NC Terminal Groin Study:

Feasibility and Advisability of the Use of a Terminal Groin as an Erosion Control Device

UPDATE AND DISCUSSION

Science Panel Meeting

January 19, 2010

MOFFATT & NICHOL

DIAL CORDY AND ASSOCIATES INC
Environmental Consultants

Meeting Agenda

- Introductions
- Analysis and Preliminary Results Discussions:
  - Coastal Engineering Analysis / Physical Effects (1)
  - Environmental Analysis and Impacts (2)
  - Construction Techniques, Costs, Locations (3, 5, 6)
  - Economic Impacts (4)
- Next Steps

Selected Study Evaluation Sites

North Carolina

- Oregon Inlet
- Fort Macon

Florida

- Amelia Island
- Captiva Island
- John's Pass

Task 1- Coastal Engineering Analysis

– Examining the Five Study Sites:
  - Physical Processes (waves, sediment transport, etc.)
  - Geologic Setting
  - Structural Characteristics
  - Pre- and Post-Construction Shorelines on Both Sides of Inlet Where Terminal Groin Constructed
  - Shoreline Change and Volume Changes (Erosion, Accretion, Beach Nourishment)

Task 1- Coastal Engineering Analysis

1A – Shoreline Change Analysis

1B – Volumetric Change, Nourishment, and Dredging

1C – Physical and Geological Setting

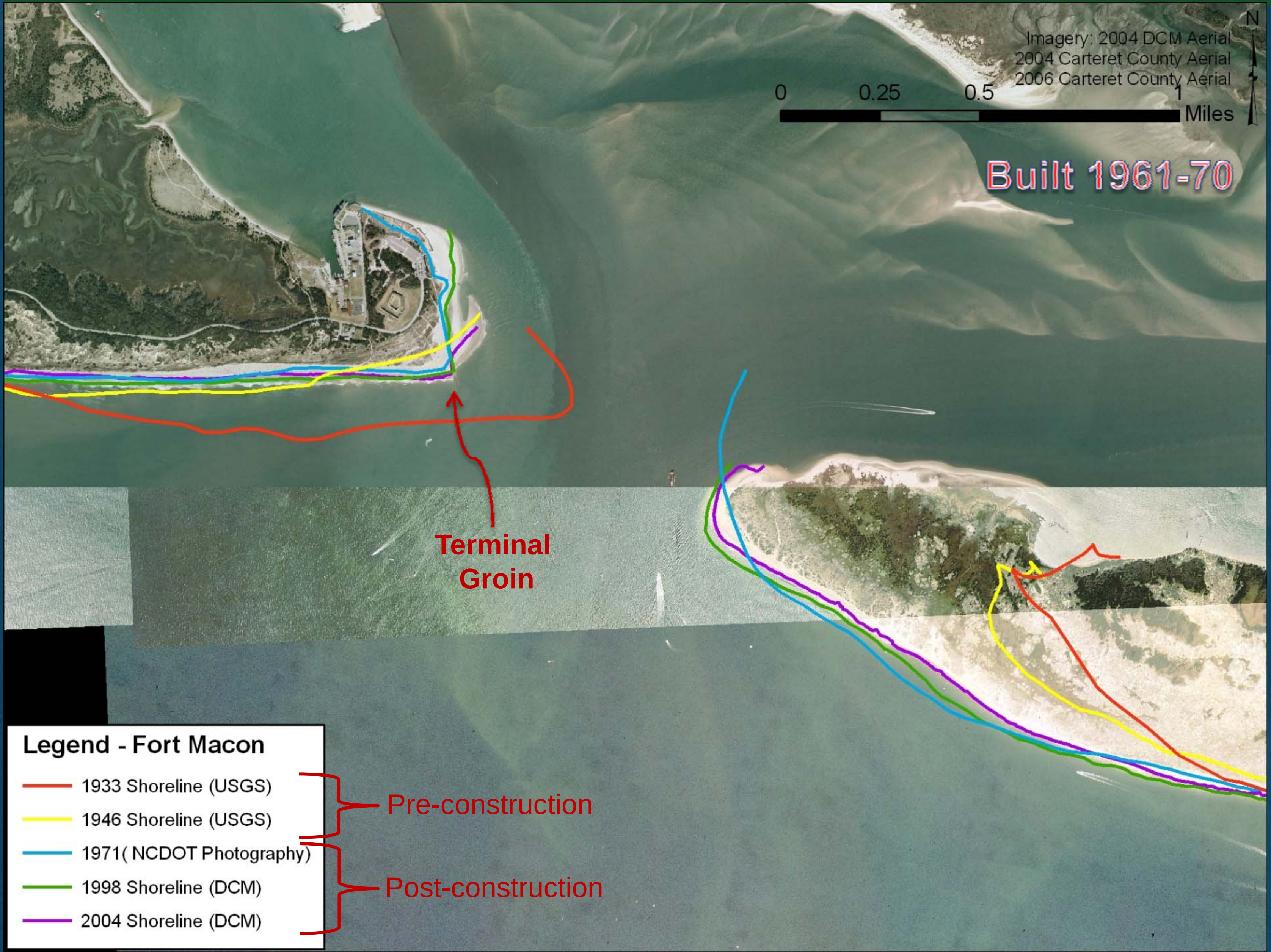
1D – Terminal Groin Structure Information

1E – Engineering Activities Log

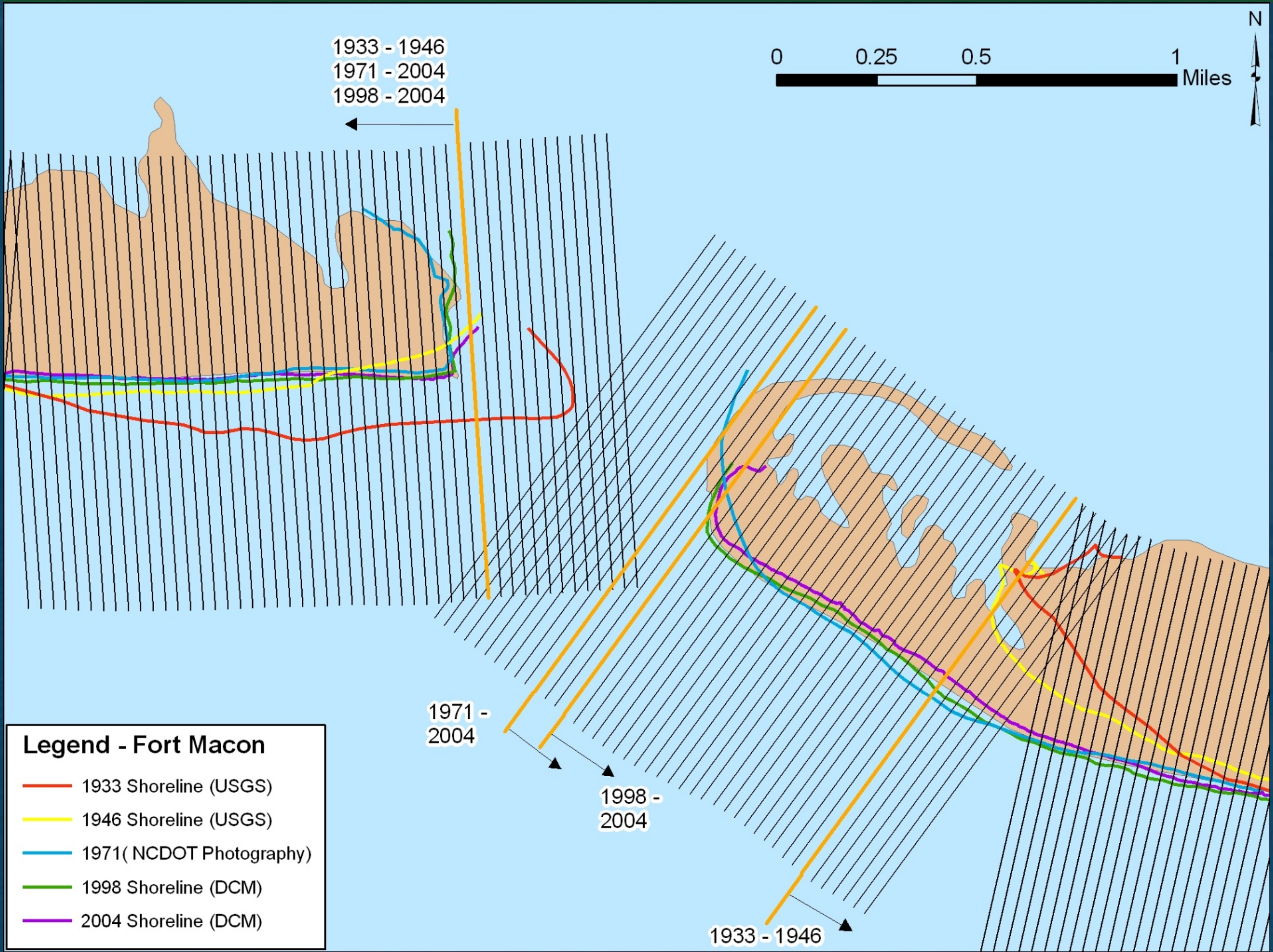
Task 1A- Shoreline Change Analysis

- – Use historic shorelines, surveys, and aerials to assess shoreline change pre- and post-construction
- – Calculate shoreline change rate (erosion, accretion) at transects perpendicular to the shoreline every 50 m on both sides of the inlet
- – Calculate shoreline change in 0.25 mile intervals to a distance of 3 miles each direction

Fort Macon


Imagery: 2004 DCM Aerial
2004 Carteret County Aerial
2006 Carteret County Aerial
N
0
0.25
0.5
1
Miles
Built 1961-70
Terminal Groin
Legend - Fort Macon
1933 Shoreline (USGS)
1946 Shoreline (USGS)
1971(NCDOT Photography)
1998 Shoreline (DCM)
2004 Shoreline (DCM)
Pre-construction
Post-construction

Fort Macon


1933 - 1946
1971 - 2004
1998 - 2004
0 0.25 0.5 1
Miles
N
1971 - 2004
1998 - 2004
1933 - 1946
Legend - Fort Macon
1933 Shoreline (USGS)
1946 Shoreline (USGS)
1971(NCDOT Photography)
1998 Shoreline (DCM)
2004 Shoreline (DCM)

Fort Macon

Total Change

Distance from Inlet (mi)	1933-1946 West Average Erosion Rate (ft/yr)	1933-1946 East Average Erosion Rate (ft/yr)	1971-2004 West Average Erosion Rate (ft/yr)	1971-2004 East Average Erosion Rate (ft/yr)	1998-2004 West Average Erosion Rate (ft/yr)	1998-2004 East Average Erosion Rate (ft/yr)
0 - 0.25	74.2	55.0	13.0	8.9	21.0	26.5
0 - 0.5	66.6	43.5	7.6	7.1	5.8	22.5
0 - 0.75	57.8	28.8	5.0	7.3	0.6	22.9
0 - 1	49.8	18.8	3.6	7.8	3.1	24.6
0 - 2	27.0	5.9	2.4	4.2	4.7	19.4
0 - 3	18.8	1.2	3.0	2.5	3.4	14.3

Interval Change

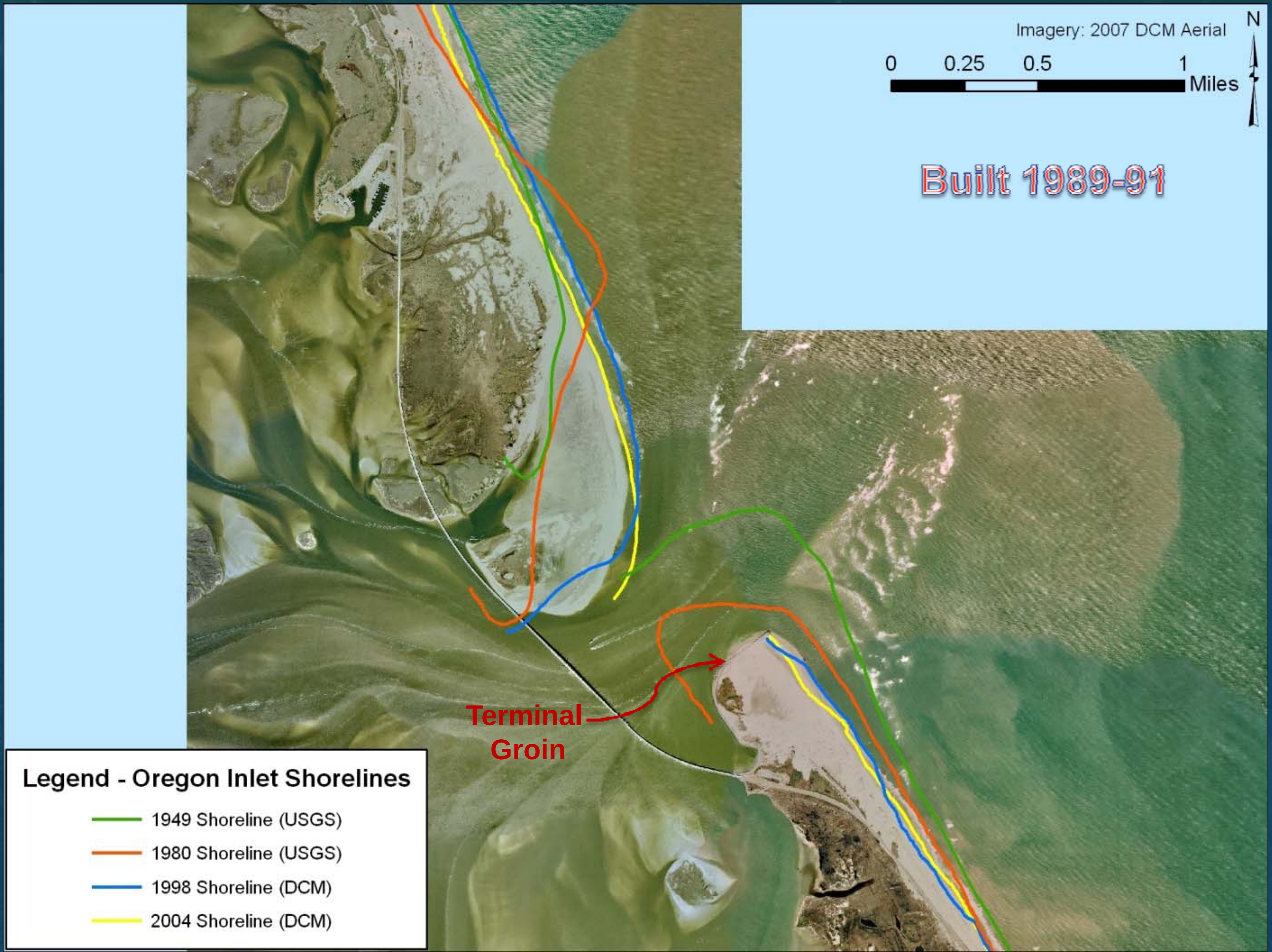
Distance from Inlet (mi)	1933-1946 West Average Erosion Rate (ft/yr)	1933-1946 East Average Erosion Rate (ft/yr)	1971-2004 West Average Erosion Rate (ft/yr)	1971-2004 East Average Erosion Rate (ft/yr)	1998-2004 West Average Erosion Rate (ft/yr)	1998-2004 East Average Erosion Rate (ft/yr)
0 - 0.25	74.2	55.0	13.0	8.9	21.0	26.5
0.25 - 0.5	59.0	32.0	2.2	5.3	9.5	18.5
0.5 - 0.75	40.1	0.5	0.2	7.7	9.8	23.8
0.75 - 1	25.7	11.1	0.5	9.4	14.1	29.5
1 - 2	3.4	11.4	0.8	0.6	6.9	12.4
2 - 3	0.4	9.8	4.3	1.4	0.1	2.4

Shoreline recession (erosion)
Shoreline growth (accretion)

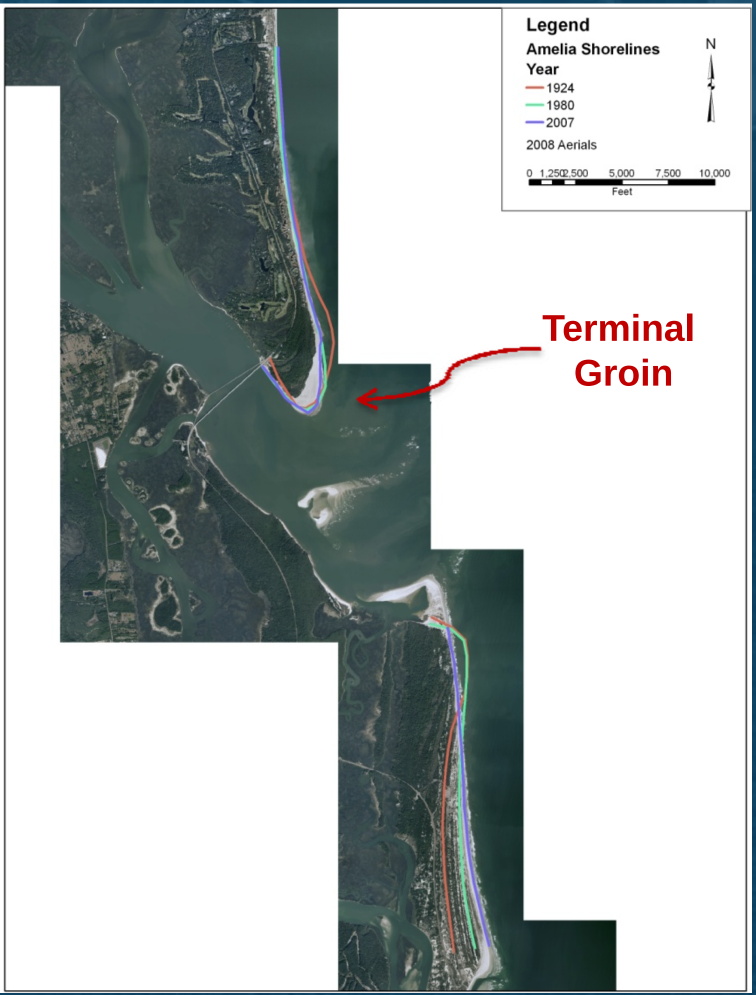
Shoreline Change Analysis

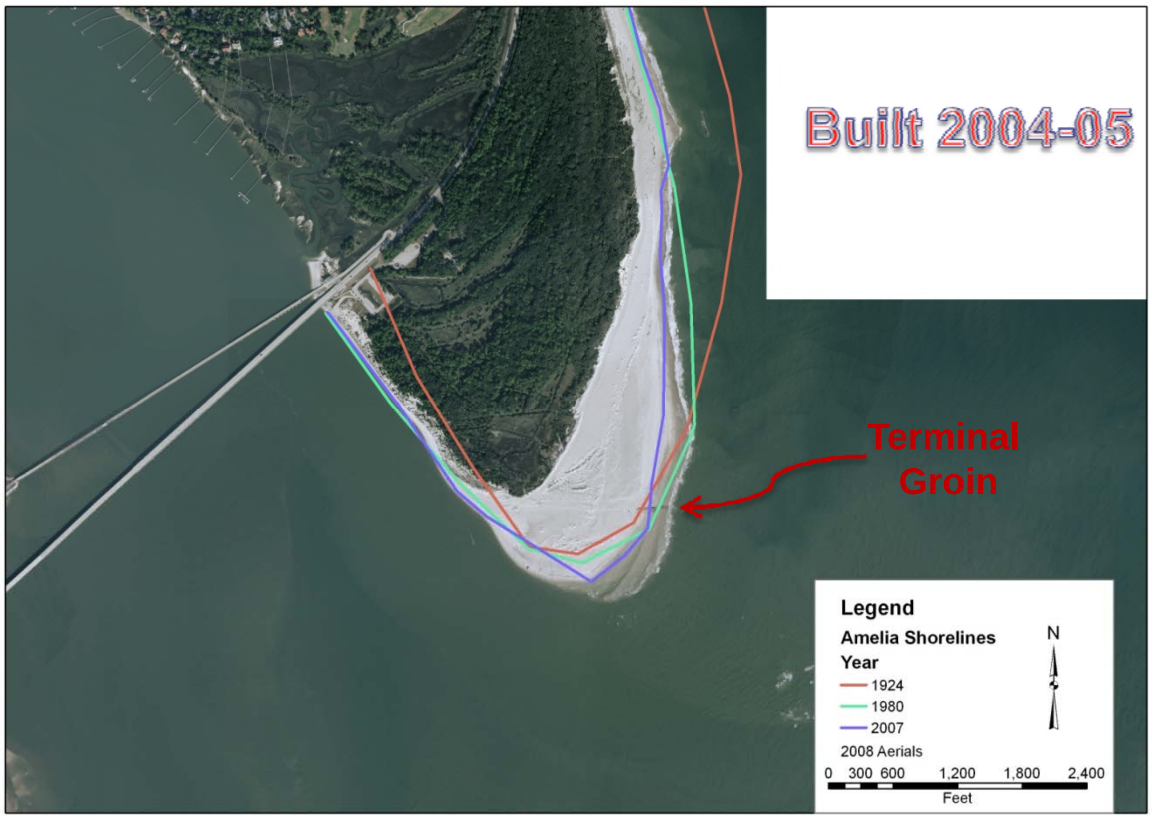
Study Site	Year Terminal Groin Constructed	Pre-construction Shorelines	Post-construction Shorelines
Oregon Inlet	1989 - 1991	1949 - 1980	1998 - 2004
Fort Macon	1961, 1965, 1970[a]	1933 - 1946	1971 – 2004 / 1998 - 2004
Amelia Island	2004 – 2005	1924 - 1980	2007
Captiva Island	1977, 2006[b]	1951 - 1974	1982 – 2004 / 1989 – 2004
John's Pass	North: 1961, 1987[c] South: 2000	1873 – 1926 1873 – 1926 / 1974 – 1997	1974 – 1997 / 2001 – 2005 N/A

