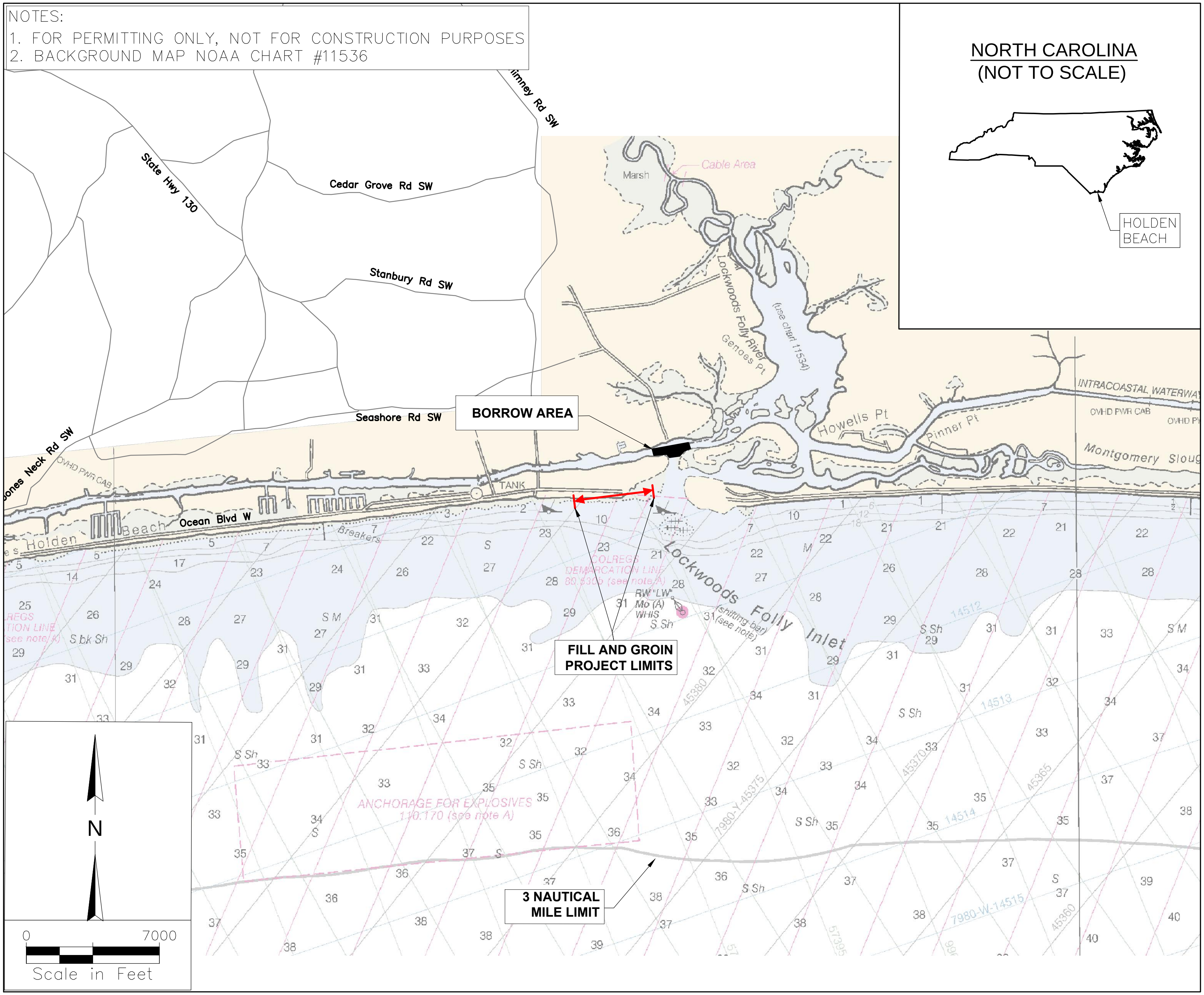
APPENDIX I

HOLDEN BEACH PERMIT SHEETS

NOTES:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. BACKGROUND MAP NOAA CHART #11536



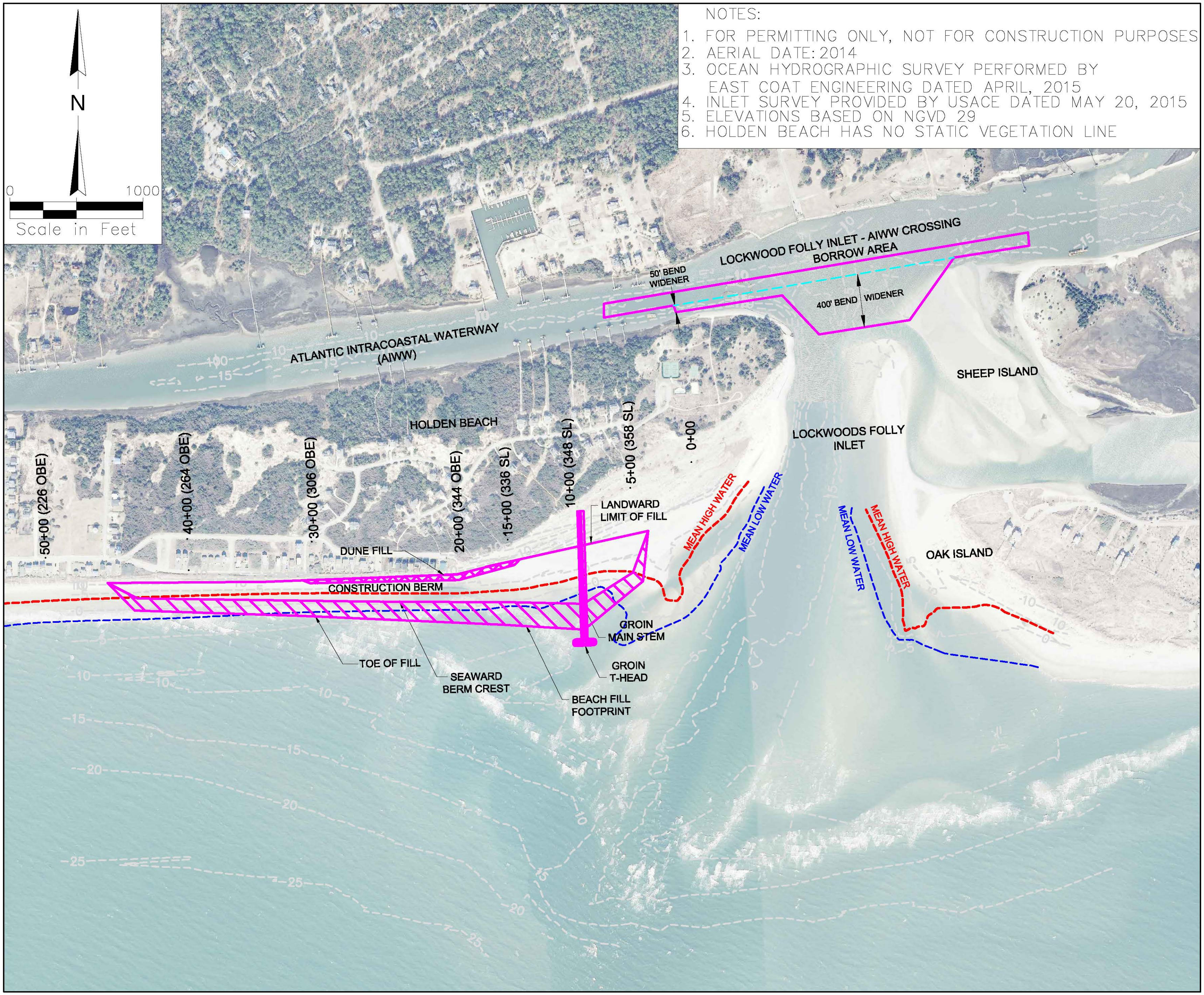
LOCATION MAP

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

ATM
APPLIED TECHNOLOGY & MANAGEMENT
941 Houston Northcutt Blvd #201
Mt Pleasant, SC 29464
843.414.1040
NC License # C-1718

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 1

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462



NOTES:

1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. AERIAL DATE: 2014
3. OCEAN HYDROGRAPHIC SURVEY PERFORMED BY EAST COAT ENGINEERING DATED APRIL, 2015
4. INLET SURVEY PROVIDED BY USACE DATED MAY 20, 2015
5. ELEVATIONS BASED ON NGVD 29
6. HOLDEN BEACH HAS NO STATIC VEGETATION LINE

ATM[SM]
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PROPOSED PROJECT OVERVIEW

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 2

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

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PROPOSED PROJECT

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

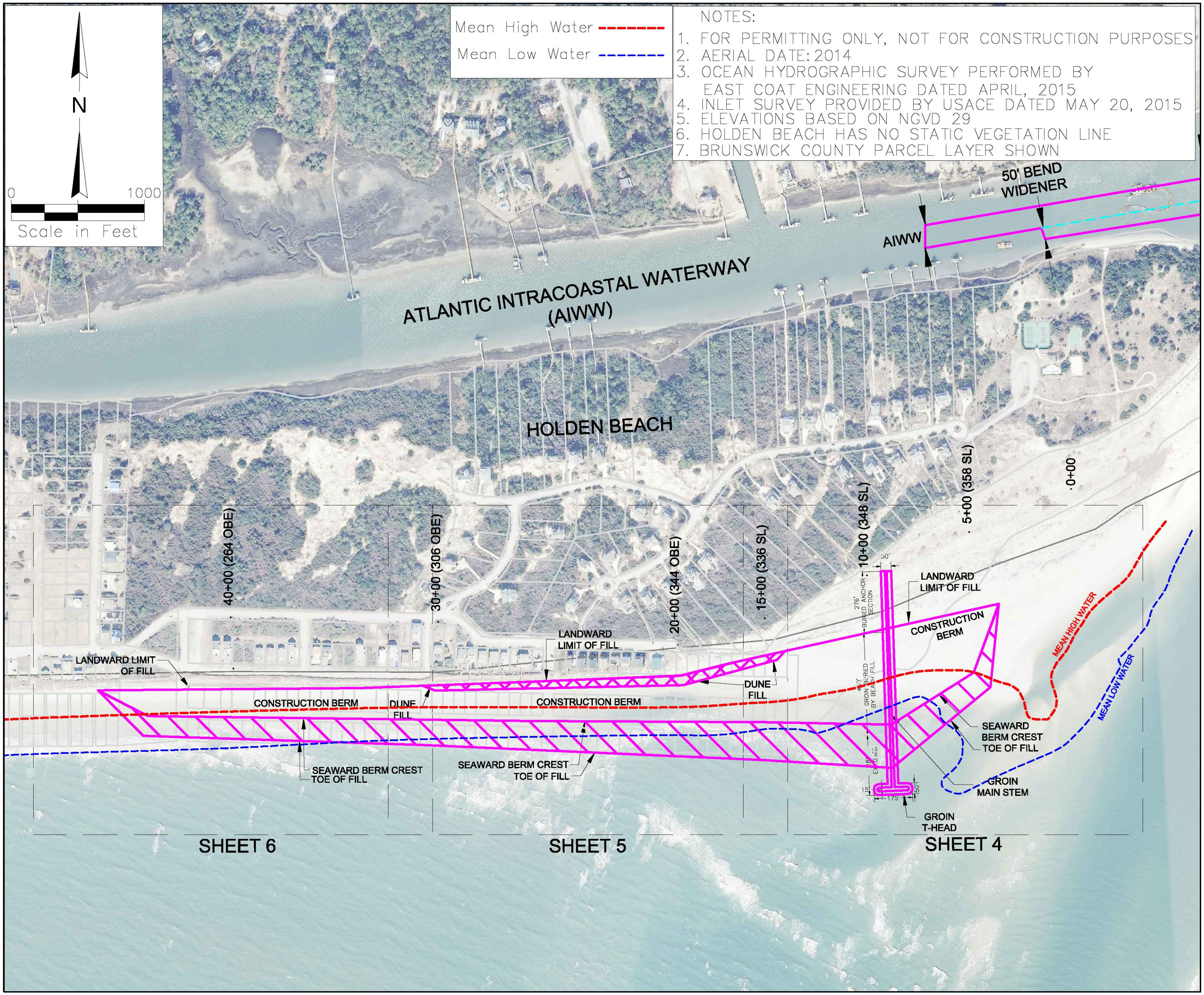
JOB NUMBER: 08-1687

ISSUE DATE: 08-11-2015

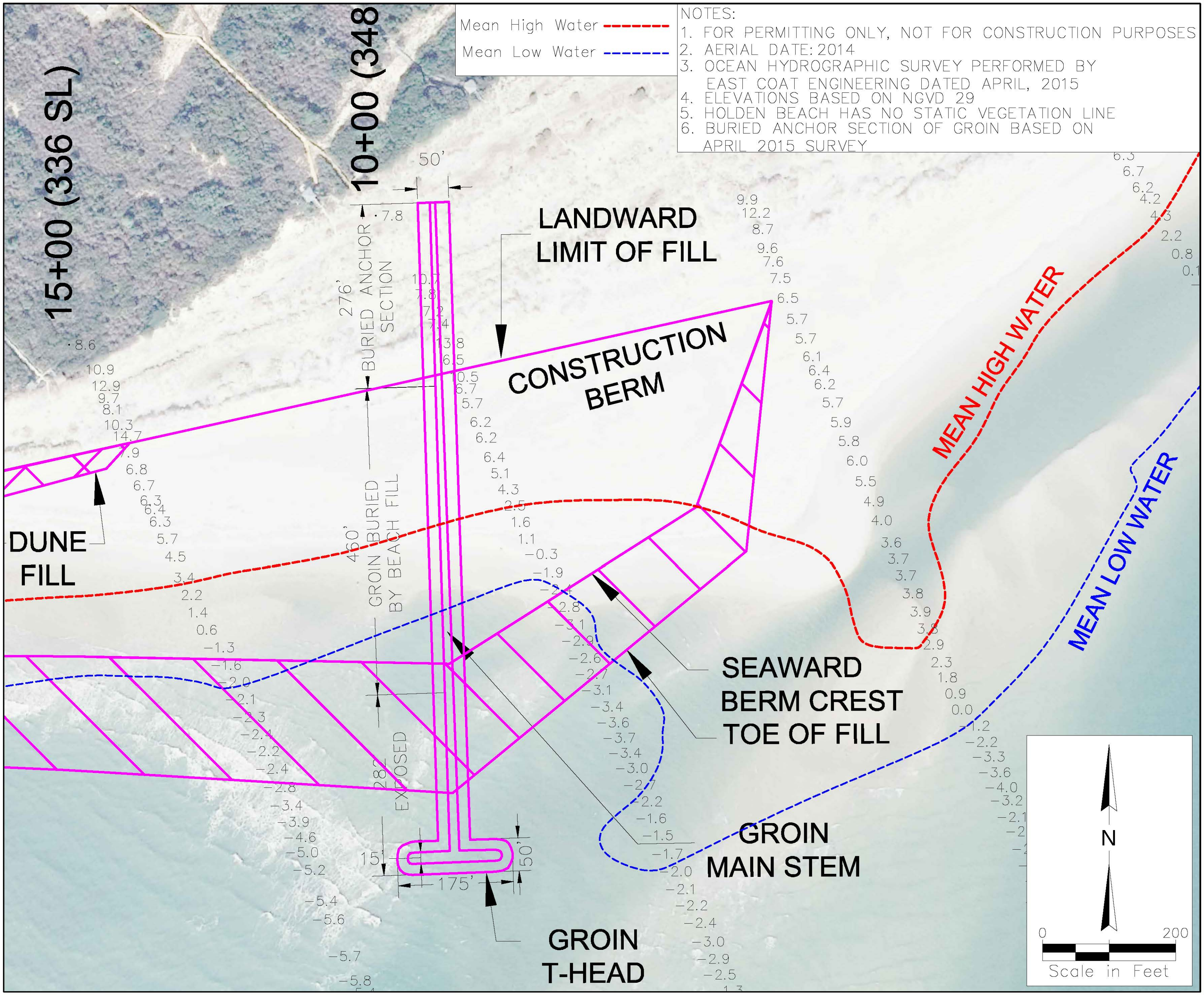
SHEET NUMBER: 3

APPLICANT INFORMATION

TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462



NOTES:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. AERIAL DATE: 2014
3. OCEAN HYDROGRAPHIC SURVEY PERFORMED BY EAST COAT ENGINEERING DATED APRIL, 2015
4. INLET SURVEY PROVIDED BY USACE DATED MAY 20, 2015
5. ELEVATIONS BASED ON NGVD 29
6. HOLDEN BEACH HAS NO STATIC VEGETATION LINE
7. BRUNSWICK COUNTY PARCEL LAYER SHOWN



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PROPOSED PROJECT

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 4

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

APPLIED TECHNOLOGY & MANAGEMENT

ATM

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PROPOSED PROJECT

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687

ISSUE DATE: 08-11-2015

SHEET NUMBER: 5

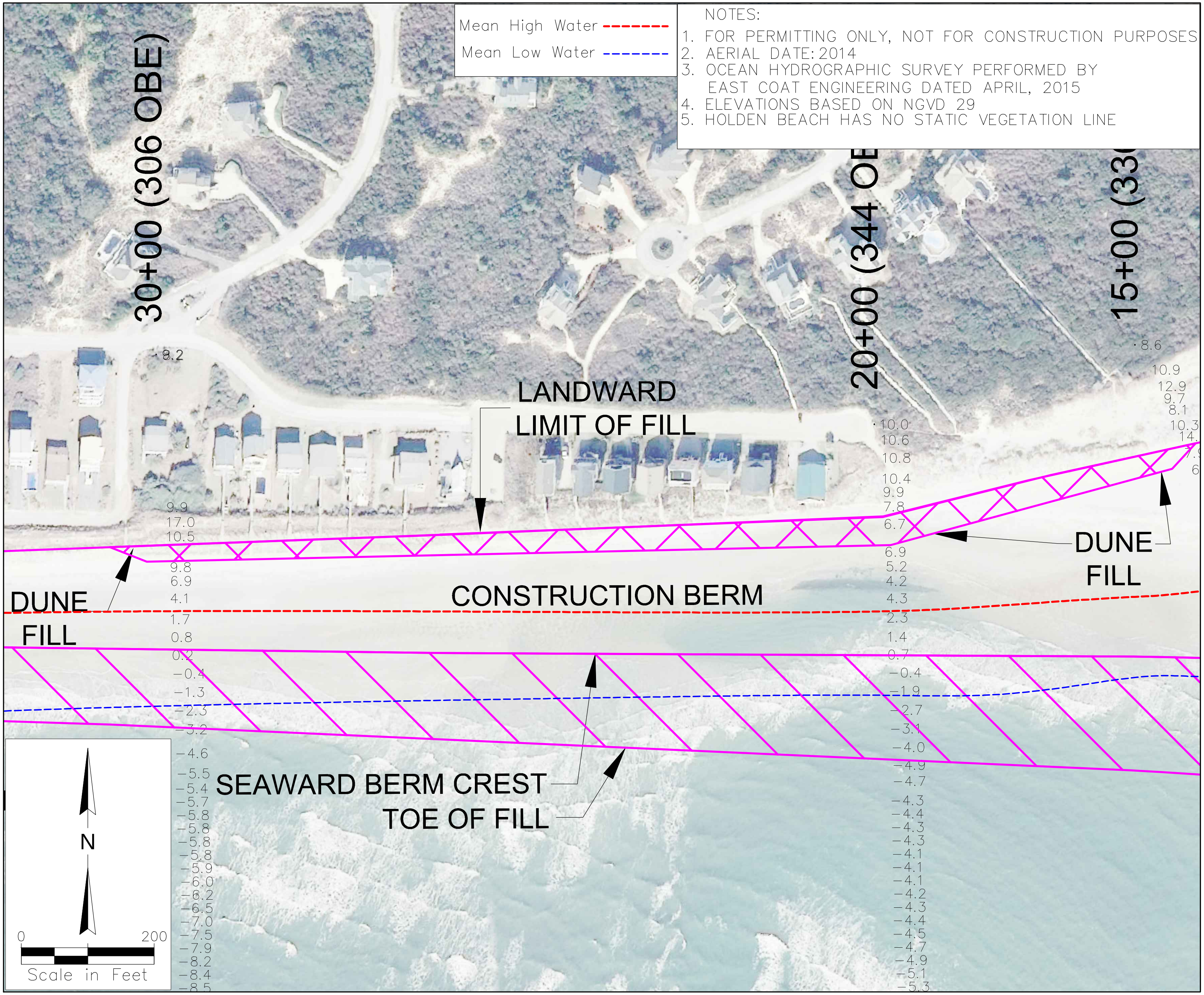
APPLICANT INFORMATION

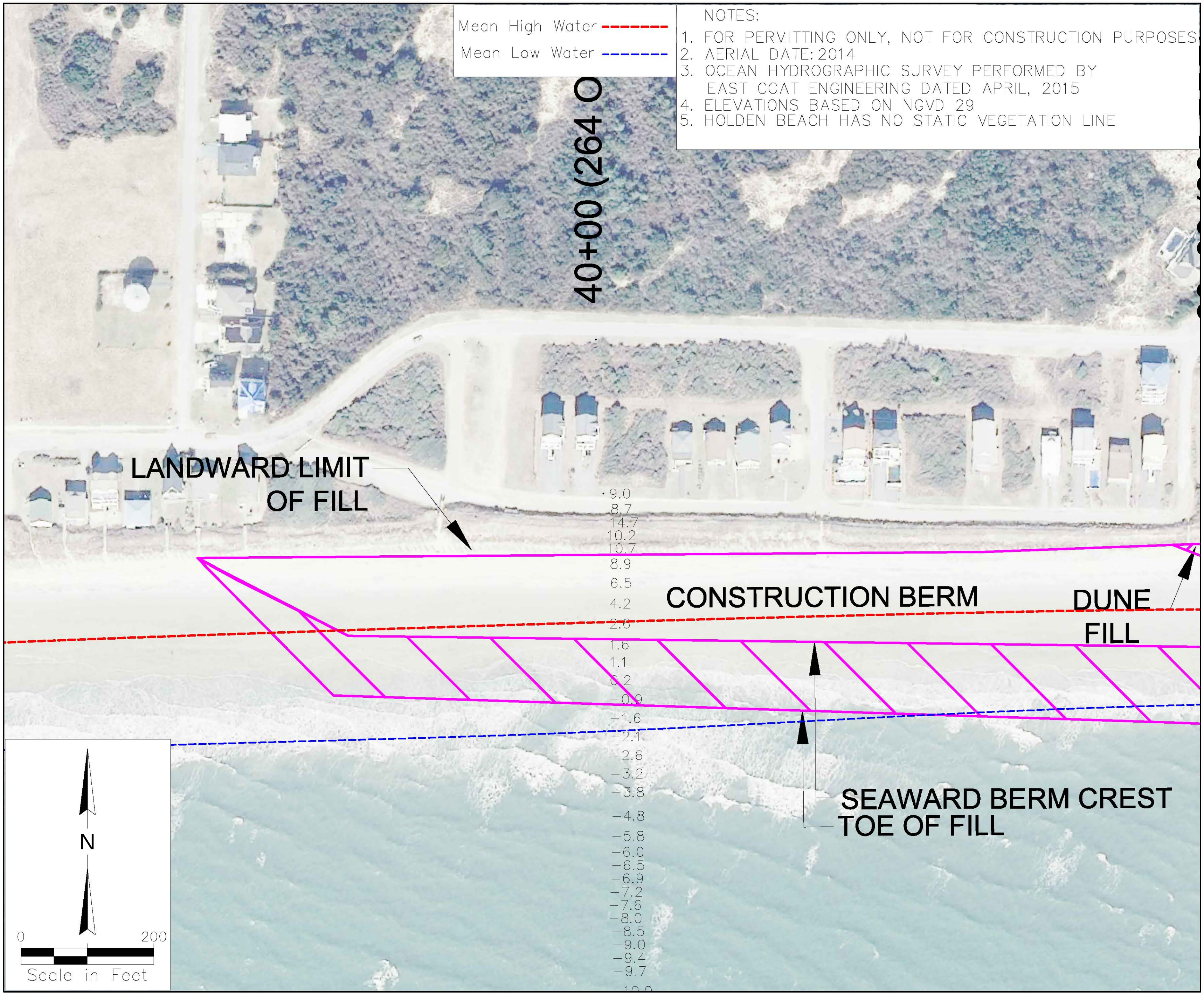
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

Mean High Water

Mean Low Water

NOTES:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. AERIAL DATE: 2014
3. OCEAN HYDROGRAPHIC SURVEY PERFORMED BY EAST COAT ENGINEERING DATED APRIL, 2015
4. ELEVATIONS BASED ON NGVD 29
5. HOLDEN BEACH HAS NO STATIC VEGETATION LINE





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PROPOSED PROJECT

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 6

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

LOCKWOOD FOLLY INLET TIDAL DATUMS

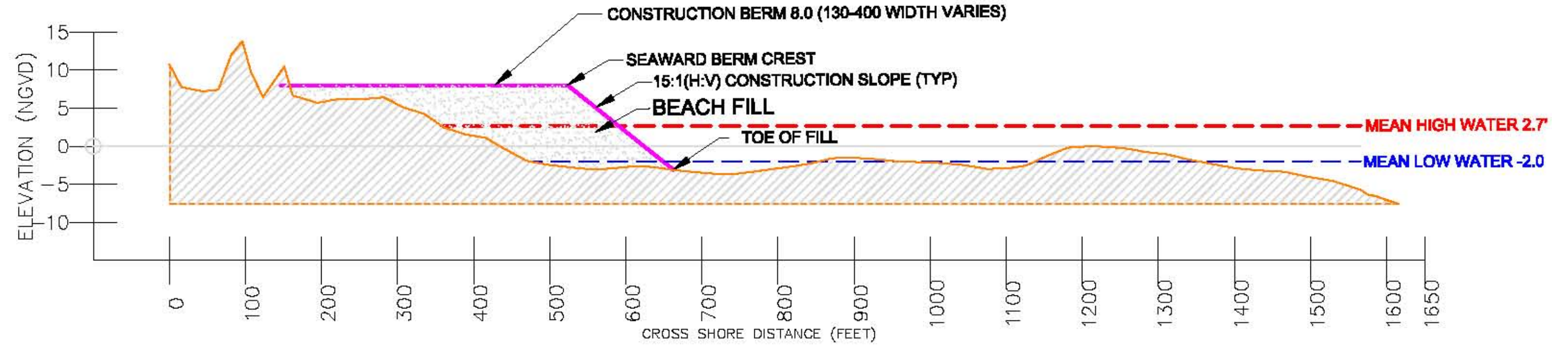
2.7'	MEAN HIGH WATER
1.0'	NAVD 88
0.5'	MEAN SEA LEVEL
0.0'	NGVD 29
-2.0'	MEAN LOW WATER

	FILL
	EXISTING SURFACE

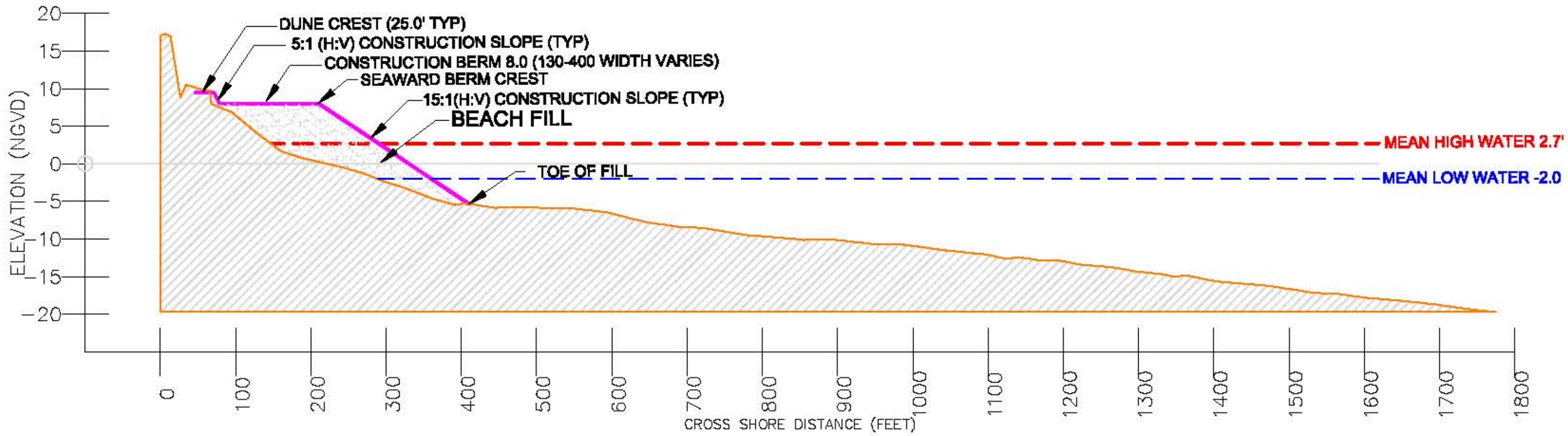
Notes:

1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. HYDROGRAPHIC SURVEY PERFORMED BY EAST COAT ENGINEERING DATED APRIL, 2015
3. HORIZONTAL COORDINATES ARE NC GRID (NAD83)
4. ELEVATIONS BASED ON NGVD 29
5. HOLDEN BEACH HAS NO STATIC VEGETATION LINE

STA 10+00 PROFILE



STA 30+00 PROFILE



HORIZONTAL
0 250
Scale in Feet

VERTICAL
0 25
Scale in Feet

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PROFILE VIEWS
TYPICAL BEACH FILL

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 7

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

APPLIED TECHNOLOGY & MANAGEMENT

ATM

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GROIN PROFILE VIEW

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687

ISSUE DATE: 08-11-2015

SHEET NUMBER: 8

APPLICANT INFORMATION

TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

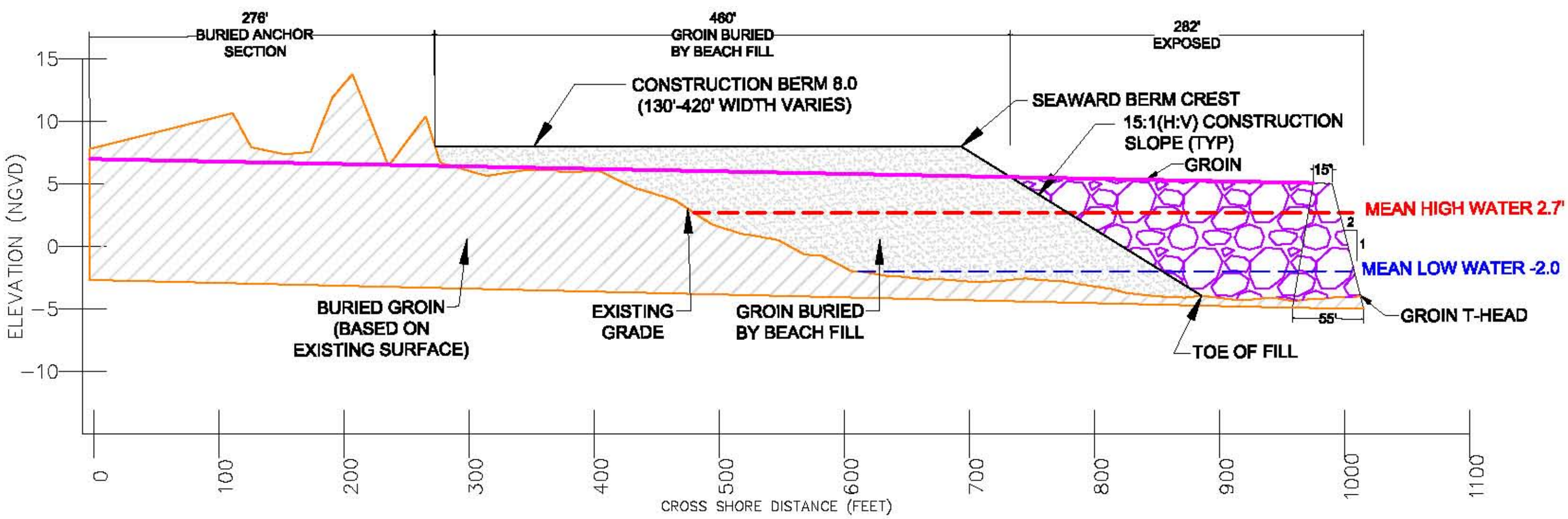
HORIZONTAL 0 150 Scale in Feet

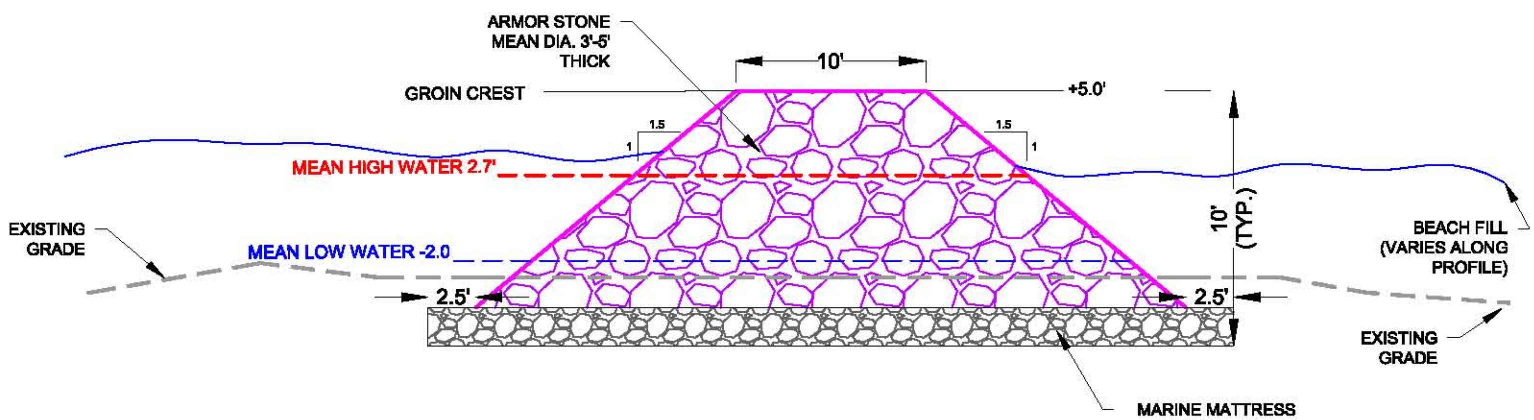
VERTICAL 0 15 Scale in Feet

	EXISTING GRADE (EXCAVATION NOT SHOWN)
	BEACH FILL
	GROIN / T-HEAD

Notes:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. ELEVATIONS BASED ON NGVD 29
3. HOLDEN BEACH HAS NO STATIC VEGETATION LINE
4. NO CORE STONE PROPOSED TO ALLOW MORE PERMEABILITY
5. BURIED ANCHOR SECTION OF GROIN BASED ON APRIL 2015 SURVEY

GROIN PROFILE



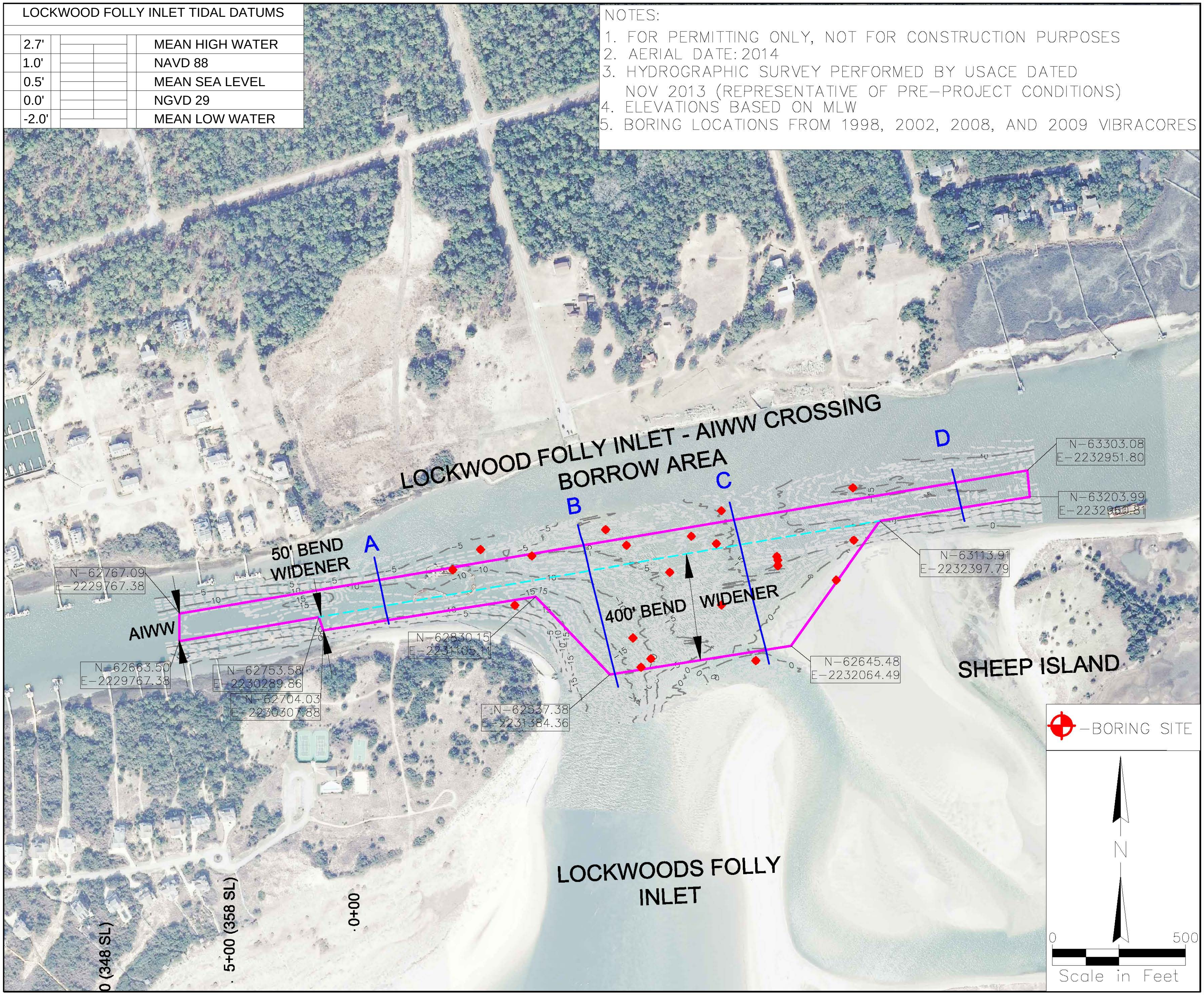


TYPICAL GROIN CROSS SECTION
(MAIN STEM)
(NOT TO SCALE)

LOCKWOOD FOLLY INLET TIDAL DATUMS

2.7'	MEAN HIGH WATER
1.0'	NAVD 88
0.5'	MEAN SEA LEVEL
0.0'	NGVD 29
-2.0'	MEAN LOW WATER

NOTES:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. AERIAL DATE: 2014
3. HYDROGRAPHIC SURVEY PERFORMED BY USACE DATED NOV 2013 (REPRESENTATIVE OF PRE-PROJECT CONDITIONS)
4. ELEVATIONS BASED ON MLW
5. BORING LOCATIONS FROM 1998, 2002, 2008, AND 2009 VIBRACORES



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BORROW AREA

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 9

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

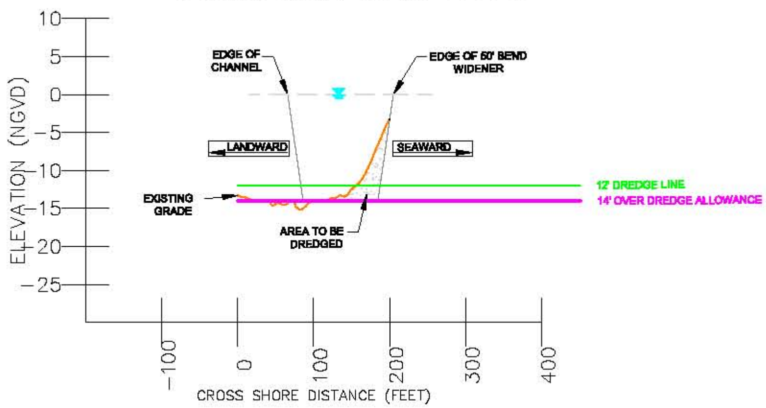
LOCKWOOD FOLLY INLET TIDAL DATUMS

2.7'	MEAN HIGH WATER
1.0'	NAVD 88
0.5'	MEAN SEA LEVEL
0.0'	NGVD 29
-2.0'	MEAN LOW WATER

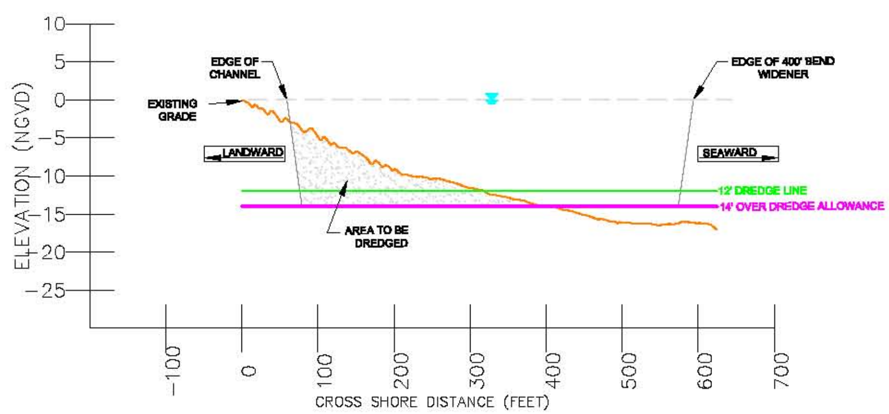
	AREAS TO BE DREDGED
	EXISTING GRADE

NOTES:
1. FOR PERMITTING ONLY, NOT FOR CONSTRUCTION PURPOSES
2. HYDROGRAPHIC SURVEY PERFORMED BY USACE DATED NOV. 2013 (REPRESENTATIVE OF PRE-PROJECT CONDITIONS)
3. HORIZONTAL COORDINATES ARE NC GRID (NAD83)
4. ELEVATIONS BASED ON MLW
5. HOLDEN BEACH HAS NO STATIC VEGETATION LINE

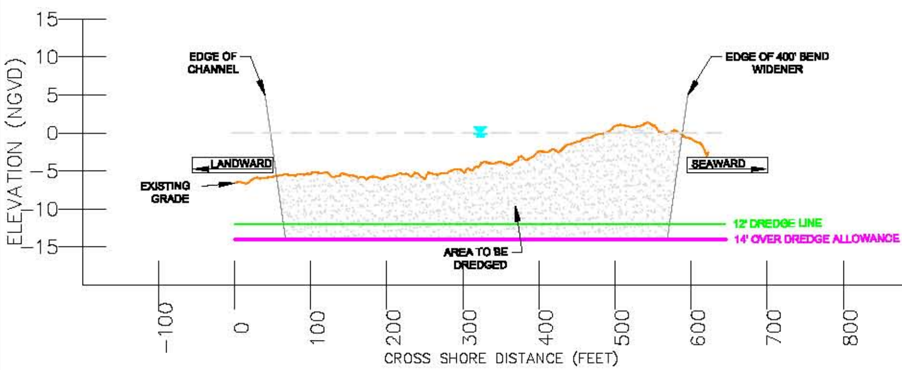
BORROW AREA PROFILE A



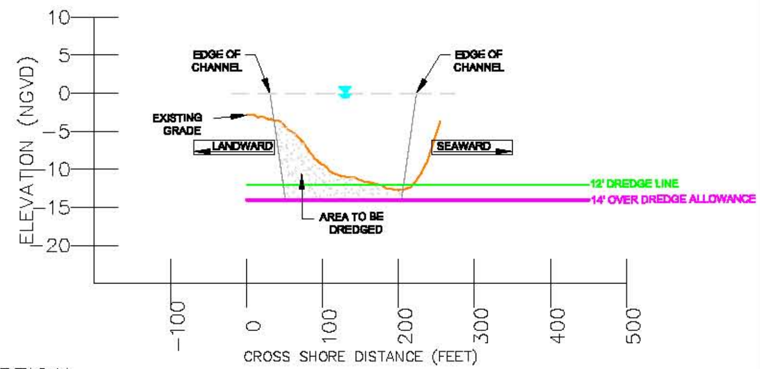
BORROW AREA PROFILE B



BORROW AREA PROFILE C



BORROW AREA PROFILE D



HORIZONTAL
0 250
Scale in Feet

VERTICAL
0 25
Scale in Feet

ATM APPLIED TECHNOLOGY & MANAGEMENT
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INSHORE BORROW PROFILES

Holden Beach East End
Shoreline Stabilization
Brunswick County, North Carolina

JOB NUMBER: 08-1687
ISSUE DATE: 08-11-2015
SHEET NUMBER: 10

APPLICANT INFORMATION
TOWN OF HOLDEN BEACH
110 ROTHSCHILD STREET
HOLDEN BEACH, NC 28462

APPENDIX J

HOLDEN BEACH RESOLUTION

RESOLUTION 11-12
TERMINAL GROIN PERMIT APPLICATION

WHEREAS, the Town of Holden Beach, North Carolina is a barrier island bounded by the Atlantic Intracoastal Waterway to the north, the Atlantic Ocean to the South, the Shallotte Inlet to the West and the Lockwood Folly Inlet to the East; and,

WHEREAS, the Town of Holden Beach CAMA Land Use Plan supported the reconsideration of the previous state prohibition on erosion control structures particularly in inlet hazard areas; and,

WHEREAS, the Town of Holden Beach has supported by action and resolutions; all adopted unanimously, legislative efforts over the past several years to allow terminal groins in locations adjacent to NC inlets according to specific criteria and as determined by sound engineering practice; and,

WHEREAS, Senate Bill 110 "An Act To Authorize the Permitting And Construction Of Up To Four Terminal Groins Under Certain Conditions" has been enacted by the General Assembly; and,

WHEREAS, the Division of Coastal Management has presented the Terminal Groin Permit Process to the Coastal Resources Commission at their 25 August 2011 meeting; and,

WHEREAS, the Town of Holden Beach has a Beach Management Plan that identifies a terminal groin structure at the island's east end adjacent to the Lockwood Folly inlet as a solution that would help to stabilize the area; and,

WHEREAS, the Town of Holden believes it is in the best interest of its citizens, property owners, visitors, neighbors, mariners, commercial and recreational fisherman to stabilize the east end of Holden Beach adjacent to the Lockwood Folly Inlet; and,

WHEREAS, the Town of Holden Beach would like to move forward with obtaining the permits required to construct a Terminal Groin on the east end of Holden Beach.

NOW THEREFORE BE IT RESOLVED that the Board of Commissioners of the Town of Holden Beach NC does hereby direct the Holden Beach Town Manager to make application to the North Carolina Division of Coastal Management/Coastal Resources Commission for a permit to construct a Terminal Groin on the east end of Holden Beach adjacent to the Lockwood Folly Inlet.

This the 13th day of September, 2011.

J. Alan Holden

J. Alan Holden, Mayor

ATTEST:

Heather Finnell

Heather Finnell, Town Clerk

TOWN OF HOLDEN BEACH SEAL ESTABLISHED FEBRUARY 14, 1969 HOLDEN BEACH, NC

APPENDIX K

LOCKWOODS FOLLY INLET HISTORICAL AERIAL IMAGERY

The following images were scanned from air photography.
All images were georectified as close as they could be considering the different angles and altitudes of each photo set through the years.
1938 & 1949 photography was not georectified and was only placed on a slide.

-Adam Faircloth
Cartographer
US Army Corps of Engineers
Wilmington District
910-251-4476
adam.g.faircloth@usace.army.mil

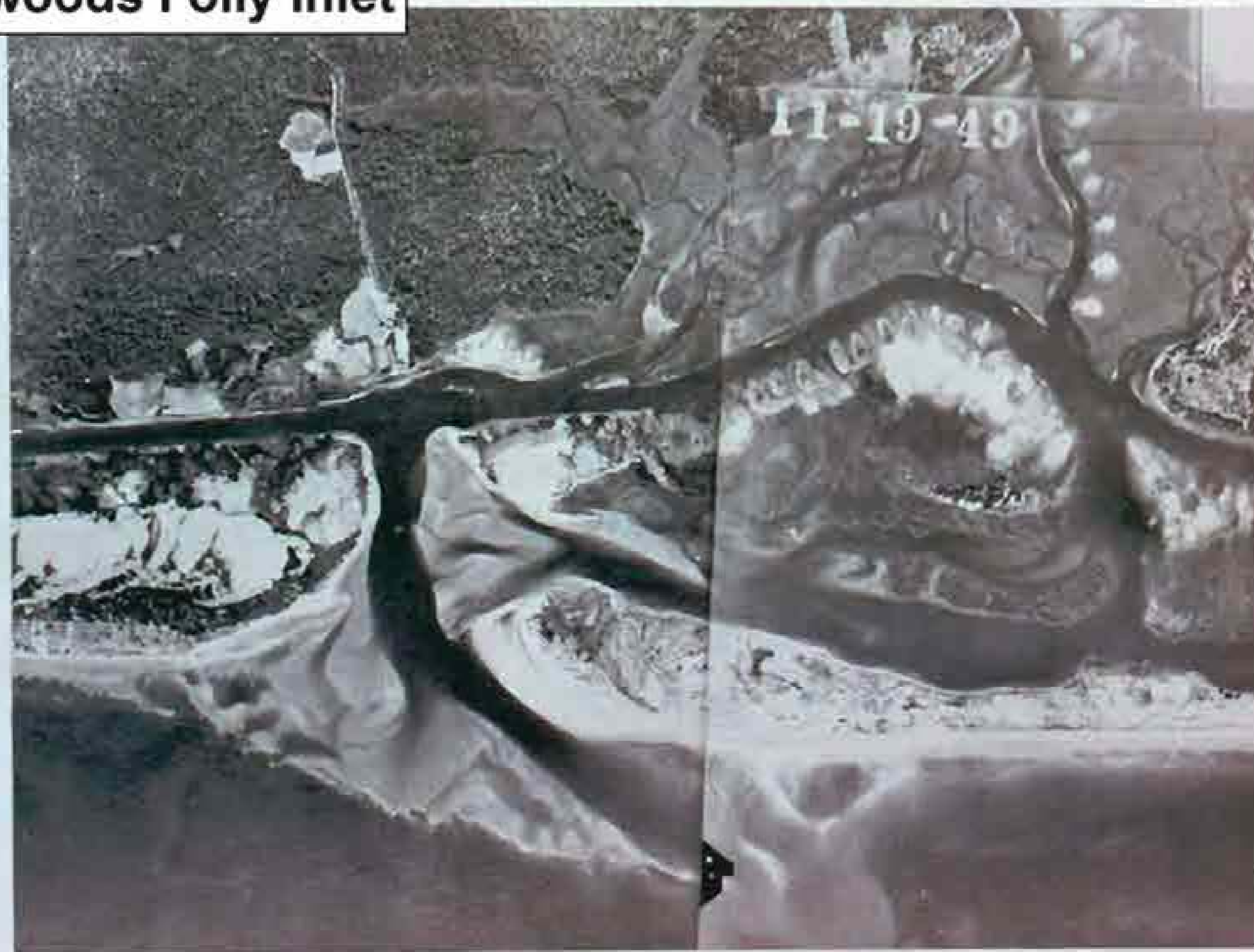
Lockwoods Folly Inlet

LOCKWOODS FOLLY INLET
1938

PHOTO PLATE V

April 5, 1938

Lockwoods Folly Inlet

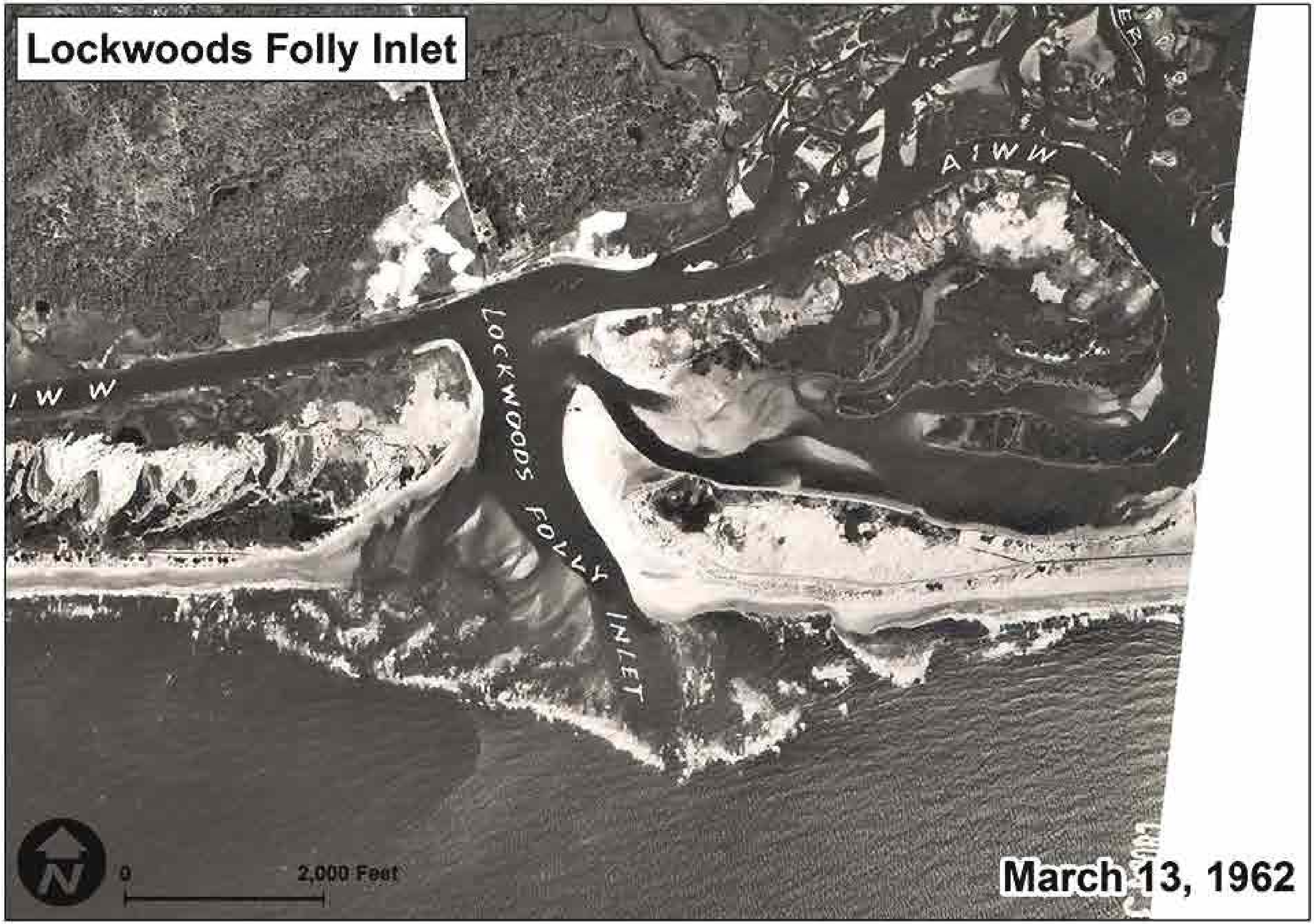


LOCKWOODS FOLLY INLET

PHOTO PLATE VI

November 19, 1949


Lockwoods Folly Inlet
0
2,000 Feet
N
May 4, 1958



Lockwoods Folly Inlet
AIWW
IWW
LOCKWOODS FOLLY INLET
0
2,000 Feet
N
March 13, 1962

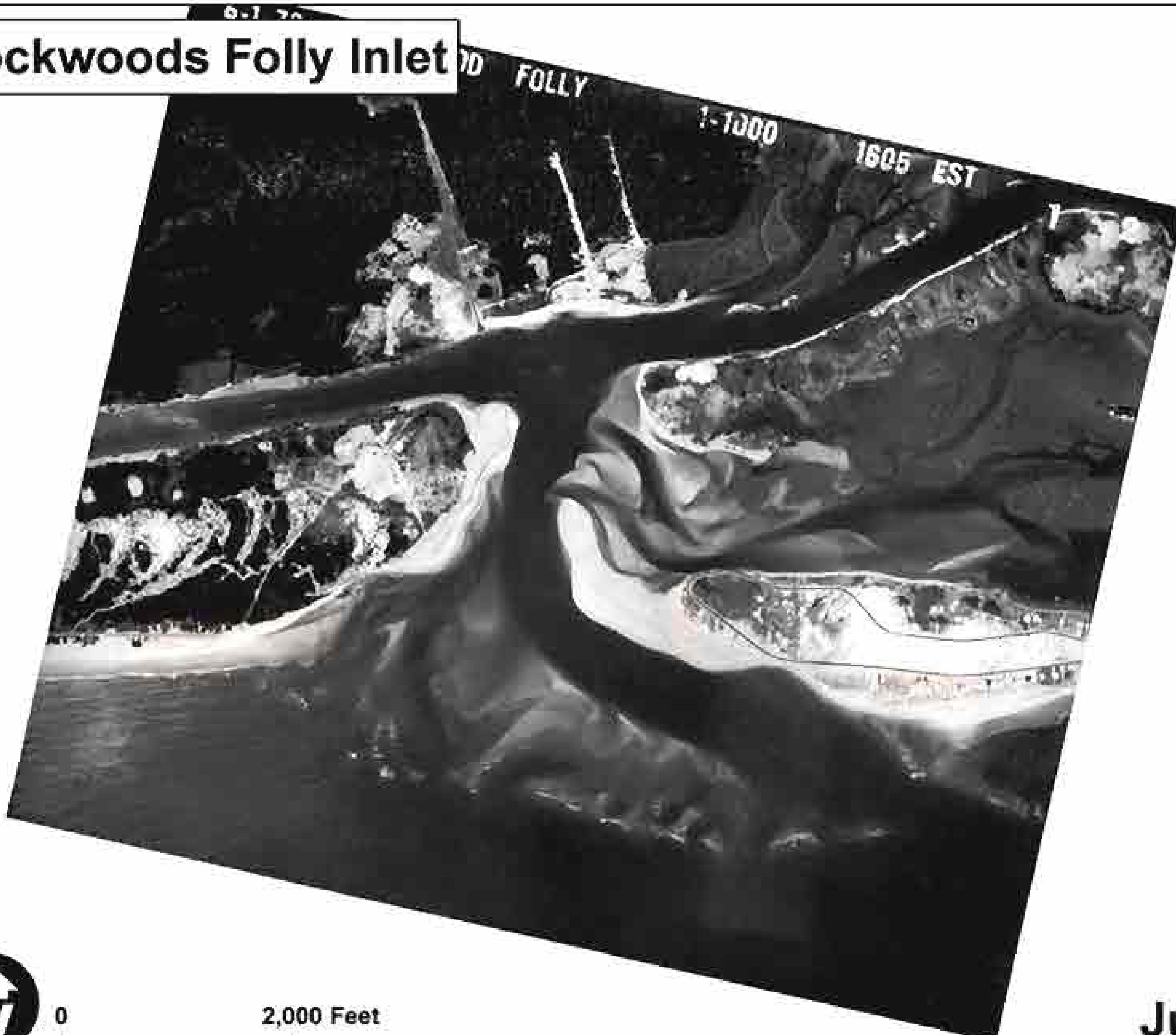
Lockwoods Folly Inlet
0
2,000 Feet
April 28, 1970

