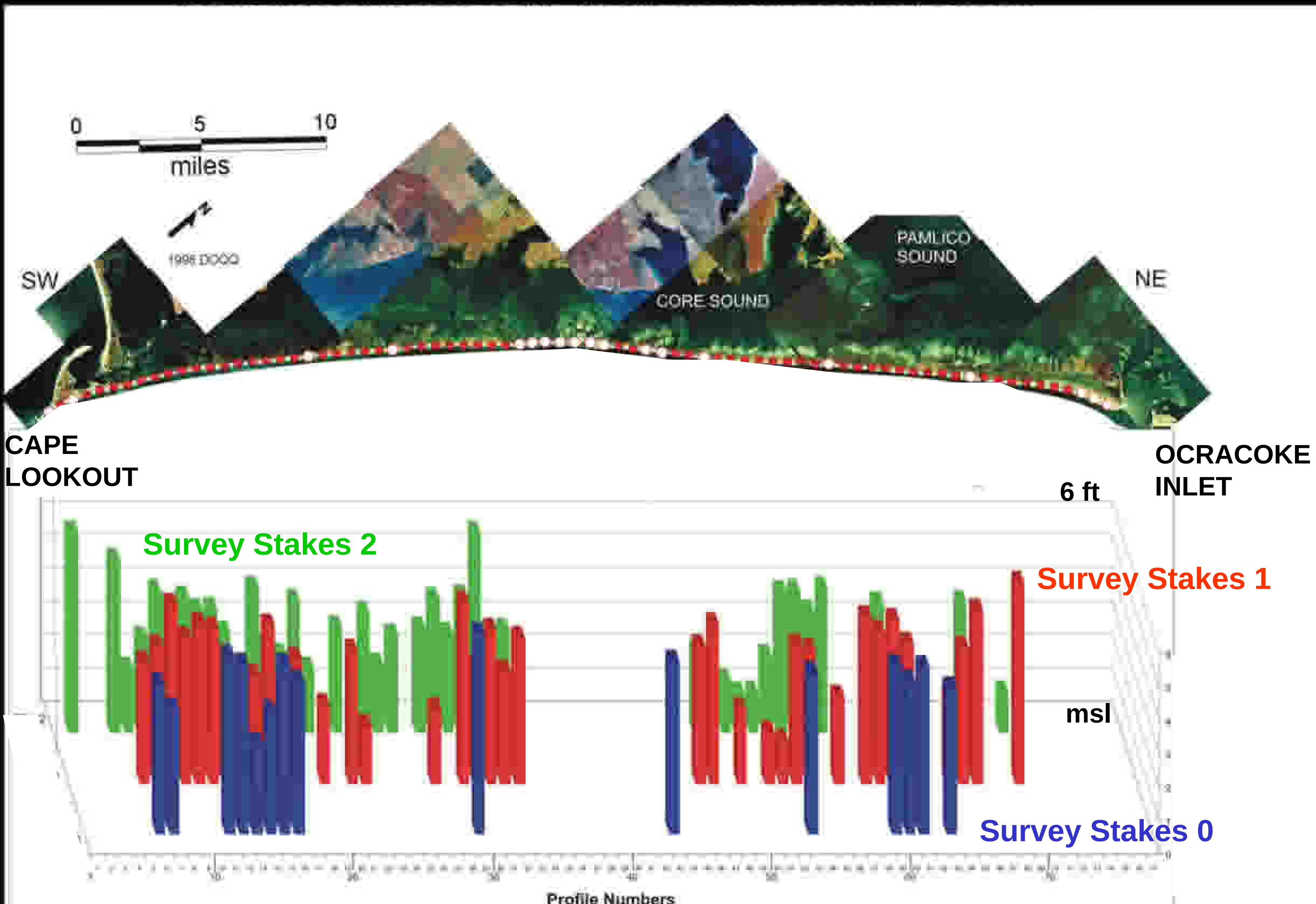
SUMMARY OF AVERAGE ANNUAL EROSION RATES FT/YR

		North Core	South Core	All of Core	
USACE	1960 - 1962	-52	-21	-36	Stormy, short term
G&G	1962 - 1971	+20	+ 4	+12	Non-Stormy, intermediate term
ECU	1960 - 2001	-8	-3	-5	Mixed, long term
NCDCM	1946 - 1998	-5	-5	-5	Mixed, long term

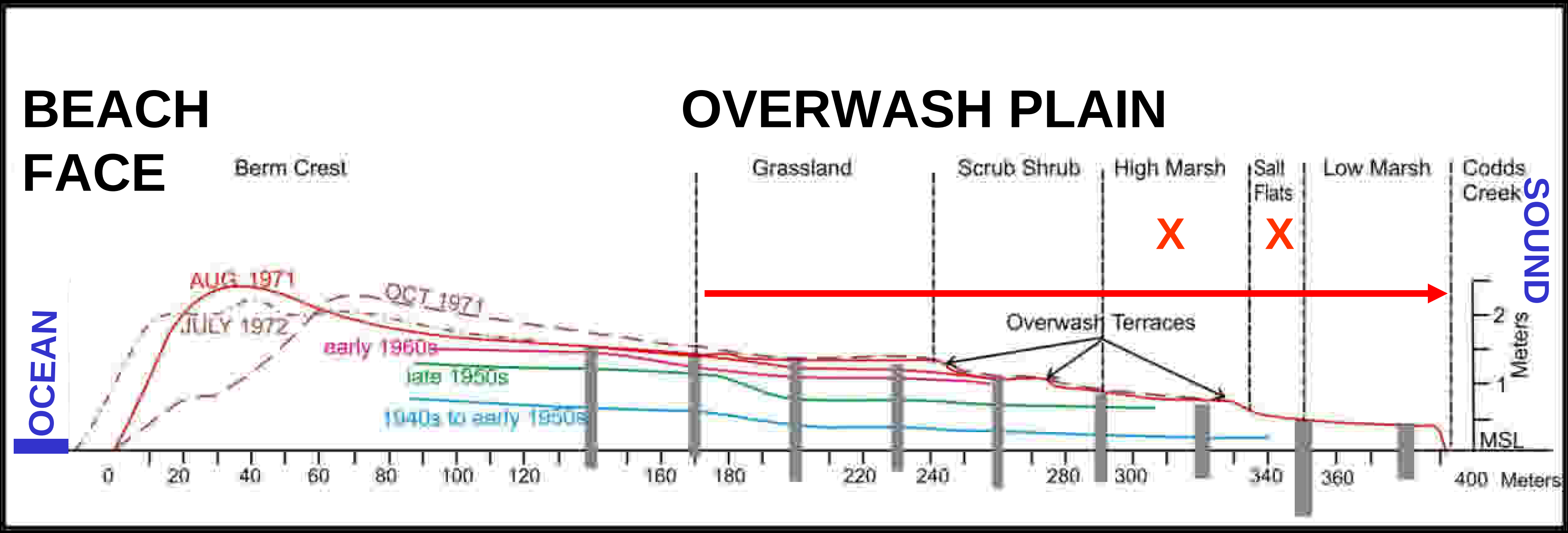
EVOLUTION OF THE DRUM INLETS



NET INCREASE IN GROUND ELEVATION 1961-2001



CROSS SECTION OF CORE BANKS SHOWS INCREASING ISLAND ELEVATION RESULTING FROM STORM OVERWASH THROUGH TIME



WITH STORM OVERWASH AND ELEVATION INCREASE VEGETATION COMMUNITIES MIGRATE SOUNDWARD

Modified from Godfrey & Godfrey, 1976

CONCLUSIONS

1. USACE DATA SETS DEMONSTRATE THAT STORMS IN THE SHORT TERM PRODUCE LARGE-SCALE CHANGES DOMINATED BY MAJOR RECESSION (AVE. RATE = -36 FT/YR).

2. G&G DATA DEMONSTRATE NON-STORMY PERIODS RESULT IN SHORELINE ACCRETION THAT CAN APPROACH PRE-STORM CONDITIONS. (AVE. RATE = +12 FT//YR).

3. THE NET LONG-TERM CHANGE DOCUMENTED BY BOTH THE ECU 1960-2001 AND NCDCM 1946-1998 DATA SETS PRODUCED THE SAME NET RESULTS (AVE. RATE = -5 FT/YR).

4. OVERWASH CONTRIBUTES TO INCREASED ISLAND ELEVATION WHICH LEADS TO SUBSEQUENT INCREASE IN VEGETATION.

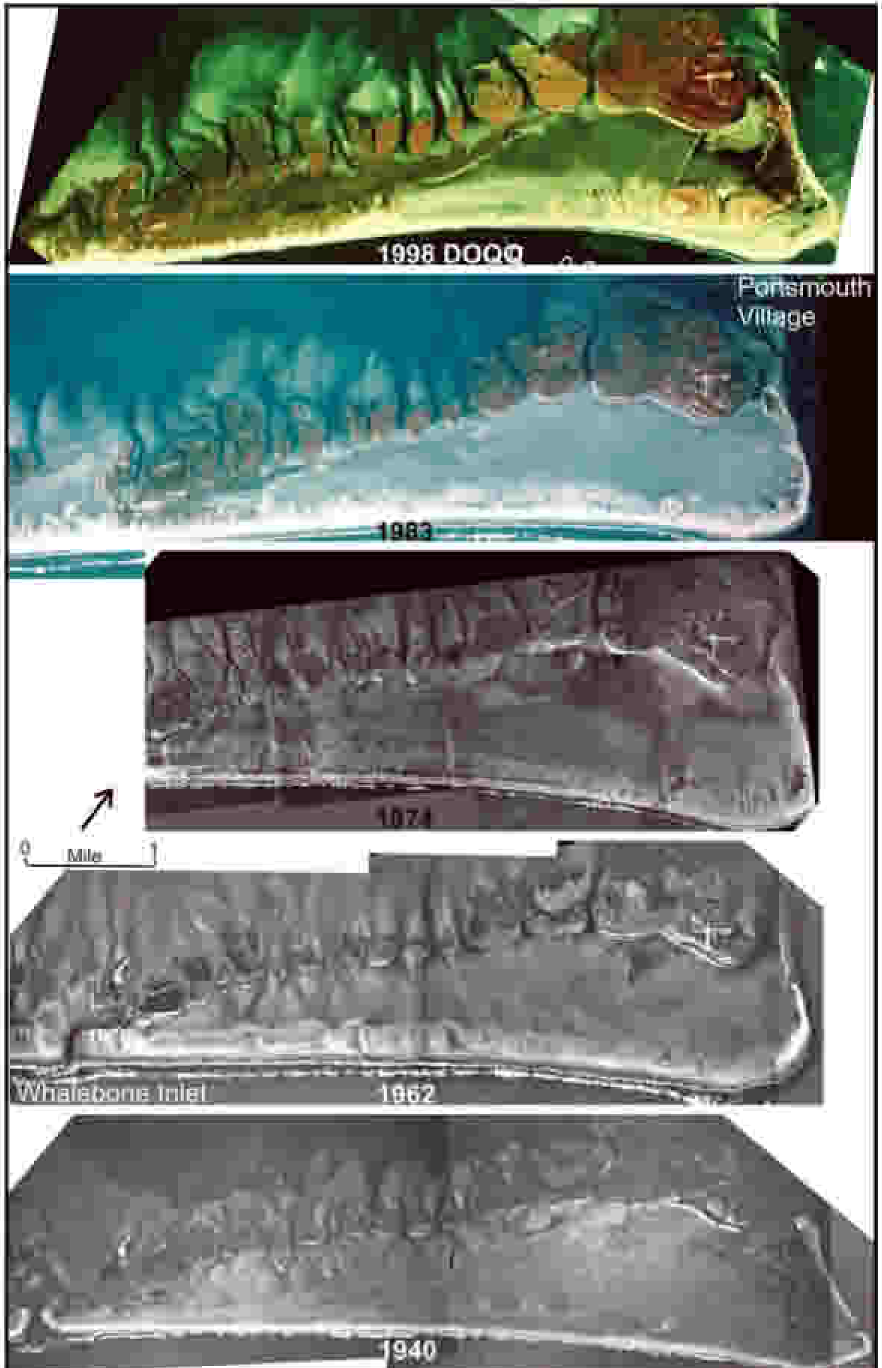
5. WITH STORM OVERWASH AND ELEVATION INCREASE VEGETATION COMMUNITIES MIGRATE SOUNDWARD THROUGH TIME.

INLETS and OVERWASH: CRUCIAL PROCESSES FOR BUILDING ISLAND WIDTH AND ELEVATION AS SEA-LEVEL RISES AND OCEAN SHORELINES RECEDE!

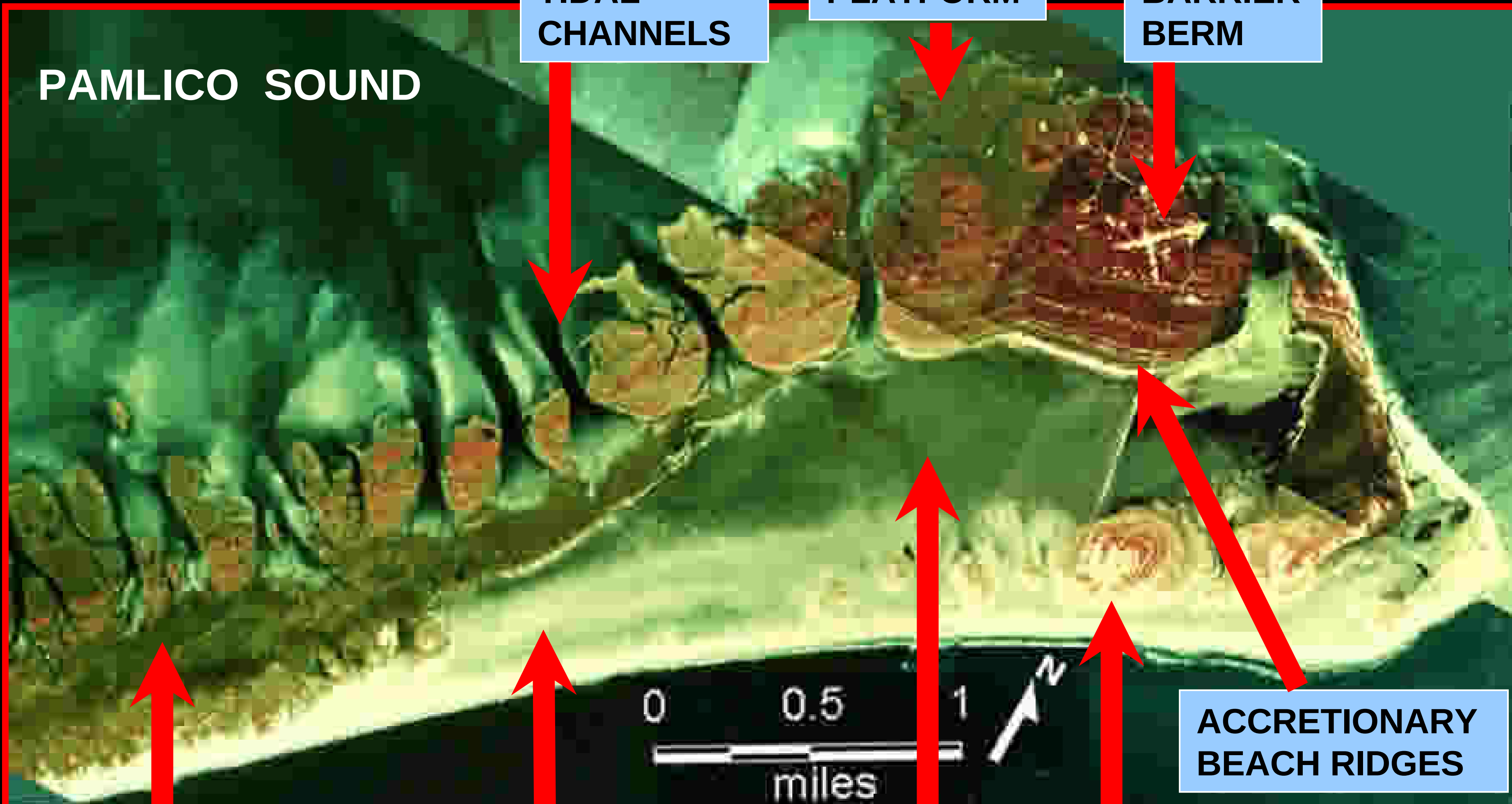
TIME-SLICE ANALYSIS UTILIZES AERIAL PHOTO SERIES AND MAPS TO DEVELOP THE

---

1. EVOLUTION OF BARRIER ISLAND GEOMORPHIC FEATURES AND ASSOCIATED ECOSYSTEMS
2. PROCESS—RESPONSE DYNAMICS OF BARRIER ISLAND SYSTEMS