Oregon Inlet

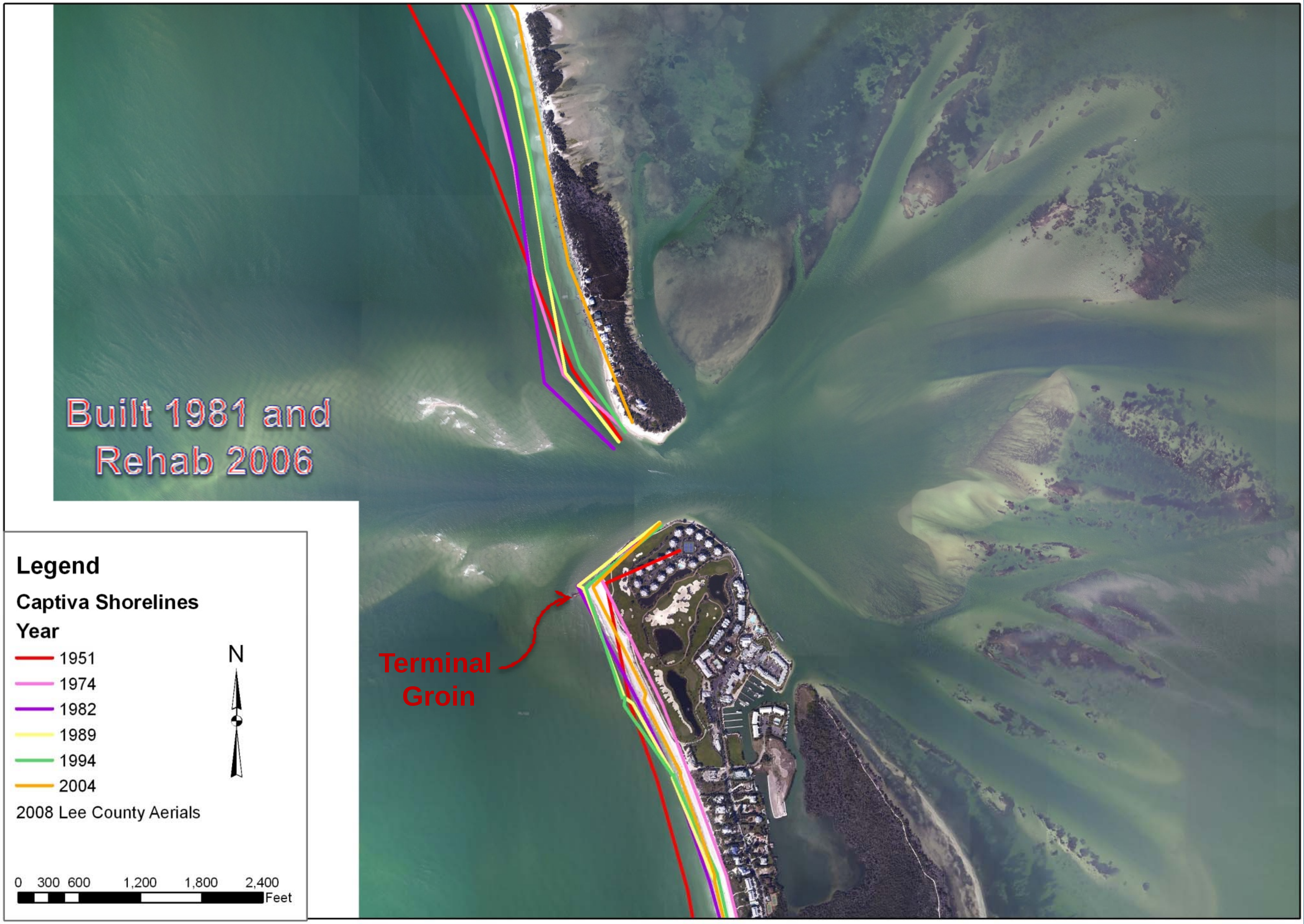


Amelia Island

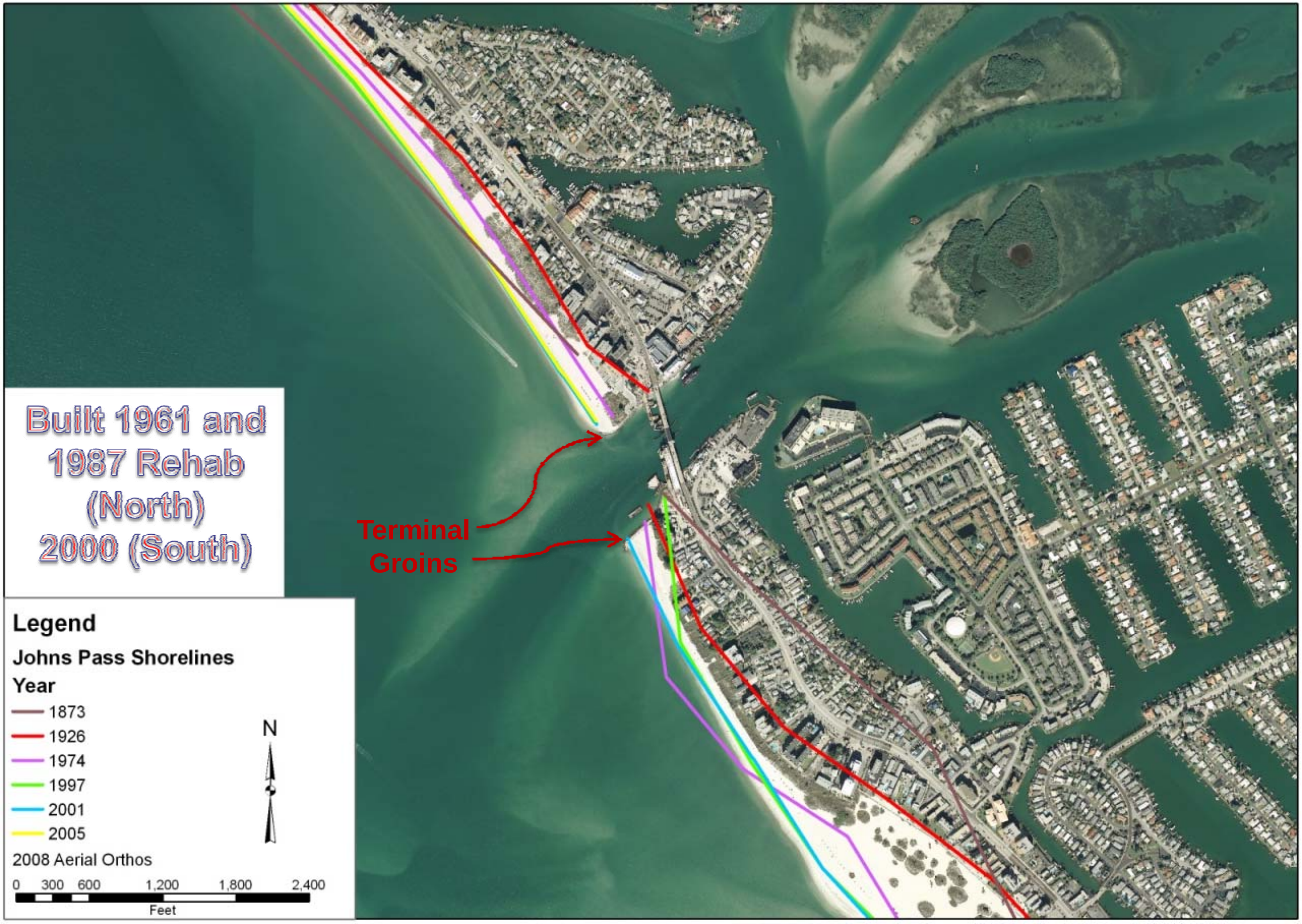




Captiva Island



John's Pass

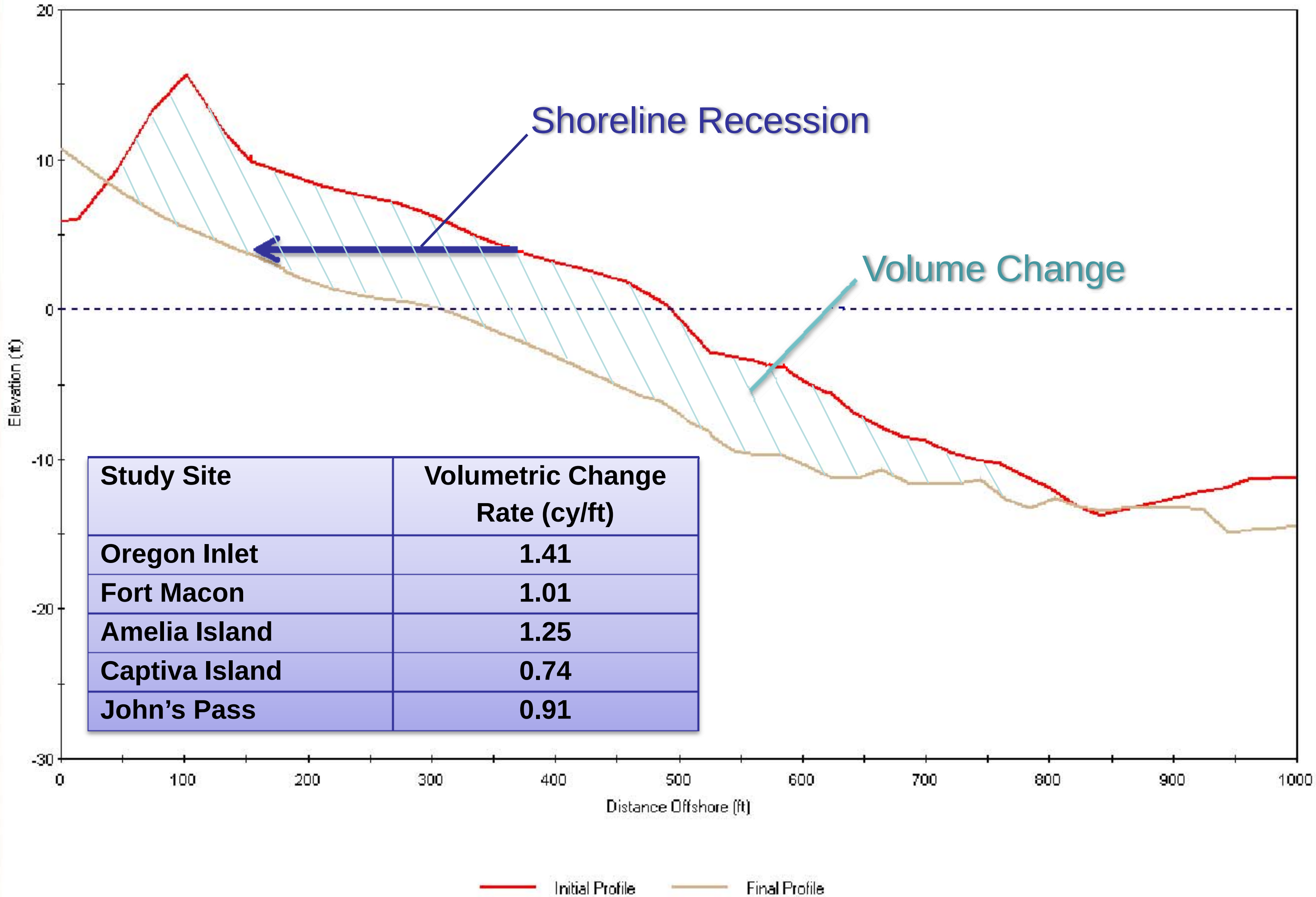


Built 1961 and
1987 Rehab
(North)
2000 (South)
Terminal
Groins
Legend
Johns Pass Shorelines
Year
1873
1926
1974
1997
2001
2005
N
2008 Aerial Orthos
0 300 600 1,200 1,800 2,400
Feet

Task 1B - Volumetric Change, Nourishment, and Dredging

- Examine survey profiles in the vicinity of the five study sites to establish a typical shoreline change (MHW) to beach volume relationship
- Calculate beach volume changes (total, pre- and post-project where possible)
- Compiled dredging, beach nourishment and beach placement data

Shoreline Recession and Volume Change



Study Site	Volumetric Change Rate (cy/ft)
Oregon Inlet	1.41
Fort Macon	1.01
Amelia Island	1.25
Captiva Island	0.74
John's Pass	0.91

Fort Macon

	Fort Macon						
	Distance from Inlet (mi)	1933 - 1946 West Total Volume (cy/yr)	1933 - 1946 East Total Volume (cy/yr)	1971 - 2004 West Total Volume (cy/yr)	1974 - 2004 East Total Volume (cy/yr)	1998 - 2004 West Total Volume (cy/yr)	1998 - 2004 East Total Volume (cy/yr)
Total Change	0 - 0.25	38,769	28,737	17,297	11,783	27,773	35,112
	0 - 0.5	69,581	45,453	20,197	18,772	15,245	59,567
	0 - 0.75	90,541	45,168	19,921	29,027	2,318	91,155
	0 - 1	103,982	39,365	19,308	41,469	16,412	130,310
	0 - 2	98,724	21,482	22,588	38,973	43,944	179,682
	0 - 3	98,033	6,096	39,711	33,268	44,490	189,315
Interval Change	0 - 0.25	38,769	28,737	17,297	11,783	27,773	35,112
	0.25 - 0.5	30,812	16,716	2,900	6,989	12,528	24,456
	0.5 - 0.75	20,960	285	276	10,255	12,926	31,588
	0.75 - 1	13,441	5,804	613	12,442	18,731	39,154
	1 - 2	5,258	17,883	3,280	2,496	27,532	49,373
	2 - 3	691	15,386	17,123	5,706	546	9,633

Beach Volume Loss(erosion)
Beach Volume Gain(accretion)

Fort Macon – Beach Nourishment

Beach Nourishment							
	Distance from Inlet (mi)	1933 - 1946 West (cy/yr)	1933 - 1946 East (cy/yr)	1971 - 2004 West (cy/yr)	1974 - 2004 East (cy/yr)	1998 - 2004 West (cy/yr)	1998 - 2004 East (cy/yr)
Total Change	0 - 0.25	0	0	21,542	0	4,361	0
	0 - 0.5	0	0	43,084	0	8,723	0
	0 - 0.75	0	0	64,626	0	13,084	0
	0 - 1	0	0	86,168	0	17,446	0
	0 - 2	0	0	136,292	0	34,891	0
	0 - 3	0	0	165,368	0	34,891	0
Interval Change	0 - 0.25	0	0	21,542	0	4,361	0
	0.25 - 0.5	0	0	21,542	0	4,361	0
	0.5 - 0.75	0	0	21,542	0	4,361	0
	0.75 - 1	0	0	21,542	0	4,361	0
	1 - 2	0	0	50,123	0	17,446	0
	2 - 3	0	0	29,077	0	0	0

Fort Macon – Net Change

Fort Macon - Change Net Beach Nourishment							
	Distance from Inlet (mi)	1933 - 1946 West Total Volume (cy/yr)	1933 - 1946 East Total Volume (cy/yr)	1971 - 2004 West Total Volume (cy/yr)	1974 - 2004 East Total Volume (cy/yr)	1998 - 2004 West Total Volume (cy/yr)	1998 - 2004 East Total Volume (cy/yr)
Total Change	0 - 0.25	38,769	28,737	4,245	11,783	23,411	35,112
	0 - 0.5	69,581	45,453	22,887	18,772	6,522	59,567
	0 - 0.75	90,541	45,168	44,705	29,027	10,766	91,155
	0 - 1	103,982	39,365	66,861	41,469	33,858	130,310
	0 - 2	98,724	21,482	113,704	38,973	78,835	179,682
	0 - 3	98,033	6,096	125,657	33,268	79,382	189,315
Interval Change	0 - 0.25	38,769	28,737	4,245	11,783	23,411	35,112
	0.25 - 0.5	30,812	16,716	18,642	6,989	16,890	24,456
	0.5 - 0.75	20,960	285	21,818	10,255	17,288	31,588
	0.75 - 1	13,441	5,804	22,155	12,442	23,092	39,154
	1 - 2	5,258	17,883	46,843	2,496	44,977	49,373
	2 - 3	691	15,386	11,953	5,706	546	9,633

Net Beach Volume Loss(erosion)
Net Beach Volume Gain(accretion)

Fort Macon – Dredge

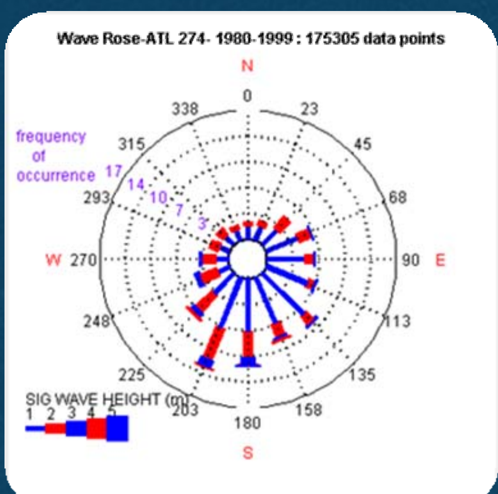
Dredging Period used for calculations	Dredge Volume	
	(cy)	(cy/yr)
Total (1927 - 2005)	65,831,942	843,999
Pre (1927 - 1970)	27,518,800	639,972
Post (1970 - 2005)	38,313,142	1,064,254
Material Disposed on the ODMDS (1972 - 2005)	27,044,274	819,523

*Beaufort Inlet / Morehead City Harbor Channel

1C – Physical Setting

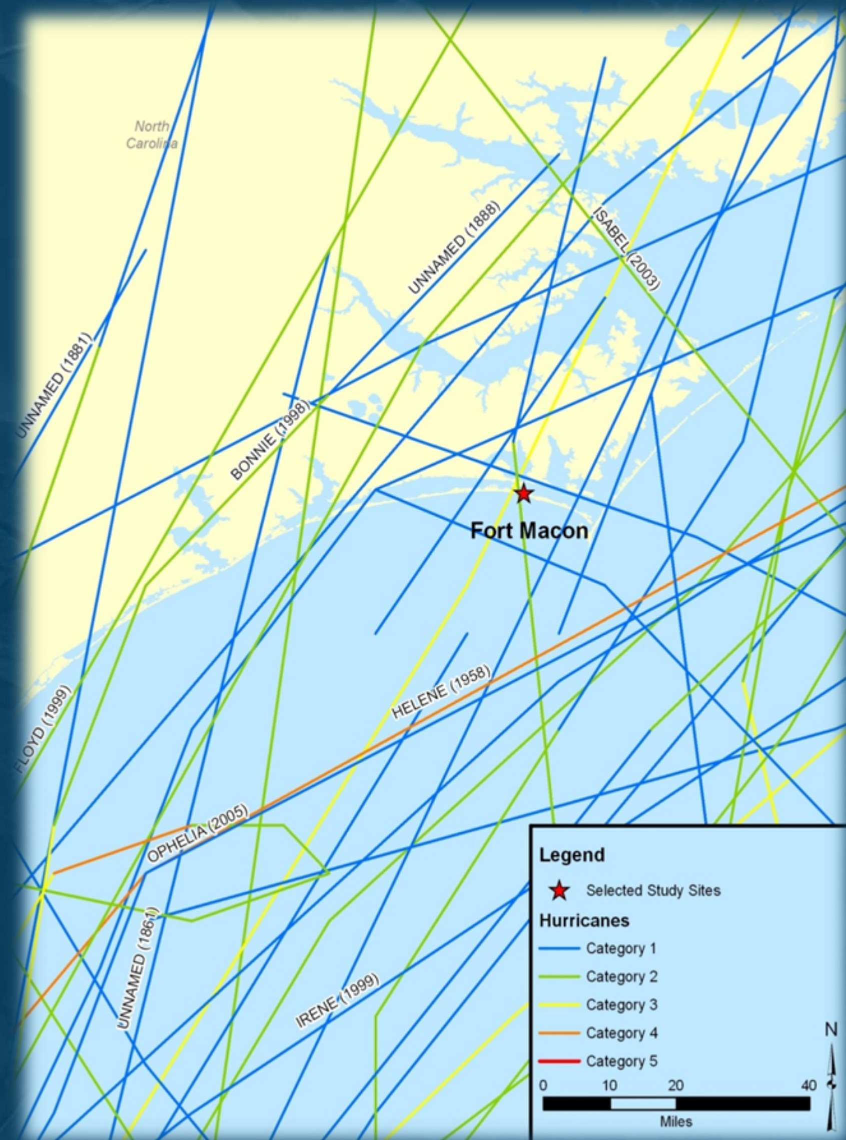
– Physical Processes

- Waves
- Tides, Currents
- Sediment Transport
- Storm Activity



Tides

	Station	
	Beaufort (8656483)	Wrightsville Beach (8658163)
MHHW (ft)	3.54	4.31
MHW (ft)	3.26	3.96
DTL (ft)	1.77	2.15
MTL (ft)	1.70	2.06
MSL (ft)	1.71	2.05
MLW (ft)	0.15	0.15
MLLW (ft)	0.00	0.00
NAVD (ft)	-	2.51
Maximum	6.29	7.08
Max Date	19990916	20080925
Max Time	9:12	20:54
Minimum	-1.92	-2.81
Min Date	19780111	20070416
Min Time	3:18	4:24



1C – Physical Setting

Example - Data Summary

Study Site	Average Tidal Range (MHHW – MLLW)	Average Offshore Significant Wave Height	Average Offshore Peak Wave Period	Number of Storms* between 1851 - 2008 (within 65 nm)
Oregon Inlet	2.43 ft	3.9 ft	7.0 sec	98
Fort Macon	3.93 ft	3.3 ft	5.0 sec	117
Amelia Island	5.34 ft	3.3 ft	7.0 sec	83
Captiva Island	2.10 ft	2.3 ft	4.0 sec	65
John's Pass	2.40 ft	2.3 ft	4.0 sec	65

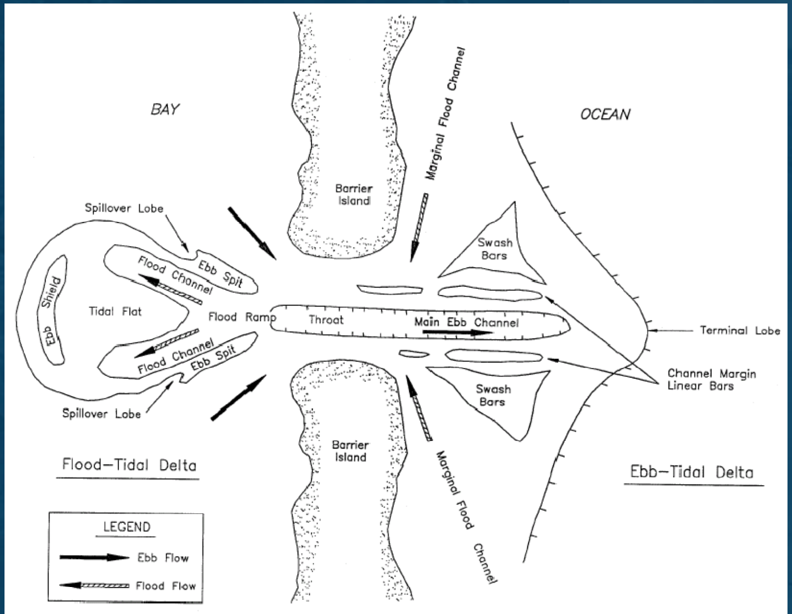
1C – Geological Setting

– Can Impart a Strong Signature on the Physical Processes Affecting Erosional-Depositional Patterns

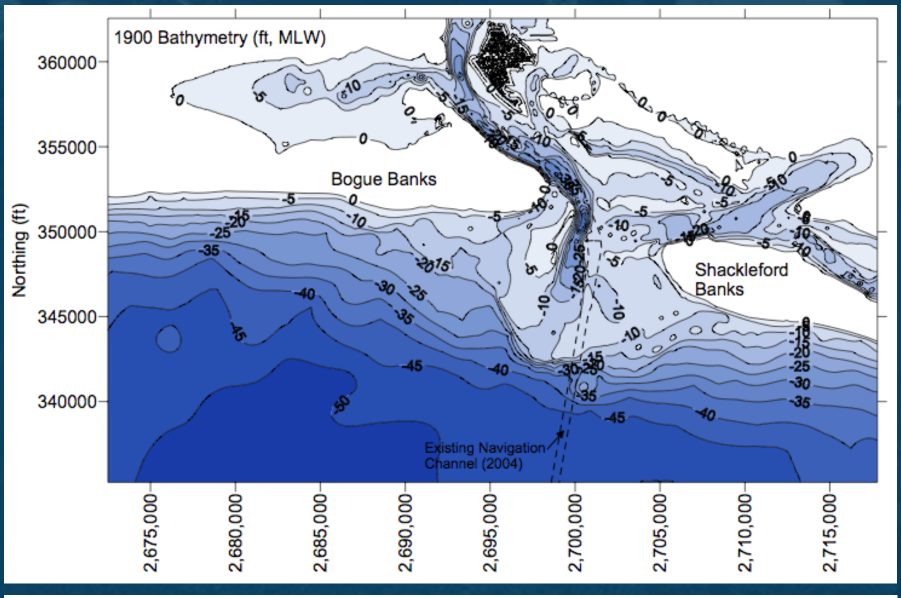
– Historical Geologic Features/Stratigraphy

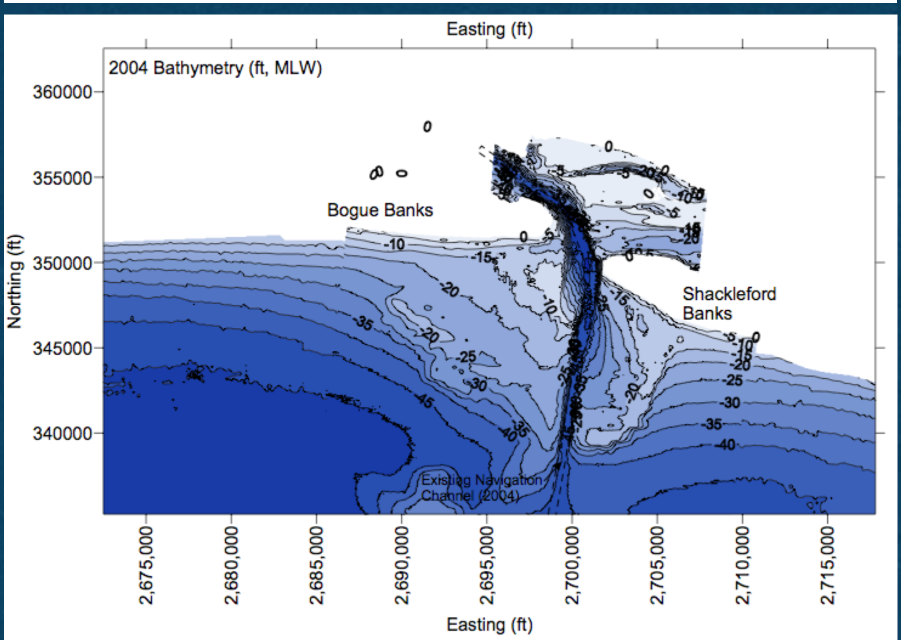
– Inlet Migration, Delta and Channel Patterns