Lockwoods Folly Inlet

August 1971


Lockwoods Folly Inlet
0026
0
2,000 Feet
November 1, 1971

Lockwoods Folly Inlet



0 2,000 Feet

June 1, 1972

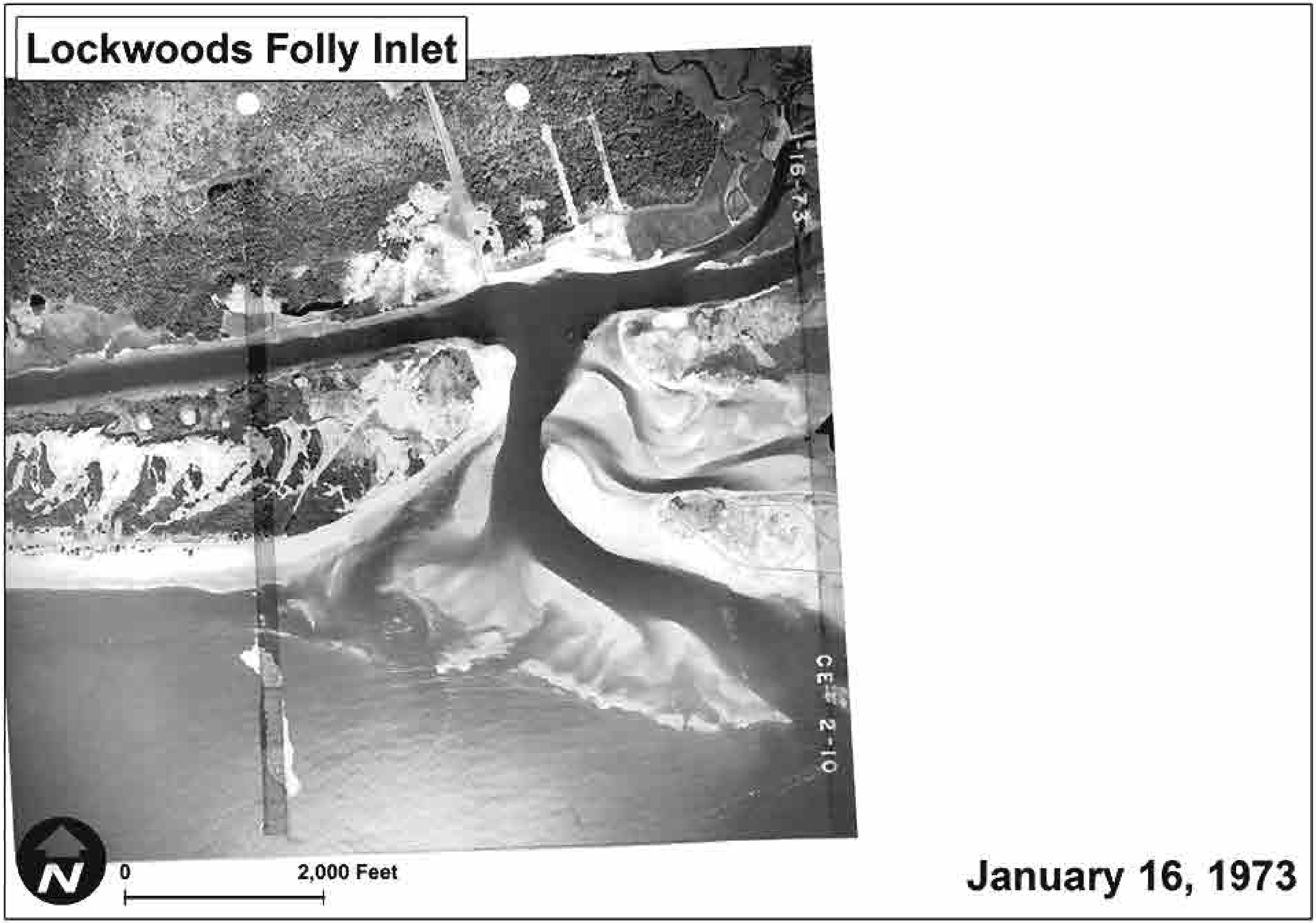
Lockwoods Folly Inlet

0

November 6, 1972

Lockwoods Folly Inlet

December 17, 1972


Lockwoods Folly Inlet
1-16-73
CE 2-10
N
0
2,000 Feet
January 16, 1973

Lockwoods Folly Inlet

February 28, 1973

Lockwoods Folly Inlet

N

0 2,000 Feet

April 30, 1973

Lockwoods Folly Inlet

0 2,000 Feet

July 10, 1973

Lockwoods Folly Inlet

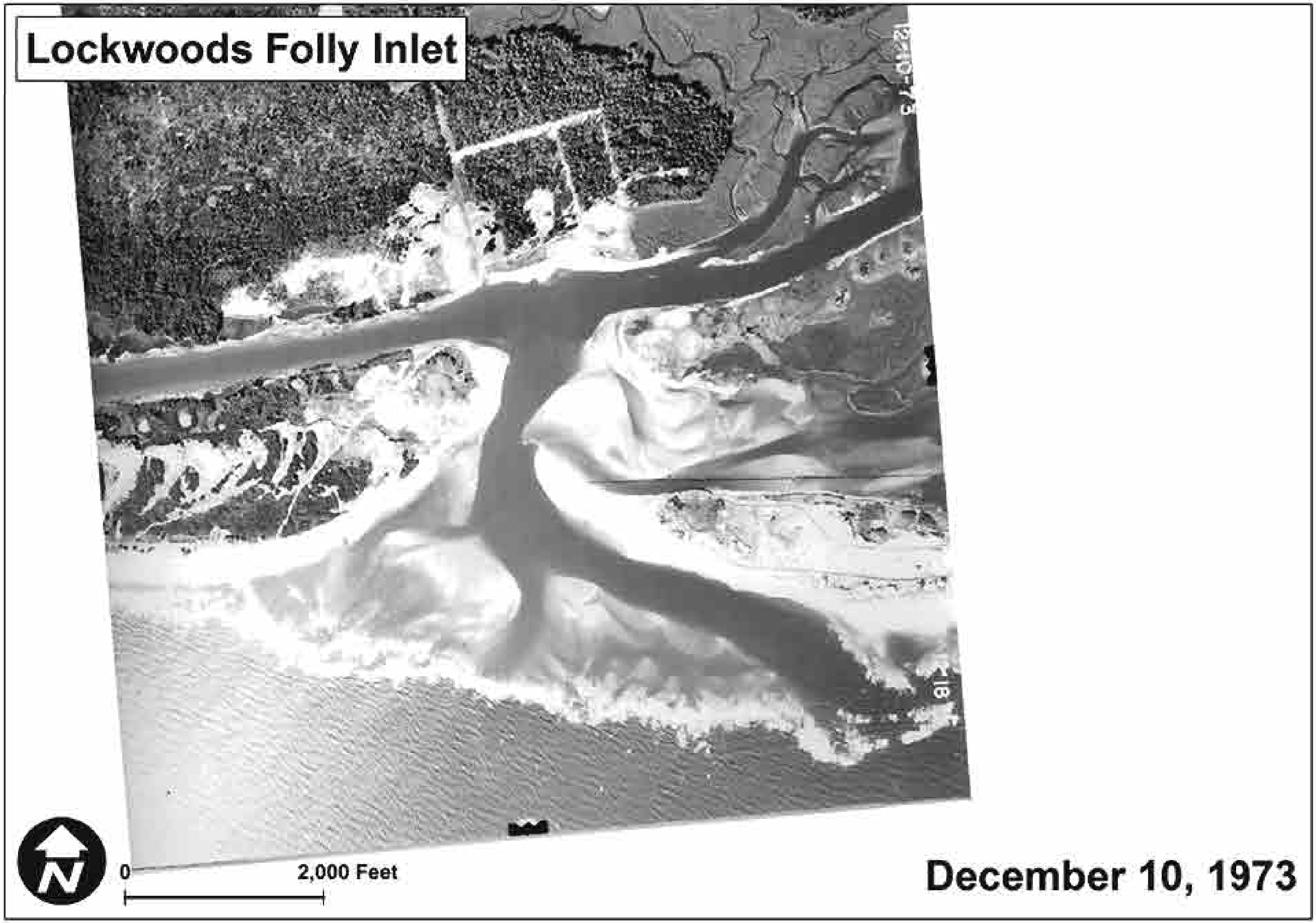
0 2,000 Feet

September 11, 1973

Lockwoods Folly Inlet

0 2,000 Feet

October 23, 1973

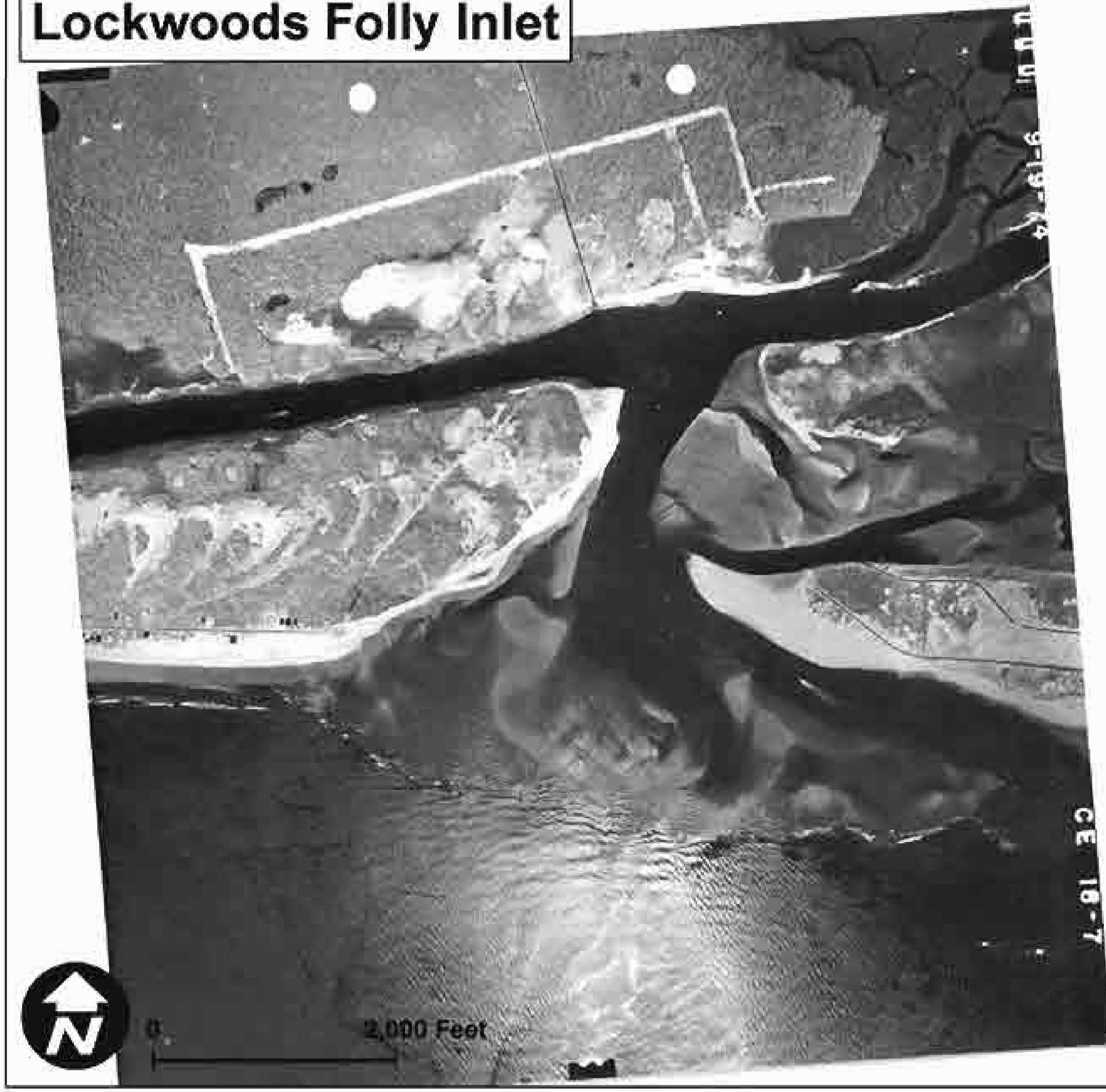

Lockwoods Folly Inlet
0
2,000 Feet
December 10, 1973

Lockwoods Folly Inlet

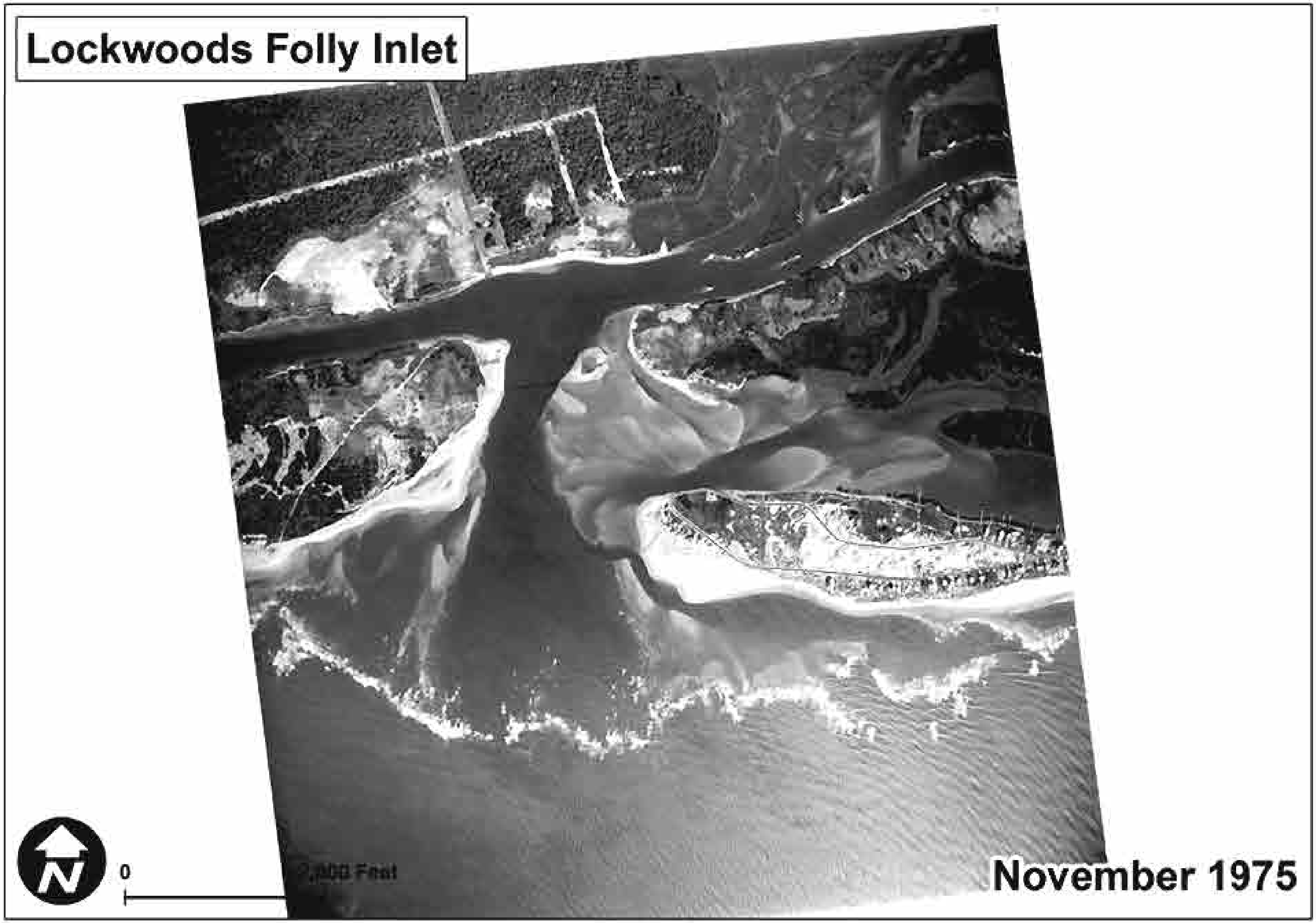
February 5, 1974


Lockwoods Folly Inlet
CE 17-4
0
2,000 Feet
July 14, 1974

Lockwoods Folly Inlet



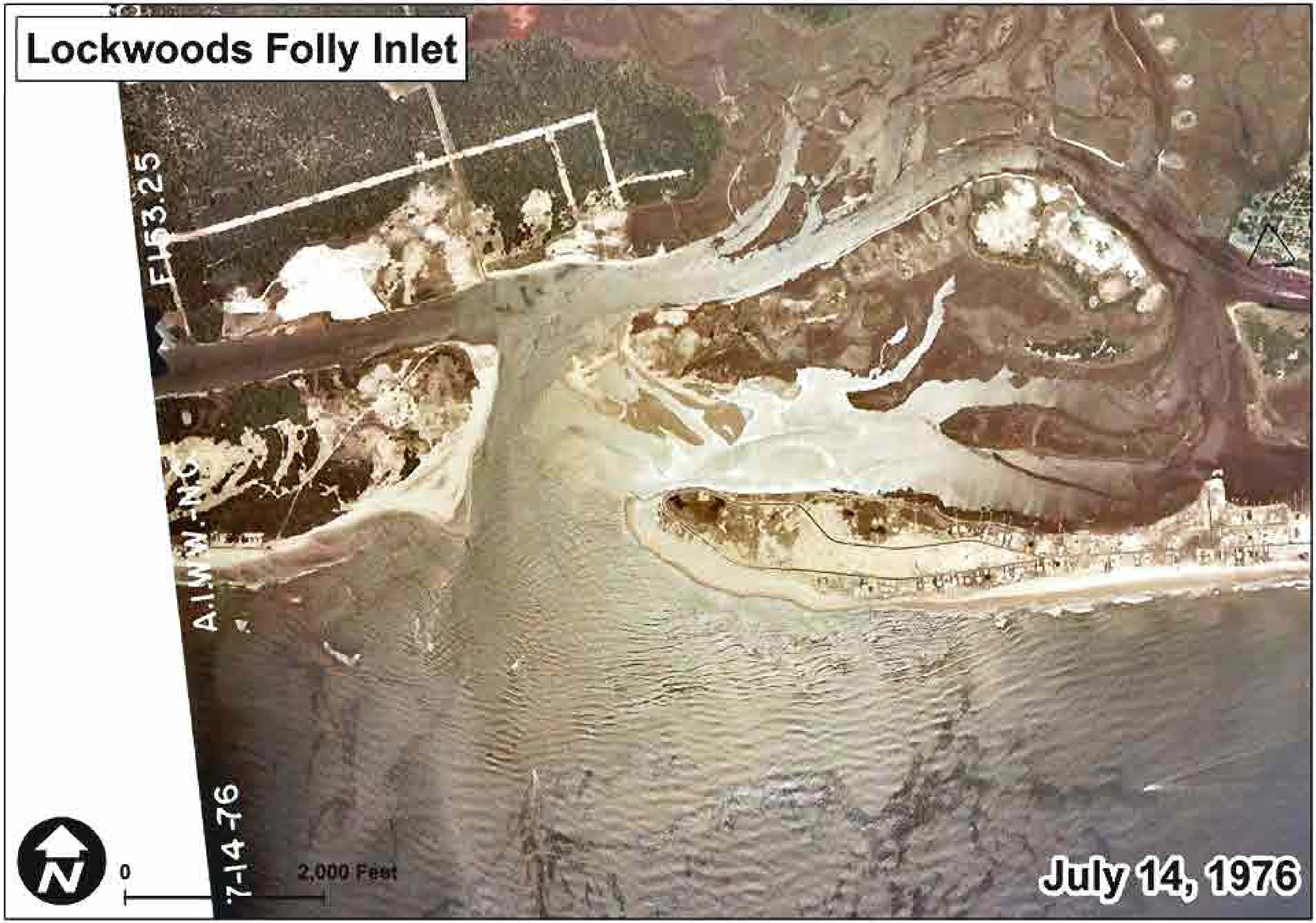
September 19, 1974



Lockwoods Folly Inlet
N
0
Feet
November 1975

Lockwoods Folly Inlet

February 5, 1976


Lockwoods Folly Inlet
0
2,000 Feet
7-14-76
July 14, 1976

Lockwoods Folly Inlet

August 11, 1976

Lockwoods Folly Inlet

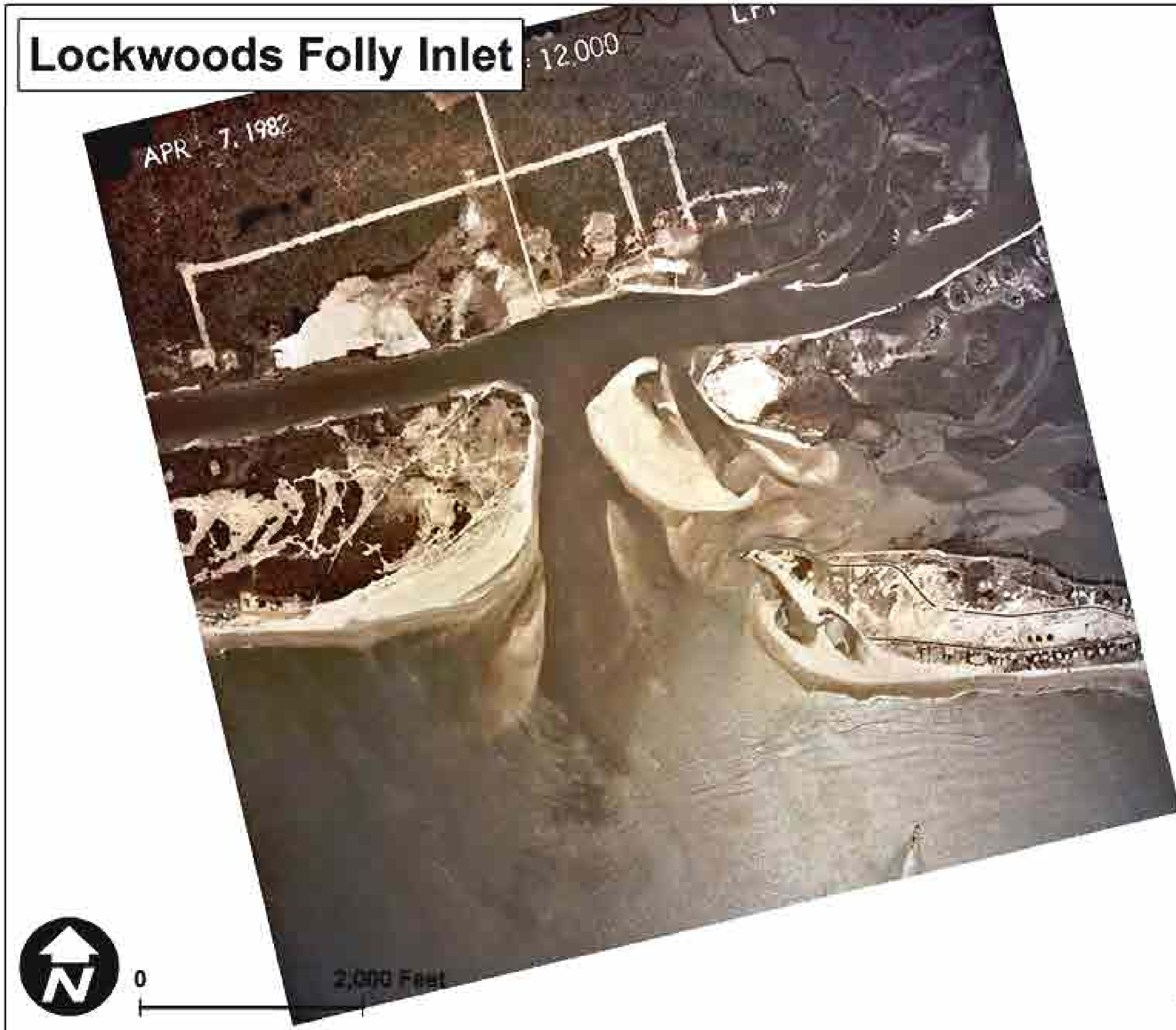
0 2,000 Feet

November 1, 1978

Lockwoods Folly Inlet


Lockwoods Folly Inlet
0
2,000 Feet
January 25, 1980

Lockwoods Folly Inlet

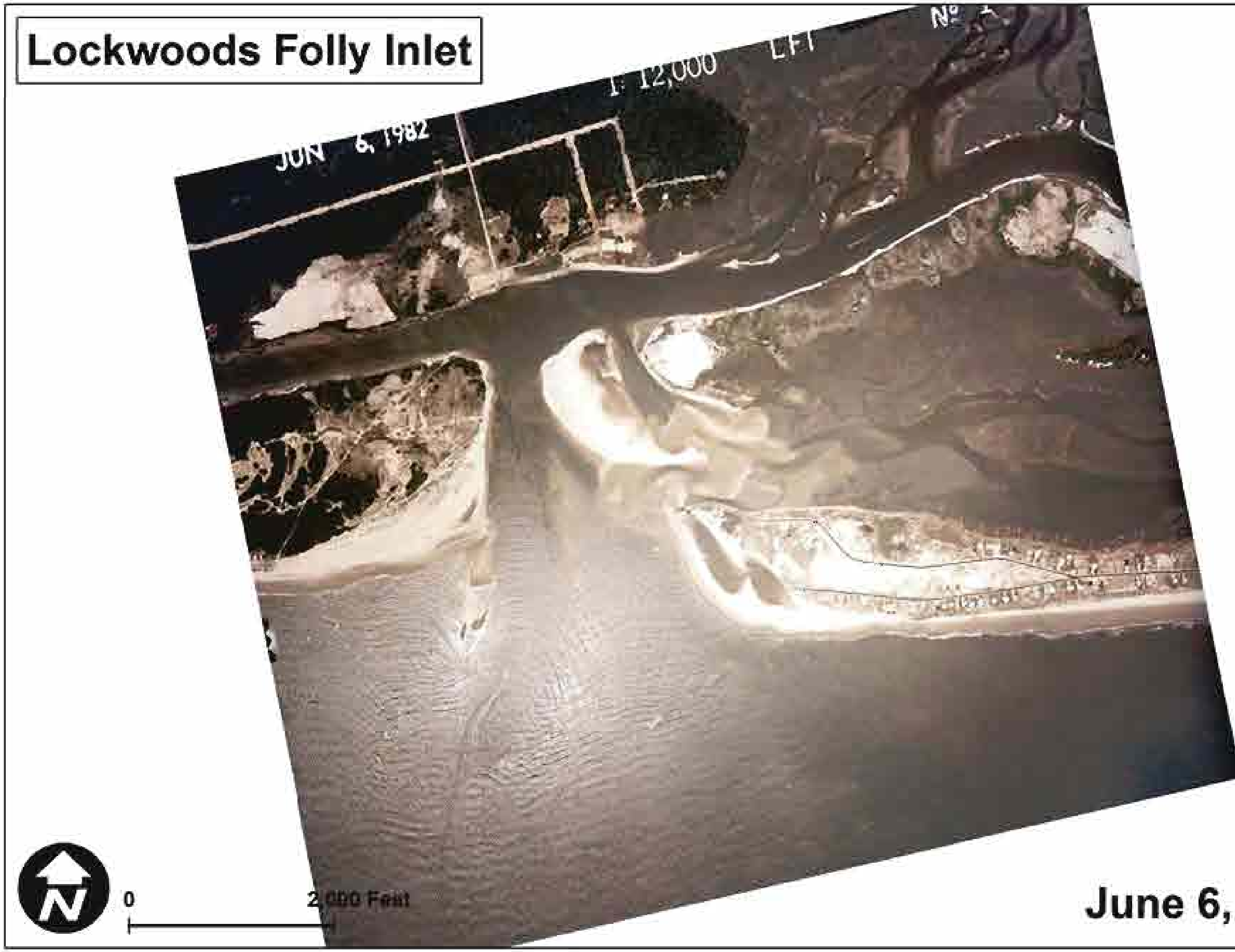


April 7, 1982

Lockwoods Folly Inlet

May 5, 1982

Lockwoods Folly Inlet

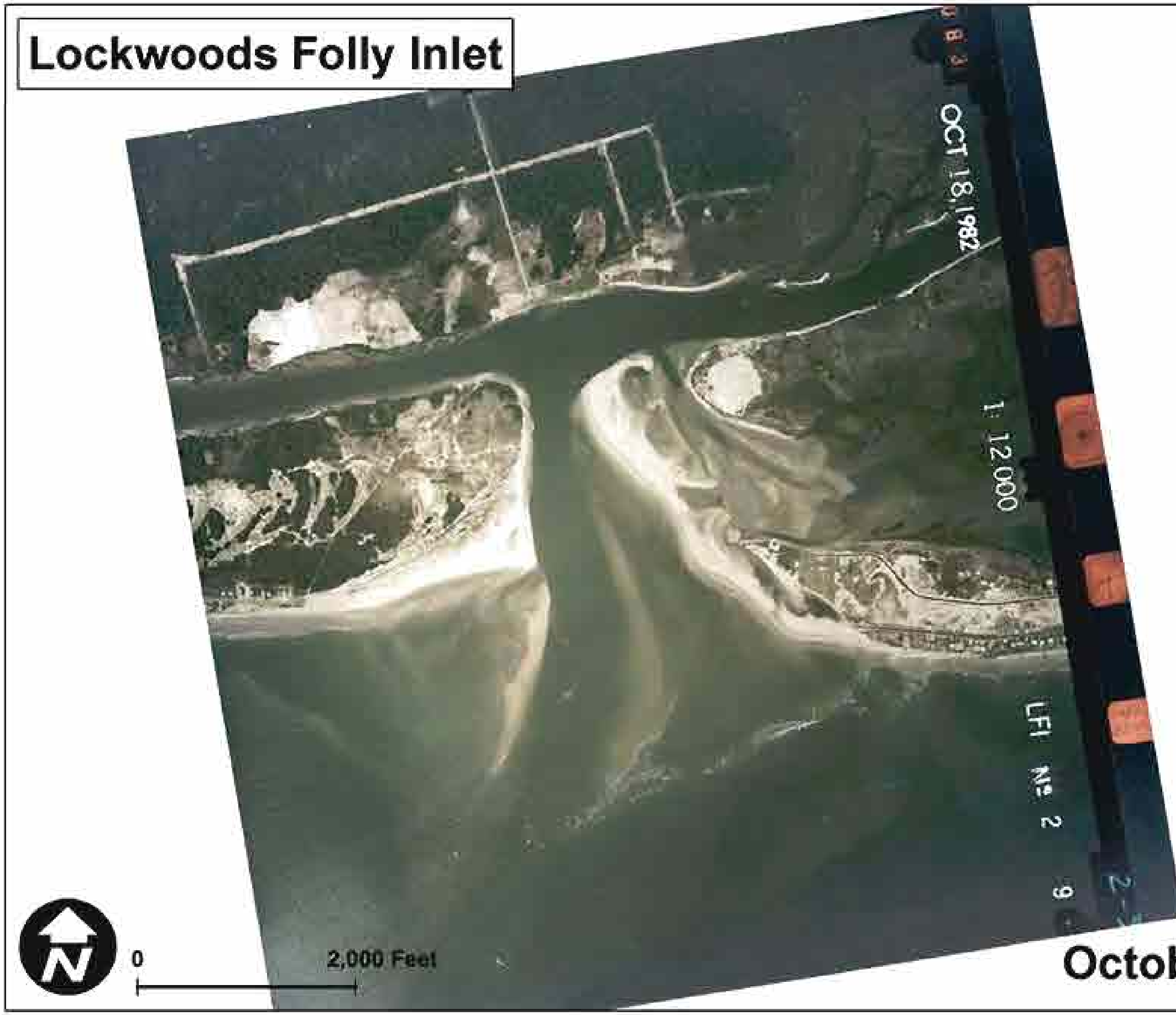


June 6, 1982

Lockwoods Folly Inlet

August 20, 1982

Lockwoods Folly Inlet

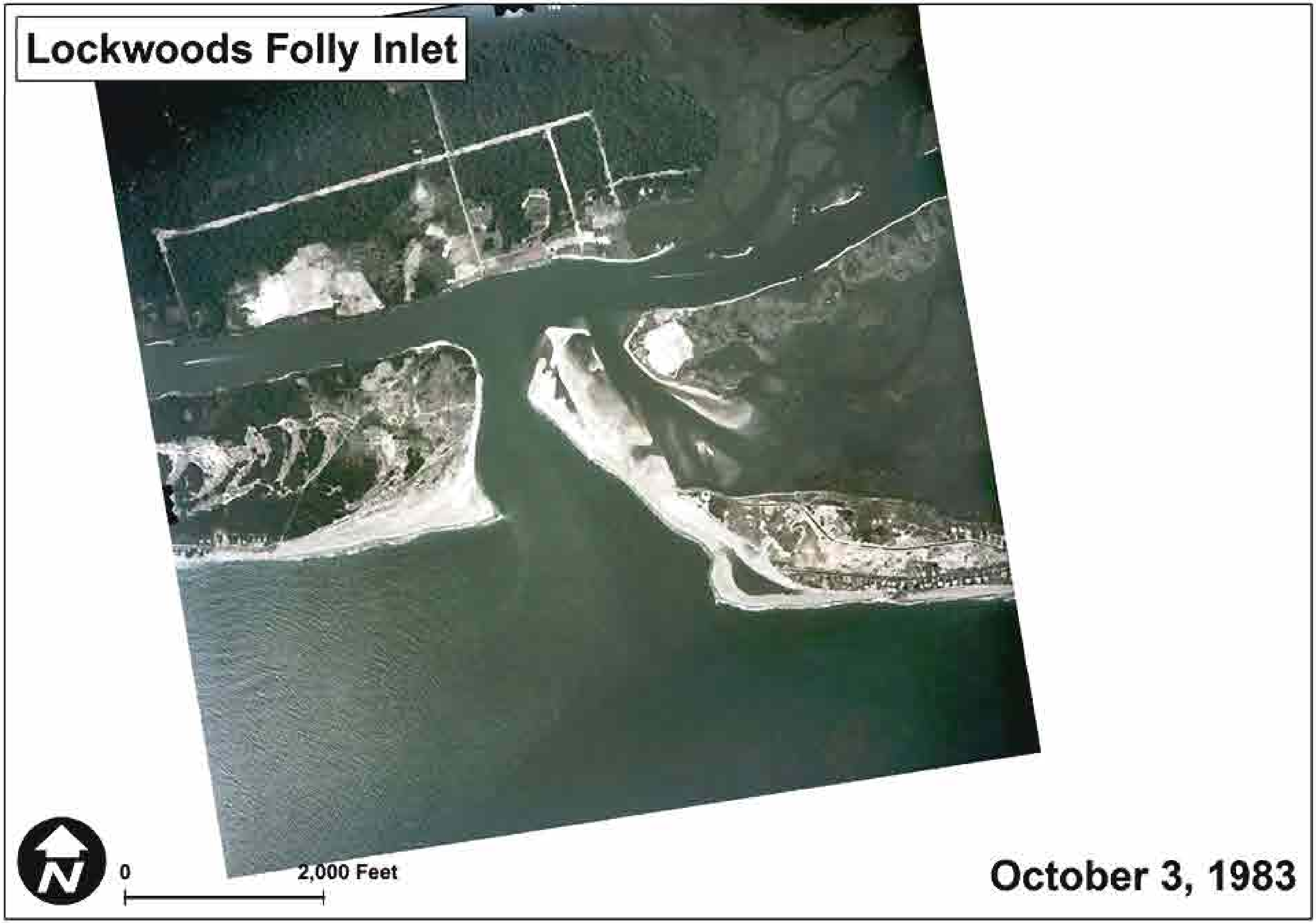


October 18, 1982

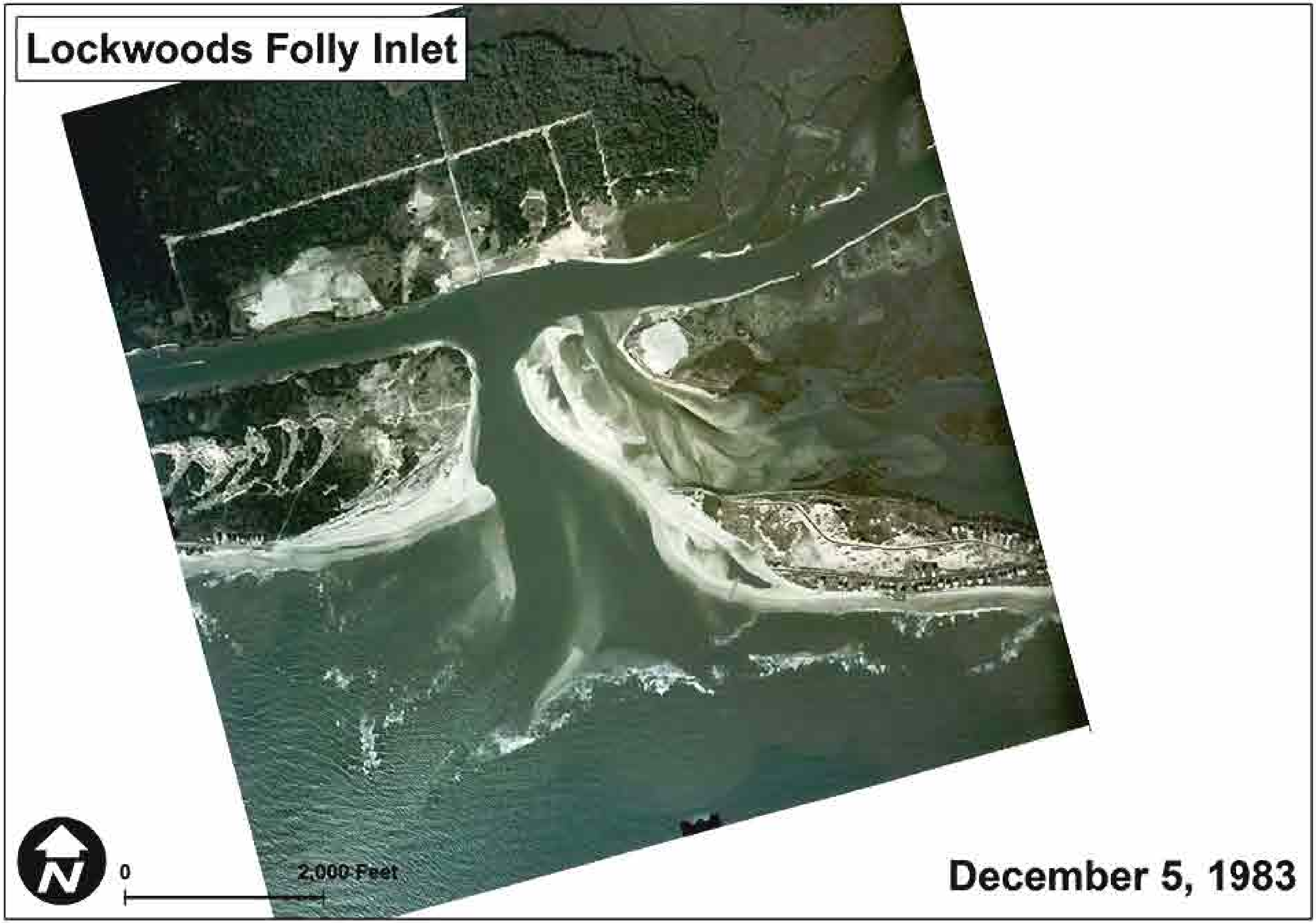
Lockwoods Folly Inlet

0 2,000 Feet

September 1983



Lockwoods Folly Inlet
N
0
2,000 Feet
October 3, 1983



Lockwoods Folly Inlet
0
2,000 Feet
December 5, 1983

Lockwoods Folly Inlet

0 2,000 Feet

February 12, 1984

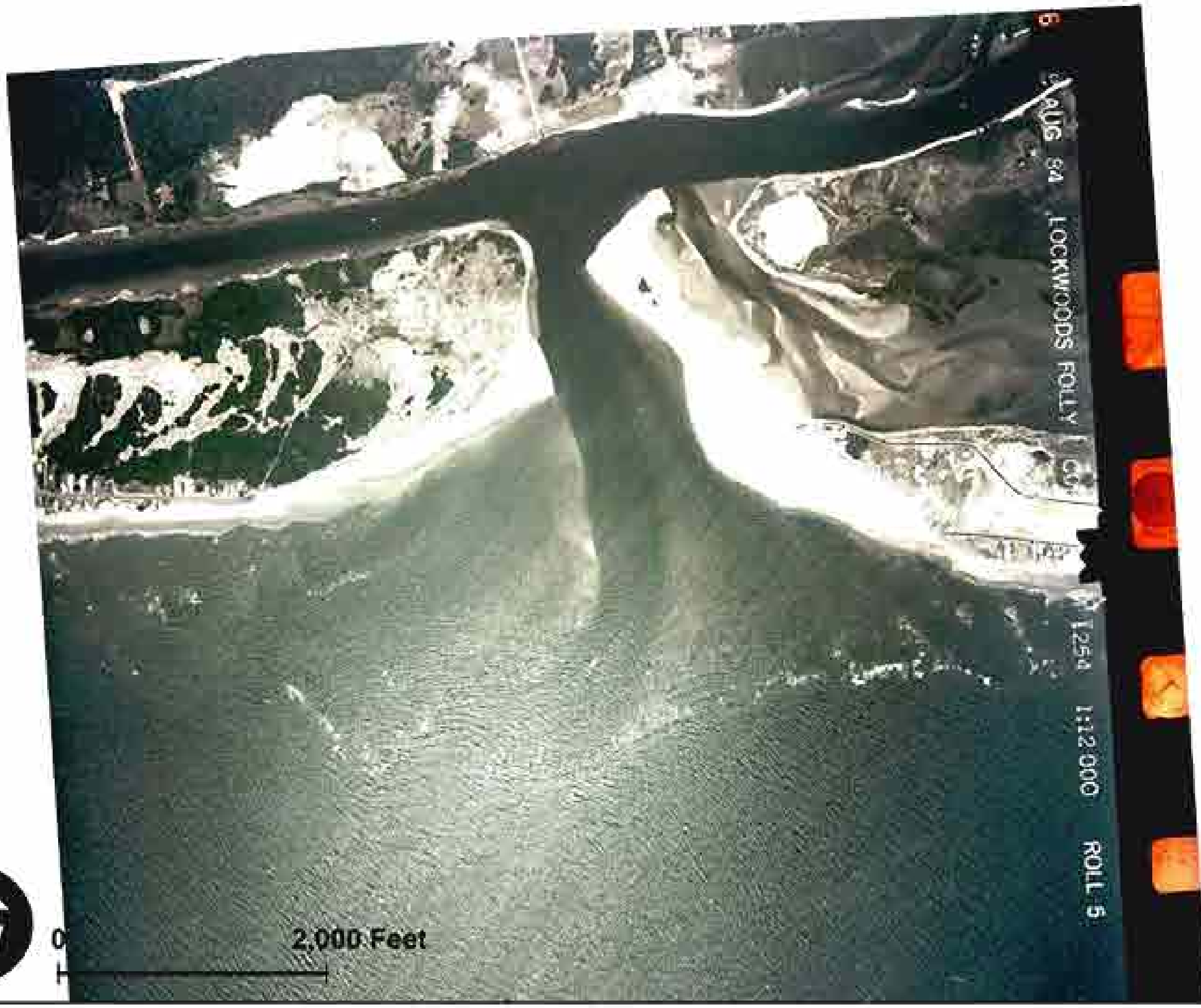
Lockwoods Folly Inlet

April 11, 1984

Lockwoods Folly Inlet

June 11, 1984

Lockwoods Folly Inlet



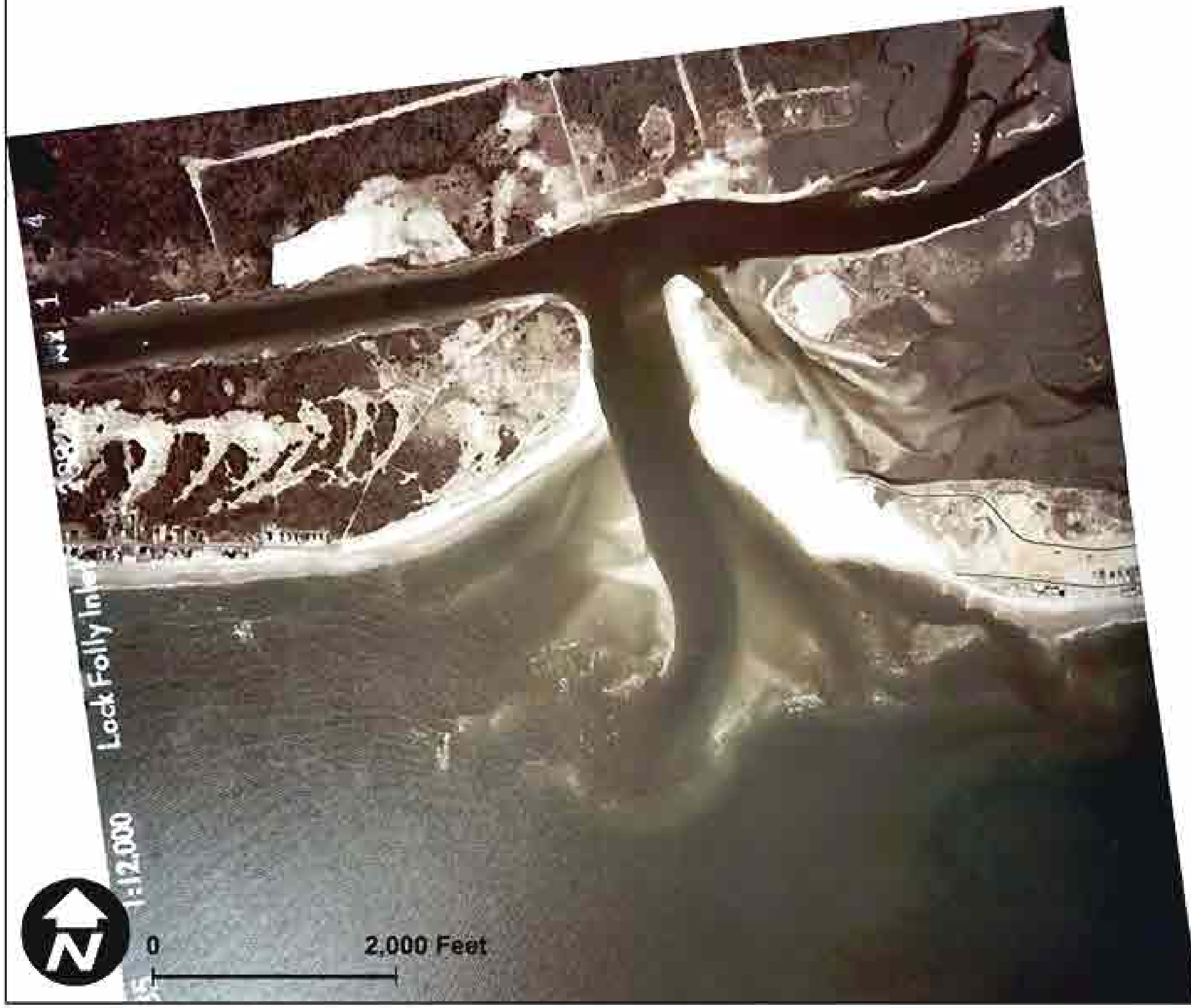
0 2,000 Feet

August 9, 1984

Lockwoods Folly Inlet

October 3, 1984

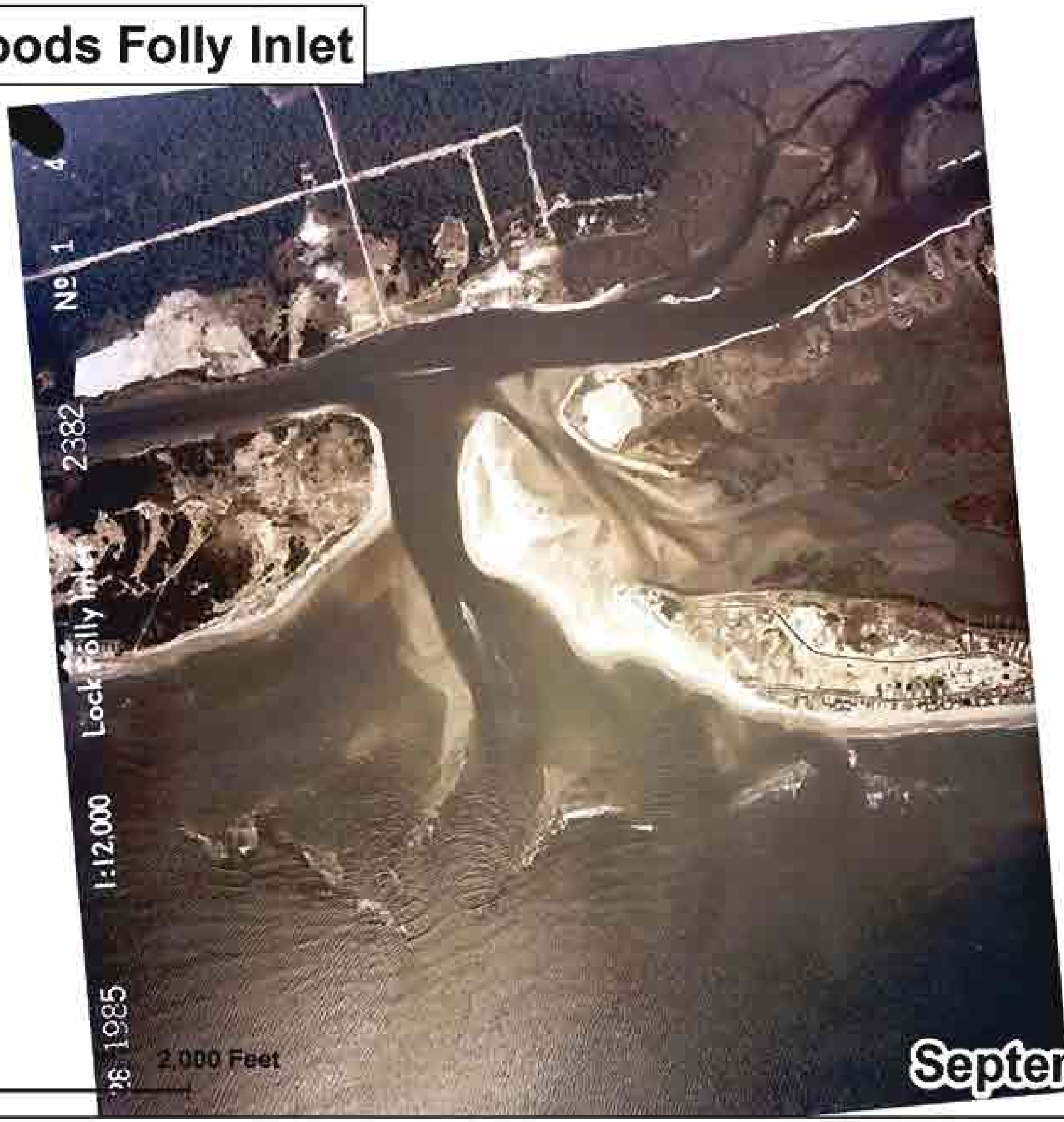
Lockwoods Folly Inlet



March 19, 1985

Lockwoods Folly Inlet

Lockwoods Folly Inlet



0 2,000 Feet

September 28, 1985

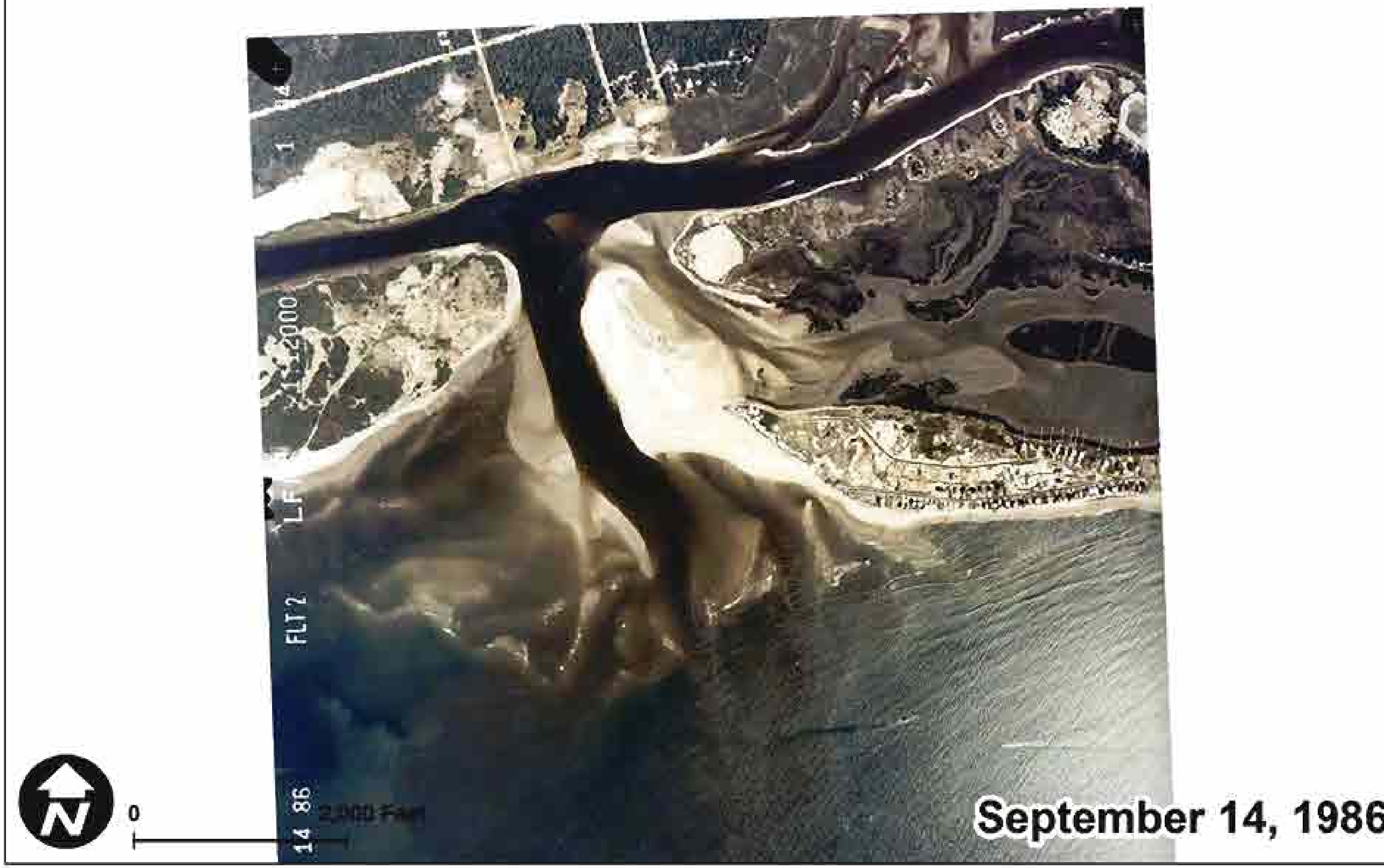
Lockwoods Folly Inlet

December 22, 1985

Lockwoods Folly Inlet

March 24, 1986

Lockwoods Folly Inlet

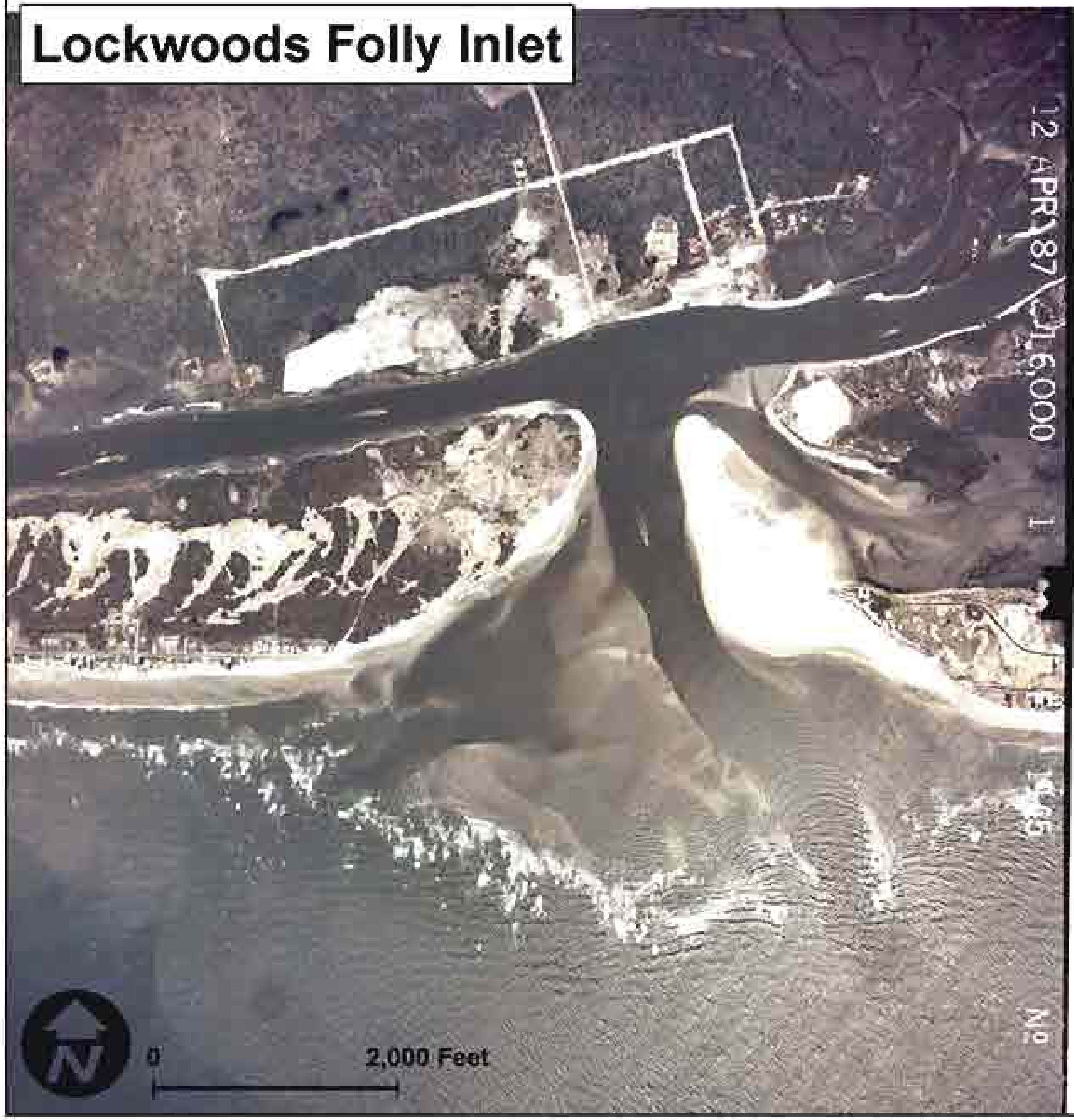


Lockwoods Folly Inlet

January 13, 1987

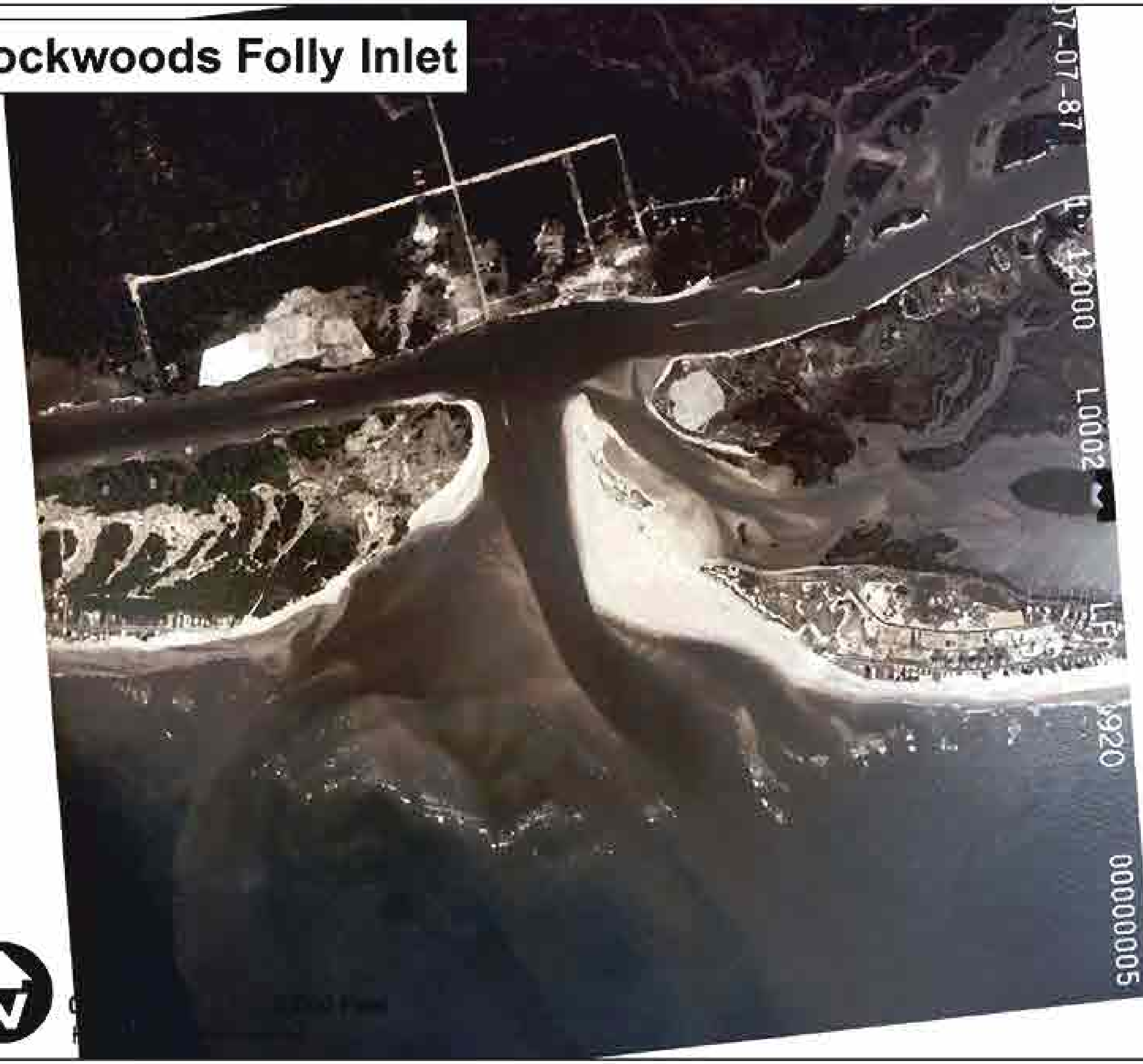
Lockwoods Folly Inlet

February 8, 1987



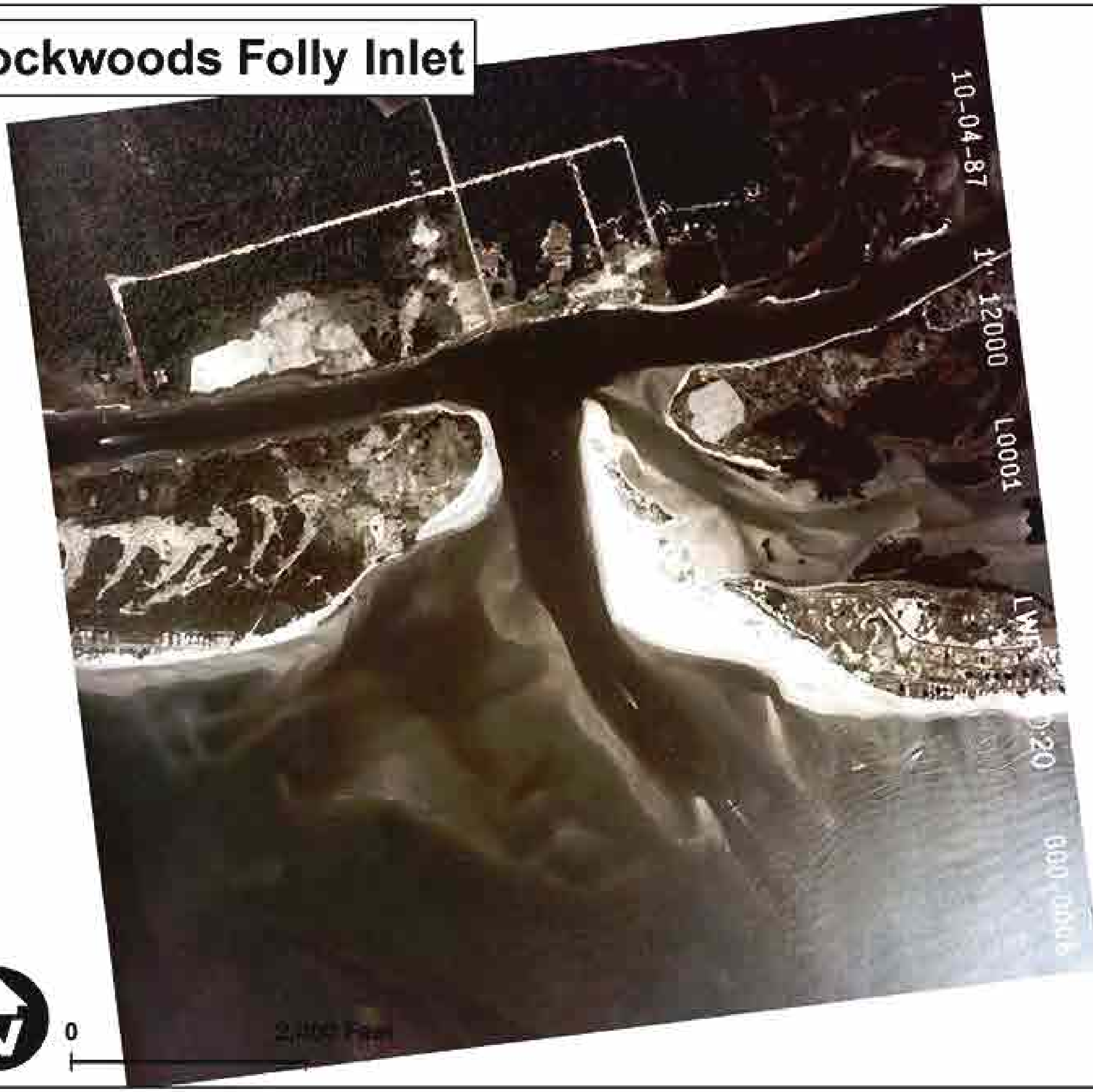
April 12, 1987

Lockwoods Folly Inlet



July 7, 1987

Lockwoods Folly Inlet



0 2,000 Feet

October 4, 1987

Lockwoods Folly Inlet

January 29, 1988

Lockwoods Folly Inlet

April 30, 1988

Lockwoods Folly Inlet

Lockwoods Folly Inlet

March 25, 1989

Lockwoods Folly Inlet

October 9, 1989

Lockwoods Folly Inlet

January 11, 1990

Lockwoods Folly Inlet

April 8, 1990

Lockwoods Folly Inlet

0

May 8, 1990

Lockwoods Folly Inlet

Lockwoods Folly Inlet

0 2,000 Feet

January 14, 1991

Lockwoods Folly Inlet

May 30, 1991

Lockwoods Folly Inlet

October 19, 1991

Lockwoods Folly Inlet

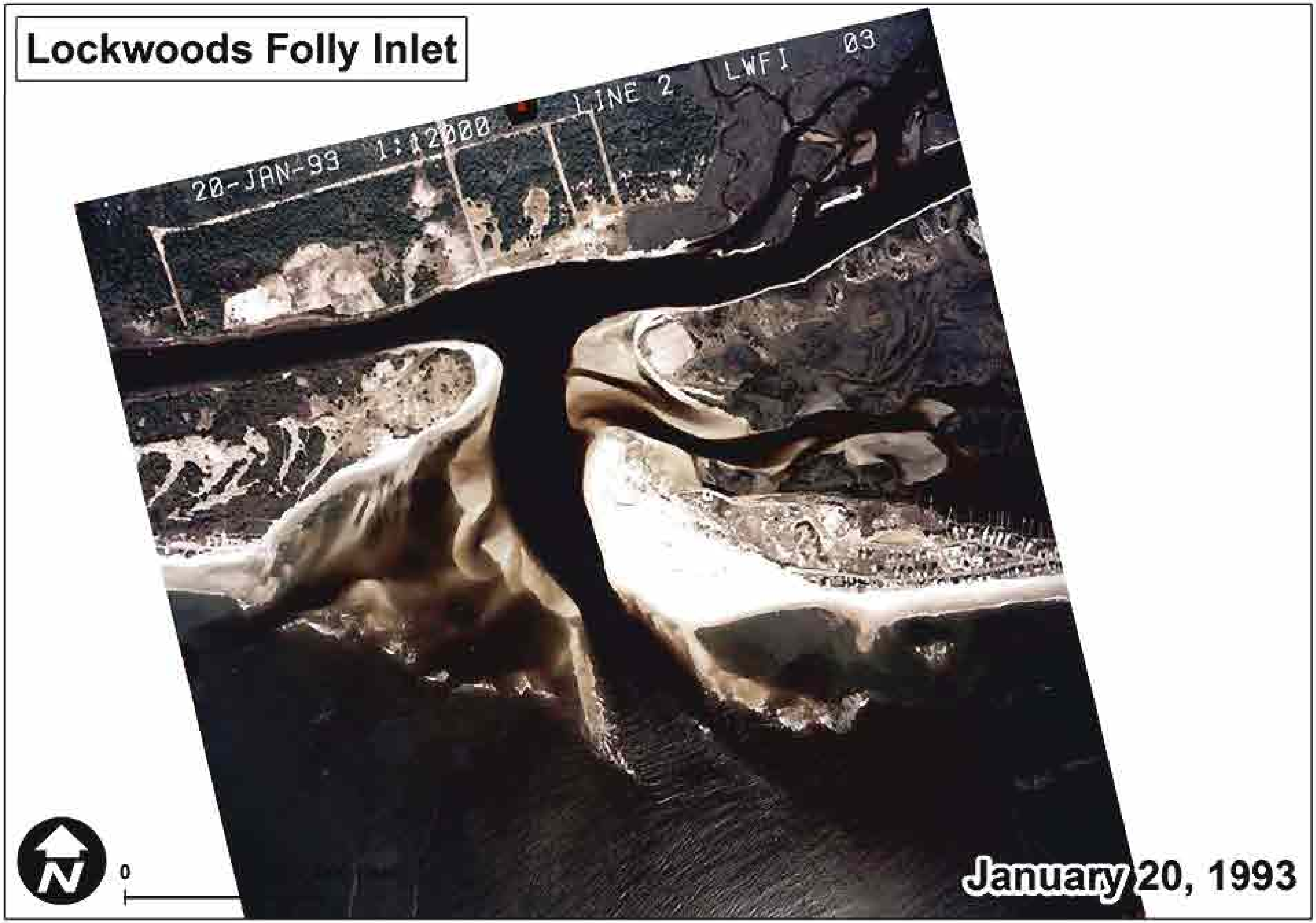
Lockwoods Folly Inlet

May 4, 1992

Lockwoods Folly Inlet

November 8, 1992

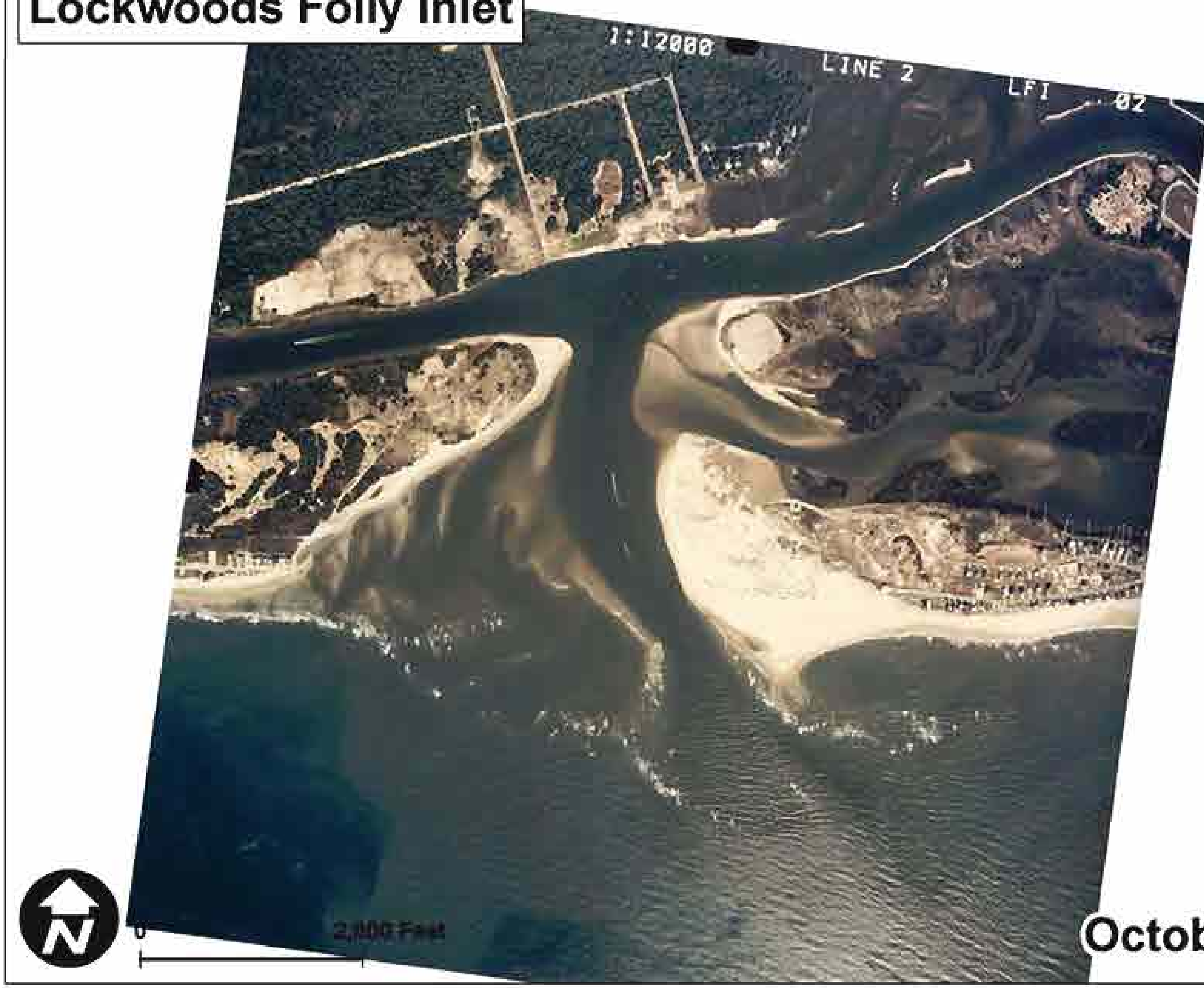
Lockwoods Folly Inlet



Lockwoods Folly Inlet

July 6, 1993

Lockwoods Folly Inlet



October 29, 1993

Lockwoods Folly Inlet

Lockwoods Folly Inlet

Lockwoods Folly Inlet

April 7, 1994

Lockwoods Folly Inlet

0 2,000 Feet

November 13, 1994

Lockwoods Folly Inlet

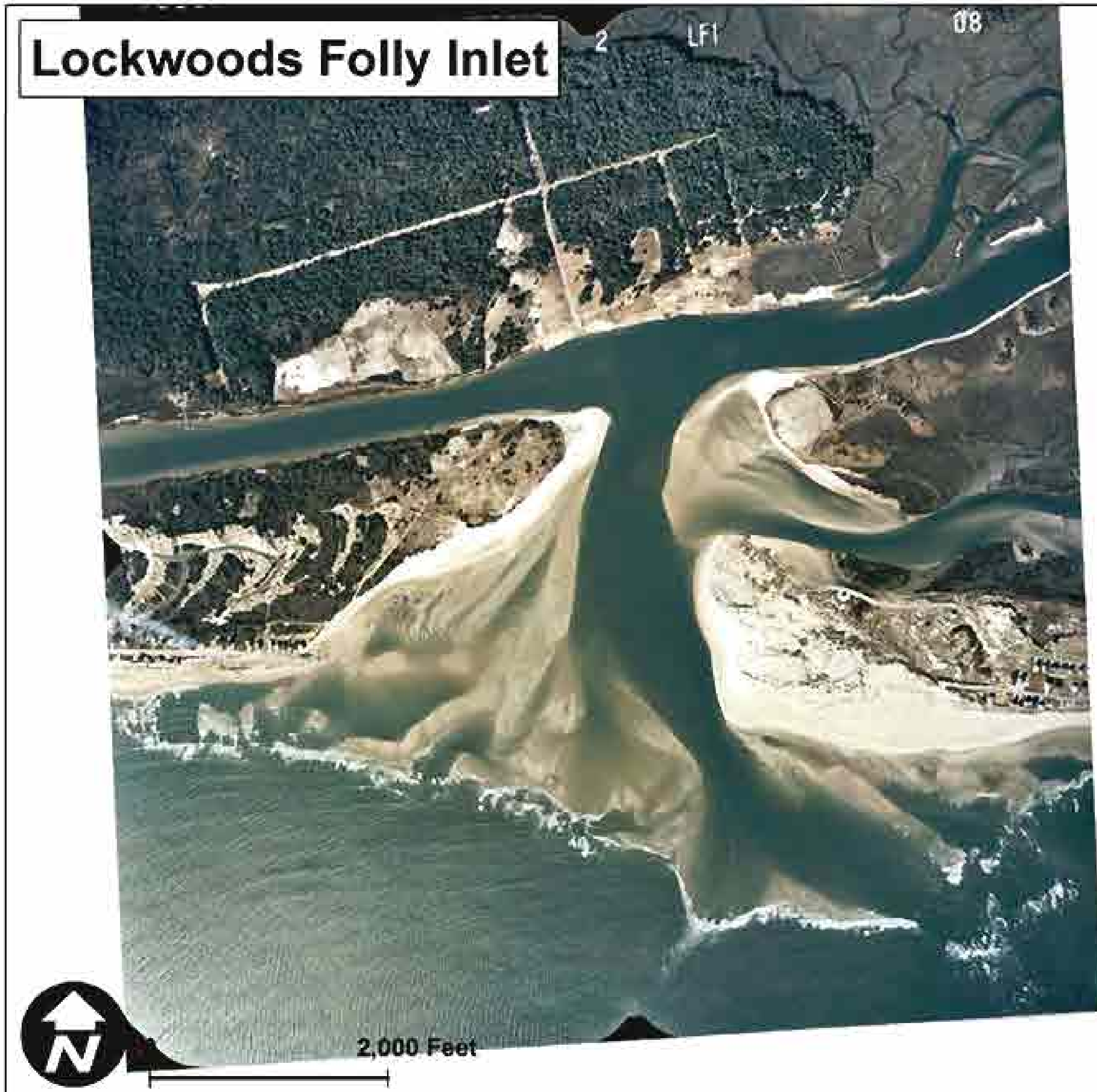
Lockwoods Folly Inlet

0 2,000 Feet

April 15, 1995


Lockwoods Folly Inlet
11 9 95
1:12000
LFI
03
0
2,000 Feet
November 9, 1995

Lockwoods Folly Inlet



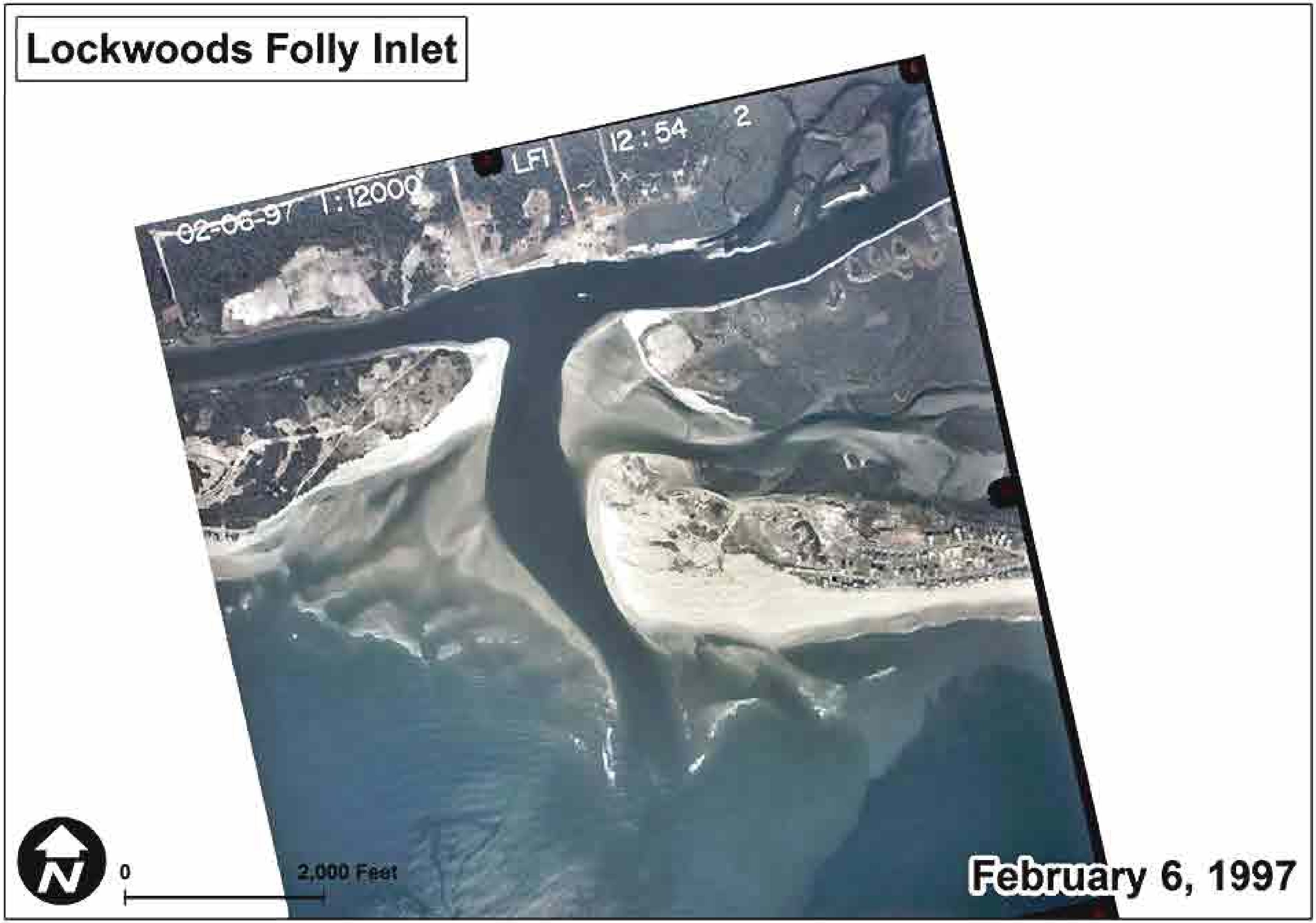
January 22, 1996

Lockwoods Folly Inlet

Lockwoods Folly Inlet

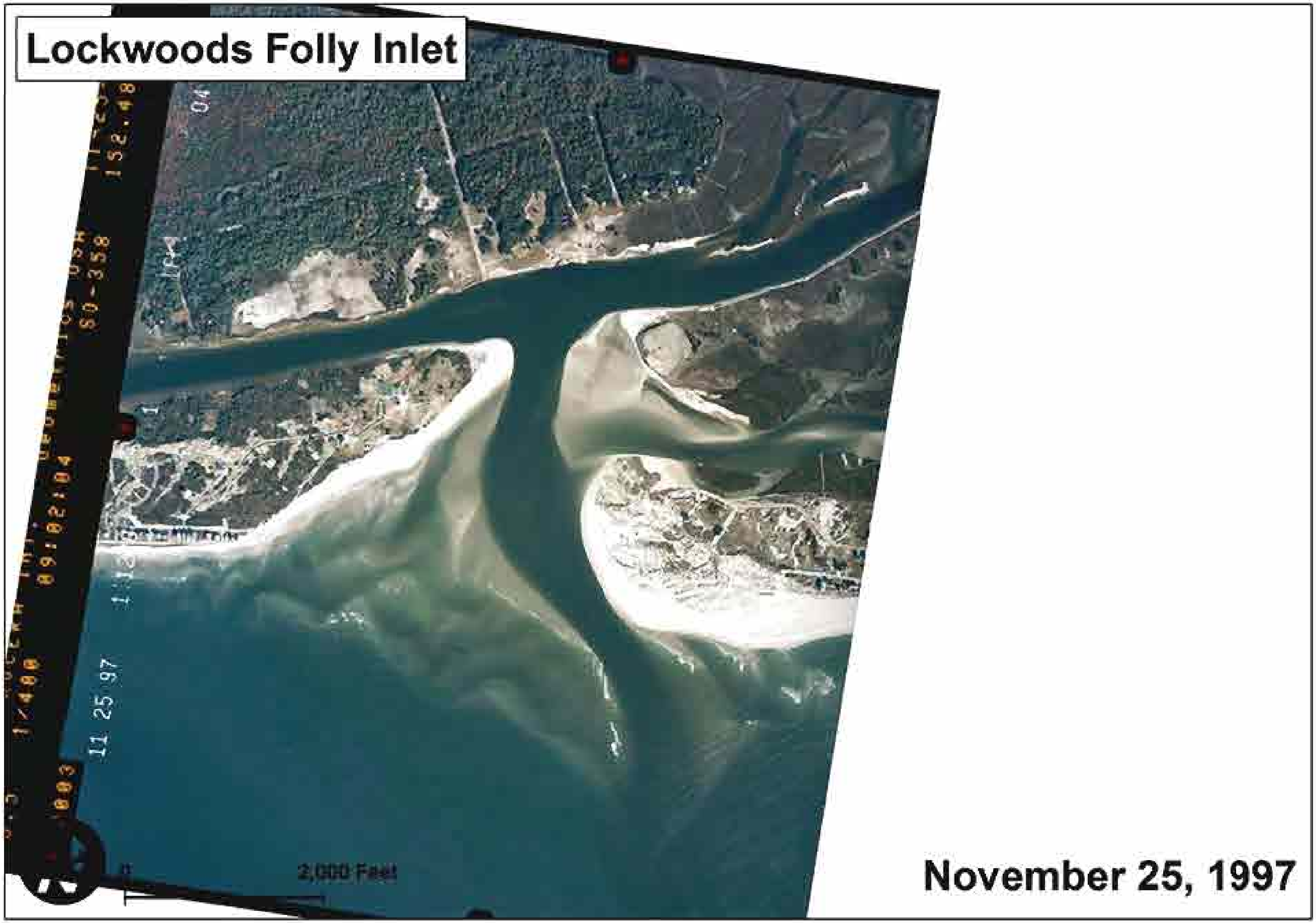
September 15, 1996

Lockwoods Folly Inlet

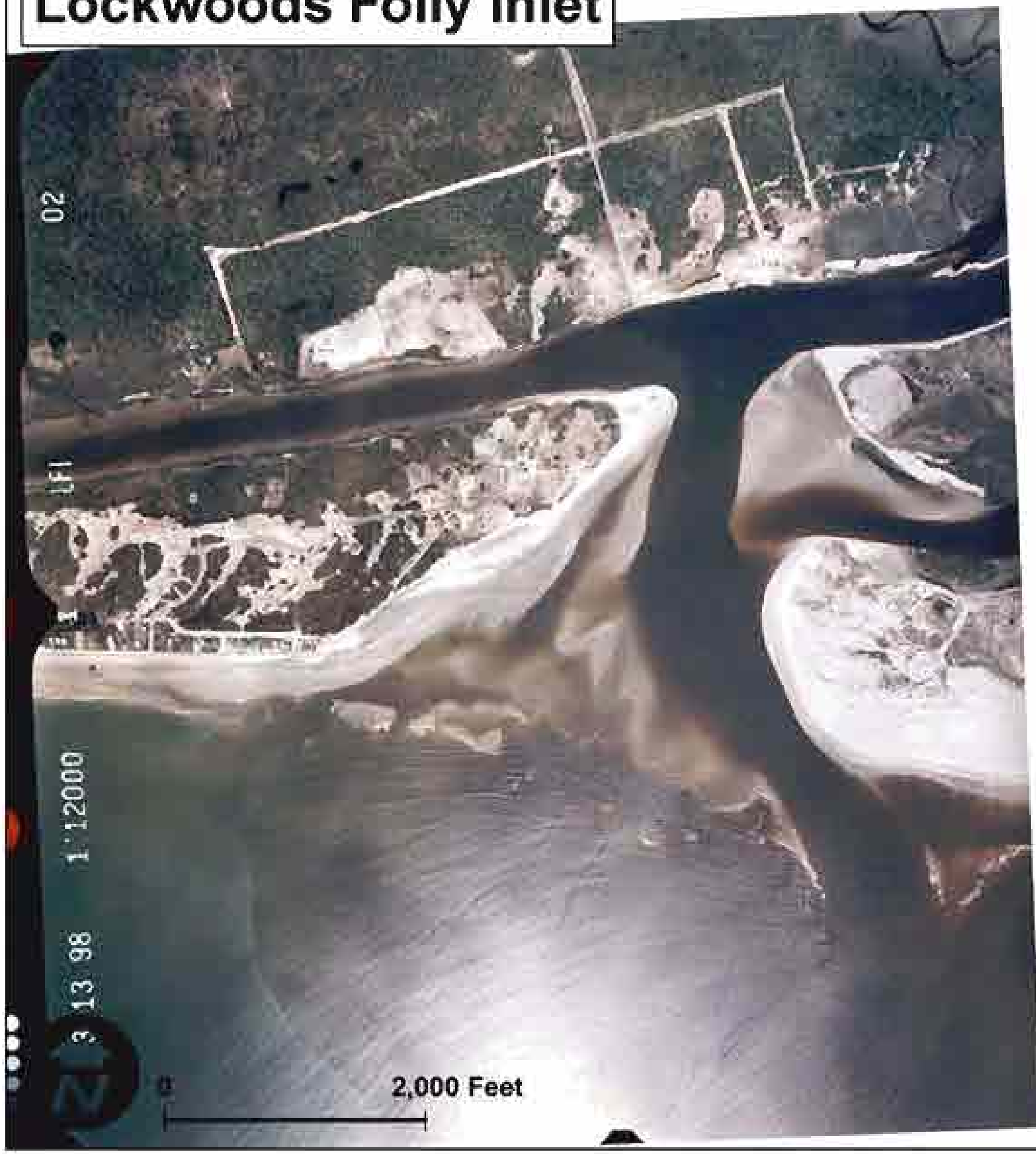

Lockwoods Folly Inlet
02-06-97 1:12000 LFI 12:54 2
0
2,000 Feet
February 6, 1997

Lockwoods Folly Inlet

May 18, 1997


Lockwoods Folly Inlet
0
2,000 Feet
November 25, 1997

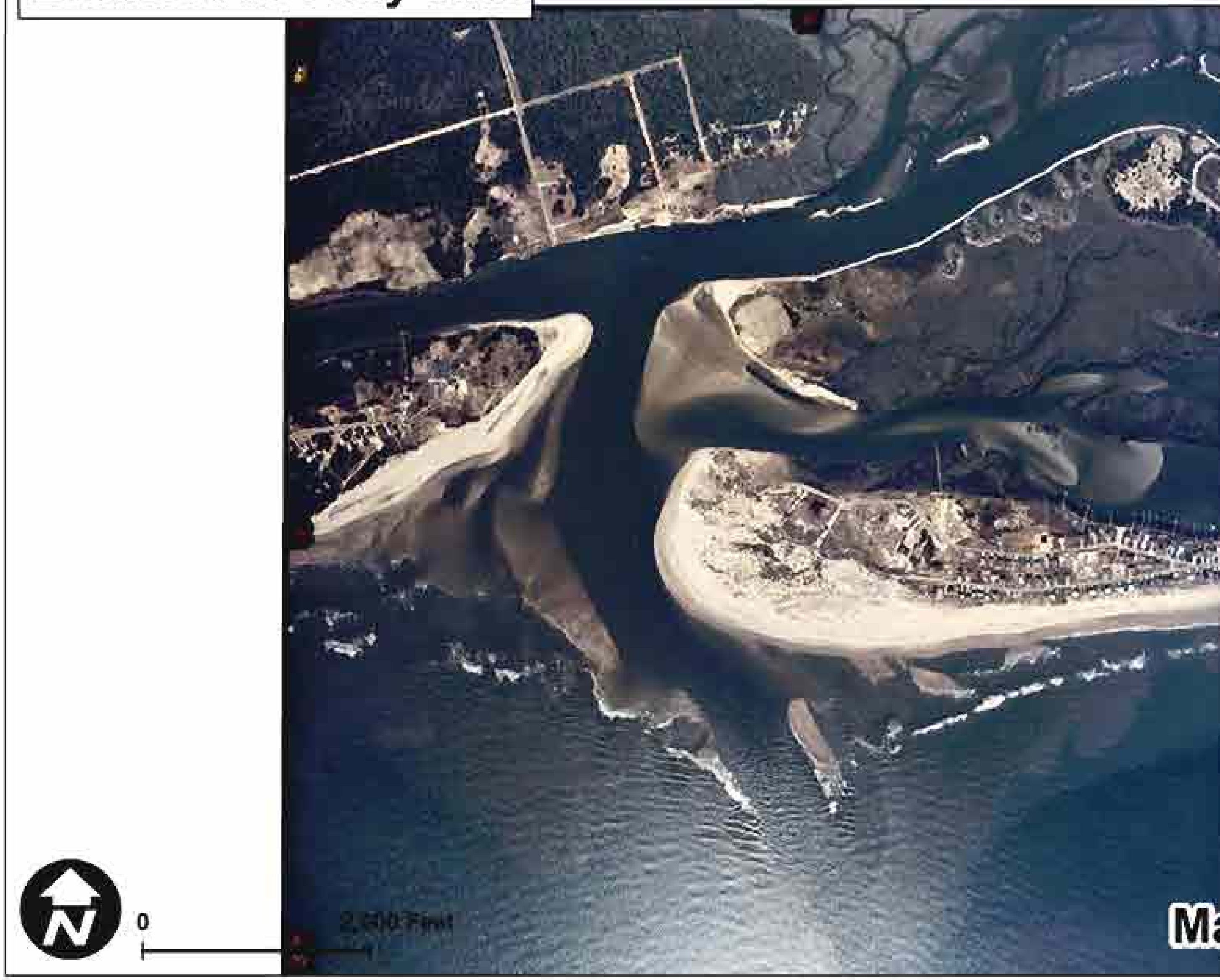
Lockwoods Folly Inlet



March 13, 1998

Lockwoods Folly Inlet

Lockwoods Folly Inlet

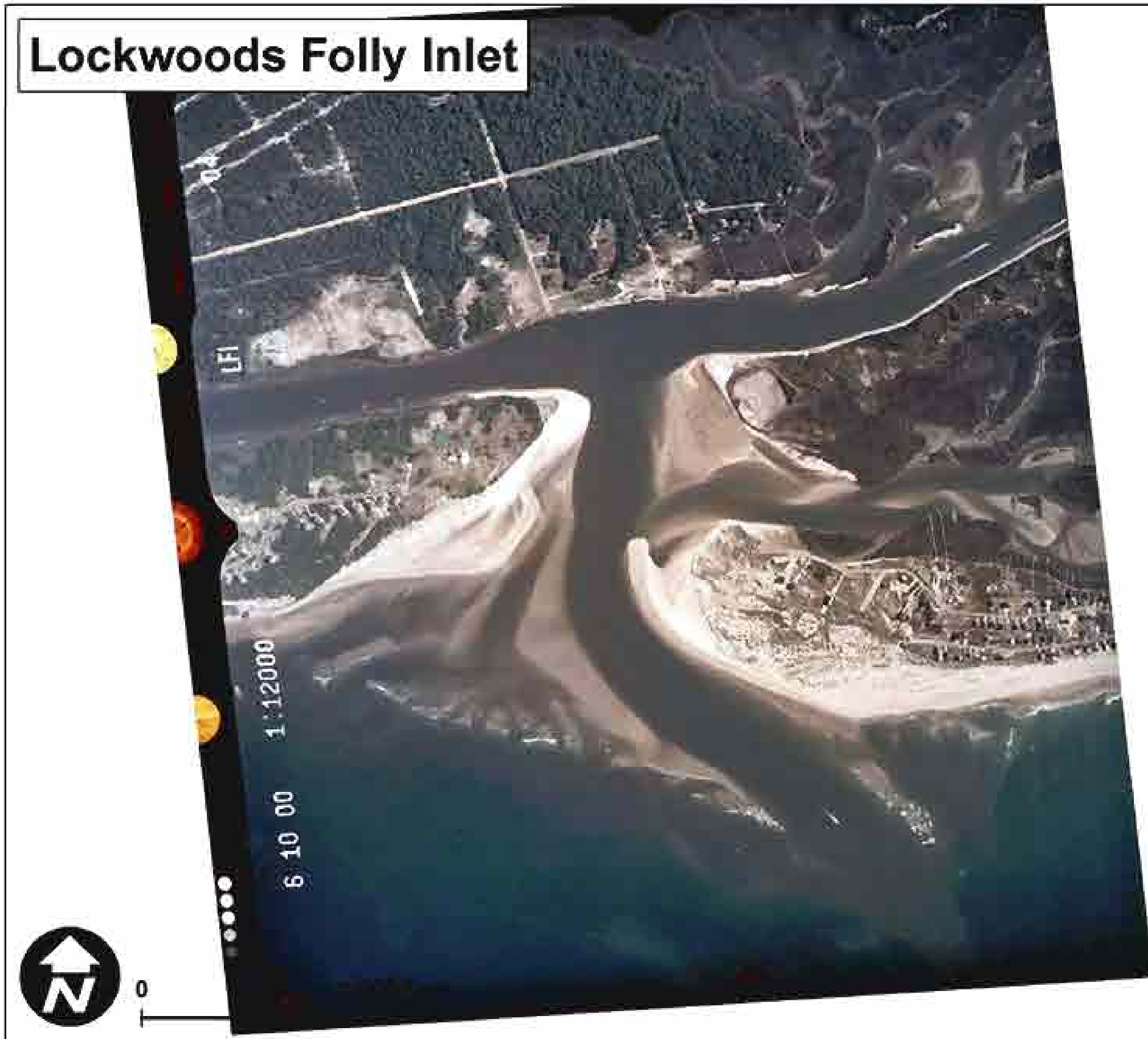


March 2, 1999


Lockwoods Folly Inlet
04
11 6 99 1 12000
0
November 6, 1999

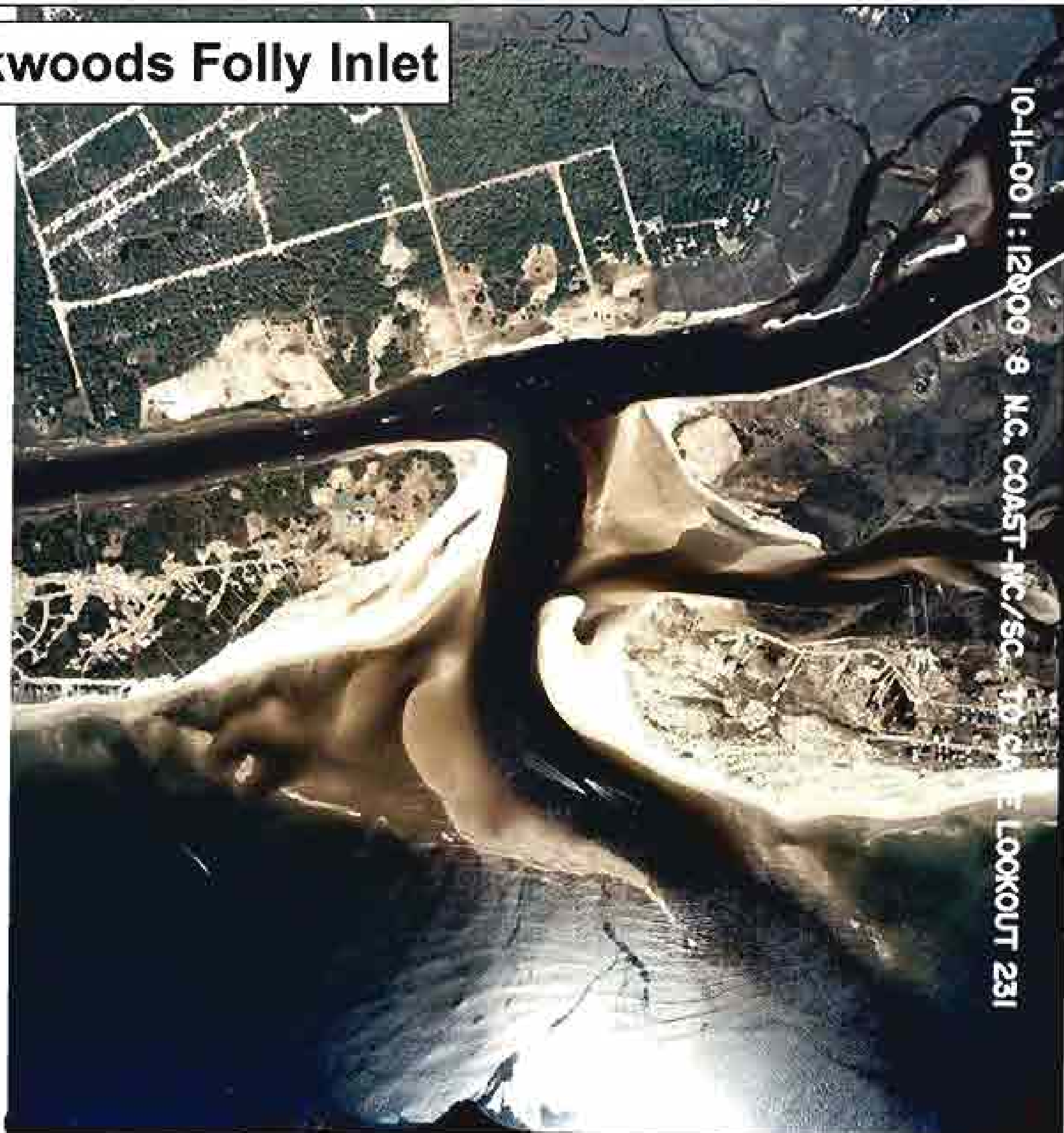

Lockwoods Folly Inlet
N
0
2,000 Feet
April 5, 2000

Lockwoods Folly Inlet



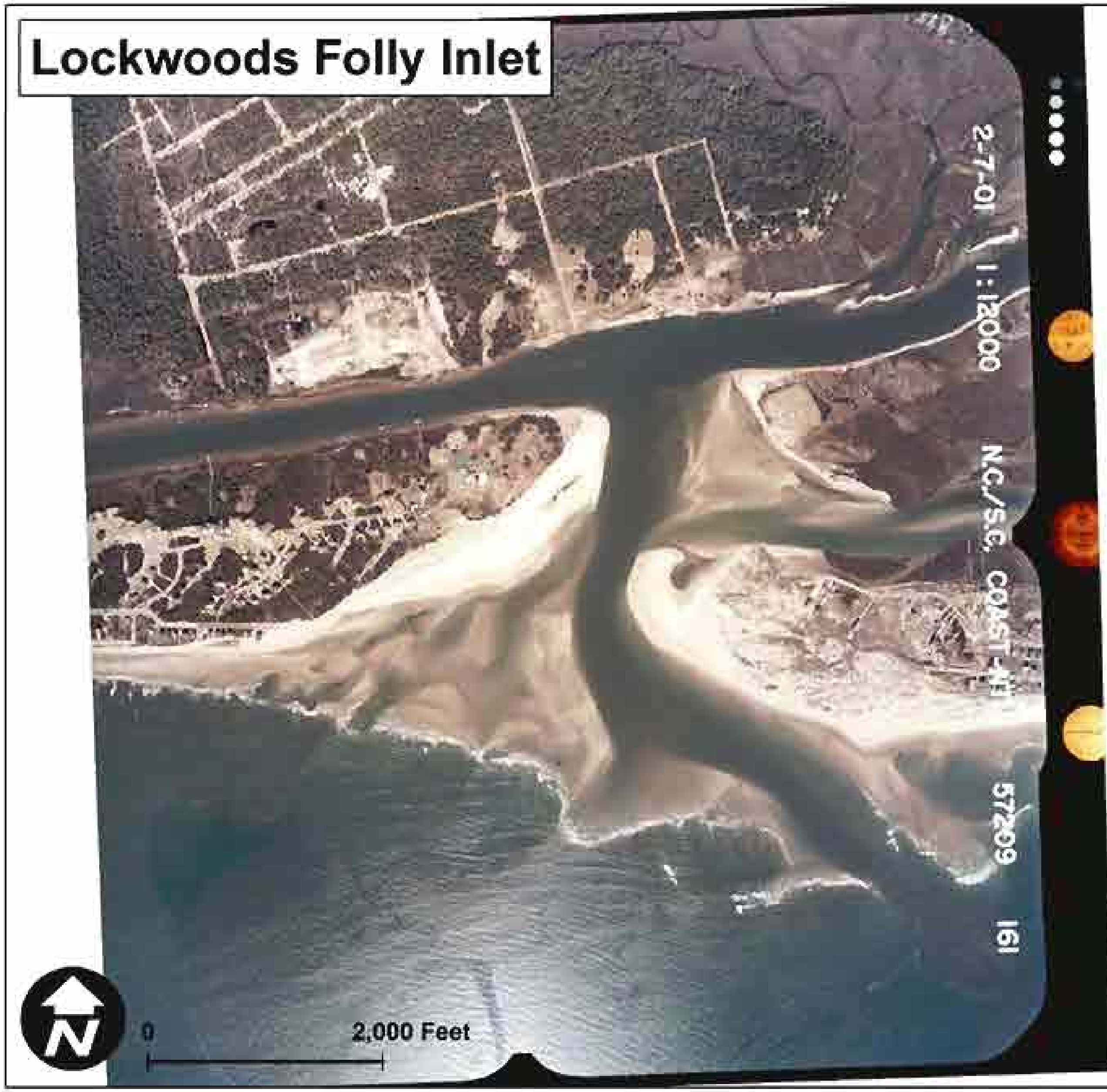
June 10, 2000

Lockwoods Folly Inlet



October 11, 2000

Lockwoods Folly Inlet



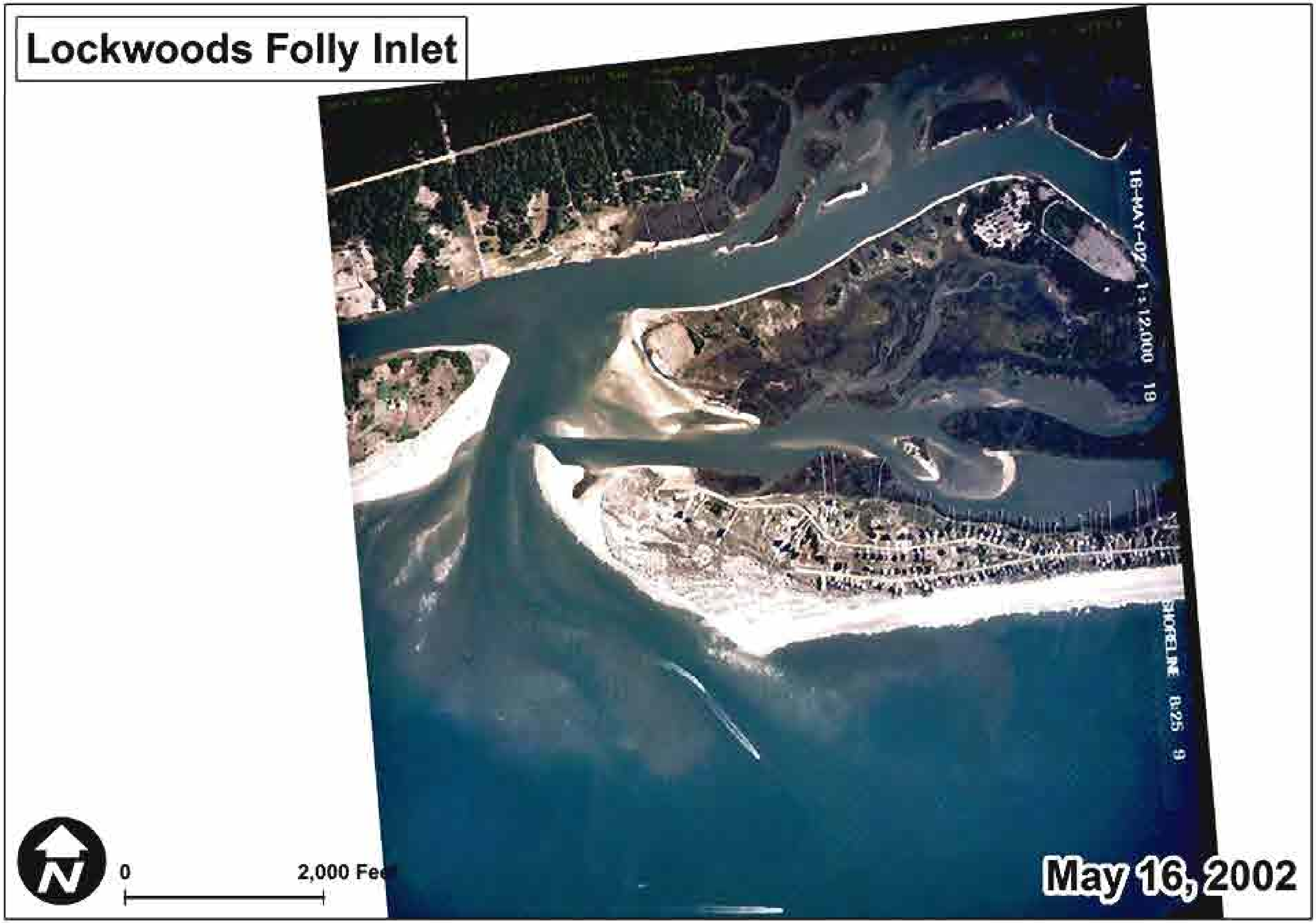
February 7, 2001

Lockwoods Folly Inlet

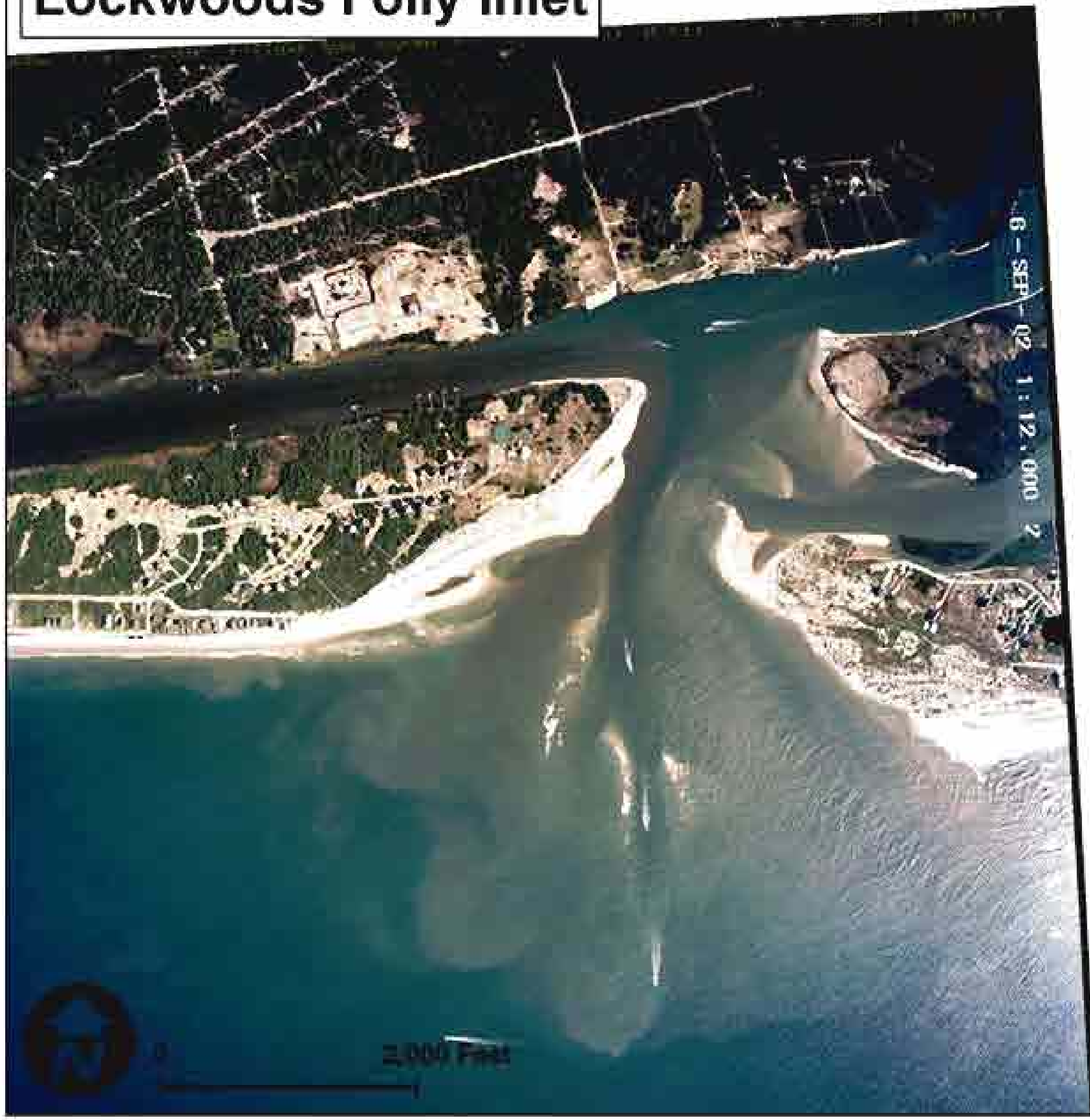

Lockwoods Folly Inlet
0
2,000 Feet
June 30, 2001

Lockwoods Folly Inlet

September 28, 2001


Lockwoods Folly Inlet
0
2,000 Feet
May 16, 2002

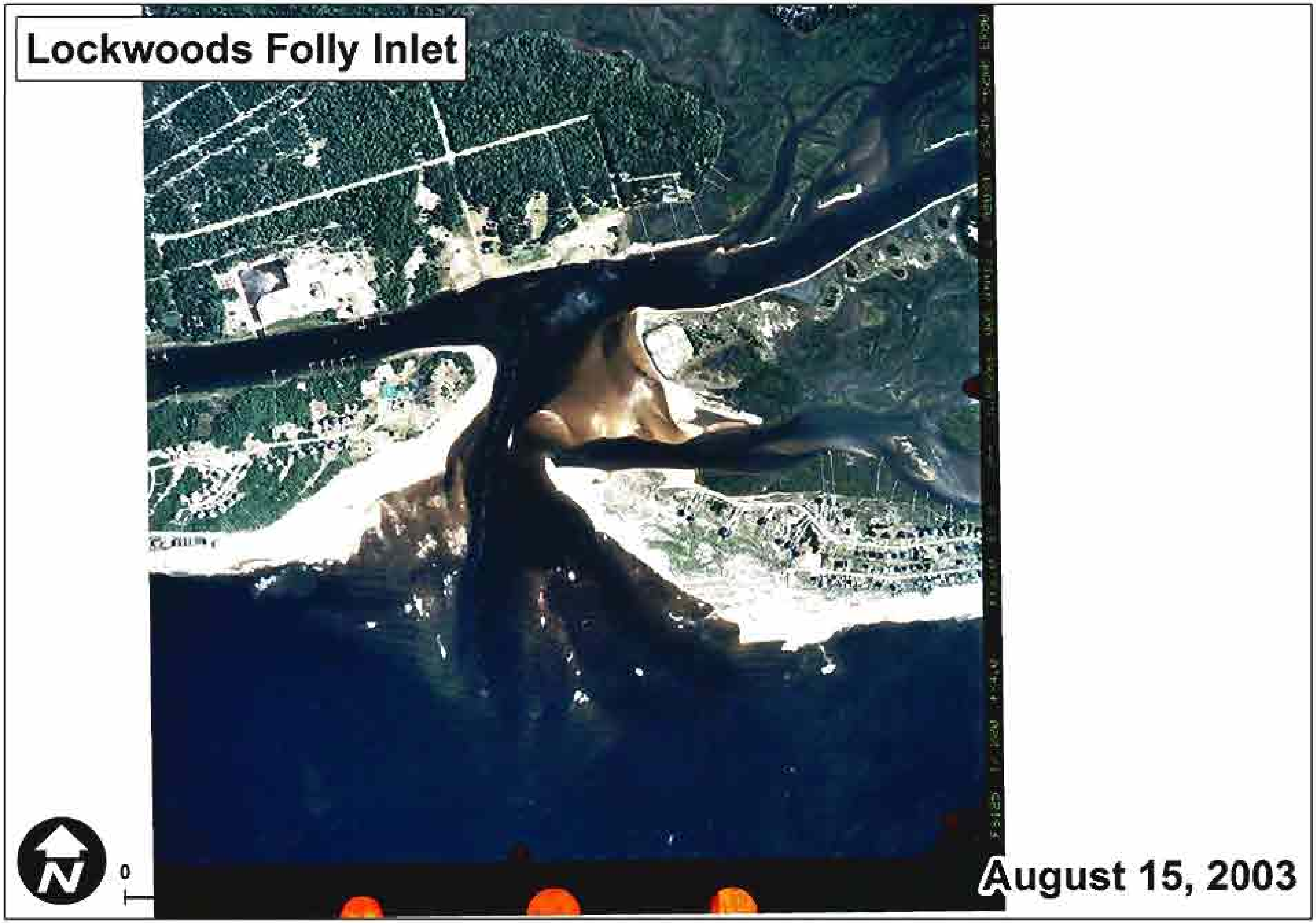
Lockwoods Folly Inlet



September 6, 2002

Lockwoods Folly Inlet

Lockwoods Folly Inlet


Lockwoods Folly Inlet
0
August 15, 2003

Lockwoods Folly Inlet

October 13, 2003


Lockwoods Folly Inlet
0
2,000 Feet
March 2004

Lockwoods Folly Inlet

June 1, 2004


Lockwoods Folly Inlet
0
2,000 Feet
N
2005

Lockwoods Folly Inlet
0
2,000 Feet
N
2006

Lockwoods Folly Inlet
0
2,000 Feet
N
February 20, 2008

APPENDIX L

ANNOTATED BIBLIOGRAPHY OF NEARSHORE AND ESTUARINE FISHERIES

ANNOTATED BIBLIOGRAPHY:

Nearshore and Estuarine Fisheries Data
North Carolina and South Carolina Inlets
(With Emphasis on Inlets of the Cape Fear Region)

Prepared for

Village of Bald Head Island Shoreline Protection Project

1. **Birkhead, W.A. et al. 1979.** Ecological monitoring in the lower Cape Fear estuary, 1971-1976. Report 79-1. Carolina Power and Light Company, Raleigh, North Carolina. 292 pp.

   Carolina Power and Light Company. 1979. Brunswick Steam Electric Plant, Ocean Larval Fish, November 1976-August 1978. Environmental Technology Section. 119 pp.

   Carolina Power and Light Company. 1985. Brunswick Steam Electric Plant, Cape Fear Studies, Interpretive Report. Environmental Technology Section. 93 pp.

   Carolina Power and Light Company. 1992. Brunswick Steam Electric Plant, 1992 Biological Monitoring Report. Environmental Technology Section. 60pp.

   <u>Location of Studies</u>: Lower Cape Fear River Estuary, NC.

   <u>Synopsis of Studies</u>: As part of Carolina Power and Light's NPDES Permit NC0007064, CP &L, now Progress Energy, embarked on a multi–decade, comprehensive biological monitoring program to describe the offshore concentrations and changes in density over time of commercially important taxa in the nearshore and estuarine environments of the Cape Fear River Estuary. Beginning in 1971 and continuing through 1992, fish and invertebrate taxa were sampled, identified and monitored for changes in abundance, seasonality, or recruitment to the estuary via impingement resulting from the normal operations and modification of the Brunswick Electric Steam Plant's (BESP) water intakes. More than 40 taxa (CP&L, 1979) of fish and invertebrates were identified with 9 (CP&L,1992) commercially significant species (Atlantic menhaden, bay anchovy, spot, croaker, southern flounder, brown shrimp, pink shrimp, white shrimp, and blue crab) studied in 5 different locations throughout the Cape Fear River Estuary. Conclusions (as of the 1992 biological monitoring report) were that the normal operations of the BESP have not adversely affected the typical species composition,

seasonal occurrence, and spatial distribution of dominant fish and shellfish in the Cape Fear Estuary.

2. **Hackney, C.T., M. Posey, S. Ross, and A. Norris. 1996.** A Review and Synthesis of Data on Surf Zone Fishes and Invertebrates in the South Atlantic Bight and the Potential Impacts from Beach Renourishment. For Wilmington District, US Army Corps of Engineers, Wilmington, North Carolina.

   Location of Study: South Atlantic Bight (SAB) (Cape Hatteras, NC to Cape Canaveral, FL) with special emphasis on North Carolina.

   Synopsis of Study: The paper provides a thorough review of fishes and benthic invertebrates most common in the surf zone along the South Atlantic Bight. The study identified 130 different taxa found in the surf zone of the SAB with 40 of those occurring in North Carolina. Discussion of life histories of 9 fish species and 5 invertebrate groups that are important to humans for food and recreation as well as other important species found in the surf zone of the SAB and to provide recommendations on future management and biological monitoring needs as they relate to repeated beach renourishment of the barrier islands of the Southeastern United States.

3. **Markovsky, W.C. 2004.** The role of the Cape Fear River discharge plume in fisheries production: aggregation and trophic enhancement. A Thesis submitted to the University of North Carolina at Wilmington. Department of Biological Sciences. 86 pp.

   Location of Study: The Cape Fear River and nearshore waters, NC.

   Synopsis of Study: The thesis study examined the effects of small river plumes such as the Cape Fear River on the overall abundance of larval fish abundance compared to the less turbid waters of the adjacent waters and to compare this with other known plume effects of larger rivers like the Mississippi River. Conclusions of this study suggest that smaller river plumes also have higher concentrations of ichthyoplancton possibly suggesting greater larval aggregation compared to the adjacent waters but more research is needed to fully understand these processes. Note that sampling included a station west of Bald Head Island in the mouth of the Cape Fear River.

4. **Moser, M. L., and S. W. Ross. 1993.** Distribution and movements of shortnose sturgeon (Acipenser brevirostrum) and other anadromous fishes of the lower Cape Fear River, North Carolina. Final Report to the U.S. Army Corps of Engineers, Wilmington, North Carolina.

Moser, M.L. and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the Low Cape Fear River, North Carolina. Transactions of the American Fisheries Society. 124 (2): 225-235.

Location of Studies: Cape Fear River, NC.

Synopsis of Studies: To provide life history, distribution of and habitat requirements of shortnose and Atlantic sturgeons as well as other anadromous fish species known to occur in the Cape Fear River such as striped bass and American shad.

5. **Versar, Inc. 2003.** Effects of dredged material beach disposal on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island and Holden Beach, NC; Interim study findings, Volume I Text. Report prepared for Frank Yelverton, USACE Wilmington District. 61pp.

Versar, Inc. 2003b. Effects of dredged material beach disposal on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island and Holden Beach, NC; Interim study findings, Volume II Figure and Tables. Report prepared for Frank Yelverton, USACE Wilmington District. 321pp.

Versar, Inc. 2004. Year 2 recovery from impacts of beach nourishment on surf zone and nearshore fish and benthic resources on Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, NC. (Final study findings). Report prepared for Frank Yelverton, USACE Wilmington District. 54pp.

Location of Studies: Bald Head Island, Caswell Beach, Oak Island, and Holden Beach, NC.

Synopsis of Studies: A two-year study evaluating the water quality and biological effects of large scale beach disposal that was conducted as part of the Cape Fear River navigational channel deepening project. Fish sampling results reported between 39 and 92 nekton species identified between the surf zone and nearshore waters depending on the sampling gear type used (haul seine, otter trawl and gillnet). Results of this sampling documented similar surf zone species as those found in the South Atlantic Bight study by Hackney et al. 1996. The final report of the two year study indicated no immediate impacts in fish abundances and diversities among disturbed, undisturbed, and reference stations at any beach.

6. **Ross, S. W. and John Bichy. 2002.** Checklist of the Fishes Documented from the Zeke's Island and Masonboro Island Components of the North Carolina National Estuarine Research Reserve. The National Estuarine Research Reserve Technical Report Series 2002:2 31pp.
Location of Study: Masonboro Island and Zeke's Island, NC.