1998 DOQQ
Portsmouth
Village
1983
1974
0
Mile
1
Whalebone Inlet
1962
1940

PORTSMOUTH ISLAND--1998




PAMLICO SOUND
PORTSMOUTH
ALGAL FLATS

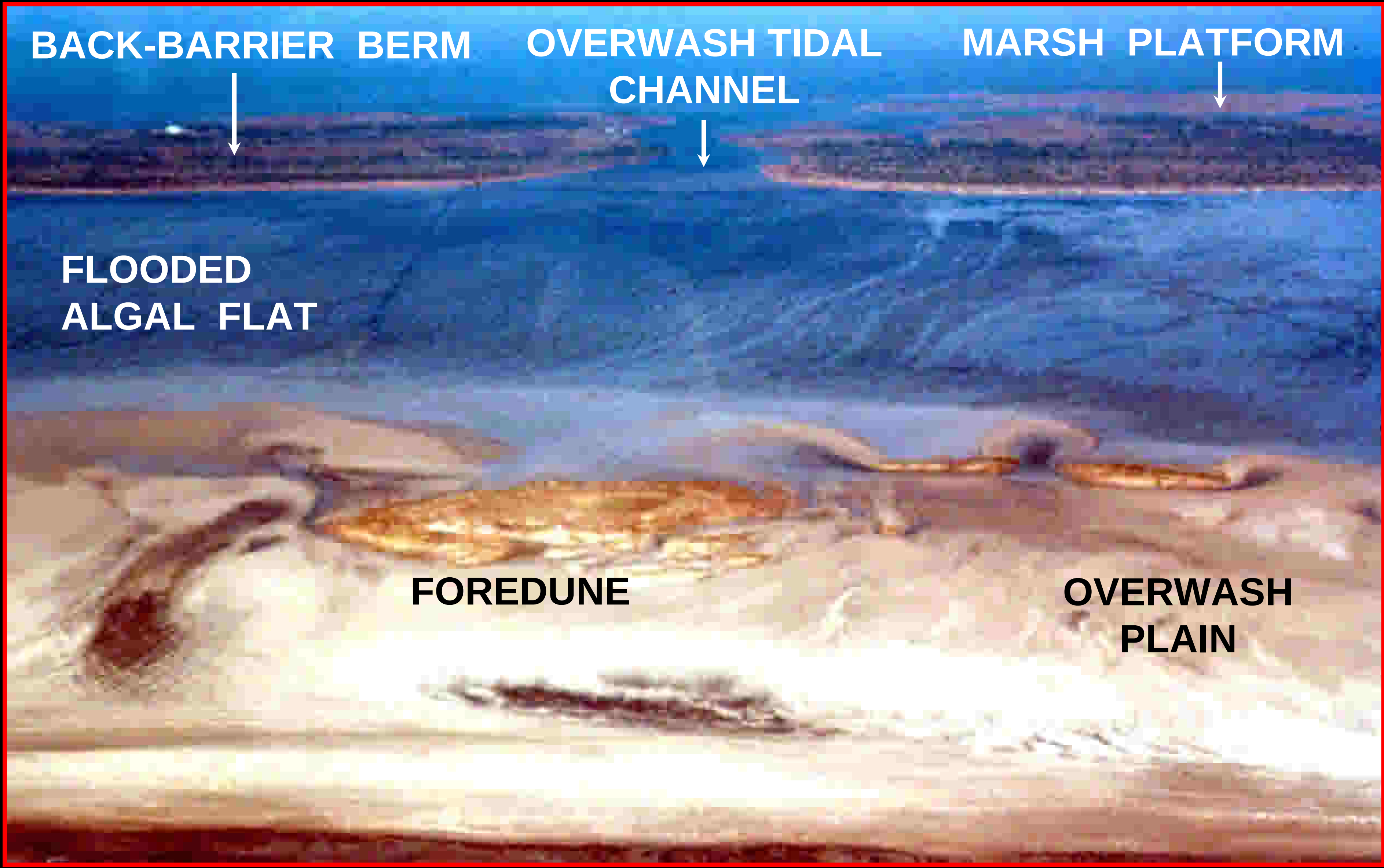

FORE DUNES


OVERWASH
TIDAL CHANNELS

BACK—BARRIER BERM

SAND TRAPPED BY *SPARTINA PATENS*

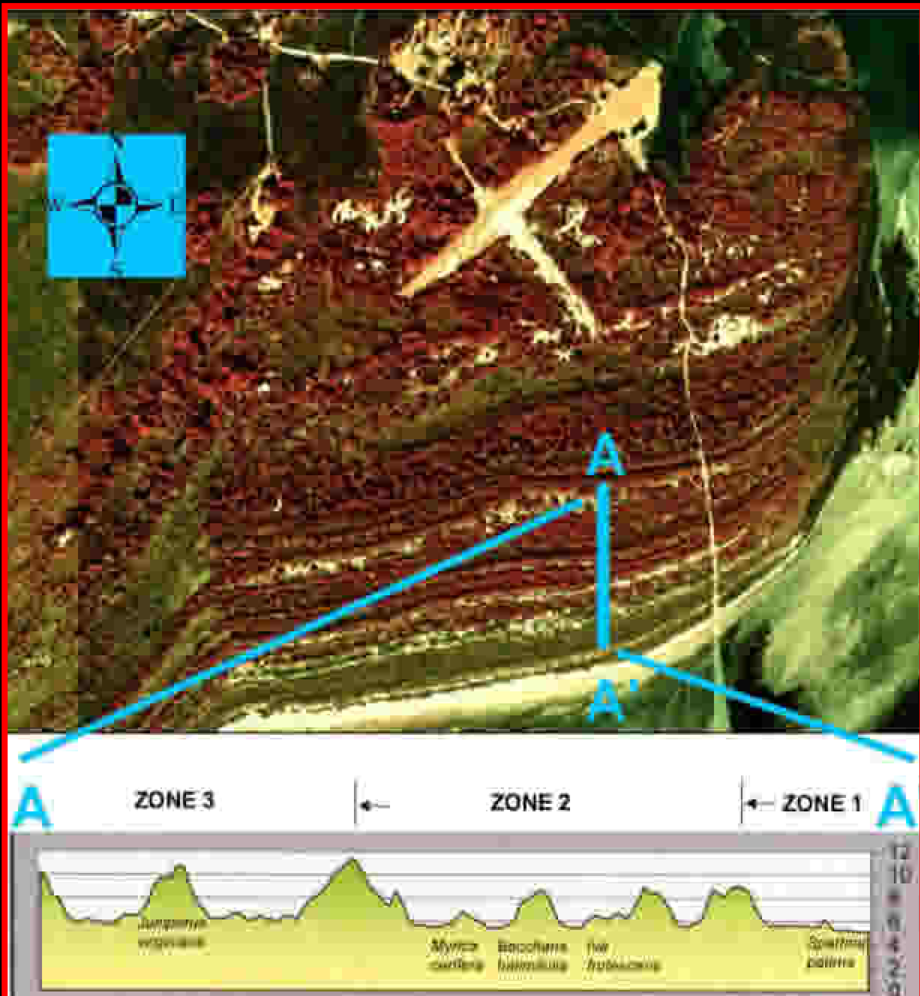
SEASONAL AEOLIAN DUNE RINGS IN FRONT OF BACK—BARRIER BERM