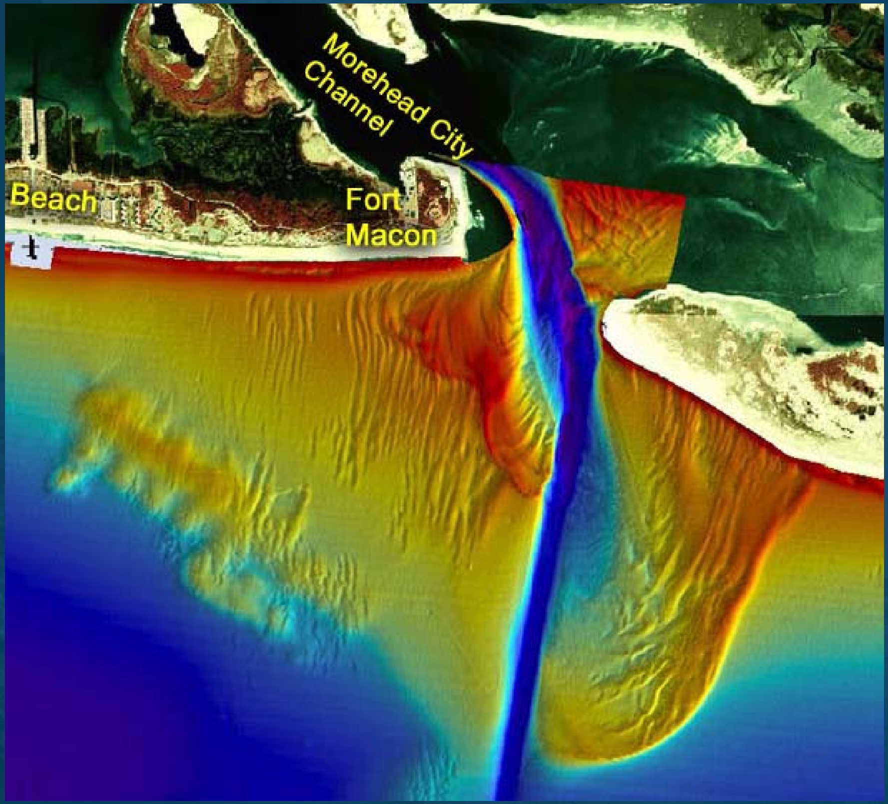
General Tidal Inlet Features



1C – Geological Setting







Dredging and Tidal Prism Changes…

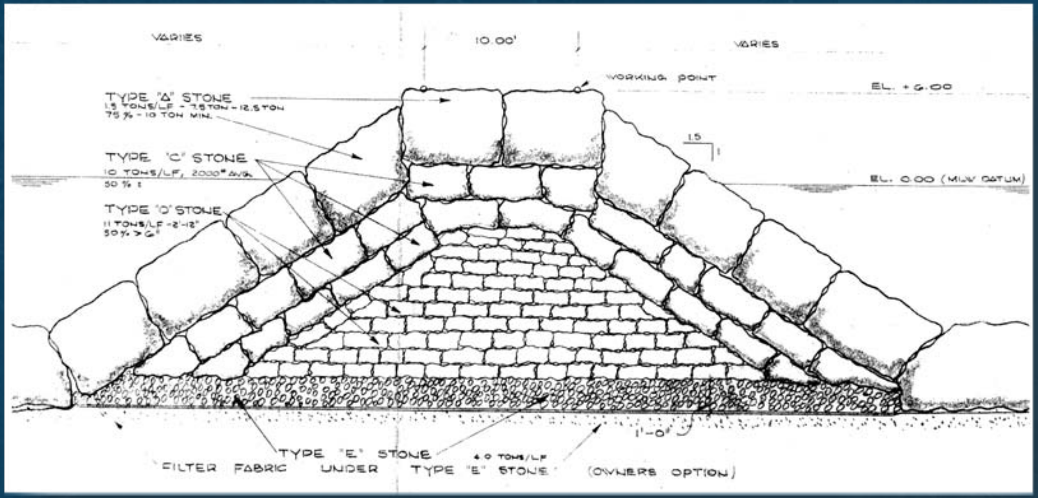
Resulting Offshore Bar (Terminal Lobe) Changes

1D – Terminal Groin Structure Characteristics

– Structural Drawings

– Dimensions, Materials…

Length = 1,530 ft
Base Width = 58-66 ft
Crest = 6 ft MLW
(10 ft wide)
Armor = 7.5 – 12.5 ton



1D – Terminal Groin Structure Characteristics

Study Site	Structure Plans	Dimensions
Oregon Inlet	NCDOT (undated)	3,125 ft (Crest varies 8-9.5 ft MSL)
Fort Macon	Henry Von Oesen & Associates (5/65 and 10/68)	1,530 ft (Crest at 6 ft MLW)
Amelia Island	Olsen Associates Inc. (10/02)	1,500 ft (5.2 ft NGVD29)
Captiva Island	Some information in reports and articles - no drawings	350 ft
John's Pass	Pinellas County Permit Drawings (10/84 and 4/85)	North – 460 ft (6.7 ft MLW) South – 400 ft

1E – Engineering Activities Log

- Terminal Groin Construction
- Dredging of Adjacent Channel
- Beach Nourishment and Nearshore Placement

ENGINEERING ACTIVITIES LOG FOR FORT MACON

Date	Project Type	Description	Vol (cy)	Extent (ft)	Unit Vol (cy/ft	Sand Source
1829 - 1834	Fort Construction	Fort Macon Construction				
1911	Dredging	Navigational Improvements to Beaufort Inlet begin; Channel dredged to 300-ft wide				
1936	Dredging	Outer Bar Channel deepened to -30 ft and 400-ft wide; channel location becomes fixed				
1961	Beach Nourishment			7,656		
1961	Seawall, Revetment, Partial Groin Construction	Due to financial constraints, the groin was only built to a length of 720 ft at an elevation of 6 ft, instead of 9 and excluded the structure's top armor layer. The revetment (250 ft) and seawall (530 ft) were constructed along the dune bank starting just north of the present-day Fort Macon parking lot in a southeastern direction				
1965	Groin Extention & Construction; Beach Nourishment	Groin extended an additional 410 ft oceanward; Additional groin was constructed west of the revetment due to extensive erosion on the back, or sound side, of the island and its impact to the US Coast Guard station. Beach fill was also placed on the beach between the present day bathhouse and boardwalk region and the terminal groin	93,000			
August, 1970	Groin Extention & Construction; Beach Nourishment	Groin extended an additional 400 ft to a total length of 1,530 ft; A stone groin (480 ft long) was built near the bathhouse in an effort to stabilize the beach fill placed in the area of the bathhouse and boardwalk	100,000			
1970	Dredging	Beaufort Inlet Channel Maintenance	1,191,558			Disposal: ODMDS

Task 2 – Environmental Analysis

Analysis and Preliminary Results Discussion

DIAL CORDY AND ASSOCIATES INC
Environmental Consultants

Methodology

List of representatives contacted for environmental data and/or information as it relates to terminal groins

Representatives	North Carolina	Florida
State/Local Agency	17	33
Federal Agency	26	21
Non-profit Organization[a]	8	11
For-profit Organization[b]	23	13
Individual[c]	2	0
Total	76	77

Biological Resources Evaluated

- Infaunal communities
- Shorebirds and waterbirds
- Fisheries
- Coastal habitats
- Water quality
- Federally protected species

General Marine Resources

• Terminal groin structures are frequently located within estuarine and coastal systems; however, only a limited amount of information exists on the biological effects of such structures [Coastal Engineering Research Center (CERC) 1981].

• Potential effects vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that would potentially be affected, and the nature of the interaction of a particular species with the dredging activities.

• Several factors can contribute to the magnitude of re-suspension and spatial extent of plumes, including prevalent meteorological and sea state conditions, granulometry of the fill sediments (e.g., % silts or clays), and mode of placement (e.g., hydraulic pipeline or vessel pump-out).

Infaunal Communities

- In cases where sediment texture is substantially changed due to the placement of a higher fraction of fine sediments on the beach, recovery of benthic infaunal communities may be delayed (Reilly and Bellis 1983; Peterson et al. 2000).

- Where there is a high correspondence between the fill site and ambient beach sediments (e.g. Nelson 1993; Van Dolah et al. 1994; Hackney et al. 1996; Jutte et al. 1999; Burlas et al. 2001), infaunal recolonization is more rapid and potential limitations to benthic food availability are reduced.

- The placement of rock to construct a terminal groin would result in a loss of benthic organisms. The placement of rock may also result in the permanent loss of intertidal and nearshore subtidal habitat; however, this loss may be negligible when compared to the total amount of intertidal habitat within a specific project area (USACE 2008).

Fisheries

- The importance of surf zone habitat as a nursery area for juvenile fish along the high-energy beaches of the eastern United States and northern Gulf of Mexico is becoming increasingly evident (Ross et al. 1987; Lazzari et al. 1999; Layman 2000; Able et al. 2009).

- Localized fish abundance and distribution patterns have been significantly associated with the presence of the rock groins, with greater fish captures and higher species richness at areas nearest the groins.

- Water quality effects anticipated during and immediately following construction of a terminal groin may also have short-term effects to EFH. As described by Dolan (1999), the majority of larval fish migrates along the coast within the inshore longshore transport system and therefore could be negatively affected if turbidity levels increase significantly.

Shorebirds and Colonial Waterbirds

- According to NC Wildlife Resources Commission (NCWRC) (2009), the barrier islands and associated inlets on which many waterbirds depend are being severely altered by attempts to stabilize beaches.

- The effects of coastal sediment management on birds have rarely been studied in Florida (USACE 2009). Consequently, despite a large amount of coordinated (and uncoordinated) coastal bird surveys (Sprandel et al. 1997; Douglass and Coburn 2002; Ferland and Haig 2002; Lamonte et al. 2006; Gore et al. 2007) the year-round distribution, abundance, and habitat associations of Florida's shoreline-dependent birds is still poorly known.

- Coastal development, coastal protection, dredging, and human disturbance are listed as actions that can significantly affect the ability of coasts and intertidal waters to sustain waterbirds (Kushlan et al. 2002).

Threatened and Endangered Species

- Wintering plovers prefer wide beaches in the vicinity of inlets (Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994) with moist substrate features such as intertidal flats, algal flats, and ephemeral pools (Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994). Factors that affect distribution, abundance, and survival of the federally-threatened piping plover on wintering grounds are poorly understood (Cohen et al. 2008).

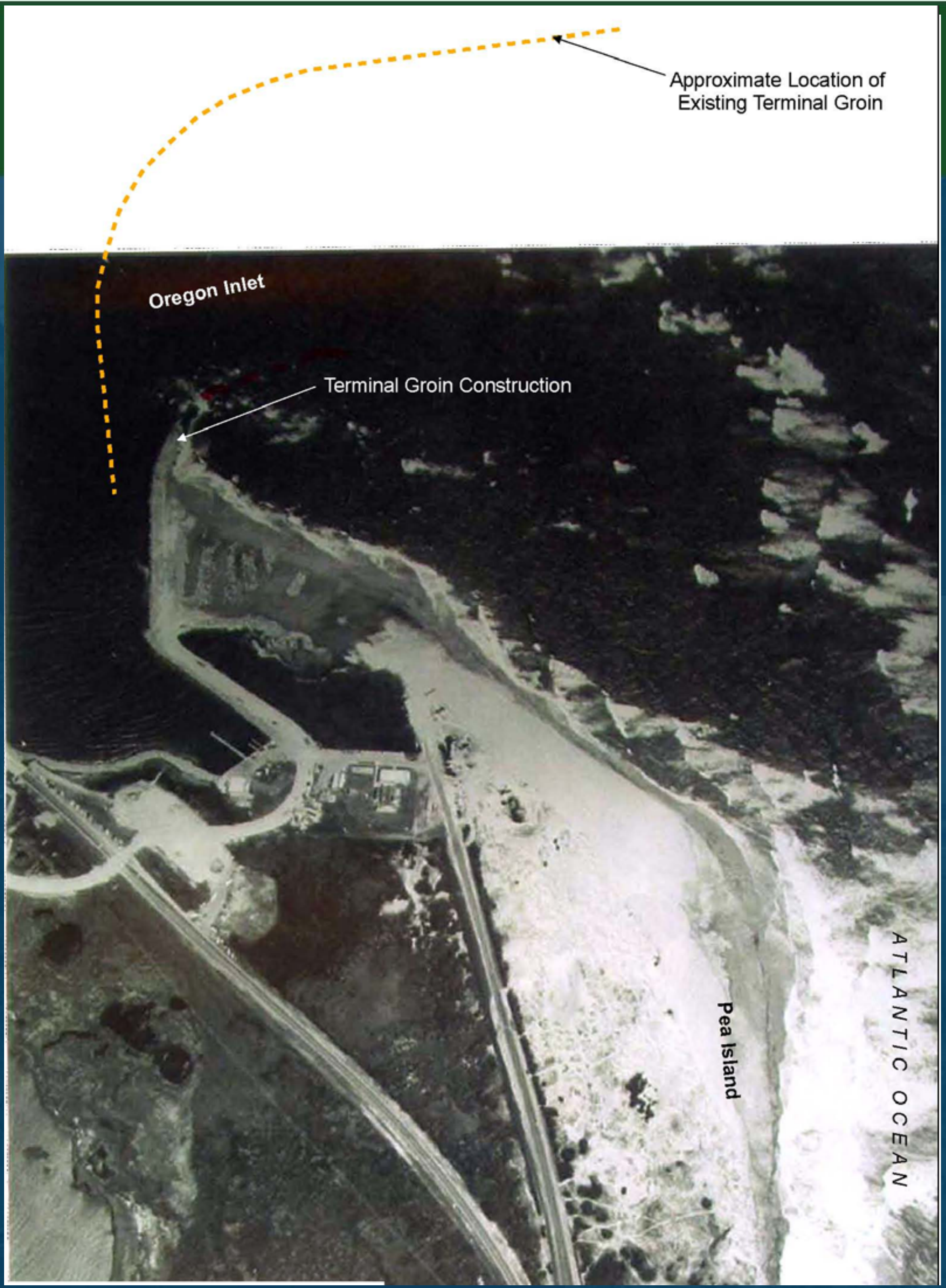
- The use of hard structures both parallel and perpendicular to the shoreline can lead to habitat loss for nesting sea turtles and according to USFWS (2008), the data on effects of groins on sea turtle mortality are insufficient to make a threat determination.

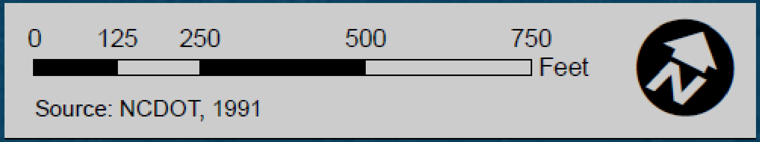
- In most cases, groins are used as design components in combination with beach fill, in “critical erosion” or hot spot areas. Therefore, pre-project nesting conditions are generally degraded with limited sea turtle crawl activity.

Pea Island

Habitat Change

- NCDOT 1991 – during groin construction
- NRCS 2009 – post-construction
- Combination depicting the evolution of the terminal groin fillet





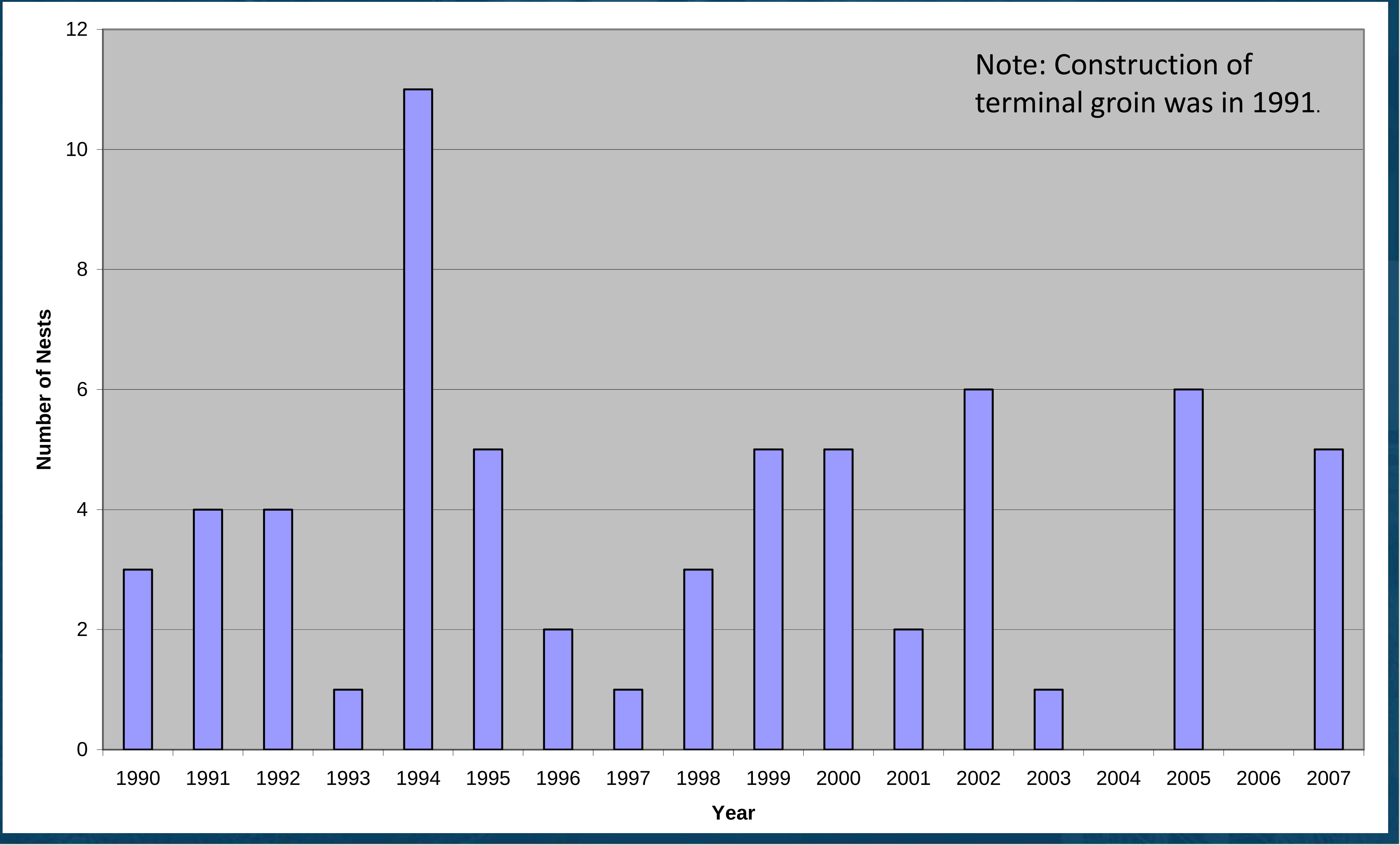
Pea Island

Seagrass Habitat

- Extensive SAV habitat exists (NOAA 2009)
- NOAA currently mapping study area to determine change in extent of SAV