Synopsis of Study: This report establishes baseline data to document the two Reserves (Masonboro Island and Zeke's Island) ichthyofauna and is to serve as a benchmark to measure future changes. This effort documents 155 and 103 fish species, representing 58 families, so far recorded from Masonboro Island and Zeke's Island NCNERR components, respectively.

7. **Ross, S. W. and Johnny E. Lancaster. 1996.** Movements of juvenile fishes using surf zone nursery habitats and the relationship of movements to beach nourishment along a North Carolina beach: Pilot project. Final Report to NOAA Office of Coastal Resource Management and the U. S. Army Corps of Engineers (Wilmington District) for NOAA Award No. NA570z0318. 31p.

Location of Study: Masonboro Island and Carolina Beach, NC.

Synopsis of Study: This study showed that two dominant fishes, Florida pompano and Gulf kingfish, using the surf zone as a nursery area exhibited a strong fidelity to small areas of the beach. Since these fishes are quite mobile, this suggests that resources at most beach locations where they initially settle are not limiting or that predation pressures are not high enough to cause large scale movements during the nursery period. Through the use of small coded wire tags it was determined through consistent recaptures of individuals in the same vicinity that large sections of the surf zone are functionally independent habitats.

8. **Hettler Jr., W. F. and C. J. Chester. 1990.** Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. Marine Ecology Progress Series 68:157-168.

Location of Study: Beaufort Inlet, NC

Synopsis of Study: This study provides a database on the species, numbers, and sizes of larval/early juvenile fishes in a North Carolina inlet throughout the entire year. Species were classified into 3 main temporal assemblages: winter and early spring, late spring, and summer. All species collected during winter were advanced post flexion larvae or juveniles, while many of the spring/summer species were pre-flexion and flexion larvae. At total of 74 species or genera representing 34 families were collected during the study. Anchovy dominated the non-winter catches.

Variability in observed total fish densities between hauls within collections was high. About one-third of the species found in the collections later utilized nearby marshes as a nursery habitat.

9. **Hettler Jr., W. F. and D. L. Barker. 1993.** Distribution and abundance of larval fishes at two NC Inlets. Estuarine, Coasts and Shelf Science. 37, 161-179.

   Location of Study: Oregon Inlet, NC and Ocracoke Inlet, NC.

   Synopsis of Study: Oregon Inlet and Ocracoke Inlet were quantitatively sampled for larvae at new moon monthly intervals during 1988-89. Stations inside of both inlets were sampled both during day and night at single stations. Oregon inlet, located in a more temperate marine province, was expected to have a different taxonomic community than Ocracoke Inlet, but, of 77 taxa collected from both inlets, 54 occurred at both inlets. Documented differences in lowest and highest abundances were reported for each inlet with Oregon Inlet lowest occurring in Feb. and highest in late August. Ocracoke Inlet had it's lowest in November highest in June. The highest percentage of larval abundance differed at each site with the majority of larvae capture near the bottom at Oregon Inlet and near the surface at Ocracoke Inlet. Most larvae were caught at night at both sites. Twenty-one species were significantly different in mean length between the two inlets.

10. **Hettler Jr., W. F. and Jonathan A. Hare. 1998.** Abundance and size of larval fishes outside the entrance to Beaufort Inlet, North Carolina. Estuaries, Vol 21, No. 3, 476-499pp.

   Location of Study: Beaufort Inlet, NC.

   Synopsis of Study: Sampling of seven (7) ocean-spawned, estuarine-dependent fishes (Atlantic menhaden, spot, Atlantic croaker, pinfish, Gulf flounder, summer flounder, and southern flounder) was conducted on two transects, one on either side of Beaufort Inlet, North Carolina during the winter immigration season. Larval densities and lengths varied greatly between species and locations either inside or outside the inlet. Larval densities also varied greatly both inside and outside the inlet depending upon the direction of the wind component. Distance, direction to the inlet from offshore shelf spawning areas and water temperature all play a role in overall densities outside the inlet. Patterns in larval density outside of Beaufort Inlet were complex and apparently influence by both physical processes that supply larvae to the nearshore region and nearshore physical dynamics.

11. **Weinstein, M.P., Sidney L. Weiss, Ronald G. Hodson, and Lawrence R. Gerry. 1980.** Retention of three taxa of postlarval fishes in an intensively flushed tidal estuary, Cape Fear River, North Carolina. Fisheries Bulletin. Vol. 78, No. 2.

Location of Study: Cape Fear River, NC.
Synopses of Study: Fixed nets were used to sample postlarvae of spot, Atlantic croaker, and flounders over several 24-hour periods in the Cape Fear River, near Wilmington, North Carolina. Results of this study indicate that that postlarva of these species exhibit behavioral patterns with respect to photoperiod and tide which are instrumental in enabling these organisms to maintain selected positions in the estuary and avoid being flushed seaward. By migrating to the surface at night, both spot and flounders make apparent use of tides to augment lateral migration into the marsh. However, Atlantic croaker tended to remain more toward the bottom and accumulated in larger numbers in deep water at the head of the estuary.

12. **Hare, J. O., J.A. Quinlan, F.E. Werner, B.O. Blanton, J.J. Govini, R.B. Forward, L.R. Settle, and D.E. Hoss. 1999.** Larval transport during winter in the SABRE study area: results of a coupled vertical larval behavior-three-dimensional circulation model. Fisheries Oceanography. 8(2): 57 7

Location of Study: Beaufort Inlet, NC.

Synopsis of Study: Two surveys of larval abundance and water flow were performed within the estuarine region near Beaufort Inlet, North Carolina. Each survey extended over 2 full semidiurnal tidal cycles and included measurements of larvae concentration and velocity distribution at several locations. A net ingress of larvae from the open ocean into the estuary was observed during both surveys. Most larvae entered the estuary over the eastern and central portions of the inlet, where the subtidal flow was up-estuary. However, the mean circulation played a minor role in the net movements of larvae into the estuary. Net up-estuary transport of larvae was principally due to variation of larval abundance with tidal flow; with abundance during flood tide usually far exceeding ebb tide abundance. This mode of transport was likely driven by a behavioral response to tidal flow in which larvae tended to descend to the bottom on falling tides and reside throughout the water column on rising tides.

13. **Hare, Jonathan A., John A. Quinlan, Francisco E. Werner, Brian O. Blanton, John J. Govoni, Richard B. Forward, Lawrence R. Settle, and Donald E. Hoss. 1999.** Larval transport during winter in the SABRE study area: results of a coupled vertical larval behavior-three dimensional circulation model. Fisheries Oceanography. 8(Supplemental 2), 57-76.

Location of Study: Circulation Model using fictitious locations between Cape Romain, SC and Cape Hatteras, NC (South Atlantic Bight Recruitment Experiment [SABRE])

Synopsis of Study: Three dimensional circulation model was used in conjunction with larval fish vertical behavior models to study the interaction between larval vertical distribution, advection and the outcome of larval transport along the central portion of the east coast of the United States. Vertical behavior models were developed for Atlantic menhaden and spot. The purpose of the model was to investigate the transport pathways of Atlantic menhaden and spot larvae from offshore spawning grounds to estuarine nursery habitats. Both physical (e.g. wind) and biological (e.g. changes in larval behavior) events were responsible for many of the observed patterns in larval transport. Overall, larval transport was determined by circulation but was modified by larval vertical distributions.

14. **Blanton, J. O., Francisco E. Werner, Andras Kapolnai, Brian O. Blanton, David Knott, and Elizabeth L. Wenner. 1999.** Wind-generated transport of fictitious passive larvae into shallow tidal estuaries. Fisheries Oceanography. 8(Supplemental 2), 210-223.

Location of Study: Model depicting the North Edisto Inlet, SC.

Synopsis of Study: Both field and model results indicate that wind stress with an onshore component efficiently transports particles and larvae toward inlets where they can be transported by flood tide into estuarine environments. Peak abundance of larval white shrimp and blue crab megalopae are associated with certain wind directions. Passive particles were initially distributed uniformly in a zone of the continental shelf which extended 20 km offshore and 20 km alongshore in either direction. Each simulation was conducted for five tidal cycles (2.5 days) under constant wind stress. These simulations indicated that larvae are withdrawn from the continental shelf into the inlet from a narrow zone parallel to the shoreline but extending less than 5 km offshore. The withdrawal zone changed to one directly offshore of the inlet only for a wind direction that pointed directly toward the inlet mouth. Under downwelling-favorable winds, particles originating in the surface accumulate along the downwind boundary and drift shoreward with time causing a pooling of larvae along the coast. This scenario is repeated with less efficiency for upwelling-favorable winds with particles originating near the bottom.

15. Allen, Dennis M. and D. Lynn Barker. 1990. Interannual variations in larval fish recruitment to estuarine epibenthic habitats. Marine Ecology Progress Series. Vol. 63: 113-125.

Location of Study: North Inlet Estuary, SC.

Synopsis of Study: More than 45 species of fish were collected during epibenthic sled trawls from the North Inlet estuary in South Carolina between 1981 and 1985. Two distinct periods of larval fish recruitment were identified: summer in which gobies and anchovies were most abundant and winter, in which spot and croaker dominated. Arrival dates were consistent during all years of collections. It was also reported that during extended periods of low salinity in the winters of 1983 and 1984, winter taxa were significantly more abundant than in other years. Low salinity conditions represented extreme changes for an otherwise high salinity estuary, yet no notable differences in the taxonomic composition, ranks, or timing of arrivals were observed between the 4 winters sampled. Further, size distributions of larval fishes were very similar at all locations. These observations suggest that factors controlling larval fish recruitment and fluctuations in abundance were operating on a large spatial scale. Major ecosystem level disturbances such as extreme reductions in salinities during some winters did not appear to alter temporal patterns of larval fish recruitment as much as the magnitude of utilization of epibenthic habitats.

APPENDIX M

BIRD NESTING DATA (1972-2014)

Colonial Waterbird Species List (order by date)
Years: 1972 - 2014
Species: all

Site Number	Site Name	Species	# Nests	Survey Date
NC-BW-050-01	Lockwood's Folly	Royal Tern	3000	05/30/1972
NC-BW-050-01	Lockwood's Folly	Great Blue Heron	5	04/01/1975
NC-BW-050-01	Lockwood's Folly	Great Blue Heron	3	04/01/1976
NC-BW-042-01	Lockwood Folly Inlet, East	Least Tern	1	06/23/1997

*Based on the most recent site description

Colonial Waterbird Species List
Years: 1972 - 2014

Great Blue Heron:

This species nests exclusively inland (primarily in river swamps). Inland surveys were conducted in 75, 76, 96, 2008, 2009, 2010, 2011, 2012; thus, complete survey years provide the best estimate of great blue heron nesting in the state.

Least Tern:

complete survey years: 77, 83, 88, 93, 95, 97, 99, 01, 04, 07, 11, 14
Although this species is strongly associated with estuarine systems, some inland nesting occurs on rooftops. These sites are well surveyed during complete coastal survey years, thus it is assumed that totals for complete survey years are indeed statewide totals.

Royal Tern:

complete survey years: 77, 83, 88, 93, 95, 97, 99, 01, 04, 07, 11, 12, 13, 14

Because this species is strongly associated with estuarine systems, it is assumed that totals for complete survey years are indeed statewide totals. For years 2012 & 2013 data are derived from a gull management study.