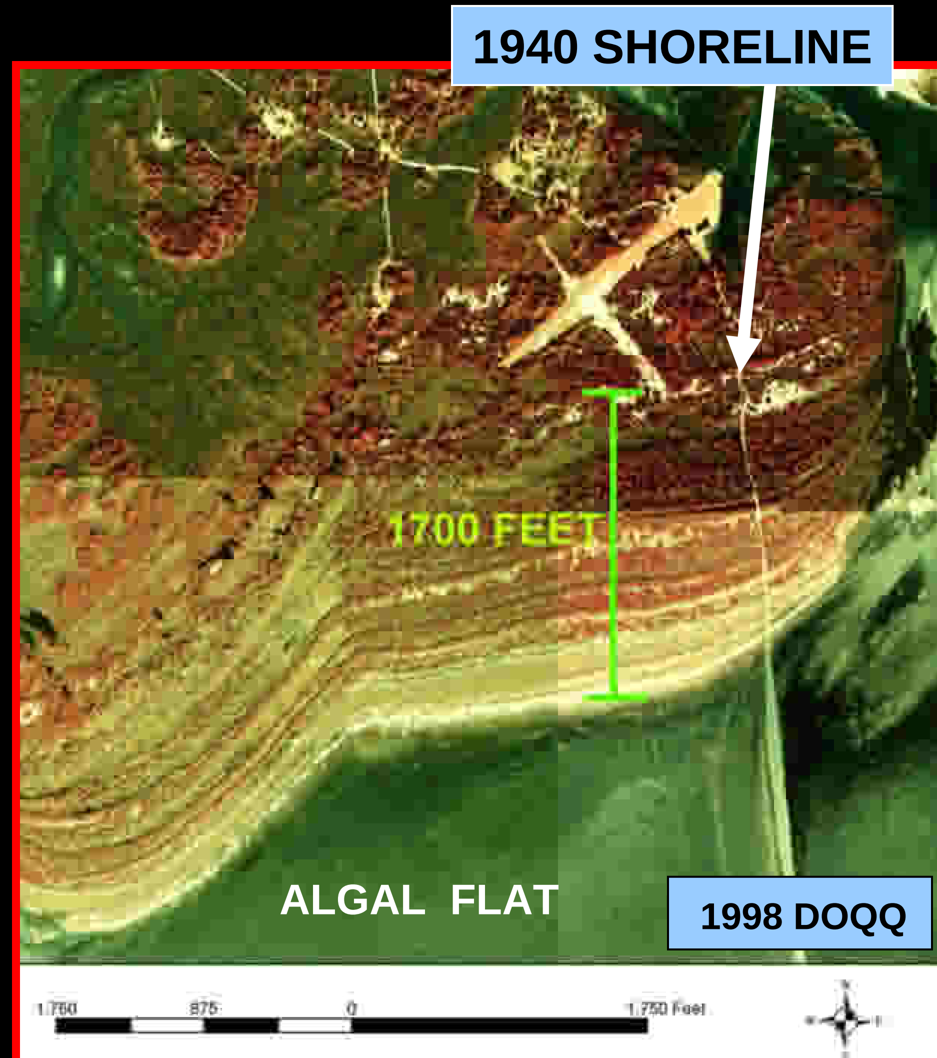


PORTSMOUTH SITE: POST--HURRICANE BONNIE 1998

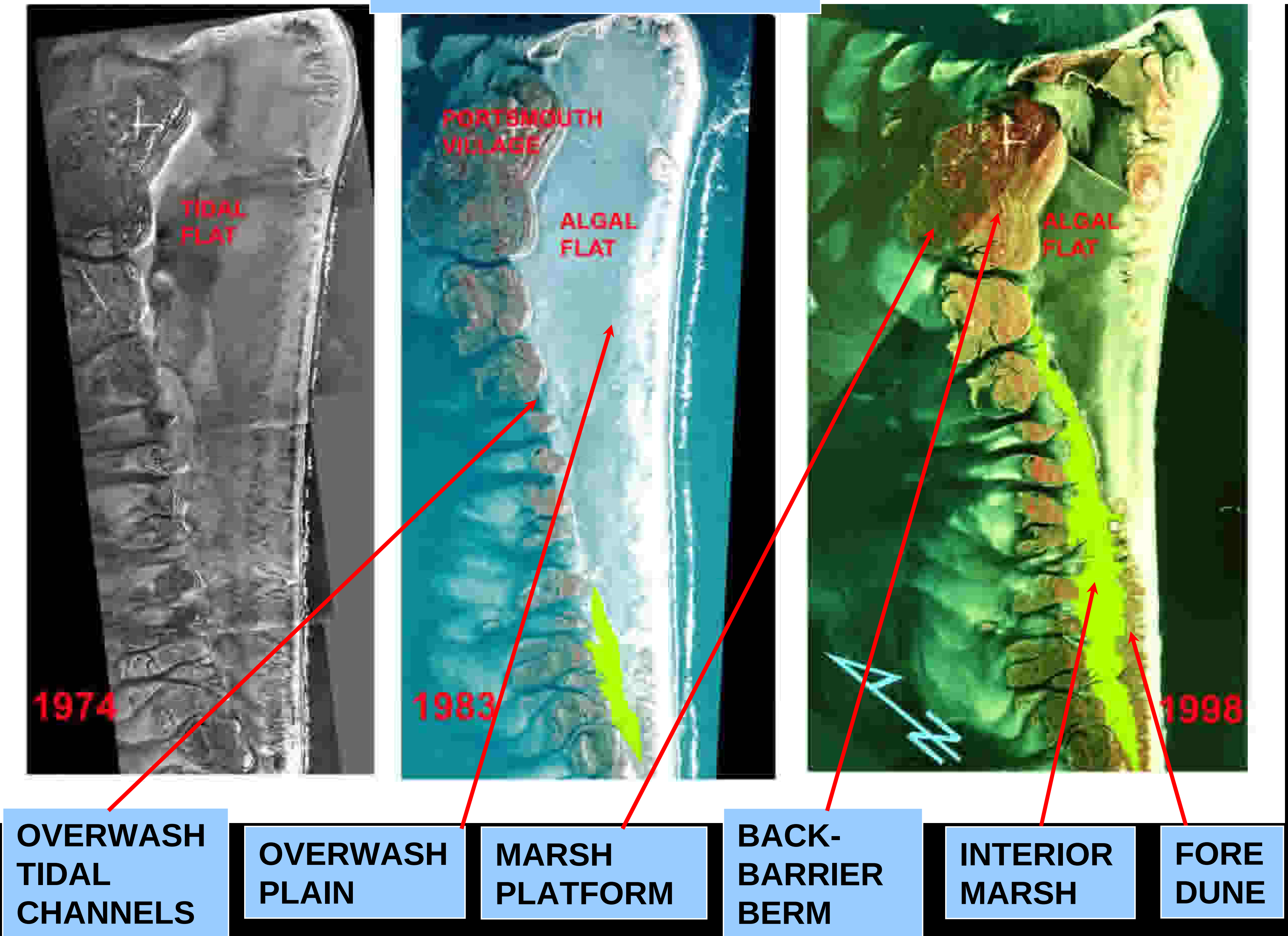
FLOOD THE ALGAL FLATS AND REWORK AEOLIAN DUNE RINGS INTO BEACH RIDGES

PORTSMOUTH ACCRETIONARY BEACH RIDGES



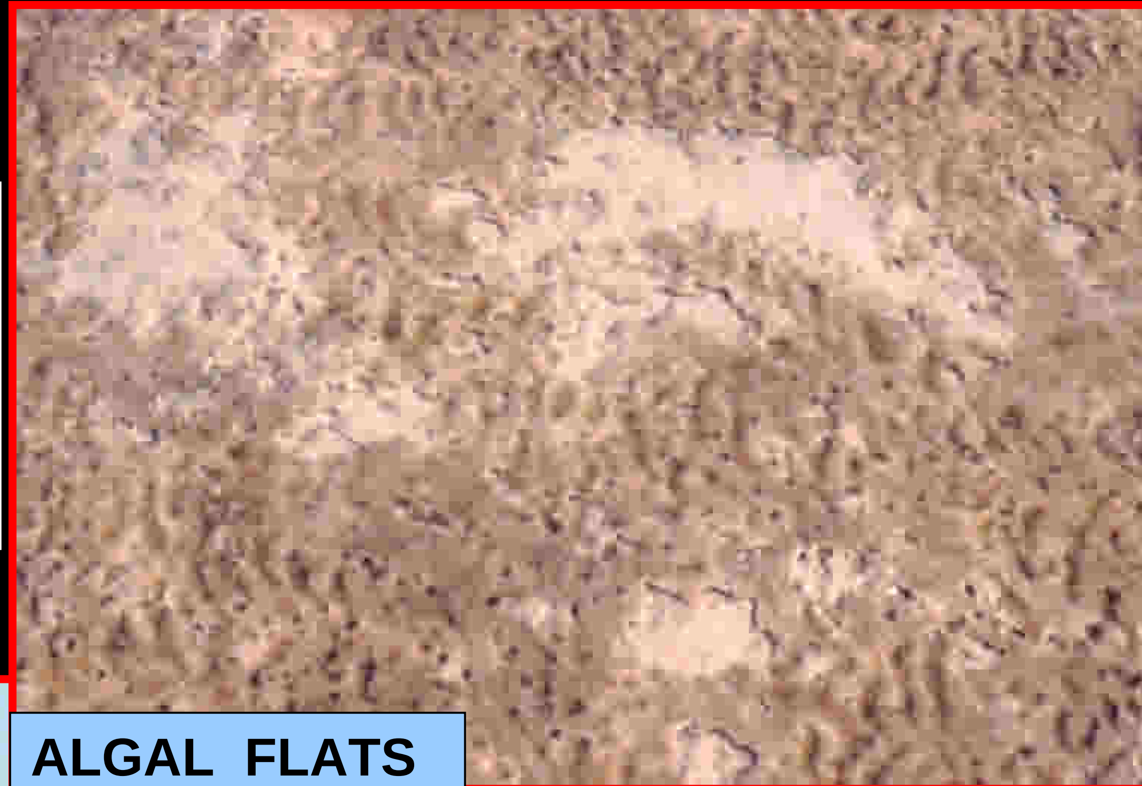


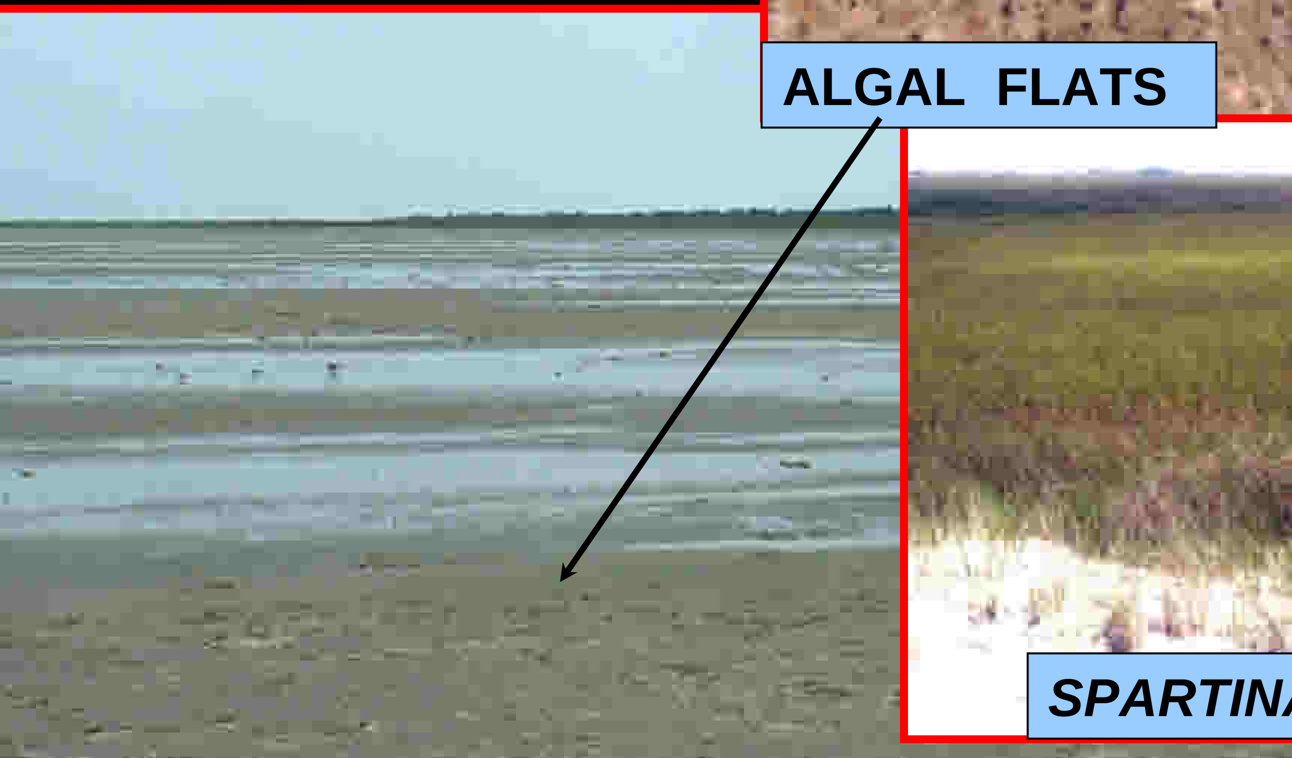
PORTSMOUTH ISLAND



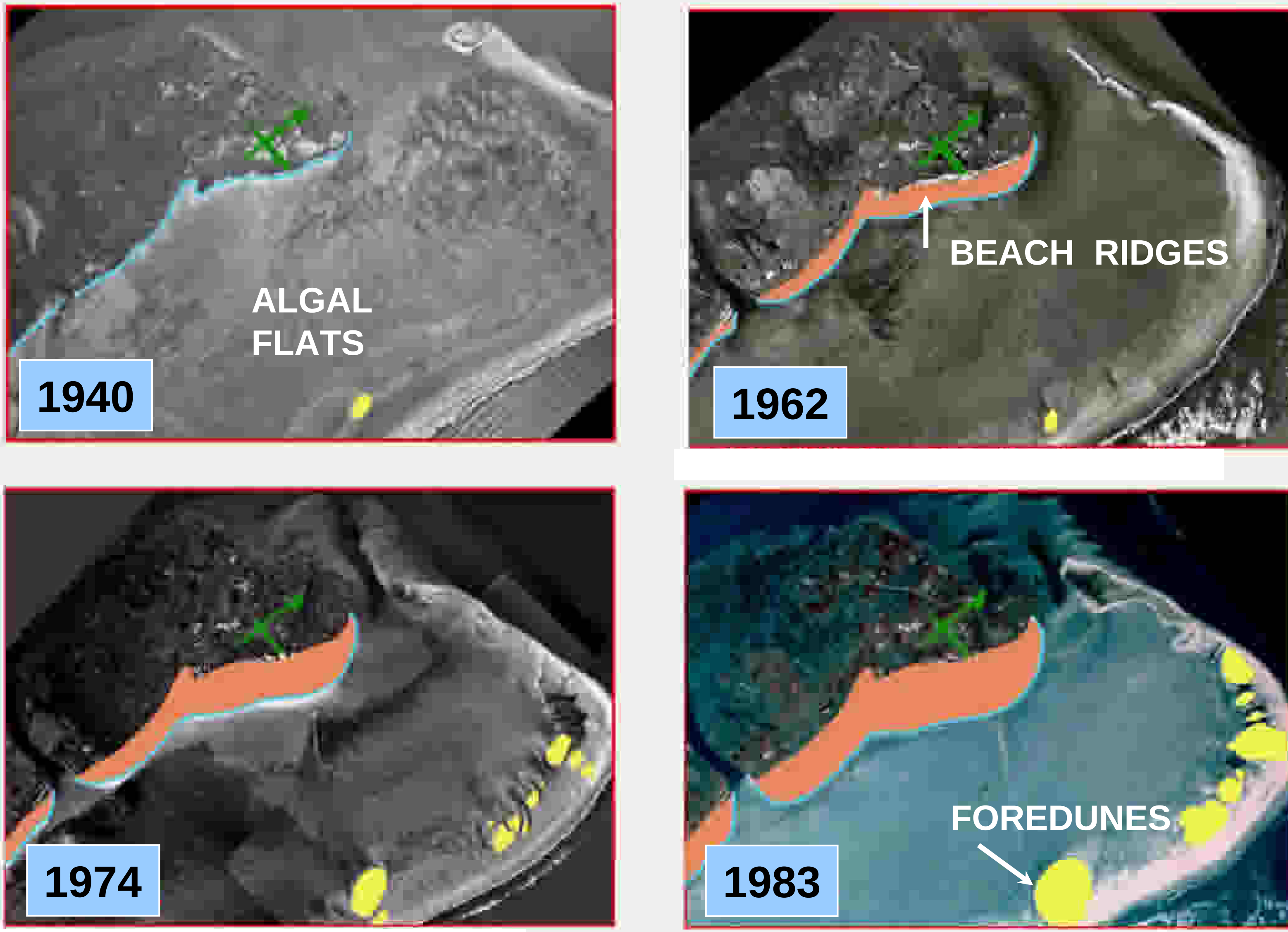
PORTSMOUTH OVERWASH PLAIN:

ALGAL → GRASS FLATS



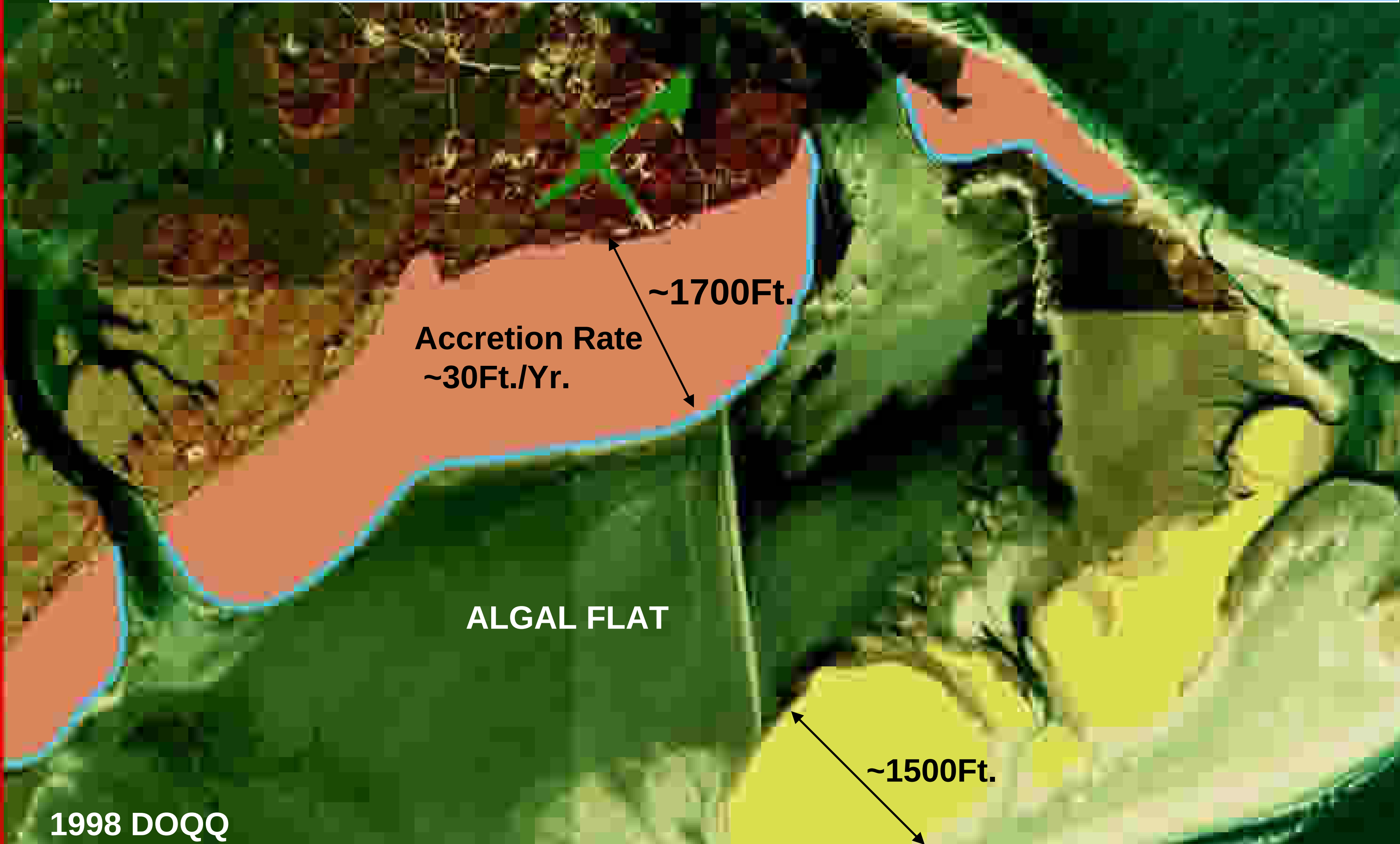


PORTSMOUTH VILLAGE: RATE OF ACCRETION BEACH RIDGES & FOREDUNES: 1940--1983



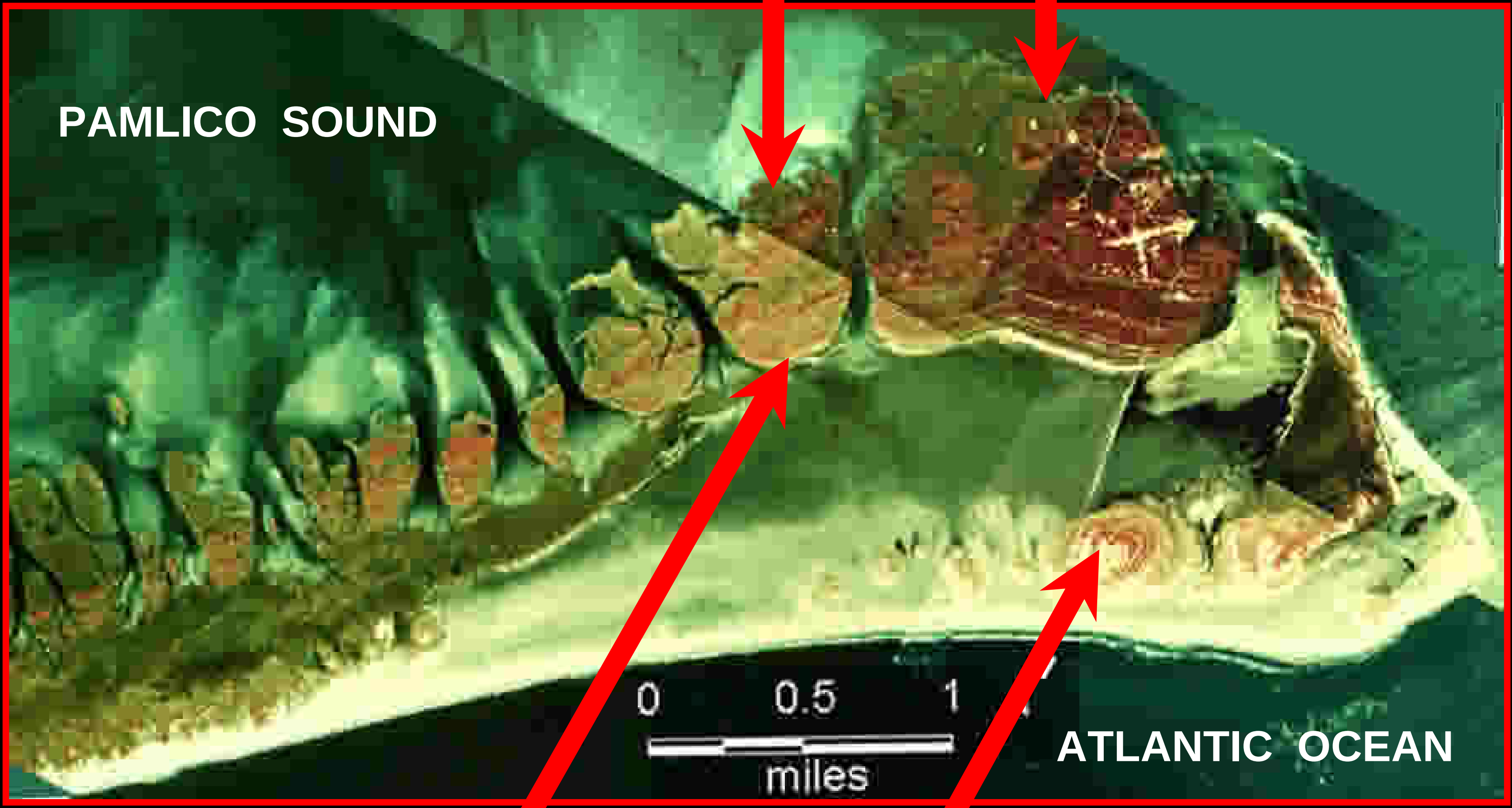
BEACH RIDGE AND FOREDUNE ACCRETION 1940 –1998

PORTSMOUTH AREA, NORTH CORE BANKS

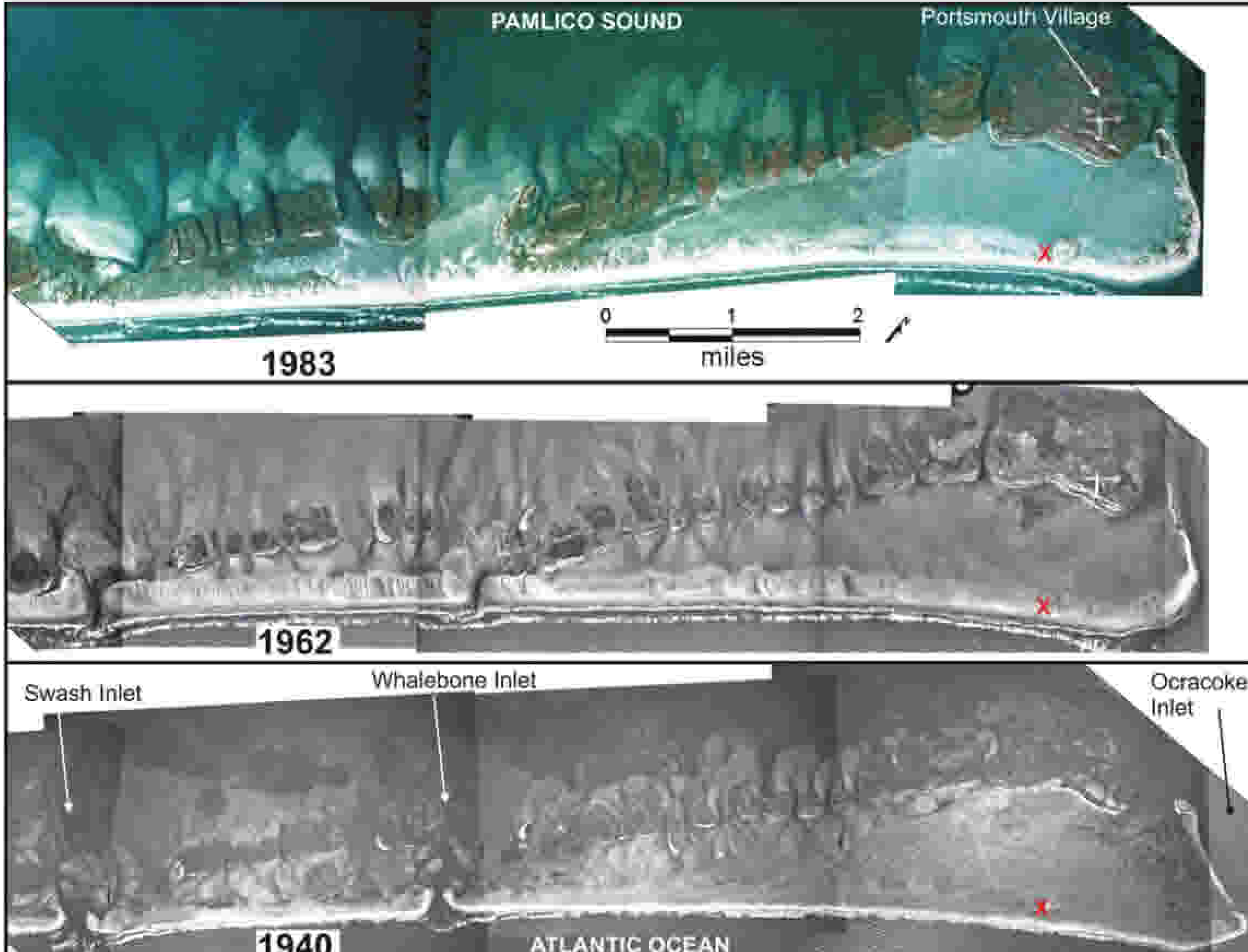


PORTSMOUTH ISLAND--1998

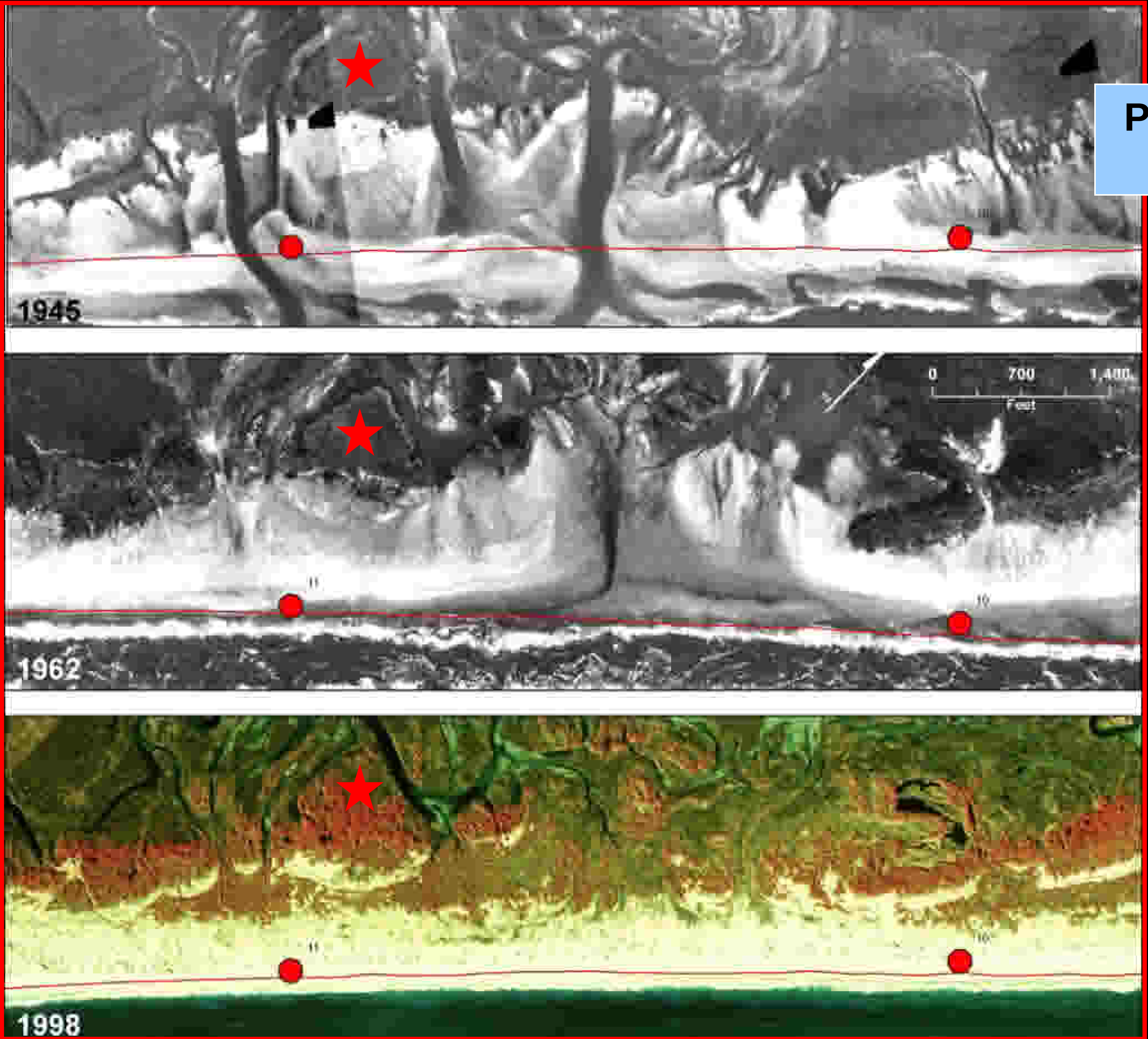
ESTUARINE PROCESSES



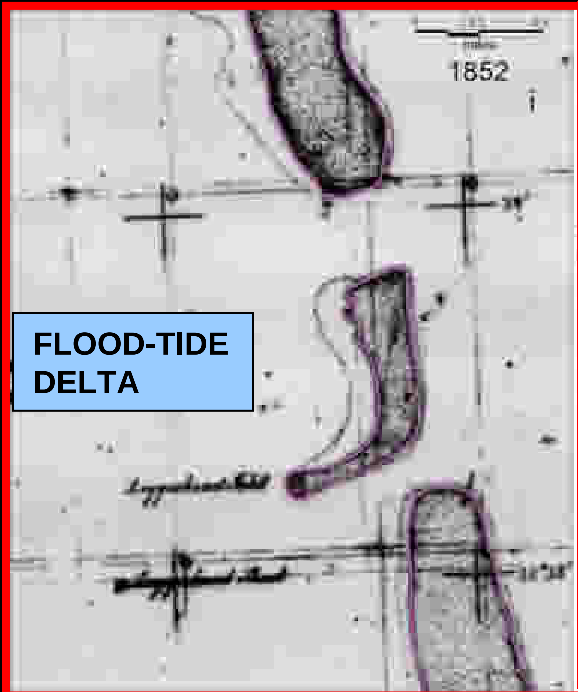
OCEANIC PROCESSES

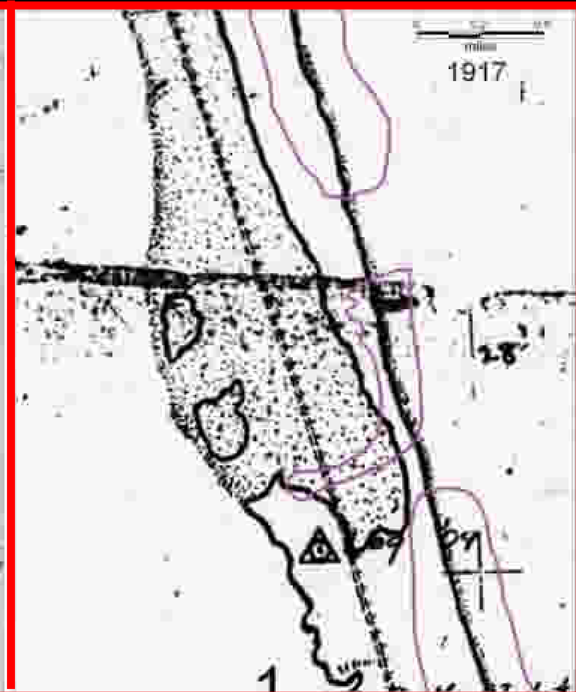

PAMLICO SOUND
Portsmouth Village
0
1
2
miles
1983
1962
Swash Inlet
Whalebone Inlet
Ocracoke Inlet
1940
ATLANTIC OCEAN

PILANTARY INLET



ARE THE PROCESS—RESPONSE DYNAMICS BUILDING PORTSMOUTH ISLAND IMPORTANT IN THE NORTHERN OUTER BANKS?