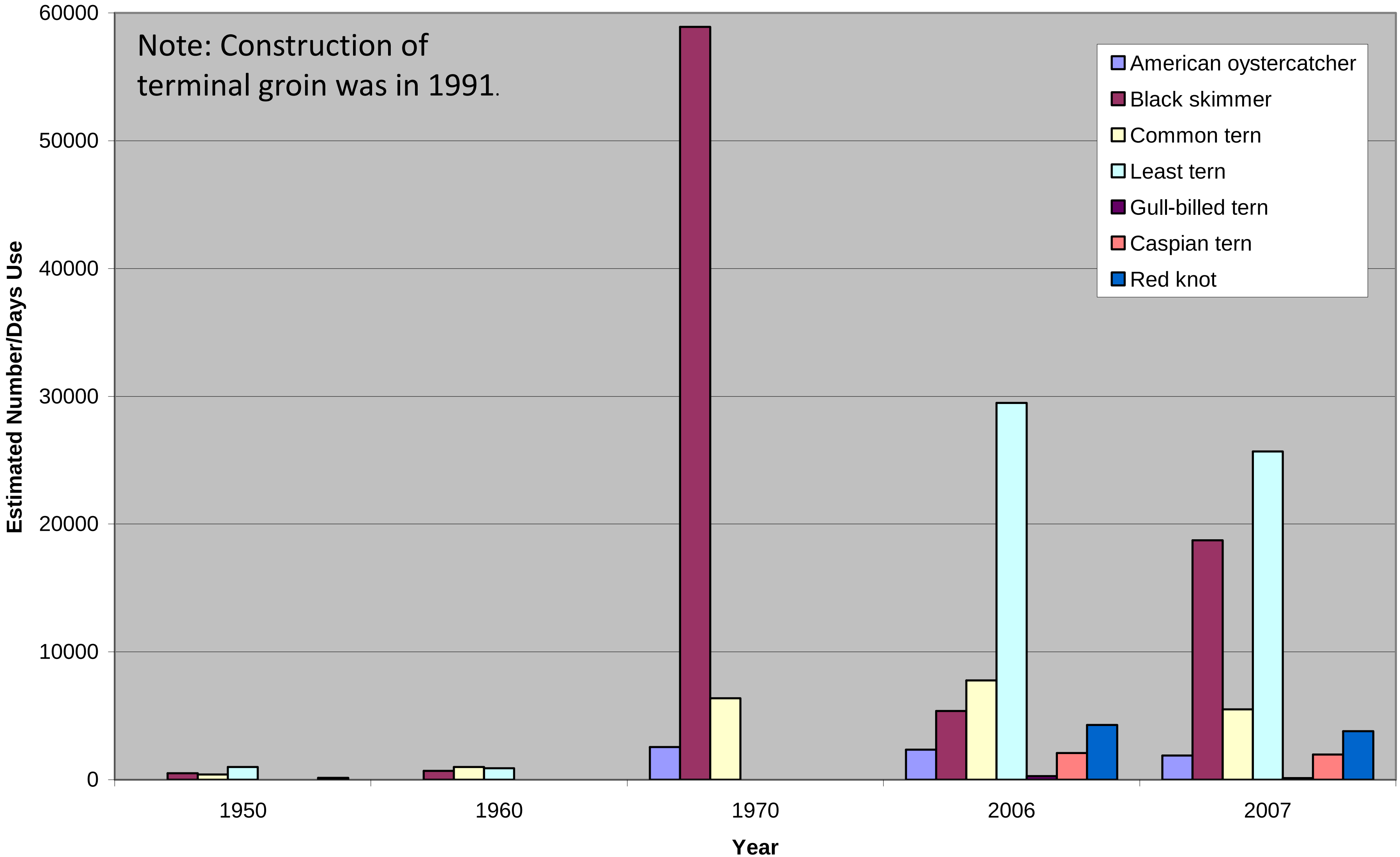
Pea Island

Loggerhead Sea Turtle Nesting Data from PINWR



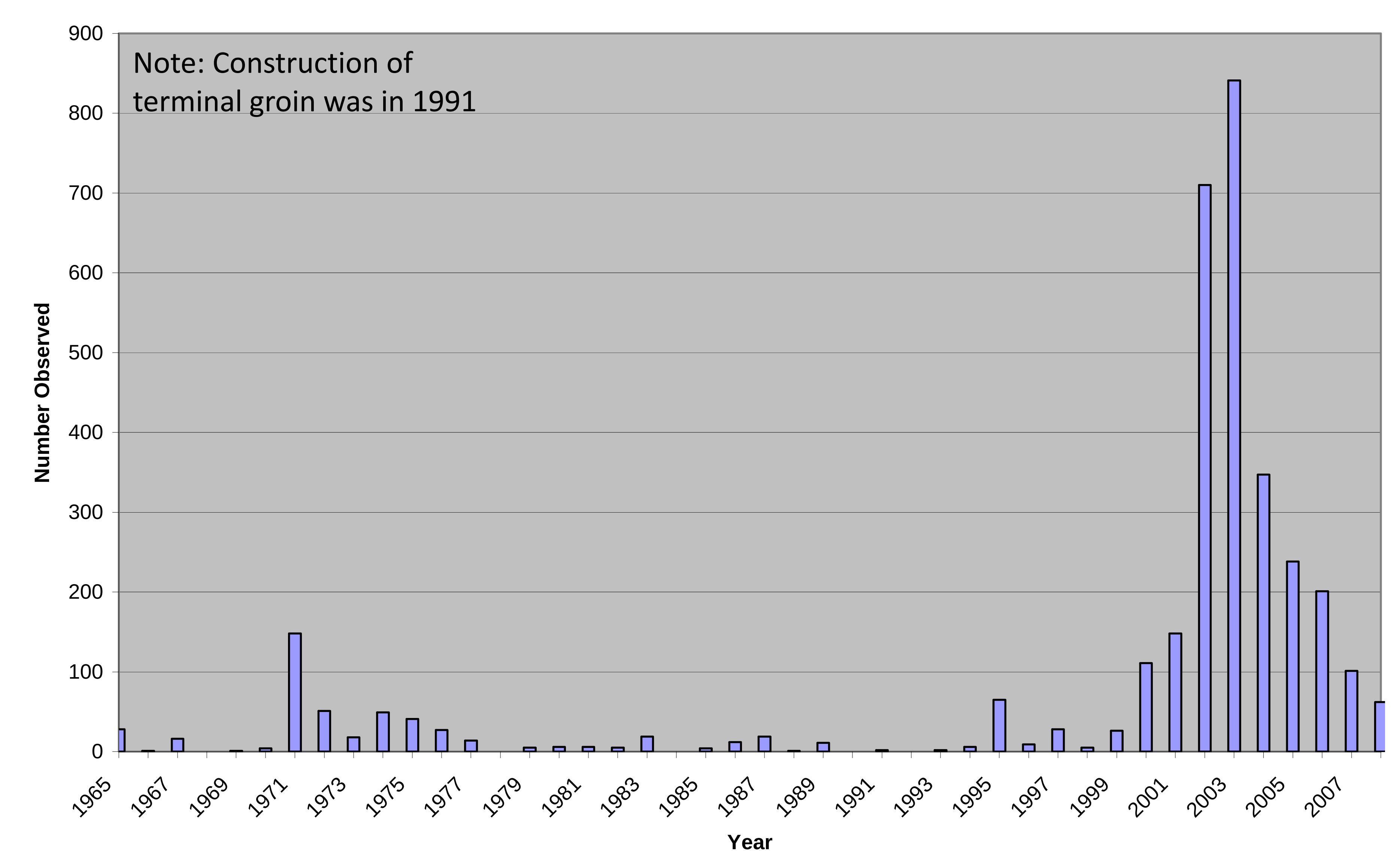
Pea Island

Shorebird Survey Data in the Vicinity of Oregon Inlet



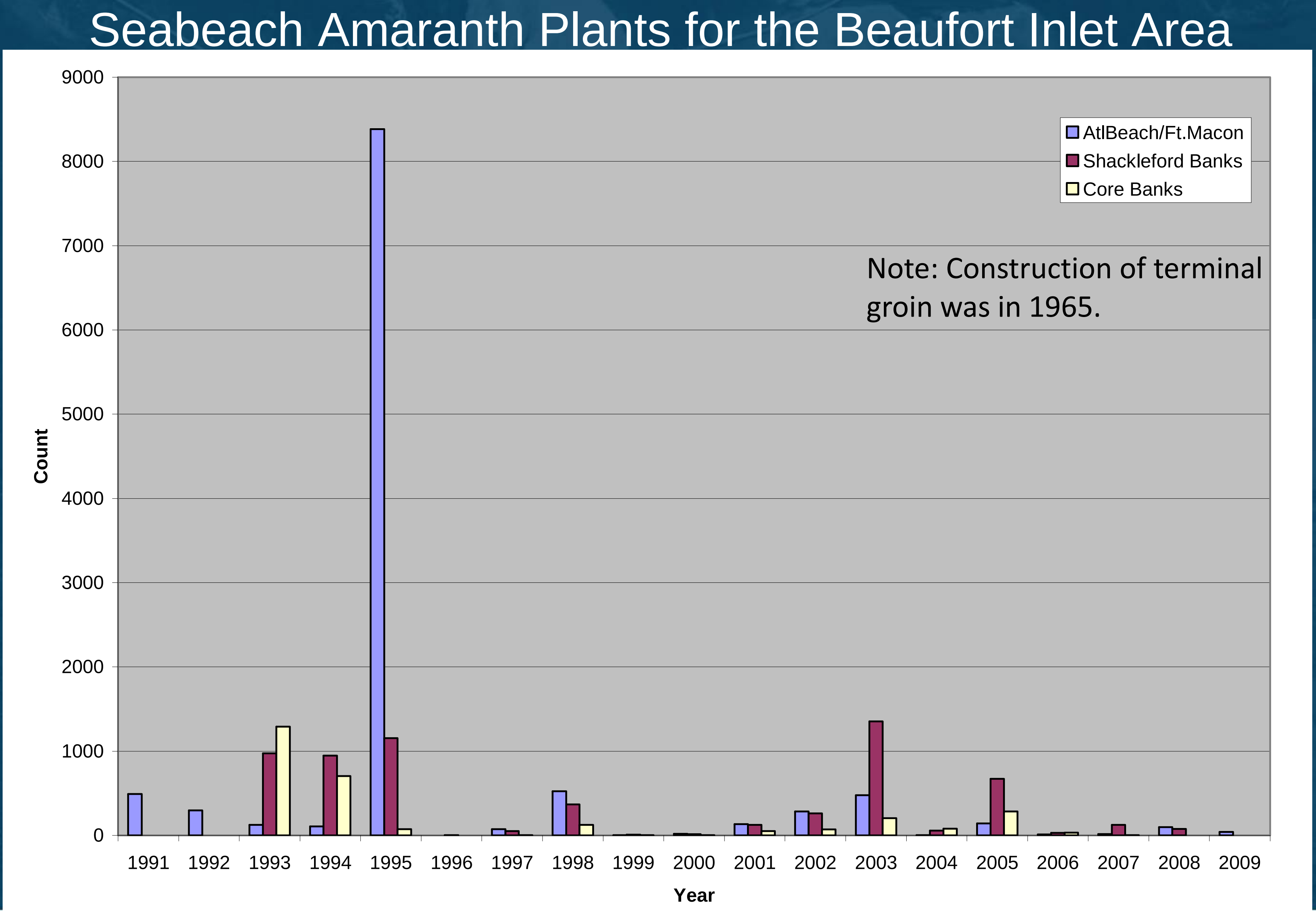
Pea Island

Annual Piping Plover Observations in the Vicinity of Oregon Inlet



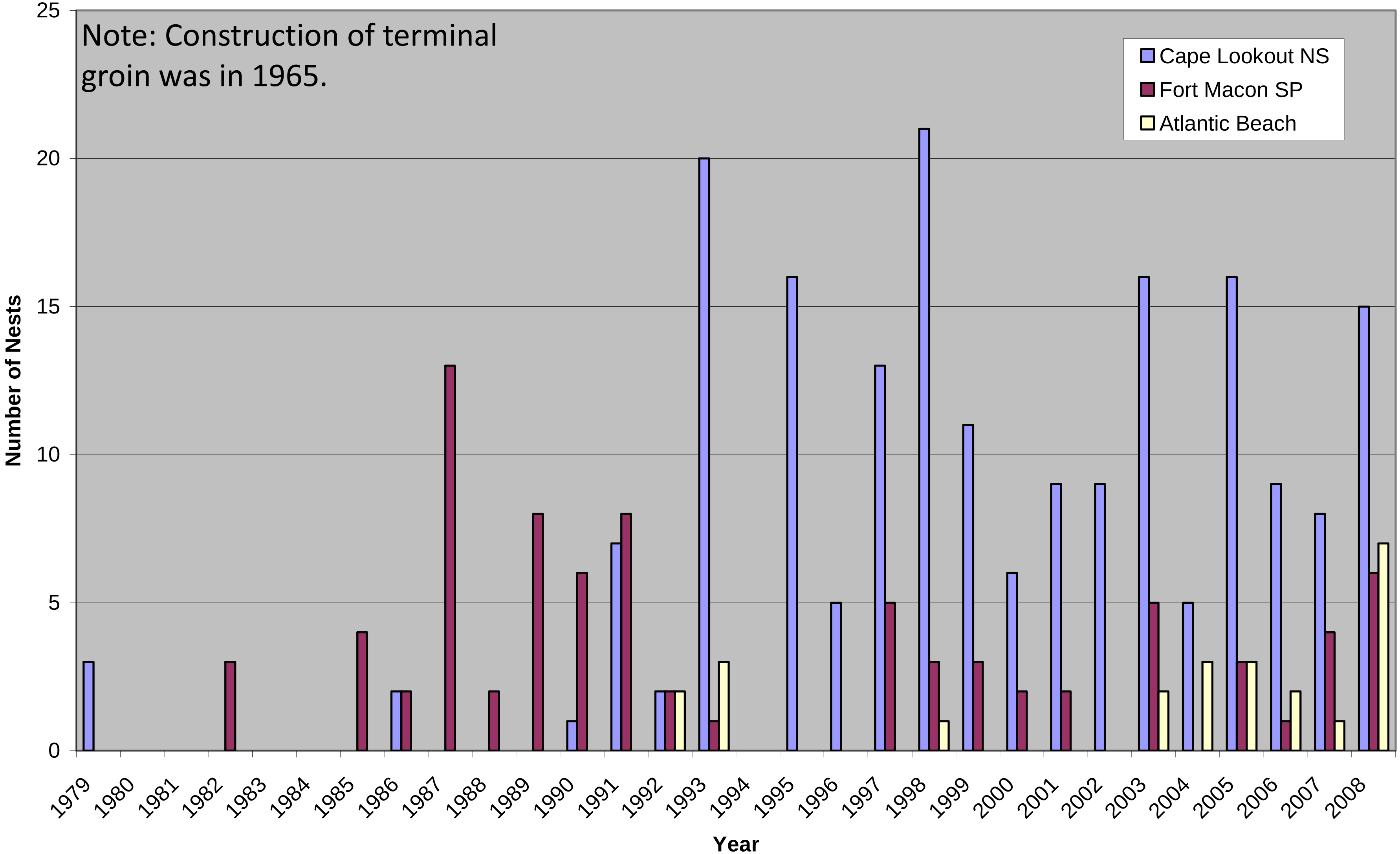
Fort Macon, Beaufort Inlet, North Carolina

Fort Macon


Seabeach Amaranth Plants for the Beaufort Inlet Area
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Count
AtlBeach/Ft.Macon
Shackleford Banks
Core Banks
Note: Construction of terminal groin was in 1965.
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Year

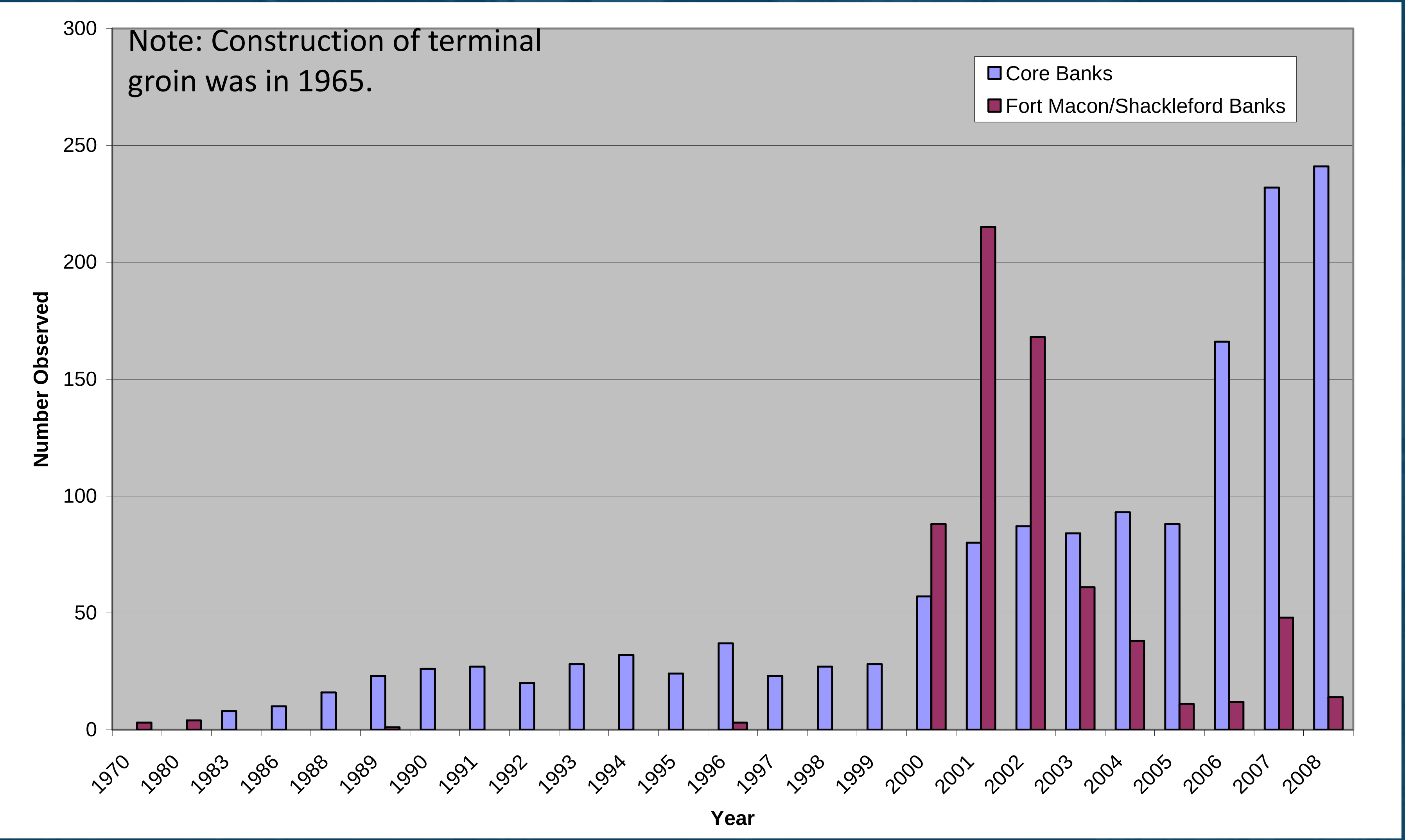
Fort Macon

Sea Turtle Nesting Activity for the Beaufort Inlet Area



Fort Macon

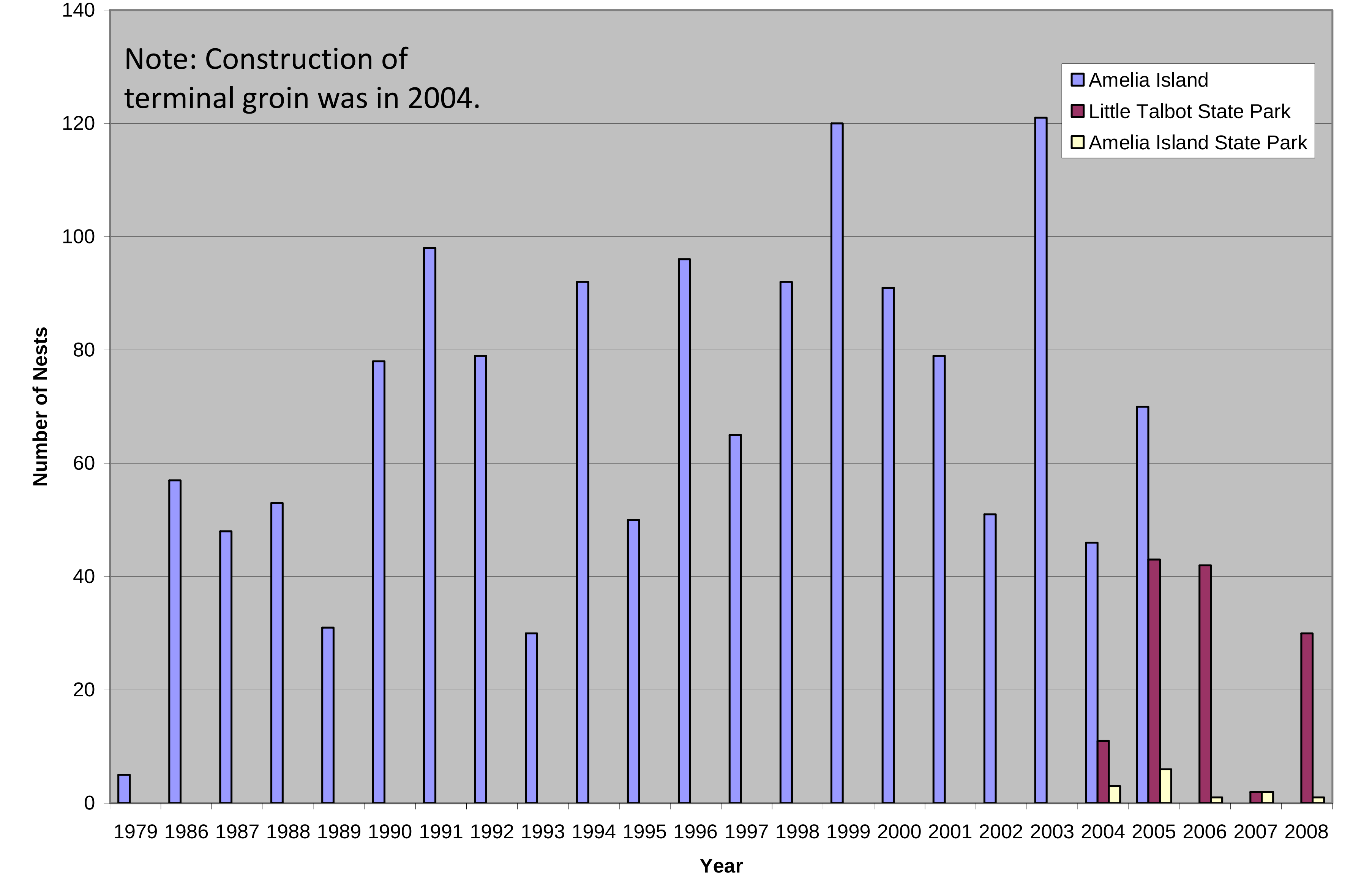
Annual Piping Plover Observations



South Amelia Island, Nassau Sound, Florida

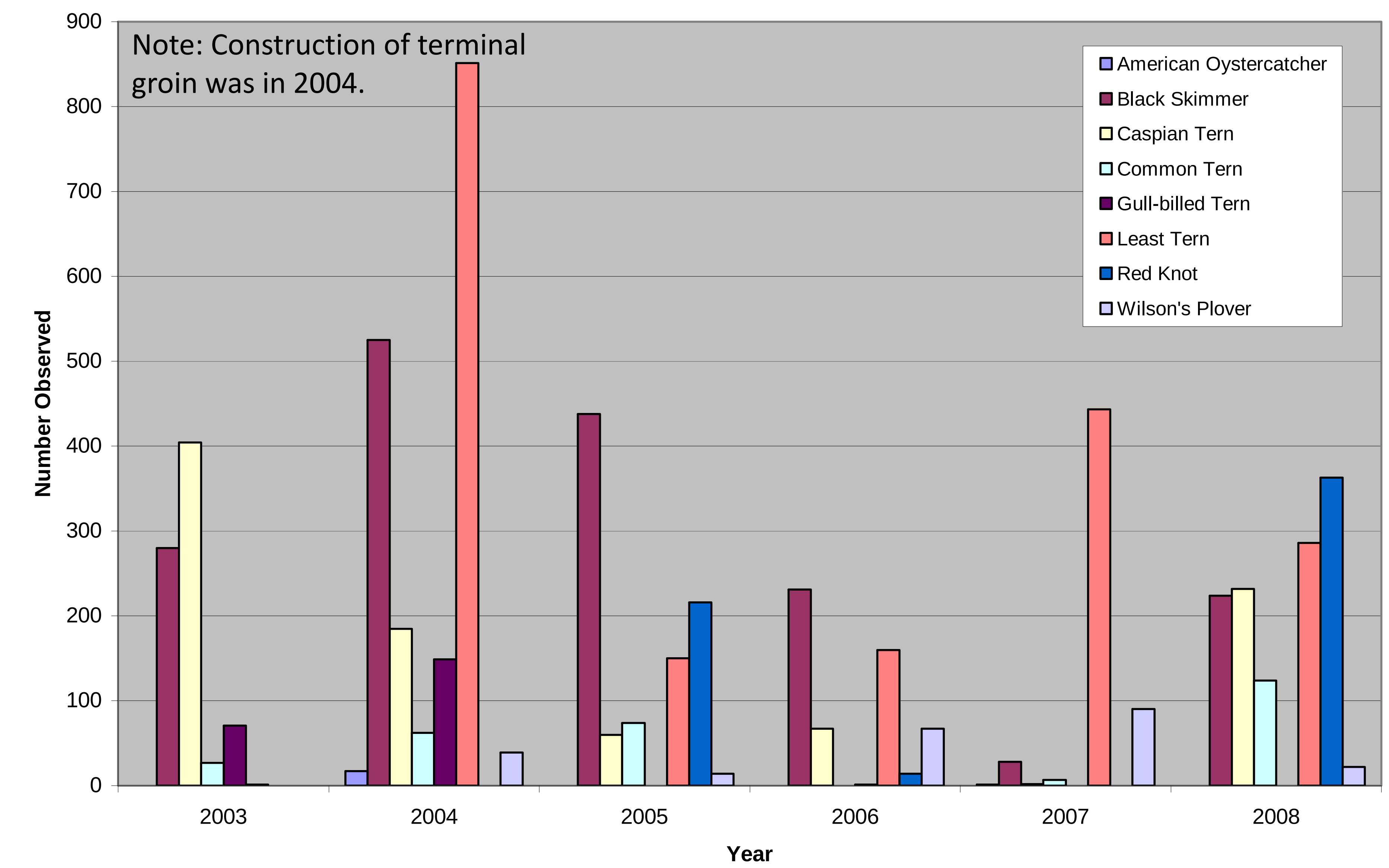
Amelia Island

Sea Turtle Nesting Data from Amelia Island and Little Talbot SP



Amelia Island

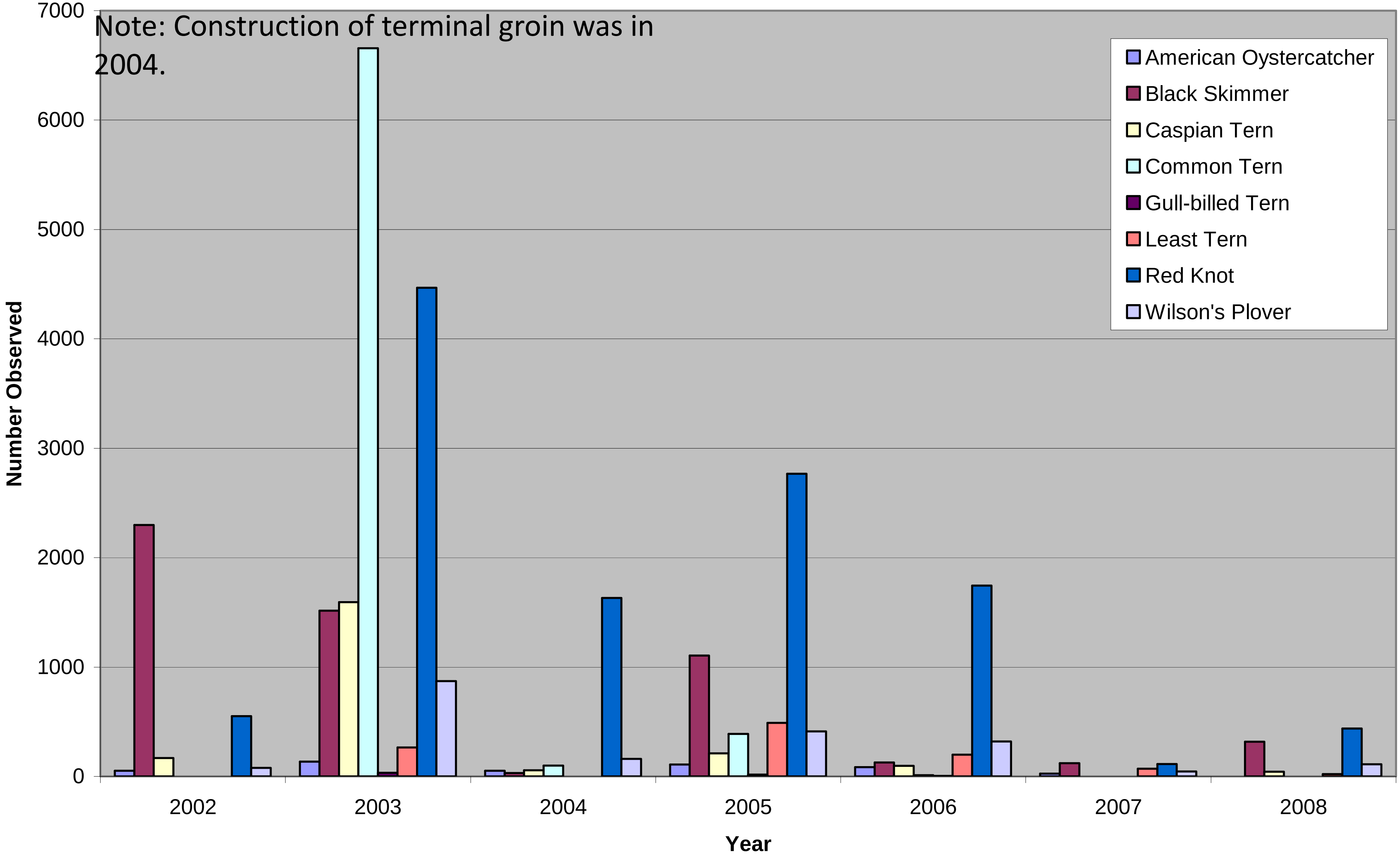
Amelia Island State Park Non-Nesting Shorebird Observations



Nassau Sound Islands
(Bird Islands)