Date	Site Name	Survey	Species	Num Birds
07/01/2001	Holden Beach East	Best Estimate	Piping Plover	0
07/01/1999	Holden Beach East	Best Estimate	Piping Plover	0
07/01/1998	Holden Beach East	Best Estimate	Piping Plover	0
07/01/1997	Holden Beach East	Best Estimate	Piping Plover	0
07/01/1994	Holden Beach East	Best Estimate	Piping Plover	0
07/01/2008	Holden Beach	Best Estimate	Piping Plover	0
07/01/2006	Holden Beach	Best Estimate	Piping Plover	0
06/08/2005	Holden Beach	Best Estimate	Piping Plover	0
06/03/2004	Holden Beach	Best Estimate	Piping Plover	0
07/01/2003	Holden Beach	Best Estimate	Piping Plover	0
07/01/2002	Holden Beach	Best Estimate	Piping Plover	0
07/01/2008	Oak Island	Best Estimate	Piping Plover	0
07/01/2006	Oak Island	Best Estimate	Piping Plover	0
06/08/2005	Oak Island	Best Estimate	Piping Plover	0
06/03/2004	Oak Island	Best Estimate	Piping Plover	0
07/01/2003	Oak Island	Best Estimate	Piping Plover	0
07/01/2002	Oak Island	Best Estimate	Piping Plover	0
07/01/2001	Oak Island	Best Estimate	Piping Plover	0
07/01/1999	Oak Island	Best Estimate	Piping Plover	0
07/01/1998	Oak Island	Best Estimate	Piping Plover	0
07/01/1997	Oak Island	Best Estimate	Piping Plover	0
07/01/1994	Oak Island	Best Estimate	Piping Plover	0
07/01/1992	Oak Island	Best Estimate	Piping Plover	0
07/01/1990	Oak Island	Best Estimate	Piping Plover	2
06/01/2000	Holden Beach East	Breeding Census Window	Piping Plover	0
06/01/1999	Holden Beach East	Breeding Census Window	Piping Plover	0
06/01/1998	Holden Beach East	Breeding Census Window	Piping Plover	0
06/01/2014	Holden Beach	Breeding Census Window	Piping Plover	0
06/01/2013	Holden Beach	Breeding Census Window	Piping Plover	0
06/01/2012	Holden Beach	Breeding Census Window	Piping Plover	0
06/05/2007	Holden Beach	Breeding Census Window	Piping Plover	0
06/09/2003	Holden Beach	Breeding Census Window	Piping Plover	0
06/01/2014	Oak Island	Breeding Census Window	Piping Plover	0
06/01/2013	Oak Island	Breeding Census Window	Piping Plover	0
06/01/2012	Oak Island	Breeding Census Window	Piping Plover	0
06/02/2008	Oak Island	Breeding Census Window	Piping Plover	0
06/05/2007	Oak Island	Breeding Census Window	Piping Plover	0
06/09/2003	Oak Island	Breeding Census Window	Piping Plover	0
05/28/2001	Oak Island	Breeding Census Window	Piping Plover	0
06/01/2000	Oak Island	Breeding Census Window	Piping Plover	0
06/01/1999	Oak Island	Breeding Census Window	Piping Plover	0
06/01/1998	Oak Island	Breeding Census Window	Piping Plover	0

Date	Site Name	Survey	Species	Num Birds
1987	Oak Island	East Coast Winter Distribution Survey	Piping Plover	3
02/03/2001	Holden Beach East	International Piping Plover Coodination Group	Piping Plover	0
01/18/1996	Holden Beach East	International Piping Plover Coodination Group	Piping Plover	0
06/11/1991	Holden Beach East	International Piping Plover Coodination Group	Piping Plover	0
06/06/2006	Holden Beach	International Piping Plover Coodination Group	Piping Plover	0
02/01/2006	Holden Beach	International Piping Plover Coodination Group	Piping Plover	0
06/01/1996	Holden Beach	International Piping Plover Coodination Group	Piping Plover	1
06/06/2006	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
02/01/2006	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
02/04/2001	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
06/01/1996	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
01/18/1996	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
06/12/1991	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
01/28/1991	Oak Island	International Piping Plover Coodination Group	Piping Plover	0
05/11/1989	Holden Beach East	NC Breeding Census	Piping Plover	0
05/11/1989	Oak Island	NC Breeding Census	Piping Plover	1
05/21/1988	Oak Island	NC Breeding Census	Piping Plover	2
02/07/1998	Holden Beach East	NC Winter Census	Piping Plover	0
1991	Holden Beach East	NC Winter Census	Piping Plover	0
03/01/1990	Holden Beach East	NC Winter Census	Piping Plover	0
1987	Holden Beach East	NC Winter Census	Piping Plover	0
03/03/1990	Oak Island	NC Winter Census	Piping Plover	1
1989	Oak Island	NC Winter Census	Piping Plover	2
1989	Oak Island	NC Winter Census	Piping Plover	0
05/02/2006	Holden Beach East	Permit Requirement	Piping Plover	1
09/20/2001	Holden Beach East	Permit Requirement	Piping Plover	2
06/01/2001	Holden Beach East	Permit Requirement	Piping Plover	0
05/09/2001	Holden Beach East	Permit Requirement	Piping Plover	2
04/10/2001	Holden Beach East	Permit Requirement	Piping Plover	3
09/11/2001	Oak Island	Permit Requirement	Piping Plover	1
08/15/2001	Oak Island	Permit Requirement	Piping Plover	1
04/06/2001	Oak Island	Permit Requirement	Piping Plover	2

Date	Site Name	Survey	Species	Num Birds
06/01/2011	Lockwood Folly Inlet, East	Breeding Census W	American Oystercatcher	2
06/01/2011	Oak Island	Breeding Census W	American Oystercatcher	2

Date	Site Name	Survey	Species	Num Birds
06/05/2007	Holden Beach East	AMOY/WIPL Survey	Wilson's Plover	2
06/01/2001	Holden Beach East	Permit Requirement	Wilson's Plover	2
05/11/1989	Holden Beach East	NC Breeding Census	Wilson's Plover	0
06/01/2011	Holden Beach	Breeding Census Window	Wilson's Plover	10
06/01/2011	Lockwood Folly Inlet, East	Breeding Census Window	Wilson's Plover	2
06/08/2010	Oak Island	AMOY/WIPL Survey	Wilson's Plover	1
05/27/2000	Oak Island	Unspecified	Wilson's Plover	4
05/11/1989	Oak Island	NC Breeding Census	Wilson's Plover	2

Date	Site Name	Survey_Type	Species	Num Birds
5/23/2012	Holden Beach	Aerial REKN Surveys	Red Knot	56
5/23/2012	Long Beach (Oak Island)	Aerial REKN Surveys	Red Knot	0
5/24/2011	Long Beach (Oak Island)	Aerial REKN Surveys	Red Knot	22
5/24/2011	Holden Beach	Aerial REKN Surveys	Red Knot	15
5/24/2010	Oak Island and Lockwoods Folly Inlet	Aerial REKN Surveys	Red Knot	0
5/24/2010	Holden Beach and Inlet	Aerial REKN Surveys	Red Knot	0
5/20/2009	W Long Bch (Oak Isl) at Inlet	Aerial REKN Surveys	Red Knot	18
5/20/2008	Cape Fear to SC Line	Aerial REKN Surveys	Red Knot	0
5/23/2007	Lockwood Folly Inlet	Aerial REKN Surveys	Red Knot	0
5/23/2006	Oak Island – Caswell Beach/W end of Long Beach	Aerial REKN Surveys	Red Knot	0
5/23/2006	Holden Beach – east and west end	Aerial REKN Surveys	Red Knot	0

APPENDIX N

SEA TURTLE NESTING LOCATIONS (2005-2014)

Legend

- Permit Area Boundary (1,655 ac.)
- Loggerhead Turtle Nesting Records 2005*

* North Carolina Wildlife Resources Commission, 2014.

0 0.125 0.25 0.5 0.75 Miles

Source: USGS, NAIP, Brunswick County, NC 2008.

Loggerhead Turtle Nesting Near and Within Permit Area, 2005	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Source: USGS, NAIP, Brunswick County, NC 2008.

Legend

- Permit Area Boundary (1,655 ac.)
- Loggerhead Turtle Nesting Records 2006*

* North Carolina Wildlife Resources Commission, 2014.

Loggerhead Turtle Nesting Near and Within Permit Area, 2006	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Legend

- Permit Area Boundary (1,655 ac.)
- Loggerhead Turtle Nesting Records 2007*

* North Carolina Wildlife Resources Commission, 2014.

Source: USGS, NAIP, Brunswick County, NC 2008.

Loggerhead Turtle Nesting Near and Within Permit Area, 2007	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Loggerhead Turtle Nesting Near and Within Permit Area, 2008	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Source: USGS, NAIP, Brunswick County, NC 2008.

Legend

- Permit Area Boundary (1,655 ac.)
- Loggerhead Turtle Nesting Records 2009*

* North Carolina Wildlife Resources Commission, 2014.

Loggerhead Turtle Nesting Near and Within Permit Area, 2009	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Legend

Permit Area Boundary (1,655 ac.)

Loggerhead Turtle Nesting Records 2010*

* North Carolina Wildlife Resources Commission, 2014.

0 0.125 0.25 0.5 0.75 Miles

Source: USGS, NAIP, Brunswick County, NC 2008.

Loggerhead Turtle Nesting Near and Within Permit Area, 2010	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Legend

Permit Area Boundary (1,655 ac.)

Loggerhead Turtle Nesting Records 2011*

* North Carolina Wildlife Resources Commission, 2014.

Loggerhead Turtle Nesting Near and Within Permit Area, 2011	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Loggerhead Turtle Nesting Near and Within Permit Area, 2012

Holden Beach East End Shore Protection Project
Environmental Impact Statement

Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Legend

Permit Area Boundary (1,655 ac.)

Loggerhead Turtle Nesting Records 2013*

* North Carolina Wildlife Resources Commission, 2014.

0 0.125 0.25 0.5 0.75 Miles

Source: USGS, NAIP, Brunswick County, NC 2008.

Loggerhead Turtle Nesting Near and Within Permit Area, 2013	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

Loggerhead Turtle Nesting Near and Within Permit Area, 2014	
Holden Beach East End Shore Protection Project Environmental Impact Statement	
Scale: 1 inch = 0.25 mile	Drawn By: MR
Date: October 2014	Approved By: DY
DIAL CORDY AND ASSOCIATES INC Environmental Consultants	J12-1213

APPENDIX O

UNDERSTANDING COST AND BENEFITS

Appendix M: Understanding the Costs and Benefits of Shoreline Change

1.0 Introduction

Actions associated with mitigating the effects of shoreline change are expected to create an array of costs and benefits. These include market costs, such as any physical or engineering costs associated with active mitigation, as well as non-market costs and benefits, such as those associated with changes in the quality of recreational experiences and effects on the natural environment. Shoreline nourishment, armoring via hardened structures, and retreat all entail costs and benefits that accrue to different groups of stakeholders and over different time periods. As noted in Landry (2011), nourishing shorelines by adding sand may protect coastal habitats and real estate as well as the possibilities for recreation, but without maintenance, the duration of such benefits can be expected to be temporary. Armoring the shoreline may likewise protect coastal property, but may have adverse impacts on habitats and proximate shorelines. Shoreline retreat may involve relocation or demolition of existing buildings and infrastructure and can be expected to impose substantial costs and burdens on coastal property owners. Local governments may also be opposed to shoreline retreat for reasons related to the potential infrastructure losses, diminished property tax revenues, and impacts on coastal tourism, or real estate sales (Landry, 2011).

As a result of these disparate costs and benefits, alternative efforts to mitigate shoreline erosion can be expected to be valued differently by different groups of people. Direct and indirect economic impacts from alternative shoreline management strategies will vary across a given population, as will preferences for maintaining, preserving or allowing natural change (Judge, Osborne and Smith, 1995). As noted in Judge, Osborne and Smith (1995), some individuals will have preference for non-interventionist approaches that allow natural erosion to take place. These individuals may derive real economic value from the existence of unfettered coastal ecosystems. While such “retreat” options will likely have an adverse impact on the value of beaches and beach front property at eroding sites, they may also induce positive or negative value changes at proximate sites via changes in crowding or changes in aesthetic appeal. For example, as noted in Parsons and Powell (2001), the amenity value of beachfront properties lost to erosion may not be lost in the aggregate, but rather transferred to properties farther inland. Further, in the absence of land use controls active mitigation efforts such as beach armoring or renourishment may serve to encourage additional use and/or development, which may in turn compromise the integrity and value of the beach that such efforts were designed to protect or create a situation where continued mitigation is necessary to protect value. With regard to this latter point, Gopalakrishnan et al. (2011) find that beach replenishment activities are likely to occur more frequently in communities where baseline property values are higher.

Finally, certain groups of stakeholders may have different and contrasting values related to natural or anthropogenic changes to the shoreline. For example, as noted in Landry, Keeler and Kriesel (2003), property owners may desire shoreline proximity for recreational and aesthetic reasons and also value shoreline distance for protection from erosion. Huang et al. (2007) also note that anthropogenic modifications to beaches involve multiple positive and negative impacts on individual stakeholders. They find that erosion control measures are less valued when there are adverse impacts on wildlife, water quality and erosion at neighboring beaches.

In light of diverse impacts and preferences, economic analysis of the potential gains and losses from proposed shoreline management actions can be a useful input for policy makers who are confronted with the need to balance conflicting objectives while conforming to budgetary limitations. However, as alluded to above, understanding the economic values associated with shoreline management alternatives is a complex and multifaceted undertaking. Determining which strategy makes the most economic sense for a given coastal community is an empirical question, requiring detailed consideration of an array of natural, physical and socioeconomic characteristics (Parsons and Powell, 2001) and forecasting potential impacts into the future. Coupling these complexities with the inherently dynamic nature of marine coastlines suggests that the effects of shoreline management alternatives will vary according to myriad factors such as preferences for recreation, the degree of shoreline development, the characteristics of proximate and substitute sites and the bio-physical character of affected coastal ecosystems. As such, quantitative forecasting of the economic impacts of shoreline management alternatives is fraught with difficulty.

2.0 Limitations

The purpose of this appendix is to review the extant literature regarding economic considerations that are pertinent to the proposed management alternatives for the Holden Beach Inlet and Terminal Groin Project and to summarize available evidence in the literature so as to frame and characterize the potential scope of economic costs and benefits associated with the proposed alternatives. This appendix and accompanying discussion in the EIS should be taken as a framework for understanding the potential scope of economic impacts associated with the range of project alternatives evaluated in the EIS.

3.0 Economic Value and Valuation

Economists define the value of a particular good or service as what it is *worth* to people, in terms of the contribution of the good or service to well-being (Bockstael et al., 2000). Value is best measured by what people are *willing and able to pay* (WTP) for a good or service. Value should not be confused with the *cost* or expenditure required to obtain a good or service, because cost may differ greatly from what something is worth. For example, a beach renourishment project may involve $5 million in physical and engineering costs, but may generate considerably more (or less) in actual economic value.

It should also be recognized that economic value extends to goods and services that are not explicitly traded in markets such as clean beaches and healthy habitats, and may include benefits not directly associated with use such as the benefits resulting from the knowledge that particular species or ecosystems exist ("existence values"), are available for potential future use ("option values") or are available for future generations ("bequest values"). The measurement of non-market values is detailed in later sections of this report. Evidence in support of "non-use values" includes the willingness of people to give up time and other resources (including money) for goods and services that they never interact with in any tangible fashion. While relatively unknown outside the economics profession, the consideration of non-use values is germane to any analysis of beach management alternatives due to their explicit mention in the Water Resource Council Principles and Guidelines (P&G) for federal projects (USACE, 2000 as noted in Landry, 2011).

More generally, it is clear that coastal ecosystems provide a variety of goods and services that create real economic value via contributions to human well-being. These include services that affect the value of goods that are traded in markets such as the protection of coastal real estate and tourism, as well as services that impact non-market goods and services such as aesthetics, habitat provision and opportunities for recreation. Quantifying the associated benefits to people from these goods and services is the domain of *economic valuation*. Valuation simply means empirical estimation of what something is worth, typically in monetary terms.

3.1 Valuation Methods

Because humans interact with the environment in many ways, approaches to valuation take a variety of forms. The choice of method is most often a function of what is being valued and the intended use or policy purpose of the value estimates. A common point of demarcation for valuation methods pertains to whether the economic values in question are market-based or "non-market" values. Market values are often readily observed using applicable prices and quantities. Measuring and monetizing the costs and benefits associated with changes that are not revealed in market transactions requires the application of empirical techniques that fall under the category of non-market valuation. Non-market values pertain to changes in human wellbeing and may be associated with active uses of resources (e.g. recreation), passive uses of resources (e.g. aesthetics) or not associated with any tangible use (e.g. concern for the condition of the natural environment). Non-market valuation techniques for estimating the associated benefits to people are well-established in the academic and practitioner literature.

Examples of market-based valuation methods include the market price method, the replacement cost method and the damage avoidance method. Non-market valuation methods include the travel cost method, hedonic pricing and the contingent valuation method. A variety of sources are available for detailed reviews of these methods (e.g. Smith, 1996; Bockstael, et al., 2000; Schuhmann, 2012). For the purposes of this report, we only review those methods that are pertinent to the valuation of changes to coastal systems. Much of the review below is based upon Schuhmann (2012).

3.1.1 The Replacement Cost Approach

Some goods and services provided by the natural environment can be replaced by manmade goods and services. This basic idea is the foundation of the *replacement cost approach* (RC) to valuation, which uses the *costs* associated with providing replacement services as the value of the associated natural services. As such, this approach fits into the category of market-based valuation methods. As an example, artificial breakwaters may provide some of the shoreline protection services afforded by barrier islands or reefs. The costs of constructing breakwaters may therefore be used as an estimate of the economic value that stands to be lost if the natural service was to be degraded. The replacement cost approach is appealing in its ease of calculation and interpretation – the method typically relies on readily available market data and represents the opportunity costs associated with the degradation of natural assets in terms of costs that would have to be incurred in the absence of protection.

The replacement cost approach should be used with caution, however, as it does not deliver a true measure of the value of natural goods and services in the sense of net gains to society. In short, the replacement cost method provides a measurement of *costs*, which may not reflect the benefits gained from natural resources. For example, the cost of widening a beach via sand management may be entirely unrelated to the benefits derived from naturally wide beaches. Moreover, this method should only be applied when certain conditions are met (Bockstael et al., 2000; EPA, 2009; WRI, 2009). First, the manmade alternatives must provide an effective replacement for natural services. While it is unlikely that manmade alternatives can provide the full range of benefits provided by natural assets, there must be at least some service flows that can be attained via substitution of manmade alternatives. Further, the costs of that substitute must be known or estimable and must represent the least-cost means of providing the service in question. Finally, society must be willing and able to incur the costs associated with the replacement. These latter two points may require extensive research to confirm, as the scope of economic costs associated with habitat modification likely extends beyond monetary or market-based expenses. Only when these non-market costs are understood, measured and conveyed to the public can society's willingness to accept them be established.

3.1.2 The Cost (Damage) Avoidance Approach

Related to the replacement cost approach, the *cost (damage) avoidance approach* (CA) is based on the idea that manmade services may be able to offset or prevent harm caused by natural or anthropogenic change. The cost avoidance approach relies on market-based estimates of the costs associated with potential damage to manmade assets as an estimate of the value of the natural services that prevent those damages from occurring. For example, the cost of replacing coastal property may be used as an estimate of the benefits derived from beach nourishment activities that mitigate damage from storms. As noted in Landry (2011), this is the approach employed by the US Army Corps of Engineers when defining benefits in P&G. As is the case with the replacement cost approach, this method ascribes estimates of *costs* to notions of *value*, which may not be the most accurate means of understanding the *benefits* derived from changes in natural resources. Using the value of coastal real estate as an estimate for the value of beach width may lead to the conclusion that highly developed beaches are worth more than undeveloped beaches. While this may seem logical from a private landowner's perspective, the opposite may be true from the perspective of society. That is, undeveloped beaches may confer larger economic gains to society than developed ones. Landry (2011) provides additional discussion of this important issue.

3.1.3 Revealed Preference Methods

In terms of understanding the economic value of beach width and shoreline amenities, the most commonly employed non-market valuation methods are the revealed preference approaches of *hedonic pricing* method and the *travel cost method*. These approaches are based on establishing empirical links between changes in natural resources and market behaviors. For example, beach width may affect sales prices of coastal real estate or influence the number of tourists that visit a particular destination. By collecting data on real estate sales or travel to the coast, the associated value of beach width can be estimated. Specifically, the hedonic pricing method uses data on house characteristics (size, age, neighborhood characteristics, etc.), associated environmental amenities (e.g. proximity to the coast or beach width near the house) and selling prices. To estimate the contribution of those environmental amenities to the market value of the house, regression analysis is used where price serves as the dependent variable and independent variables are house characteristics, including environmental amenities. The estimated regression coefficient on the environmental characteristic represents the marginal change in average selling price for a change in that characteristic, and can be interpreted as the implicit price of the characteristic. Because this method relies on actual transactions, value results are difficult to critique, provided that proper methodology was employed and that the environmental characteristics of interest were accurately quantified and have not undergone meaningful change since the time of the real estate transactions. The literature contains several applications of the hedonic pricing method to value coastal attributes, many of which are reviewed herein.

The travel cost method is another revealed preference approach that is commonly employed to value natural resources associated with recreation. Site visitation data, including travel costs and the number of trips taken to a particular destination are collected and used to estimate a trip demand curve, where explicit and implicit travel expenses serve as a proxy for price. The net benefits of a particular site or the value of the resources within each site can then be estimated by integrating under the estimated demand curve at a particular price point (e.g. mean or median price). Numerous examples of recreation demand models applied to value beach visitation appear in the published literature. Pertinent applications are reviewed later in this report.

3.1.4 Stated Preference Methods

The above methods are useful for understanding the economic value associated with property and recreation aspects of coastal quality and amenities, but they are not amenable to the valuation of benefits that are not associated with direct use. When people derive values from simply knowing that natural resources are preserved or maintained in a particular state, s*tated preference methods* such as the Contingent Valuation Method (CVM) and Choice Modeling (CM) must be employed. These methods, which rely on surveys to elicit values, are well-accepted approaches for valuing non-market goods and services. CVM has been adopted by the U.S. Department of Interior to measure non-market values associated with damages under CERCLA 1980 (US DOI 1986), while NOAA has endorsed the use of this method for damage assessment under the Oil Pollution Act of 1990 (Arrow et al. 1993). The CM approach appears to be gaining favor in the economics literature as it avoids many of the difficulties associated with CVM and allows multidimensional attribute changes to be valued simultaneously (Huybers, 2004). As is the case with all valuation approaches, estimates of value are subject to an array of biases and caveats, hence care must be taken with regard to proper methodology and interpretation.

3.1.4 Economic Impact Analysis

In addition to estimating changes in economic value to users, property owners and other direct stakeholders, analysts may be interested in understanding the effects of changes in natural resource quantity or quality on the broader economy. Such impacts might include additional revenues, incomes and employment realized by local, regional and national economies. *Economic impact analysis* is the process concerned with such estimation, and recognizes that a portion of each dollar spent by a consumer or producer represents revenue earned by someone else in the economy. As the new revenue earner spends that income, each transaction creates additional income that ripples through businesses and households creating "economic multiplier effects". These impacts are estimable, and are typically categorized into *direct* effects, *indirect* effects and *induced* effects. *Direct effects* are market contributions to the economy, and are typically measured by gross total revenues, total employment or gross incomes. *Indirect effects* are impacts on the incomes and wages of the suppliers of inputs used in the industry in question when those earnings are subsequently spent on other goods and services. *Induced effects* are the economic impacts of spending of generated income by households who are either directly or indirectly employed in the industry. Indirect and induced effects taken together are often referred to as *value added effects* (Fedler, 2010).

Economic impact analysis relies on the use of input-output models which delineate forward and backward linkages in earnings and spending between economic sectors of interest and the rest of the economy. An empirical understanding of these linkages allows for the estimation of *multipliers* which quantify the extent to which a given economic activity (direct effect) generates other economic activity. Value added multipliers convert direct expenditures into total economic impact (Fedler, 2010). For example, if the estimated value added multiplier for tourism spending is 1.5, then each $1 of direct spending by tourists results in an additional $1.50 of indirect and induced effects, for a total economic impact of $2.50. Because economic impact analysis does not calculate net economic gains to market participants and does not account for non-market values, economic impact analysis and the use of input-output models should be considered a complement rather than a substitute for the calculation of economic value using other methods described above (Hoagland, et al, 2005).

4.0 Beach Nourishment as a Dynamic Optimization Problem

A recent branch of economics research has examined beach management decisions as a dynamic optimization problem where the timing and rate of renourishment that maximizes the discounted present value of net gains (benefits less costs) is derived (Landry, 2011). Required inputs for such modeling efforts include a rate of natural erosion or decay, the economic costs of beach nourishment, a parameter that converts sand volume to beach width, and a function representing aggregate benefits from beach width. The principle outputs are an optimal schedule of renourishment, the optimal quantity of sand that should be applied during each operation, and a measurement of how these values are affected by changes in the inputs (Landry, 2011). An obvious benefit of this approach is the ability to determine, *a priori*, the potential economic value of beach management actions under a range of hypothetical conditions. A downside is the time, effort and expertise required to conduct the modeling. Some notable results can be gleaned from prior work in the literature and applied to North Carolina coastlines.

5.0 Categories of Potential Impacts from Coastal Management Alternatives

The economic costs and benefits associated with shoreline management projects will include changes in market values and non-market values. Affected market values may include with the physical costs of active mitigation efforts (e.g. construction and maintenance costs associated with hardened structures, acquisition of beach nourishment material, destruction and/or relocation of coastal real estate), and the change in economic value to coastal property and public infrastructure. Non-market values include those associated with changes to the size and integrity of beaches and dunes, inlets and their associated functions, including provision of public recreational opportunities, aesthetics and wildlife habitat. Effects on coastal property values will materialize in market values, and likely entail elements of both market and non-market values. These include changes in the storm protection benefits from beaches and dunes as well as values associated with recreation and aesthetics.

When comparing management alternatives, it is important to note that in many cases the benefits of active mitigation efforts can be considered costs of inaction. For example, the benefits of shoreline stabilization via nourishment or hardened structures include maintaining the integrity of the shoreline and the associated real estate. These economic values are likely to be partially or wholly sacrificed in the absence of active mitigation. Hence, an analysis of the costs of inaction (e.g. retreat) would include lost shoreline integrity and declinations in the economic value of associated real estate. Likewise, the benefits of inaction may include the value associated with maintaining natural environmental conditions in a state unaltered by active mitigation.

A deep body of literature exists examining the nature, scope and measurement of these economic values. Below, we provide a brief overview of this literature so as to provide a context for the potential scope of changes in economic value that might be associated with alternative shoreline management projects under consideration in North Carolina.

5.1 Values Associated with Coastal Property and Physical Capital

Natural and anthropogenic changes to shorelines can be expected to affect the value of coastal real estate. The value of at-risk property can be viewed as a potential economic cost associated with inaction (e.g. retreat) or an economic benefit of protection via active management (e.g. nourishment, armoring). Hence, an appraisal of coastal property values and/or derivation of the effect of beach characteristics on property values via the hedonic pricing method can serve as a valuable input in terms of understanding the costs and benefits of management alternatives.

However, caution must be exercised when conducting such appraisals for a number of reasons. First, property values can fluctuate with local and national economic conditions. Available sales, tax assessment or appraisal data may be reflective of market that may no longer be applicable to contemporaneous or future valuations. Further, natural characteristics of coastlines the associated economic benefits are inherently dynamic, which may create empirical difficulties when attempting to quantify the association between those characteristics and property values. For example, even with periodic renourishment, sand volume and beach width can be expected to vary over time. As such, explorations of the relationship between beach characteristics and property values that rely on measurements of those characteristics at a particular point in time may not properly account for anticipated future change or the flow of benefits from average quality metrics (Gopalakrishnan et al., 2011). Indeed, market participants' understanding of shoreline dynamics and expectations regarding shoreline management interventions will likely be capitalized into market values (Landry and Hindsley, 2011; Landry, 2011). For example, if a strategy of retreat is reasonably anticipated, the value of threatened properties could be driven toward zero (Landry, 2011). Likewise, uncertainty regarding legislative or budgetary conditions may confer a perception of investment risk, which can also be expected to be capitalized into market values. To the extent that shoreline characteristics at the time and location of data collection do not reflect those expectations, value estimates will be compromised.

An additional complication arises from the potential endogeneity between property values and shoreline characteristics. While it is clear that property values will depend on the characteristics of proximate shorelines (additional discussion below), shoreline characteristics may also depend on property values. As noted in Gopalakrishnan et al. (2011), shoreline management decisions may depend on the benefits from changing the natural character of the shoreline. For example, beach nourishment might occur on a larger scale or more frequent interval where beaches protect valuable real estate. This bi-directional causality may confound empirical estimation of the effect of beach width on property values.

To summarize, the value of at-risk property and assets that stand to be lost or protected can and should be considered when appraising the costs and benefits associated with alternative actions for shoreline management. The hedonic pricing method is the most commonly employed approach to understanding the relationship between shoreline characteristics and the market value of such assets, but such analysis should be exercised with careful consideration of the above cautions and caveats.

5.1.1 Categories of Value

Parsons and Powell (2001) categorize the costs of shoreline retreat as land loss, capital (structure) loss, proximity loss, and transition loss. The economic value of land loss is the difference between the value of affected land in the absence of beach erosion and the value of the same land with beach erosion. Because there will always be a given area of land that is beach front, value lost to erosion is associated with diminished land availability inshore rather than the loss of beachfront land. Capital loss is the difference between the asset value of housing, commercial buildings, and public infrastructure in the absence of beach erosion and the value of those same assets with beach erosion, including any loss of use and additional maintenance costs associated with retreat.

Proximity loss is the decrease in human welfare associated with adjusting the pattern of coastal development in response to an unstable shoreline. For example, Parsons and Powell (2001) note that in the face of an unstable shoreline, permanent structures may be rebuilt further from the shore or temporary structures may be built close to the shore. Either case confers less economic welfare associated with proximity than permanent structures built close to the shore, which is the presumed pattern of coastal development when shorelines are stable. Finally, transition loss is the economic costs associated with removal of housing, commercial buildings, and public infrastructure and includes costs of labor, capital and materials. It is important to note that the costs associated with replacing coastal real estate may not be an appropriate proxy for the benefits of avoiding replacement, as the latter entails the value associated with occupying a property, which may or may not be related to construction costs (Landry, 2011).

5.1.2 Examples from the literature

A deep body of literature examines the relationship between the value of coastal real estate and environmental amenities such as views, distance to shorelines, beach width and water quality. Each of these amenities is found to enhance property values as reflected in market prices. The contribution of amenities such as views and beach width is found to diminish with distance from the ocean.

With regard to ocean views, Benson et al. (1997) and Benson et al. (1998) use the Hedonic Pricing approach to estimate the value of scenic views to single family homes in Washington. Both studies find that homes with ocean views are associated with statistically significant price premiums. The 1997 study suggests that ocean frontage adds up to 147 percent to the market price of a home. Views of the ocean add between 10 and 32 percent to market prices, with lower values corresponding to partial views. The richer dataset used in the 1998 study allows for detailed characterization of view quality and distance from the water, and suggests that prices of homes with high quality (unobstructed) views of the ocean are 59 percent higher than prices of otherwise comparable homes on average. Lower quality ocean views convey lower price premiums, ranging between 8 and 31 percent. Not unexpectedly, while controlling for the quality of view, the value of ocean views is found to be inversely related to distance from the water. Prices of homes that are a very short distance from the water with unobstructed views may be more than 68 percent higher than otherwise similar homes.

Pompe and Rinehart (1999) also find that property buyers value ocean views. These authors apply the hedonic pricing approach to home sales in South Carolina and find that views of the ocean add approximately 45 percent to the value of developed lots and 83 percent to the value of vacant (undeveloped) lots.

Numerous studies explore the economic value of beach width to property owners. Pompe and Rinehart (1995) and Pompe and Rinehart (1999) find that property buyers value wider beaches. These two studies - applications of the Hedonic Pricing approach to data from coastal property sales in South Carolina – show that the marginal value of beach width varies with distance from the beach and differs for developed and undeveloped lots. Specifically, Pompe and Rinehart (1995) find that an additional foot of beach width is estimated to increase the value of developed and undeveloped oceanfront lots by $554 and $754 respectively. At a distance of one-half mile from the beach, the price premium for an additional foot of width is found to be considerably lower, roughly $254 and $165 for developed and undeveloped lots respectively. In Pompe and Rinehart (1999), an additional foot of beach width is found to add $194.09 and $310.84 to the market value of developed and undeveloped oceanfront lots, respectively. The authors caution that these latter estimates are based on a relatively small number of oceanfront parcels. Smaller price premiums are found for properties that are not oceanfront with ocean views, and even smaller (but still statistically significant) premiums are found for properties near the beach, but without ocean views.

With regard to loss of beach width to erosion, Parsons and Powell (2001) use a hedonic price regression to estimate the costs of shoreline retreat in Delaware. Specifically, using a range of estimates for average erosion rates at seven different beach communities along the Delaware coast, they approximate the expected location of the shoreline in the absence of active management actions and predict which specific houses would be lost as the shoreline migrates. For each structure that is predicted to be lost, value is predicted using a hedonic price regression based on market data. It is important to note the reason why the hedonic approach is employed rather than simply relying on market values of at-risk real estate: The hedonic approach allows the estimation of the coastal amenity value associated with each structure. This coastal amenity value is subtracted from this anticipated loss under the assumption that such value is simply transferred to other structures that are now closer to the shoreline. The costs associated with removal of the structure (i.e. the transition loss) are assumed to be $25,000 per structure and are added to create an estimate of the total loss associated with losing that property to retreat. Commercial structure losses are approximated using Marshall and Swift's property appraisal method. It is important to note that the authors assume that the majority of the value associated with infrastructure is capitalized into the value of residential structures, and as such the associated losses are captured in the hedonic estimation. To the extent that such infrastructure conveys economic benefits to the public at large (e.g. tourists, or nearby residents), this assumption results in an underestimate of the true costs of retreat. Further, while the authors mention the costs of infrastructure removal and/or relocation, it is not clear that these costs are explicitly accounted for. The authors also do not attempt to estimate proximity losses, which are assumed to be small. Finally, the authors do not account for unstable beach conditions and the effect of such future risk on values of homes that are now closer to the shoreline.

Their results suggest that over a 50-year period, the costs of active beach renourishment are expected to be substantially less than the lost value associated with retreat. The authors suggest that the costs of renourishment would have to increase by a factor of four for retreat to be an economically preferable alternative, though they caution that cost estimates may vary greatly with assumed rates of erosion. Because of the characteristics of the study area, the majority of losses from retreat are those associated with residential real estate. Transition losses and losses associated with commercial structures are found to account for about 15% of total losses. Importantly, the coastal amenity value is found to be a statistically significant component of the economic value of at-risk property. For example, for an ocean-front house valued at $300,000, the ocean-front amenity is found to account for nearly $132,000 of the value. A bay-front house of similar value would owe $24,000 to its proximity to water and canal frontage appears to be worth $63,000. The authors also suggest that for houses less than a half-mile from the beach, each 25 feet of distance from the coast is worth about $1200 for a representative $300,000 house. Because these amenity values can be assumed to transfer to properties further inland as a result of retreat, these results suggest that a simple subtraction of the current market value of at-risk real estate will grossly overestimate the costs of retreat and unimpeded shoreline recession. That is, while retreat can be expected to diminish or eliminate the market value of beachfront properties, the beachfront itself will always exist. Hence, properties that were once “one row back” will now be beachfront, and can be expected to increase in value. Nonetheless, given the current costs and technology associated with shoreline renourishment, retreat appears to be an unfavorable option from a market costs perspective.

Landry, Keeler and Kriesel (2003) explore the desirability of shoreline management alternatives by quantifying the economic impacts on coastal property owners who face risk of economic loss from erosion, the change in value of recreational uses of coastal areas that may be impacted by shoreline management and the costs of management. Effects on the natural environment (e.g. habitat loss or change) are not considered. Specifically, the incremental value of improved beach widths for coastal residents is estimated using hedonic analysis applied to a sample of 318 property sales on Tybee Island, GA. Including among the set of sales price determinants in the hedonic regression are beach width, distance from the beach, erosion risk, and the presence of erosion control structures. The measure of erosion risk was an indicator variable for property proximity to known high risk areas on the island. Beach width is found to be a statistically significant determinant of property value, with each one-meter increase adding $233 to property value. Ocean-front and inlet-front amenity values are estimated to be of $34,068 and $87,620 respectively. Property values in high risk areas were estimated to be reduced by $9,269.

Landry and Hindsley (2011) also apply the hedonic pricing method to real estate transactions for single-family residences in Tybee Island, GA, and measure the value of high- and low-tide beach and dune widths at nearby beaches, adjusted for changes in beach width due to sand replenishment activities. They find that beach and dune width have a statistically significant influence property value for properties located within 300 meters from the shore, but find no relationship for properties located further from the shore. Specifically, Landry and Hindsley estimate marginal willingness-to-pay for beach width for houses within 300 meters from the beach ranges from $421 to $487 for an additional meter of high-tide beach, or $272 to

$465 for an additional meter of low-tide beach. The incremental value of dune width ranges from $212 to $383 per meter for houses within the 300 meter distance. When the estimation is extended to properties beyond the 300 meter distance, marginal values decrease. These authors also find that the value of ocean frontage is estimated to be between $39,000 and $75,000 and between $121,000 and $128,000 inlet frontage.

Gopalakrishnan et al. (2011) estimate the value of beach width to coastal property in ten coastal towns in North Carolina[1] using hedonic pricing models. When beach width is treated as an exogenous characteristic, the average increase in oceanfront property value is approximately $1,440 per additional foot of beach width. This value approaches zero for properties that are located more than 330 feet from the beach. When beach width is treated as endogenously determined[2] (i.e. property values are function of beach width and beach width, via nourishment activity, is a function of property value), the authors find that beach width likely accounts for a larger portion of coastal property value. Specifically, the coefficient on the (fitted) beach width variable is five times larger than in the exogenous specification, suggesting that the average increase in oceanfront property value is approximately $8,800 per additional foot of beach width, or a roughly 0.5 percent increase in value per 1 percent increase in beach width. The authors suggest that their results indicate that property values will be more sensitive to beach width when there is severe erosion and beach replenishment is used to stabilize the shoreline. Notably, unlike Landry and Hindsley (2011), Gopalakrishnan et al. (2011) find that the presence of dunes does not impact property values.

5.1.3 Summary

There is a preponderance of evidence that property owners place considerable economic value on beach width. This value declines with distance from the shore. While some literature suggests that the existence of dunes has a positive impact on property values, the

[1] The sample of towns includes Carolina Beach, Kure Beach and Wrightsville Beach in New Hanover County. All other towns in the sample are in Carteret County or Dare County.

[2] This model is estimated via two-stage least squares, where geomorphological variables are used to instrument for beach width in the first stage, and fitted values of beach width are used in the price hedonic in the second stage.

evidence to date is not clear. It is important to note, as articulated by Landry and Hindsley (2011), interpretation of specific value estimates such as those detailed above depends on individual perceptions of future resource quality. If conditions are expected to improve over time, value estimates should be interpreted as lower bounds on true value. If instead, conditions are expected to degrade, value estimates should be interpreted as upper bounds on true value.

5.2 Coastal Infrastructure

In addition to privately owned residential properties, coastal areas also contain physical capital in the form of public infrastructure (e.g. roads, water, electric, sewer). As with privately held capital, this public capital conveys economic benefits to society. Again, the value of these benefits to society can be considered a benefit of erosion control measures, or a cost associated with the failure to control erosion. It is important to note, as expressed in Parsons and Powell (2001), that some of the benefits associated with public capital accrue directly to property owners and will be capitalized into market values for associated real estate (e.g. water and sewer services), and thus included as part of damage avoidance estimates if the value of privately held coastal property is assessed. Yet, other aspects of value for these public assets are not amenable to market valuation, because the benefits derived from their use are not for sale (e.g. the value of public roads adjacent to public beaches). The only readily available market measure of value is that pertaining to new construction costs. That is, while there is no observable market value of what infrastructure is worth in terms of benefits conveyed to the public, we can observe or estimate the cost associated with its construction. As a case in point, in order to measure the potential value of terminal groins in terms of protecting public assets, the cost of constructing public infrastructure was used in NCCRC (2010).

While the procedural endorsement of the RC and CA approaches is understandable in light of the lack of an alternative proxy for value, as noted in the discussion above, the monetary estimates derived from these approaches should not be used without careful consideration. In particular, infrastructure replacement costs seem a tenuous measure of the value of protecting in-situ infrastructure in situations where a lack of protection induces sufficient erosion to eliminate any possibility of replacing that infrastructure. In circumstances where inundation (conversion of land habitat to water) removes the possibility of replacement, the cost of constructing infrastructure might best be considered an unrecoverable sunk cost. Costs that are germane to these situations would include expenses associated with physical removal of the infrastructure. However, when inundation necessitates replacement of lost infrastructure at an alternative location services in order to maintain service flows to properties that remain unaffected by erosion, replacement costs may be an appropriate estimate of at-risk value provided that they account for costs associated with right-of-way acquisition, engineering, permitting, and construction costs (in addition to removal of infrastructure).

5.3 Values Associated with Recreation and Tourism

5.3.1 Categories of value

Alternative actions for mitigating the effects of shoreline change are expected to impact the quantity and quality of recreation and tourism opportunities at the site of interest. Management action or inaction may also create effects on proximate sites or sites that are considered substitutes. These effects may include changes in beach area, the quality of sand, ease of access, the quality of the marine environment, the quality of scenery and the quantity or quality of habitats and species. Changes in economic values will be manifested in changes in the quantity or quality of extractive direct uses (e.g. catch-and-keep fishing), non-extractive direct uses (e.g. sunbathing, bird watching, walking/running, surfing, catch-and-release fishing), and passive uses (e.g. enjoying the aesthetics of a coastal area). In the case of beach nourishment and/or armoring, perhaps the most obvious of these changes is that associated with the amount of physical space available for recreation. Landry (2011) categorizes the economic value of changes in beach area as associated with improvements in scenery and aesthetics, allowing space for more users and decreasing congestion for existing users.

These categories of value are not mutually exclusive. Indeed, a single user can derive economic value from all of the above activities. Further, due to the non-rival and non-excludable characteristics of many of these uses, value derived by one individual does not preclude others from enjoying benefits as well. The most widely applied methodology for estimation of the economic value of changes in coastal quality as it pertains to recreation is the travel cost method, or its close cousin, random utility modeling. Applications of these revealed preference approaches are detailed in an extensive body of literature, some of which is reviewed below. Stated preference approaches such as the contingent valuation method and choice modeling may be appropriate in cases where benefits extend to aspects of value associated with more passive uses.

In addition to value accruing to direct users, additional economic impacts from changes in coastal quality may be realized by local businesses via changes in tourism demand and by governments via changes in tax revenues. Estimation of such economic impacts requires the use of economic impact analysis (input-output models) described earlier in this report. While the estimation of tourism multipliers and the economic impacts of discrete tourism-related events have received attention in the literature (e.g Dwyer et al., 2004; Frechtling and Horvath, 1999; Hodur and Leistritz, 2007), a recent review of the economics of coastal erosion by Landry (2011) finds a dearth of research regarding the economic benefits accruing to local businesses from beach management.

Finally, it is important to note that management alternatives involving shoreline retreat may not create losses in terms of foregone recreation and tourism opportunities. As discussed in Parsons and Powell (2001), if the shoreline is simply relocated farther inland, with no changes to other beach characteristics, the welfare derived from recreationists can be assumed to be unchanged. More generally, to the extent that shoreline change does have an adverse effect on the quantity or quality of recreational opportunities, the degree of economic loss to users and associated businesses will depend upon the availability of substitute locations for such activities (Landry, 2011). If alternative sites are available, proximate and of similar quality, the economic losses associated with diminished quality at one site may be mitigated via substitution.

Clearly, the economic value from coastal recreation and tourism is multi-faceted and involves numerous user groups. A comprehensive empirical estimation of quality-induced changes in values associated with recreation is not straightforward, and should be site-specific entailing multiple valuation approaches.

5.3.2 Examples from the literature

The literature pertaining to the economic value of coastal recreation is vast. This literature includes estimates of the value of access, typically addressed via revealed preference methods, as well as the value associated with changes in site quality, which is more commonly assessed via stated preference techniques. We do not attempt to provide a comprehensive review of this literature, but rather try to highlight particular studies that may be germane to the issues at hand.

Bin et al. (2005) apply the travel cost method to estimate the economic value of beach recreation in North Carolina. Data were collected at seven beach sites in the state, including Topsail Island and Wrightsville Beach. Value estimates range from $11 to $80 for day trips and between $11 and $41 for overnight trips. There is notable variation in value estimates across sites, with higher values found for beaches that are inaccessible by automobile or are not as well-known as other beaches in the sample. The authors speculate that the perception of exclusivity may influence the recreational value of beaches and suggest that unique site characteristics and user preferences for different types of experiences are important determinants of value.

In a contingent valuation analysis of beach renourishment in the Cape Hatteras National Seashore, N.C., Judge, Osborne and Smith (1995) find that average willingness to pay for beach renourishment is approximately $178 per person per year. This value was a positive function of anticipated future visitation and is inversely related to prior experience at the site. Willingness to pay also decreases with distance from the site for those users with no prior experience visiting Cape Hatteras and is a positive function of education level and the attitude that beach towns suffering from storm erosion should receive additional federal assistance.

Whitehead et al. (2008) use the travel cost method and a combination of revealed preference and stated preference data to estimate changes in recreation demand at 17 beaches in southeastern North Carolina that would occur with improved parking and beach nourishment. The study area included numerous beaches in Carteret, Pender, Onslow, New Hanover and Brunswick Counties. Regarding beach nourishment, respondents were informed that beach nourishment projects would be performed at least once every 3 to 5 years for a 50-year term for the purpose of shore protection and enhanced recreation opportunities, and average beach width would increase by 100 feet. A majority of respondents (58%) expressed support for the beach nourishment policy, and most respondents (85%) felt that the stated beach nourishment policy would be effective in maintaining beach width. Yet, some respondents (21%) were satisfied with current beach widths and some (18%) felt that beach width should not be altered by people. Enhanced beach width was found to increase total net gains to beach visitors by approximately $7 per person per trip and roughly $68 per person per year.

5.4 Values Associated with Coastal Species and Habitats

As is the case with empirical explorations regarding the economic value associated with coastal recreation, the literature on the economic value of species and habitats is extensive. Howarth and Farber (2002) provide important background reading regarding the economic valuation of ecosystem services, and note the importance of constructing monetary measures of economic wellbeing that account for non-market values held by people. These non-market values include existence values pertaining to species and ecosystems. The authors also highlight the importance of accounting for values held by a range of stakeholder groups rather than value held by a "representative" individual. A review of the literature provided by Spurgeon (1999) suggests that use and non-use benefits derived from coastal ecosystems are substantial. These ecosystems provide an array of valuable services that result in economic benefits to the public at large. Barbier et al. (2008) note the importance of considering nonlinearities when accounting for changes in coastal ecosystem service flows. Specifically, they note that changes in coastal ecosystem services do not necessarily respond linearly to changes in habitat size. This implies that valuation of coastal ecosystem services should not be based on simple linear extrapolations of lost habitat to point estimates of monetary value.

In the case of wetlands, ecosystem services include filtration, storage, and detoxification of residential and agricultural wastes and mitigation of pollution and nutrient-laden runoff into receiving water bodies (Stedman and Dahl, 2008). Wetland preservation can be viewed as a cost-saving measure for communities as these water-quality services can involve considerably lower costs than community or municipal water treatment alternatives (US EPA, 2006). By absorbing and storing flood waters, wetlands can also serve as a natural buffer protecting adjacent real estate from the effects of rising surface waters during storms. Similarly, dune habitats provide important storm-protection services for coastal land and property. Wetlands and dunes also provide important transitional habitat between aquatic and terrestrial environments for resident and migratory wildlife. Wetlands serve as critical nursing areas for marine organisms, including the majority of fish and shellfish species harvested in the U.S. (US EPA, 2006). The quality and abundance of coastal ecosystems are therefore directly related to the health of fish and wildlife stocks (Stedman and Dahl, 2008).

The existence of dunes and wetlands in a community may enhance property values for storm protection benefits, aesthetics and through improved opportunities for recreation activities such as hiking, bird watching, and photography. Wetlands may be considered a disamenity if they are associated with odors, insects or undesirable wildlife interactions.

Several studies have attempted to estimate the economic impact of proximate wetlands on land values using the hedonic pricing method. Generally, these studies suggest that the effect of wetlands on property values depends on the type and character of the wetland. For example, in an examination of property values in rural Florida, Reynolds and Regalado (1998) find that proximity to scrub-shrub and shallow pond wetlands has a positive impact on property values, while proximity to emergent palustrine wetlands may have an adverse effect. In mainland North Carolina, Bin and Polasky (2003) find that the open and sparsely vegetated nature of coastal wetlands provide a value-enhancing amenity while more densely forested inland wetlands do not, and may in fact decrease property values.

Numerous studies employing stated preference methods find substantial economic value associated with recreation, wildlife habitat, flood control, and improved water quality from wetland services (McConnell and Walls, 2005). Woodward and Wui (2001) review the results from 39 empirical studies, and find that type of wetland and method of analysis has substantial effect on estimated wetland values, noting that only imprecise estimates of wetland values can be garnered from the literature. Hence, it is reasonable to conclude that wetlands are an important source of economic value to surrounding areas, but without case-specific empirical analysis, a reasonable approximate of the magnitude or distribution of that value is not feasible.

Spurgeon (1999) provides an overview of the economics associated with coastal habitat rehabilitation and creation, including a review of the relevant literature. The author notes that the costs associated with habitat rehabilitation or creation costs vary widely between and within ecosystems. The two studies that pertain to dune habitats suggest that rehabilitation costs may range from approximately $19,000 to $25,000 per hectare.[3]

Numerous studies are available that pertain to the economic value of species and species protection. Shogren et al. (1999) provide useful background reading. Loomis and White (1996) provide results from a meta-analysis of the economic benefits of rare and endangered species. Whitehead (1993) estimates willingness to pay for preservation of coastal non-game habitat and loggerhead sea turtle nesting habitat in North Carolina using the contingent valuation method and a sample of 600 North Carolina residents. Average annual willingness to pay is approximately $11 for the loggerhead sea turtle program and $15 for the coastal nongame wildlife program. In addition to generating estimates of the economic value of coastal habitat associated with species protection, this work highlights the importance of accounting for uncertainty when estimating the economic value associated with threatened or endangered wildlife populations. The author notes that failure to account for uncertainty with regard to the continued existence of the resource as well as uncertainty pertaining to demand and preferences may result in inappropriate benefits estimates.

[3] The latter value pertains to a 2.5 ha dune rehabilitation project in Scotland and includes costs associated with replanting dune grass, providing fencing for trapping sand and installing gabion revetments. Additional maintenance costs for the project are noted as less than $1,000 per year. The former value pertains to a 17.8 ha dune rehabilitation project in Monterey, CA.

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APPENDIX P

CENTRAL REACH PROJECT PERMITS

North Carolina Department of Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

December 22, 2011

Joshua Daniel
Tidewater Atlantic Research, Inc.
PO Box 2494
Washington, NC 27889

Re: Phase I Remote-Sensing Submerged Cultural Resource and Hard Bottom Survey of a Proposed Borrow Area off Brunswick County, ER 11-2295

Dear Mr. Daniel:

Thank you for your email of November 28, 2011, transmitting the archaeological survey report by Tidewater Atlantic Research, Inc. for the above project.

During the course of the survey, a single magnetic anomaly was located within the project area. Based on your remote sensing findings, we concur with your recommendation that no further archaeological investigation be conducted in connection with this project. Despite being a high probability area for cultural resources, no potentially significant anomalies were identified indicating the project will not involve significant archaeological resources.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Quality

Beverly Eaves Perdue
Governor

Charles Wakild P E
Director

Dee Freeman
Secretary

June 18 2012

David Hewett Town Manager
Town of Holden Beach
110 Rothschild Street
Holden Beach NC 28462

Re **Town of Holden Beach Central Reach Beach Nourishment** Brunswick County
Atlantic Ocean (30759 99 (1) SB)
DWQ Project # 20011836 Ver 3 USACE Action ID # SAW 2011 01914

APPROVAL of 401 Water Quality Certification with Additional Conditions MODIFICATION

Dear Mr Hewett

Attached hereto is a copy of Certification No 3780 issued to Mr David Hewett Town Manager of the Town of Holden Beach dated June 18 2012 **This Certification replaces the Certification issued February 13, 2009** In addition you should get any other federal state or local permits before you go ahead with your project including (but not limited to) Solid Waste Sediment and Erosion Control Stormwater Dam Safety Non discharge and Water Supply Watershed regulations If we can be of further assistance do not hesitate to contact us

Sincerely

Charles Wakild P E

CW/kah/*ym*

Attachments Certificate of Completion

cc Dave Timpy – Wilmington District USACOE
Chad Coburn – DWQ Wilmington Regional Office
Stephen Rynas – DCM Morehead City
Jeff Garnett – EPA Sam Nunn Federal Center 61 Forsyth Street SW Atlanta GA 30303
File Copy
Fran Way Applied Technology and Management Inc P O Box 20336 Charleston SC 29413

011836Ver3TOHoldenBeachCentralReachBeachRenourishment(Brunswick)401_IC_MOD

Permit Class
MODIFICATION/MAJOR

Permit Number
14-02

STATE OF NORTH CAROLINA
Department of Environment and Natural Resources
and
Coastal Resources Commission

Permit

for

X Major Development in an Area of Environmental Concern pursuant to NCGS 113A-118

X Excavation and/or filling pursuant to NCGS 113-229

Issued to **Town of Holden Beach, PO Box 449, Supply, NC 28462**

Authorizing development in Brunswick Counties at Atlantic Ocean, from 781 Ocean Blvd. West to 240 Ocean Blvd. East, as requested in the permittee's application dated 12/15/11, AEC Hazard Notice dated 7/9/12, and workplan drawings (20), 1-20 of 20 all dated 12/5/11.

This permit, issued on **July 10, 2012**, is subject to compliance with the application (where consistent with the permit), all applicable regulations, special conditions and notes set forth below. Any violation of these terms may be subject to fines, imprisonment or civil action; or may cause the permit to be null and void.

1) In order to protect threatened and endangered species and to minimize adverse impacts to offshore, nearshore, intertidal and beach resources, no excavation or beach nourishment activities shall occur from April 1 to November 15 of any year without prior approval from the Division of Coastal Management in consultation with the Division of Marine Fisheries and the North Carolina Wildlife Resources Commission.

Excavation

2) All excavation activities shall take place entirely within the areas indicated on attached Sheet No. 17 of 20 (Project Borrow Site).

(See attached sheets for Additional Conditions)

This permit action may be appealed by the permittee or other qualified persons within twenty (20) days of the issuing date. An appeal requires resolution prior to work initiation or continuance as the case may be.

This permit must be accessible on-site to Department personnel when the project is inspected for compliance.

Any maintenance work or project modification not covered hereunder requires further Division approval.

All work must cease when the permit expires on

December 31, 2015

In issuing this permit, the State of North Carolina agrees that your project is consistent with the North Carolina Coastal Management Program.

Signed by the authority of the Secretary of DENR and the Chairman of the Coastal Resources Commission.

Doug V Huggett for

Braxton C. Davis, Director
Division of Coastal Management

This permit and its conditions are hereby accepted.

Signature of Permittee

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: **Town of Holden Beach**	File Number: **2012-00286**	Date: **September 28, 2012**

	Attached is:	See Section below
X	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
☐	PROFFERED PERMIT (Standard Permit or Letter of permission)	B
☐	PERMIT DENIAL	C
☐	APPROVED JURISDICTIONAL DETERMINATION	D
☐	PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/inet/functions/cw/cecwo/reg or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT	
REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)	
ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.	
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:	
If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division,** **Attn: David Timpy, Project Manger** **69 Darlington Avenue** **Wilmington, NC 28403**	If you only have questions regarding the appeal process you may also contact: Mr. Jason Steele, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137
RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.	

Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, Attn: David Timpy, 69 Darlington Avenue, Wilmington, North Carolina 28403

For Permit denials, Proffered Permits and approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Jason Steele, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801
Phone: (404) 562-5137

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF

September 28, 2012

Regulatory Division

Action ID. SAW-2012-00286

The Town of Holden Beach
Attention: David W. Hewett
110 Rothschild Street
Holden Beach, North Carolina 28462

Dear Mr. Hewett:

In accordance with your written request of December 15, 2011, and the ensuing administrative record, enclosed are two copies of a permit to construct the Holden Beach Beach Fill Project, Brunswick County, North Carolina. Your proposed project consists of dredging, via a hopper dredge, approximately 1,300,000 cy of material from an offshore borrow area located 1.8 to 3.0 miles offshore of Oak Island and to place this material onto approximately 22,000 feet of shoreline in Holden Beach. The proposed area of beach fill is between Stations 40+00 and 260+00 and would taper (approximately 1,500- 2,000 ft) at each end of the beach fill. The proposed project design consists of a dune that is 9.5 ft high by 25 ft wide that would transition to a beach berm at an elevation of 7.0 ft NGVD29. The beach berm width would vary from 140 ft to 190 ft. The average fill placement density along the project area is 60 sf per linear foot along the entire project area.

You should acknowledge that you accept the terms and conditions of the enclosed permit by signing and dating each copy in the spaces provided ("Permittee" on page 3). Your signature, as permittee, indicates that, as consideration for the issuance of this permit, you voluntarily accept and agree to comply with all of the terms and conditions of this permit. All pages of both copies of the signed permit with drawings should then be returned to this office for final authorization. A self-addressed envelope is enclosed for your convenience.

Title 33, Part 325.1(f), of the Code of Federal Regulations reads, in part, that, "A $10 fee will be charged for permit applications when the work is noncommercial in nature and provides personal benefits that have no connection with a commercial enterprise...", and "A fee of $100 will be charged for permit applications when the planned or ultimate purpose of the project is commercial or industrial in nature and is in support of operations that charge for the production, distribution, or sale of goods or services." As your application fits the former category, you are requested to remit your check for $10.00, made payable to the Finance and Accounting Officer, USAED, Wilmington. The check should accompany the signed and dated copies of your permit.

This correspondence contains a proffered permit for the above described site. If you object to this decision, you may request an administrative appeal under Corps regulations at 33 CFR part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this decision you must submit a completed RFA form to the South Atlantic Division, Division Office at the Following address:

Mr. Jason Steele, Administrative Appeal Review Officer
CESAD-ET-CO-R
U.S. Army Corps of Engineers, South Atlantic Division
60 Forsyth Street, Room 9M15
Atlanta, Georgia 30303-8801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by November 28, 2012.

It is not necessary to submit an RFA form to the Division Office if you do not object to the decision in contained in this correspondence.

After the permit is authorized in this office, the original copy will be returned to you; the duplicate copy will be permanently retained in this office. If you have questions, please contact Dave Timpy at the Wilmington Regulatory Field Office, telephone 910-251-4634.

Sincerely,

Dale Beter, Chief
Wilmington Regulatory Field Office

Enclosures

SAW-2012-00286, SPECIAL CONDITIONS

1. In accordance with 33 U.S.C. 1341(d), all conditions of the North Carolina Division of Water Quality 401 Certification and the North Carolina Division of Coastal Management CAMA Major Permit are incorporated as part of the Department of the Army permit. Therefore, they are not listed as special conditions.

2. This Department of the Army permit does not obviate the need to obtain other Federal, State or local authorizations required by law.

3. All work authorized by this permit must be performed in strict compliance with the attached plans, which are a part of this permit. Any modification to these plans must be approved by the U.S. Army Corps of Engineers (Corps) prior to implementation.

4. Except as authorized by this permit or any Corps approved modification to this permit, no excavation, fill or mechanized land-clearing activities shall take place at any time in the construction or maintenance of this project, within waters or wetlands. This permit does not authorize temporary placement or double handling of excavated or fill material within waters or wetlands outside the permitted area. This prohibition applies to all borrow and fill activities connected with this project.

5. Except as specified in the plans attached to this permit, no excavation, fill or mechanized land-clearing activities shall take place at any time in the construction or maintenance of this project, in such a manner as to impair normal flows and circulation patterns within waters or wetlands or to reduce the reach of waters or wetlands.

6. The permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the work will, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the water or wetland to its pre-project condition.

7. Violations of these conditions or violations of Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act must be reported in writing to the Wilmington District Corps within 24 hours of the permittee's discovery of the violation.

8. All mechanized equipment will be regularly inspected and maintained to prevent contamination of waters and wetlands from fuels, lubricants, hydraulic fluids, or other toxic materials. In the event of a spill of petroleum products or any other hazardous waste, the permittee shall immediately report it to the N.C. Division of Water Quality at (919) 733-5083, ext. 526 or (800) 662-7956 and provisions of the North Carolina Oil Pollution and Hazardous Substances Control Act will be followed.

9. Unless otherwise authorized by this permit, all fill material placed in waters or wetlands shall be be clean and free of any pollutants except in trace quantities. Metal products, organic materials (including debris from land clearing activities), or unsightly debris will not be used.

10. The permittee shall require its contractors and/or agents to comply with the terms and conditions of this permit in the construction and maintenance of this project, and shall provide each of its contractors and/or agents associated with the construction or maintenance of this project with a copy of this permit. A copy of this permit, including all conditions, shall be available at the project site during construction and maintenance of this project.

11. The permittee shall employ all sedimentation and erosion control measures necessary to prevent an increase in sedimentation or turbidity within waters and wetlands outside the permit area. This shall include, but is not limited to, the immediate installation of silt fencing or similar appropriate devices around all areas subject to soil disturbance or the movement of earthen fill, and the immediate stabilization of all disturbed areas. Additionally, the project must remain in full compliance with all aspects of the Sedimentation Pollution Control Act of 1973 (North Carolina General Statutes Chapter 113A Article 4).

12. The permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the work will, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the waterway to its former conditions. If the permittee fails to comply with this direction, the Secretary or his representative may restore the waterway, by contract or otherwise, and recover the cost from the permittee.

13. The authorized structure and associated activity must not interfere with the public's right to free navigation on all navigable waters of the United States. No attempt will be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the authorized work for reason other than safety.

14. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal, relocation, or alteration. The permittee shall notify NOAA/NATIONAL OCEAN SERVICE Chief Source Data Unit N CS261, 1315 E West HWY- RM 7316, Silver Spring, MD 20910-3282 at least two weeks prior to beginning work and upon completion of work.

15. If submerged cultural resources are encountered during the operation, the District Engineer will be immediately notified so that coordination can be initiated with the Underwater Archeology Unit (UAU) of the Department of Cultural Resources. In emergency situations, the permittee should immediately contact Mr. Chris Southerly at (910) 458-9042, Fort Fisher, so that a full assessment of the artifacts can be made.

16. The permittee will comply with all U.S. Coast Guard (USCG) regulations for dredging operations. The permittee will contact Mr. Joseph Edge, U.S. Coast Guard, Sector North Carolina Waterways Management at (252) 247-4525 at least 30 days prior to construction.

Contact with the U.S. Coast Guard will initiate the Local Notice for Mariners procedures to ensure all safety precautions for aids to navigation are implemented. The permittee will notify our office when this coordination with the U.S. Coast Guard has been commenced and updates will be provided to Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy.

17. This permit authorizes beach nourishment activities to be carried out one time along the entire reach of the requested project area. Any request to carry out additional activities within the area where nourishment activities have been completed under this permit will require additional authorization.

18. The permitee shall provide the Corps a final set of construction plans for the authorized project prior to construction.

19. A pre-construction meeting must be held with our office at least two weeks prior to conducting the work to ensure the contractor fully understands the conditions of this permit. Participates may include, but not limited to, representatives from NC Division of Coastal Management, NC Division of Water Quality, NC Wildlife Resource Commission, and U.S. Coast Guard.

20. The contractors name, phone number, and address, including a field contact name and number, will be submitted to the Wilmington District prior to any work.

21. In order to protect juvenile finfish resources, no excavation or filling activities will be permitted between the dates of April 1st and September 30th of any year without the prior approval of the North Carolina Division of Coastal Management and the Corps.

22. In order to protect nesting piping plover and sea turtles and to reduce the likelihood of adverse impacts to manatees, the placement of sediment and beach grading from April 1st through November 15th is prohibited.

23. All mobilization and demobilization work shall be conducted outside the shorebird nesting season from April 1st thru August 31st and outside the sea turtle nesting season from May 1st thru November 15th.

24. The Permittee shall conduct surveys for sea beach amaranth both before, and for three years after, sediment placement is totally compete in order to avoid direct burial and to monitor recovery of the plant. The three years of post-construction monitoring for seabeach amaranth should be conducted during the summer months.

25. A representative of the Corps will periodically and randomly inspect the work for compliance with these conditions. Deviations from these procedures may result in cessation of work until the problem is resolved to the satisfaction of the Corps.