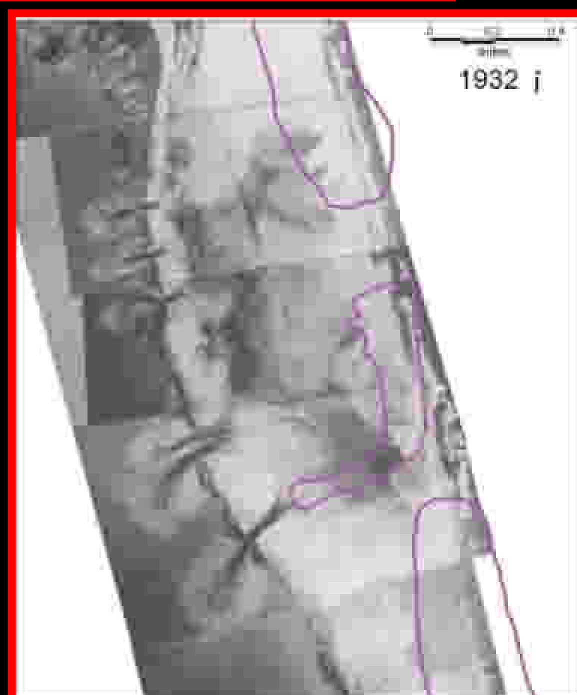


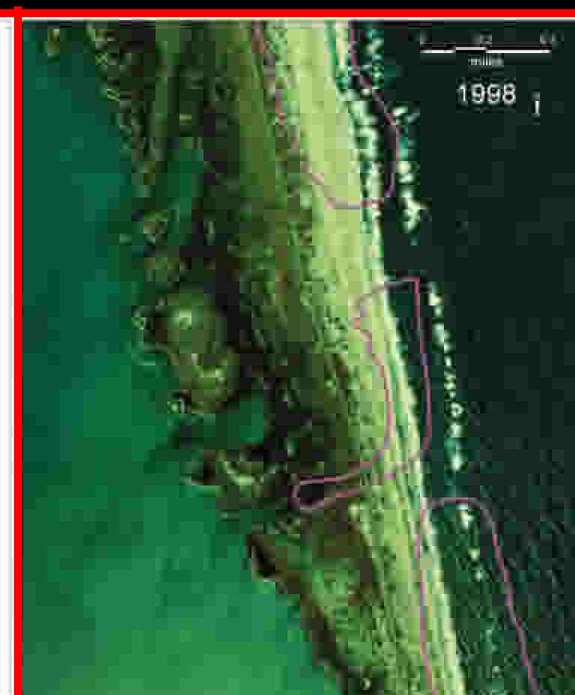


2. LOGGERHEAD OVERWASH PLAIN PRE-1917 (1899 Hurricane?)

4. STABILIZED OVERWASH PLAIN & FORMATION OF MOLAR—TOOTH STRUCTURE 1998

1. LOGGERHEAD INLET 1852

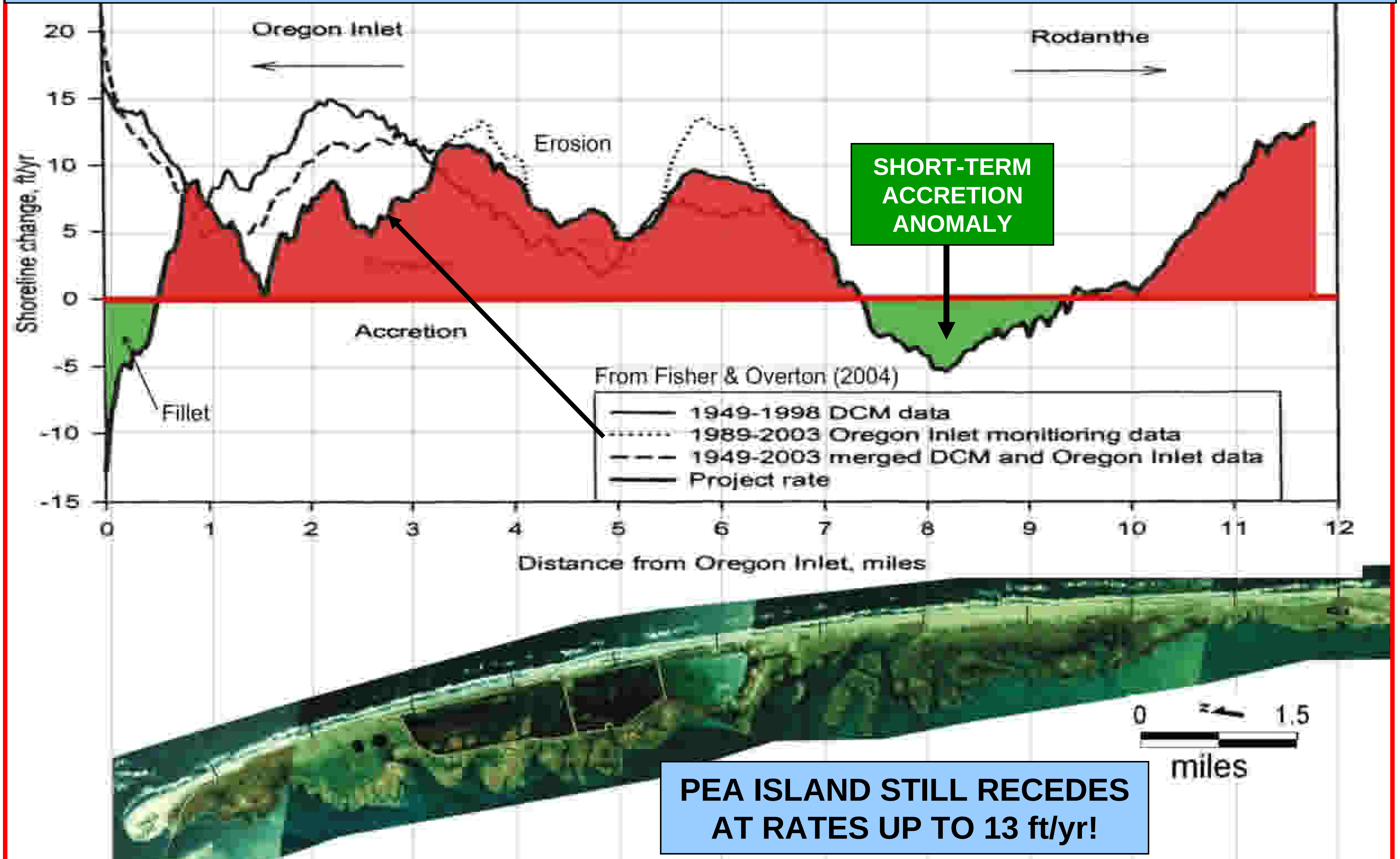


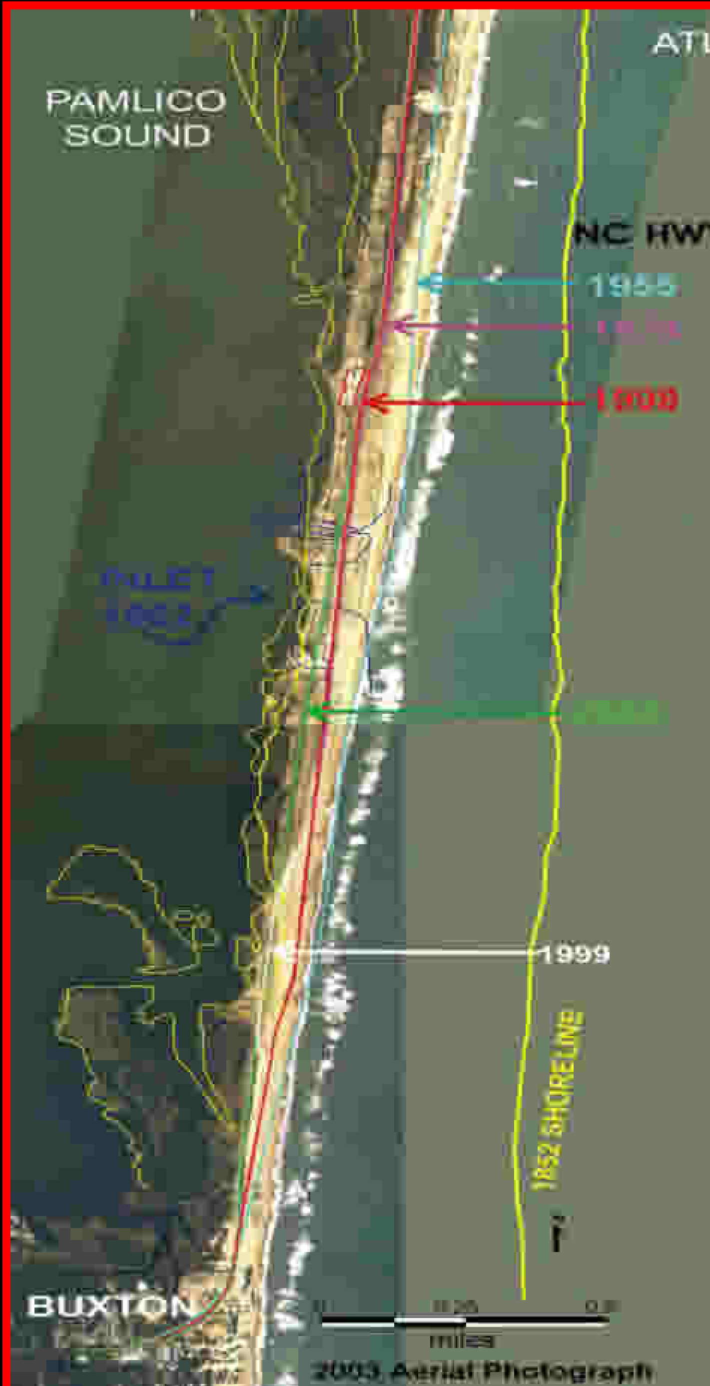


3. REACTIVATED OVERWASH PLAIN (1932 Hurricane)

<u>2. OVERWASH FANS</u>: A CRUCIAL PROCESS FOR BUILDING ISLAND ELEVATION AS SEA-LEVEL RISES AND OCEAN SHORELINES RECEDE!

SHORT-TERM EROSION RATES INCLUDE: 1) CONSTRUCTION OF BARRIER DUNE RIDGES SINCE LATE 1930's, 2) ROUTINE OREGON INLET DREDGING SINCE 1960, & 3) ~ANNUAL BEACH NOURISHMENT PROJECTS SINCE 1989.





BARRIER ISLAND NARROWING

1. OCEAN SHORELINE RECEDED 900 FT (N) TO 2500 FT (S) FROM 1852--2003 (151 YRS).

2. AVE. ANNUAL EROSION RATE = - 6 TO - 14 FT/YR.

3. 29% TO 76% OF 1852 ISLAND WIDTH HAS BEEN LOST.

4. HWY 12 HAS BEEN MOVED WEST 4 TIMES SINCE 1955 WITH NO ISLAND LEFT!

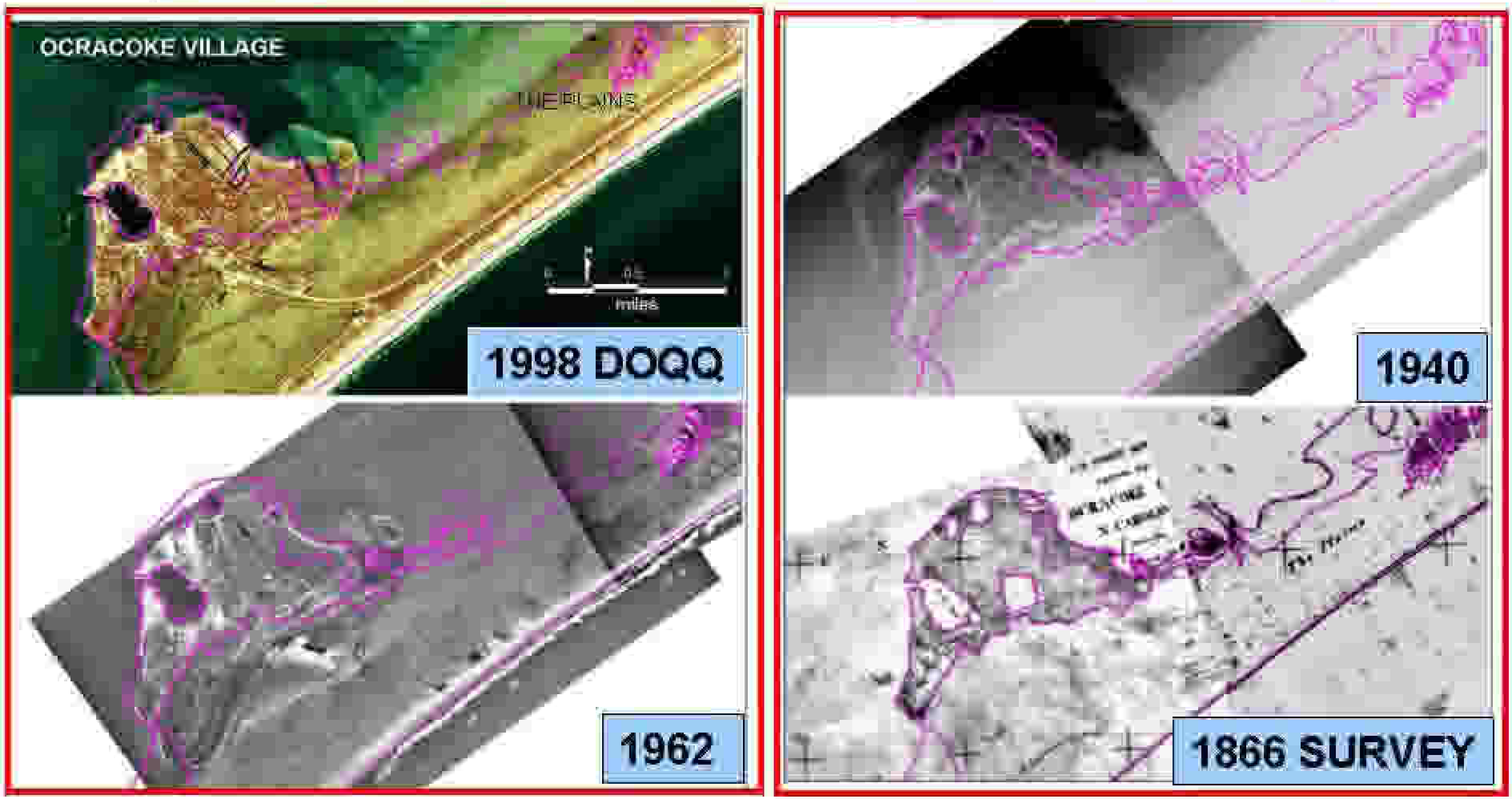
BUXTON INLET
MAR 1962 TO FEB 1963

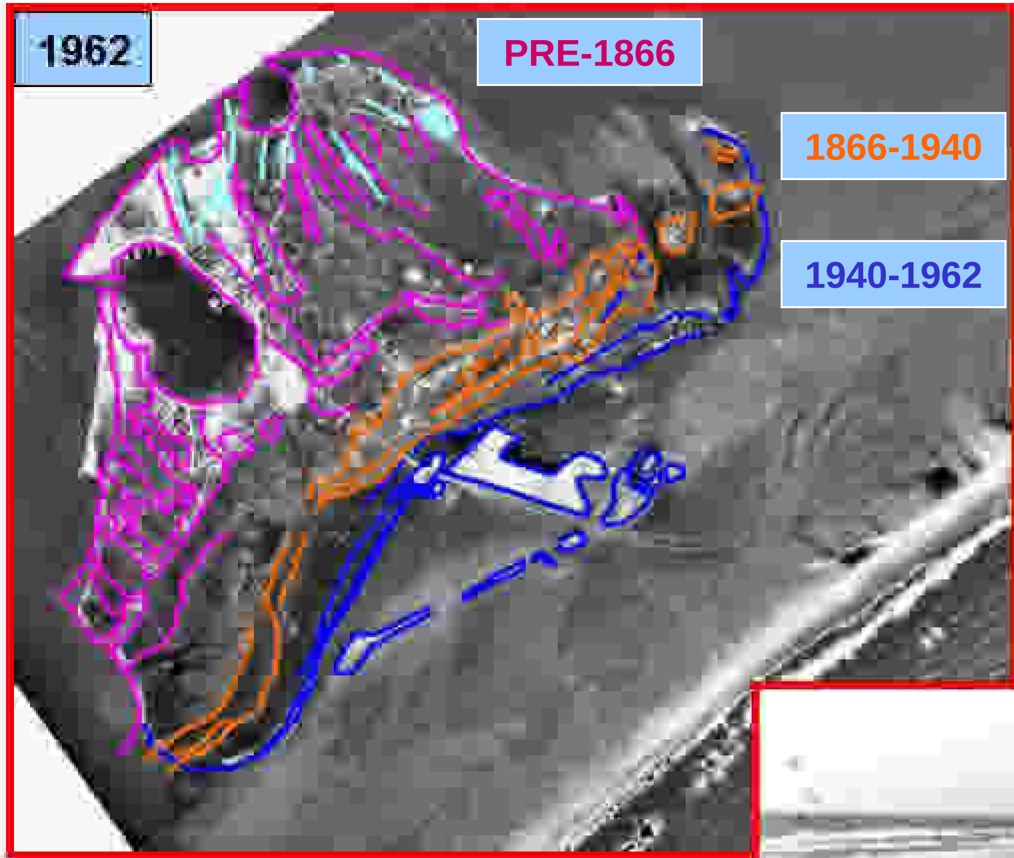
HUMAN PROCESSES:

CONSTRUCTED BARRIER-DUNE RIDGES SEVERELY LIMIT OVERWASH DYNAMICS AND DO <u>NOT</u> STOP SHORELINE RECESSION!