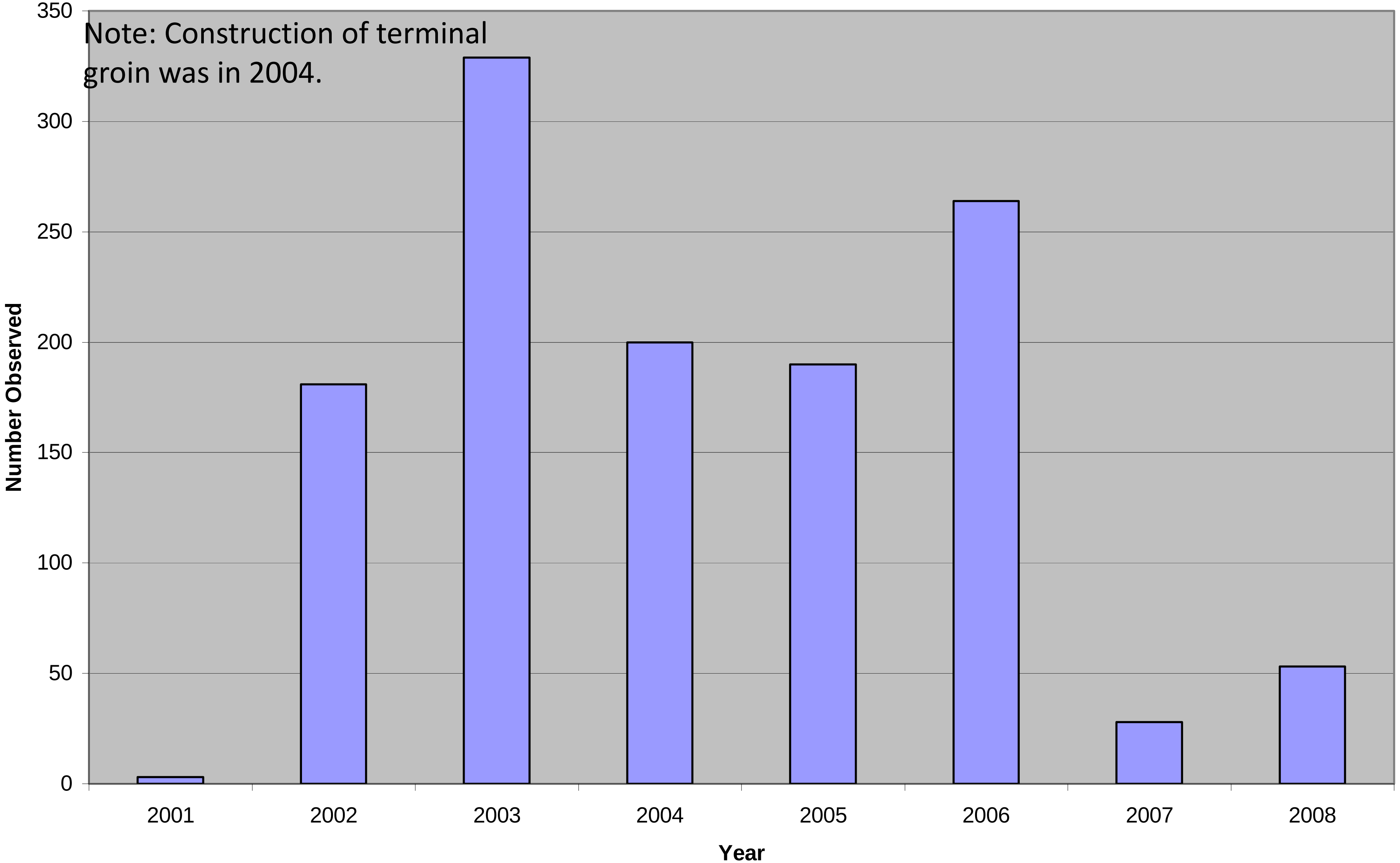
Amelia Island

Bird Islands Non-Nesting Shorebird Observations



Amelia Island

Piping Plover Observations for Nassau Sound



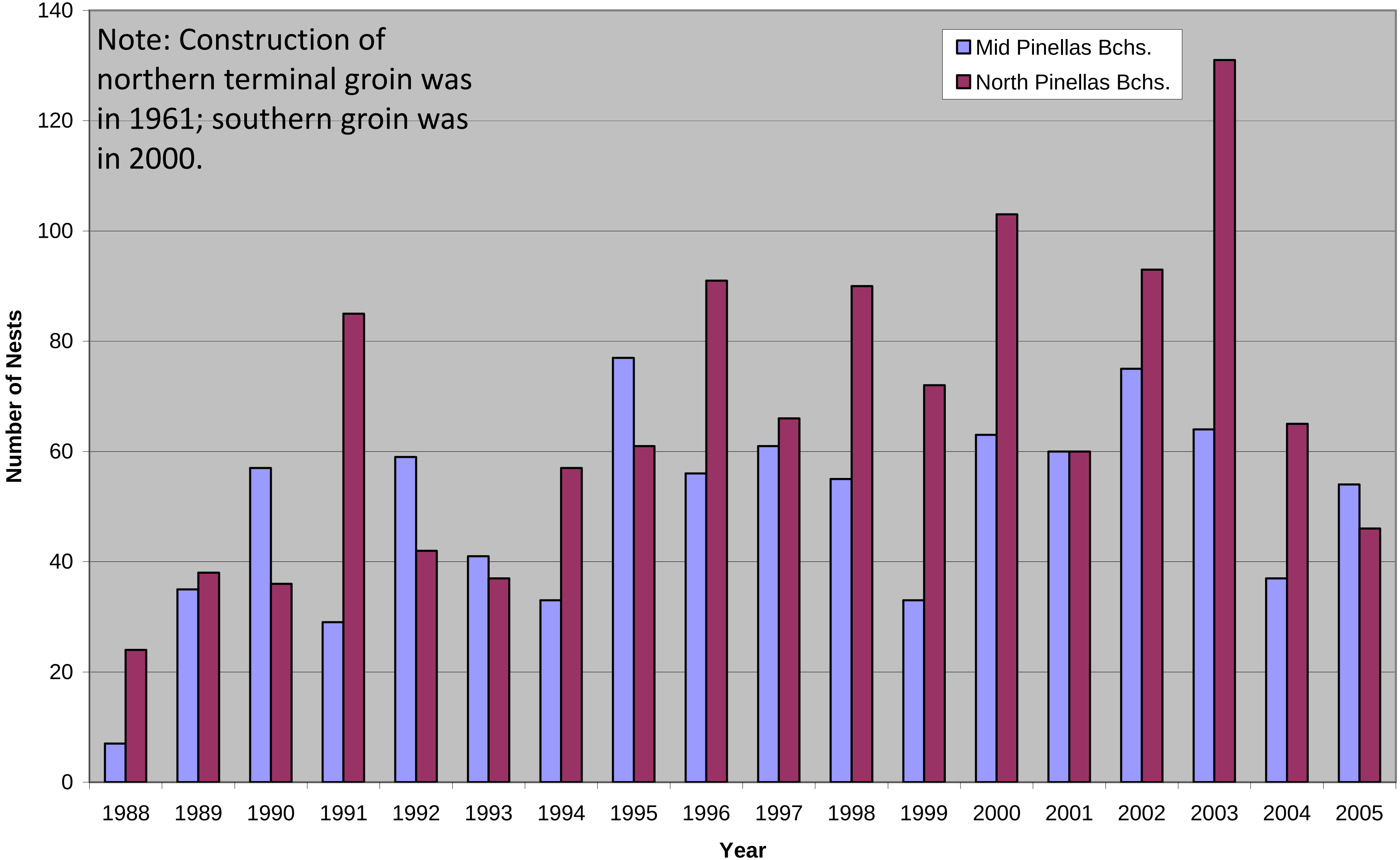
Treasure Island, John's Pass, Florida

November 1999

April 2002

John's Pass

Sea Turtle Nesting Data for Mid and North Pinellas Beaches



John’s Pass

Habitat Change for John’s Pass, FL from 1999 to 2006

Legend

John’s Pass SAV/Tidal Flats (SWFWMD, 2006)

Description

- Tidal Flats (43.3 ac.)
- Patchy (Discontinuous) Seagrass (308.3 ac.)
- Continuous Seagrass (404.4 ac.)

John’s Pass SAV/Tidal Flats (SWFWMD, 1999)

Description

- Tidal Flats (86.7 ac.)
- Patchy (Discontinuous) Seagrass (90.5 ac.)
- Continuous Seagrass (222.1 ac.)

Scale: 0, 500, 1,000, 2,000, 3,000, 4,000 Feet

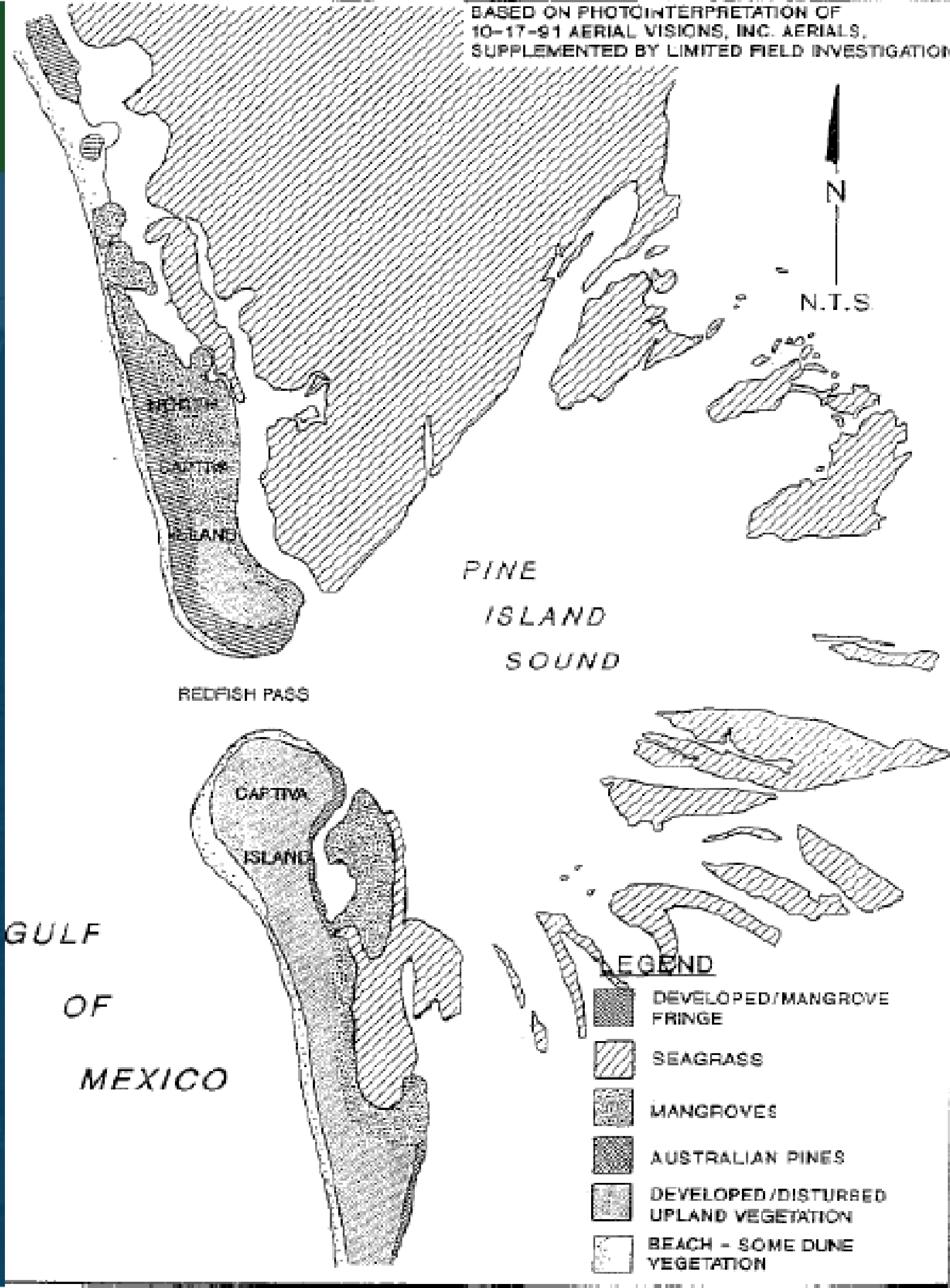
Source: Southwest Florida Water Management District, SWFWMD 2006
Seminole, FL Digital Ortho Quad, FDEP 1999

Redfish Pass, Captiva Island, Florida

Redfish Pass

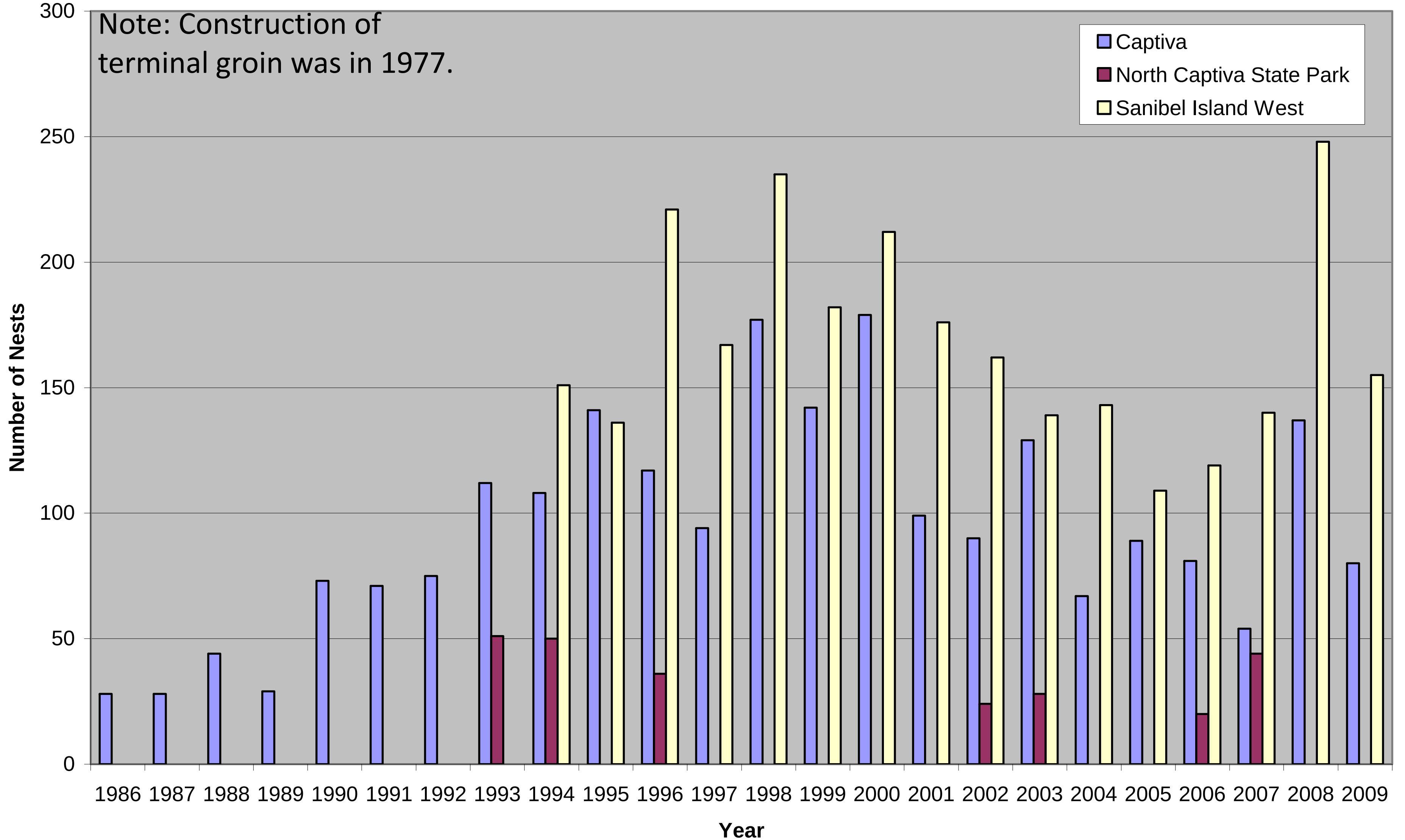
Seagrass and Mangrove Habitat

- NMFS considers these habitats as sensitive and are included as Essential Fish Habitat
- These habitats have remained relatively stable



Redfish Pass

Loggerhead Sea Turtle Nesting Data



Environmental Summary

- No new natural resource data were collected during this study;
- Existing secondary sources and raw data were collected to evaluate environmental affects;
- Available data were not directly related to construction of terminal groin; and
- Prior to construction and after construction data were only available for some sites and resources

Task 3 – Construction Techniques

<u>Legislative Language</u>

– The study shall consider "information regarding the engineering techniques used to construct terminal groins, including technological advances and techniques that minimize the impact on adjacent shorelines."

<u>Purpose</u>

– To examine the engineering techniques that are used to construct terminal groins with a focus on those techniques which may minimize probable shoreline impacts on adjacent shorelines.

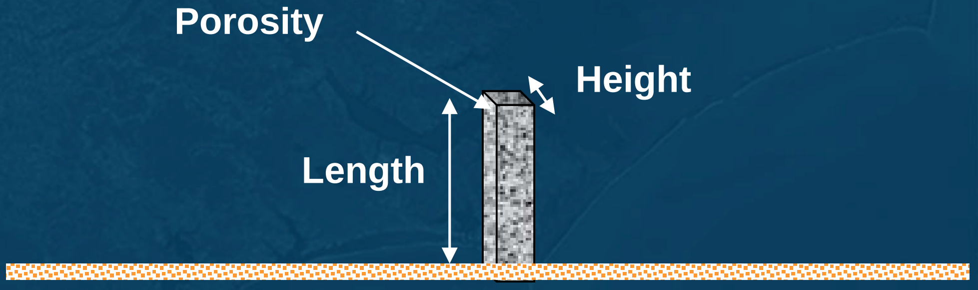
Task 3 – Construction Techniques

Method/Approach

– Literature Review of Techniques Used to Limit Impacts on Adjacent Shorelines:

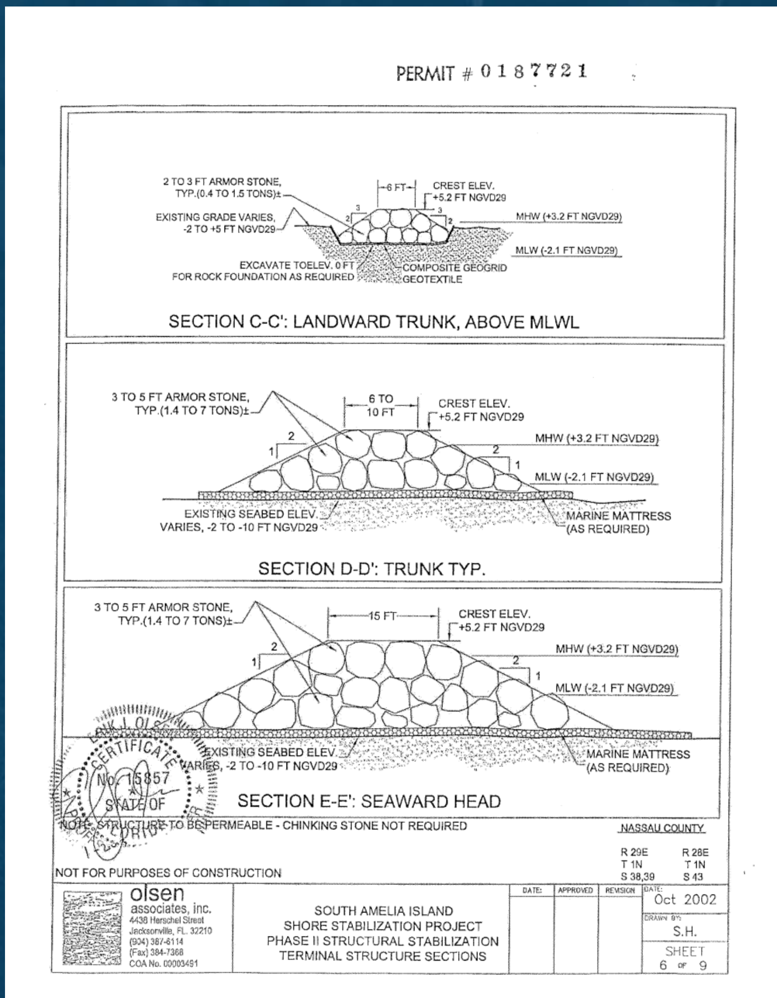
- Limits on Groin Height and Length
- Porosity of Structures (Sediment Transmission)
- Materials, etc.

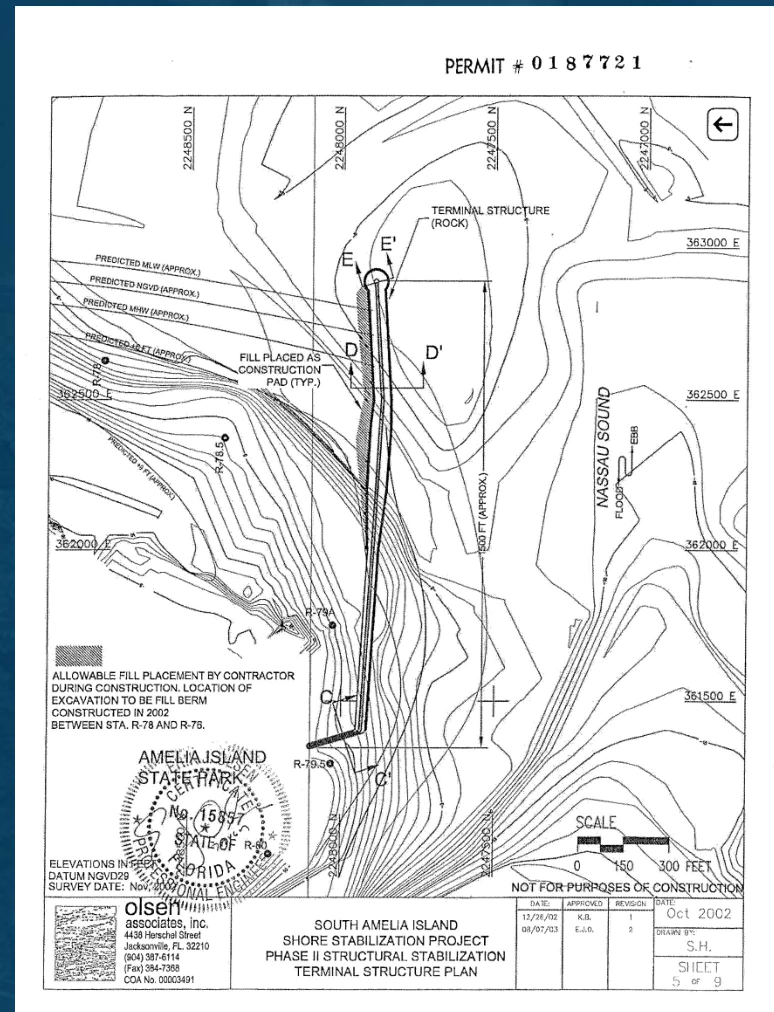
– Parametric Study Supplemented With Available Data On Site Performance



Task 3 – Construction Techniques

Amelia Island – Leaky Groin





Task 3 – Construction Techniques

<u>Preliminary Results</u>

- Groin Length
  - Should Be Just Long Enough To Retain The Required Beach Width Without Causing An Undue Reduction In Sediment Transport To Downdrift Beaches
  - Longshore Sediment Transport Is Dependant On The Groin Length Relative To Surf Zone Width
  - The Back Length Of The Groin Should Be Sufficiently Long As To Avoid Outflanking At The Upper End Of The Beach
- To Limit Effects, Groin Height Should Be Just Above The Beach Level.
  - Adjustments To Nourishment Volumes And Design Berm Heights May Need To Be Made Depending On Beach Behavior. Groin Height Should Consider Wave Overtopping And Determine The Desired Sediment Transport Over The Structure.
- Design Groin Permeability Has To Weigh The Disruption Of Sediment Transport With The Potential For Increased Dredging If The Structure Is Adjacent To A Navigation Channel. Permeable Groins Are Less Expensive From An Initial And Maintenance Cost Aspect Compared To Impermeable Structures.

Task 3 – Construction Techniques

Preliminary Results

- Groin Structure Shape Has Also Been Shown To Influence Sediment Transport With The Application Of Inclined And Notched Structures As Well As Various Planform Shapes (T-shaped, L-shaped, Dogleg, Etc.)
- Material Types Have Also Been Shown To Affect Sediment Transport Rates And Shoreline Behavior. Concrete, Steel, And Timber Sheeting And Pilings Allow For Adjustments In The Field And Well As Removal Of The Structures If Shown To Have An Unacceptable Adverse Impact.
- Currently Investigating Correlations With Five (5) Study Sites And Will Include In Draft Report

Task 5 – Initial Construction & Maintenance Costs

Legislative Language

– The study shall consider “information regarding the public and private monetary costs of the construction and maintenance of terminal groins.”