26. All necessary precautions and measures will be implemented so that any activity will not kill, injure, capture, pursue, harass, or otherwise harm any protected federally listed species

(such as sea turtles, whales, manatee, sturgeon (Shortnose and Atlantic), and piping plover). While accomplishing the authorized work, if the permittee discovers or observes a damaged or hurt listed endangered or threatened species, the District Engineer will be immediately notified so that required coordination can be initiated with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service.

27. In the event an incidental sea turtle, whale, manatee, sturgeon (Shortnose and Atlantic) take occurs by a dredge, the permittee must stop all dredging operations and contact the Wilmington District Corps for consultation to determine the appropriate action, including the immediate implementation of sea turtle conservation measures that must be taken. The permittee shall immediately notify the Corps, Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy, by email at: David.L.Timpy@usace.army.mil, or by telephone at: (910) 251-4634 that an incidental take has occurred.

28. Routine beach surveillance will be conducted during construction to prevent unintentional damage to sea turtles and their nesting areas. If a nest or a turtle crawl is identified in the project area, the permittee will immediately stop all beach disposal activities and contact the Wilmington District and the North Carolina Wildlife Resources Commission to determine appropriate action.

29. The permittee understands and agrees that, even where it is in full compliance with the terms and conditions of this permit and other required authorizations, incidental take of sea turtles or other endangered species by the permittee may require suspension of the permit by the Corps. The amount of incidental take that will trigger suspension, and the need for any such suspension, shall be determined at the time in the sole discretion of the Corps. The permittee understands and agrees on behalf of itself, its agents, contractors, and other representatives, that no claim, legal action in equity or for damages, adjustment, or other entitlement against the Corps shall arise as a result of such suspension or related action.

30. No dredging shall occur outside of the authorized borrow area without prior approval of the Corps.

31. No dredged material shall be placed at any time in waters outside the permitted beach nourishment disposal area. Material shall be placed on the beach from hopper dredge to the beach via a pipeline.

32. All material used for the beach nourishment must be beach compatible, clean, free of debris and clay, and free of any pollutants except in trace quantities. The permittee shall ensure that an inspector is present during all beach disposal activities and immediately reports to the Corps should any potentially incompatible material be placed on the beach. During dredging operations, material placed on the beach shall be inspected daily to ensure compatibility. During dredging operations, a sediment analysis of the material placed on the beach, including shell content (calcium carbonate) percentage and color shall be submitted to the Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy, on a WEEKLY basis until completion of the project. This analysis shall include, at a minimum, the location of the sample station, shell percentage, silt/clay content, grain size, and color as

indicated by the Munsell Color Chart. If during the sampling process non-beach compatible material, including large amounts of shell, is or has been placed on the beach all work shall stop immediately and the Corps be notified by the permittee and/or its contractors to determine the appropriate plan of action.

33. All borrow material placed on the beach will evaluated by color using the Munsell Color Chart. All material placed on the beach must have a hue of 10YR, a value between 5 and 8 (a chroma of 4 or less is required for values of 7 and 8, and a chroma of 3 or less is required for values of 5 and 6). If any material is placed on the beach that does not meet these criteria all work must stop and the Corps must be notified to determine the appropriate action. These measures are to ensure that all sediment placed on the beach is similar to the historic, native beach in sand grain size, density, shear resistance, heavy mineral content, moisture content, and color. The Permittee shall cease all work if any deviations from the accepted levels of beach compatible material are observed and contact Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy.

34. The permittee shall document soil colors along eight sample beach profiles using the Munsell Color Chart. This monitoring should take place as soon after placement of material is complete. The permittee will document soil color at the surface, -0.5 ft, -1 ft and -2 ft at each sample site.

35. Visual surveys of escarpments shall be made along the beach fill area immediately after completion of construction. Between April 1st and December 1st, all escarpments in the newly placed beach fill that exceed 18 inches shall be graded to match adjacent grades on the beach. Removal of any escarpments during the sea turtle hatching season (May 1 through November 15) shall be coordinated with the North Carolina Wildlife Resources Commission.

36. A representative of the Corps, Regulatory Division will periodically and randomly inspect the work for compliance with these conditions. Deviations from these procedures may result in cessation of work until the problem is resolved to the satisfaction of the Corps. No claim, legal action in equity or for damages, adjustment, or other entitlement shall be asserted against the United States on account of any such required cessation or related action, by the permittee, its agents, contractors, or other representatives.

37. The permittee shall provide written notification of project completion immediately upon completion of the work authorized by this permit.

38. The permittee will provide two copies of the as-built surveys of the offshore borrow dredged during this project and the beach fill areas within 30 days of project completion to the Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy.

DA Permit Special Conditions for Hopper Dredge Operations
Action ID #SAW-2012-00026
Town of Holden Beach

1. Endangered Species Protection:

a. Hopper dredging is being approved under the South Atlantic Regional Biological Opinion (RBO) which can be viewed on the ERDC web site at the following link: http://el.erdc.usace.army.mil/seaturtles/refs-bo.cfm. The National Marine Fisheries Service (NMFS) has directed that the RBO issued to the Corps serve as the formal consultation for the Holden Beach Beach Nourishment project. The RBO includes an Incidental Take Statement (ITS) issued to the Corps for its civil and military hopper dredging projects. Under the RBO/ITS, incidental takes are authorized on a Fiscal Year (FY) (October 1 - September 30) basis to be metered out by the Division Commander, South Atlantic Division, U.S. Army Corps of Engineers for the southeastern United States for Corps civil and military projects. The Permittee is hereby advised to avoid any incidental take in that such take may trigger the cessation of hopper dredging for the remainder of that FY. The Permittee understands and agrees that, even where it is in full compliance with the terms and conditions of the RBO/ITS, incidental take by the Permittee may require suspension of the permit by the Corps. The amount of incidental take that will trigger suspension, and the need for any such suspension, shall be determined at the time in the sole discretion of the Corps. The Permittee understands and agrees on behalf of itself, its agents, contractors, and other representatives, that no claim, legal action in equity or for damages, adjustment, or other entitlement against the Corps shall arise as a result of such suspension or related action.

b. Dredging operations **shall cease immediately** upon the first incidental take, and thereafter as directed by the Corps, until the District Engineer, or his designee, notifies the Permittee to resume dredging. The Permittee shall immediately notify the Corps, Wilmington District, Dave Timpy that an incidental take has occurred. The Sea Turtle Mortality Report, attached to this permit, will be filled out by the Observer immediately (within 6 hours) and e-mailed in pdf format to takereport.nmfsser@noaa.gov and Corps, Wilmington District, Dave Timpy. The permittee shall contact the National Dredging Quality Management (DQM) program (http://dqm.usace.army.mil/) to assure that project information is loaded and data is being appropriately transferred prior to project commencement.

2. Pre-Dredging Submittals:

a. No dredging shall be performed by a hopper dredge without the inclusion of a rigid sea turtle deflector device. Within 15 days of the anticipated start date, the Permittee shall electronically submit drawings showing the proposed device and its attachment to the Corps, Wilmington District, Dave Timpy. These drawings shall include the approach angle for any and all depths to be dredged during the dredging.

b. The Permittee shall electronically submit detailed drawings showing the proposed draghead grating system(s) and draghead(s), and documentation that supports grate sizing (such as dredge pump manufacturer's recommended maximum particle size dimension(s), etc.).

c. The permittee shall electronically submit an operational plan to achieve protection of sea turtles during the hopper dredging operation.

A copy of the approved drawings and calculations shall be available on the vessel during the dredging. No dredging work shall be allowed to commence until approval of the turtle deflector device has been granted by the Corps, Wilmington District. Sample Turtle Deflector Design Details are available on the website listed in special condition number 11.

3. Pre-Dredging Inspection:

A pre-dredging inspection of the hopper dredge shall be performed by the Corps, Wilmington District in accordance with the protocol entitled "COE SEA TURTLE INSPECTION CHECKLIST FOR HOPPER DREDGES for Corps projects or Corps/Army Permitted Project" located on the website listed in special condition number 11 below.

4. Hopper Dredge Equipment:

Hopper dredge dragheads shall be equipped with sea turtle deflectors which are rigidly attached. Deflectors shall be solid with no openings in the face. Such designs will be considered provided sufficient information is included indicating a particular modification is effective in minimizing potential turtle takes. Corps technical staff will coordinate with NOAA Fisheries on the effectiveness of this alternate design. No dredging shall be performed by a hopper dredge without an installed turtle deflector device approved by the Corps. Sample Turtle Deflector Design Details are on the first web site indicated in special condition number 11 below.

a. Deflector Design:

(1) The leading V-shaped portion of the deflector shall have an included angle of
less than 90 degrees. Internal reinforcement shall be installed in the deflector to prevent structural failure of the device. The leading edge of the deflector shall be designed to have a plowing effect of at least 6" depth when the drag head is being operated. Appropriate instrumentation or indicator shall be used and kept in proper calibration to insure the critical "approach angle". (Information Only Note: The design "approach angle" or the angle of lower drag head pipe relative to the average sediment plane is very important to the proper operation of a deflector. If the lower drag head pipe angle in actual dredging conditions varies tremendously from the design angle of approach used in the development of the deflector, the 6" plowing effect does not occur. Therefore, every effort should be made to insure this design "approach angle" is maintained with the lower drag pipe.)

(2) If adjustable depth deflectors are installed, they shall be rigidly attached to the
drag head using either a hinged aft attachment point or an aft trunnion attachment point in association with an adjustable pin front attachment point or cable front attachment point with a stop set to obtain the 6" plowing effect. This arrangement allows fine-tuning the 6" plowing

effect for varying depths. After the deflector is properly adjusted there shall be NO openings between the deflector and the drag head that are more than 4" by 4".

b. In-flow Baskets and overflow screening:

(1) The Permittee shall ensure that baskets or screening are installed over the hopper inflow(s) with no greater than 4" x 4" openings. The method selected shall depend on the construction of the dredge used and shall be approved by the District Engineer prior to commencement of dredging. The screening shall provide 100% screening of the hopper inflow(s). The screens and/or baskets shall remain in place throughout the performance of the work. The turtle deflector device and inflow screens shall be maintained in operational condition for the entire dredging operation.

(2) The Permittee shall install and maintain floodlights suitable for illumination of the baskets or screening to allow the observer to safely monitor the hopper baskets or screening to allow the observer to safely monitor the hopper basket(s) during non-daylight hours or other periods of poor visibility. Safe access shall be provided to the inflow baskets or screens to allow the observer to inspect for turtles, turtle parts, or damage.

(3) The Permittee shall implement 100% overflow screening if inflow screening is not practicable and if prior approval has been granted by the Corps, Wilmington District.

c. Draghead grating:

(1) Draghead grating may be used to prevent over-sized objects (relative to respective pump and distribution system designs) from reaching and becoming lodged or damaging, the dredge pump and/or slurry distribution system. The Permittee may not use a draghead grating system that would prevent turtle remains from entering the hopper inflow screening. Detailed drawings showing the proposed draghead grating system(s) and draghead(s), and documentation that supports grate sizing (such as dredge pump manufacturer's recommended maximum particle size dimension(s), etc.) shall be submitted. Exceptions for smaller draghead screens will be considered as necessary (e.g., in areas containing ordnance or excessive debris likely to clog or damage the pumps) with supporting justifications. No dredging shall begin until the District has approved all grating and screening.

d. Hopper Dredge Operation:

(1) The Permittee shall operate the hopper dredge to minimize the possibility of taking sea turtles and to comply with the requirements stated in the Incidental Take Statement provided by the NMFS in their RBO.

(2) The turtle deflector device and inflow screens shall be maintained in operational condition for the entire dredging operation.

(2) When initiating dredging, suction through the drag heads shall be allowed just

long enough to prime the pumps, and then the drag heads must be placed firmly on the bottom. When lifting the drag heads from the bottom, suction through the drag heads shall be allowed just long enough to clear the lines, and then must cease. Pumping water through the drag heads shall cease while maneuvering or during travel to/from the disposal area. If the required dredging section includes compacted fine sands or stiff clays, a properly configured arrangement of teeth may enhance dredge efficiency, which reduces total dredging hours, and "turtle takes." The operation of a drag head with teeth must be monitored for each dredged section to insure that excessive material is not forced into the suction line. When excess high-density material enters the suction line, suction velocities drop to extremely low levels causing conditions for plugging of the suction pipe. Dredge operators should configure and operate their equipment to eliminate all low-level suction velocities. Pipe plugging in the past was easily corrected, when low suction velocities occurred, by raising the drag head off the bottom until the suction velocities increased to an appropriate level. Pipe plugging cannot be corrected by raising the drag head off the bottom. Arrangements of teeth and/or the reconfiguration of teeth should be made during the dredging process to optimize the suction velocities.

(3) Raising the drag head off the bottom to increase suction velocities is not acceptable. The primary adjustment for providing additional mixing water to the suction line should be through water ports. To insure that suction velocities do not drop below appropriate levels, the Dredging Inspector for the Permittee shall monitor production meters throughout the job and adjust primarily the number and opening sizes of water ports. Water port openings on top of the drag head or on raised standpipes above the drag head shall be screened before they are utilized on the dredging project. If a dredge section includes sandy shoals on one end of tract line and mud sediments on the other end of the tract line, the equipment shall be adjusted to eliminate drag head pick-ups to clear the suction line.

(4) The drag head shall be buried a minimum of 6 inches in the sediment at all times.
Although the over depth prism is not the required dredging prism, the Permittee shall achieve the required prism by removing the material from the allowable over depth prism.

(5) During turning operations the pumps must either be shut off or reduced in speed
to the point where no suction velocity or vacuum exists.

(6) These operational procedures are intended to stress the importance of balancing
the suction pipe densities and velocities in order to keep from taking sea turtles. As stated in Condition #2, the Permittee shall develop and submit a written operational plan to minimize turtle takes.

5. Recording charts for Hopper Dredge(s):

The recording system shall be capable of capturing data at variable intervals but with a frequency of not less than every 60 seconds. All data shall be time correlated to a 24-hour clock and the recording system shall include a method of daily evaluation of the data collected. This data shall be made available at the request of the issuing District.

6. The National Dredging Quality Management (DQM) Program:

The Corps former Silent Inspector program has been replaced by the National Dredging Quality Management (DQM) Program. DQM is the Corps' next generation automated dredging monitoring system and analysis tools for the modern Corps dredging manager. The mission of the National DQM Program is to provide the Corps dredging manager with a nationally standardized low cost remote monitoring and documentation system. This system provides the Corps with timely data access, multiple reporting formats, full technical support, including dredge certifications, data quality control, database management, and support for the DQM operating system. On board the dredge, sensors continually monitor dredge activities, operations, and efficiency. Information from these sensors is routed to the National DQM Support Center for data processing, storage and publishing. The DQM system must have been certified by the Engineer Research and Development Center (EEDC) within the last year and comply with the latest specifications for hopper dredges. Questions regarding certification should be addressed to the DQM support center at 877-840-8024. Additional information, including the current required hopper dredge specifications at DQM is available at http://dqm.usace.army.mil/Default.aspx.

7. (Atlantic Only) Sea Turtle Non-Capture Trawl Sweeping

In order to minimize or reduce taking of turtles during dredging, non-capture trawling is required. This type of trawling is designed to use non-capture type trawling equipment to sweep in the proximity of the dredging operations in order to stimulate sea turtles to move out of the dredge path. No sea turtles will be captured using this trawling technique. Non-capture trawl sweeping shall be performed 48 hours prior to initiating dredging and shall continue throughout dredging operations. Conduct non-capture trawl sweeping operations in the vicinity of dredge operations, but maintain a safe distance from the dredge. Trawl equipment used (e.g. trawling nets) and trawl sweeping operations shall be conducted such that no sea turtles or other marine organism by-catch are captured. As much as possible, non-capture trawl sweeping shall be conducted to maximize the amount of time during each 24-hour trawl day that the trawl equipment (e.g. trawling nets) sweeps the bottom sediment in the vicinity of the dredging operation (i.e. maximize the bottom time with the trawling equipment). Such trawling in the vicinity of the dredge shall be conducted continuously, stopping after every 4 to 6 hours to check the condition of the trawl equipment and assure that no turtles have been captured.

a. Non-capture Trawl Sweeping Period:
Non-capture trawl sweeping shall be conducted as described below:

(1) A day of non-capture trawl sweeping shall be defined as 24 hours of continuous trawling.

(2) Non-capture trawl sweeping may be conducted as 24-hours of trawling as a continuous trawl; however, two separate crews must be available on board to work two 12-hour shifts.

b. Turtle Handling and Endangered Species Permits:
No sea turtles are to be intentionally captured during non-capture trawl sweeping operations. No endangered species permits to handle sea turtles are required for non-capture trawl sweeping. Should a sea turtle become entangled in the trawling nets; the nearest marine facility will be notified for arrangements to be made to transfer the animal as needed.

c. Reporting:

A daily log will be kept for each non-capture trawl sweeping operations. The non-capture trawl sweeping log will be submitted to the Corps, Wilmington District, Dave Timpy at the completion of the project. Data to be included with this log daily will include:

(1) GIS coordinate of trawl locations at the start and end of each sweep

(2) Times recorded for each trawl sweep duration;

(3) Description of dredge proximity during each sweep;

(4) General notes as appropriate (e.g. condition of equipment at the end of each sweep, snags occurring during each sweep, incidental debris, etc.).

(5) Water Quality and Physical Measurements: Water temperature measurements shall be taken at the water surface each day using a laboratory thermometer. Weather conditions shall be recorded from visual observations and instruments on the trawler. Weather conditions, air temperature, wind velocity and direction, sea state-wave height, and precipitation shall be recorded on the Sea Turtle Trawling Report on the web site indicated in special conditions number 12 below. High and low tides shall be recorded.

d. Non-Capture Trawl Sweeping Equipment:

(1) To reduce the chances of sea turtles becoming entangled and caught in the net webbing during non-capture trawl sweeping, the Contractor shall use standard flat-style shrimp trawling nets. Nets shall have one to two-inch webbing holes, the webbing should be made of nylon material (preferably dipped.)

(2) The bag end of these nets shall be completely cut out so that the nets remaining on the rigging are approximately 30 to 50-feet long. The nets shall be long enough to provide a trailing length of net in the water to "stimulate turtles" to move but not be long enough to be able to twist when: 1) being pulled in the water; 2) being pulled up and onto the deck; 3) the vessel is stationary; or 4) the trawl vessel turns while trawling. This net length may be shorter or longer depending on the specific configurations of the trawler and its rigging, but must be set up to

specifically prevent the twisting of the net. The nets should be installed and adjusted such that organisms are not being collected (turtles and other by-catch).

(3) The bag end of the nets shall be cut away to create a large open end on the nets.

The webbing shall be monitored so that tears and rips do not occur in the remaining webbing that might entangle and capture organisms (particularly turtles).

(4) To ensure that the lead line and mouth of the trawl nets maintain contact with the

seafloor as best as possible, the lead line of each net shall be rigged with weights, mud rollers, tickler chains and/or trawling cookies (as appropriate for the environmental conditions and sediment type).

For the first 48 hours after beginning non-capture trawling operations, pull and check the nets every hour to evaluate and document the:

(a) Status of the nets (particularly twisting of the tail end);

(b) Net contents (turtles and other bycatch) and, after the first 48-hours and

appropriate net configuration has been established, gradually increase trawling times to a maximum of 2-3-hours.

8. Endangered Species Observers:

During dredging operations, observers approved by the National Oceanic and Atmospheric Administration – Fisheries (NOAA-Fisheries) sea turtles, sturgeon (Shortnose and Atlantic) and whales shall be aboard to monitor for the presence of the species. Observer coverage shall be 100 percent (24hr/day) and shall be conducted year round. During transit to and from the disposal area, the observer shall monitor from the bridge during daylight hours for the presence of endangered species, especially the Northern right whale, during the period December through March. During dredging operations, while dragheads are submerged, the observer shall continuously monitor the inflow and/or overflow screening for turtles and/or turtle parts and sturgeon (Shortnose and Atlantic) and/or sturgeon (Shortnose and Atlantic) parts. Upon completion of each load cycle, dragheads should be monitored as the draghead is lifted from the sea surface and is placed on the saddle in order to assure that sea turtles that may be impinged within draghead are not lost and un-accounted for. Observers shall physically inspect dragheads and inflow and overflow screening/boxes for threatened and endangered species take. Other abiotic and biotic debris found in the screens during their examination for sea turtle or sturgeon (Shortnose and Atlantic) parts shall be recorded and then disposed of so as not to impede the functioning of the screens during the next load cycle.

a. Monitoring Reports: The results of the monitoring shall be recorded on the appropriate observation sheets. There is a sheet for each load, a daily summary sheet, and a weekly summary sheet. In addition, there will be a post dredging summary sheet. Observations sheets will be completed regardless of whether any takes of sturgeon (Shortnose or Atlantic), whales, or sea turtles occur. In the event of any sea turtle or sturgeon (Atlantic or Shortnose) take by the dredge, appropriate incident reporting forms shall be completed. In the event an incidental sea turtle, whales, manatee, sturgeon (Shortnose or Atlantic) take occurs by a dredge, the permittee must stop all dredging operations and contact the Wilmington District for consultation to determine the appropriate action, including the immediate implementation of sea turtle conservation measures that must be taken. The permittee shall immediately notify Wilmington District, Regulatory Division, Wilmington Regulatory Field Office, Attn: Mr. Dave Timpy, by email David.L.Timpy@usace.army.mil or by telephone at (910) 251-4634 that an incidental take has occurred. Additionally, all specimens shall be photographed with a digital camera. These photographs shall be attached to respective reports for documentation. Dredging of subsequent loads shall not commence until all appropriate reports are completed from the previous dredging load to ensure completeness and thoroughness of documentation associated with the incidental take Reports shall be submitted to the Corps within 24-hours of the take. Copies of the forms shall be legible. Observer forms may be accessed on the web site indicated in special condition number 12 below.

b. Endangered Species Observer(s): A list of endangered species observer-biologists (ESOs) that have been NMFS-approved to monitor threatened/endangered species takes by hopper dredges can be obtained by contacting NOAA Fisheries' Northeast Region, Protected Resources Division. The main contact is Ms. Julie Crocker; she can be reached at julie.crocker@noaa.gov or 978-281-9300 ext.6530.

c. The Permittee shall provide a digital camera, with an image resolution capability of at least 300 dpi, in order to photographically report all incidental takes, without regard to species, during dredging operations. Immediately following the incidental take of any threatened or endangered species, images shall be provided, via email, CD, DVD, or USB (thumb/flash/jump drive) to the Contracting Officer's Representative in a .JPG or .TIF format and shall accompany incidental take forms. The nature of findings shall be fully described in the incidental take forms including references to photographs.

9. Manatee, Sea Turtle, Sturgeon, and Whale Sighting Reports

Any take concerning a manatee, sea turtle, sturgeon (Shortnose or Atlantic), or whale (Atlantic only); or sighting of any injured or incapacitated manatees, sea turtles, or whales shall be reported immediately to the Corps, Wilmington District, c/o Dave Timpy.

A copy of the incidental take report shall be provided within 24 hours of the incident. The Permittee shall also immediately report any collision with and/or injury to a manatee to the United States Fish and Wildlife Service. If a sea turtle is taken by the dredge (live or dead), the Permittee shall email a PDF version of the incidental take report to NOAA-Fisheries Southeast Region at the following email address within 24 hours of the take: takereport.nmfsser@noaa.gov and to the Corps, Wilmington District, c/o Dave Timpy.

10. Disposition of Sea Turtles or Turtle Parts

a. Turtles taken by hopper dredge

(1) Dead turtles - Upon removal of sea turtle and/or parts from the draghead or screening, observers shall take photographs as to sufficiently document major characteristics of the turtle or turtle parts including but not limited to dorsal, ventral, anterior, and posterior views. For all photographs taken, a backdrop shall be prepared to document the dredge name, observer company name, contract title, time, date, species, load number, location of dredging, and specific location taken (draghead, screening, etc.). Carcass/turtle parts shall also be scanned for flipper and Passive Integrated Transponder (PIT) tags. Any identified tags shall be recorded on the "Sea Turtle Incidental Take Form" that is included in the "Endangered Species Observer Program Forms" located on the web site indicated in special condition number 12 below. Turtle parts which cannot be positively identified to species, on board the dredge or barge(s) shall be preserved by the observer(s) for later identification. A tissue sample shall be collected from any lethally taken sea turtle and submitted under the process stated in the "Protocol for Collecting Tissue Samples from Turtles for Genetic Analysis" found in the CONSTRUCTION FORMS AND DETAILS below. All genetic samples collected shall be submitted to NMFS within 30-days of collection and verification of submittal to NMFS shall be provided to the Corps, Wilmington District, c/o Dave Timpy. After all data collection is complete, the sea turtle parts shall be placed in plastic bags, labeled as to the time, date, and dredged reach of collection, kept frozen and transported to the Sea Turtle Hospitable, Surf City, North Carolina. If no local facility is capable of receiving the sea turtle/parts, they should be marked (spray paint works well), weighted down and disposed of in accordance with the direction of the Corps, Wilmington District, c/o Dave Timpy.

(2) Live Turtles - Observer(s) shall measure, weigh, scan for PIT tags, tag (Iconnel flipper and PIT tags (if PIT tag not located during scan, and only if observer is qualified to tag using PIT tags)), and photograph any live turtle(s) incidentally taken by the dredge. Observer(s) (or their authorized representative) shall coordinate with the Corps, Wilmington District, c/o Dave Timpy and Doug Piatkowski, to transport, as soon as possible, the live turtle(s) taken by the dredge to an approved rehabilitation facility in the project area.

11. Report Submission:

The Permittee shall maintain a log detailing all incidents, including sightings, collisions with, injuries, or killing of manatees, sea turtles, sturgeon (Shortnose or Atlantic), or whales occurring during the contract period. The data shall be recorded on forms available on the website as indicated in special condition number 12. All data in original form shall be forwarded directly to the Wilmington District Corps within 10 days of collection. Following project completion, a report summarizing the above incidents and sightings shall be submitted to:

Dave Timpy
Regulatory Division
Army Corps of Engineers
Wilmington District

Doug Piatkowski
Environmental Resources Branch
Army Corps of Engineers
Wilmington District

National Marine Fisheries Service
Protected Species Management Branch
263 13th Avenue South
St. Petersburg, Florida 33701

Molly Ellwood
Southeastern Permit Coordinator
NCWRC/Habitat Conservation Program
127 Cardinal Drive
Wilmington, North Carolina 28405

Dr. Matthew Godfrey
North Carolina Wildlife Resources Commission
1507 Ann Street
Beaufort, North Carolina 28516

12. Reporting Forms:

In order to avoid use of outdated forms, the Permittee is directed to the following website for forms and attachments required under this permit. Links to these forms are under the heading "Turtle Information".
http://el.erdc.usace.army.mil/seaturtles

(List of forms required under this permit include: Sea Turtle/Pre and Post-Hopper Dredging Project Checklist, Endangered Species Observer Program Forms, Sea Turtle Tagging and Relocation Report, and Sea Turtle Trawling Report.)

DEPARTMENT OF THE ARMY PERMIT

Permittee: Town of Holden Beach

Permit No.: SAW-2012-00286

Issuing Office: CESAW-RG-L

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: To provide beach restoration along eroding sections of the Holden Beach shoreline sufficient to maintain the island's restored protective and recreational beachfront and natural dune system. The proposed plan includes dredging, via a hopper dredge, approximately 1,300,000 cy of material from an offshore borrow area located 1.8 to 3.0 mi offshore of Oak Island and to place this material onto approximately 22,000 ft (4.18 mi) of shoreline in Holden Beach, Brunswick County, North Carolina.

Project Location: Oak Island and Holden Beach, Brunswick County, North Carolina

General Conditions:

1. The time limit for completing the work authorized ends on December 31, 2017 If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit,

Special Conditions:

SEE ATTACHED SPECIAL CONDITIONS

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

(X) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf
of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity
authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit, Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

_______________________________ _______________

(PERMITTEE) Town of Holden Beach, David W. Hewett *(DATE)*

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

_______________________________ _______________

(DISTRICT ENGINEER) STEVEN A. BAKER, COLONEL *(DATE)*

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

_______________________________ _______________

(TRANSFEREE) ***(DATE)***

*U.S. GOVERNMENT PRINTING OFFICE 1986 - 717-425

ADDITIONAL CONDITIONS

3) Excavation shall not exceed –42.5' NGVD29.

4) Excavation shall be accomplished by a hopper dredge. Use of any other method of excavation shall require modification of this permit.

Beach Nourishment

5) This permit authorizes beach nourishment activities to be carried out one (1) time along the entire reach of the requested project area. Any request to carry out additional activities within an area where nourishment activities have been completed under this permit shall require a modification of this permit.

6) Prior to the initiation of beach nourishment activity along each section of beach, the existing mean high water line shall be surveyed and a copy provided to the Division of Coastal Management.

NOTE: The permittee is advised that the State of North Carolina claims title to all currently submerged lands and any future lands that are raised above the Mean High Water level as a result of this project.

7) Prior to the initiation of any beach nourishment activity above the mean high water contour line within the limits of the permittee's jurisdiction, easements or similar legal instruments shall be obtained from all affected property owners.

8) Prior to the initiation of any beach nourishment activity, the permittee shall coordinate with the Division of Coastal Management to determine the static vegetation line that shall be used as the reference point for measuring future oceanfront setbacks. The static vegetation line, which is defined as the vegetation line that existed within one year prior to the onset of initial project construction, shall be established using on-ground observation and survey or aerial imagery. This static vegetation line shall then be marked and a survey depicting this static vegetation line shall be submitted to the Division of Coastal Management prior to any beach nourishment activities.

9) The seaward nourishment limit shall be conducted in accordance with the approved work plats labeled Plan View (Sheets 3-15 of 20).

10) Temporary dikes shall be used to retain and direct flow of material parallel to the shoreline to minimize surf zone turbidities. The temporary dikes shall be removed and the beach graded in accordance with approved profiles upon completion of pumping activities in that particular section of beach.

11) Should the dredging operations encounter sand deemed non-compatible with 15A NCAC 07H .0312 (Technical Standards for Beach Fill Projects), the dredge operator shall immediately cease operation and contact the Division of Coastal Management. Dredge operations shall resume only after resolution of the issue of sand compatibility.

12) In order to prevent leakage, dredge pipes shall be routinely inspected. If leakage is found and repairs cannot be made immediately, pumping of material shall stop until such leaks are fixed.

ADDITIONAL CONDITIONS

13) Once a section is complete, piping and heavy equipment shall be removed or shifted to a new section and the area graded and dressed to final approved slopes.

14) Land-based equipment necessary for beach nourishment work shall be brought to the site through existing accesses. Should the work result in any damage to existing accesses, the accesses shall be restored to pre-project conditions immediately upon project completion in that specific area.

NOTE: The permittee is advised that any new access site would require a modification of this permit.

15) Where oceanfront development exists at elevations nearly equal to that of the native beach, a low protective dune shall be pushed up along the backbeach to prevent slurry from draining towards the development.

16) Dune disturbance shall be kept to a minimum. Any alteration of existing dunes shall be coordinated with the Division of Coastal Management as well as the appropriate property owner(s). All disturbed areas shall be restored to original contours and configuration with reference to the surveyed normal high water line and shall be revegetated immediately following project completion in that section of beach.

Mitigation and Monitoring

17) Unless specifically altered herein, the permittee shall implement all mitigation and monitoring commitments made in the permit application, and project purpose and description, that was prepared for this project.

18) Immediately after completion of the beach nourishment project, and prior to the next three sea turtle nesting seasons, beach compaction shall be monitored and tilling shall be conducted as deemed necessary by the Division of Coastal Management in coordination with appropriate review agencies.

19) Immediately after completion of any phase of the beach nourishment project, and prior to the next three nesting seasons, monitoring shall be conducted to determine if escarpments are present that would adversely affect nesting sea turtles and/or public access. If such escarpments are present, the permittee shall coordinate with the Division of Coastal Management for necessary remediation.

Cultural Resource Protection

20) Prior to any excavation or beach nourishment activities, the permittee shall contact the NCDCR Underwater Archaeology Branch at (910) 458-9042 to determine the location of any significant historical resources located within the project area to assure avoidance and incidental impacts during operations.

21) There exists the possibility that the authorized activities may unearth a beached shipwreck. Should such a finding occur, the permittee shall immediately move to another area. The NCDCR Underwater Archaeology Branch shall be contacted at (910) 458-9042 to determine appropriate response procedures.

ADDITIONAL CONDITIONS

General

22) This permit shall not be assigned, transferred, sold, or otherwise disposed of to a third party without the written approval of the Division of Coastal Management.

23) The permittee and his contractor shall schedule a pre-construction conference with the Division of Coastal Management prior to the initiation of any dredging activities.

24) No attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the authorized work.

NOTE: The permittee's contractor is advised to contact the U.S. Coast Guard at (910) 815-4895, ext. 108 to discuss operations and appropriate lighting, markers, etc. for all dredge equipment.

25) The permittee shall obtain any necessary authorizations or approvals from the US Army Corps of Engineers prior to initiation of any permitted activity. All conditions of this Federal approval shall be adhered to.

26) The permittee and/or his contractor shall provide for proper storage and handling of all oils, chemicals, hydraulic fluids, etc., necessary to carry out the project.

27) The N.C. Division of Water Quality has authorized the proposed project under General Water Quality Certification No. 3780 (DWQ Project No. 20011836, Ver. 3), which was issued on 6/18/12. Any violation of the Water Quality Certification shall also be considered a violation of this CAMA Permit.

28) No sand shall be placed on any sand bags that have been determined by the Division of Coastal Management to be subject to removal under 15A NCAC 07H .0308(a)(2). In order to ensure compliance with this condition, the Division of Coastal Management shall be contacted at (910) 796-7215 prior to project initiation so that Division staff may meet on site with the permittee and/or contractor.

29) This Major Modification shall be attached to the original of Permit No. 14-02, which was issued on 2/1/02, as well as all subsequent modification, renewals and refinements, and copies of all documents shall be readily available on site when Division personnel inspect the project for compliance.

30) All conditions and stipulations of the active permit remain in force under this minor modification unless altered herein.

ADDITIONAL CONDITIONS

NOTE: The permittee is advised that the Division of Coastal Management shall regulate the removal of existing sandbags and the placement of new sandbags in accordance with 15A NCAC 07H .0308(a)(2)(F), or in accordance with any variances granted by the N.C. Coastal Resources Commission.

NOTE: This permit does not eliminate the need to obtain any additional state, federal or local permits, approvals or authorizations that may be required.

NOTE: Future nourishment activities may require a modification of this permit. The permittee shall contact a representative of the Division at (910) 796-7215 prior to the commencement of any such activity for this determination.

NORTH CAROLINA 401 WATER QUALITY CERTIFICATION

THIS CERTIFICATION is issued in conformity with the requirements of Section 401 Public Laws 92 500 and 95 217 of the United States and subject to the North Carolina Division of Water Quality (DWQ) Regulations in 15 NCAC 2H Section 0500 to Mr David Hewett Town Manager of the Town of Holden Beach to nourish approximately 22 000 linear feet of shoreline by placing up to 1 310 000 cubic yards of beach compatible sand on approximately 52 acres of beach above Mean High Water (MHW) and approximately 140 acres below MHW from Station 40+00 to Station 260+00 The sand source of this project is a borrow area of approximately 590 acres to be dredged as described within the application filed on the 15th day of February of 2012 with additional information received on June 11 2012 This project covers approximately 4 2 miles of shoreline in the Lumber River Basin in association with the Town of Holden Beach nourishment project Brunswick County North Carolina

The application and supporting documentation provides adequate assurance that the proposed work will not result in a violation of applicable Water Quality Standards and discharge guidelines Therefore the State of North Carolina certifies that this activity will not violate the applicable portions of Sections 301 302 303 306 307 of PL 92 500 and PL 95 217 if conducted in accordance with the application the supporting documentation and conditions hereinafter set forth

This approval is only valid for the purpose and design submitted in the application materials and as described in the Public Notice and the Division of Coastal Management Applications and modifications If the project is changed prior to notification a new application for a new Certification is required If the property is sold the new owner must be given a copy of the Certification and approval letter and is thereby responsible for complying with all conditions of this Certification Any new owner must notify the Division and request the Certification be issued in their name Should wetland or stream fill be requested in the future additional compensatory mitigation may be required as described in 15A NCAC 2H 0506 (h) (6) and (7) If any plan revisions from the approved site plan result in a change in stream or wetland impact or an increase in impervious surfaces the DWQ shall be notified in writing and a new application for 401 Certification may be required For this approval to be valid compliance with the conditions listed below is required

Conditions of Certification

1 Impacts Approved

The following impacts are hereby approved as long as all of the other specific and general conditions of this Certification (or Isolated Wetland Permit) are met No other impacts are approved including incidental impacts

Type of Impact	Amount Approved (Units)	Plan Location or Reference
Beach (Above Mean High Water)	52 acres	Application and Public Notice
Open Water (near shore) below MHW filled	140 acres	Application and Public Notice
Open Water (off shore source dredge)	590 acres	Application and Public Notice

Sediment and Erosion Control

2 Erosion and sediment control practices must be in full compliance with all specifications governing the proper design installation and operation and maintenance of such Best Management Practices in order to protect surface waters standards
   a The erosion and sediment control measures for the project must be designed installed operated and maintained in accordance with the most recent version of the *North Carolina Sediment and Erosion Control Planning and Design Manual*
   b The design installation operation and maintenance of the sediment and erosion control measures must be such that they equal or exceed the requirements specified in the most recent version of the *North Carolina Sediment and Erosion Control Manual* The devices shall be maintained on all construction sites borrow sites and waste pile (spoil) projects including contractor owned or leased borrow pits associated with the project
   c For borrow pit sites the erosion and sediment control measures must be designed installed operated and maintained in accordance with the most recent version of the *North Carolina Surface Mining Manual*
   d The reclamation measures and implementation must comply with the reclamation in accordance with the requirements of the Sedimentation Pollution Control Act

3 No waste spoil solids or fill of any kind shall occur in wetlands waters or riparian areas beyond the footprint of the impacts depicted in the 404/401Permit Application All construction activities including the design installation operation and maintenance of sediment and erosion control Best Management Practices shall be performed so that no violations of state water quality standards statutes or rules occur

4 Sediment and erosion control measures shall not be placed in wetlands or waters to the maximum extent practicable If placement of sediment and erosion control devices in wetlands and waters is unavoidable they shall be removed and the natural grade restored within six months of the date that the Division of Land Resources has released the project

Continuing Compliance

5 Mr David Hewett, Town Manager of the Town of Holden Beach shall conduct construction activities in a manner consistent with State water quality standards (including any requirements resulting from compliance with section 303(d) of the Clean Water Act) and any other appropriate requirements of State law and federal law Mr David Hewett, Town Manager of the Town of Holden Beach shall require its contractors (and/or agents) to comply with all of the terms of this Certification and shall provide each of its contractors (and/or agents) a copy of this Certification A copy of this Certification shall be included in the construction contract and available on the job site at all times If the Division determines that such standards or laws are not being met (including the failure to sustain a designated or achieved use) or that State or federal law is being violated or that further conditions are necessary to assure compliance the Division may reevaluate and modify this Certification to include conditions appropriate to assure compliance with such standards and requirements in accordance with 15A NCAC 2H 0507(d) Before modifying the Certification the Division shall notify Mr David Hewett Town Manager of the Town of Holden Beach the US Army Corps of Engineers and provide public notice in accordance with 15A NCAC 2H 0503 and provide opportunity for a public hearing in accordance with 15A NCAC 2H 0504 Any new or revised conditions shall be provided to Mr David Hewett Town Manager of the Town of Holden Beach in writing shall be provided to the United States Army Corps of Engineers for reference in any Permit

issued pursuant to Section 404 of the Clean Water Act and shall also become conditions of the 404 Permit for the project

Other conditions

6 Any final construction plans for this project must include or reference the application and plans approved by the DWQ under this authorization letter and certification

7 All applicable moratoriums shall be observed as required by the NC Division of Marine Fisheries NC Wildlife Resources US Fish and Wildlife and National Marine Fisheries

8 This Certification covers the one time event of beach renourishment for the Town of Holden Beach at the location previously specified Any future activity that includes work in the inter tidal zone or additional renourishment will require a new 401 Water Quality application and certification

9 Certificate of Completion

Upon completion of all work approved within the 401 Water Quality Certification or applicable Buffer Rules Upon completion of all work approved within the 401 Water Quality Certification or applicable Buffer Rules and any subsequent modifications the applicant is required to return the attached certificate of completion to the 401 Oversight/Express Review Permitting Unit North Carolina Division of Water Quality 1650 Mail Service Center Raleigh NC 27699 1650

Also, this approval to proceed with your proposed impacts or to conduct impacts to waters as depicted in your application shall expire upon expiration of the 404 or CAMA Permit

If this Certification is unacceptable to you you have the right to an adjudicatory hearing upon written request within sixty (60) days following receipt of this Certification This request must be in the form of a written petition conforming to Chapter 150B of the North Carolina General Statutes and filed with the Office of Administrative Hearings 6714 Mail Service Center Raleigh N C 27699 6714 If modifications are made to an original Certification you have the right to an adjudicatory hearing on the modifications upon written request within sixty (60) days following receipt of the Certification Unless such demands are made this Certification shall be final and binding

This the 18th day of June 2012
DIVISION OF WATER QUALITY

Charles Wakild P E

CW/kah/*ym*

3780

APPENDIX Q

ENVIRONMENTAL CONSEQUENCES IMPACT SUMMARY

				Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
Resource Category	Stressor	Effect	Direct (D) or Indirect (I)	Level of Effect	Potential Cumulative Effects? (Y or N)	Level of Effect	Potential Cumulative Effects? (Y or N)	Level of Effect	Potential Cumulative Effects? (Y or N)	Level of Effect	Potential Cumulative Effects? (Y or N)	Level of Effect	Potential Cumulative Effects? (Y or N)	Level of Effect	Potential Cumulative Effects? (Y or N)
MARINE COMMUNITIES															
Soft Bottom	Dredging	Mechanical Habitat Disturbance/Benthic Invertebrate Loss	D	Low to Moderate	N	Absent	N	Low to Moderate	N	Moderate	Y	Low	N	Low	N
	Dredging	Demersal Fish Entrainment	D	Low	N	Low	N	Low	N	Low	N	Low	N	Low	N
	Dredging	Invertebrate Prey Loss Effects on Demersal Fishes	I	Low to Moderate	Y	Absent	N	Low to Moderate	Y	Moderate	Y	Low	Y	Low	Y
	Dredging	Sediment Suspension/Redeposition	I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Beach Fill	Benthic Invertebrate Loss	D	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Beach Fill	Invertebrate Prey Loss Effects on Demersal/Surf Zone Fishes	I	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Beach Fill	Sediment Suspension/Redeposition	I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
Hard Bottom	Dredging	Mechanical Habitat Disturbance/Benthic Invertebrate Loss	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Dredging	Sediment Suspension/Redeposition	I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Dredging	Hardbottom/Reef Fish Entrainment	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
Water Column	Dredging	Sediment Suspension/Turbidity	D, I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Dredging	Underwater Noise Effects	D,I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Dredging	Larval Fish/Invertebrate Entrainment	D	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Beach Fill/Groin/Inlet Management	Hydrodynamic Effects on Larval Transport	I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
OCEANFRONT BEACH COMMUNITIES															
Intertidal Beach	Beach Fill	Shorebird Disturbance/Displacement (Foraging)	D	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Beach Fill	Invertebrate Infauna Loss	D	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Beach Fill	Invertebrate Prey Loss Effects on Shorebirds/Surf Zone Fishes	I	Low to Moderate	Y	Absent	N	Low to Moderate	Y	Low to Moderate	Y	Low	Y	Low	Y
	Shoreline Erosion	Erosional Habitat Loss	I	Low	N	High	N	Low	N	High	N	Low	N	Low	N
Dry Beach and Dune	Beach Fill	Invertebrate Macrofauna Loss	D	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Beach Fill	Shorebird Disturbance/Displacement (Nesting/Roosting)	D	Absent to Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Beach Fill	Habitat Modification (Sediment Composition/Beach Morphology)	I	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Shoreline Erosion	Erosional Habitat Loss	I	Moderate	N	High	Y	Moderate	N	Moderate	N	Low	N	Low	N
	Beach Fill/Groin/Inlet Management	Downdrift Effects on Adjacent Beaches	I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
INLET COMMUNITIES															
Intertidal Flats and Shoals	Dredging	Mechanical Habitat Disturbance	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Beach Fill	Shorebird Disturbance/Displacement (Foraging)	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Invertebrate Infauna Loss	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Invertebrate Prey Loss Effects on Shorebirds/Fishes	I	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill/Groin/Inlet Management	Habitat Loss/Modification (Hydrodynamic/Sediment Transport Effects)	I	Absent to Low	N	Absent	N	Absent to Low	N	Moderate	Y	Absent to Low	N	Absent to Low	N
Inlet Dry Beach and Dune	Beach Fill	Invertebrate Macrofauna Loss	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Shorebird Disturbance/Displacement (Nesting/Roosting)	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Habitat Modification (Sediment Composition/Beach Morphology)	I	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill/Groin/Inlet Management	Habitat Loss/Modification (Hydrodynamic/Sediment Transport Effects)	I	Low	N	Low	N	Low	N	Low to Moderate	Y	Low	N	Low	N
ESTUARINE COMMUNITIES															

Shellfish	Dredging	Mechanical Habitat Disturbance	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Dredging	Sediment Suspension/Redeposition	I	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
SAV	Dredging	Mechanical Habitat Disturbance	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Dredging	Sediment Suspension/Redeposition	I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
Tidal Marshes	Dredging	Mechanical Habitat Disturbance	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Beach Fill/Groin/Inlet Management	Marsh Erosion (Hydrodynamic Effects)	I	Absent	N	Absent to Low	N	Absent	N	Absent	N	Absent	N	Absent	N
THREATENED/ENDANGERED SPECIES															
N. Atlantic Right/Humpback Whales	Dredging	Vessel Collision Risk	D	Absent	N	Absent	N	Absent to Low	N	Low	N	Absent to Low	N	Absent to Low	N
	Dredging	Underwater Noise Effects	D	Absent	N	Absent	N	Absent to Low	N	Low	N	Absent to Low	N	Absent to Low	N
West Indian Manatee	Dredging	Vessel Collision Risk	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
Piping Plover	Beach Fill	Disturbance/Displacement	D	Absent to Low	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Inlet Habitat Modification (Sediment Composition/Beach Morphology)	I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Beach Fill/Dredging/Groin	Inlet Habitat Modification (Hydrodynamic/Sediment Transport Effects)	I	Absent	N	Absent	N	Absent	N	Moderate	Y	Absent	N	Absent	N
Red Knot	Beach Fill	Disturbance/Displacement	D	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Beach Fill	Ocean Beach Habitat Modification (Sediment Composition/Beach Morphology)	I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Shoreline Erosion	Erosional Ocean Beach Habitat Loss	I	Moderate	N	High	Y	Moderate	N	High	N	Low	N	Low	N
	Beach Fill/Dredging/Groin	Inlet Habitat Modification (Hydrodynamic/Sediment Transport Effects)	I	Absent	N	Absent	N	Absent	N	Moderate	Y	Absent	N	Absent	N
Wood Stork	Beach Fill/Dredging	Disturbance/Habitat Modification	D,I	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
Sea Turtles	Beach Fill	Disruption of Sea Turtle Nesting/Hatchling Emergence	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
	Beach Fill	Habitat Modification (Sediment Composition/Beach Morphology)	I	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Shoreline Erosion	Erosional Dry Beach Habitat Loss	I	Moderate	N	High	Y	Moderate	N	Moderate	N	Low	N	Low	N
	Dredging	Entrainment	D	Absent	N	Absent	N	Absent to Low	N	Low	N	Absent to Low	N	Absent to Low	N
Atlantic/Shortnose Sturgeon	Dredging	Entrainment	D	Absent	N	Absent	N	Absent to Low	N	Low	N	Absent to Low	N	Absent to Low	N
	Dredging	Benthic Habitat Modification	I	Low	N	Absent	N	Low	N	Low to Moderate	N	Low	N	Low	N
	Dredging	Sediment Suspension/Redeposition	D,I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
Seabeach Amaranth	Beach Fill	Mechanical Injury/Burial of Plants	D	Absent	N	Absent	N	Absent to Low	N	Absent to Low	N	Absent to Low	N	Absent to Low	N
	Beach Fill	Habitat Modification (Sediment Composition/Beach Morphology)	I	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Shoreline Erosion	Erosional Dry Beach Habitat Loss	I	Moderate	N	High	Y	Moderate	N	Moderate	N	Low	N	Low	N
CULTURAL RESOURCES															
Civil War Vessels (Shipwrecks)	Dredging	Mechanical Disturbance	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N	Absent	N
PUBLIC INTEREST FACTORS															
Public Safety	Beach Fill	Beach Fill Placement Operations	D	Low	N	Absent	N	Low	N	Low	N	Low	N	Low	N
	Beach Fill/Dredging/Groin	Hazards to Navigation	D	Absent	N	Absent	N	Absent	N	Absent	N	Absent to Low	N	Absent to Low	N
Aesthetics/Recreation	Active Beach Fill/Dredging	Reduction in Aesthethic Quality	D,I	Low to Moderate	N	Absent	N	Low to Moderate	N	Low to Moderate	N	Low	N	Low	N
	Shoreline Erosion	Reduction in Recreational Beach Width	I	Moderate to High	N	High	Y	Moderate to High	N	Moderate	N	Low	N	Low	N
Economics	Beach Fill/Groin/Inlet Management	30-Year Construction and Maintenance Costs	D	Moderate	N	Absent	N	High	N	High	N	Low	N	Low	N
	Shoreline Erosion	Loss of Property/Infrastructure/Tax Base	I	Moderate to High	N	High	Y	Moderate to High	N	Moderate	N	Low	N	Low	N
	Shoreline Erosion	Loss of Recreational/Environmental Value	I	Moderate	N	High	Y	Moderate	N	Moderate	N	Low	N	Low	N

APPENDIX R

EASTERN CHANNEL SHOREBIRD MONITORING PLAN

SHOREBIRD MONITORING PLAN

Lower Lockwoods Folly River Habitat Restoration Project Phase 1 - Eastern Channel

FEBRUARY 2015

Prepared for:

The Town of Oak Island

Submitted to:

Fish and Wildlife Service
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636

Prepared by:

Dial Cordy and Associates Inc.
201 North Front Street, Suite 307
Wilmington, NC 28401

DIAL CORDY
AND ASSOCIATES INC
Environmental Consultants

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1.0 INTRODUCTION

A during- and post-construction shorebird monitoring plan has been developed and implemented from March 2015 through August 31, 2018 by Dial Cordy and Associates Inc. for the Town of Oak Island to monitor shorebird habitat along the oceanfront, Lockwood Folly Inlet shorelines, and Eastern Channel. The plan includes monitoring of piping plover, waterbirds, colonial waterbirds and other shorebirds during and after construction of the proposed project. These monitoring efforts will occur in conjunction with the construction of the Lockwood Folly River Habitat Restoration Project, Phase I Eastern Channel within the oceanfront/inlet/estuarine complex to provide information on shorebird, specifically piping plover, habitat utilization within the project area.

1.1 Project Summary

The project consists of dredging a new 100-foot wide channel within Eastern Channel (between Oak Island and Sheep Island) to a depth of -3 to - 15 feet (ft) and placing approximately 201,800 cubic yards (cy) of beach-compatible material on the western beaches of Oak Island (Figure 1). Approximately 3.49 acres of intertidal shoals above the mean lower low water (MLLW) will be dredged. Dredging of Eastern Channel will be performed by a cutterhead dredge pipeline dredge and conveyed to the beach placement areas via a 24-inch reinforced concrete pipeline, existing within the Town of Oak Island's easement.

The beach fill will be placed along two separate reaches. Reach 1 is proposed to be 2,900 linear feet (lf), while Reach 2 is proposed to be 1,500 lf, for a total of 4,400 If of fill. The beach fill will impact a total of 22.4 acres of intertidal and dry beach area. The beach fiIl will include a flat berm at an elevation of 7.0 North American Vertical Datum (NAVD), extending seaward to a depth of approximately -7 to -8 ft NAVD, on a 1:20 slope. A 20-foot wide dune with a crest elevation of 10.0 ft NAVD will be restored in front of four properties that installed sandbags during 2014 (6623,662I,6617, and 6615 West Beach Drive, Oak Island, North Carolina). There will be a 250 lf taper section at the beginning and end of each reach.

Dredging will likely be conducted from west to east. Likewise, beach fiIl will be conducted from west to east, and will involve movement of heavy equipment and pipe along the beaches. Once a section is completed, pipe and heavy equipment will be shifted to a new section and the process repeated. Land-based equipment will be brought to the site over public roads, and will enter the beach at existing beach access points along the western end of Oak Island. Existing dunes and vegetation on the beach will be avoided.

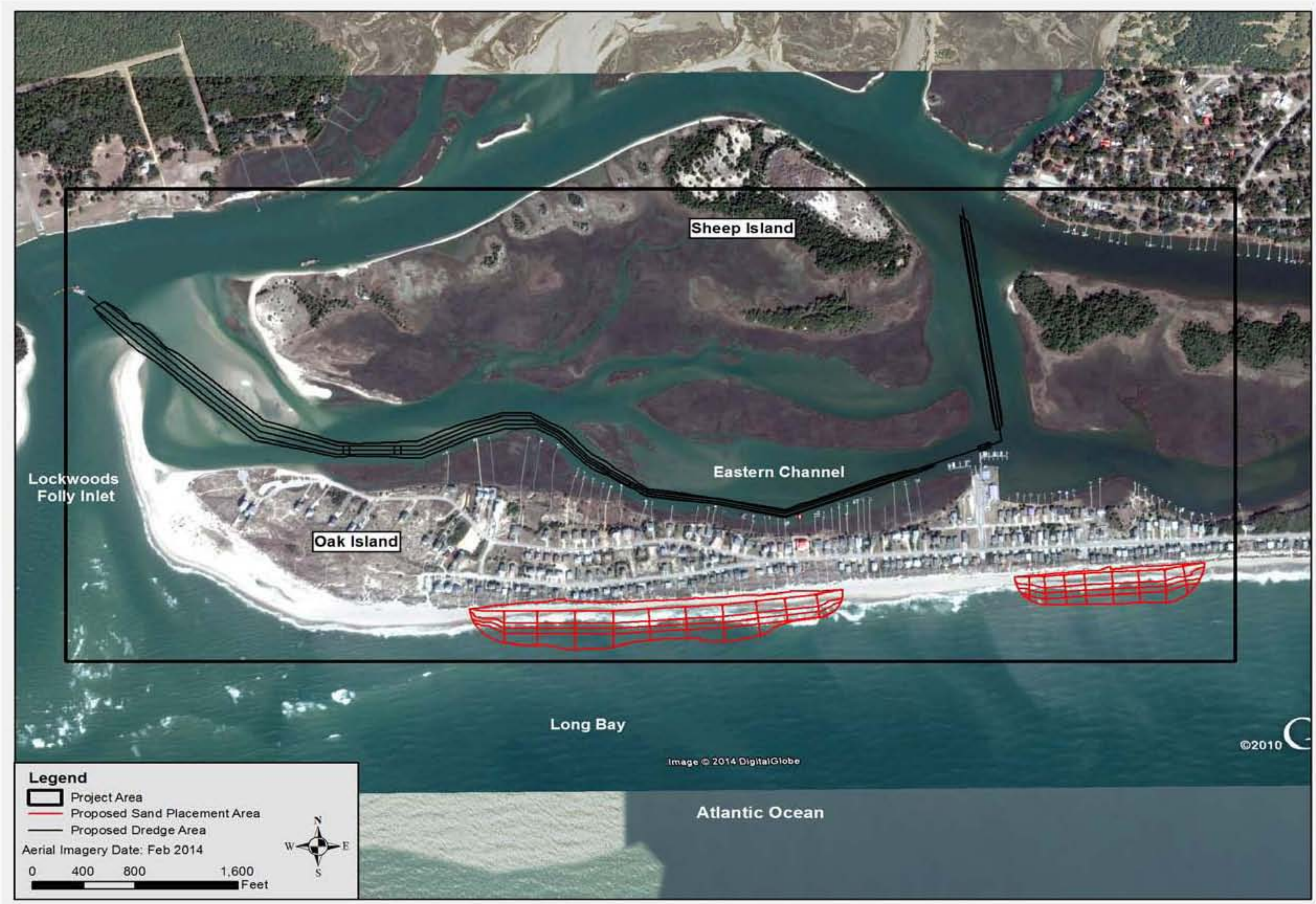


Figure 1. Project Area

2.0 PURPOSE AND GOALS

As described in Appendix A – United States Fisheries and Wildlife Service (USFWS) Biological Opinion, the proposed project will destroy approximately 3.49 acres of the approximately 90-acre critical habitat unit. This critical habitat unit is one of 141 designated critical habitat units for wintering piping plovers in the southeastern United States, and the second smallest of the 18 designated critical habitat units in North Carolina. Disturbance to suitable habitat resulting from dredging and placement of sand would affect the ability of an undetermined number of piping plovers to find suitable foraging and roosting habitat during construction and maintenance for an unknown length of time after construction.

The USFWS anticipates that directly and indirectly an unspecified amount of piping plovers in 3.49 acres of critical habitat and along 4,400 lf of shoreline, all at some point, potentially usable by piping plovers, could be taken in the form of habitat loss as a result of this proposed action therefore Reasonable and Prudent Measures necessary to minimize take of piping plovers includes the development of this bird monitoring plan to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction.

3.0 BIRD MONITORING PLAN

This bird monitoring plan was developed to monitor piping plover, red knot, waterbirds, colonial waterbirds, and other shorebirds during and after construction. Monitoring will be conducted for a minimum of three (3) full years past the completion of construction (anticipated to occur May 2015), until the end of the shorebird nesting season (August 31) of the third year after construction (2018). Based on results of the monitoring, continued bird monitoring may also be required during subsequent maintenance events. Post-construction monitoring will be coordinated after the review of at least three years' worth of data and approval by the United States Army Corps of Engineers (USACE), USFWS, North Carolina Division of Coastal Management (NCDCM), and North Carolina Wildlife Resource Commission (NCWRC).

3.1 Schedule

During construction, bird monitoring will be conducted weekly. For at least three years after construction is completed, bimonthly (twice-monthly) bird surveys will be conducted in all intertidal and shoreline areas along Lockwood Folly Inlet. Transects were established to encompass, at a minimum, all intertidal areas in the vicinity of Eastern Channel and Lockwoods Folly Inlet on both sides of the inlet (Oak Island, Sheep Island, and Holden Beach), and the ocean shoreline from Lockwoods Folly Inlet east to approximately 6001 West Beach Drive (or the eastern end of the westernmost sand placement area) (Figure 2).

The following information will be collected, mapped, and reported for each survey area and event:

- Date, location, time of day, weather, and tide cycle when survey was conducted;
- Latitude and longitude of observed piping plover and red knot locations (decimal degrees);
- Any color bands observed on piping plovers or red knots or other birds;
- Behavior (e.g., foraging, roosting, preening, bathing, flying, aggression, walking, courtship, copulation);
- Landscape features(s) where birds are located (e.g., inlet spit, tidal creeks, shoals, lagoon shoreline);
- Habitat features(s) used by birds when observed (e.g., intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation);
- Substrata used by birds (e.g., sand, mud/sand, mud, algal mat); and
- The amount and type of recreational use (e.g., people, dogs on or off leash, vehicles, boats).

3.1.1 Observation Method and Survey Areas

Species observations will be conducted with the use of a spotting scope and binoculars to identify nesting, roosting, foraging, territory establishment, courtship and copulating activities within the survey areas (Figure 2). Observations of breeding sites and nesting pair counts will be included as part of the report documentation, as well as observations and recording of eggs, chicks and fledged individuals.

Table 1 illustrates a representative field data form to be used for documenting bird species use and habitat dependence in the monitored survey areas. The number of species and their associated activities will be accounted for in each of the surveyed habitats. A separate form will be used for each survey area (Survey Area 1 – 5) in conjunction with each survey event (i.e., five forms will be completed for each survey event). The following will also apply:

- Species flying overhead of a surveyed habitat will be reported as flying;
- Birds observed as diving or floating in the nearshore will be reported as utilizing surf zone habitat;
- Banding combinations identified on species of shorebirds and colonial waterbirds, including piping plovers, will be recorded in the notes column to assist in identifying population migration patterns;
- Species observations along the dry beach habitat of the inlet shorelines will extend up to the landward edge of the frontal dune or edge of vegetation, whichever comes first; and
- Bird species observed, but not currently listed as a species will be identified and accounted for under “Other Species.”

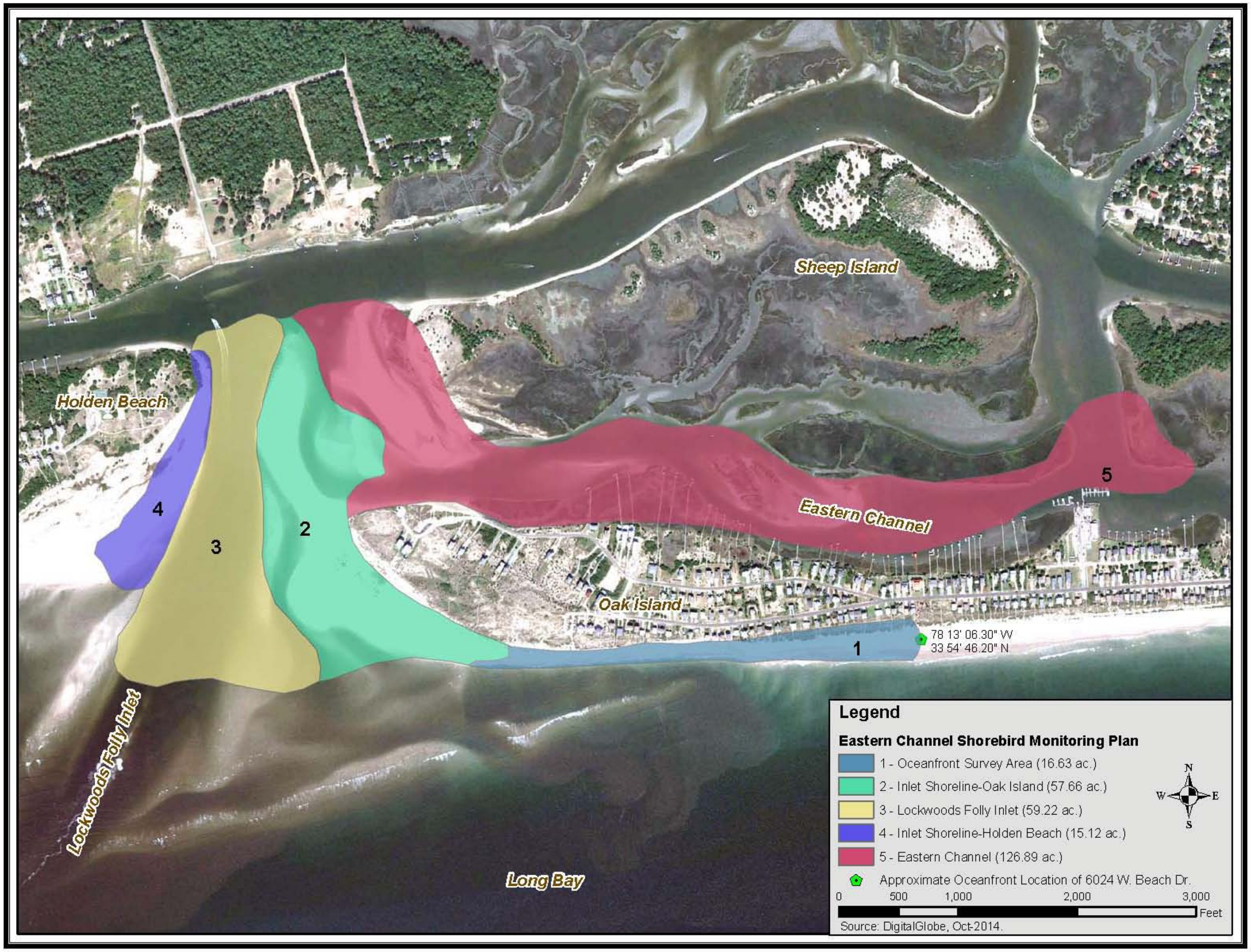


Figure 2. Bird Survey Areas

Table 1. Sample field form. One form will be completed for each survey area for each survey event.