THEY ARE TOTALLY OUT OF EQUILIBRIUM WITH NATURAL BARRIER DYNAMICS!

THE PLAINS TO OCRACOKE VILLAGE SITE

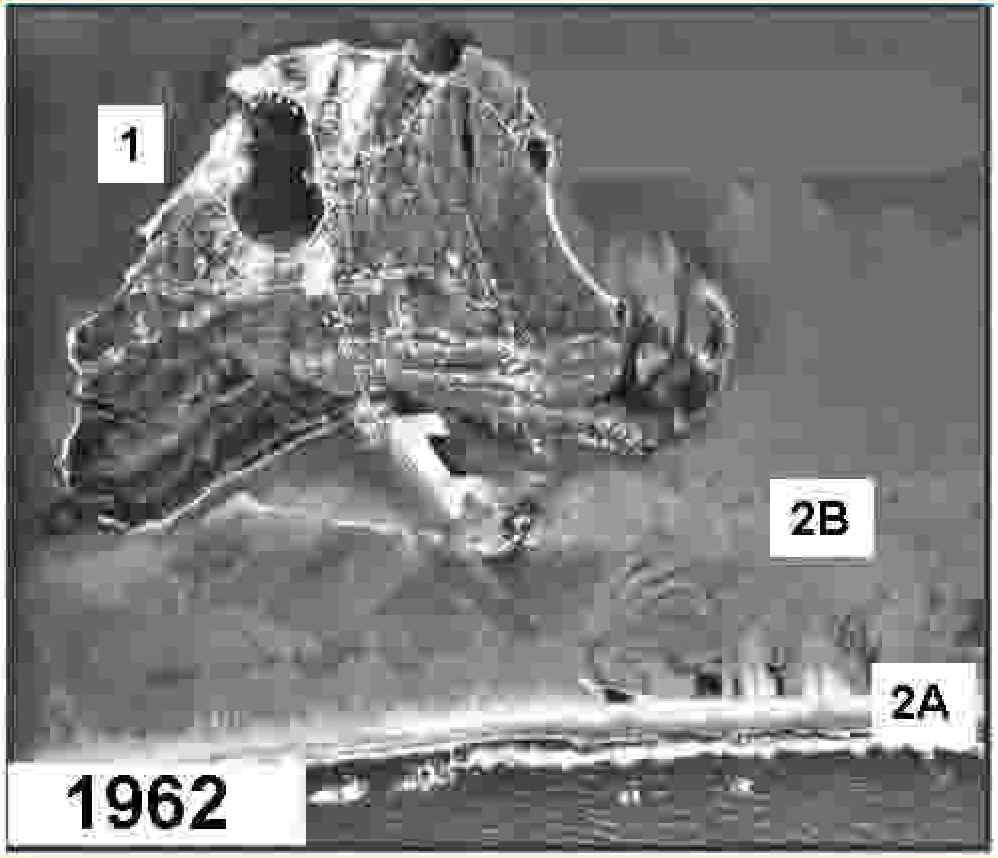


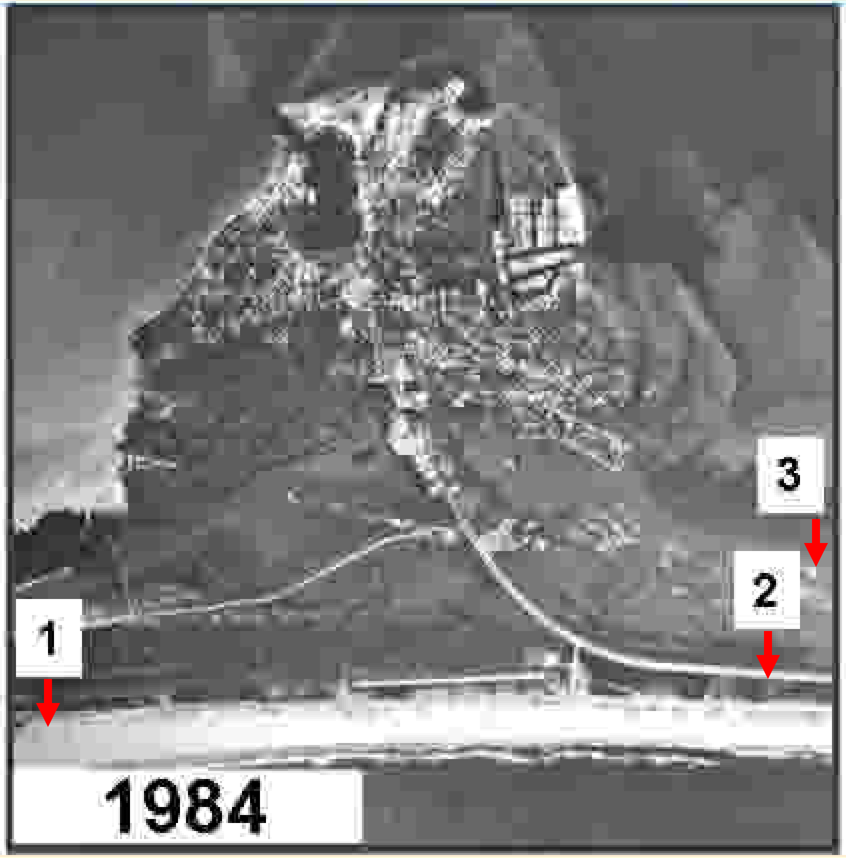


1962 ASH WEDNESDAY STORM

CONSTRUCTED BARRIER-DUNE RIDGE AND PLANTINGS TERMINATED THE NATURAL BEACH RIDGE ACCRETION

OCRACOKE VILLAGE COMPLEX BARRIER ISLAND





1. OLDER BARRIER ISLAND SEGMENT WITH BEACH RIDGE & SWALE STRUCTURES

2. YOUNGER MODERN BARRIER SEGMENT BEING WELDED ONTO OLDER SEGMENT

A. BEACH BERM CREST

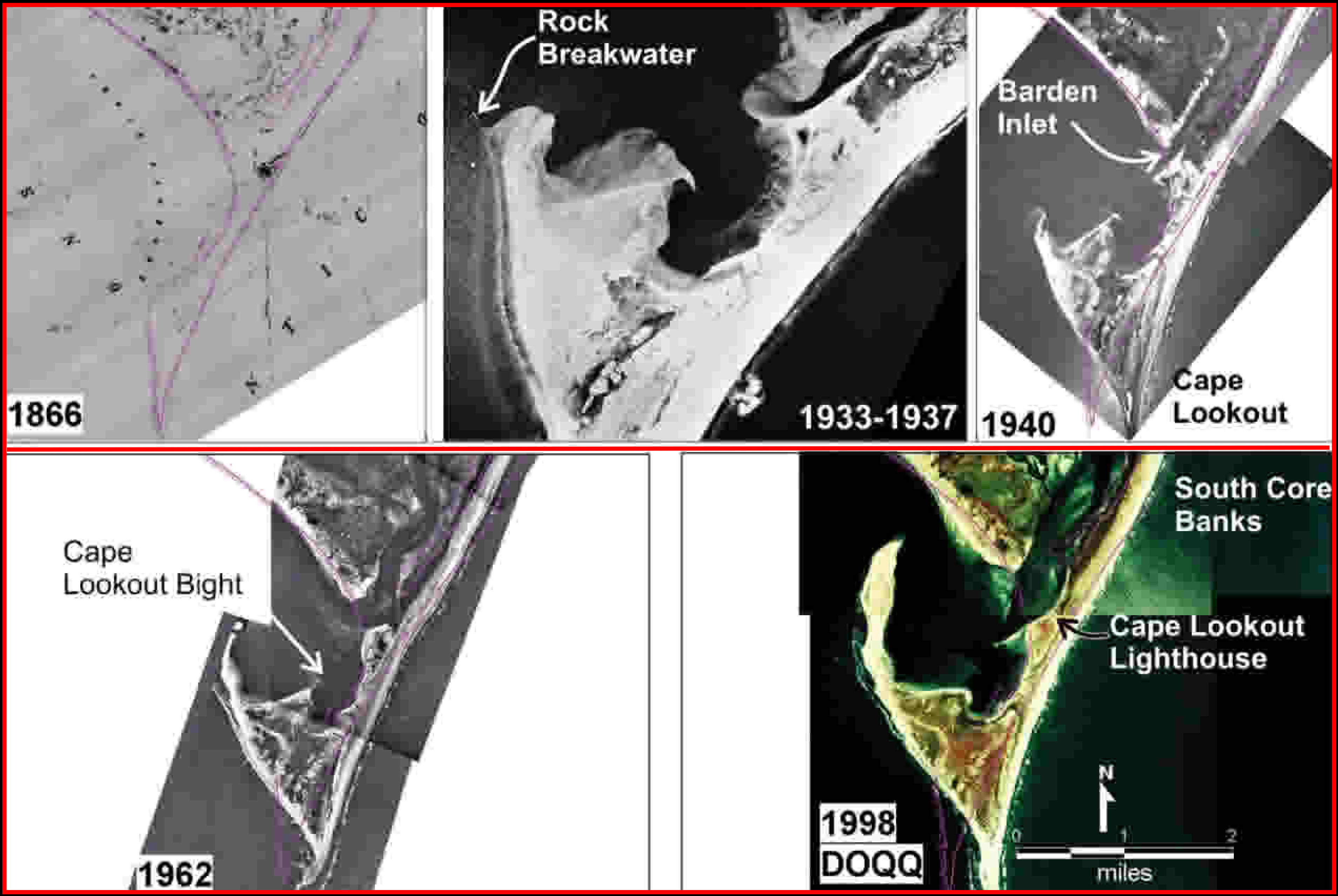
B. OVERWASH PLAIN

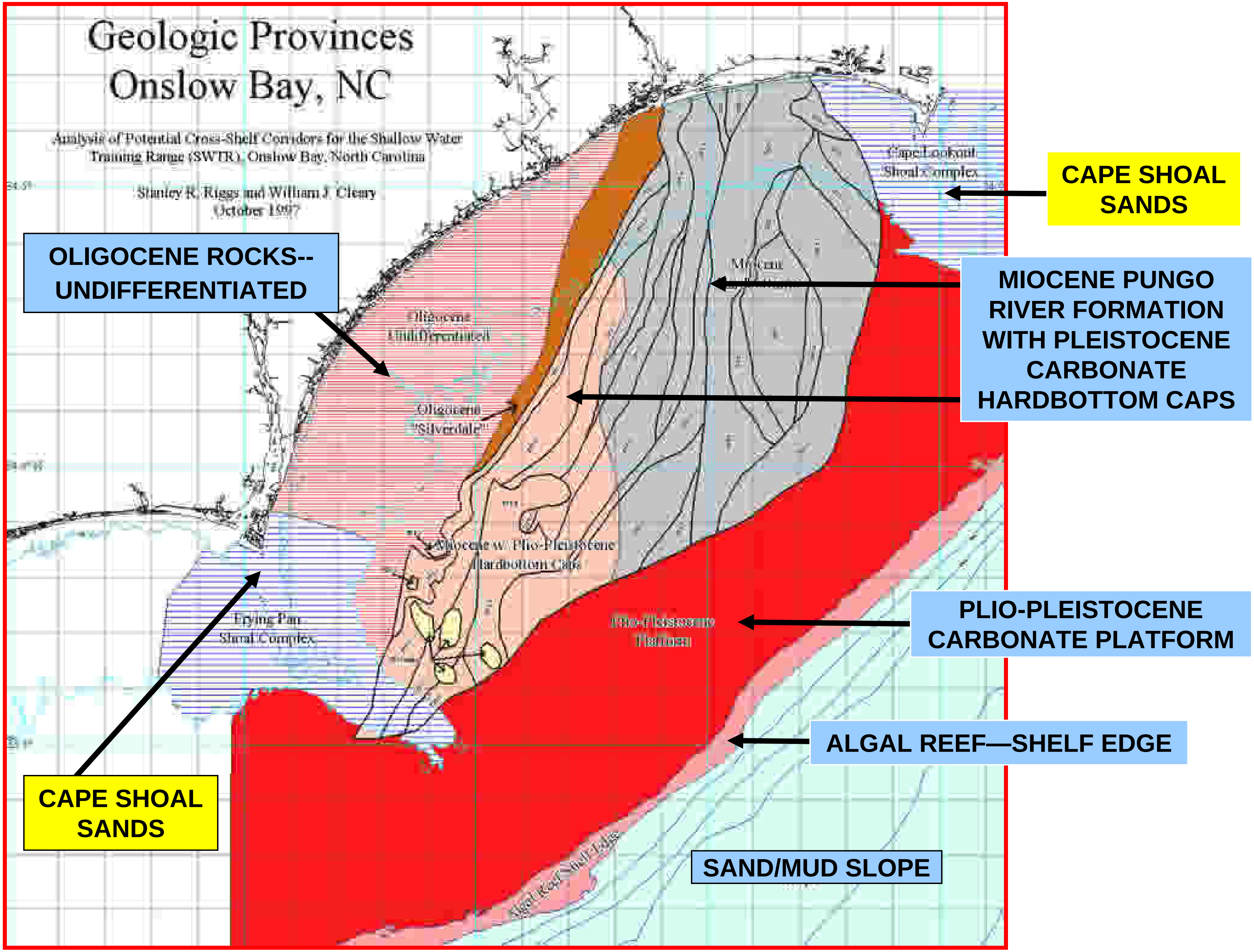
1. CONSTRUCTED DUNE RIDGES -- TERMINATED OVERWASH