Purpose

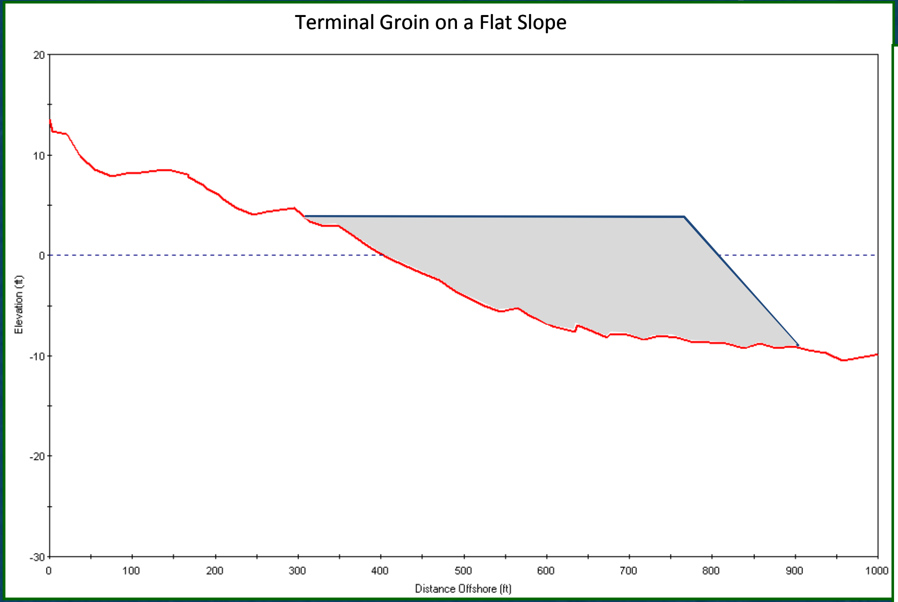
– To examine the potential initial construction and maintenance costs for terminal groin structures

Task 5 – Initial Construction & Maintenance Costs

Method/Approach

– Review Available Cost Data For Existing Terminal Groins Including Public and Private Costs

– Develop Ranges of Potential Costs Based on Typical Expected Terminal Groin Dimensions and Typical North Carolina Offshore Slopes



Task 5 – Initial Construction & Maintenance Costs

Preliminary Results

– Typical $/ft Costs (Depending on Structure Height and Section)
  - Rock - $1500 - $8500/ft
  - Steel and Concrete - $4000 - $6000/ft
  - Timber - $4000 - $5000/ft
  - Geotextile Tube - $250 - $1000/ft
– Check Of Unit Rates Against Amelia and Oregon Inlet
– Some Materials Not Suitable for Larger Structures in Deeper Water
– Annual Maintenance Costs – Between 5 -15% of Initial Cost
– Beach Nourishment Costs Should Also Be Included – May Range Between $250k - $750k Annually

Task 5 – Initial Construction & Maintenance Costs

Preliminary Results – Short Groin

Scenario 1 – Short Groin (~450 ft long; Crest Elev 4 ft above MLW)

Length	450
Height	12
- Rubble Mound (small stone)	
Unit Cost	$1950/LF
Total Cost	$880K
- Rubble Mound (large stone)	
Unit Cost	$2240/LF
Total Cost	$1.1M
- Geotextile Tubes	
Unit Cost	$350/LF
Total Cost	$160K
- Steel Sheet Piles w/ concrete fascia & cap	
Unit Cost	$4000/LF
Total Cost	$1.8M
- Concrete sheet piles (tied back)	
Unit Cost	$4600/LF
Total Cost	$2.1M
- Timber piles	
Unit Cost	$3900/LF
Total Cost	$1.8M

Task 5 – Initial Construction & Maintenance Costs

Preliminary Results – Long Groin

Scenario 2 – Long Groin (~1500 ft long; Crest Elev 4 ft above MLW)

Length	1500
Height	20.5
- Rubble Mound (small stone)	
Unit Cost	$3850/LF
Total Cost	$5.8M
- Rubble Mound (large stone)	
Unit Cost	$4375/LF
Total Cost	$6.6M
- Geotextile Tubes*	
Unit Cost	N/A
Total Cost	N/A
- Steel Sheet Piles w/ concrete fascia & cap	
Unit Cost	$4500/LF
Total Cost	$6.8M
- Concrete sheet piles (tied back)	
Unit Cost	$5000/LF
Total Cost	$7.5M
- Timber piles*	
Unit Cost	N/A
Total Cost	N/A

Task 6 – Potential Terminal Groin Locations

Legislative Language

- The study shall consider “whether the potential use of terminal groins should be limited to navigable, dredged inlet channels.”

Purpose

- To examine whether terminal groins should only be constructed at navigable, dredged inlet channels.

Task 6 – Potential Terminal Groin Locations

Method/Approach

- Literature Review of Existing Locations (Inlets – dredged, natural)
- Issues With Respect to Use at Navigable, Dredged Inlets vs. Non-dredged Inlets
- Inlet Behavior
- Assess And Comment On The Locations Of Terminal Groins With Respect To The Inlet Conditions As Well As The Geologic And Hydrodynamic Setting Of Each Of The Five Study Cases
- Based On The Findings From Task 1 Also Report The Impacts Of The Structures On Dredging Quantities And Downdrift Shoreline Behavior Depending On Level Of Inlet Management

Task 6 – Potential Terminal Groin Locations

Preliminary Results

- Most All Existing Terminal Groins Are Located Adjacent to Navigable, Dredged Inlets
- Geologic Setting, Sediment Budgets and Hydrodynamic Forcing Patterns Are Crucial Considerations to Siting and Potential Effects
- Relative Scale of Structure to Above Factors is Key to Future Behavior
- Inlet Behavior (Migrating vs. Oscillatory) Must Also Be Considered

Task 4 – Economic Study

Legislative Language

- The study shall consider "information regarding the current and projected economic impact to the State, local governments, and the private sector from erosion caused by shifting inlets, including loss of property, public infrastructure, and tax base."

Purpose

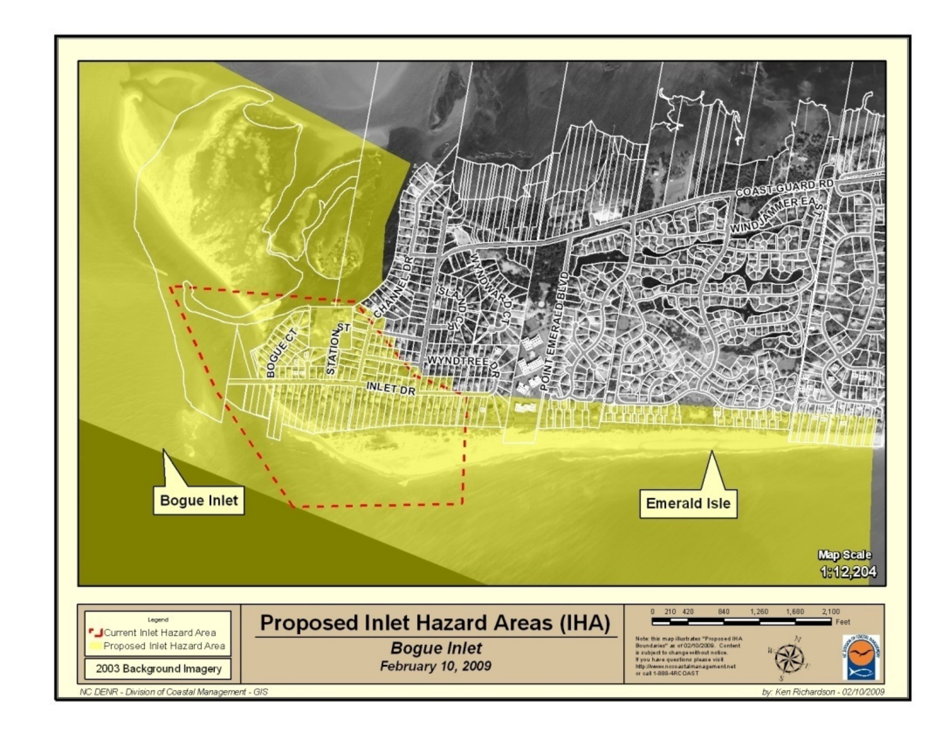
- To examine the potential economic impact to State, local, and private entities from erosion caused by shifting inlets.

Task 4 – Economic Study

Method/Approach

- Properties at Risk (Use Proposed Inlet Hazard Areas)
- Assemble Current Property Location and Value Data – Location (County Parcel Data) – Value (County Appraisals, NCDOT, Utility Companies)
- Identify Individual Properties At Risk Over 30-yr Period (Proposed Inlet “Risk Lines”) – “Baseline Condition”
- Identify Individual Properties At Risk with Terminal Groins In Place – “Project Condition”
- Assume The Average Change In Pre- Versus Post- Construction Erosion Rates For The Five Study Sites Will Be Equivalent To The Change In The 30-yr Risk Lines
- Assess Property Value Losses Under Each Case Including Property Loss, Diminished Market Value, Public Infrastructure, and Tax Base Losses

Task 4 – Economic Study



Task 4 – Economic Study

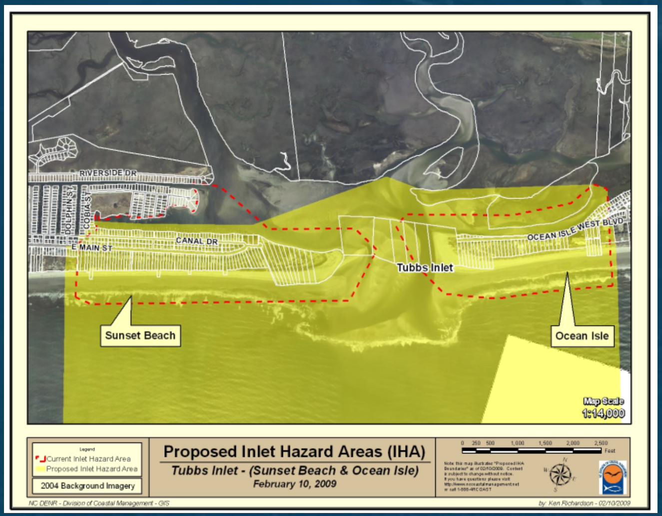
Preliminary Results

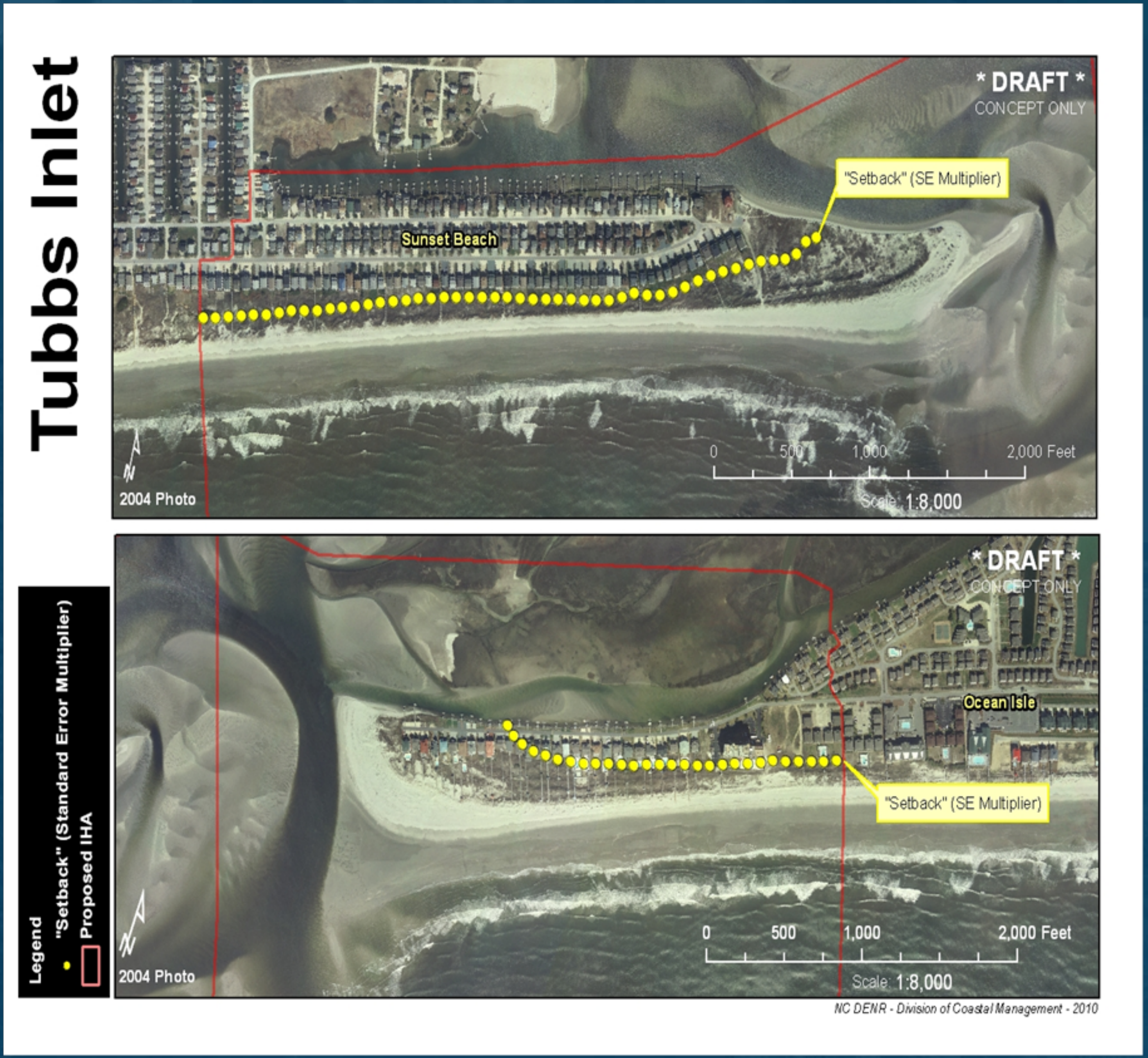
- Given That The Science Panel Must Approve Of The Methodology And The Use Of These New Risk Lines, The Only Calculations That Have Been Ongoing Are the Values Within The IHAs.
- For An Example, The Total Value Of Properties And Infrastructure Within ONE SIDE of An Unnamed Proposed IHA Within Brunswick County Is:

  - RESIDENTIAL PROPERTY LOSSES (Source: GIS Brunswick County, NC. http://gis.brunsco.net/)
    - 218 single family homes
    - Total Land Value: $188.08 million
    - Total Building Value: $42.09 million
    - Total Value other taxable improvements: $1.00 million Grand Total Value: **$231.18 million**
  - COMMERCIAL PROPERTY LOSSES (Source: GIS Brunswick County, NC. http://gis.brunsco.net/)
    - None.
  - GOVERNMENT/PUBLIC PROPERTY LOSSES (Source: GIS Brunswick County, NC. http://gis.brunsco.net/)
    - None.
  - ROAD INFRASTRUCTURE LOSSES (Source: NCDOT Construction Cost Estimates 2008)
    - 6885 ft. 2-lane road w. 2' paved shoulders (no curb, gutter, parking or sidewalk) @ avg. construction cost of $3 million/mile = **$3.91 million**
  - WATER LINE INFRASTRUCTURE LOSSES (Source: Cape Fear Public Utility Authority. January 2010.)
    - 6885 ft. water line @ ave. replacement cost $55/ft = **$379,000**
  - SEWER LINE INFRASTRUCTURE LOSSES (Source: Cape Fear Public Utility Authority. January 2010.)
    - 6885 ft. sewer line @ ave. replacement cost $150/ft = **$1.03 million**
  - ELECTRIC UTILITY INFRASTRUCTURE LOSSES
    - 6885 ft. electric utility lines/poles (cost to be determined)