DATE					WEATHER/SKY	Clear	P. Cloudy	Cloudy	Fog	Lt. Rain		
Survey Area	1=OI Beach	2=LWF Shore	3=LWF Inlet	4 = HB Shore	5 = Eastern Channel	WIND SPEED (mph)	0-10	10-15	15-20	>20		
OBSERVER					WIND DIRECTION	N	NE	E	SE	S	SW	W	NW
TIDE: LOW					AIR TEMP. (°F)							
HIGH					WAVE HEIGHT (ft)	0 to 1	1 to 3	3 to 5	4 to 6			
DISTURBANCE SOURCE	Human	Pet	Predator									
DISTURBANCE LEVEL	None	Low	Medium	High								
START TIME												
END TIME												

	SURF			INTERTIDAL			DRY BEACH			
SPECIES	Feeding	Resting	Flying	Feeding	Resting	Flying	Feeding	Resting	Flying	Notes: (Nesting, Banding, etc.)
Common Loon										
Brown Pelican										
Double-crested Cormorant										
Great Blue Heron										
Great Egret										
Snowy Egret										
Little Blue Heron										
Tricolored Heron										
White Ibis										
Glossy Ibis										
Black-bellied Plover										
Wilson's Plover										
Semipalmated Plover										
Piping Plover										
Killdeer										
American Oystercatcher										
Greater Yellowlegs										
Solitary Sandpiper										
Willet										
Spotted Sandpiper										
Whimbrel										
Marbled Godwit										
Ruddy Turnstone										
Red Knot										
Sanderling										
Semipalmated Sandpiper										
Western Sandpiper										
Least Sandpiper										
Pectoral Sandpiper										
Dunlin										
Short-billed Dowitcher										
Long-billed Dowitcher										
Laughing Gull										
Bonaparte's Gull										
Ring-billed Gull										
Herring Gull										
Lesser Black-backed Gull										
Great Black-backed Gull										
Gull-billed Tern										
Caspian Tern										
Royal Tern										
Sandwich Tern										
Common Tern										
Forster's Tern										
Least Tern										
Black Tern										
Black Skimmer										
Woodstork										
OTHER SPECIES										
Bald Eagle										
Turkey Vulture										

Field observations will be conducted during daylight hours. Surveys will primarily occur during high tide for each event.

Observations along narrow beach habitats will be conducted by walking along the beach. Wider, open areas such as washover habitats will involve walking in a zigzag pattern to observe all birds utilizing the area. Mixed flocks of roosting shorebirds will be surveyed so that all species are accounted for. Surveys will not be conducted during inclement weather conditions (high winds > 20 mph, heavy rains, and/or below freezing conditions). A boat/kayak may be used for accessing shoal transect areas and inlet habitats on Holden Beach. The use of ATV's or similar vehicles will not be used during surveys.

3.2 Reporting

All monitoring information will be provided in standardized form on an Excel spreadsheet. Monitoring results will be submitted annually (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Raleigh Field Office. Information will be submitted to the following address:

Pete Benjamin, Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
Post Office Box 33726
Raleigh, NC 27636-3726

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification will be made to the USFWS Law Enforcement Office below. Additional notification will be made to the USFWS Ecological Services Field Office identified above and to the NCWRC at (252) 241-7367. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Tom Chisdock
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801

Appendix A

US Fish and Wildlife Service Biological Opinion

AMENDED BIOLOGICAL OPINION

Town of Oak Island

Lockwoods Folly River Habitat Restoration Project
Phase 1 - Eastern Channel

April 27, 2015

Corps Action ID No. SAW-2014-02180

USFWS Log No. 04EN2000-2015-F-0142

Table of Contents

Acronyms

Act	**Endangered Species Act**
BA	**Biological Assessment**
BO	**Biological Opinion**
CBRA	**Coastal Barrier Resources Act**
CFR	**Code of Federal Regulations**
CH	**Critical Habitat**
CITES	**Convention on International Trade in Endangered Species of Wild Fauna and Flora**
Corps	**U.S. Army Corps of Engineers**
CRC	**North Carolina Coastal Resources Commission**
DCM	**North Carolina Division of Coastal Management**
DOI	**U.S. Department of the Interior**
F	**Fahrenheit**
FR	**Federal Register**
IPCC	**Intergovernmental Panel on Climate Change**
ITP	**Incidental Take Permit**
LF	**Linear Feet**
NAVD	**North American Vertical Datum**
NCWRC	**North Carolina Wildlife Resources Commission**
NMFS	**National Marine Fisheries Service**

NOAA	**National Oceanic and Atmospheric Administration**
NWR	**National Wildlife Refuge**
PCE	**Primary Constituent Element**
Service	**U.S. Fish and Wildlife Service**
U.S.C.	**United States Code**
U.S.	**United States**
USEPA	**United States Environmental Protection Agency**

CONSULTATION HISTORY

August 27, 2014 – the Service participated in a scoping meeting (by phone) for the project.

October 24, 2014 – the applicant's consultant submitted an "update memo" and vibracore data by email.

November 20, 2014 – the Service discussed the project with the applicant's consultant by phone.

November 26, 2014 – the Service discussed the applicant's project and draft BA with the applicant's consultant by email.

December 1, 2014 – the Service discussed the project with the applicant's consultant by phone.

December 2, 2014 – the applicant's consultant provided an updated estimate of impacts to piping plover critical habitat, by email.

December 5, 2014 – the applicant's consultant provided an update on the project and submittal of project documents.

December 19, 2014 - the Service discussed the project with the Corps by phone.

December 23, 2014 – The Corps sent out a notice by email, requesting comments on the proposed project by January 22, 2015. The notice also indicated the Corps' determination of "may affect, not likely to adversely affect" sea turtles, West Indian manatee, red knot, and seabeach amaranth, and "may affect, likely to adversely affect" the piping plover. The Service concurred with the determination of "may affect, not likely to adversely affect" for sea turtles, West Indian manatee, red knot, and seabeach amaranth.

December 29, 2014 – The applicant's consultant and the Corps clarified that the applicant is also seeking authorization for maintenance dredging and beach placement activities, after initial construction.

January 8, 2015 – the Corps requested formal consultation for piping plover.

January 8, 2015 – The applicant's consultant provided additional information concerning previous actions in the Action Area.

January 26, 2015 – The applicant submitted a modification request to the Corps and to North Carolina Division of Coastal Management (DCM). The modification was to change the proposed disposal site for non-compatible material from Sheep Island to Horse Island.

February 7, 2015 – the Service issued a biological opinion for piping plover.

February 27, 2015 – A preconstruction meeting was held (the Service was unable to attend). During the meeting, the agencies agreed to revisit the timeline to complete the work.

March 20, 2015 – the applicant requested a permit modification and extension of time to complete the project until June 10, 2015. The applicant proposes to be done with the beach fill operations and to have equipment removed from the beach by May 20, 2015.

March 25, 2015 – the Corps requested reinitiation of consultation.

BIOLOGICAL OPINION

I. INTRODUCTION

A biological opinion is the document that states the opinion of the Service as to whether a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. This amended biological opinion addresses piping plover (*Charadrius melodus melodus*) and piping plover designated critical habitat, red knot (*Calidris canutus rufa*), seabeach amaranth (*Amaranthus pumilus*), and the loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley sea turtles (*Lepidochelys kempii*), and loggerhead critical habitat. The amended BO evaluates the effects of the proposed action, interrelated and interdependent actions, and cumulative effects relative to the status of the species and the status of the critical habitat to arrive at a Service opinion that the proposed action is or isn't likely to jeopardize species or adversely modify critical habitat. *Jeopardize the continued existence of* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. The courts have vacated our regulatory definition for *destruction or adverse modification of designated critical habitat* (50 CFR 402.02) and the Service has not yet promulgated a new regulatory definition; therefore, this biological opinion does not rely on the regulatory definition. Instead, we have relied upon the statutory provisions of the ESA to complete our analysis with respect to critical habitat.

II. DESCRIPTION OF THE PROPOSED ACTION

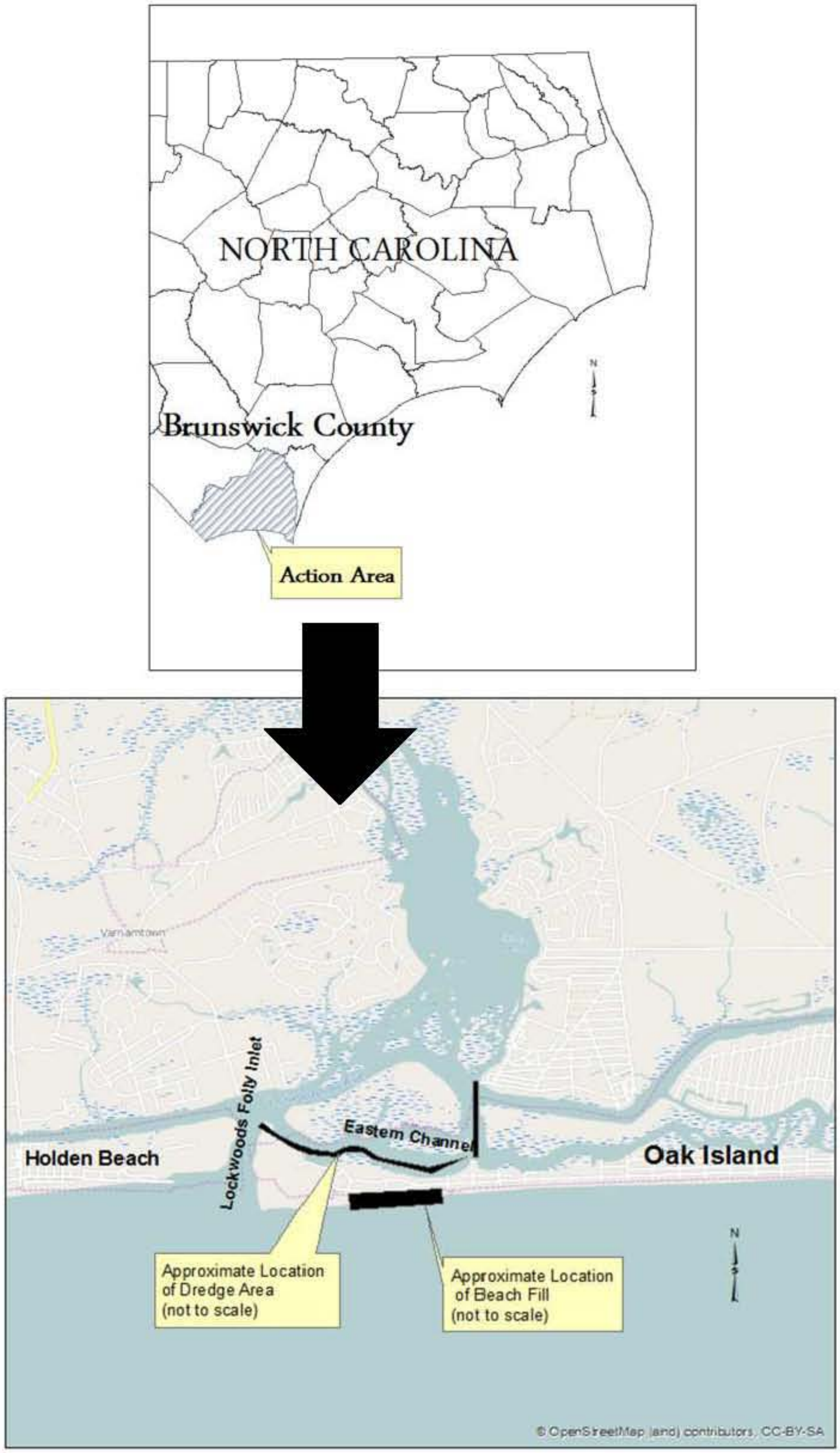
A. Location and Project Description

The project is in and around the vicinity of Lockwoods Folly Inlet, extending from the Atlantic Ocean to the Atlantic Intracoastal Waterway (AIWW), including Eastern Channel and the beachfront on Oak Island, in Brunswick County, North Carolina. The purpose of the proposed project is to improve navigation and flushing in Eastern Channel, protect properties located along the western end of Oak Island from erosion, and nourish portions of Oak Island.

The Town of Oak Island proposes to dredge Eastern Channel and dispose of the beach-compatible portion of the dredged material on the western oceanfront shoreline of Oak Island. The non-compatible material will be placed within an existing confined disposal area on Horse Island (Disposal Area 284).

The Service has described the Action Area to include Eastern Channel, Lockwoods Folly Inlet, the shoreline of Oak Island, and the adjacent Atlantic Ocean, Brunswick County, North Carolina (**Figure 1**). Land ownership within the Action Area is public and private, and land use includes conservation, recreational, and residential activities.

Figure 1. Action Area



B. Project Design

The project consists of dredging a new 100-foot wide channel within Eastern Channel (between Oak Island and Sheep Island) to a depth of -3 to -11 feet and placing approximately 226,575 cubic yards (cy) of beach-compatible material on the western beaches of Oak Island. Approximately 3.49 acres of intertidal shoals above MLLW will be dredged. Dredging of Eastern Channel will be performed by a cutterhead dredge pipeline dredge ad conveyed to the beach placement areas via a 24-inch reinforced concrete pipeline, existing within the Town of Oak Island's easement.

The beach fill will be placed along a 3,148 lf reach. The beach fill will include a flat berm at an elevation of 7.0 NAVD, extending seaward to a depth of approximately -7 to -8 ft NAVD, on a 1:20 slope. A 20-foot wide dune with a crest elevation of 10.0 ft NAVD will be restored in front of four properties that installed sandbags during 2014 (6623, 6621, 6617, and 6615 West Beach Drive, Oak Island, NC). There will be a 250 lf taper section at the beginning and end of the reach. Dredging is proposed to be conducted from west to east. Likewise, beach fill will be conducted from west to east, and will involve movement of heavy equipment and pipe along the beach. Once a section is completed, pipe and heavy equipment will be shifted to a new section and the process repeated. Land-based equipment will be brought to the site over public roads, and will enter the beach at existing beach access points along the western end of Oak Island. Existing dunes and vegetation on the beach will be avoided.

This BO addresses impacts to the piping plover (*Charadrius melodus*), red knot (*Calidris canutus rufa*), seabeach amaranth (*Amaranthus pumilus*), and the loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and Kemp's ridley sea turtles (*Lepidochelys kempii*), all Federally-listed species under the purview of the Service occurring in the Action Area. This BO also addresses critical habitat for piping plover and critical habitat for nesting loggerhead sea turtles.

The Action Area includes Eastern Channel, Lockwoods Folly Inlet, and approximately 3,148 lf and 27.0 acres of shoreline habitats on Oak Island. Approximately 3.49 acres of piping plover critical habitat in Eastern Channel will be dredged during construction. The Action Area for direct impacts includes those sections of Eastern Channel, Lockwoods Folly Inlet, and Oak Island where excavation, sediment disposal, and other earthen manipulation will occur. The Action Area for indirect impacts, however, is much larger. Because piping plovers, red knots, and sea turtles are highly mobile species, animals influenced by direct project impacts may move great distances from the actual project site. The range of these movements produced by the project constitutes the Action Area for indirect impacts; for the purposes of this opinion it will be the entire length of Oak Island and Holden Beach for piping plovers, red knots, and sea turtles.

C. Project Timing and Duration

The applicant intends to complete the project between November 16 and June 10. Construction is expected to last 30 to 60 days. Dredging of the beach-compatible portion of the channel, and placement of the sand on the beach is proposed to be completed by May 20. Maintenance dredging of Eastern Channel portions nearest to Lockwoods Folly Inlet is expected every two to six years, while maintenance dredging of the other portions of Eastern Channel is expected every six to ten years.

D. Conservation Measures

To reduce the potential impacts of the proposed project on Federally-listed species, the Applicant has proposed the following Conservation Measures:

- Beach fill will be conducted from west to east, so that areas closer to piping plover critical habitat are filled earlier in the winter.
- Placement of the sand on the beach is proposed to be completed by May 20.
- The applicant proposes to comply with the State of North Carolina Technical Standards for Beach fill Projects (15A NCAC 07H .0312).
- The applicant proposes escarpment monitoring and remedial grading for escarpments.

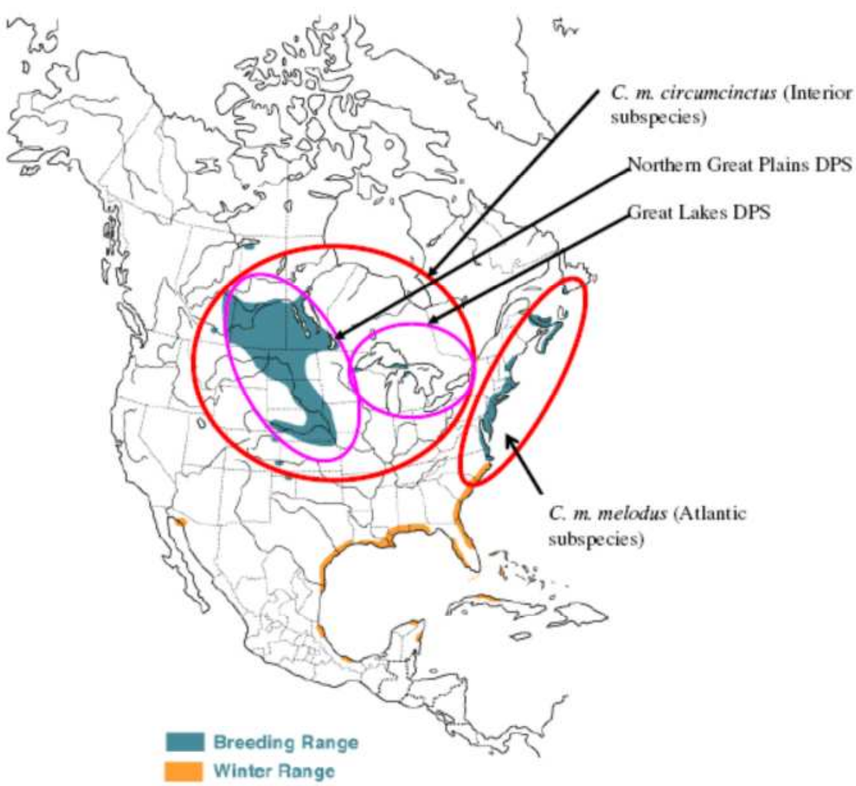
III. PIPING PLOVER

A. Status of the Species/Critical Habitat

1) Species/critical habitat description

Listing: On January 10, 1986, the piping plover was listed as endangered in the Great Lakes watershed and threatened elsewhere within its range, including migratory routes outside of the Great Lakes watershed and wintering grounds (Service 1985). Piping plovers were listed principally because of habitat destruction and degradation, predation, and human disturbance. Protection of the species under the Act reflects the species' precarious status range-wide. Three separate breeding populations have been identified, each with its own recovery criteria: the northern Great Plains (threatened), the Great Lakes (endangered), and the Atlantic Coast (threatened). Piping plovers that breed on the Atlantic Coast of the U.S. and Canada belong to the subspecies *C. m. melodus*. The second subspecies, *C. m. circumcinctus,* is comprised of two Distinct Population Segments (DPSs). One DPS breeds on the Northern Great Plains of the U.S. and Canada, while the other breeds on the Great Lakes. Each of these three entities is demographically independent. The Piping plover winters in coastal areas of the U.S. from North Carolina to Texas, and along the coast of eastern Mexico and on Caribbean islands from Barbados to Cuba and the Bahamas (Haig and Elliott-Smith 2004) (**Figure 2**).

Figure 2. Distribution and range of piping plovers (base map from Haig and Elliott-Smith 2004). Conceptual presentation of subspecies and DPS ranges are not intended to convey precise boundaries.



Piping plovers in the Action Area may include individuals from all three breeding populations. Piping plover subspecies are phenotypically indistinguishable, and most studies in the nonbreeding range report results without regard to breeding origin. Although a 2012 analysis shows strong patterns in the wintering distribution of piping plovers from different breeding populations (Gratto-Trevor et al. 2012), partitioning is not complete and major information gaps persist.

North Carolina is the only state where the piping plover's breeding and wintering ranges overlap and the birds are present year-round. Piping plovers nest above the high tide line on coastal beaches; on sand flats at the ends of sand spits and barrier islands; on gently sloping foredunes; in blowout areas behind primary dunes (overwashes); in sparsely vegetated dunes; and in overwash areas cut into or between dunes. The species requires broad, open, sand flats for feeding, and undisturbed flats with low dunes and sparse dune grasses for nesting. Piping plovers from the federally endangered Great Lakes population as well birds from the threatened populations of the Atlantic Coast and Northern Great Plains overwinter on North Carolina beaches. Piping plovers arrive on their breeding grounds in late March or early April. Following establishment of nesting territories and courtship rituals, the pair forms a depression in the sand, where the female lays her eggs. By early September both adults and young depart for their wintering areas.

Designated critical habitat: The Service has designated critical habitat for the piping plover on three occasions. Two of these designations protected different piping plover breeding populations. Critical habitat for the Great Lakes breeding population was designated May 7, 2001 (66 Federal Register [FR] 22938; USFWS 2001a), and critical habitat for the northern Great Plains breeding population was designated September 11, 2002 (67 FR 57637; USFWS 2002). The Service designated critical habitat for wintering piping plovers on July 10, 2001 (66 FR 36038; USFWS 2001b). Wintering piping plovers may include individuals from the Great Lakes and northern Great Plains breeding populations as well as birds that nest along the Atlantic Coast. The three separate designations of piping plover critical habitat demonstrate diversity of primary constituent elements (PCEs) between the two breeding populations as well as diversity of PCEs between breeding and wintering populations.

The Action Area is located within piping plover Critical Habitat Unit NC-16 (Lockwood Folly Inlet - Brunswick County). This 90- acre unit is located entirely on Oak Island and is privately-owned. The unit extends from the end of West Beach Drive, west to MLLW at Lockwood Folly Inlet, including emergent sand bars south and adjacent to the island. This unit includes land from MLLW on the Atlantic Ocean across to MLLW adjacent to the Eastern Channel and the

Intracoastal Waterway.

The PCEs essential for the conservation of wintering piping plovers are those habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components. The PCEs include intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide. Important components of intertidal flats include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent non-or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers, and are PCEs of piping plover wintering habitat. Such sites may have debris, detritus (decaying organic matter), or micro-topographic relief (less than 50 cm above substrate surface) offering refuge from high winds and cold weather. Important components of the beach/dune ecosystem include surfcast algae, sparsely vegetated backbeach and salterns (beach area above mean high tide seaward of the permanent dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or road), spits, and washover areas. Washover areas are broad, unvegetated zones, with little or no topographic relief, that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action. Critical habitat does not include existing developed sites consisting of buildings, marinas, paved areas, boat ramps, exposed oil and gas pipelines and similar structures. Only those areas containing these PCEs within the designated boundaries are considered critical habitat.

The critical habitat in the project area has been relatively undisturbed since designation in 2001. It is unclear whether the Corps' dredging of Lockwoods Folly Inlet and/or the AIWW has resulted in impacts to the critical habitat unit. Although various planning efforts have proposed dredging or nourishment within the critical habitat unit over the past decade, to the Service's knowledge, no destruction of critical habitat has occurred. As is expected in a dynamic inlet shoreline area, natural coastal processes have altered the location and configuration of the intertidal shoals and other PCEs within the unit. However, it does not appear that the general extent of critical habitat has been affected.

2) Life history

The piping plover is a small, pale sand-colored shorebird, about seven inches long with a wingspan of about 15 inches (Palmer 1967). Cryptic coloration is a primary defense mechanism for piping plovers where nests, adults, and chicks all blend in with their typical beach surroundings.

Piping plovers live an average of 5 years, although studies have documented birds as old as 11 (Wilcox 1959) and 15 years. Plovers are known to begin breeding as early as one year of age (MacIvor 1990; Haig 1992); however, the percentage of birds that breed in their first adult year is unknown. Piping plover breeding activity begins in mid-March when birds begin returning to their nesting areas (Coutu et al. 1990; Cross 1990; Goldin et al. 1990; MacIvor 1990; Hake 1993). Piping plovers generally fledge only a single brood per season, but may re-nest several times if previous nests are lost. The reduction in suitable nesting habitat due to a number of factors is a major threat to the species, likely limiting reproductive success and future recruitment into the population (USFWS 2009).

Plovers depart their breeding grounds for their wintering grounds between July and late August, but southward migration extends through November. More information about the three breeding populations of piping plovers can be found in the following documents:

a. Piping Plover, Atlantic Coast Population: 1996 Revised Recovery Plan (USFWS 1996a);
b. 2009 Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation (USFWS 2009);
c. 2003 Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*) (USFWS 2003);
d. Questions and Answers about the Northern Great Plains Population of Piping Plover (USFWS 2002).

North Carolina is one of the only states in which piping plovers may be found year-round. Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Data based on four rangewide mid-winter (late January to early February) population surveys, conducted at 5-year intervals starting in 1991, show that total numbers have fluctuated over time, with some areas experiencing increases and others decreases. Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate their wintering distribution in a given area.

Gratto-Trevor et al. (2009) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations. All eastern Canada and 94 percent of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast.

Breeding and wintering plovers feed on exposed wet sand in swash zones; intertidal ocean beach; wrack lines; washover passes; mud, sand, and algal flats; and shorelines of streams, ephemeral ponds, lagoons, and salt marshes by probing for invertebrates at or just below the surface (Coutu et al. 1990; USFWS 1996a). They use beaches adjacent to foraging areas for roosting and preening. Small sand dunes, debris, and sparse vegetation within adjacent beaches provide shelter from wind and extreme temperatures. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging and roosting (Nicholls and Baldassarre 1990; Drake 1999a; 1999b, Maddock et al. 2009). Studies have shown that the relative importance of various feeding habitat types may vary by site (Gibbs 1986; Coutu et al. 1990; McConnaughey et al. 1990; Loegering 1992; Goldin 1993; Hoopes 1993). Feeding activities may occur during all hours of the day and night (Staine and Burger 1994; Zonick 1997), and at all stages in the tidal cycle (Goldin 1993; Hoopes 1993). Wintering plovers primarily feed on invertebrates such as polychaete marine worms, various crustaceans, fly larvae, beetles, and occasionally bivalve mollusks found on top of the soil or just beneath the surface (Bent 1929; Cairns 1977; Nicholls 1989; Zonick and Ryan 1996).

Piping plovers exhibit a high degree of intra- and interannual wintering site fidelity (Nicholls and Baldassarre 1990; Drake et al. 2001; Noel and Chandler 2005; Stucker and Cuthbert 2006). However, local movements during winter are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 11.2 miles by approximately 10 percent of the banded population. Larger movements within South Carolina were seen during fall and spring migration.

Atlantic Coast plovers nest on coastal beaches, sand flats at the ends of sand spits and barrier islands, gently-sloped foredunes, sparsely-vegetated dunes, and washover areas cut into or between dunes. Plovers arrive on the breeding grounds from mid-March through mid-May and remain for three to four months per year; the Atlantic Coast plover breeding activities begin in March in North Carolina with courtship and territorial establishment (Coutu et al. 1990; McConnaughey et al. 1990). Egg-laying begins around mid-April with nesting and brood rearing activities continuing through July. They lay three to four eggs in shallow scraped depressions lined with light colored pebbles and shell fragments. The eggs are well camouflaged and blend extremely well with their surroundings. Both sexes incubate the eggs which hatch within 30 days, and both sexes feed the young until they can fly. The fledgling period, the time between the hatching of the chicks and the point at which they can fly, generally lasts 25 to 35 days.

Atlantic Coast and Florida studies highlighted the importance of inlets for nonbreeding and breeding piping plovers. Almost 90 percent of roosting piping plovers at ten coastal sites in southwest Florida were on inlet shorelines (Lott et al. 2009b). Piping plovers were among seven shorebird species found more often than expected ($p = 0.0004$; Wilcoxon Test Scores) at inlet locations versus non-inlet locations in an evaluation of 361 International Shorebird Survey sites from North Carolina to Florida (Harrington 2008).

3) Population dynamics

The International Piping Plover Breeding Census is conducted throughout the breeding grounds every 5 years by the Great Lakes/Northern Great Plains Recovery Team of the U.S. Geological Survey (USGS). The census is the largest known, complete avian species census. It is designed to determine species abundance and distribution throughout its annual cycle. The last survey in 2006 documented 3,497 breeding pairs, with a total of 8,065 birds throughout Canada and the U.S. (Elliot-Smith et al. 2009). A more recent 2010 Atlantic Coast breeding piping plover population estimate was 1,782 pairs, which was more than double the 1986 estimate of 790 pairs. This was determined to be a net increase of 86 percent between 1989 and 2010 (Service 2011). The 2006 International Piping Plover Census surveys documented 84 wintering piping plovers at 39 sites along approximately 344 km of North Carolina shoreline, and 87 breeding plovers at 29 sites along 338 km of shoreline (Elliott-Smith et al. 2009). Midwinter surveys may underestimate the abundance of nonbreeding piping plovers using a site or region during other months. In late September 2007, 104 piping plovers were counted at the south end of Ocracoke Island, North Carolina (National Park Service 2007), where none were seen during the 2006 International Piping Plover Winter Census (Elliott-Smith et al. 2009). Local movements of non-breeding piping plovers and number of surveyor visits to the site may also affect abundance estimates (Maddock et al. 2009; Cohen 2009).

The most consistent finding in the various population viability analyses conducted for piping plovers (Ryan et al. 1993; Melvin and Gibbs 1996; Plissner and Haig 2000; Wemmer et al. 2001; Larson et al. 2002; Amirault et al. 2005; Calvert et al. 2006; Brault 2007) indicates even small declines in adult and juvenile survival rates will cause increases in extinction risk. A banding study conducted between 1998 and 2004 in Atlantic Canada concluded lower return rates of juvenile (first year) birds to the breeding grounds than was documented for Massachusetts (Melvin and Gibbs 1996), Maryland (Loegering 1992), and Virginia (Cross 1996) breeding populations in the mid-1980s and very early 1990s. This is consistent with failure of the Atlantic Canada population to increase in abundance despite high productivity (relative to other breeding populations) and extremely low rates of dispersal to the U.S. over the last 15 plus years (Amirault et al. 2005). This suggests maximizing productivity does not ensure population increases.

However, other studies suggest that survivability is good at wintering sites (Drake et al. 2001). Please see the Piping Plover 5-Year Review: Summary and Evaluation for additional information on survival rates at wintering habitats (USFWS 2009).

In 2001, 2,389 piping plovers were located during a winter census, accounting for only 40 percent of the known breeding birds recorded during a breeding census (Ferland and Haig 2002). About 89 percent of birds that are known to winter in the U.S. do so along the Gulf Coast (Texas to Florida), while 8 percent winter along the Atlantic Coast (North Carolina to Florida).
The status of piping plovers on winter and migration grounds is difficult to assess, but threats to piping plover habitat used during winter and migration identified by the Service during its designation of critical habitat continue to affect the species. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Conservation efforts at some locations have likely resulted in the enhancement of wintering habitat.

Northern Great Plains Population

The Northern Great Plains plover breeds from Alberta to Manitoba, Canada and south to Nebraska; although some nesting has occurred in Oklahoma (Boyd 1991). Currently the most westerly breeding piping plovers in the United States occur in Montana and Colorado.
The decline of piping plovers on rivers in the Northern Great Plains has been largely attributed to the loss of sandbar island habitat and forage base due to dam construction and operation. Nesting occurs on sand flats or bare shorelines of rivers and lakes, including sandbar islands in the upper Missouri River system, and patches of sand, gravel, or pebbly-mud on the alkali lakes of the northern Great Plains. Plovers do nest on shorelines of reservoirs created by the dams, but reproductive success is often low and reservoir habitat is not available in many years due to high water levels or vegetation. Dams operated with steady constant flows allow vegetation to grow on potential nesting islands, making these sites unsuitable for nesting. Population declines in alkali wetlands are attributed to wetland drainage, contaminants, and predation.

The Northern Great Plains population is geographically widespread, with many birds in very remote places, especially in the U.S. and Canadian alkali lakes. Thus, determining the number of birds or even identifying a clear trend in the population is a difficult task. The International Piping Plover Census (IPPC) was designed, in part, to help deal with this problem by instigating a large effort every five years in which an attempt is made to survey every area with known or potential piping plover breeding habitat during a two-week window (i.e., the first two weeks of June). The relatively short window is designed to minimize double counting if birds move from one area to another. The 1988 recovery plan uses the numbers from the IPPC as a major criterion for delisting, as does the 2006 Canadian Recovery Plan (Environment Canada 2006).

Participation in the IPPC has been excellent on the Northern Great Plains, with a tremendous effort put forth to attempt to survey areas during the census window (Elliot-Smith et al. 2009). The large area to be surveyed and sparse human population in the Northern Great Plains make annual surveys of the entire area impractical, so the IPPC provides an appropriate tool for helping to determine the population trend. Many areas are only surveyed during the IPPC years. **Figure 3** shows the number of adult plovers in the Northern Great Plains (U.S. and Canada) for the four International Censuses. The IPPC shows that the U.S. population decreased between 1991 and 1996, then increased in 2001 and 2006. The Canadian population showed the reverse trend for the first three censuses, increasing slightly as the U.S. population decreased, and then decreasing in 2001. Combined, the IPPC numbers suggest that the population declined from 1991 through 2001, then increased almost 58% between 2001 and 2006 (Elliott-Smith et al. 2009).

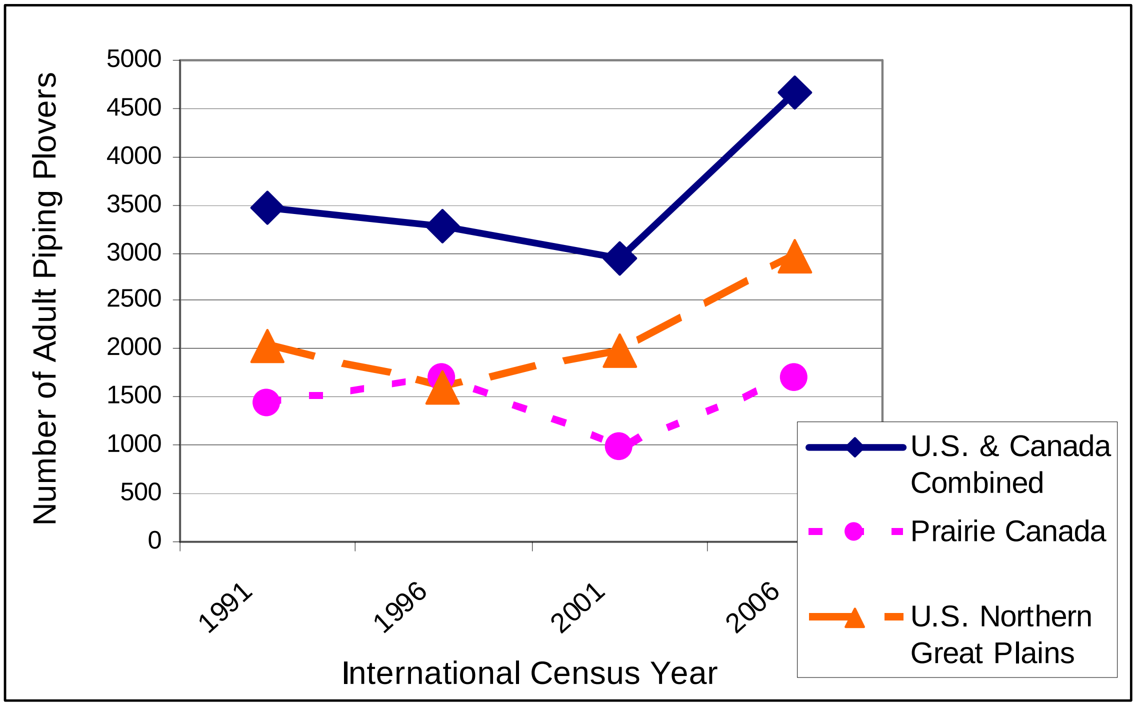


Figure 3. The number of adults reported for the U.S. and Canada Northern Great Plains during the International Censuses compared with the U.S. recovery goal.

The increase in 2006 is likely due in large part to a multi-year drought across the much of the region starting in 2001 that exposed thousands of acres of nesting habitat. The USACE ran low flows on the riverine stretches of the Missouri River for most of the years between censuses, allowing more habitat to be exposed and resulting in relatively high fledge ratios (USACE 2008a). The USACE also began to construct habitat using mechanical means (dredging sand from the riverbed) on the Missouri River in 2004, providing some new nesting and foraging habitat. The drought also caused reservoir levels to drop on many reservoirs throughout the Northern Great Plains (e.g. Missouri River Reservoirs (ND, SD), Lake McConaughey (NE)), providing shoreline habitat. The population increase may also be partially due to more intensive management activities on the alkali lakes, with increased management actions to improve habitat and reduce predation pressures.

While the IPPC provides an index to the piping plover population, the design does not always provide sufficient information to understand the population's dynamics. The five-year time interval between IPPC efforts may be too long to allow managers to get a clear picture of what the short-term population trends are and to respond accordingly if needed. As noted above, the first three IPPCs (1991, 1996, and 2001) showed a declining population, while the fourth (2006) indicated a dramatic population rebound of almost 58% for the combined U.S. and Canada Northern Great Plains population between 2001 and 2006. The preliminary results for 2011 indicate a similar grand population total as 2006, but a declining population in the United States. The larger overall population total in 2011 can be attributed to the larger numbers of plovers observed in the Bahamas. With only five data points over 20 years, it is impossible to determine if and to what extent the data reflects a real population trend versus error(s) in the 2011 census counts and/or a previous IPPC. The 2006 IPPC included a detectability component, in which a number of pre-selected sites were visited twice by the same observer(s) during the two-week window to get an estimate of error rate. This study found an approximately 76% detectability rate through the entire breeding area, with a range of between 39% to 78% detectability among habitat types in the Northern Great Plains. The results from the IPPC have been slow to be released, adding to the time lag between data collection and possible management response.

Great Lakes Population

The Great Lakes plovers once nested on Great Lakes beaches in Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario. Great Lakes piping plovers nest on wide, flat, open, sandy or cobble shoreline with very little grass or other vegetation. Reproduction is adversely affected by human disturbance of nesting areas and predation by foxes, gulls, crows and other avian species. Shoreline development, such as the construction of marinas, breakwaters, and other navigation structures, has adversely affected nesting and brood rearing.

The Recovery Plan (USFWS 2003) sets a population goal of at least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.

The Great Lakes piping plover population, which has been traditionally represented as the number of breeding pairs, has increased since the completion of the recovery plan in 2003 (Cuthbert and Roche 2007; 2006; Westbrock et al. 2005; Stucker and Cuthbert 2004; Stucker et al. 2003). The Great Lakes piping plover recovery plan documents the 2002 population at 51 breeding pairs (USFWS 2003). The 2008 census found 63 breeding pairs, an increase of approximately 23%. Of these, 53 pairs were found nesting in Michigan, while 10 were found outside the state, including six pairs in Wisconsin and four in Ontario, Canada. The 53 nesting pairs in Michigan represent approximately 50% of the recovery criterion. The 10 breeding pairs outside Michigan in the Great Lakes basin, represents 20% of the goal, albeit the number of breeding pairs outside Michigan has continued to increase over the past five years. The single breeding pair discovered in 2007 in the Great Lakes region of Canada represented the first confirmed piping plover nest there in over 30 years, and in 2008 the number of nesting pairs further increased to four.

In addition, the number of non-nesting individuals has increased annually since 2003. Between 2003-2008 an annual average of approximately 26 non-nesting piping plovers were observed, based on limited data from 2003, 2006, 2007, and 2008. Although there was some fluctuation in the total population between 2002-2008, the overall increase from 51 to 63 pairs combined with the increased observance of non-breeding individuals indicates the population is increasing. (**Figure 4**).

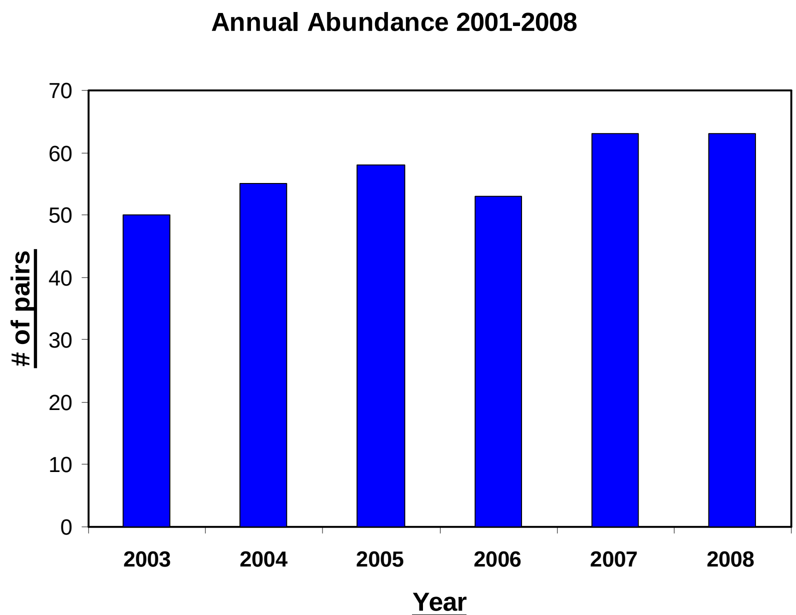


Figure 4. Annual Abundance Estimates for Great Lakes Piping Plovers (2003-2008).

Atlantic Coast Population

The Atlantic Coast piping plover breeds on coastal beaches from Newfoundland and southeastern Quebec to North Carolina. Historical population trends for the Atlantic Coast piping plover have been reconstructed from scattered, largely qualitative records. Nineteenth-century naturalists, such as Audubon and Wilson, described the piping plover as a common summer resident on Atlantic Coast beaches (Haig and Oring 1987). However, by the beginning of the 20th Century, egg collecting and uncontrolled hunting, primarily for the millinery trade, had greatly reduced the population, and in some areas along the Atlantic Coast, the piping plover was close to extirpation. Following passage of the Migratory Bird Treaty Act (40 Stat. 775; 16 U.S.C. 703-712) in 1918, and changes in the fashion industry that no longer exploited wild birds for feathers, piping plover numbers recovered to some extent (Haig and Oring 1985).

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Reports of local or statewide declines between 1950 and 1985 are numerous, and many are summarized by Cairns and McLaren (1980) and Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 1989 population estimate was 191 pairs (see Table 4, USFWS 1996a). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Piping plover surveys in the early years of the recovery effort found that counts of these cryptically colored birds sometimes went up with increased census effort, suggesting that some historic counts of piping plovers by one or a few observers may have underestimated the piping plover population. Thus, the magnitude of the species decline may have been more severe than available numbers imply.

Annual estimates of breeding pairs of Atlantic Coast piping plovers are based on multiple surveys at most occupied sites. Sites that cannot be monitored repeatedly in May and June (primarily sites with few pairs or inconsistent occupancy) are surveyed at least once during a standard nine-day count period (Hecht and Melvin 2009).

Since its 1986 listing under the ESA, the Atlantic Coast population estimate has increased 234%, from approximately 790 pairs to an estimated 1,849 pairs in 2008, and the U.S. portion of the population has almost tripled, from approximately 550 pairs to an estimated 1,596 pairs. Even discounting apparent increases in New York, New Jersey, and North Carolina between 1986 and 1989, which likely were due in part to increased census effort (USFWS 1996a), the population nearly doubled between 1989 and 2008. The largest population increase between 1989 and 2008 has occurred in New England (245%), followed by New York-New Jersey (74%). In the Southern (DE-MD-VA-NC) Recovery Unit, overall growth between 1989 and 2008 was 66%, but almost three-quarters of this increase occurred in just two years, 2003-2005. The eastern Canada population fluctuated from year to year, with increases often quickly eroded in subsequent years; net growth between 1989 and 2008 was 9%.

The overall population growth pattern was tempered by periodic rapid declines in the Southern and Eastern Canada Recovery Units. The eastern Canada population decreased 21% in just three years (2002-2005), and the population in the southern half of the Southern Recovery Unit declined 68% in seven years (1995-2001). The 64% decline in the Maine population, from 66 pairs in 2002 to 24 pairs in 2008, following only a few years of decreased productivity, provides another example of the continuing risk of rapid and precipitous reversals in population growth.

4) Status and Distribution

Reason for Listing: Hunting during the 19th and early 20th centuries likely led to initial declines in the species; however, shooting piping plovers has been prohibited since 1918 pursuant to the provisions of the Migratory Bird Treaty Act (MBTA). Other human activities, such as habitat loss and degradation, disturbance from recreational pressure, contaminants, and predation are likely responsible for continued declines. These factors include development and shoreline stabilization. The 1985 final rule stated the number of piping plovers on the Gulf of Mexico coastal wintering grounds might be declining as indicated by preliminary analysis of the Christmas Bird Count data. Independent counts of piping plovers on the Alabama coast indicated a decline in numbers between the 1950s and early 1980s. At the time of listing, the Texas Parks and Wildlife Department stated 30 percent of wintering habitat in Texas had been lost over the previous 20 years. The final rule also stated, in addition to extensive breeding area problems, the loss and modification of wintering habitat was a significant threat to the piping plover.

Range-wide Trend: Three range-wide population surveys have been conducted for the piping plover; the 1991 (Haig and Plissner 1992), 1996 (Plissner and Haig 1997), and 2006 ((Elliott-Smith et al. 2009) International Piping Plover Censuses. These surveys were completed to help determine the species distribution and to monitor progress toward recovery.

Recovery Criteria

Delisting of the three piping plover populations may be considered when the following criteria are met:

Northern Great Plains Population (USFWS 1988, 1994)

1. Increase the number of birds in the U.S. northern Great Plains states to 2,300 pairs

(Service 1994).

2. Increase the number of birds in the prairie region of Canada to 2,500 adult piping plovers (Service 1988).
3. Secure long term protection of essential breeding and wintering habitat (Service 1994).

Great Lakes Population (USFWS 2003)

1. At least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.
2. Five-year average fecundity within the range of 1.5-2.0 fledglings per pair, per year, across the breeding distribution, and ten-year population projections indicate the population is stable or continuing to grow above the recovery goal.
3. Protection and long-term maintenance of essential breeding and wintering habitat is ensured, sufficient in quantity, quality, and distribution to support the recovery goal of 150 pairs (300 individuals).
4. Genetic diversity within the population is deemed adequate for population persistence and can be maintained over the long-term.
5. Agreements and funding mechanisms are in place for long-term protection and management activities in essential breeding and wintering habitat.

Atlantic Coast Population (USFWS 1996a)

1. Increase and maintain for 5 years a total of 2,000 breeding pairs, distributed among 4 recovery units.

Recovery Unit	*Minimum Subpopulation*
Atlantic (eastern) Canada	*400 pairs*
New England	*625 pairs*
New York-New Jersey	*575 pairs*
Southern (DE-MD-VA-NC)	*400 pairs*

2. Verify the adequacy of a 2,000 pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term.
3. Achieve a 5-year average productivity of 1.5 fledged chicks per pair in each of the

4 recovery units described in criterion 1, based on data from sites that collectively support at least 90% of the recover unit's population.

4. Institute long-term agreements to assure protection and management sufficient to maintain the population targets and average productivity in each recovery unit.
5. Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

Breeding Range

Northern Great Plains Population

The IPPC numbers indicate that the Northern Great Plains population (including Canada) declined from 1991 through 2001, and then increased dramatically in 2006. This increase corresponded with a multi-year drought in the Missouri River basin that exposed a great deal of nesting habitat, suggesting that the population can respond fairly rapidly to changes in habitat quantity and quality. Despite this improvement, we do not consider the numeric, distributional, or temporal elements of the population recovery criteria achieved.

As the Missouri River basin emerges from drought and breeding habitat is inundated, the population will likely decline. The management activities carried out in many areas during drought conditions have undoubtedly helped to maintain and increase the piping plover population, especially to mitigate for otherwise poor reproductive success during wet years when habitat is limited.

While the population increase seen in recent years demonstrates the possibility that the population can rebound from low population numbers, ongoing efforts are needed to maintain and increase the population. In the U.S., piping plover crews attempt to locate most piping plover nests and take steps to improve their success. This work has suffered from insufficient and unstable funding in most areas.

Emerging threats, such as energy development (particularly wind, oil and gas and associated infrastructure) and climate change are likely to impact piping plovers both on the breeding and wintering grounds. The potential impact of both of these threats is not well understood, and measures to mitigate for them are also uncertain at this time.

In the 2009 status review, the Service concluded that the Northern Great Plains piping plover population remains vulnerable, especially due to management of river systems throughout the breeding range (USFWS 2009). Many of the threats identified in the 1988 recovery plan, including those affecting Northern Great Plains piping plover population during the two-thirds of its annual cycle spent in the wintering range, remain today or have intensified.

Great Lakes Population

The population has shown significant growth, from approximately 17 pairs at the time of listing in 1986, to 63 pairs in 2008. The total of 63 breeding pairs represents approximately 42% of the current recovery goal of 150 breeding pairs for the Great Lakes population. Productivity goals, as specified in the 2003 recovery plan, have been met over the past 5 years. During this time period the average annual fledging rate has been 1.76, well above the 1.5 fledglings per breeding pair recovery goal. A 2010 analysis of banded piping plovers in the Great Lakes, however, suggests that after-hatch year survival (adult) rates may be declining (Roche et al. 2010). Continued population growth will require the long-term maintenance of productivity goals concurrent with measures to sustain or improve important vital rates.

Although initial information considered at the time of the 2003 recovery plan suggested the population may be at risk from a lack of genetic diversity, currently available information suggests that genetic diversity may not pose a high risk to the Great Lakes population. Additional genetic information is needed to assess genetic structure of the population and verify the adequacy of a 150 pair population to maintain long-term heterozygosity and allelic diversity.

Several years of population growth is evidence of the effectiveness of the ongoing Great Lakes piping plover recovery program. Most major threats, however, including habitat degradation, predation, and human disturbance remain persistent and pervasive. Severe threats from human disturbance and predation remain ubiquitous within the Great Lakes. Expensive labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private partners. Because threats to Great Lakes piping plovers persist, reversal of gains in abundance and productivity are expected to quickly follow if current protection efforts are reduced.

Emerging potential threats to piping plovers in the Great Lakes basin include disease, wind turbine generators and, potentially, climate change. Type-E botulism in the Northern Lake Michigan basin has resulted in several piping plover mortalities since 2000 (USFWS 2013). Future outbreaks in areas that support a concentration of breeding piping plovers could impact survival rates and population abundance. Wind turbine projects, many of which are currently in the planning stages, need further study to determine potential risks to piping plovers and/or their habitat, as well as the need for specific protections to prevent or mitigate impacts. Climate change projections for the Great Lakes include the potential for significant water-level decreases. The degree to which this factor will impact piping plover habitat is unknown, but prolonged water-level decreases are likely to alter habitat condition and distribution.

In the 2009 status review, the Service concluded that the Great Lakes population remains at considerable risk of extinction due to its small size, limited distribution and vulnerability to stochastic events, such as disease outbreak (USFWS 2009). In addition, the factors that led to the piping plover's 1986 listing remain present.

Atlantic Coast Population

Substantial population growth, from approximately 790 pairs in 1986 to an estimated 1,849 pairs in 2008, has decreased the Atlantic Coast piping plover's vulnerability to extinction since ESA listing. Thus, considerable progress has been made towards the overall goal of 2,000 breeding pairs articulated in recovery criterion 1. As discussed in the 1996 revised recovery plan, however, the overall security of the Atlantic Coast piping plover is fundamentally dependent on even distribution of population growth, as specified in subpopulation targets, to protect a sparsely-distributed species with strict biological requirements from environmental variation (including catastrophes) and increase the likelihood of interchange among subpopulations. Although the New England Recovery Unit has sustained its subpopulation target for the requisite five years, and the New York-New Jersey Recovery Unit reached its target in 2007 (but dipped below again in 2008), considerable additional growth is needed in the Southern and Eastern Canada Recovery Units (recovery criterion 1).

Productivity goals (criterion 3) specified in the 1996 recovery plan must be revised to accommodate new information about latitudinal variation in productivity needed to maintain a stationary population. Population growth, particularly in the three U.S. recovery units, provides indirect evidence that adequate productivity has occurred in at least some years. However, overall security of a 2,000 pair population will require long-term maintenance of these revised recovery-unit-specific productivity goals concurrent with population numbers at or above abundance goals.

Twenty years of relatively steady population growth, driven by productivity gains, also evidences the efficacy of the ongoing Atlantic Coast piping plover recovery program. However, all of the major threats (habitat loss and degradation, predation, human disturbance, and inadequacy of other (non-ESA) regulatory mechanisms) identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive. Severe threats from human disturbance and predation remain ubiquitous along the Atlantic Coast. Expensive labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private cooperators. Because threats to Atlantic Coast piping plovers persist (and in many cases have increased since listing), reversal of gains in abundance and productivity would quickly follow diminishment of current protection efforts.

Finally, two emerging potential threats, wind turbine generators and climate change (especially sea-level rise) are likely to affect Atlantic Coast piping plovers throughout their life cycle. These two threats must be evaluated to ascertain their effects on piping plovers and/or their habitat, as well as the need for specific protections to prevent or mitigate impacts that could otherwise increase overall risks the species.

In the 2009 status review, the Service concluded that the Atlantic Coast piping plover remains vulnerable to low numbers in the Southern and Eastern Canada (and, to a lesser extent, the New York-New Jersey) Recovery Units (USFWS 2009). Furthermore, the factors that led to the piping plover's 1986 listing remain operative rangewide (including in New England), and many of these threats have increased. Interruption of costly, labor-intensive efforts to manage these threats would quickly lead to steep population declines.

Nonbreeding Range

Piping plovers spend up to 10 months of their life cycle on their migration and winter grounds, generally July 15 through as late as May 15. Piping plover migration routes and habitats overlap breeding and wintering habitats, and, unless banded, migrants passing through a site usually are indistinguishable from breeding or wintering piping plovers. Migration stopovers by banded piping plovers from the Great Lakes have been documented in New Jersey, Maryland, Virginia, and North Carolina (Stucker and Cuthbert 2006). Migrating breeders from eastern Canada have been observed in Massachusetts, New Jersey, New York, and North Carolina (Amirault et al. 2005). As many as 85 staging piping plovers have been tallied at various sites in the Atlantic breeding range (Perkins 2008 pers. communication), but the composition (e.g., adults that nested nearby and their fledged young of the year versus migrants moving to or from sites farther north), stopover duration, and local movements are unknown. In general, distance between stopover locations and duration of stopovers throughout the coastal migration range remains poorly understood.

Review of published records of piping plover sightings throughout North America by Pompei and Cuthbert (2004) found more than 3,400 fall and spring stopover records at 1,196 sites. Published reports indicated that piping plovers do not concentrate in large numbers at inland sites and that they seem to stop opportunistically. In most cases, reports of birds at inland sites were single individuals.

Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Gratto-Trevor et al. (2009) reported that six of 259 banded piping plovers observed more than once per winter moved across boundaries of the seven U.S. regions. This species exhibits a high degree of intra- and inter-annual wintering site fidelity (Nicholls and Baldassarre 1990; Drake et al. 2001; Noel et al. 2005; Stucker and Cuthbert 2006). Of 216 birds observed in different years, only eight changed regions between years, and several of these shifts were associated with late summer or early spring migration periods (Gratto-Trevor et al. 2009). Local movements are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 18 km by approximately 10% of the banded population; larger movements within South Carolina were seen during fall and spring migration. Similarly, eight banded piping plovers that were observed in two locations during 2006-2007 surveys in Louisiana and Texas were all in close proximity to their original location, such as on the bay and ocean side of the same island or on adjoining islands (Maddock 2008).

Gratto-Trevor et al. (2009) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations (**Figure 5**). All eastern Canada and 94% of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast. Although the great majority of Prairie Canada individuals were observed in Texas, particularly southern Texas, individuals from the U.S. Great Plains were more widely distributed on the Gulf Coast from Florida to Texas.

The findings of Gratto-Trevor et al. (2009) provide evidence of differences in the wintering distribution of piping plovers from these four breeding areas. However, the distribution of birds by breeding origin during migration remains largely unknown. Other major information gaps include the wintering locations of the U.S. Atlantic Coast breeding population (banding of U.S. Atlantic Coast piping plovers has been extremely limited) and the breeding origin of piping plovers wintering on Caribbean islands and in much of Mexico. Banded piping plovers from the Great Lakes, Northern Great Plains, and eastern Canada breeding populations showed similar patterns of seasonal abundance at Little St. Simons Island, Georgia (Noel et al. 2007). However, the number of banded plovers originating from the latter two populations was relatively small at that study area.

Four rangewide mid-winter (late January to early February) population surveys, conducted at five-year intervals starting in 1991, are summarized in **Table 1**. Total numbers have fluctuated over time, with some areas experiencing increases and others decreases. Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate their wintering distribution in a given area.

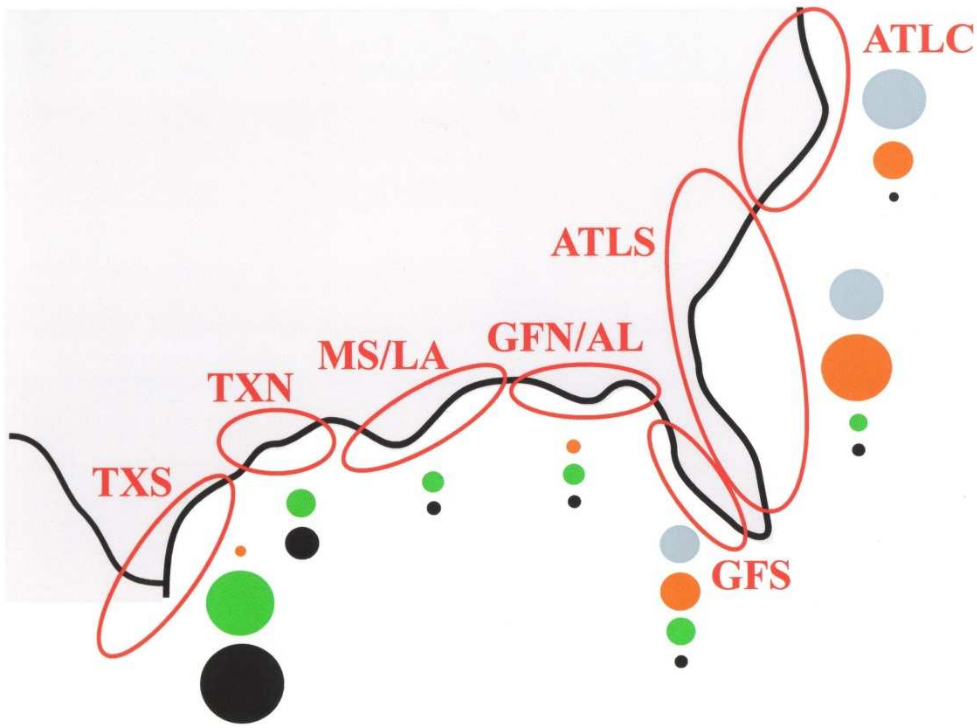


Figure 5. (from Gratto-Trevor et al. 2009, reproduced by permission). Breeding population distribution in the wintering/migration range. Regions: ATLC=Atlantic (eastern) Canada; GFS=Gulf Coast of southern Florida; GFN=Gulf Coast of north Florida; AL=Alabama; MS/LA=Mississippi and Louisiana; TXN=northern Texas; and TXS=southern Texas. For each breeding population, circles represent the percentage of individuals reported wintering along the eastern coast of the U.S. from the central Atlantic to southern Texas/Mexico up to December 2008. Each individual was counted only once. Grey circles represent Eastern Canada birds, Orange U.S. Great Lakes, Green U.S. Great Plains, and Black Prairie Canada. The relative size of the circle represents the percentage from a specific breeding area seen in that winter region. Total number of individuals observed on the wintering grounds was 46 for Eastern Canada, 150 for the U.S. Great Lakes, 169 for the U.S. Great Plains, and 356 for Prairie Canada.

Table 1. Results of the 1991, 1996, 2001, and 2006 International Piping Plover Winter Censuses (Haig et al. 2005; Elliott-Smith et al. 2009).

Location	**1991**	**1996**	**2001**	**2006**
Virginia	not surveyed (ns)	ns	ns	1
North Carolina	**20**	**50**	**87**	**84**
South Carolina	51	78	78	100
Georgia	37	124	111	212
Florida	551	375	416	454
-Atlantic	*70*	*31*	*111*	*133*
-Gulf	*481*	*344*	*305*	*321*
Alabama	12	31	30	29
Mississippi	59	27	18	78
Louisiana	750	398	511	226
Texas	1,904	1,333	1,042	2,090
Puerto Rico	0	0	6	Ns
U.S. Total	**3,384**	**2,416**	**2,299**	**3,355**
Mexico	27	16	Ns	76
Bahamas	29	17	35	417
Cuba	11	66	55	89
Other Caribbean Islands	0	0	0	28
GRAND TOTAL	**3,451**	**2,515**	**2,389**	**3,884**
Percent of Total International Piping Plover Breeding Census	62.9%	42.4%	40.2%	48.2%

Mid-winter surveys may substantially underestimate the abundance of nonbreeding piping plovers using a site or region during other months. In late September 2007, 104 piping plovers were counted at the south end of Ocracoke Island, North Carolina (NPS 2007), where none were seen during the 2006 International Piping Plover Winter Census (Elliott-Smith et al. 2009). Noel et al. (2007) observed up to 100 piping plovers during peak migration at Little St. Simons Island, Georgia, where approximately 40 piping plovers wintered in 2003–2005. Differences among fall, winter, and spring counts in South Carolina were less pronounced, but inter-year fluctuations (e.g., 108 piping plovers in spring 2007 versus 174 piping plovers in spring 2008) at 28 sites were striking (Maddock et al. 2009). Even as far south as the Florida Panhandle, monthly counts at Phipps Preserve in Franklin County ranged from a mid-winter low of four piping plovers in December 2006 to peak counts of 47 in October 2006 and March 2007 (Smith 2007). Pinkston (2004) observed much heavier use of Texas Gulf Coast (ocean-facing) beaches between early September and mid-October (approximately 16 birds per mile) than during December to March (approximately two birds per mile).

Local movements of nonbreeding piping plovers may also affect abundance estimates. At Deveaux Bank, one of South Carolina's most important piping plover sites, five counts at approximately 10-day intervals between August 27 and October 7, 2006, oscillated from 28 to 14 to 29 to 18 to 26 (Maddock et al. 2009). Noel and Chandler (2008) detected banded Great Lakes piping plovers known to be wintering on their Georgia study site in 73.8 $\pm$ 8.1 % of surveys over three years.

Abundance estimates for nonbreeding piping plovers may also be affected by the number of surveyor visits to the site. Preliminary analysis of detection rates by Maddock et al. (2009) found 87% detection during the mid-winter period on core sites surveyed three times a month during fall and spring and one time per month during winter, compared with 42% detection on sites surveyed three times per year (Cohen 2009 pers. communication).

The 2004 and 2005 hurricane seasons affected a substantial amount of habitat along the Gulf Coast. Habitats such as those along Gulf Islands National Seashore have benefited from increased washover events, which created optimal habitat conditions for piping plovers. Conversely, hard shoreline structures put into place following storms throughout the species range to prevent such shoreline migration prevent habitat creation (see *Factors Affecting Species Environment within the Action Area*). Four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 International Piping Plover Census tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82% of their surface area (Sallenger et al. 2009 in review), and a review of aerial photography prior to the 2006 Census suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009 in review) noted that habitat changes in the Chandeleurs stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (>1,000 years) diminishing sand supply, and sea-

level rise relative to the land.
The Service is aware of the following site-specific conditions that benefit several habitats piping plover use while wintering and migrating, including critical habitat units. In Texas, one critical habitat unit was afforded greater protection due to the acquisition of adjacent upland properties by the local Audubon chapter. In another unit in Texas, vehicles were removed from a portion of the beach decreasing the likelihood of automobile disturbance to plovers. Exotic plant removal that threatens to invade suitable piping plover habitat is occurring in a critical habitat unit in South Florida. The Service and other government agencies remain in a contractual agreement with the USDA for predator control within limited coastal areas in the Florida panhandle, including portions of some critical habitat units. Continued removal of potential terrestrial predators is likely to enhance survivorship of wintering and migrating piping plovers.

The status of piping plovers on winter and migration grounds is difficult to assess, but threats to piping plover habitat used during winter and migration identified by the Service during its designation of critical habitat continue to affect the species. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas. Conservation efforts at some locations have likely resulted in the enhancement of wintering habitat.

Threats to Piping Plovers

The three recovery plans stated that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The plans further stated that beach maintenance and nourishment, inlet dredging, and artificial structures, such as jetties, groins, and revetments, could eliminate wintering areas and alter sedimentation patterns leading to the loss of nearby habitat. Unregulated motorized and pedestrian recreational use, inlet and shoreline stabilization projects, beach maintenance and nourishment, and pollution affect most winter and migration areas.

Important components of ecologically sound barrier beach management include perpetuation of natural dynamic coastal formation processes. Structural development along the shoreline or manipulation of natural inlets upsets the dynamic processes and results in habitat loss or degradation (Melvin et al. 1991). Throughout the range of migrating and wintering piping plovers, inlet and shoreline stabilization, inlet dredging, beach maintenance and nourishment activities, and seawall installations continue to constrain natural coastal processes. Dredging of inlets can affect spit formation adjacent to inlets and directly remove or affect ebb and flood tidal shoal formation. Jetties, which stabilize an island, cause island widening and subsequent growth of vegetation on inlet shores. Seawalls restrict natural island movement and exacerbate erosion. As discussed in more detail below, all these efforts result in loss of piping plover habitat. Construction of these projects during months when piping plovers are present also causes disturbance that disrupts the birds' foraging efficiency and hinders their ability to build fat reserves over the winter and in preparation for migration, as well as their recuperation from migratory flights. In addition, up to 24 shorebird species migrate or winter along the Atlantic Coast and almost 40 species of shorebirds are present during migration and wintering periods in the Gulf of Mexico region (Helmers 1992). Continual degradation and loss of habitats used by wintering and migrating shorebirds may cause an increase in intra-specific and inter-specific competition for remaining food supplies and roosting habitats. In Florida, for example, approximately 825 miles of coastline and parallel bayside flats (unspecified amount) were present prior to the advent of high human densities and beach stabilization projects. We estimate that only about 35% of the Florida coastline continues to support natural coastal formation processes, thereby concentrating foraging and roosting opportunities for all shorebird species and forcing some individuals into suboptimal habitats. Thus, intra- and inter-specific competition most likely exacerbates threats from habitat loss and degradation.