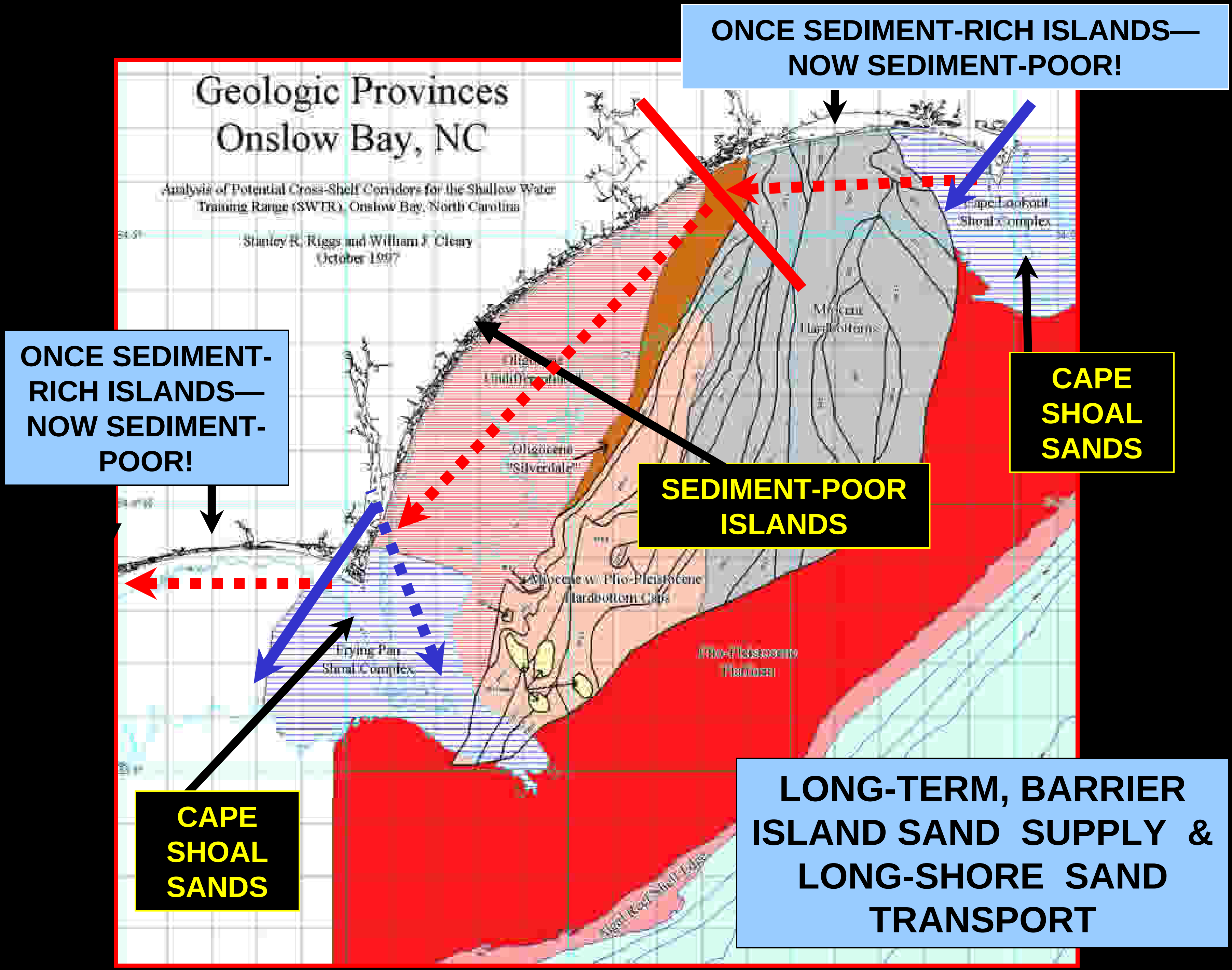
2. UPPER OVERWASH PLAIN VEGETATED WITH SCRUB/SHRUB

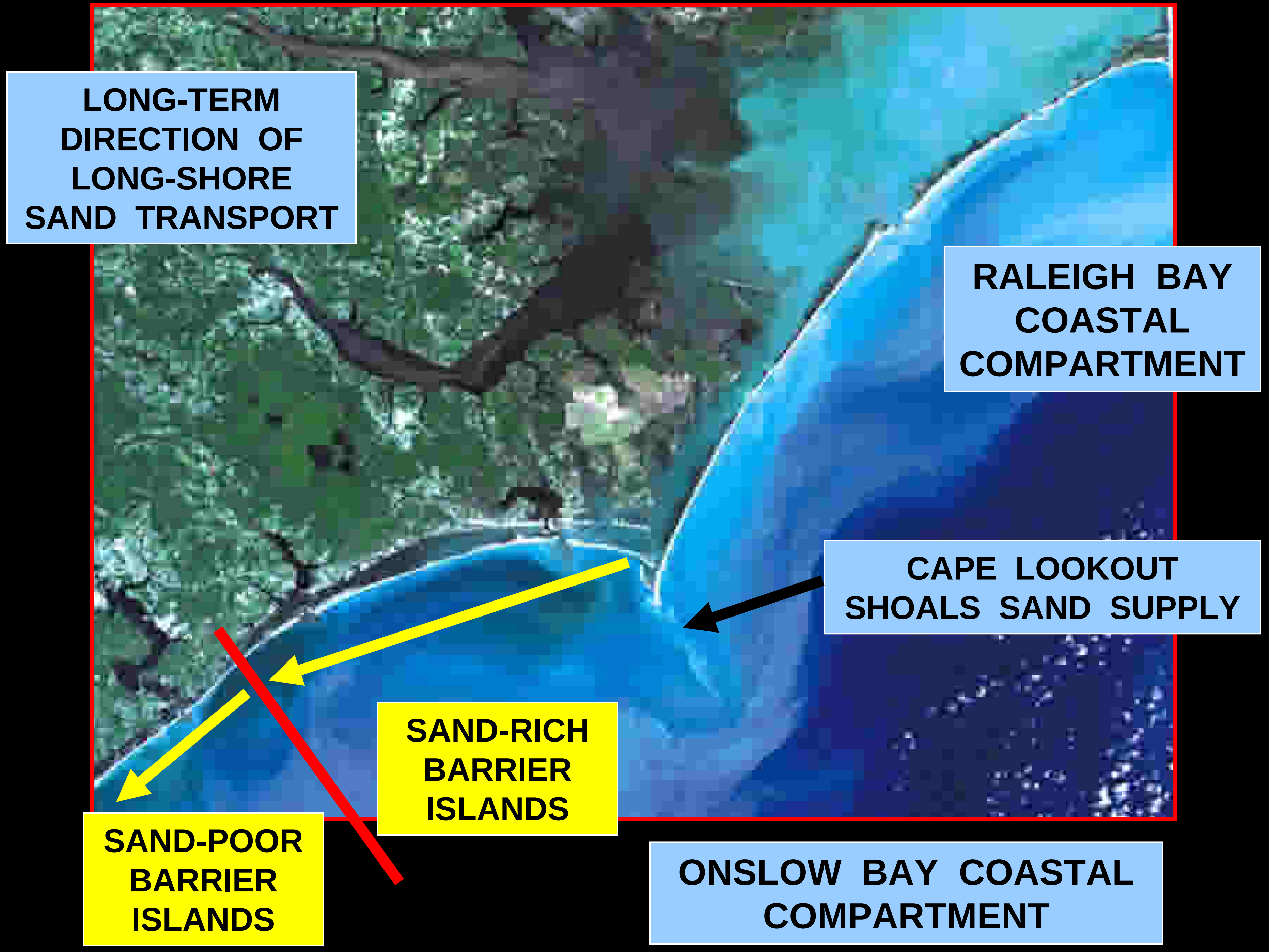
3. MIDDLE AND LOWER OVERWASH PLAIN VEGETATED WITH MARSH GRASS

EVOLUTIONARY HISTORY OF CAPE LOOKOUT

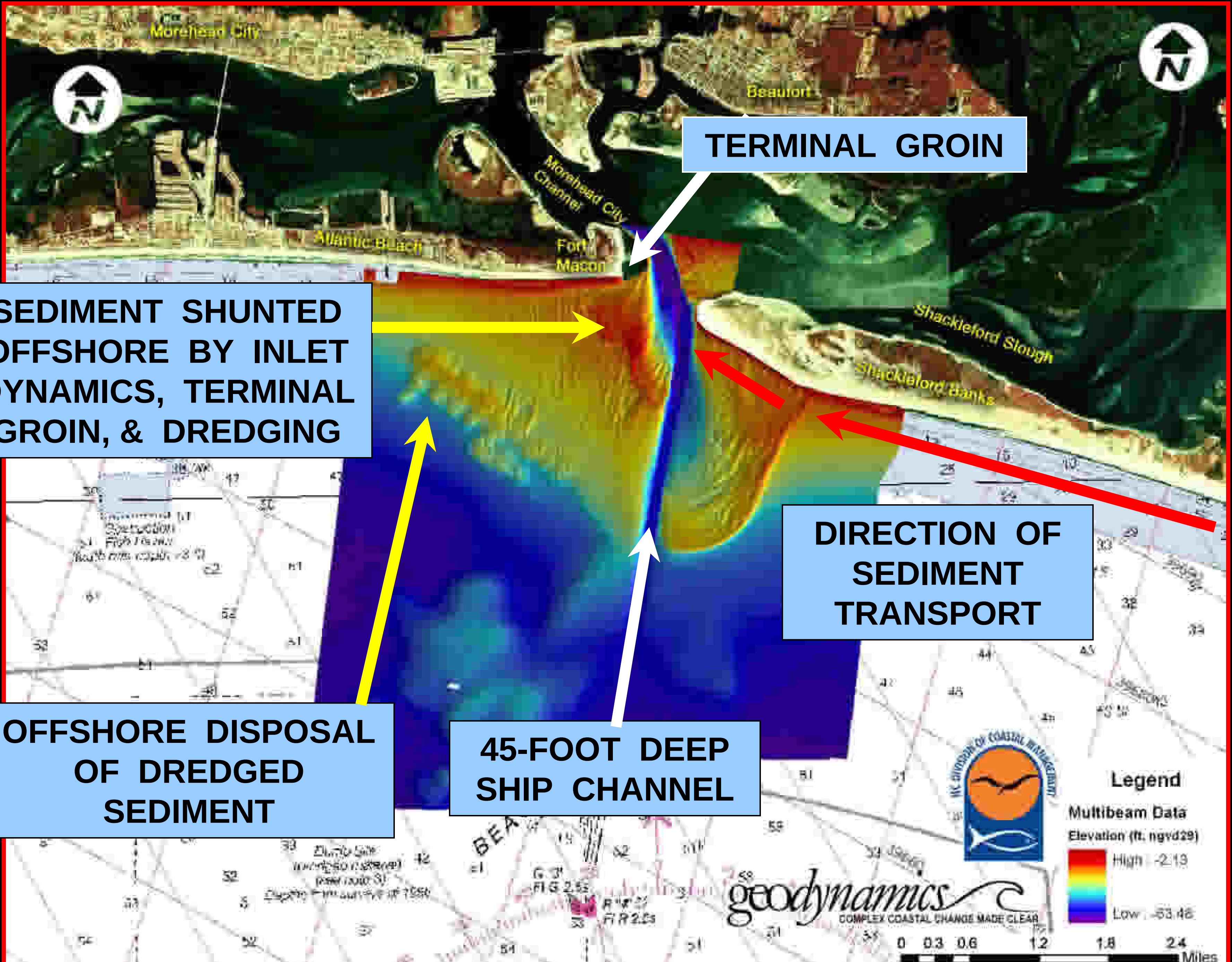



Geologic Provinces
Onslow Bay, NC
Analysis of Potential Cross-Shelf Corridors for the Shallow Water
Training Range (SWTR), Onslow Bay, North Carolina
Stanley R. Riggs and William J. Cleary
October 1997
Cape Lookout
Shoal Complex
CAPE SHOAL SANDS
OLIGOCENE ROCKS--UNDIFFERENTIATED
MIOCENE PUNGO RIVER FORMATION WITH PLEISTOCENE CARBONATE HARDBOTTOM CAPS
Oligocene
Undifferentiated
Oligocene
"Silverdale"
Miocene w/ Plio-Pleistocene
Hardbottom Caps
Frying Pan
Shoal Complex
Plio-Pleistocene
Platform
PLIO-PLEISTOCENE CARBONATE PLATFORM
ALGAL REEF—SHELF EDGE
CAPE SHOAL SANDS
SAND/MUD SLOPE


ONCE SEDIMENT-RICH ISLANDS—NOW SEDIMENT-POOR!
Geologic Provinces
Onslow Bay, NC
Analysis of Potential Cross-Shelf Corridors for the Shallow Water Training Range (SWTR), Onslow Bay, North Carolina
Stanley R. Riggs and William J. Cleary
October 1997
Cape Lookout Shoal Complex
Miocene Hardbottoms
ONCE SEDIMENT-RICH ISLANDS—NOW SEDIMENT-POOR!
CAPE SHOAL SANDS
Oligocene "Silverdale"
SEDIMENT-POOR ISLANDS
Miocene w/ Plio-Pleistocene Hardbottom Caps
Frying Pan Shoal Complex
CAPE SHOAL SANDS
LONG-TERM, BARRIER ISLAND SAND SUPPLY & LONG-SHORE SAND TRANSPORT



LONG-TERM DIRECTION OF LONG-SHORE SAND TRANSPORT
RALEIGH BAY COASTAL COMPARTMENT
CAPE LOOKOUT SHOALS SAND SUPPLY
SAND-RICH BARRIER ISLANDS
SAND-POOR BARRIER ISLANDS
ONSLOW BAY COASTAL COMPARTMENT


TERMINAL GROIN
SEDIMENT SHUNTED OFFSHORE BY INLET DYNAMICS, TERMINAL GROIN, & DREDGING
DIRECTION OF SEDIMENT TRANSPORT
OFFSHORE DISPOSAL OF DREDGED SEDIMENT
45-FOOT DEEP SHIP CHANNEL
Morehead City
Beaufort
Morehead City Channel
Atlantic Beach
Fort Macon
Shackleford Slough
Shackleford Banks
Legend
Multibeam Data
Elevation (ft. ngvd29)
High : -2.13
Low : -53.48
geodynamics
COMPLEX COASTAL CHANGE MADE CLEAR
0 0.3 0.6 1.2 1.8 2.4
Miles

BEAUFORT INLET TERMINAL GROIN AT FORT MACON

IF TERMINAL GROINS WORKED, THERE SHOULD NOT BE A NEED FOR BEACH NOURISHMENT AT FORT MACON TO ATLANTIC BEACH!

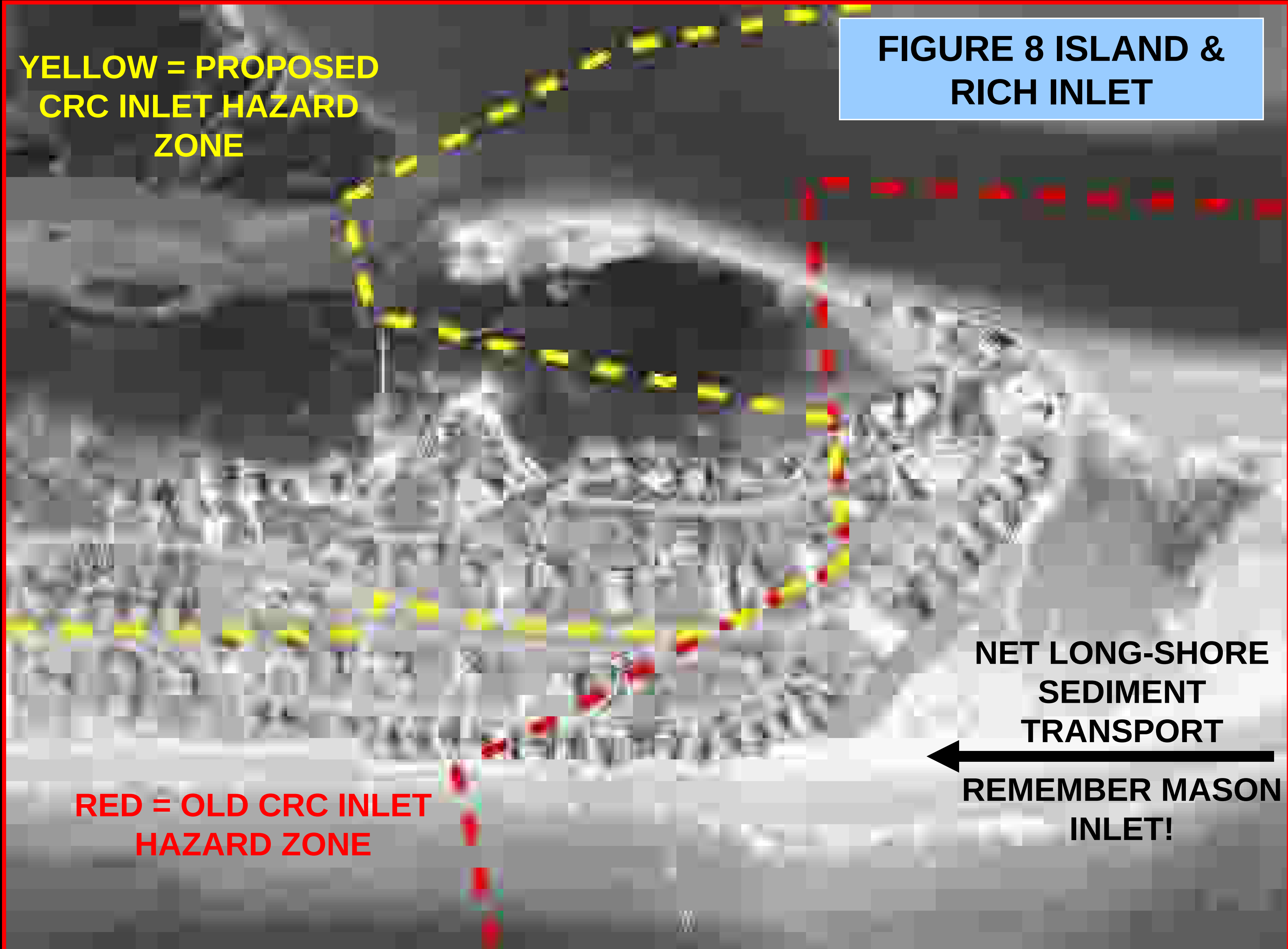
SEDIMENT DREDGED FROM BEAUFORT INLET TO NOURISH THE FORT MACON TO ATLANTIC BEACH SEGMENT