Task 4 – Economic Study

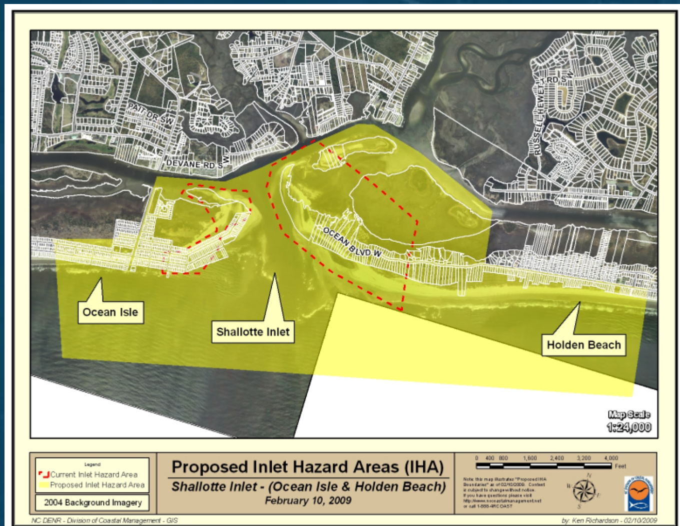
Tubbs Inlet





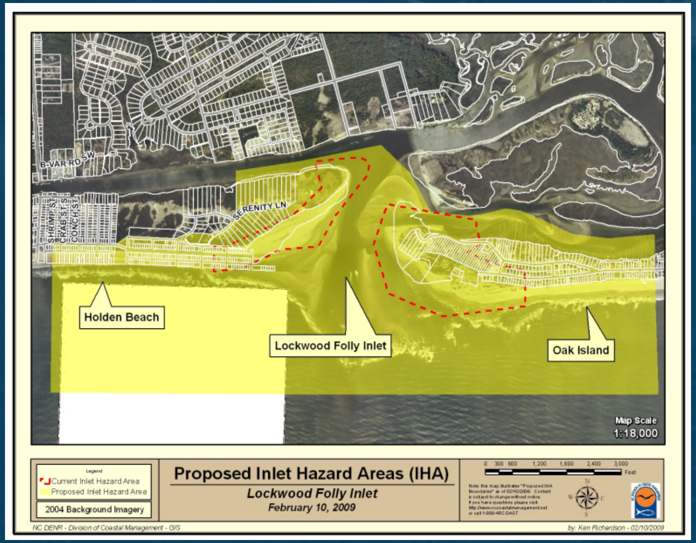
Task 4 – Economic Study

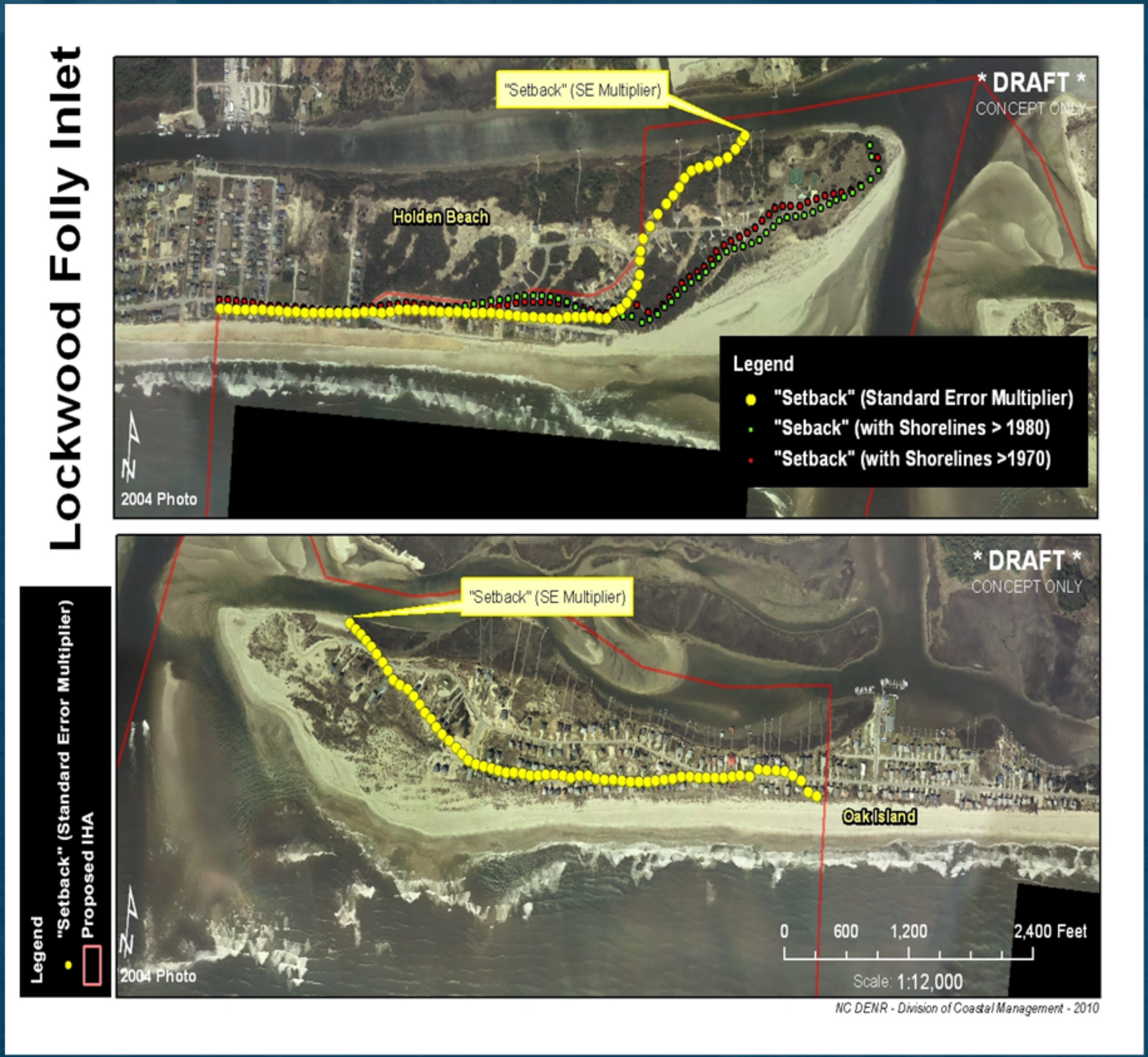
Shallotte Inlet



Task 4 – Economic Study

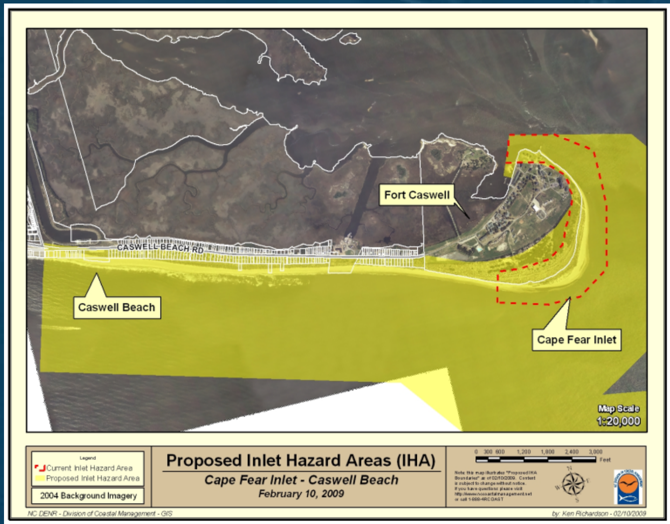
Lockwood Folly Inlet

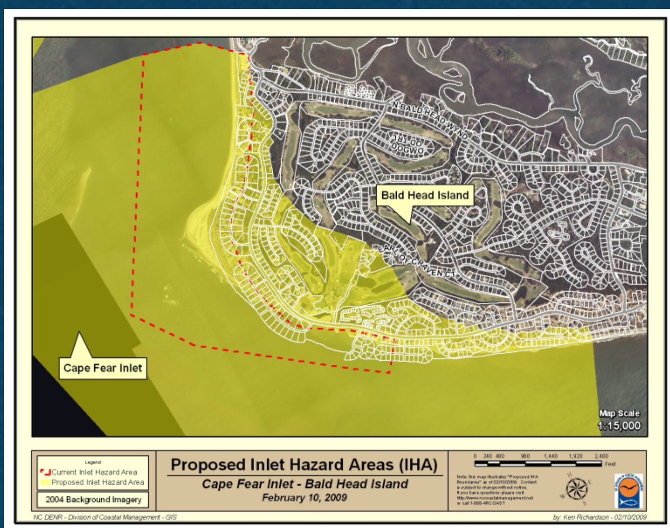


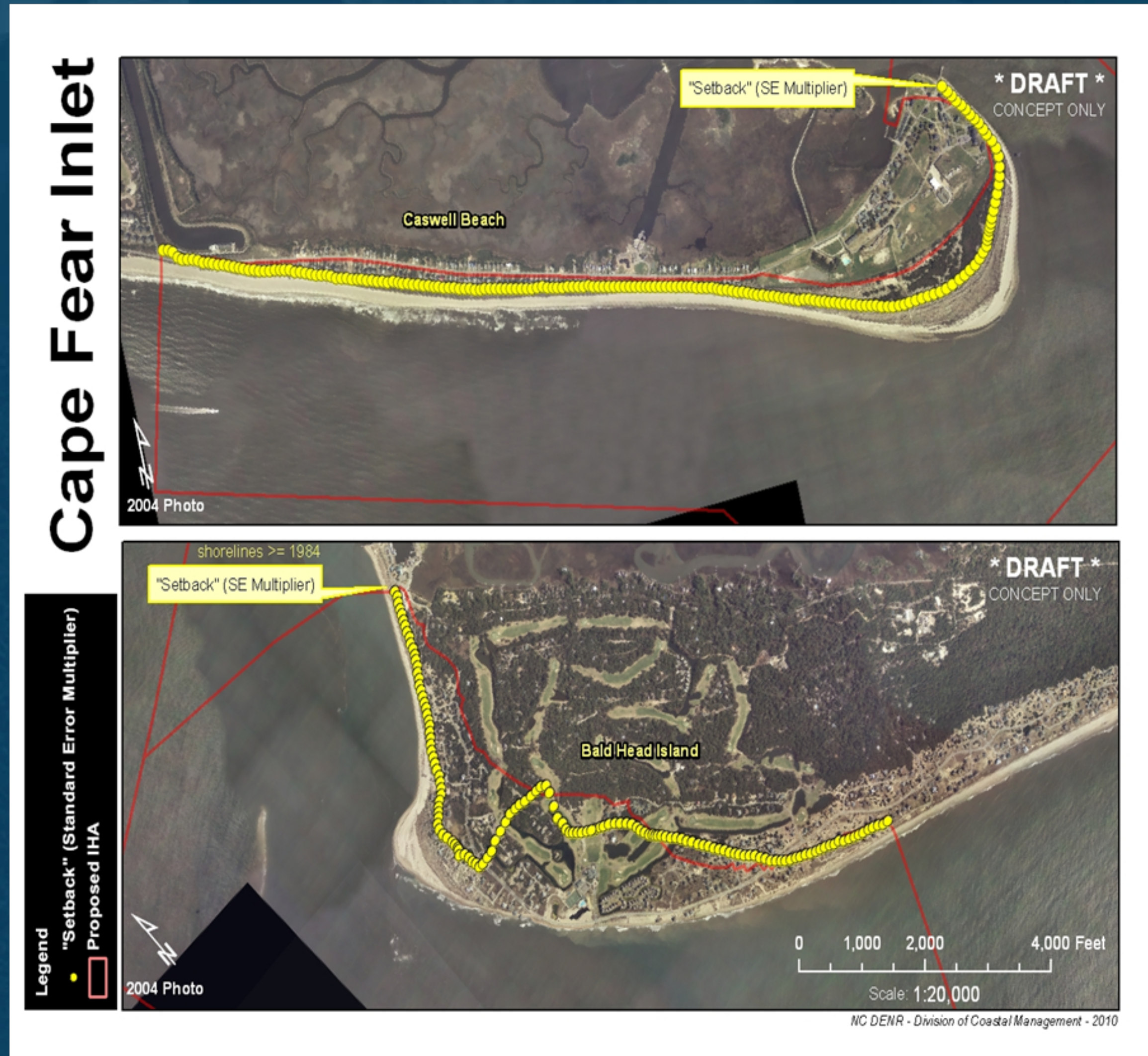


Task 4 – Economic Study

Cape Fear Inlet

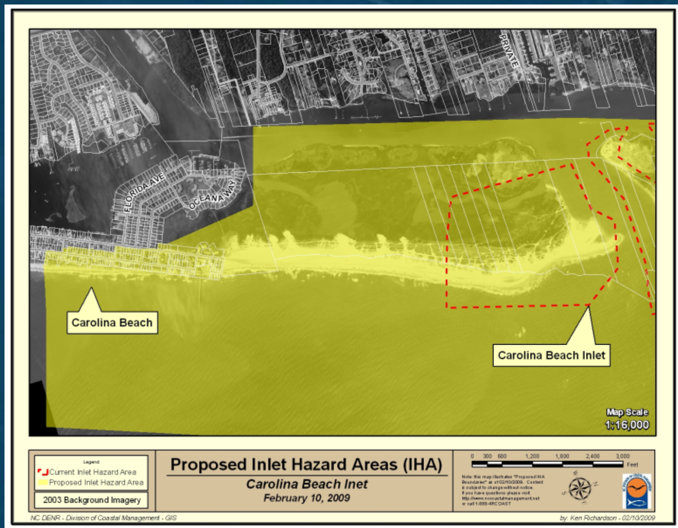


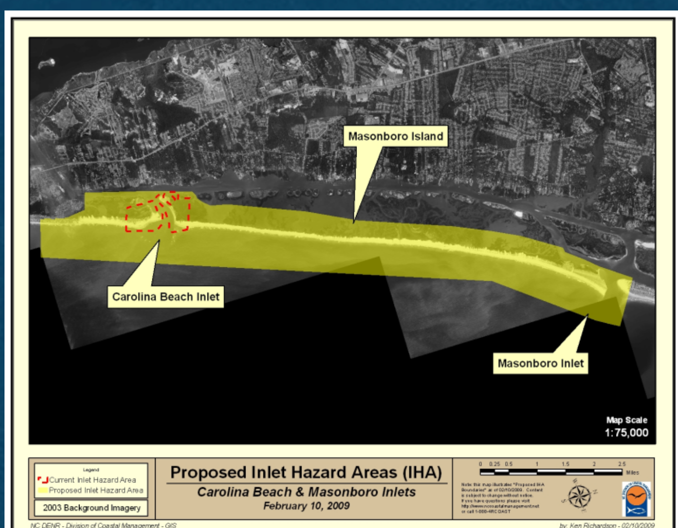


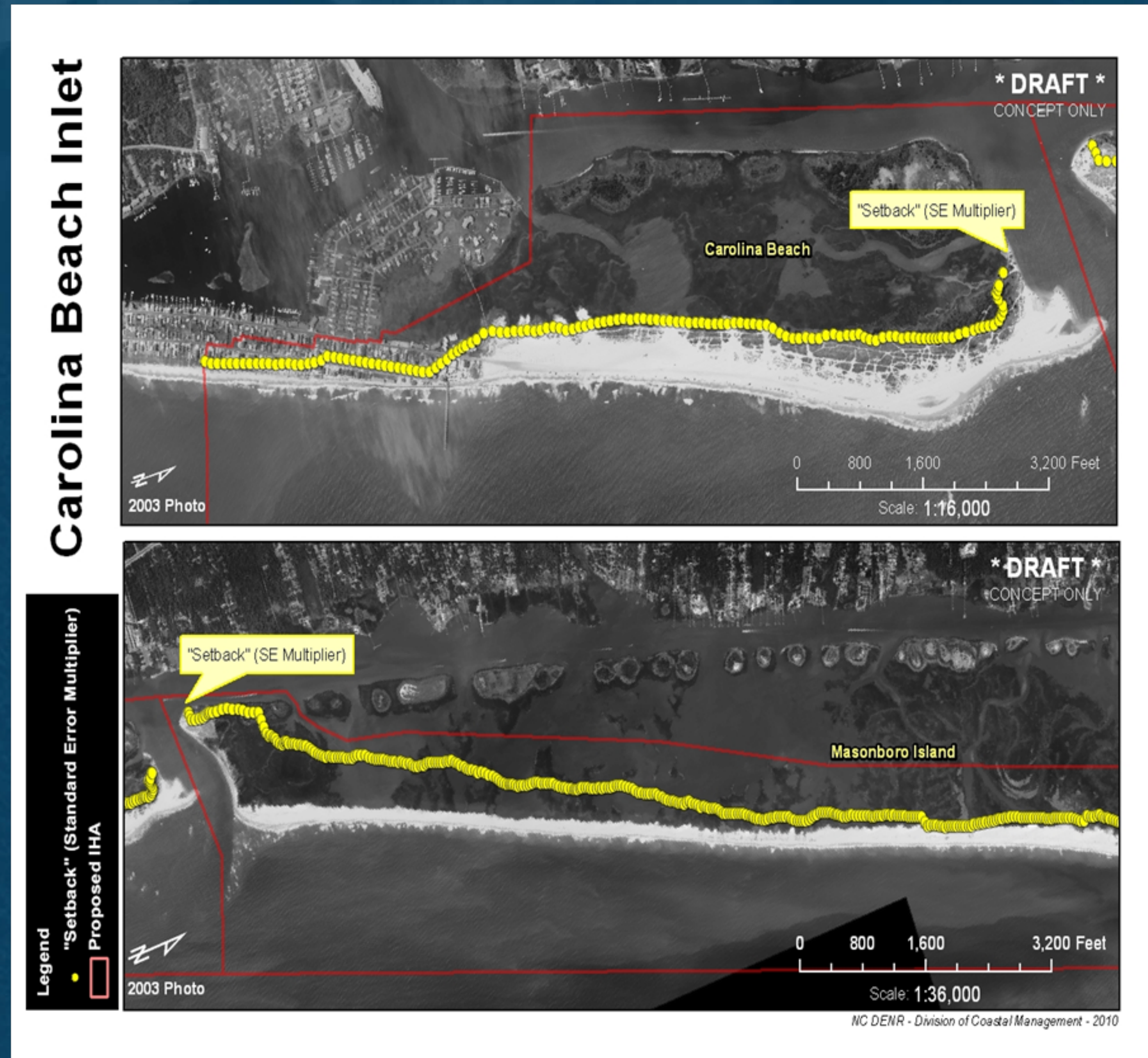


Task 4 – Economic Study

Carolina Beach Inlet

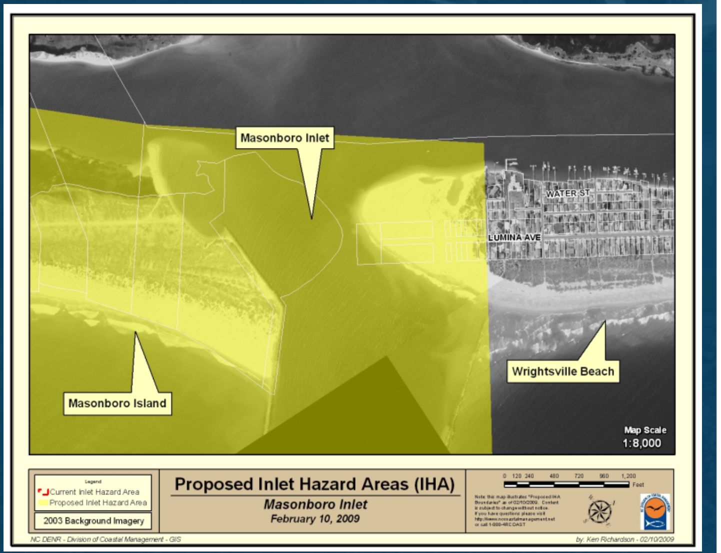


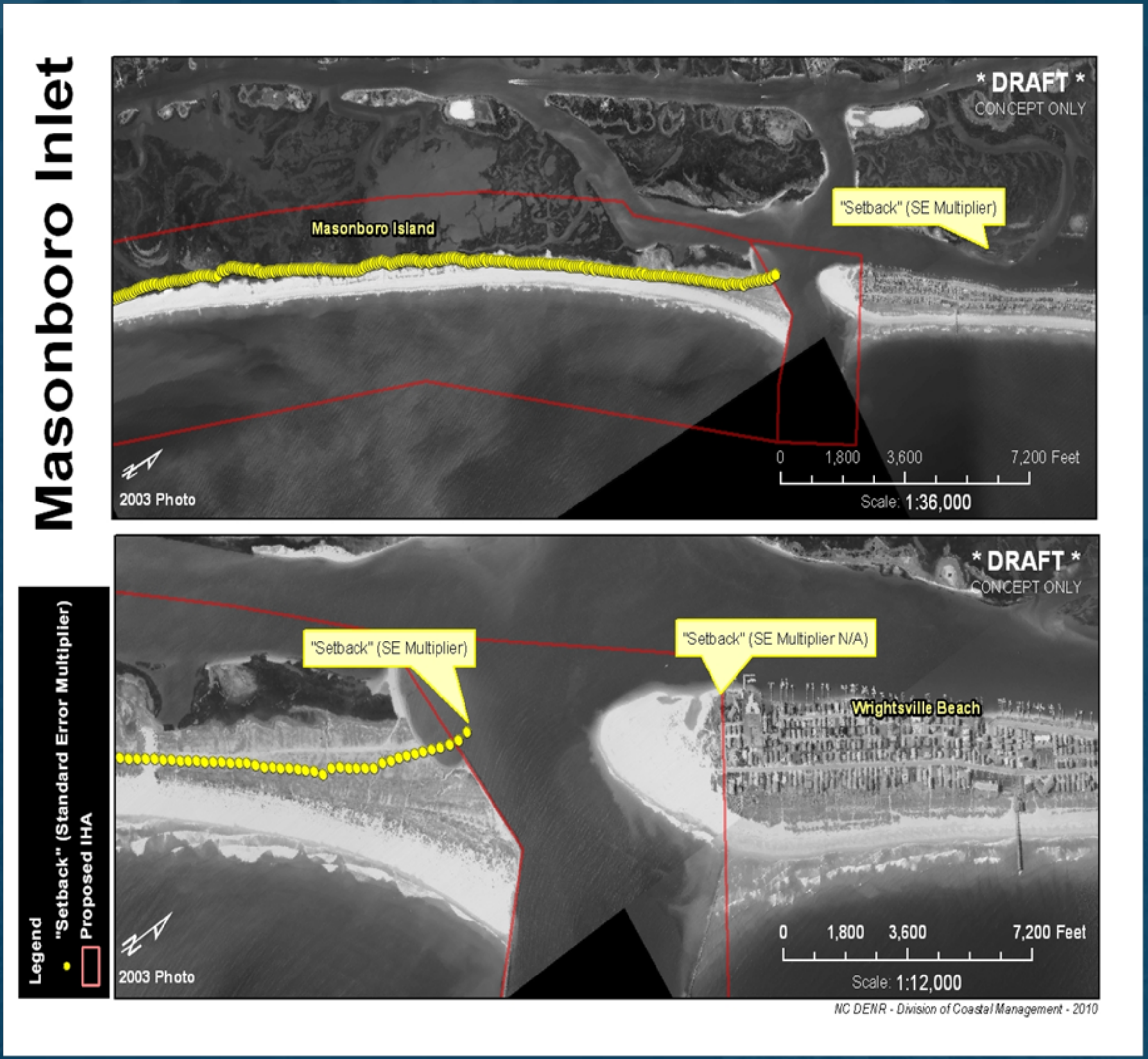




Task 4 – Economic Study

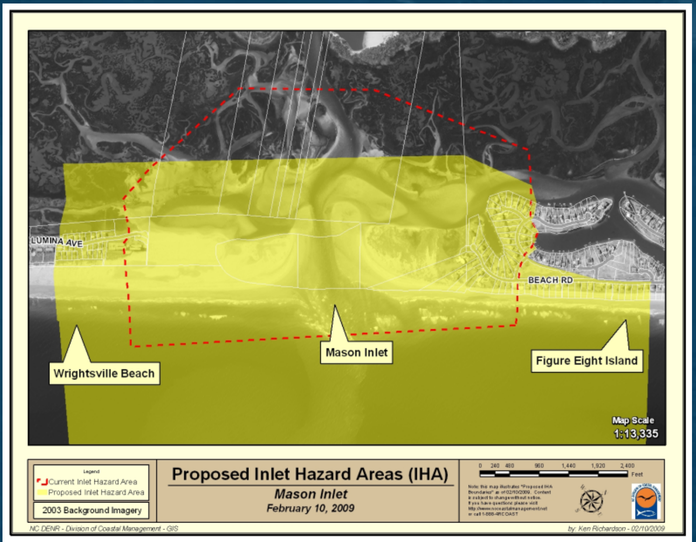
Masonboro Inlet

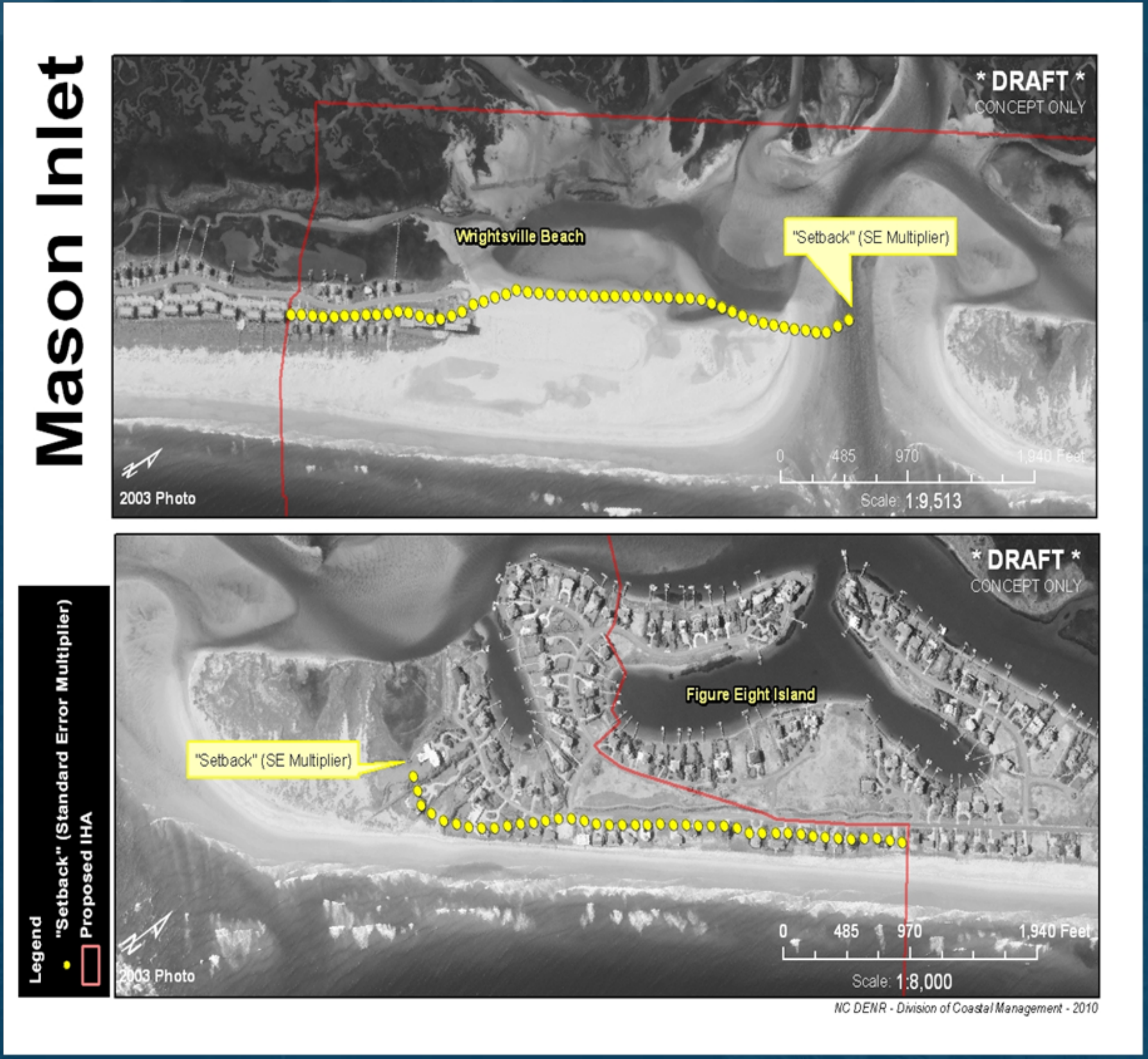




Task 4 – Economic Study

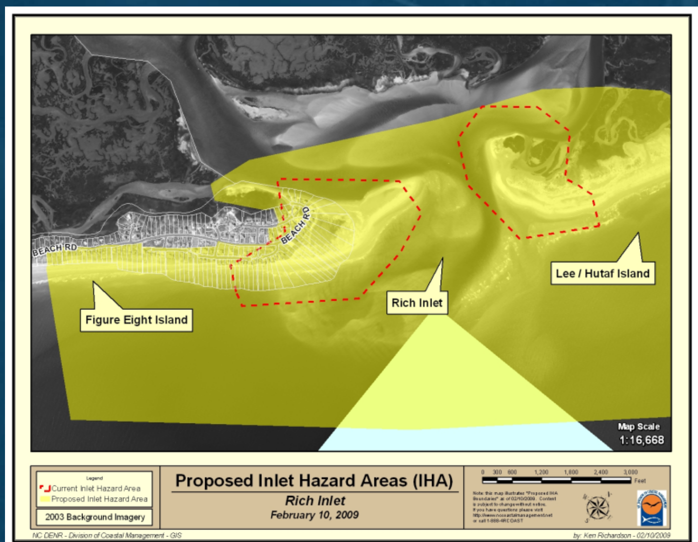
Mason Inlet

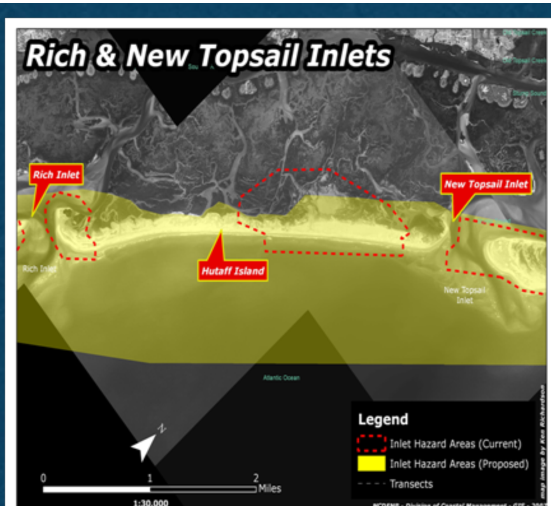


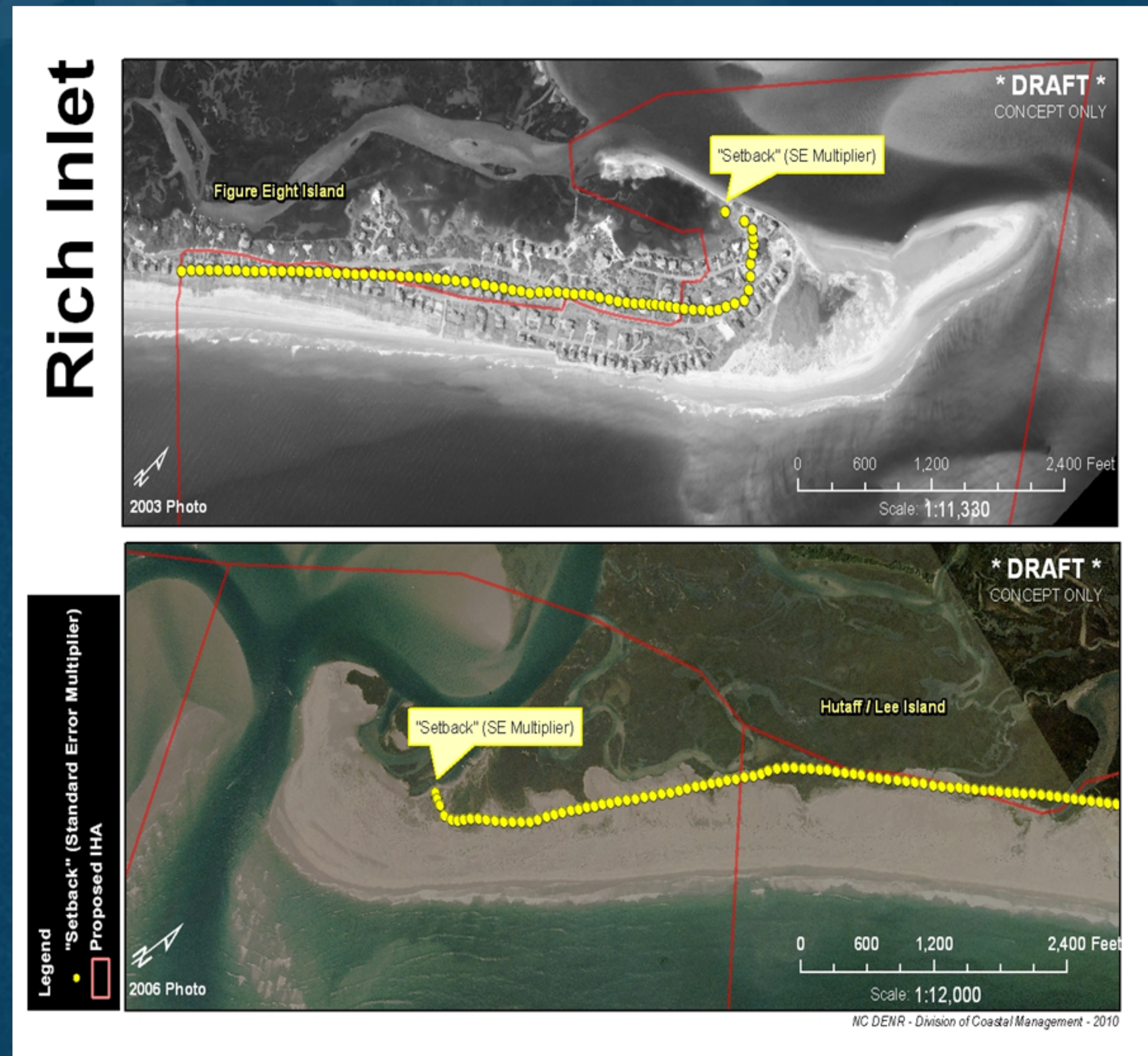