Sand placement projects

In the wake of episodic storm events, managers of lands under public, private, and county ownership often protect coastal structures using emergency storm berms; this is frequently followed by beach nourishment or renourishment activities (nourishment projects are considered "soft" stabilization versus "hard" stabilization such as seawalls). Berm placement and beach nourishment deposit substantial amounts of sand along Gulf of Mexico and Atlantic beaches to protect local property in anticipation of preventing erosion and what otherwise will be considered natural processes of overwash and island migration (Schmitt and Haines 2003).

Past and ongoing stabilization projects fundamentally alter the naturally dynamic coastal processes that create and maintain beach strand and bayside habitats, including those habitat components that piping plovers rely upon. Although impacts may vary depending on a range of factors, stabilization projects may directly degrade or destroy piping plover roosting and foraging habitat in several ways. Front beach habitat may be used to construct an artificial berm that is densely planted in grass, which can directly reduce the availability of roosting habitat. Over time, if the beach narrows due to erosion, additional roosting habitat between the berm and the water can be lost. Berms can also prevent or reduce the natural overwash that creates roosting habitats by converting vegetated areas to open sand areas. The vegetation growth caused by impeding natural overwash can also reduce the maintenance and creation of bayside intertidal feeding habitats. In addition, stabilization projects may indirectly encourage further development of coastal areas and increase the threat of disturbance.

At least 668 of 2,340 coastal shoreline miles (29% of beaches throughout the piping plover winter and migration range in the U.S.) are bermed, nourished, or renourished, generally for recreational purposes and to protect commercial and private infrastructure (**Table 2**). However, only approximately 54 miles or 2.31% of these impacts have occurred within critical habitat. In Louisiana, sediment placement projects are deemed environmental restoration projects by the USFWS, because without the sediment, many areas would erode below sea level.

Table 2. Summary of the extent of nourished beaches in piping plover wintering and migrating habitat within the conterminous U.S. From USFWS unpublished data (project files, gray literature, and field observations).

State	**Sandy beach shoreline miles available**	**Sandy beach shoreline miles nourished to date (within critical habitat units)**	**Percent of sandy beach shoreline affected (within critical habitat units)**
North Carolina	301[7]	117[5] (unknown)	39 (unknown)
South Carolina	187[1]	56 (0.6)	30 (0.32))
Georgia	100[1]	8 (0.4)	8 (0.40)
Florida	825[2]	404 (6)[6]	49 (0.72)
Alabama	53[1]	12 (2)	23 (3.77)
Mississippi	110[3]	$\geq$6 (0)	5 (0)
Louisiana	397[1]	Unquantified (usually restoration-oriented)	Unknown
Texas	367[4]	65 (45)	18 (12.26)
Overall Total	2,340 (does not include Louisiana)	$\geq$668 does not include Louisiana (54 in CH)	29% ($\geq$2.31% in CH)

Data from [1]www.50states.com; [2] Clark 1993; [3]N.Winstead, Mississippi Museum of Natural Science 2008; [4] www.Surfrider.org; [5] **H. Hall, USFWS, pers. comm. 2009**; [6] partial data from Lott et al. (2009a); [7]NOAA, 1975.

Inlet stabilization/relocation

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties, groins, or by seawalls and/or adjacent industrial or residential development. Using Google Earth© (accessed April 2009 and October 2014), Service's biologists visually estimated the number of navigable mainland or barrier island tidal inlets throughout the wintering range of the piping plover in the conterminous U.S. that have some form of hardened structure. This includes seawalls or adjacent development, which lock the inlets in place (**Table 3**).

Table 3. Number of hardened inlets by state. Asterisk (*) represents an inlet at the state line, in which case half an inlet is counted in each state.

State	**Visually estimated number of navigable mainland and barrier island inlets per state**	**Number of hardened inlets**	**% of inlets affected**
North Carolina	20	2.5* (+ 1 proposed)	12.5% (17.5%)
South Carolina	34	3.5*	10.3%
Georgia	26	2	7.7%
Florida	82	41	50%
Alabama	14	6	42.9%
Mississippi	16	7	43.8%
Louisiana	40	9	22.5%
Texas	17	10	58.8%
Overall Total	249	81 (82 with proposed)	32.5% (32.9%)

Tidal inlet relocation can cause loss and/or degradation of piping plover habitat; although less permanent than construction of hard structures, effects can persist for years. Service biologists are aware of at least seven inlet relocation projects (two in North Carolina, three in South Carolina, two in Florida), but this number likely under-represents the extent of this activity.

Sand mining/dredging

Sand mining, the practice of extracting (dredging) sand from sand bars, shoals, and inlets in the nearshore zone, is a less expensive source of sand than obtaining sand from offshore shoals for beach nourishment. Sand bars and shoals are sand sources that move onshore over time and act as natural breakwaters. Inlet dredging reduces the formation of exposed ebb and flood tidal shoals considered to be primary or optimal piping plover roosting and foraging habitat. Removing these sand sources can alter depth contours and change wave refraction as well as cause localized erosion (Hayes and Michel 2008). Exposed shoals and sandbars are also valuable to piping plovers, as they tend to receive less human recreational use (because they are only accessible by boat) and therefore provide relatively less disturbed habitats for birds. We do not have a good estimate of the amount of sand mining that occurs across the piping plover wintering range, nor do we have a good estimate of the number of inlet dredging projects that occur. Most jettied inlets need maintenance dredging, but non-hardened inlets are often dredged as well.

Groins

Groins (structures made of concrete, rip rap, wood, or metal built perpendicular to the beach in order to trap sand) are typically found on developed beaches with severe erosion. Although groins can be individual structures, they are often clustered along the shoreline. Groins can act as barriers to longshore sand transport and cause downdrift erosion (Hayes and Michel 2008), which prevents piping plover habitat creation by limiting sediment deposition and accretion. These structures are found throughout the southeastern Atlantic Coast, and although most were in place prior to the piping plover's 1986 ESA listing, installation of new groins continues to occur. In North Carolina, there is one currently existing groin, at Fort Macon in Carteret County. There are also two degraded groin/jetty structures in Dare County, adjacent to the old location of the Cape Hatteras lighthouse. In 2014, the Village of Bald Head Island received state authorization to build a terminal groin at the mouth of the Cape Fear River/Wilmington Harbor Channel. Three other local governments in North Carolina are seeking authorization for terminal groins (Ocean Isle Beach, Holden Beach, and Figure 8 Island).

Seawalls and revetments

Seawalls and revetments are vertical hard structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate intertidal foraging habitat and adjacent roosting habitat. Seawalls confine the wave energy and intensify the erosion by concentrating the sediment transport processes in an increasingly narrow zone. Eventually, the beach disappears, leaving the seawall directly exposed to the full force of the waves (Williams et al 1995). Physical characteristics that determine microhabitats and biological communities can be altered after installation of a seawall or revetment, thereby depleting or changing composition of benthic communities that serve as the prey base for piping plovers. At four California study sites, each comprised of an unarmored segment and a segment seaward of a seawall, Dugan and Hubbard (2006) found that armored segments had narrower intertidal zones, smaller standing crops of macrophyte wrack, and lower shorebird abundance and species richness. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) and sandbag revetments are softer alternatives, but act as barriers by preventing overwash. We did not find any sources that summarize the linear extent of seawall, revetment, and geotube installation projects that have occurred across the piping plover's wintering and migration habitat. There are two existing rock revetments along the coast of North Carolina: one at Fort Fisher (approximately 3,040 lf), and another along Carolina Beach (approximately 2,050 lf). A 1,450 lf sandbag revetment is currently in construction at the north end of North Topsail Beach.

Exotic/invasive vegetation

One identified threat to piping plover habitat, not described in the listing rule or recovery plans, is the spread of coastal invasive plants into suitable piping plover habitat. Like most invasive species, coastal exotic plants reproduce and spread quickly and exhibit dense growth habits, often outcompeting native plant species. If left uncontrolled, invasive plants cause a habitat shift from open or sparsely vegetated sand to dense vegetation, resulting in the loss or degradation of piping plover roosting habitat, which is especially important during high tides and migration periods.

Beach vitex (*Vitex rotundifolia*) is a woody vine introduced into the southeastern U.S. as a dune stabilization and ornamental plant (Westbrooks and Madsen 2006). It currently occupies a very small percentage of its potential range in the U.S.; however, it is expected to grow well in coastal communities throughout the southeastern U.S. from Virginia to Florida, and west to Texas (Westbrooks and Madsen 2006). In 2003, the plant was documented in New Hanover, Pender, and Onslow counties in North Carolina, and at 125 sites in Horry, Georgetown, and Charleston counties in South Carolina. Task forces formed in North and South Carolina in 2004-05 have made great strides to remove this plant from their coasts. To date, about 200 sites in North Carolina have been treated, with 200 additional sites in need of treatment. Similar efforts are underway in South Carolina (Suiter 2009 pers. communication).

The Australian pine (*Casuarina equisetifolia*) changes the vegetative structure of the coastal community in south Florida and islands within the Bahamas. Shorebirds prefer foraging in open areas where they are able to see potential predators, and tall trees provide good perches for avian predators. Australian pines potentially impact shorebirds, including the piping plover, by

reducing attractiveness of foraging habitat and/or increasing avian predation.
The propensity of these exotic species to spread, and their tenacity once established, make them a persistent threat, partially countered by increasing landowner awareness and willingness to undertake eradication activities.

Wrack removal and beach cleaning

Wrack on beaches and baysides provides important foraging and roosting habitat for piping plovers (Drake 1999a; Smith 2007; Maddock et al. 2009; Lott et al. 2009b; and many other shorebirds on their winter, breeding, and migration grounds. Because shorebird numbers are positively correlated with wrack cover and biomass of their invertebrate prey that feed on wrack (Tarr and Tarr 1987; Hubbard and Dugan 2003; Dugan et al. 2003), grooming will lower bird numbers (Defreo et al. 2009).

There is increasing popularity in the Southeast, especially in Florida, for beach communities to carry out “beach cleaning” and “beach raking” actions. Beach cleaning occurs on private beaches, where piping plover use is not well documented, and on some municipal or county beaches that are used by piping plovers. Most wrack removal on state and federal lands is limited to post-storm cleanup and does not occur regularly.

Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber and Sons 2012). These efforts remove accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers. Removal of wrack also eliminates a beach’s natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Nordstrom et al. 2006; Neal et al. 2007). Beach cleaning or grooming can result in abnormally broad unvegetated zones that are inhospitable to dune formation or plant colonization, thereby enhancing the likelihood of erosion (Defreo et al. 2009).

Predation

The 1996 Atlantic Coast Recovery Plan summarized evidence that human activities affect types, numbers, and activity patterns of some predators, thereby exacerbating natural predation on breeding piping plovers. The impact of predation on migrating or wintering piping plovers remains largely undocumented.

Recreational disturbance

Intense human disturbance in shorebird winter habitat can be functionally equivalent to habitat loss if the disturbance prevents birds from using an area (Goss-Custard et al. 1996), which can lead to roost abandonment and local population declines (Burton et al. 1996). Pfister et al. (1992) implicate anthropogenic disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. Disturbance, i.e., beach driving, human and pet presence that alters bird behavior, disrupts piping plovers as well as other shorebird species. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995; Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000).

Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a; 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Beach driving and off-road vehicles can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The 1996 Atlantic Coast recovery plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993; Goldin 1993). The plan also notes that the magnitude of the threat from off-road vehicles is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance will otherwise be very slight. Godfrey et al. (1980 as cited *in* Lamont et al. 1997) postulated that vehicular traffic along the beach may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of off-road vehicles negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where off-road vehicle use is allowed, and recommended controlled management experiments to determine if recreational disturbance drives roost site selection. Ninety-six percent of piping plover detections were on the south side of the inlet even though it was farther away from foraging sites (1.8 km from the sound side foraging site to the north side of the inlet versus 0.4 km from the sound side foraging site to the north side of the inlet; Cohen et al. 2008).

Based on surveys with land managers and biologists, knowledge of local site conditions, and other information, we have estimated the levels of eight types of disturbance at sites in the U.S. with wintering piping plovers. There are few areas used by wintering piping plovers that are devoid of human presence, and just under half have leashed and unleashed dog presence (Smith 2007; Lott et al. 2009b; Service unpubl. data 2009; Maddock and Bimbi unpubl. data). **Table 4** summarizes the disturbance analysis results. Data are not available on human disturbance at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table 4. Percent of known piping plover winter and migration habitat locations, by state, where various types of anthropogenic disturbance have been reported.

	Percent by State							
Disturbance Type	**AL**	**FL**	**GA**	**LA**	**MS**	**NC**	**SC**	**TX**
Pedestrians	67	92	94	25	100	100	88	54
Dogs on leash	67	69	31	25	73	94	25	25
Dogs off leash	67	81	19	25	73	94	66	46
Bikes	0	19	63	25	0	0	28	19
ATVs	0	35	0	25	0	17	25	30
ORVs	0	21	0	25	0	50	31	38
Boats	33	65	100	100	0	78	63	44
Kite surfing	0	10	0	0	0	33	0	0

Although the timing, frequency, and duration of human and dog presence throughout the wintering range are unknown, studies in Alabama and South Carolina suggest that most disturbances to piping plovers occurs during periods of warmer weather, which coincides with piping plover migration (Johnson and Baldassarre 1988; Lott et al. 2009b; Maddock et al. 2009). Smith (2007) documents varying disturbance levels throughout the nonbreeding season at northwest Florida sites.

LeDee (2008) collected survey responses in 2007 from 35 managers (located in seven states) at sites that were designated as critical habitat for wintering piping plovers. Ownership included federal, state, and local governmental agencies and non-governmental organizations managing national wildlife refuges; national, state, county, and municipal parks; state and estuarine research reserves; state preserves; state wildlife management areas; and other types of managed lands. Of 44 reporting sites, 40 allowed public beach access year-round and four sites were closed to the public. Of the 40 sites that allow public access, 62% of site managers reported >10,000 visitors during September-March, and 31% reported >100,000 visitors. Restrictions on visitor activities on the beach included automobiles (at 81% of sites), all-terrain vehicles (89%), and dogs during the winter season (50%). Half of the survey respondents reported funding as a primary limitation in managing piping plovers and other threatened and endangered species at their sites. Other limitations included "human resource capacity" (24%), conflicting management priorities (12%), and lack of research (3%).

Disturbance can be addressed by implementing recreational management techniques such as vehicle and pet restrictions and symbolic fencing (usually sign posts and string) of roosting and feeding habitats. In implementing conservation measures, managers need to consider a range of site-specific factors, including the extent and quality of roosting and feeding habitats and the types and intensity of recreational use patterns. In addition, educational materials such as informational signs or brochures can provide valuable information so that the public understands the need for conservation measures.

In sum, although there is some variability among states, disturbance from human beach recreation and pets poses a moderate to high and escalating threat to migrating and wintering piping plovers. Systematic review of recreation policy and beach management across the nonbreeding range will assist in better understanding cumulative impacts. Site-specific analysis and implementation of conservation measures should be a high priority at piping plover sites that have moderate or high levels of disturbance and the Service and state wildlife agencies should increase technical assistance to land managers to implement management strategies and monitor their effectiveness.

Climate Change (sea-level rise)

Over the past 100 years, the globally-averaged sea level has risen approximately 10-25 centimeters (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Douglas et al. 2001 as cited in Hopkinson et al. 2008). The IPCC suggests that by 2080 sea-level rise could convert as much as 33% of the world's coastal wetlands to open water (IPCC 2007). Although rapid changes in sea level are predicted, estimated time frames and resulting water levels vary due to the uncertainty about global temperature projections and the rate of ice sheets melting and slipping into the ocean (IPCC 2007; CCSP 2008).

Potential effects of sea-level rise on coastal beaches may vary regionally due to subsidence or uplift as well as the geological character of the coast and nearshore (CCSP 2009; Galbraith et al. 2002). In the last century, for example, sea-level rise along the U.S. Gulf Coast exceeded the global average, and averages as high as 0.32 inches per year, because those areas are subsiding (USEPA 2014). Sediment compaction and oil and gas extraction compound tectonic subsidence (Penland and Ramsey 1990; Morton et al. 2003; Hopkinson et al. 2008). Low elevations and proximity to the coast make all nonbreeding coastal piping plover foraging and roosting habitats vulnerable to the effects of rising sea level. Sea-level rise was cited as a contributing factor in the 68% decline in tidal flats and algal mats in the Corpus Christi area (i.e., Lamar Peninsula to Encinal Peninsula) in Texas between the 1950s and 2004 (Tremblay et al. 2008). Mapping by Titus and Richman (2001) showed that more than 80% of the lowest land along the Atlantic and Gulf coasts was in Louisiana, Florida, Texas, and North Carolina, where 73.5% of all wintering piping plovers were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat if natural coastal dynamics are impeded by numerous structures or roads, especially if those shorelines are also armored. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20-70% of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50% and 5% probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively. The 50% and 5% probability sea level change projections were based on assumed global temperature increases of 2° C (50% probability) and 4.7° C (5% probability). The most severe losses were projected at sites where the coastline is unable to move inland due to steep topography or seawalls. The Galbraith et al. (2002) Gulf Coast study site, Bolivar Flats, Texas, is a designated critical habitat unit known to host high numbers of piping plovers during migration and throughout the winter; e.g., 275 individuals were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009). Under the 50% likelihood scenario for sea-level rise, Galbraith et al. (2002) projected approximately 38% loss of intertidal flats at Bolivar Flats by 2050; however, after initially losing habitat, the area of tidal flat habitat was predicted to slightly increase by the year 2100, because Bolivar Flats lacks armoring, and the coastline at this site can thus migrate inland. Although habitat losses in some areas are likely to be offset by gains in other locations, Galbraith et al. (2002) noted that time lags may exert serious adverse effects on shorebird populations. Furthermore, even if piping plovers are able to move their wintering locations in response to accelerated habitat changes, there could be adverse effects on the birds' survival rates or reproductive fitness.

Table 5 displays the potential for adjacent development and/or hardened shorelines to impede response of habitat to sea-level rise in the eight states supporting wintering piping plovers. Although complete linear shoreline estimates are not readily obtainable, almost all known piping plover wintering sites in the U.S. were surveyed during the 2006 International Piping Plover Census. To estimate effects at the census sites, as well as additional areas where piping plovers have been found outside of the census period, Service biologists reviewed satellite imagery and spoke with other biologists familiar with the sites. Of 406 sites, 204 (50%) have adjacent structures that may prevent the creation of new habitat if existing habitat were to become inundated. These threats will be perpetuated in places where damaged structures are repaired and replaced, and exacerbated where the height and strength of structures are increased. Data do not exist on the amount or types of hardened structures at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table 5. Number of sites surveyed during the 2006 winter International Piping Plover Census with hardened or developed structures adjacent to the shoreline.

State	Number of sites surveyed during the 2006 winter Census	Number of sites with some armoring or development	Percent of sites affected
North Carolina	37 (+2)*	20	51
South Carolina	39	18	46
Georgia	13	2	15

Florida	188	114	61
Alabama	4 (+2)*	3	50
Mississippi	16	7	44
Louisiana	25 (+2)*	9	33
Texas	78	31	40
Overall Total	406	204	50

An asterisk (*) indicates additional piping plovers sites not surveyed in the 2006 Census.

Sea-level rise poses a significant threat to all piping plover populations during the migration and wintering portion of their life cycle. Ongoing coastal stabilization activities may strongly influence the effects of sea-level rise on piping plover habitat. Improved understanding of how sea-level rise will affect the quality and quantity of habitat for migrating and wintering piping plovers is an urgent need.

Storm events

Although coastal piping plover habitats are storm-created and maintained, the 1996 Atlantic Coast Recovery Plan also noted that storms and severe cold weather may take a toll on piping plovers, and the 2003 Great Lakes Recovery Plan postulated that loss of habitats such as overwash passes or wrack, where birds shelter during harsh weather, poses a threat.

Storms are a component of the natural processes that form coastal habitats used by migrating and wintering piping plovers, and positive effects of storm-induced overwash and vegetation removal have been noted in portions of the wintering range. For example, Gulf Islands National Seashore habitats in Florida benefited from increased washover events that created optimal habitat conditions during the 2004 and 2005 hurricane seasons, with biologists reporting piping plover use of these habitats within six months of the storms (Nicholas 2005 pers. communication). Hurricane Katrina (2005) overwashed the mainland beaches of Mississippi, creating many tidal flats where piping plovers were subsequently observed (Winstead 2008). Hurricane Katrina also created a new inlet and improved habitat conditions on some areas of Dauphin Island, Alabama (LeBlanc 2009 pers. communication). Conversely, localized storms, since Katrina, have induced habitat losses on Dauphin Island (LeBlanc 2009 pers. communication).

Noel and Chandler (2005) suspect that changes in habitat caused by multiple hurricanes along the Georgia coastline altered the spatial distribution of piping plovers and may have contributed to winter mortality of three Great Lakes piping plovers. Following Hurricane Ike in 2008, Arvin

(2009) reported decreased numbers of piping plovers at some heavily eroded Texas beaches in the center of the storm impact area and increases in plover numbers at sites about 100 miles to the southwest. However, piping plovers were observed later in the season using tidal lagoons and pools that Ike created behind the eroded beaches (Arvin 2009).

The adverse effects on piping plovers attributed to storms are sometimes due to a combination of storms and other environmental changes or human use patterns. For example, four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 International Piping Plover Census tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82% of their surface area (Sallenger et al. 2009 unpublished), and a review of aerial photography prior to the 2006 Census suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009 unpublished) noted that habitat changes in the Chandeleurs stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (>1,000 years) diminishing sand supply, and sea-level rise relative to the land.

Other storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, and berm and seawall construction. Such stabilization activities can result in the loss and degradation of feeding and resting habitats. Storms also can cause widespread deposition of debris along beaches. Removal of debris often requires large machinery, which can cause extensive disturbance and adversely affect habitat elements such as wrack. Another example of indirect adverse effects linked to a storm event is the increased access to Pelican Island (LeBlanc 2009 pers. communication) due to merging with Dauphin Island following a 2007 storm (Gibson et al. 2009).

In sum, storms can create or enhance piping plover habitat while causing localized losses elsewhere in the wintering and migration range. Available information suggests that some birds may have resiliency to storms and move to unaffected areas without harm, while other reports suggest birds may perish from storm events. Significant concerns include disturbance to piping plovers and habitats during cleanup of debris, and post-storm acceleration of shoreline stabilization activities, which can cause persistent habitat degradation and loss.

Summary

Habitat loss and degradation on winter and migration grounds from shoreline and inlet stabilization efforts, both within and outside of designated critical habitat, remain a serious threat to all piping plover populations. Modeling strongly suggests that the population is very sensitive to adult and juvenile survival. Therefore, while there is a great deal of effort extended to improve breeding success, to improve and maintain a higher population over time, it is also necessary to ensure that the wintering habitat, where birds spend most of their time, is secure. On the wintering grounds, the shoreline areas used by wintering piping plovers are being developed, stabilized, or otherwise altered, making it unsuitable. Even in areas where habitat conditions are appropriate, human disturbance on beaches may negatively impact piping plovers' energy budget, as they may spend more time being vigilant and less time in foraging and roosting behavior. In many cases, the disturbance is severe enough, that piping plovers appear to avoid some areas altogether. Threats on the wintering grounds may impact piping plovers'

breeding success if they start migration or arrive at the breeding grounds with a poor body condition.

5) Analysis of the Species Likely to be Affected

The proposed action has the potential to adversely affect wintering and migrating piping plovers and their habitat from all breeding populations that may use the Action Area. The Atlantic Coast breeding population of piping plover is listed as threatened, while the Great Lakes breeding population is listed as endangered. Potential effects to piping plover include direct loss of foraging and roosting habitat in the Action Area and attraction of predators due to food waste from the construction crew. Plovers face predation by avian and mammalian predators that are present year-round on the wintering and nesting grounds. Although the piping plover is not currently known to nest in the Action Area, the stabilization of the shoreline may also result in less suitable nesting habitat for all shorebirds, including the piping plover.

B. Environmental Baseline

North Carolina barrier beaches are part of a complex and dynamic coastal system that continually respond to inlets, tides, waves, erosion and deposition, longshore sediment transport, and depletion, fluctuations in sea level, and weather events. The location and shape of the coastline perpetually adjusts to these physical forces. Winds move sediment across the dry beach forming dunes and the island interior landscape. The natural communities contain plants and animals that are subject to shoreline erosion and deposition, salt spray, wind, drought conditions, and sandy soils. Vegetative communities include foredunes, primary and secondary dunes, interdunal swales, sand pine scrub, and maritime forests.

During storm events, overwash across the barrier islands is common, depositing sediments on the bayside, clearing vegetation and increasing the amount of open, sandflat habitat ideal for shoreline dependent shorebirds. However, the protection or persistence of these important natural land forms, processes, and wildlife resources is often in conflict with long-term beach stabilization projects and their indirect effects, i.e., increases in residential development, infrastructure, and public recreational uses, and preclusion of overwash which limits the creation of open sand flats preferred by piping plovers.

1) Status of the Species within the Action Area

On Oak Island, the 2006 International Piping Plover Census surveys documented no wintering piping plovers, and no breeding piping plovers (Elliott-Smith et al. 2009). However, surveys were conducted only on one date during each season. The NCWRC conducted coastwide surveys for breeding piping plover between June 1 and June 9, 2014. In North Carolina in 2014, 65 nesting pairs were detected, 14 chicks fledged, and the estimated productivity was 0.22 fledglings/pair. Ninety-four (94) percent of Piping Plover pairs nested within Cape Hatteras and Cape Lookout National Seashores in 2014 (Schweitzer and Abraham, 2014).

Data provided by the Town of Oak Island's consultant indicate as many as two piping plovers during the summer of 2001 on Oak Island, and as many as three piping plovers in the Lockwoods Folly Inlet area in this same span of time (Oak Island or Holden Beach east). It is unclear from the data how many piping plovers were documented within the Action Area.

Critical Habitat Unit NC- 16

The critical habitat in the project area has been relatively undisturbed since designation in 2001. It is unclear whether the Corps' dredging of Lockwoods Folly Inlet and/or the AIWW has resulted in impacts to the critical habitat unit. Although various planning efforts have proposed dredging or nourishment within the critical habitat unit over the past decade, to the Service's knowledge, no destruction of critical habitat has occurred. As is expected in a dynamic inlet shoreline area, natural coastal processes have altered the location and configuration of the intertidal shoals and other PCEs within the unit. However, it does not appear that the general extent of critical habitat has been previously affected. The proposed project will destroy approximately 3.49 acres of the approximately 90-acre critical habitat unit. This critical habitat unit is one of 141 designated critical habitat units for wintering piping plovers in the southeastern United States, and the second smallest of the 18 designated critical habitat units in North Carolina. In North Carolina, 21,083 acres of critical habitat for wintering piping plovers was designated. Some of this acreage has been affected in the past by activities such as dredging, beach nourishment, and jetty construction. However, most of the critical habitat units in North Carolina remain unaffected by development.

2) Factors affecting the species environment within the Action Area

A wide range of recent and on-going activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 6** lists the most recent projects, within the past 5 years.

Table 6. Actions that have occurred in the Action Area in the last five years.

Year	Species Impacted	Project Type	Anticipated Take
2014	Loggerhead, green, Kemp's ridley, and leatherback sea turtle, piping plover, red knot, seabeach amaranth	Sandbag placement in front of four properties.	250 lf of beach shoreline
Regularly, most recently in 2014	Loggerhead, green, leatherback, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	AIWW dredging, Lockwoods Folly Inlet dredging. Beach nourishment may be associated.	Unknown amount of beach shoreline and inlet habitats
Repeating activity, beginning in 2011	Loggerhead, green, leatherback, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Beach bulldozing	47,000 lf of beach shoreline
Repeating activity, beginning	Loggerhead, green, leatherback, and Kemp's ridley sea	Beach raking with Cherrington 5000 to remove rocks	12,100 lf of shoreline, approximately 19.44 acres of beach habitat

in 2010	turtle, piping plover, red knot, seabeach amaranth	from beach	
2009	Loggerhead, green, leatherback, and Kemp's ridley sea turtle, piping plover, red knot, seabeach amaranth	Sand placement from Wilmington Harbor Sand Management Plan.	Unknown amount of beach shoreline

Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas. The Brunswick County Beaches project was authorized by Public Law 89-789 (November 6, 1966), for the purposes of hurricane wave protection and beach erosion control. However, no work has been conducted under the authorized project.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result. Historically, there has been a Federal navigation project in the Lockwoods Folly Inlet and AIWW for decades, and the Corps dredges the inlet at least annually. In some cases, the inlet is dredged using a sidecast dredge, such as the Dredge Merritt. In an unknown number of dredging events, the sediment has been placed on Oak Island using pipelines.

Beach scraping can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Beach raking: Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts may remove accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers. Removal of wrack also eliminates a beach's natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Nordstrom et al. 2006; Neal et al. 2007). Beach cleaning or grooming can result in abnormally broad unvegetated zones that are inhospitable to dune formation or plant colonization, thereby enhancing the likelihood of erosion (Defreo et al. 2009). The applicant has indicated that beach raking is targeted only towards removal of rock from previous nourishment efforts.
Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from beachfront and nearby residences.

Sand nourishment: The beaches of Oak Island are regularly nourished with sand from the Corps and other dredging projects.

Shoreline stabilization: Sandbags on private properties provide stabilization to the shoreline of Oak Island.

C. EFFECTS OF THE ACTION

This section is an analysis of the beneficial, direct and indirect effects of the proposed action on migrating and wintering piping plovers within the Action Area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

1) Factors to be considered

The proposed project will occur within habitat for migrating and wintering piping plovers and construction will occur during a portion of the migration and winter seasons. Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. Short-term and temporary impacts to piping plovers could result from project work disturbing roosting plovers and degrading currently occupied adjacent foraging areas.

Proximity of the action: Dredging of the intertidal shoals and placement of sand on 3,148 feet of beach would occur within Critical Habitat Unit NC-16, within and adjacent to foraging and roosting habitats for migrating or wintering piping plovers.

Distribution: Project construction activities that may impact migrants and the wintering population of piping plovers on Oak Island would occur within Critical Habitat Unit NC-16, in the intertidal shoals along Eastern Channel and along the shoreline of Oak Island.

Timing: The timing of project construction could directly and indirectly impact migrating and wintering piping plovers. Piping plovers may be present year-round in the Action Area, however, the timing of project activities will likely occur during the migration and wintering period.
Nature of the effect: The effects of the project construction include a long-term reduction in foraging habitat, a long-term decreased rate of change that may preclude habitat creation. A decrease in the survival of piping plovers on the migration and winter grounds due to the lack of optimal habitat may contribute to decreased survival rates, decreased productivity on the breeding grounds, and increased vulnerability to the three populations.

The Service expects the action will result in direct and indirect, long-term effects to piping plovers. In the construction area, there will be direct loss of piping plover Critical Habitat Unit NC-16, and of foraging and roosting habitat. The Service expects there may be morphological changes to adjacent piping plover habitat, including roosting and foraging habitat. Activities that affect or alter the use of optimal habitat or increase disturbance to the species may decrease the survival and recovery potential of the piping plover.

Duration: Dredging and sand nourishment under this authorization may occur every two to six years, and each event is expected to take 30 to 60 days to complete. After each dredging event, the loss of Critical Habitat in the intertidal shoals will not be recovered unless and until sand movement again creates shoals in the project area. The mean linear distance moved by wintering plovers from their core area is estimated to be approximately 2.1 miles (Drake et al. 2001), suggesting they could be negatively impacted by temporary disturbances anywhere in their core habitat area.

Disturbance frequency: Disturbance from construction activities will occur every two to six years for the life of the permit.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the piping plover migration and winter seasons. Conservation measures have been incorporated into the project to minimize impacts. The Action Area encompasses an area in the nesting and wintering range of the piping plover. The severity is likely to be slight, as plovers located within the Action Area are expected to move outside of the construction zone due to disturbance; therefore, no plovers are expected to be directly taken as a result of this action.

2) Analyses for effects of the action

Beneficial effects: For some highly eroded beaches, sand placement will have a beneficial effect on the habitat's ability to support wintering piping plovers. Narrow beaches that do not support a productive wrack line may see an improvement in foraging habitat available to piping plovers following sand placement. The addition of sand to the sediment budget may also increase a sand-starved beach's likelihood of developing habitat features valued by piping plovers, including washover fans and emergent nearshore sand bars.

Direct effects: Direct effects are those direct or immediate effects of a project on the species or its habitat. Dredging of this channel requires the removal of emergent shoals that may have formed over time. In this case, the dredging activities will result in a complete take of that habitat. However, this take could be either temporary or more permanent in nature depending upon the location of future shoaling within the inlet.

The construction window will extend through the piping plover migration and winter season and into the nesting season. Since piping plovers can be present on these beaches year-round, construction is likely to occur while this species is utilizing these beaches and associated habitats. Heavy machinery and equipment (e.g., dredges, trucks and bulldozers operating in Action Area) may adversely affect piping plovers in the Action Area by disturbance and disruption of normal activities such as roosting and foraging, and possibly forcing birds to expend valuable energy reserves to seek available habitat elsewhere.

Burial and suffocation of invertebrate species will occur during the sand placement, and will affect at least 4,400 lf of shoreline. The dredging of the intertidal shoals in Eastern Channel will destroy approximately 3.49 acres of piping plover critical habitat. However, the rest of the critical habitat unit should remain functional to serve the intended conservation role for the piping plover.

Indirect effects: The proposed project includes dredging of piping plover critical habitat and beach renourishment as protective elements against shoreline erosion to protect man-made infrastructure. Indirect effects include reducing the potential for the formation of optimal habitats. The proposed project may limit the creation of optimal foraging and roosting habitat, and may increase the attractiveness of these beaches for recreation increasing recreational pressures within the Action Area. Recreational activities that potentially adversely affect plovers include disturbance by unleashed pets and increased pedestrian use.

3) Species' response to the proposed action

The Service anticipates potential adverse effects throughout the Action Area by limiting proximity to roosting, foraging, and nesting habitat and degrading occupied foraging habitat. Elliott and Teas (1996) found a significant difference in actions between piping plovers encountering pedestrians and those not encountering pedestrians. Piping plover encountering pedestrians spend proportionately more time in non-foraging behavior. This study suggests that interactions with pedestrians on beaches cause birds to shift their activities from calorie acquisition to calorie expenditure. In winter and migration sites, human disturbance continues to decrease the amount of undisturbed habitat and appears to limit local piping plover abundance (Zonick and Ryan 1996).

Disturbance also reduces the time migrating shorebirds spend foraging (Burger 1991). Pfister et al. (1992) implicate disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. While piping plover migration patterns and needs remain poorly understood and occupancy of a particular habitat may involve shorter periods relative to wintering, information about the energetics of avian migration indicates that this might be a particularly critical time in the species' life cycle.

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. It is reasonable to expect continued shoreline stabilization and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development. However, the Service is unaware of any other planned projects that may affect designated critical habitat for wintering piping plovers.

IV RED KNOT

A. Status of the Species/Critical Habitat

1) Species/critical habitat description

On December 11, 2014, the Service listed the rufa red knot (*Calidris canutus rufa*) (or red knot) as threatened throughout its range.

The red knot is a medium-sized shorebird about 9 to 11 inches (in) (23 to 28 centimeters (cm)) in length. The red knot migrates annually between its breeding grounds in the Canadian Arctic and several wintering regions, including the Southeast United States (Southeast), the Northeast Gulf of Mexico, northern Brazil, and Tierra del Fuego at the southern tip of South America. During both the northbound (spring) and southbound (fall) migrations, red knots use key staging and stopover areas to rest and feed. Red knots migrate through and overwinter in North Carolina. The term “winter” is used to refer to the nonbreeding period of the red knot life cycle when the birds are not undertaking migratory movements. Red knots are most common in North Carolina during the migration season (mid-April through May and July to Mid-October), and may be present in the state throughout the year (Fussell 1994; Potter et al. 1980). Wintering areas for the red knot include the Atlantic coasts of Argentina and Chile, the north coast of Brazil, the Northwest Gulf of Mexico from the Mexican State of Tamaulipas through Texas to Louisiana, and the Southeast United States from Florida to North Carolina (Newstead et al. 2013; Niles et al. 2008). Smaller numbers of knots winter in the Caribbean, and along the central Gulf coast, the mid-Atlantic, and the Northeast United States. Little information exists on where juvenile red knots spend the winter months (USFWS and Conserve Wildlife Foundation 2012), and there may be at least partial segregation of juvenile and adult red knots on the wintering grounds. There is no designation of critical habitat for red knot.

2) Life history

Each year red knots make one of the longest distance migrations known in the animal kingdom, traveling up to 19,000 miles (mi) (30,000 kilometers (km) annually between breeding grounds in the Arctic Circle and wintering grounds. Red knots undertake long flights that may span thousands of miles without stopping. As they prepare to depart on long migratory flights, they undergo several physiological changes. Before takeoff, the birds accumulate and store large amounts of fat to fuel migration and undergo substantial changes in metabolic rates. In addition, leg muscles, gizzard (a muscular organ used for grinding food), stomach, intestines, and liver all decrease in size, while pectoral (chest) muscles and heart increase in size. Due to these physiological changes, red knots arriving from lengthy migrations are not able to feed maximally until their digestive systems regenerate, a process that may take several days. Because stopovers are time-constrained, red knots require stopovers rich in easily-digested food to achieve adequate weight gain (Niles et al. 2008; van Gils et al. 2005a; van Gils et al. 2005b; Piersma et al. 1999) that fuels the next migratory flight and, upon arrival in the Arctic, fuels a body transformation to breeding condition (Morrison 2006). Red knots from different wintering areas appear to employ different migration strategies, including differences in timing, routes, and stopover areas. However, full segregation of migration strategies, routes, or stopover areas does not occur among red knots from different wintering areas.

Major spring stopover areas along the Mid- and South Atlantic coast include Río Gallegos, Península Valdés, and San Antonio Oeste (Patagonia, Argentina); Lagoa do Peixe (eastern Brazil, State of Rio Grande do Sul); Maranhão (northern Brazil); the Virginia barrier islands (United States); and Delaware Bay (Delaware and New Jersey, United States) (Cohen et al. 2009; Niles et al. 2008; González 2005). Important fall stopover sites include southwest Hudson Bay (including the Nelson River delta), James Bay, the north shore of the St. Lawrence River, the Mingan Archipelago, and the Bay of Fundy in Canada; the coasts of Massachusetts and New Jersey and the mouth of the Altamaha River in Georgia, United States; the Caribbean (especially Puerto Rico and the Lesser Antilles); and the northern coast of South America from Brazil to Guyana (Newstead et al. 2013; Niles 2012; Niles et al. 2010; Schneider and Winn 2010; Niles et al. 2008; Antas and Nascimento 1996; Morrison and Harrington 1992; Spaans 1978). However, large and small groups of red knots, sometimes numbering in the thousands, may occur in suitable habitats all along the Atlantic and Gulf coasts from Argentina to Canada during migration (Niles et al. 2008).

Some red knots wintering in the Southeastern United States and the Caribbean migrate north along the U.S. Atlantic coast before flying overland to central Canada from the mid-Atlantic, while others migrate overland directly to the Arctic from the Southeastern U.S. coast (Niles et al. 2012). These eastern red knots typically make a short stop at James Bay in Canada, but may also stop briefly along the Great Lakes, perhaps in response to weather conditions (Niles et al. 2008; Morrison and Harrington 1992). Red knots are restricted to the ocean coasts during winter, and occur primarily along the coasts during migration. However, small numbers of rufa red knots are reported annually across the interior United States (i.e., greater than 25 miles from the Gulf or Atlantic Coasts) during spring and fall migration—these reported sightings are concentrated along the Great Lakes, but multiple reports have been made from nearly every interior State (eBird.org 2012).

Long-distance migrant shorebirds are highly dependent on the continued existence of quality habitat at a few key staging areas. These areas serve as stepping stones between wintering and breeding areas. Conditions or factors influencing shorebird populations on staging areas control much of the remainder of the annual cycle and survival of the birds (Skagen 2006; International Wader Study Group 2003). At some stages of migration, very high proportions of entire populations may use a single migration staging site to prepare for long flights. Red knots show some fidelity to particular migration staging areas between years (Duerr et al. 2011; Harrington 2001).

Habitats used by red knots in migration and wintering areas are similar in character, generally coastal marine and estuarine (partially enclosed tidal area where fresh and salt water mixes) habitats with large areas of exposed intertidal sediments. In North America, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments and lagoons, and peat banks (Cohen et al. 2010; Cohen et al. 2009; Niles et al. 2008; Harrington 2001; Truitt et al. 2001). The supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated (Harrington 2008).

The red knot is a specialized molluscivore, eating hard-shelled mollusks, sometimes supplemented with easily accessed softer invertebrate prey, such as shrimp- and crab-like organisms, marine worms, and horseshoe crab (*Limulus polyphemus*) eggs (Piersma and van Gils 2011; Harrington 2001). Mollusk prey are swallowed whole and crushed in the gizzard (Piersma and van Gils 2011). Foraging activity is largely dictated by tidal conditions, as red knots rarely wade in water more than 0.8 to 1.2 in (2 to 3 cm) deep (Harrington 2001). Due to bill morphology, the red knot is limited to foraging on only shallow-buried prey, within the top 0.8 to 1.2 in (2 to 3 cm) of sediment (Gerasimov 2009; Zwarts and Blomert 1992).

The primary prey of the rufa red knot in non-breeding habitats include blue mussel (*Mytilus edulis*) spat (juveniles); *Donax* and *Darina* clams; snails (*Littorina spp*.), and other mollusks, with polycheate worms, insect larvae, and crustaceans also eaten in some locations. A prominent departure from typical prey items occurs each spring when red knots feed on the eggs of horseshoe crabs, particularly during the key migration stopover within the Delaware Bay of New Jersey and Delaware. Delaware Bay serves as the principal spring migration staging area for the red knot because of the availability of horseshoe crab eggs (Clark et al. 2009; Harrington 2001;

Harrington 1996; Morrison and Harrington 1992), which provide a superabundant source of easily digestible food.

Red knots and other shorebirds that are long-distance migrants must take advantage of seasonally abundant food resources at intermediate stopovers to build up fat reserves for the next non-stop, long-distance flight (Clark et al. 1993). Although foraging red knots can be found widely distributed in small numbers within suitable habitats during the migration period, birds tend to concentrate in those areas where abundant food resources are consistently available from year to year.

3) Population dynamics

In the United States, red knot populations declined sharply in the late 1800s and early 1900s due to excessive sport and market hunting, followed by hunting restrictions and signs of population recovery by the mid-1900s (Urner and Storer 1949; Stone 1937; Bent 1927). However, it is unclear whether the red knot population fully recovered its historical numbers (Harrington 2001) following the period of unregulated hunting. More recently, long-term survey data from two key areas (Tierra del Fuego wintering area and Delaware Bay spring stopover site) both show a roughly 75 percent decline in red knot numbers since the 1980s (Dey et al. 2011; Clark et al. 2009; Morrison et al. 2004; Morrison and Ross 1989; Kochenberger 1983; Dunne et al. 1982; Wander and Dunne, 1982).

For many portions of the knot's range, available survey data are patchy. Prior to the 1980s, numerous natural history accounts are available, but provide mainly qualitative or localized population estimates. No population information exists for the breeding range because, in breeding habitats, red knots are thinly distributed across a huge and remote area of the Arctic. Despite some localized survey efforts, (e.g., Niles et al. 2008), there are no regional or comprehensive estimates of breeding abundance, density, or productivity (Niles et al. 2008).

Counts in wintering areas are useful in estimating red knot populations and trends because the birds generally remain within a given wintering area for a longer period of time compared to the areas used during migration. This eliminates errors associated with turnover or double-counting that can occur during migration counts. Harrington et al. (1988) reported that the mean count of birds wintering in Florida was 6,300 birds (± 3,400, one standard deviation) based on 4 aerial surveys conducted from October to January in 1980 to 1982. Based on these surveys and other work, the Southeast wintering group was estimated at roughly 10,000 birds in the 1970s and 1980s (Harrington 2005a).

Based on resightings of birds banded in South Carolina and Georgia from 1999 to 2002, the Southeast wintering population was estimated at 11,700 ± 1,000 (standard error) red knots. Although there appears to have been a gradual shift by some of the southeastern knots from the Florida Gulf coast to the Atlantic coasts of Georgia and South Carolina, population estimates for the Southeast region in the 2000s were at about the same level as during the 1980s (Harrington 2005a). Based on recent modeling using resightings of marked birds staging in Georgia in fall, as well as other evidence, the Southeast wintering group may number as high as 20,000 (B. Harrington pers. comm. November 12, 2012), but field survey data are not available to corroborate this estimate.

Beginning in 2006, coordinated red knot surveys have been conducted from Florida to Delaware Bay during 2 consecutive days from May 20 to 24 (**Table 7**). This period is thought to represent the peak of the red knot migration. There has been variability in methods, observers, and areas covered. From 2006 to 2010, there was no change in counts that could not be attributed to varying geographic survey coverage (Dey et al. 2011); thus, we do not consider any apparent trends in these data before 2010.

Table 7. Red knot counts along the Atlantic coast of the United States, May 20 to 24, 2006 to 2012 (A. Dey pers. comm. October 12, 2012; Dey et al. 2011).

<table>
<tr><th>State</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th></tr>
<tr><td>New Jersey</td><td>7,860</td><td>4,445</td><td>10,045</td><td rowspan="2">16,229</td><td>8,945</td><td>7,737</td><td>23,525</td></tr>
<tr><td>Delaware</td><td>820</td><td>2,950</td><td>5,350</td><td>5,530</td><td>5,067</td><td>3,433</td></tr>
<tr><td>Maryland</td><td></td><td></td><td>663</td><td>78</td><td>5</td><td>83</td><td>139</td></tr>
<tr><td>Virginia</td><td>5,783</td><td>5,939</td><td>7,802</td><td>3,261</td><td>8,214</td><td>6,236</td><td>8,482</td></tr>
<tr><td>North Carolina</td><td>235</td><td>304</td><td>1,137</td><td>1,466</td><td>1,113</td><td>1,868</td><td>2,832</td></tr>
<tr><td>South Carolina</td><td></td><td>125</td><td>180</td><td>10</td><td>1,220</td><td>315</td><td>542</td></tr>
<tr><td>Georgia</td><td>796</td><td>2,155</td><td>1,487</td><td></td><td>260</td><td>3,071</td><td>1,466</td></tr>
<tr><td>Florida</td><td></td><td></td><td>868</td><td>800</td><td>41</td><td></td><td>10</td></tr>
<tr><td>Total</td><td>15,494</td><td>15,918</td><td>27,532</td><td>21,844</td><td>25,328</td><td>24,377</td><td>40,429</td></tr>
</table>

Because red knot numbers peak earlier in the Southeast than in the mid-Atlantic (M. Bimbi pers. comm. June 27, 2013), the late-May coast-wide survey data likely reflect the movement of some birds north along the coast, and may miss other birds that depart for Canada from the Southeast along an interior (overland) route prior to the survey window. Thus, greater numbers of red knots may utilize Southeastern stopovers than suggested by the data in **Table 7**. For example, a peak count of over 8,000 red knots was documented in South Carolina during spring 2012 (South Carolina Department of Natural Resources 2012). Dinsmore et al. (1998) found a mean of 1,363 (±725) red knots in North Carolina during spring 1992 and 1993, with a peak count of 2,764 birds.

4) Status and Distribution

Reason for listing: The Service has determined that the rufa red knot is threatened due to loss of both breeding and nonbreeding habitat; potential for disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies ("mismatches") in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions.
Range-Wide Trends:

Wintering areas for the red knot include the Atlantic coasts of Argentina and Chile, the north coast of Brazil, the Northwest Gulf of Mexico from the Mexican State of Tamaulipas through Texas to Louisiana, and the Southeast United States from Florida to North Carolina (Newstead et al. 2013; L. Patrick pers. comm. August 31, 2012; Niles et al. 2008). Smaller numbers of knots winter in the Caribbean, and along the central Gulf coast (Alabama, Mississippi), the mid-Atlantic, and the Northeast United States. *Calidris canutus* is also known to winter in Central America and northwest South America, but it is not yet clear if all these birds are the *rufa* subspecies.

In some years, more red knots have been counted during a coordinated spring migration survey than can be accounted for at known wintering sites, suggesting there are unknown wintering areas. Indeed, geolocators have started revealing previously little-known wintering areas, particularly in the Caribbean (Niles et al. 2012; L. Niles pers. comm. January 8, 2013).

The core of the Southeast wintering area (i.e., that portion of this large region supporting the majority of birds) is thought to shift from year to year among Florida, Georgia, and South Carolina (Niles et al. 2008). However, the geographic limits of this wintering region are poorly defined. Although only small numbers are known, wintering knots extend along the Atlantic coast as far north as Virginia (L. Patrick pers. comm. August 31, 2012; Niles et al. 2006), Maryland (Burger et al. 2012), and New Jersey (BandedBirds.org 2012; H. Hanlon pers. comm. November 22, 2012; A. Dey pers. comm. November 19, 2012). Still smaller numbers of red knots have been reported between December and February from Long Island, New York, through Massachusetts and as far north as Nova Scotia, Canada (eBird.org 2012).

Recovery Criteria

A Recovery Plan for the red knot has not yet been completed. It will be developed, pursuant to Subsection 4(f) of the ESA, in the near future.

Threats to the Red Knot

Within the nonbreeding portion of the range, red knot habitat is primarily threatened by the highly interrelated effects of sea level rise, shoreline stabilization, and coastal development. Lesser threats to nonbreeding habitat include agriculture and aquaculture, invasive vegetation, and beach maintenance activities. Within the breeding portion of the range, the primary threat to red knot habitat is from climate change. With arctic warming, vegetation conditions in the breeding grounds are expected to change, causing the zone of nesting habitat to shift and perhaps contract. Arctic freshwater systems—foraging areas for red knots during the nesting season—are particularly sensitive to climate change.

Climate Change & Sea Level Rise

The natural history of Arctic-breeding shorebirds makes this group of species particularly vulnerable to global climate change (Meltofte et al. 2007; Piersma and Lindström 2004; Rehfisch and Crick 2003; Piersma and Baker 2000; Zöckler and Lysenko 2000; Lindström and Agrell 1999). Relatively low genetic diversity, which is thought to be a consequence of survival through past climate-driven population bottlenecks, may put shorebirds at more risk from human-induced climate variation than other avian taxa (Meltofte et al. 2007); low genetic diversity may result in reduced adaptive capacity as well as increased risks when population sizes drop to low levels.

In the short term, red knots may benefit if warmer temperatures result in fewer years of delayed horseshoe crab spawning in Delaware Bay (Smith and Michaels 2006) or fewer occurrences of late snow melt in the breeding grounds (Meltofte et al. 2007). However, there are indications that changes in the abundance and quality of red knot prey are already underway (Escudero et al. 2012; Jones et al. 2010), and prey species face ongoing climate-related threats from warmer temperatures (Jones et al. 2010; Philippart et al. 2003; Rehfisch and Crick 2003), ocean acidification (NRC 2010; Fabry et al. 2008), and possibly increased prevalence of disease and parasites (Ward and Lafferty 2004). In addition, red knots face imminent threats from loss of habitat caused by sea level rise (NRC 2010; Galbraith et al. 2002; Titus 1990), and increasing asynchronies ("mismatches") between the timing of their annual breeding, migration, and wintering cycles and the windows of peak food availability on which the birds depend (Smith et al. 2011; McGowan et al. 2011; Meltofte et al. 2007; van Gils et al. 2005a; Baker et al. 2004).

With arctic warming, vegetation conditions in the red knot's breeding grounds are expected to change, causing the zone of nesting habitat to shift and perhaps contract, but this process may take decades to unfold (Feng et al. 2012; Meltofte et al. 2007; Kaplan et al. 2003). Ecological shifts in the Arctic may appear sooner. High uncertainty exists about when and how changing interactions among vegetation, predators, competitors, prey, parasites, and pathogens may affect the red knot, but the impacts are potentially profound (Fraser et al. 2013; Schmidt et al. 2012; Meltofte et al. 2007; Ims and Fuglei 2005).

For most of the year, red knots live in or immediately adjacent to intertidal areas. These habitats are naturally dynamic, as shorelines are continually reshaped by tides, currents, wind, and storms. Coastal habitats are susceptible to both abrupt (storm-related) and long-term (sea level rise) changes. Outside of the breeding grounds, red knots rely entirely on these coastal areas to fulfill their roosting and foraging needs, making the birds vulnerable to the effects of habitat loss from rising sea levels. Because conditions in coastal habitats are also critical for building up nutrient and energy stores for the long migration to the breeding grounds, sea level rise affecting conditions on staging areas also has the potential to impact the red knot's ability to breed successfully in the Arctic (Meltofte et al. 2007).

According to the NRC (2010), the rate of global sea level rise has increased from about 0.02 in (0.6 mm) per year in the late 19th century to approximately 0.07 in (1.8 mm) per year in the last half of the 20th century. The rate of increase has accelerated, and over the past 15 years has been in excess of 0.12 in (3 mm) per year. In 2007, the IPCC estimated that sea level would "likely" rise by an additional 0.6 to 1.9 feet (ft) (0.18 to 0.59 meters (m)) by 2100 (NRC 2010). This projection was based largely on the observed rates of change in ice sheets and projected future thermal expansion of the oceans but did not include the possibility of changes in ice sheet dynamics (e.g., rates and patterns of ice sheet growth versus loss). Scientists are working to improve how ice dynamics can be resolved in climate models. Recent research suggests that sea levels could potentially rise another 2.5 to 6.5 ft (0.8 to 2 m) by 2100, which is several times larger than the 2007 IPCC estimates (NRC 2010; Pfeffer et al. 2008). However, projected rates of sea level rise estimates remain rather uncertain, due mainly to limits in scientific understanding of glacier and ice sheet dynamics (NRC 2010; Pfeffer et al. 2008). The amount of sea level change varies regionally because of different rates of settling (subsidence) or uplift of the land, and because of differences in ocean circulation (NRC 2010). In the last century, for example, sea level rise along the U.S. mid- Atlantic and Gulf coasts exceeded the global average by 5 to 6 in (13 to 15 cm) because coastal lands in these areas are subsiding (USEPA 2013). Land subsidence also occurs in some areas of the Northeast, at current rates of 0.02 to 0.04 in (0.5 to 1 mm) per year across this region (Ashton et al. 2007), primarily the result of slow, natural geologic processes (NOAA 2013). Due to regional differences, a 2-ft (0.6-m) rise in global sea level by the end of this century would result in a relative sea level rise of 2.3 ft (0.7 m) at New York City, 2.9 ft (0.9 m) at Hampton Roads, Virginia, and 3.5 ft (1.1 m) at Galveston, Texas (U.S. Global Change Research Program (USGCRP) 2009). **Table 8** shows that local rates of sea level rise in the range of the red knot over the second half of the 20th century were generally higher than the global rate of 0.07 in (1.8 mm) per year.

Table 8. Local sea level trends from within the range of the red knot (NOAA 2012)

Station	Mean Local Sea Level Trend (mm per year)	Data Period
Pointe-Au-Père, Canada	-0.36 ± 0.40	1900–1983
Woods Hole, Massachusetts	2.61 ± 0.20	1932–2006
Cape May, New Jersey	4.06 ± 0.74	1965–2006
Lewes, Delaware	3.20 ± 0.28	1919–2006
Chesapeake Bay Bridge Tunnel, Virginia	6.05 ± 1.14	1975–2006
Beaufort, North Carolina	2.57 ± 0.44	1953–2006
Clearwater Beach, Florida	2.43 ± 0.80	1973–2006
Padre Island, Texas	3.48 ± 0.75	1958–2006
Punto Deseado, Argentina	-0.06 ± 1.93	1970–2002

Data from along the U.S. Atlantic coast suggest a relationship between rates of sea level rise and long-term erosion rates; thus, long-term coastal erosion rates may increase as sea level rises (Florida Oceans and Coastal Council 2010). However, even if such a correlation is borne out, predicting the effect of sea level rise on beaches is more complex. Even if wetland or upland coastal lands are lost, sandy or muddy intertidal habitats can often migrate or reform. However, forecasting how such changes may unfold is complex and uncertain. Potential effects of sea level rise on beaches vary regionally due to subsidence or uplift of the land, as well as the geological character of the coast and nearshore (U.S. Climate Change Science Program (CCSP) 2009b; Galbraith et al. 2002). Precisely forecasting the effects of sea level rise on particular coastal habitats will require integration of diverse information on local rates of sea level rise, tidal ranges, subsurface and coastal topography, sediment accretion rates, coastal processes, and other factors that is beyond the capability of current models (CCSP 2009b; Frumhoff et al. 2007; Thieler and Hammar-Klose 2000; Thieler and Hammar-Klose 1999).

Because the majority of the Atlantic and Gulf coasts consist of sandy shores, inundation alone is unlikely to reflect the potential consequences of sea level rise. Instead, long-term shoreline changes will involve contributions from inundation and erosion, as well as changes to other coastal environments such as wetland losses. Most portions of the open coast of the United States will be subject to significant physical changes and erosion over the next century because the majority of coastlines consist of sandy beaches, which are highly mobile and in a state of continual change (CCSP 2009b).

By altering coastal geomorphology, sea level rise will cause significant and often dramatic changes to coastal landforms including barrier islands, beaches, and intertidal flats (CCSP 2009b; Rehfisch and Crick 2003), primary red knot habitats. Due to increasing sea levels, storm-surge-driven floods now qualifying as 100-year events are projected to occur as often as every 10 to 20 years along most of the U.S. Atlantic coast by 2050, with even higher frequencies of such large floods in certain localized areas (Tebaldi et al. 2012). Rising sea level not only increases the likelihood of coastal flooding, but also changes the template for waves and tides to sculpt the coast, which can lead to loss of land orders of magnitude greater than that from direct inundation alone (Ashton et al. 2007).

Red knot migration and wintering habitats in the U.S. generally consist of sandy beaches that are dynamic and subject to seasonal erosion and accretion. Sea level rise and shoreline erosion have reduced availability of intertidal habitat used for red knot foraging, and in some areas, roosting sites have also been affected (Niles et al. 2008). With moderately rising sea levels, red knot habitats in many portions of the United States would be expected to migrate or reform rather than be lost, except where they are constrained by coastal development or shoreline stabilization (Titus et al. 2009). However, if the sea rises more rapidly than the rate with which a particular coastal system can keep pace, it could fundamentally change the state of the coast (CCSP 2009b).

Climate change is also resulting in asynchronies during the annual cycle of the red knot. The successful annual migration and breeding of red knots is highly dependent on the timing of departures and arrivals to coincide with favorable food and weather conditions. The frequency and severity of asynchronies is likely to increase with climate change. In addition, stochastic encounters with unfavorable conditions are more likely to result in population-level effects for red knots now than when population sizes were larger, as reduced numbers may have reduced the resiliency of this subspecies to rebound from impacts.

For unknown reasons, more red knots arrived late in Delaware Bay in the early 2000s, which is generally accepted as a key causative factor (along with reduced supplies of horseshoe crab eggs) behind red knot population declines that were observed over this same timeframe. Thus, the red knot's sensitivity to timing asynchronies has been demonstrated through a population-level response. Both adequate supplies of horseshoe crab eggs and high-quality foraging habitat in Delaware Bay can serve to partially mitigate minor asynchronies at this key stopover site. However, the factors that caused delays in the spring migrations of red knots from Argentina and Chile are still unknown, and we have no information to indicate if this delay will reverse, persist, or intensify. Superimposed on this existing threat of late arrivals in Delaware Bay are new threats of asynchronies emerging due to climate change. Climate change is likely to affect the reproductive timing of horseshoe crabs in Delaware Bay, mollusk prey species at other stopover sites, or both, possibly pushing the peak seasonal availability of food outside of the windows when red knots rely on them. In addition, both field studies and modeling have shown strong links between the red knot's reproductive output and conditions in the Arctic including insect abundance and snow cover. Climate change may also cause shifts in the period of optimal arctic conditions relative to the time period when red knots currently breed.

Shoreline stabilization

Structural development along the shoreline and manipulation of natural inlets upset the naturally dynamic coastal processes and result in loss or degradation of beach habitat (Melvin et al. 1991). As beaches narrow, the reduced habitat can directly lower the diversity and abundance of biota (life forms), especially in the upper intertidal zone. Shorebirds may be impacted both by reduced habitat area for roosting and foraging, and by declining intertidal prey resources, as has been documented in California (Defeo et al. 2009; Dugan and Hubbard 2006). In Delaware Bay, hard structures also cause or accelerate loss of horseshoe crab spawning habitat (CCSP 2009b; Botton et al. in Shuster et al. 2003; Botton et al. 1988), and shorebird habitat has been, and may continue to be, lost where bulkheads have been built (Clark in Farrell and Martin 1997). In addition to directly eliminating red knot habitat, hard structures interfere with the creation of new shorebird habitats by interrupting the natural processes of overwash and inlet formation. Where hard stabilization is installed, the eventual loss of the beach and its associated habitats is virtually assured (Rice 2009), absent beach nourishment, which may also impact red knots. Where they are maintained, hard structures are likely to significantly increase the amount of red knot habitat lost as sea levels continue to rise.

In a few isolated locations, however, hard structures may enhance red knot habitat, or may provide artificial habitat. In Delaware Bay, for example, Botton et al. (1994) found that, in the same manner as natural shoreline discontinuities like creek mouths, jetties and other artificial obstructions can act to concentrate drifting horseshoe crab eggs and thereby attract shorebirds. Another example comes from the Delaware side of the bay, where a seawall and jetty at Mispillion Harbor protect the confluence of the Mispillion River and Cedar Creek. These structures create a low energy environment in the harbor, which seems to provide highly suitable conditions for horseshoe crab spawning over a wider variation of weather and sea conditions than anywhere else in the bay (G. Breese pers. comm. March 25, 2013). Horseshoe crab egg densities at Mispillion Harbor are consistently an order of magnitude higher than at other bay beaches (Dey et al. 2011), and this site consistently supports upwards of 15 to 20 percent of all the knots recorded in Delaware Bay (Lathrop 2005). Notwithstanding localized red knot use of artificial structures, and the isolated case of hard structures improving foraging habitat at Mispillion Harbor, the nearly universal effect of such structures is the degradation or loss of red knot habitat.

Sand Placement

Where shorebird habitat has been severely reduced or eliminated by hard stabilization structures, beach nourishment may be the only means available to replace any habitat for as long as the hard structures are maintained (Nordstrom and Mauriello 2001), although such habitat will persist only with regular nourishment episodes (typically on the order of every 2 to 6 years). In Delaware Bay, beach nourishment has been recommended to prevent loss of spawning habitat for horseshoe crabs (Kalasz 2008; Carter et al. in Guilfoyle et al. 2007; Atlantic States Marine Fisheries Commission (ASMFC) 1998), and is being pursued as a means of restoring shorebird habitat in Delaware Bay following Hurricane Sandy (Niles et al. 2013; USACE 2012). Beach nourishment was part of a 2009 project to maintain important shorebird foraging habitat at Mispillion Harbor, Delaware (Kalasz pers. comm. March 29, 2013; Siok and Wilson 2011). However, red knots may be directly disturbed if beach nourishment takes place while the birds are present. On New Jersey's Atlantic coast, beach nourishment has typically been scheduled for the fall, when red knots are present, because of various constraints at other times of year. In addition to causing disturbance during construction, beach nourishment often increases recreational use of the widened beaches that, without careful management, can increase disturbance of red knots. Beach nourishment can also temporarily depress, and sometimes permanently alter, the invertebrate prey base on which shorebirds depend. In addition to disturbing the birds and impacting the prey base, beach nourishment can affect the quality and quantity of red knot habitat (M. Bimbi pers. comm. November 1, 2012; Greene 2002). The artificial beach created by nourishment may provide only suboptimal habitat for red knots, as a steeper beach profile is created when sand is stacked on the beach during the nourishment process. In some cases, nourishment is accompanied by the planting of dense beach grasses, which can directly degrade habitat, as red knots require sparse vegetation to avoid predation. By precluding overwash and Aeolian transport, especially where large artificial dunes are constructed, beach nourishment can also lead to further erosion on the bayside and promote bayside vegetation growth, both of which can degrade the red knot's preferred foraging and roosting habitats (sparsely vegetated flats in or adjacent to intertidal areas). Preclusion of overwash also impedes the formation of new red knot habitats. Beach nourishment can also encourage further development, bringing further habitat impacts, reducing future alternative management options such as a retreat from the coast, and perpetuating the developed and stabilized conditions that may ultimately lead to inundation where beaches are prevented from migrating (M. Bimbi pers. comm. November 1, 2012; Greene 2002).