1. **BEAUFORT INLET DREDGED SINCE 1911**
   - **A. 1911-1961 DEPTH OF - 30 ft**
   - **B. 1961-1978 DEPTH OF - 35 ft**
   - **C. 1978-1994 DEPTH OF - 40 ft**
   - **D. 1994-PRESENT DEPTH OF - 45 ft**

2. TERMINAL GROIN BUILT AT FORT MACON IN MID 1960s

3. 1978-2004 FORT MACON & ATLANTIC BEACH (E 6 miles) NOURISHED WITH <u>13,143,000 yds^3</u> OF SEDIMENT

- **A. FORT MACON: <u>2.9 MILLION yds3</u>**
- **B. ATLANTIC BEACH: <u>10.2 MILLION yds3</u>**


YELLOW = PROPOSED CRC INLET HAZARD ZONE
FIGURE 8 ISLAND & RICH INLET
NET LONG-SHORE SEDIMENT TRANSPORT
REMEMBER MASON INLET!
RED = OLD CRC INLET HAZARD ZONE

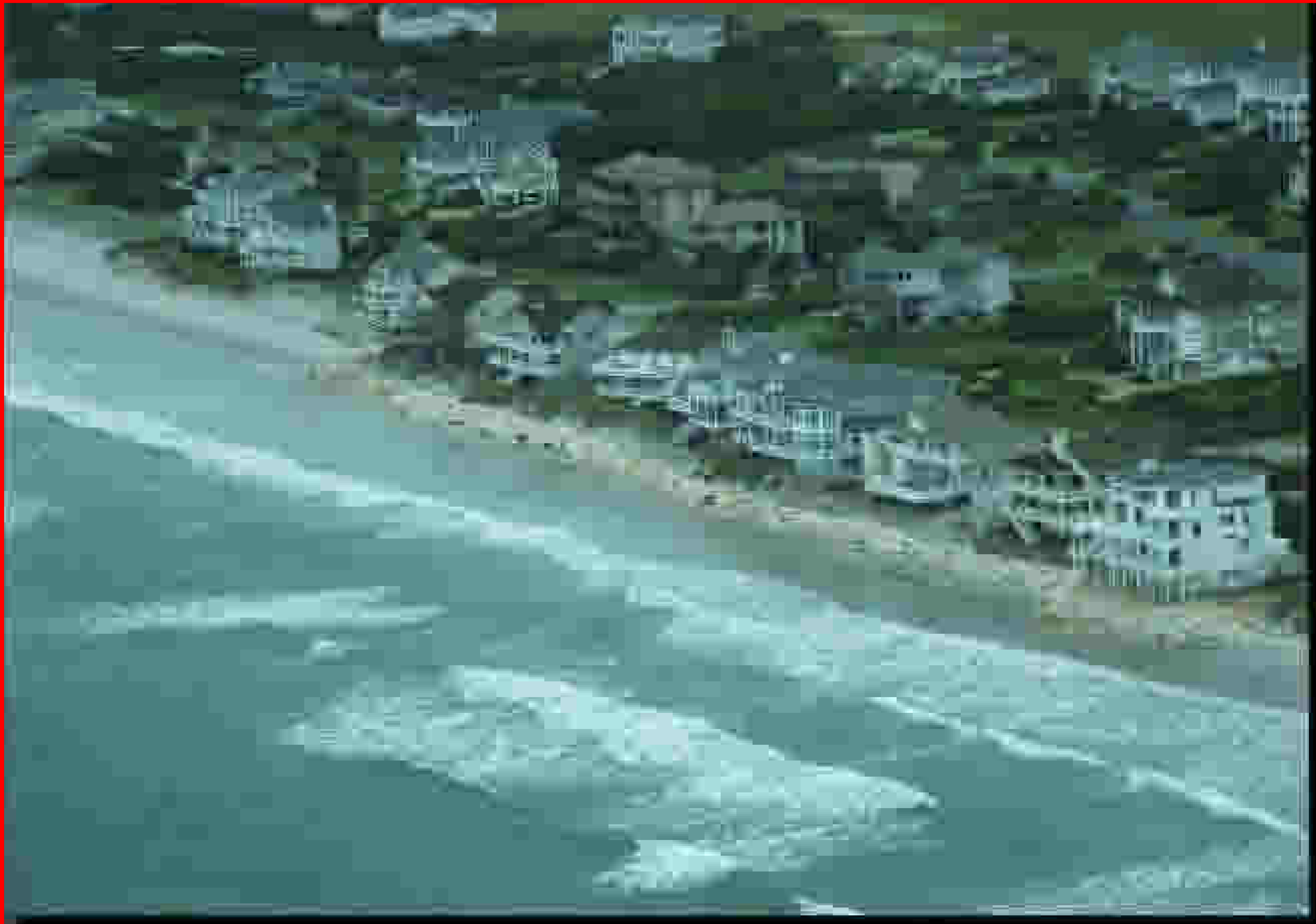
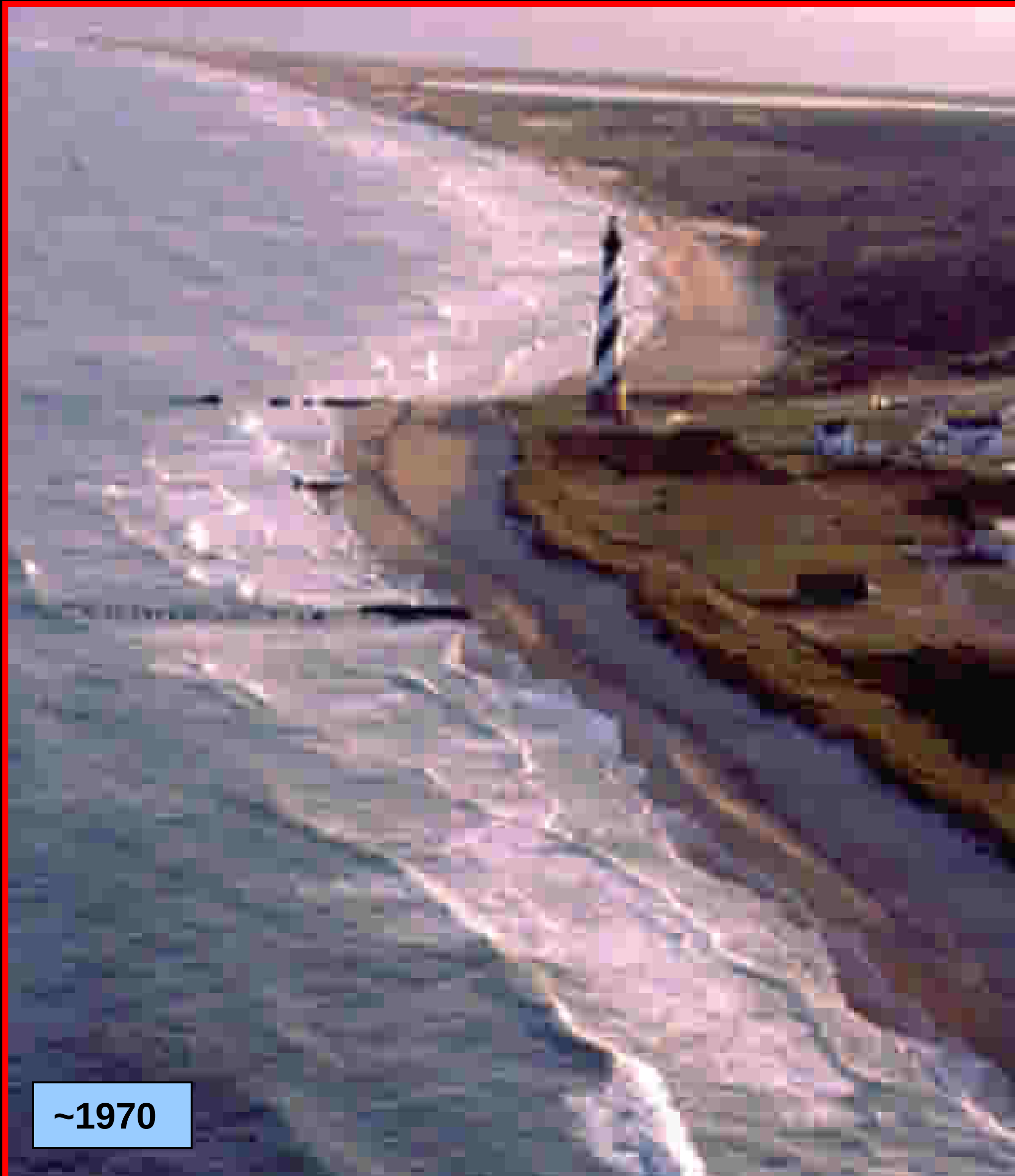


photo by Ken Richardson - 9/27/2007

Figure Eight Island at Rich Inlet

CAPE HATTERAS LIGHTHOUSE GROINS:

A VERY PREDICTABLE DOWNSTREAM CONSEQUENCES



AT BODIE ISLAND, SEDIMENT TRANSPORT IS FROM N TO S ACROSS OREGON INLET TO PEA ISLAND

DREDGING OF OREGON INLET AND TERMINAL GROIN PREVENT SAND TRANSPORT TO PEA ISLAND!

FALLACY OF TERMINAL GROINS AND THE THREAT TO NC'S BARRIER ISLANDS!

PEA ISLAND EXAMPLE

TERMINAL GROIN PERMIT TO HARDEN OREGON INLET REQUIRED NOURISHMENT OF DOWN-STREAM PEA ISLAND BEACHES WITH SAND FROM ANNUAL INLET DREDGING

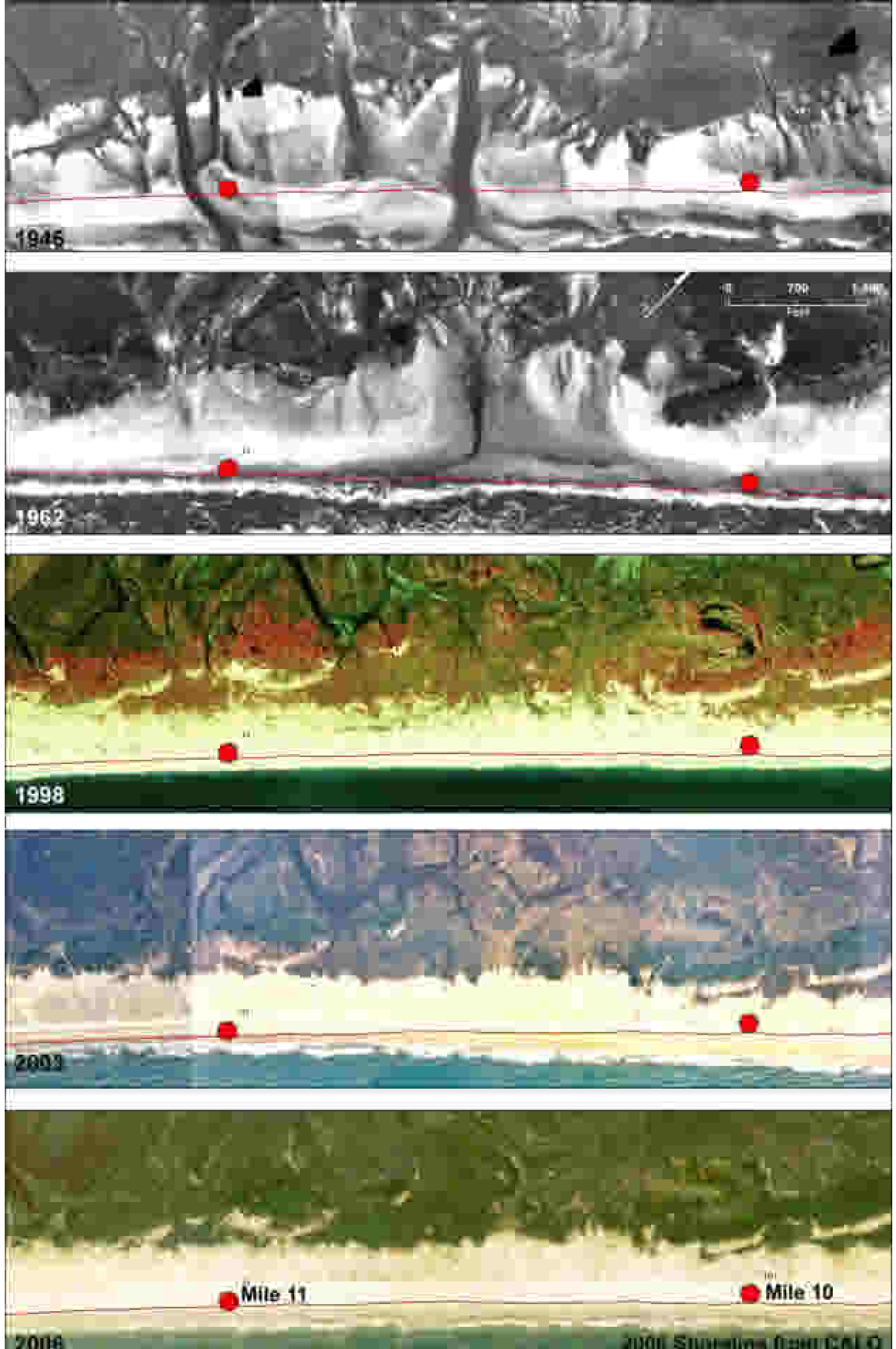
APPROX. 7.7 MILLION yds^3 OF INLET SAND WERE PUMPED-PLACED ON MILES 1-- 6 OF PEA ISLAND IN 23 OPERATIONS BETWEEN 1989-2005!

HOWEVER, PEA ISLAND'S OCEAN SHORELINE CONTINUES TO ERODE AT RATES UP TO 13 ft/yr!

"GOING—TO—SEA"
NC HWY 12

WHAT ARE THE FUTURES OF PEA ISLAND NWR & NC HWY 12?

FIGURE 8 ISLAND, 2007


1946
1962
1998
2003
Mile 11
Mile 10
2006