Task 4 – Economic Study

Rich Inlet

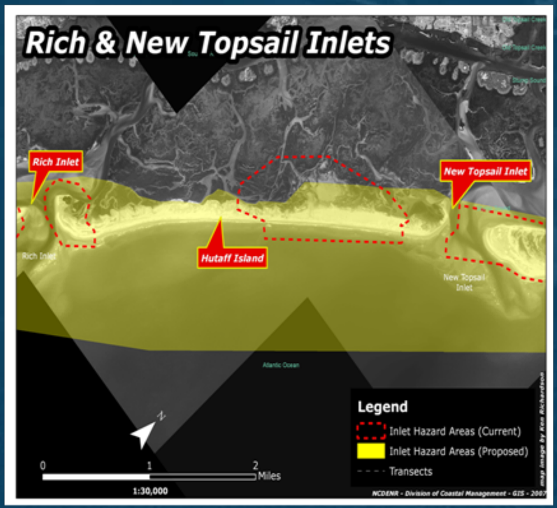


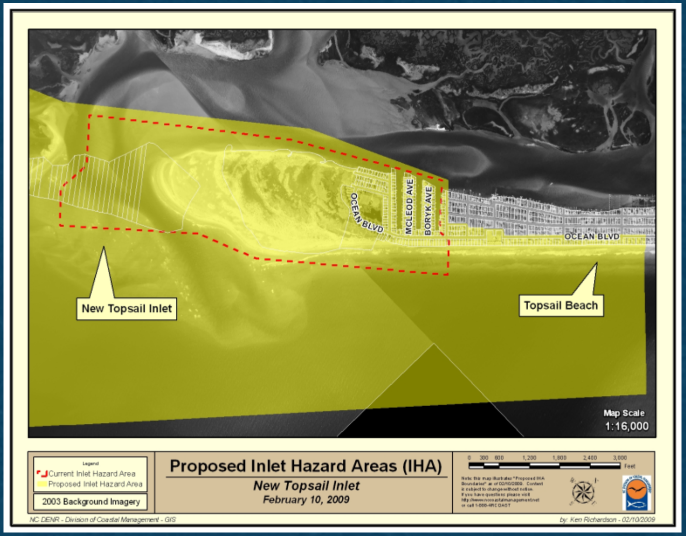


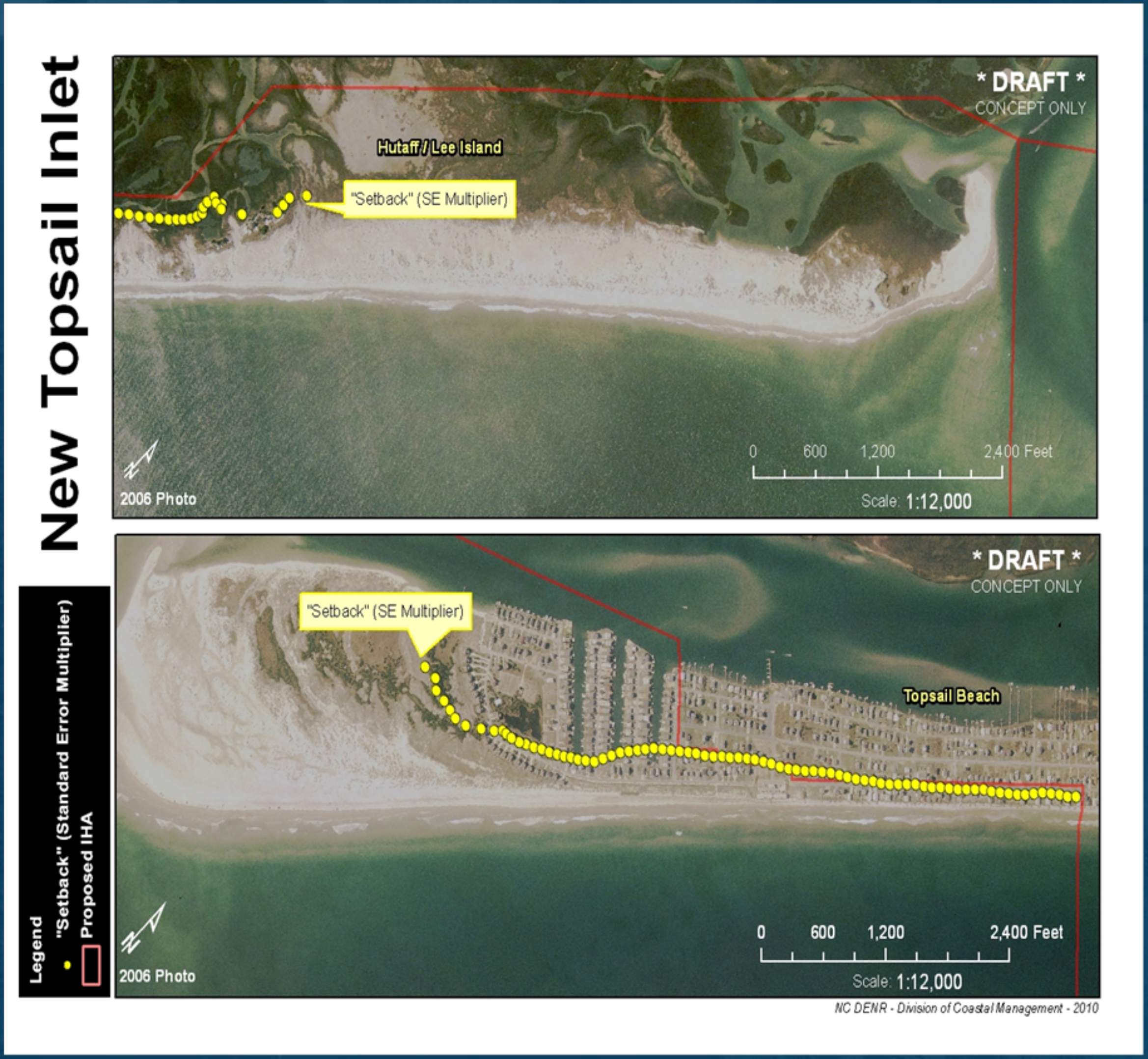


Task 4 – Economic Study

New Topsail Inlet

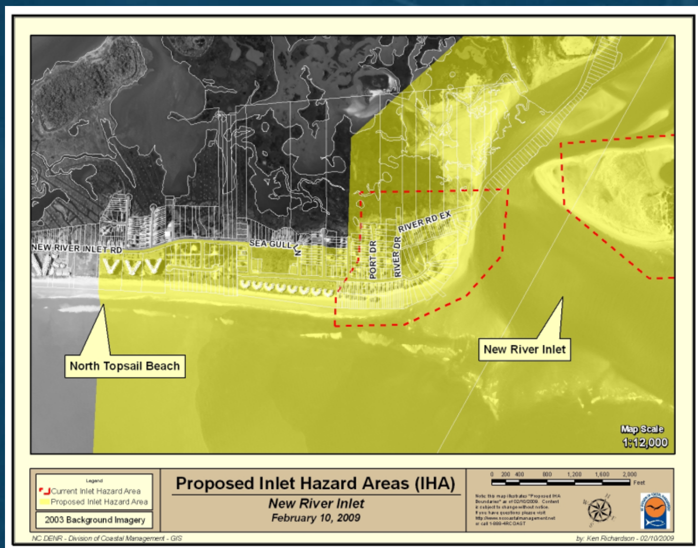


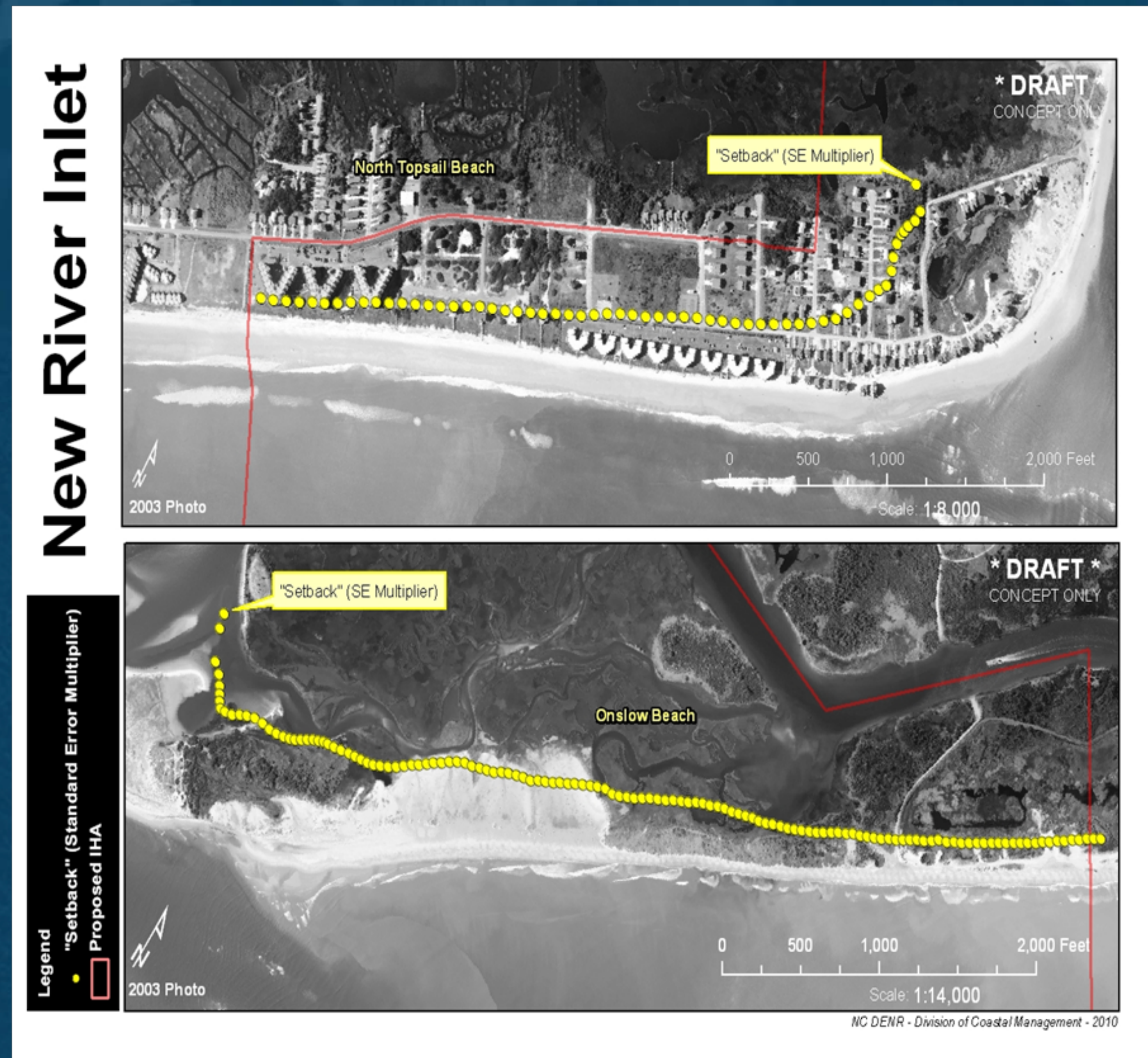




Task 4 – Economic Study

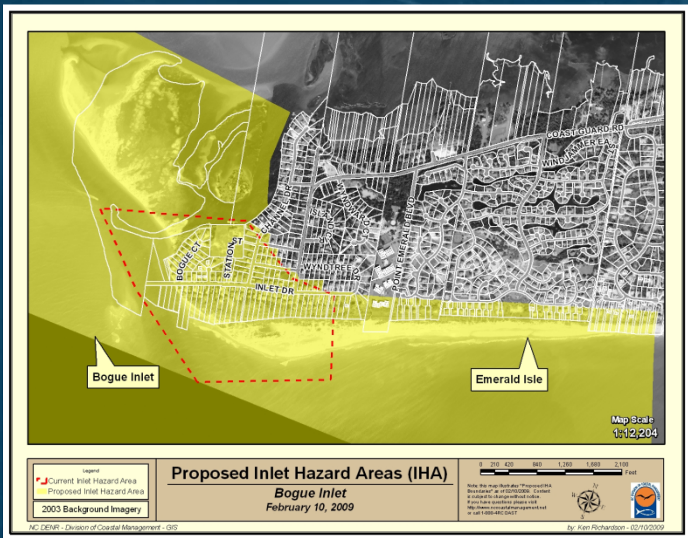
New River Inlet

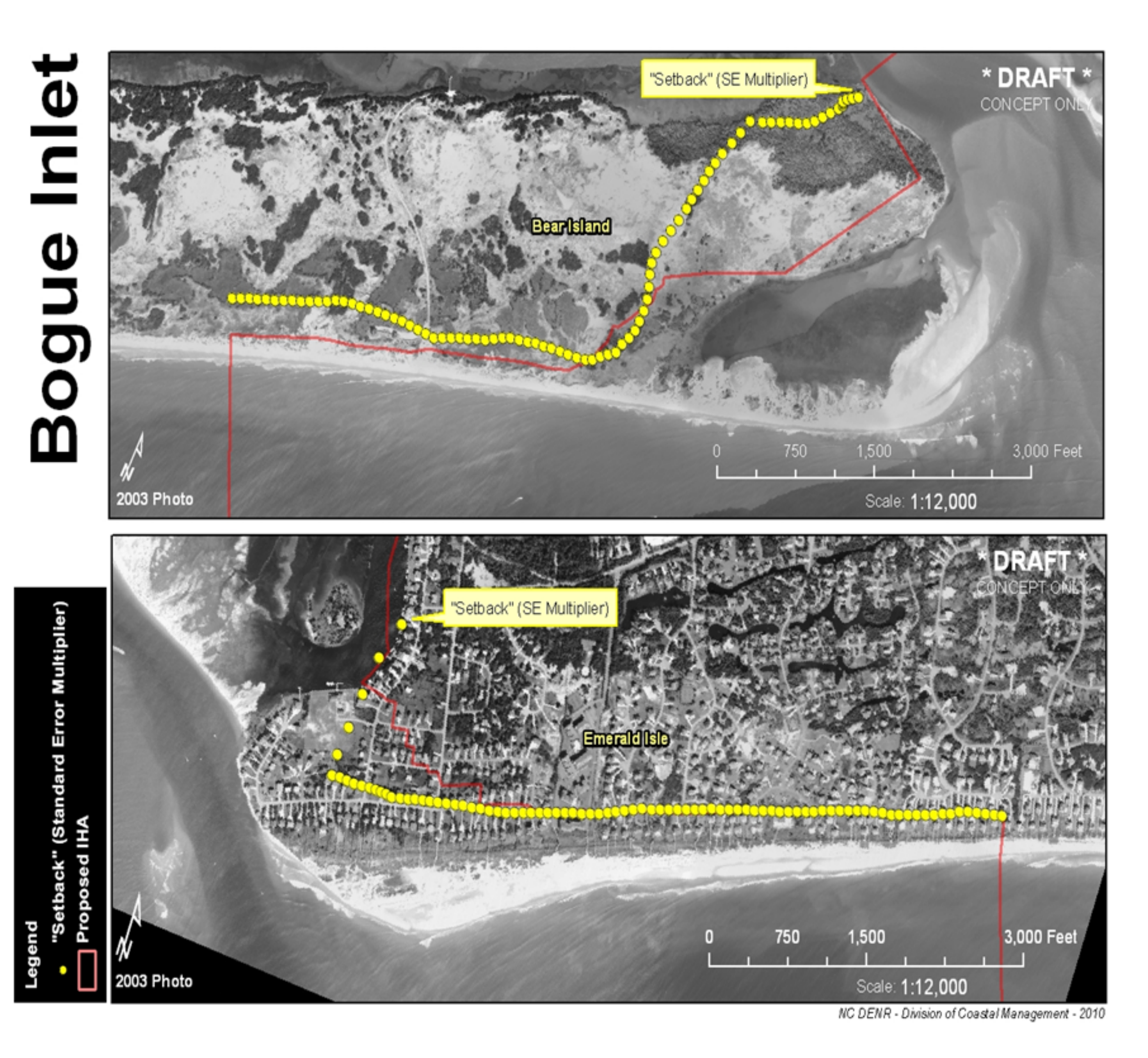




Task 4 – Economic Study

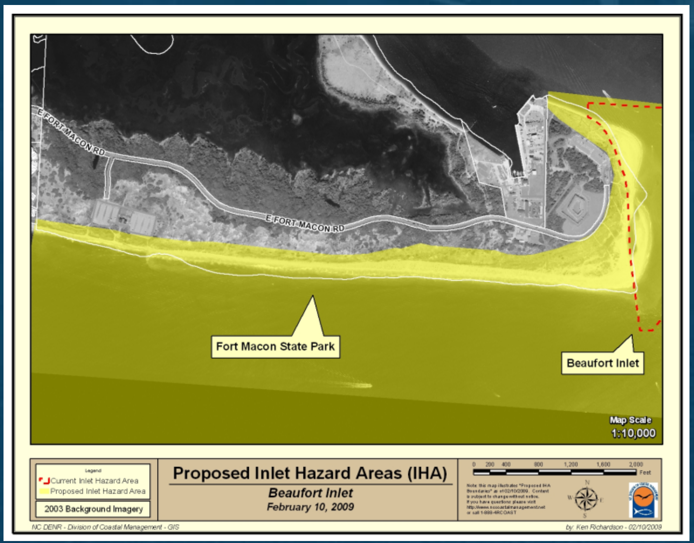
Bogue Inlet

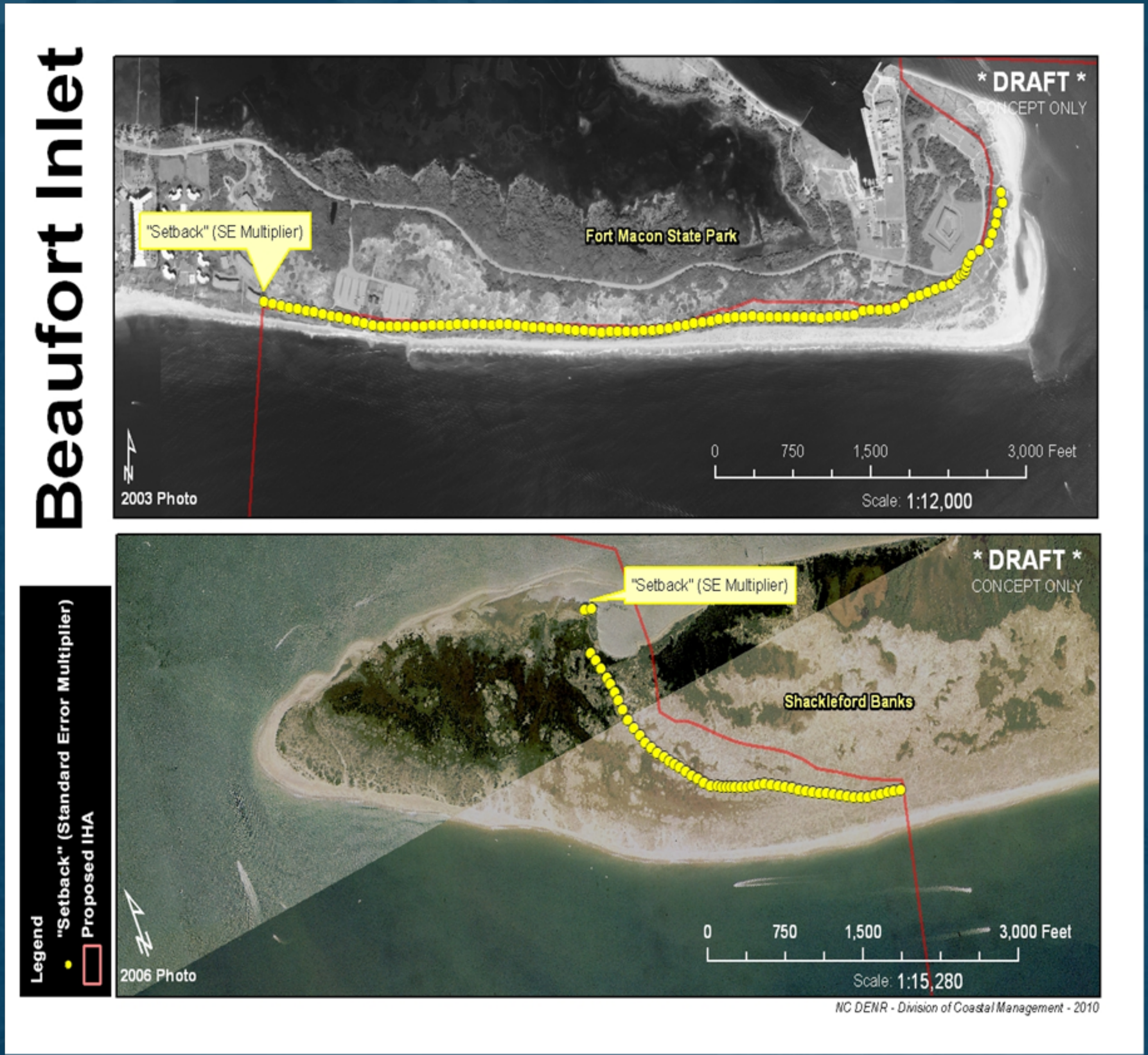




Task 4 – Economic Study

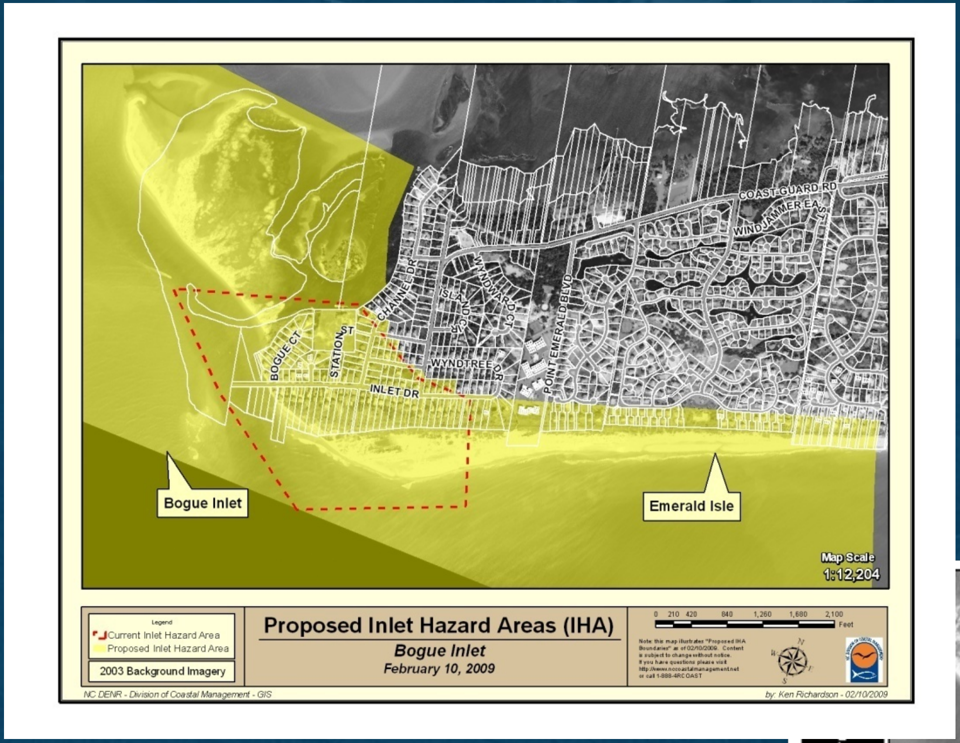
Beaufort Inlet





Task 4 – Economic Study

Bogue Inlet



Next Steps

- Working Draft Report – February 1, 2010
- Science Panel Meeting – February 8, 2010 Raleigh
- Steering Committee Meeting – February 15, 2010 New Bern
- Next CRC Meeting and Public Hearing – February 17, 2010 – Wilmington
- Final Draft Report – March 1, 2010
- Science Panel Meeting – March 12, 2010 - Raleigh