The quantity and quality of red knot prey may also be affected by the placement of sediment for beach nourishment or disposal of dredged material. Invertebrates may be crushed or buried during project construction. Although some benthic species can burrow through a thin layer of additional sediment, thicker layers (over 35 in (90 cm)) smother the benthic fauna (Greene 2002). By means of this vertical burrowing, recolonization from adjacent areas, or both, the benthic faunal communities typically recover. Recovery can take as little as 2 weeks or as long as 2 years, but usually averages 2 to 7 months (Greene 2002; Peterson and Manning 2001). Although many studies have concluded that invertebrate communities recovered following sand placement, study methods have often been insufficient to detect even large changes (e.g., in abundance or species composition), due to high natural variability and small sample sizes (Peterson and Bishop 2005). Therefore, uncertainty remains about the effects of sand placement on invertebrate communities, and how these impacts may affect red knots.

Dredging/sand mining

Many inlets in the U.S. range of the red knot are routinely dredged and sometimes relocated. In addition, nearshore areas are routinely dredged (“mined”) to obtain sand for beach nourishment. Regardless of the purpose, inlet and nearshore dredging can affect red knot habitats. Dredging often involves removal of sediment from sand bars, shoals, and inlets in the nearshore zone, directly impacting optimal red knot roosting and foraging habitats (Harrington in Guilfoyle et al. 2007; Winn and Harrington in Guilfoyle et al. 2006). These ephemeral habitats are even more valuable to red knots because they tend to receive less recreational use than the main beach strand. In addition to causing this direct habitat loss, the dredging of sand bars and shoals can preclude the creation and maintenance of red knot habitats by removing sand sources that would otherwise act as natural breakwaters and weld onto the shore over time (Hayes and Michel 2008; Morton 2003). Further, removing these sand features can cause or worsen localized erosion by altering depth contours and changing wave refraction (Hayes and Michel 2008), potentially degrading other nearby red knot habitats indirectly because inlet dynamics exert a strong influence on the adjacent shorelines. Studying barrier islands in Virginia and North Carolina, Fenster and Dolan (1996) found that inlet influences extend 3.4 to 8.1 mi (5.4 to 13.0 km), and that inlets dominate shoreline changes for up to 2.7 mi (4.3 km). Changing the location of dominant channels at inlets can create profound alterations to the adjacent shoreline (Nordstrom 2000).

Reduced food availability

Commercial harvest of horseshoe crabs has been implicated as a causal factor in the decline of the rufa red knot, by decreasing the availability of horseshoe crab eggs in the Delaware Bay stopover (Niles et al. 2008). Notwithstanding the importance of the horseshoe crab and Delaware Bay, other lines of evidence suggest that the rufa red knot also faces threats to its food resources throughout its range.

During most of the year, bivalves and other mollusks are the primary prey for the red knot. Mollusks in general are at risk from climate change-induced ocean acidification (Fabry et al. 2008). Oceans become more acidic as carbon dioxide emitted into the atmosphere dissolves in the ocean. The pH (percent hydrogen, a measure of acidity or alkalinity) level of the oceans has decreased by approximately 0.1 pH units since preindustrial times, which is equivalent to a 25 percent increase in acidity. By 2100, the pH level of the oceans is projected to decrease by an additional 0.3 to 0.4 units under the highest emissions scenarios (NRC 2010). As ocean acidification increases, the availability of calcium carbonate declines. Calcium carbonate is a key building block for the shells of many marine organisms, including bivalves and other mollusks (USEPA 2012; NRC 2010). Vulnerability to ocean acidification has been shown in bivalve species similar to those favored by red knots, including mussels (Gaylord et al. 2011; Bibby et al. 2008) and clams (Green et al. 2009). Reduced calcification rates and calcium metabolism are also expected to affect several mollusks and crustaceans that inhabit sandy beaches (Defeo et al. 2009), the primary nonbreeding habitat for red knots. Relevant to Tierra del Fuego-wintering knots, bivalves have also shown vulnerability to ocean acidification in Antarctic waters, which are predicted to be affected due to naturally low carbonate saturation levels in cold waters (Cummings et al. 2011).

Blue mussel spat is an important prey item for red knots in Virginia (Karpanty et al. 2012). The southern limit of adult blue mussels has contracted from North Carolina to Delaware since 1960 due to increasing air and water temperatures (Jones et al. 2010). Larvae have continued to recruit to southern locales (including Virginia) via currents, but those recruits die early in the summer due to water and air temperatures in excess of lethal physiological limits. Failure to recolonize southern regions will occur when reproducing populations at higher latitudes are beyond dispersal distance (Jones et al. 2010). Thus, this key prey resource may soon disappear from the red knot's Virginia spring stopover habitats (Karpanty et al. 2012).

Reduced food availability at the Delaware Bay stopover site due to commercial harvest and subsequent population decline of the horseshoe crab is considered a primary causal factor in the decline of the rufa subspecies in the 2000s (Escudero et al. 2012; McGowan et al. 2011; CAFF 2010; Niles et al. 2008; COSEWIC 2007; González et al. 2006; Baker et al. 2004; Morrison et al. 2004), although other possible causes or contributing factors have been postulated (Fraser et al. 2013; Schwarzer et al. 2012; Escudero et al. 2012; Espoz et al. 2008; Niles et al. 2008). Due to harvest restrictions and other conservation actions, horseshoe crab populations showed some signs of recovery in the early 2000s, with apparent signs of red knot stabilization (survey counts, rates of weight gain) occurring a few years later. Since about 2005, however, horseshoe crab population growth has stagnated for unknown reasons. Under the current management framework (known as Adaptive Resource Management, or ARM), the present horseshoe crab harvest is not considered a threat to the red knot because harvest levels are tied to red knot populations via scientific modeling. Most data suggest that the volume of horseshoe crab eggs is currently sufficient to support the Delaware Bay's stopover population of red knots at its present size. However, because of the uncertain trajectory of horseshoe crab population growth, it is not yet known if the egg resource will continue to adequately support red knot populations over the next 5 to 10 years. In addition, implementation of the ARM could be impeded by insufficient funding for the shorebird and horseshoe crab monitoring programs that are necessary for the functioning of the ARM models. Many studies have established that red knots stopping over in Delaware Bay during spring migration achieve remarkable and important weight gains to complete their migrations to the breeding grounds by feeding almost exclusively on a superabundance of horseshoe crab eggs. A temporal correlation occurred between increased horseshoe crab harvests in the 1990s and declining red knot counts in both Delaware Bay and Tierra del Fuego by the 2000s. Other shorebird species that rely on Delaware Bay also declined over this period (Mizrahi and Peters in Tanacredi et al. 2009), although some shorebird declines began before the peak expansion of the horseshoe crab fishery (Botton et al. in Shuster et al. 2003).

Hunting

Legal and illegal sport and market hunting in the mid-Atlantic and Northeast United States substantially reduced red knot populations in the 1800s, and we do not know if the subspecies ever fully recovered its former abundance or distribution. Neither legal nor illegal hunting are currently a threat to red knots in the United States, but both occur in the Caribbean and parts of South America. Hunting pressure on red knots and other shorebirds in the northern Caribbean and on Trinidad is unknown. Hunting pressure on shorebirds in the Lesser Antilles (e.g., Barbados, Guadeloupe) is very high, but only small numbers of red knots have been documented on these islands, so past mortality may not have exceeded tens of birds per year. Red knots are no longer being targeted in Barbados or Guadeloupe, and other measures to regulate shorebird hunting on these islands are being negotiated. Much larger numbers (thousands) of red knots occur in the Guianas, where legal and illegal subsistence shorebird hunting is common. About 20 red knot mortalities have been documented in the Guianas, but total red knot hunting mortality in this region cannot be surmised. Subsistence shorebird hunting was also common in northern Brazil, but has decreased in recent decades. We have no evidence that hunting was a driving factor in red knot population declines in the 2000s, or that hunting pressure is increasing. In addition, catch limits, handling protocols, and studies on the effects of research activities on survival all indicate that overutilization for scientific purposes is not a threat to the red knot.

Threats to the red knot from overutilization for commercial, recreational, scientific, or educational purposes exist in parts of the Caribbean and South America. Specifically, legal and illegal hunting does occur. We expect mortality of individual knots from hunting to continue into the future, but at stable or decreasing levels due to the recent international attention to shorebird hunting.

Predation

In wintering and migration areas, the most common predators of red knots are peregrine falcons (*Falco peregrinus*), harriers (*Circus spp*.), accipiters (Family Accipitridae), merlins (*F. columbarius*), shorteared owls (*Asio flammeus*), and greater black-backed gulls (*Larus marinus*) (Niles et al. 2008). Other large are anecdotally known to prey on shorebirds (Breese 2010). In migration areas like Delaware Bay, terrestrial predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) may be a threat to red knots by causing disturbance, but direct mortality from these predators may be low (Niles et al. 2008).

Although little information is available from the breeding grounds, the long-tailed jaeger (*Stercorarius longicaudus*) is prominently mentioned as a predator of red knot chicks in most accounts. Other avian predators include parasitic jaeger (*S. parasiticus*), pomarine jaeger (*S. pomarinus*), herring gull and glaucous gulls, gyrfalcon (*Falcon rusticolus*), peregrine falcon, and snowy owl (*Bubo scandiacus*). Mammalian predators include arctic fox (*Alopex lagopus*) and sometimes arctic wolves (*Canis lupus arctos*) (Niles et al. 2008; COSEWIC 2007). Predation pressure on Arctic-nesting shorebird clutches varies widely regionally, interannually, and even within each nesting season, with nest losses to predators ranging from close to 0 percent to near 100 percent (Meltofte et al. 2007), depending on ecological factors. Abundance of arctic rodents, such as lemmings, is often cyclical, although less so in North America than in Eurasia. In the Arctic, 3- to 4-year lemming cycles give rise to similar cycles in the predation of shorebird nests. When lemmings are abundant, predators concentrate on the lemmings, and shorebirds breed successfully. When lemmings are in short supply, predators switch to shorebird eggs and chicks (Niles et al. 2008; COSEWIC 2007; Meltofte et al. 2007; USFWS 2003b; Blomqvist et al. 2002; Summers and Underhill 1987).

Recreational disturbance

In some wintering and stopover areas, red knots and recreational users (e.g., pedestrians, ORVs, dog walkers, boaters) are concentrated on the same beaches (Niles et al. 2008; Tarr 2008). Recreational activities affect red knots both directly and indirectly. These activities can cause habitat damage (Schlacher and Thompson 2008; Anders and Leatherman 1987), cause shorebirds to abandon otherwise preferred habitats, and negatively affect the birds' energy balances. Effects to red knots from vehicle and pedestrian disturbance can also occur during construction of shoreline stabilization projects including beach nourishment. Red knots can also be disturbed by motorized and nonmotorized boats, fishing, kite surfing, aircraft, and research activities (Niles et al. 2008; Peters and Otis, 2007; Harrington 2005b; Meyer et al. 1999; Burger 1986) and by beach raking or cleaning.

5) Analysis of the Species Likely to be Affected

The proposed action has the potential to adversely affect wintering and migrating red knots and their habitat. Potential effects to red knots include direct loss of foraging and roosting habitat in the Action Area due to dredging of intertidal habitats, degradation of foraging habitat and destruction of the prey base from sand disposal, and attraction of predators due to food waste from the construction crew. Like the piping plover, red knots face predation by avian and mammalian predators that are present year-round on the migration and wintering grounds.

B. Environmental Baseline

1) Status of the species within the Action Area

Aerial survey data provided by NCWRC indicate that 56 red knots were reported in one survey on Holden Beach in May 2012, and 22 red knots were reported in another survey on Oak Island in 2011. Please see **Table 9** for NCWRC data by year. It is important to note that aerial surveys have typically been conducted only one day per year, and it red knots may be found on NC beaches year-round.

Table 9 Number of red knot observations by aerial survey on Holden Beach and Oak Island

Date	Holden Beach	Oak Island
5/23/2006	0	0
5/23/2007	Not surveyed	0
5/20/2009	Not surveyed	18 (at inlet)
5/24/2010	0	0

5/24/2011	15	22
5/23/2012	56	0

2) Factors affecting the species environment within the Action Area

A wide range of recent and on-going beach disturbance activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 6** (page 54) lists the most recent projects, within the past 5 years.

Beach nourishment

The beaches of Oak Island are regularly nourished with sand from the Corps and other sources. Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas. The Brunswick County Beaches project was authorized by Public Law 89-789 (November 6, 1966), for the purposes of hurricane wave protection and beach erosion control. However, no work has been conducted under the authorized project.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result. Historically, there has been a Federal navigation project in the Lockwoods Folly Inlet and AIWW for decades, and the Corps dredges the inlet at least annually. In some cases, the inlet is dredged using a sidecast dredge, such as the Dredge Merritt. In an unknown number of dredging events, the sediment has been placed on Oak Island using pipelines.

Beach scraping can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Beach raking: Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts may remove accumulated wrack, eliminating a beach's natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Nordstrom et al. 2006; Neal et al. 2007). Beach cleaning or grooming can result in abnormally broad unvegetated zones that are inhospitable to dune formation or plant colonization, thereby enhancing the likelihood of erosion (Defreo et al. 2009). The applicant has indicated that beach raking is targeted only towards removal of rock from previous nourishment efforts.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from beachfront and nearby residences.

Shoreline stabilization: Sandbags on private properties provide stabilization to the shoreline of Oak Island.

C. Effects of the Action

This section is an analysis of the beneficial, direct and indirect effects of the proposed action on migrating and wintering red knots within the Action Area. The analysis includes effects interrelated and interdependent of the project activities. An interrelated activity is an activity that is part of a proposed action and depends on the proposed activity. An interdependent activity is an activity that has no independent utility apart from the action.

1) Factors to be considered

The proposed project will occur within habitat used by migrating and wintering red knots and construction will occur during a portion of the migration and winter seasons. Long-term and permanent impacts could preclude the creation of new habitat and increase recreational disturbance. Short-term and temporary impacts to red knots could result from project work disturbing roosting red knots and degrading currently occupied foraging areas.

Proximity of action: Dredging and beach renourishment will occur within and adjacent to red knot roosting and foraging habitat.

Distribution: Project construction activities that may impact migrants and the wintering population of red knots on Oak Island would occur on the beach front and along Eastern Channel.

Timing: The timing of project construction could directly and indirectly impact migrating and wintering red knots.

Nature of the effect: The effects of the project construction include a temporary reduction in foraging habitat, a long term decreased rate of change that may preclude habitat creation, and increased recreational disturbance. A decrease in the survival of red knots on the migration and winter grounds due to the lack of optimal habitat may contribute to decreased survival rates, decreased productivity on the breeding grounds, and increased vulnerability to the population.

Duration: Dredging and beach nourishment will be a one-time activity, which will take up to four months to complete. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact migrating and wintering red knots in subsequent seasons after sand placement.

Disturbance frequency: Disturbance from construction activities will be short term, lasting up to two years. Recreational disturbance may increase after project completion and have long-term impacts.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the red knot migration and winter seasons.

2) Analyses for effects of the action

Beneficial effects: For some highly eroded beaches, sand placement may have a beneficial effect on the habitat's ability to support wintering or migrating red knots. The addition of sand to the sediment budget may increase a sand-starved beach's likelihood of developing habitat features valued by red knots.

Direct effects: Direct effects are those direct or immediate effects of a project on the species or its habitat. Dredging of intertidal habitat in Eastern Channel is a direct loss of foraging habitat. The construction window will extend into one or more red knot migration and winter seasons. Heavy machinery and equipment (e.g., trucks and bulldozers operating on Action Area beaches, the placement of the dredge pipeline along the beach, and sand disposal) may adversely affect migrating and wintering red knots in the Action Area by disturbance and disruption of normal activities such as roosting and foraging, and possibly forcing birds to expend valuable energy reserves to seek available habitat elsewhere.

Burial and suffocation of invertebrate species will occur during each sand placement activity. Impacts will affect 3,148 lf of shoreline. Timeframes projected for benthic recruitment and re-establishment following beach nourishment are between 6 months to 2 years. Depending on actual recovery rates, impacts will occur even if nourishment activities occur outside the red knot migration and wintering seasons.

Indirect effects: The proposed project includes beach renourishment along 3,148 lf of shoreline. Indirect effects include reducing the potential for the formation of optimal habitats (coastal marine and estuarine habitats with large areas of exposed intertidal sediments).
The proposed project may limit the creation of optimal foraging and roosting habitat, and may increase the attractiveness of these beaches for recreation increasing recreational pressures within the Action Area. Recreational activities that potentially adversely affect red knots include disturbance by unleashed pets and increased pedestrian use.

3) Species' response to the proposed action

The proposed project will occur within habitat that is used by migrating and wintering red knots. Since red knots can be present on these beaches almost year-round, construction is likely to occur while this species is utilizing these beaches and associated habitats. Short-term and temporary impacts to red knot activities could result from project work occurring on the beach that flushes birds from roosting or foraging habitat. Long-term impacts could include a hindrance in the ability of migrating or wintering red knots to recuperate from their migratory flight from their breeding grounds, survive on their wintering areas, or to build fat reserves in preparation for migration. Long-term impacts may also result from changes in the physical characteristics of the beach from the placement of the sand.

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued dredging, shoreline stabilization, and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

V. SEABEACH AMARANTH

A. Status of the Species/Critical Habitat

1) Species/critical habitat description

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant that grows on Atlantic barrier islands and ocean beaches currently ranging from South Carolina to New York. It was listed as threatened under the Act on April 7, 1993 (58 FR 18035) because of its vulnerability to human and natural impacts and the fact that it had been eliminated from two-thirds of its historic range (USFWS 1996b). Seabeach amaranth stems are fleshy and pink-red or reddish, with small rounded leaves that are 0.5 to 1.0 inches in diameter. The green leaves, with indented veins, are clustered toward the tip of the stems, and have a small notch at the rounded tip. Flowers and fruits are relatively inconspicuous, borne in clusters along the stems. Seabeach amaranth will be considered for delisting when the species exists in at least six states within its historic range and when a minimum of 75 percent of the sites with suitable habitat within each state are occupied by populations for l0 consecutive years (USFWS 1996b). The recovery plan states that mechanisms must be in place to protect the plants from destructive habitat alterations, destruction or decimation by off-road vehicles or other beach uses, and protection of populations from debilitating webworm predation. There is no designation of critical habitat for seabeach amaranth.

2) Life History

Seabeach amaranth is an annual plant. Germination of seabeach amaranth seeds occurs over a relatively long period, generally from April to July. Upon germinating, this plant initially forms a small unbranched sprig, but soon begins to branch profusely into a clump. This clump often reaches one foot in diameter and consists of five to 20 branches. Occasionally, a clump may get as large as three feet or more across, with 100 or more branches. Flowering begins as soon as plants have reached sufficient size, sometimes as early as June, but more typically commencing in July and continuing until the death of the plant in late fall. Seed production begins in July or August and peaks in September during most years, but continues until the death of the plant. Weather events, including rainfall, hurricanes, and temperature extremes, and predation by webworms have strong effects on the length of the reproductive season of seabeach amaranth. Because of one or more of these influences, the flowering and fruiting period can be terminated as early as June or July. Under favorable circumstances, however, the reproductive season may extend until January or sometimes later (Radford et al. 1968; Bucher and Weakley 1990; Weakley and Bucher1992).

3) Population dynamics

Within North Carolina and across its range, seabeach amaranth numbers vary from year to year. Data in North Carolina is available from 1987 to 2013. Recently, the number of plants across the entire state dwindled from a high of 19,978 in 2005 to 165 in 2013. This trend of decreasing numbers is seen throughout its range. 249,261 plants were found throughout the species' range in 2000. By 2013, those numbers had dwindled to 1,320 plants (USFWS, unpublished data).

Seabeach amaranth is dependent on natural coastal processes to create and maintain habitat. However, high tides and storm surges from tropical systems can overwash, bury, or inundate seabeach amaranth plants or seeds, and seed dispersal may be affected by strong storm events. In September of 1989, Hurricane Hugo struck the Atlantic Coast near Charleston, South Carolina, causing extensive flooding and erosion north to the Cape Fear region of North Carolina, with less severe effects extending northward throughout the range of seabeach amaranth. This was followed by several severe storms that, while not as significant as Hurricane Hugo, caused substantial erosion of many barrier islands in the seabeach amaranth's range. Surveys for seabeach amaranth revealed that the effects of these climatic events were substantial (Weakley and Bucher 1992). In the Carolinas, populations of amaranth were severely reduced. In South Carolina, where the effects of Hurricane Hugo and subsequent dune reconstruction were extensive, amaranth numbers declined from 1,800 in 1988 to I88 in 1990, a reduction of 90 percent. A 74 percent reduction in amaranth numbers occurred in North Carolina, from 41,851 plants in 1988 to 10,898 in 1990. Although population numbers in New York increased in 1990, range-wide totals of seabeach amaranth were reduced 76 percent from 1988 (Weakley and Bucher 1992). The extent stochastic events have on long-term population trends of seabeach amaranth has not been assessed.

4) Status and Distribution

The species historically occurred in nine states from Rhode Island to South Carolina (USFWS 2003c). By the late 1980s, habitat loss and other factors had reduced the range of this species to North and South Carolina. Since 1990, seabeach amaranth has reappeared in several states that had lost their populations in earlier decades. However, threats like habitat loss have not diminished, and populations are declining overall. It is currently found in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina. The typical habitat where this species is found includes the lower foredunes and upper beach strands on the ocean side of the primary sand dunes and overwash flats at accreting spits or ends of barrier islands.

Seabeach amaranth has been and continues to be threatened by destruction or adverse alteration of its habitat. As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, it is extremely vulnerable to habitat fragmentation and isolation of small populations. Further, because this species is easily recognizable and accessible, it is vulnerable to taking, vandalism, and the incidental trampling by curiosity seekers. Seabeach amaranth is afforded legal protection in North Carolina by the General Statutes of North Carolina, Sections 106-202.15, 106- 202.19 (N.C. Gen. Stat. section 106 (Supp. 1991)), which provide for protection from intrastate trade (without a permit).

The most serious threats to the continued existence of seabeach amaranth are construction of beach stabilization structures, natural and man-induced beach erosion and tidal inundation, fungi (i.e., white wilt), beach grooming, herbivory by insects and mammals, and off-road vehicles. Herbivory by webworms, deer, feral horses, and rabbits is a major source of mortality and lowered fecundity for seabeach amaranth. However, the extent to which herbivory affects the species as a whole is unknown.

Potential effects to seabeach amaranth from vehicle use on the beaches include vehicles running over, crushing, burying, or breaking plants, burying seeds, degrading habitat through compaction of sand and the formation of seed sinks caused by tire ruts. Seed sinks occur when blowing seeds fall into tire ruts, then a vehicle comes along and buries them further into the sand preventing germination. If seeds are capable of germinating in the tire ruts, the plants are usually destroyed before they can reproduce by other vehicles following the tire ruts. Those seeds and their reproductive potential become lost from the population.

Pedestrians also can negatively affect seabeach amaranth plants. Seabeach amaranth occurs on the upper portion of the beach which is often traversed by pedestrians walking from parking lots, hotels, or vacation property to the ocean. This is also the area where beach chairs and umbrellas are often set up and/or stored. In addition, resorts, hotels, or other vacation rental establishments may set up volleyball courts or other sporting activity areas on the upper beach at the edge of the dunes. All of these activities can result in the trampling and destruction of plants. Pedestrians walking their dogs on the upper part of the beach, or dogs running freely on the upper part of the beach, may result in the trampling and destruction of seabeach amaranth plants.
The extent of the effects that dogs have on seabeach amaranth is not known.

Recovery Criteria

Delisting of seabeach amaranth will be considered when a minimum of 75 percent of the sites with suitable habitat within at least six of the nine historically occupied States are occupied by seabeach amaranth populations for 10 consecutive years.

5) Analysis of the Species Likely to be Affected

The predominant threat to seabeach amaranth is the destruction or alteration of suitable habitat, primarily because of beach stabilization efforts and storm-related erosion (USFWS 1993). Other important threats to the plant include beach grooming and vehicular traffic, which can easily break or crush the fleshy plant and bury seeds below depths from which they can germinate; and predation by webworms (caterpillars of small moths) (USFWS 1993). Webworms feed on the leaves of the plant and can defoliate the plants to the point of either killing them or at least reducing their seed production. Beach vitex (*Vitex rotundifulia*) is another threat to seabeach amaranth, as it is an aggressive, invasive, woody plant that can occupy habitat similar to seabeach amaranth and outcompete it (Invasive Species Specialist Group (ISSG) 2010).

The proposed action has the potential to adversely affect seabeach amaranth within the proposed Action Area. Potential effects include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities; and, destruction of plants by trampling or breaking as a result of increased recreational activities. The Applicant proposes to place sand between November 15 and May 20, which includes the growing season of seabeach amaranth. Therefore, there is the potential for sand placement to adversely impact plants in the Action Area.

B. Environmental Baseline

1) Status of the species within the Action Area

Since 1992, seabeach amaranth surveys have been conducted on Oak Island and Holden Beach. The numbers of seabeach amaranth vary widely from year to year, from 9 individuals in 2000, to 5,367 individuals in 1998. See **Table 10** for data from the Corps.

Table 10. Annual seabeach amaranth numbers on Oak Island and Holden Beach, NC between 1992 and 2010.

Year	Number of plants	
	Oak Island	Holden Beach
1992	3148	21
1993	6103	52
1994	4409	239
1995	4628	59
1996	1983	99
1997	599	1
1998	5367	32
1999	15	268
2000	9	10
2001	66	223
2002	542	702
2003	1267	843
2004	11	79
2005	174	800
2006	462	1954
2007	116	281
2008	65	574
2009	64	123
2010	1576	434

2) Factors affecting the species environment within the Action Area

A wide range of recent and on-going beach disturbance activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 6** (page 54) lists the most recent projects, within the past 5 years.

Beach scraping can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has become more frequent on North Carolina beaches in the past 20 years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Beach raking: Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts may remove vegetation or seeds, including seabeach amaranth. The applicant has indicated that beach raking is targeted only towards removal of rock from previous nourishment efforts.

Shoreline stabilization: Sandbags on private properties provide stabilization to the shoreline of Oak Island.

Pedestrian Use of the Beach: There are a number of potential sources of pedestrians and pets, including those individuals originating from the beachfront and nearby residences.

Sand nourishment: The beaches of Oak Island are regularly nourished with sand from the Corps Wilmington Harbor SMP and other sources.

C. EFFECTS OF THE ACTION

1) Factors to be considered

Proximity of action: Beach renourishment will occur within and adjacent to seabeach amaranth habitat.

Distribution: Project construction activities that may affect seabeach amaranth plants on Oak Island would occur along the shoreline.

Timing: The timing of project construction could directly and indirectly impact seabeach amaranth.

Nature of the effect: The effects of the project construction include burying, trampling, or injuring plants as a result of construction operations and/or sediment disposal activities; burying seeds to a depth that would prevent future germination as a result of construction operations and/or sediment disposal activities; and, destruction of plants by trampling or breaking as a result of increased recreational activities.

Duration: Sand placement will be a one-time activity and will take up to four months to complete. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact seabeach amaranth in subsequent seasons after sand placement.

Disturbance frequency: Disturbance from construction activities will be short term, lasting up to two years. Recreational disturbance may increase after project completion and have long-term impacts.

Disturbance intensity and severity: Project construction is anticipated to be conducted during portions of the seabeach amaranth growing and flowering season.

2) Analyses for effects of the action

Beneficial Effects: The placement of beach-compatible sand may benefit this species by providing additional suitable habitat or by redistributing seed sources buried during past storm events, beach disposal activities, or natural barrier island migration. Disposal of dredged sand may be compatible with seabeach amaranth provided the timing of beach disposal is appropriate, the material placed on the beach is compatible with the natural sand, and special precautions are adopted to protect existing seabeach amaranth plants. Further studies are needed to determine the best methods of beach disposal in seabeach amaranth habitat (Weakley and Bucher 1992).

Direct Effects: Sand placement activities may bury or destroy existing plants, resulting in mortality, or bury seeds to a depth that would prevent future germination, resulting in reduced plant populations. Increased traffic from recreationists and their pets can also destroy existing plants by trampling or breaking the plants.

Indirect Effects: Future tilling of the beach may be necessary if beach compaction hinders sea turtle nesting activities. Thus, the placement of heavy machinery or associated tilling equipment on the beach may destroy or bury existing plants.

3) Species' response to the proposed action

The placement of sand in the Action Area could bury existing plants if work is conducted during the growing season. Sand placement at any time of year could also bury seeds to a depth that would prevent germination.

Sand placement beaches could also have positive impacts on seabeach amaranth by creating additional habitat for the species. Although more study is needed before the long-term impacts can be accurately assessed, several populations are shown to have established themselves on beaches receiving dredged sediments, and have thrived through subsequent applications of dredged material (Weakley and Bucher 1992).

D. CUMULATIVE EFFECTS

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued dredging, shoreline stabilization, and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

VI. LOGGERHEAD, GREEN, LEATHERBACK, AND KEMP'S RIDLEY SEA TURTLES

A. Status of the Species/Critical Habitat

1) Species/critical habitat description

Species/critical habitat description – Loggerhead Sea Turtle

The loggerhead sea turtle, which occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans, was federally listed worldwide as a threatened species on July 28, 1978 (43 Federal Register (FR) 32800). On September 22, 2011, the loggerhead sea turtle's listing under the Act was revised from a single threatened species to nine distinct population segments (DPS) listed as either threatened or endangered. The nine DPSs and their statuses are:

Northwest Atlantic Ocean DPS – threatened
Northeast Atlantic Ocean – endangered
Mediterranean Sea DPS – endangered
South Atlantic Ocean DPS – threatened
North Pacific Ocean DPS – endangered
South Pacific Ocean DPS – endangered
North Indian Ocean DPS – endangered
Southwest Indian Ocean – threatened
Southeast Indo-Pacific Ocean DPS – threatened

The loggerhead sea turtle grows to an average weight of about 200 pounds and is characterized by a large head with blunt jaws. Adults and subadults have a reddish-brown carapace. Scales on the top of the head and top of the flippers are also reddish-brown with yellow on the borders. Hatchlings are a dull brown color (National Marine Fisheries Service (NMFS) 2009a). The loggerhead feeds on mollusks, crustaceans, fish, and other marine animals.

The loggerhead may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. Within the Northwest Atlantic, the majority of nesting activity occurs from April through September, with a peak in June and July (Williams-Walls et al. 1983; Dodd 1988; Weishampel et al. 2006). Nesting occurs within the Northwest Atlantic along the coasts of North America, Central America, northern South America, the Antilles, Bahamas, and Bermuda, but is concentrated in the southeastern United States and on the Yucatán Peninsula in Mexico on open beaches or along narrow bays having suitable sand (Sternberg 1981; Ehrhart 1989; Ehrhart et al. 2003; NMFS and Service 2008).

Designated critical habitat

On July 10, 2014, the Service designated portions North Carolina beaches as critical habitat for the Northwest Atlantic (NWA) population of loggerhead sea turtles. Oak Island is located within Critical Habitat Unit LOGG-T-NC-07 (Oak Island, Brunswick County). From the Federal Register (FR) Notice (see http://www.regulations.gov/#!documentDetail;D=FWS-R4-ES-2012-0103-0001), this unit consists of 20.9 km (13.0 mi) of island shoreline along the Atlantic Ocean. The island is separated from the mainland by the Atlantic Intracoastal Waterway, Cape Fear River, Eastern Channel, and salt marsh. The unit extends from the mouth of the Cape Fear River to Lockwoods Folly Inlet. The unit includes lands from the MHW line to the toe of the secondary dune or developed structures. Land in this unit is in private and or local government ownership. This unit has high-density nesting by loggerhead sea turtles in North Carolina.

In total, 1,189.9 kilometers (km) (739.3 miles) of loggerhead sea turtle nesting beaches have been designated as critical habitat in the States of North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. These beaches account for 48 percent of an estimated 2,464 km (1,531 miles) of coastal beach shoreline, and account for approximately 84 percent of the documented nesting (numbers of nests) within these six States. The designated critical habitat has been identified by the recovery unit in which they are located. Recovery units are management subunits of a listed entity that are geographically or otherwise identifiable and essential to the recovery of the listed entity. Within the United States, four recovery units have been identified for the Northwest Atlantic population of the loggerhead sea turtle. The four recovery units for which we propose to designate terrestrial critical habitat are the Northern Recovery Unit (NRU), Peninsular Florida Recovery Unit (PFRU), Dry Tortugas Recovery Unit (DTRU), and Northern Gulf of Mexico Recovery Unit (NGMRU). For the NRU, the Service designated 393.7 km (244.7 miles) of Atlantic Ocean shoreline in North Carolina, South Carolina, and Georgia, encompassing approximately 86 percent of the documented nesting (numbers of nests) within the recovery unit.

Under the Act and its implementing regulations, the Service is required to identify the physical or biological features essential to the conservation of the loggerhead sea turtle in areas occupied at the time of listing, focusing on the features' primary constituent elements (PCEs). The Service considers PCEs to be those specific elements of the physical or biological features that provide for a species' life-history processes and are essential to the conservation of the species. The terrestrial PCEs specific to the DPS are the extra-tidal or dry sandy beaches from the mean high-water line to the toe of the secondary dune, which are capable of supporting a high density of nests or serving as an expansion area for beaches with a high density of nests and that are well distributed within each State, or region within a State, and representative of total nesting, consisting of four components:

1. PCE 1—Suitable nesting beach habitat that has (a) relatively unimpeded nearshore access from the ocean to the beach for nesting females and from the beach to the ocean for both post-nesting females and hatchlings and (b) is located above mean high water to avoid being inundated frequently by high tides.

2. PCE 2—Sand that (a) allows for suitable nest construction, (b) is suitable for facilitating gas diffusion conducive to embryo development, and (c) is able to develop and maintain temperatures and a moisture content conducive to embryo development.

3. PCE 3—Suitable nesting beach habitat with sufficient darkness to ensure nesting turtles are not deterred from emerging onto the beach and hatchlings and post-nesting females orient to the sea.

4. PCE 4—Natural coastal processes or artificially created or maintained habitat mimicking natural conditions. This includes artificial habitat types that mimic the natural conditions described in PCEs 1 to 3 above for beach access, nest site selection, nest construction, egg deposition and incubation, and hatchling emergence and movement to the sea. Habitat modification and loss occurs with beach stabilization activities that prevent the natural transfer and erosion and accretion of sediments along the ocean shoreline. Beach stabilization efforts that may impact loggerhead nesting include beach nourishment, beach maintenance, sediment dredging and disposal, inlet channelization, and construction of jetties and other hard structures. However, when sand placement activities result in beach habitat that mimics the natural beach habitat conditions, impacts to sea turtle nesting habitat are minimized.

Species/critical habitat description - Green Sea Turtle

The green sea turtle was federally listed on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green sea turtle has a worldwide distribution in tropical and subtropical waters.

The green sea turtle grows to a maximum size of about 4 feet and a weight of 440 pounds. It has a heart-shaped shell, small head, and single-clawed flippers. The carapace is smooth and colored gray, green, brown, and black. Hatchlings are black on top and white on the bottom (NMFS 2009b). Hatchling green turtles eat a variety of plants and animals, but adults feed almost exclusively on seagrasses and marine algae.

Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (NMFS and Service 1991). Nests have been documented, in smaller numbers, north of these Counties, from Volusia through Nassau Counties in Florida, as well as in Georgia, South Carolina, North Carolina, and as far north as Delaware in 2011. Nests have been documented in smaller numbers south of Broward County in Miami-Dade. Nesting also has been documented along the Gulf coast of Florida from Escambia County through Franklin County in northwest Florida and from Pinellas County through Monroe County in southwest Florida (FWC/FWRI 2010b).

Green sea turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The green turtle is attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting.

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys. No designated critical habitat is present in the Action Area.

Species/critical habitat description - Leatherback Sea Turtle

The leatherback sea turtle was federally listed as an endangered species on June 2, 1970 (35 FR 8491). Leatherbacks have the widest distribution of the sea turtles with nonbreeding animals recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard 1992). Foraging leatherback excursions have been documented into higher-latitude subpolar waters. They have evolved physiological and anatomical adaptations (Frair et al. 1972; Greer et al. 1973) that allow them to exploit waters far colder than any other sea turtle species would be capable of surviving.

The adult leatherback can reach 4 to 8 feet in length and weigh 500 to 2,000 pounds. The carapace is distinguished by a rubber-like texture, about 1.6 inches thick, made primarily of tough, oil-saturated connective tissue. Hatchlings are dorsally mostly black and are covered with tiny scales; the flippers are edged in white, and rows of white scales appear as stripes along the length of the back (NMFS 2009c). Jellyfish are the main staple of its diet, but it is also known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed. This is the largest, deepest diving of all sea turtle species.

Leatherback turtle nesting grounds are distributed worldwide in the Atlantic, Pacific, and Indian Oceans on beaches in the tropics and subtropics. The Pacific Coast of Mexico historically supported the world's largest known concentration of nesting leatherbacks. The leatherback turtle regularly nests in the U.S. Caribbean in Puerto Rico and the U.S. Virgin Islands. Along the U.S. Atlantic coast, most nesting occurs in Florida (NMFS and Service 1992). Nesting has also been reported in Georgia, South Carolina, and North Carolina (Rabon et al. 2003) and in Texas (Shaver 2008). Adult females require sandy nesting beaches backed with vegetation and sloped sufficiently so the distance to dry sand is limited. Their preferred beaches have proximity to deep water and generally rough seas.

Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of St. Croix, U.S. Virgin Islands (50 Code of Federal Regulations (CFR) 17.95). There is no designated critical habitat in North Carolina.

Species/critical habitat description – Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was federally listed as endangered on December 2, 1970 (35 FR 18320). The Kemp's ridley, along with the flatback sea turtle (*Natator depressus*), has the most geographically restricted distribution of any sea turtle species. The range of the Kemp's ridley includes the Gulf coasts of Mexico and the U.S., and the Atlantic coast of North America as far north as Nova Scotia and Newfoundland.

Adult Kemp's ridleys and olive ridleys are the smallest sea turtles in the world. The weight of an adult Kemp's ridley is generally between 70 to 108 pounds with a carapace measuring approximately 24 to 26 inches in length (Heppell et al. 2005). The carapace is almost as wide as it is long. The species' coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. Their diet consists mainly of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The Kemp's ridley has a restricted distribution. Nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico (NMFS et al. 2011). Nesting also occurs in Veracruz and a few historical records exist for Campeche, Mexico (Marquez-Millan 1994). Nesting also occurs regularly in Texas and infrequently in a few other U.S. states. However, historic nesting records in the U.S. are limited to south Texas (Werler 1951, Carr 1961, Hildebrand 1963).

Most Kemp's ridley nests located in the U.S. have been found in south Texas, especially Padre Island (Shaver and Caillouet 1998; Shaver 2002, 2005). Nests have been recorded elsewhere in Texas (Shaver 2005, 2006a, 2006b, 2007, 2008), and in Florida (Johnson et al. 1999, Foote and Mueller 2002, Hegna et al. 2006, FWC/FWRI 2010b), Alabama (J. Phillips, Service, personal communication, 2007 cited in NMFS et al. 2011; J. Isaacs, Service, personal communication, 2008 cited in NMFS et al. 2011), Georgia (Williams et al. 2006), South Carolina (Anonymous 1992), and North Carolina (Marquez et al. 1996), but these events are less frequent. Kemp's ridleys inhabit the Gulf of Mexico and the Northwest Atlantic Ocean, as far north as the Grand Banks (Watson et al. 2004) and Nova Scotia (Bleakney 1955). They occur near the Azores and eastern north Atlantic (Deraniyagala 1938, Brongersma 1972, Fontaine et al. 1989, Bolten and Martins 1990) and Mediterranean (Pritchard and Marquez 1973, Brongersma and Carr 1983, Tomas and Raga 2007, Insacco and Spadola 2010).

Juvenile Kemp's ridleys spend on average 2 years in the oceanic zone (NMFS SEFSC unpublished preliminary analysis, July 2004, as cited in NMFS et al. 2011) where they likely live and feed among floating algal communities. They remain here until they reach about 7.9 inches in length (approximately 2 years of age), at which size they enter coastal shallow water habitats (Ogren 1989); however, the time spent in the oceanic zone may vary from 1 to 4 years or perhaps more (Turtle Expert Working Group (TEWG) 2000, Baker and Higgins 2003, Dodge et al. 2003).

No critical habitat has been designated for the Kemp's ridley sea turtle.

2) Life history

Life History – Loggerhead Sea Turtle

Loggerheads are long-lived, slow-growing animals that use multiple habitats across entire ocean basins throughout their life history. This complex life history encompasses terrestrial, nearshore, and open ocean habitats. The three basic ecosystems in which loggerheads live are the:

1. Terrestrial zone (supralittoral) - the nesting beach where both oviposition (egg laying) and embryonic development and hatching occur.

2. Neritic zone - the inshore marine environment (from the surface to the sea floor) where water depths do not exceed 656 feet. The neritic zone generally includes the continental shelf, but in areas where the continental shelf is very narrow or nonexistent, the neritic zone conventionally extends to areas where water depths are less than 656 feet.

3. Oceanic zone - the vast open ocean environment (from the surface to the sea floor) where water depths are greater than 656 feet.

Maximum intrinsic growth rates of sea turtles are limited by the extremely long duration of the juvenile stage and fecundity. Loggerheads require high survival rates in the juvenile and adult stages, common constraints critical to maintaining long-lived, slow-growing species, to achieve positive or stable long-term population growth (Congdon et al. 1993; Heppell 1998; Crouse 1999; Heppell et al. 1999; 2003; Musick 1999).

Numbers of nests and nesting females are often highly variable from year to year due to a number of factors including environmental stochasticity, periodicity in ocean conditions, anthropogenic effects, and density-dependent and density-independent factors affecting survival, somatic growth, and reproduction (Meylan 1982; Hays 2000; Chaloupka 2001; Solow et al. 2002). Despite these sources of variation, and because female turtles exhibit strong nest site fidelity, a nesting beach survey can provide a valuable assessment of changes in the adult female population, provided that the study is sufficiently long and effort and methods are standardized (Meylan 1982; Gerrodette and Brandon 2000; Reina et al. 2002). **Table 11** summarizes key life history characteristics for loggerheads nesting in the U.S.

Loggerheads nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Nests are typically laid between the high tide line and the dune front (Routa 1968; Witherington 1986; Hailman and Elowson 1992). Wood and Bjorndal (2000) evaluated four environmental factors (slope, temperature, moisture, and salinity) and found that slope had the greatest influence on loggerhead nest-site selection on a beach in Florida. Loggerheads appear to prefer relatively narrow, steeply sloped, coarse-grained beaches, although nearshore contours may also play a role in nesting beach site selection (Provancha and Ehrhart 1987).

The warmer the sand surrounding the egg chamber, the faster the embryos develop (Mrosovsky and Yntema 1980). Sand temperatures prevailing during the middle third of the incubation period also determine the sex of hatchling sea turtles (Mrosovsky and Yntema 1980). Incubation temperatures near the upper end of the tolerable range produce only female hatchlings while incubation temperatures near the lower end of the tolerable range produce only male hatchlings.

Table 11. Typical values of life history parameters for loggerheads nesting in the U.S. (NMFS and Service 2008).

Life History Trait	**Data**
Clutch size (mean)	100-126 eggs[1]
Incubation duration (varies depending on time of year and latitude)	Range = 42-75 days[2,3]
Pivotal temperature (incubation temperature that produces an equal number of males and females)	84˚F[5]
Nest productivity (emerged hatchlings/total eggs) x 100 (varies depending on site specific factors)	45-70 percent[2,6]
Clutch frequency (number of nests/female/season)	3-4 nests[7]
Internesting interval (number of days between successive nests within a season)	12-15 days[8]
Juvenile (<34 inches Curved Carapace Length) sex ratio	65-70 percent female[4]
Remigration interval (number of years between successive nesting migrations)	2.5-3.7 years[9]
Nesting season	late April-early September
Hatching season	late June-early November
Age at sexual maturity	32-35 years[10]
Life span	>57 years[11]

1 Dodd (1988).
2 Dodd and Mackinnon (1999, 2000, 2001, 2002, 2003, 2004).
3 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 865).
4 NMFS (2001); Foley (2005).
5 Mrosovsky (1988).
6 Witherington (2006) (information based on nests monitored throughout Florida beaches in 2005, n = 1,680).
7 Murphy and Hopkins (1984); Frazer and Richardson (1985); Hawkes *et al*. 2005; Scott 2006.
8 Caldwell (1962), Dodd (1988).
9 Richardson *et al.* (1978); Bjorndal *et al.* (1983).
10 Snover (2005).
11 Dahlen *et al.* (2000).

Loggerhead hatchlings pip and escape from their eggs over a 1- to 3-day interval and move upward and out of the nest over a 2- to 4-day interval (Christens 1990). The time from pipping to emergence ranges from 4 to 7 days with an average of 4.1 days (Godfrey and Mrosovsky 1997). Hatchlings emerge from their nests en masse almost exclusively at night, and presumably using decreasing sand temperature as a cue (Hendrickson 1958; Mrosovsky 1968; Witherington et al. 1990). Moran et al. (1999) concluded that a lowering of sand temperatures below a critical threshold, which most typically occurs after nightfall, is the most probable trigger for hatchling emergence from a nest. After an initial emergence, there may be secondary emergences on subsequent nights (Carr and Ogren 1960; Witherington 1986; Ernest and Martin 1993; Houghton and Hays 2001).

Hatchlings use a progression of orientation cues to guide their movement from the nest to the marine environments where they spend their early years (Lohmann and Lohmann 2003). Hatchlings first use light cues to find the ocean. On naturally lighted beaches without artificial lighting, ambient light from the open sky creates a relatively bright horizon compared to the dark silhouette of the dune and vegetation landward of the nest. This contrast guides the hatchlings to the ocean (Daniel and Smith 1947; Limpus 1971; Salmon et al. 1992; Witherington and Martin 1996; Witherington 1997; Stewart and Wyneken 2004).

Life history - Green Sea Turtle

Green sea turtles deposit from one to nine clutches within a nesting season, but the overall average is about 3.3 nests. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Clutch size varies from 75 to 200 eggs with incubation requiring 48 to 70 days, depending on incubation temperatures. Only occasionally do females produce clutches in successive years. Usually two or more years intervene between breeding seasons (NMFS and Service 1991). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Life History – Leatherback Sea Turtle

Leatherbacks nest an average of five to seven times within a nesting season, with an observed maximum of 11 nests (NMFS and Service 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 80 to 85 yolked eggs, with the addition of usually a few dozen smaller, yolkless eggs, mostly laid toward the end of the clutch (Pritchard 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands (McDonald and Dutton

1996). Leatherbacks are believed to reach sexual maturity in 13 to 16 years (Dutton et al. 2005; Jones et al. 2011).

Life History – Kemp's Ridley Sea Turtle

Nesting occurs primarily from April into July. Nesting often occurs in synchronized emergences, known as "arribadas" or "arribazones," which may be triggered by high wind speeds, especially north winds, and changes in barometric pressure (Jimenez et al. 2005). Nesting occurs primarily during daylight hours. Clutch size averages 100 eggs and eggs typically take 45 to 58 days to hatch depending on incubation conditions, especially temperatures (Marquez-Millan 1994, Rostal 2007).

Females lay an average of 2.5 clutches within a season (TEWG 1998) and inter-nesting interval generally ranges from 14 to 28 days (Miller 1997; Donna Shaver, Padre Island National Seashore, personal communication, 2007 as cited in NMFS et al. 2011). The mean remigration interval for adult females is 2 years, although intervals of 1 and 3 years are not uncommon (Marquez et al. 1982; TEWG 1998, 2000). Males may not be reproductively active on an annual basis (Wibbels et al. 1991). Age at sexual maturity is believed to be between 10 to 17 years (Snover et al. 2007).

3) Population dynamics

Population Dynamics – Loggerhead Sea Turtle

The loggerhead occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). However, the majority of loggerhead nesting is at the western rims of the Atlantic and Indian Oceans. The most recent reviews show that only two loggerhead nesting beaches have greater than 10,000 females nesting per year (Baldwin et al. 2003; Ehrhart et al. 2003; Kamezaki et al. 2003; Limpus and Limpus 2003; Margaritoulis et al. 2003): Peninsular Florida (U.S.) and Masirah (Oman). Those beaches with 1,000 to 9,999 females nesting each year are Georgia through North Carolina (U.S.), Quintana Roo and Yucatán (Mexico), Cape Verde Islands (Cape Verde, eastern Atlantic off Africa), and Western Australia (Australia).

The major nesting concentrations in the U.S. are found in South Florida. However, loggerheads nest from Texas to Virginia. Since 2000, the annual number of loggerhead nests in NC has fluctuated between 333 in 2004 to 1,260 in 2013 (Godfrey, unpublished data). Total estimated nesting in the U.S. has fluctuated between 49,000 and 90,000 nests per year from 1999-2010 (NMFS and Service 2008; FWC/FWRI 2010a). Adult loggerheads are known to make considerable migrations between foraging areas and nesting beaches (Schroeder et al. 2003; Foley et al. 2008). During non-nesting years, adult females from U.S. beaches are distributed in waters off the eastern U.S. and throughout the Gulf of Mexico, Bahamas, Greater Antilles, and Yucatán.

From a global perspective, the U.S. nesting aggregation is of paramount importance to the survival of the species, as is the population that nests on islands in the Arabian Sea off Oman (Ross 1982; Ehrhart 1989; Baldwin et al. 2003).

Population dynamics - Green Sea Turtle

There are an estimated 150,000 females that nest each year in 46 sites throughout the world (NMFS and Service 2007a). In the U.S. Atlantic, the majority of nesting occurs in Florida, where about 100 to 1,000 females are estimated to nest annually (FWC 2009c). In North Carolina, between 4 and 44 green sea turtle nests are laid annually (Godfrey, unpublished data). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year (NMFS and Service 1998a). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus et al. 1993). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani 1995).

Population dynamics – Leatherback Sea Turtle

A dramatic drop in nesting numbers has been recorded on major nesting beaches in the Pacific. Spotila et al. (2000) have highlighted the dramatic decline and possible extirpation of leatherbacks in the Pacific.

The East Pacific and Malaysia leatherback populations have collapsed. Spotila et al. (1996) estimated that only 34,500 females nested annually worldwide in 1995, which is a dramatic decline from the 115,000 estimated in 1980 (Pritchard 1982). In the eastern Pacific, the major nesting beaches occur in Costa Rica and Mexico. At Playa Grande, Costa Rica, considered the most important nesting beach in the eastern Pacific, numbers have dropped from 1,367 leatherbacks in 1988-1989 to an average of 188 females nesting between 2000-2001 and 2003-2004. In Pacific Mexico, 1982 aerial surveys of adult female leatherbacks indicated this area had become the most important leatherback nesting beach in the world. Tens of thousands of nests were laid on the beaches in 1980s, but during the 2003-2004 seasons a total of 120 nests were recorded. In the western Pacific, the major nesting beaches lie in Papua New Guinea, Papua, Indonesia, and the Solomon Islands. These are some of the last remaining significant nesting assemblages in the Pacific. Compiled nesting data estimated approximately 5,000 to 9,200 nests annually with 75 percent of the nests being laid in Papua, Indonesia.

However, the most recent population size estimate for the North Atlantic alone is a range of 34,000 to 94,000 adult leatherbacks (TEWG 2007). During recent years in Florida, the total number of leatherback nests counted as part of the SNBS program ranged from 540 to 1,797 from 2006-2010 (FWC/FWRI 2010a). Assuming a clutch frequency (number of nests/female/season) of 4.2 in Florida (Stewart 2007), these nests were produced by a range of 128 to 428 females in a given year.

Nesting in the Southern Caribbean occurs in the Guianas (Guyana, Suriname, and French Guiana), Trinidad, Dominica, and Venezuela. The largest nesting populations at present occur in the western Atlantic in French Guiana with nesting varying between a low of 5,029 nests in 1967 to a high of 63,294 nests in 2005, which represents a 92 percent increase since 1967 (TEWG 2007). Trinidad supports an estimated 6,000 leatherbacks nesting annually, which represents more than 80 percent of the nesting in the insular Caribbean Sea. Leatherback nesting along the Caribbean Central American coast takes place between Honduras and Colombia. In Atlantic Costa Rica, at Tortuguero, the number of nests laid annually between 1995 and 2006 was estimated to range from 199 to 1,623. Modeling of the Atlantic Costa Rica data indicated that the nesting population has decreased by 67.8 percent over this time period.

In Puerto Rico, the main nesting areas are at Fajardo (Northeast Ecological Corridor) and Maunabo on the main island of Puerto Rico and on the islands of Culebra and Vieques. Between 1993 and 2010, the number of nests in the Fajardo area ranged from 51 to 456. In the Maunabo area, the number of nests recorded between 2001 and 2010 ranged from a low of 53 in 2002 to a high of 260 in 2009 (Diez 2011). On the island of Culebra, the number of nests ranged from a low 41 in 1996 to a high of 395 in 1997 (Diez 2011). On beaches managed by the Commonwealth of Puerto Rico on the island of Vieques, the Puerto Rico Department of Natural and Environmental Resources recorded annually 14-61 leatherback nests between 1991 and 2000; 145 nests in 2002; 24 in 2003; and 37 in 2005 (Diez 2011). The number of leatherback sea turtle nests recorded on Vieques Island beaches managed by the Service ranged between 13 and

163 during 2001-2010. Using the numbers of nests recorded in Puerto Rico between 1984 and 2005, the Turtle Expert Working Group (2007) estimated a population growth of approximately 10 percent per year. Recorded leatherback nesting on the Sandy Point National Wildlife Refuge on the island of St. Croix, U.S. Virgin Islands, between 1982 and 2010, ranged from a low of 82 in 1986 to a high of 1,008 in 2001 (Garner and Garner 2010). Using the number of observed females at Sandy Point from 1986 to 2004, the Turtle Expert Working Group (2007) estimated a population growth of approximately 10 percent per year. In the British Virgin Islands, annual nest numbers have increased in Tortola from zero to six nests per year in the late 1980s to 35 to 65 nests per year in the 2000s (TEWG 2007).

The most important nesting beach for leatherbacks in the eastern Atlantic lies in Gabon, Africa. It was estimated there were 30,000 nests along 60 miles of Mayumba Beach in southern Gabon during the 1999-2000 nesting season (Billes et al. 2000). Some nesting has been reported in Mauritania, Senegal, the Bijagos Archipelago of Guinea-Bissau, Turtle Islands and Sherbro Island of Sierra Leone, Liberia, Togo, Benin, Nigeria, Cameroon, Sao Tome and Principe, continental Equatorial Guinea, Islands of Corisco in the Gulf of Guinea and the Democratic Republic of the Congo, and Angola. In addition, a large nesting population is found on the island of Bioko (Equatorial Guinea) (Fretey et al. 2007). In North Carolina between the year 2000 and 2013, as many as 9 nests were laid per year (Godfrey, unpublished data).

Population Dynamics – Kemp’s Ridley Sea Turtle

Most Kemp’s ridleys nest on the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico. Nesting also occurs in Veracruz and Campeche, Mexico, although a small number of Kemp’s ridleys nest consistently along the Texas coast (NMFS et al. 2011). In addition, rare nesting events have been reported in Alabama, Florida, Georgia, South Carolina, and North Carolina. Historical information indicates that tens of thousands of ridleys nested near Rancho Nuevo, Mexico, during the late 1940s (Hildebrand 1963). The Kemp's ridley population experienced a devastating decline between the late 1940s and the mid-1980s. The total number of nests per nesting season at Rancho Nuevo remained below 1,000 throughout the 1980s, but gradually began to increase in the 1990s. In 2009, 16,273 nests were documented along the 18.6 miles of coastline patrolled at Rancho Nuevo, and the total number of nests documented for all the monitored beaches in Mexico was 21,144 (USFWS 2010). In 2011, a total of 20,570 nests were documented in Mexico, 81 percent of these nests were documented in the Rancho Nuevo beach (Burchfield and Peña 2011). In addition, 153 and 199 nests were recorded during 2010 and 2011, respectively, in the United States, primarily in Texas.

4) Status and distribution

Status and Distribution – All Sea Turtles

Reason for Listing: There are many threats to sea turtles, including nest destruction from natural events, such as tidal surges and hurricanes, or eggs lost to predation by raccoons, foxes, ghost-crabs, and other animals. However, human activity has significantly contributed to the decline of sea turtle populations along the Atlantic Coast and in the Gulf of Mexico (NRC 1990). These factors include the modification, degradation, or loss of nesting habitat by coastal development, artificial lighting, beach driving, and marine pollution and debris. Furthermore, the overharvest of eggs for food, intentional killing of adults and immature turtles for their shells and skin, and accidental drowning in commercial fishing gear are primarily responsible for the worldwide decline in sea turtle populations.

Status and Distribution – Loggerhead Sea Turtle

Range-wide Trend: Five recovery units have been identified in the Northwest Atlantic based on genetic differences and a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries (NMFS and Service 2008). Recovery units are subunits of a listed species that are geographically or otherwise identifiable and essential to the recovery of the species. Recovery units are individually necessary to conserve genetic robustness, demographic robustness, important life history stages, or some other feature necessary for long-term sustainability of the species. The five recovery units identified in the Northwest Atlantic are:

1. Northern Recovery Unit (NRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through southern Virginia (the northern extent of the nesting range);

2. Peninsula Florida Recovery Unit (PFRU) - defined as loggerheads originating from nesting beaches from the Florida-Georgia border through Pinellas County on the west coast of Florida, excluding the islands west of Key West, Florida;

3. Dry Tortugas Recovery Unit (DTRU) - defined as loggerheads originating from nesting beaches throughout the islands located west of Key West, Florida;

4. Northern Gulf of Mexico Recovery Unit (NGMRU) - defined as loggerheads originating from nesting beaches from Franklin County on the northwest Gulf coast of Florida through Texas; and

5. Greater Caribbean Recovery Unit (GCRU) - composed of loggerheads originating from all other nesting assemblages within the Greater Caribbean (Mexico through French Guiana, The Bahamas, Lesser Antilles, and Greater Antilles).

The mtDNA analyses show that there is limited exchange of females among these recovery units (Ehrhart 1989; Foote et al. 2000; NMFS 2001; Hawkes et al. 2005). Male-mediated gene flow appears to be keeping the subpopulations genetically similar on a nuclear DNA level (Francisco-Pearce 2001).

Historically, the literature has suggested that the northern U.S. nesting beaches (NRU and NGMRU) produce a relatively high percentage of males and the more southern nesting beaches (PFRU, DTRU, and GCRU) a relatively high percentage of females (e.g., Hanson et al. 1998; NMFS 2001; Mrosovsky and Provancha 1989). The NRU and NGMRU were believed to play an important role in providing males to mate with females from the more female-dominated subpopulations to the south. However, in 2002 and 2003, researchers studied loggerhead sex ratios for two of the U.S. nesting subpopulations, the northern and southern subpopulations (NGU and PFRU, respectively) (Blair 2005; Wyneken et al. 2005). The study produced interesting results. In 2002, the northern beaches produced more females and the southern beaches produced more males than previously believed. However, the opposite was true in 2003 with the northern beaches producing more males and the southern beaches producing more females in keeping with prior literature. Wyneken et al. (2005) speculated that the 2002 result may have been anomalous; however, the study did point out the potential for males to be produced on the southern beaches. Although this study revealed that more males may be produced on southern recovery unit beaches than previously believed, the Service maintains that the NRU and NGMRU play an important role in the production of males to mate with females from the more southern recovery units.

The NRU is the second largest loggerhead recovery unit within the Northwest Atlantic Ocean DPS. Annual nest totals from northern beaches averaged 5446 nests from 2006 to 2011, a period of near-complete surveys of NRU nesting beaches, representing approximately 1,328 nesting females per year (4.1 nests per female, Murphy and Hopkins 1984) (NMFS and Service 2008). In 2008, nesting in Georgia reached what was a new record at that time (1,646 nests), with a downturn in 2009, followed by yet another record in 2011 (1,987 nests). South Carolina had the two highest years of nesting in the 2000s in 2009 (2,183 nests) and 2010 (3,141 nests). The previous high for that 11-year span was 1,433 nests in 2003. North Carolina had 947 nests in 2011, which is above the average of 765. The Georgia, South Carolina, and North Carolina nesting data come from the seaturtle.org Sea Turtle Nest Monitoring System, which is populated with data input by the State agencies. The loggerhead nesting trend from daily beach surveys was declining significantly at 1.3 percent annually from 1983 to 2007 (NMFS and USFWS, 2008). Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline (NMFS and Service 2008). Currently, however, nesting for the NRU is showing possible signs of stabilizing (76 FR 58868, September 22, 2011).

Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS and Service 2008)

1. Number of Nests and Number of Nesting Females
   a. Northern Recovery Unit
      i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is 2 percent or greater resulting in a total annual number of nests of 14,000 or greater for this recovery unit (approximate distribution of nests is North Carolina =14 percent [2,000 nests], South Carolina =66 percent [9,200 nests], and Georgia =20 percent [2,800 nests]); and
      ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

   b. Peninsular Florida Recovery Unit
      i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is statistically detectable (one percent) resulting in a total annual number of nests of 106,100 or greater for this recovery unit; and
      ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

   c. Dry Tortugas Recovery Unit
      i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 1,100 or greater for this recovery unit; and

ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

d. Northern Gulf of Mexico Recovery Unit
   i. There is statistical confidence (95 percent) that the annual rate of increase over a generation time of 50 years is three percent or greater resulting in a total annual number of nests of 4,000 or greater for this recovery unit (approximate distribution of nests (2002-2007) is Florida= 92 percent [3,700 nests] and Alabama =8 percent [300 nests]); and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

e. Greater Caribbean Recovery Unit
   i. The total annual number of nests at a minimum of three nesting assemblages, averaging greater than 100 nests annually (e.g., Yucatán, Mexico; Cay Sal Bank, Bahamas) has increased over a generation time of 50 years; and
   ii. This increase in number of nests must be a result of corresponding increases in number of nesting females (estimated from nests, clutch frequency, and remigration interval).

2. Trends in Abundance on Foraging Grounds
   A network of in-water sites, both oceanic and neritic across the foraging range is established and monitoring is implemented to measure abundance. There is statistical confidence (95 percent) that a composite estimate of relative abundance from these sites is increasing for at least one generation.

3. Trends in Neritic Strandings Relative to In-water Abundance
   Stranding trends are not increasing at a rate greater than the trends in in-water relative abundance for similar age classes for at least one generation.

Status and distribution - Green Sea Turtle

Range-wide Trend: Annual nest totals documented as part of the Florida SNBS program from 1989-2010 have ranged from 435 nests laid in 1993 to 13,225 in 2010. Nesting occurs in 26 counties with a peak along the east coast, from Volusia through Broward Counties. Although the SNBS program provides information on distribution and total abundance statewide, it cannot be used to assess trends because of variable survey effort. Therefore, green turtle nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time (1989-2010). Green sea turtle nesting in Florida is increasing based on 22 years

(1989-2010) of INBS data from throughout the state ((FWC/FWRI 2010b). The increase in nesting in Florida is likely a result of several factors, including: (1) a Florida statute enacted in the early 1970s that prohibited the killing of green turtles in Florida; (2) the species listing under the Act afforded complete protection to eggs, juveniles, and adults in all U.S. waters; (3) the passage of Florida's constitutional net ban amendment in 1994 and its subsequent enactment, making it illegal to use any gillnets or other entangling nets in State waters; (4) the likelihood that the majority of Florida green turtles reside within Florida waters where they are fully protected; (5) the protections afforded Florida green turtles while they inhabit the waters of other nations that have enacted strong sea turtle conservation measures (e.g., Bermuda); and (6) the listing of the species on Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which stopped international trade and reduced incentives for illegal trade from the U.S (NMFS and Service 2007a).

Recovery Criteria

The U.S. Atlantic population of green sea turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least six years. Nesting data must be based on standardized surveys;

2. At least 25 percent (65 miles) of all available nesting beaches (260 miles) is in public ownership and encompasses at least 50 percent of the nesting activity;

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds; and

4. All priority one tasks identified in the recovery plan have been successfully implemented.

Status and distribution - Leatherback Sea Turtle

Range-wide Trend: Pritchard (1982) estimated 115,000 nesting females worldwide, of which 60 percent nested along the Pacific coast of Mexico. Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world’s largest leatherback nesting population (historically estimated to be 65 percent of the worldwide population), is now less than 1 percent of its estimated size in 1980. Spotila et al. (1996) estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200, and an upper limit of about 42,900. This is less than one-third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean. The most recent population size estimate for the North Atlantic is a range of 34,000 to 94,000 adult leatherbacks (TEWG 2007). The largest population is in the western Atlantic. Using an age-based demographic model, Spotila et al. (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless action is taken to reduce adult mortality and increase survival of eggs and hatchlings.

In the western Atlantic, the U.S., nesting populations occur in Florida, Puerto Rico, and the U.S. Virgin Islands. In Florida, the SNBS program documented an increase in leatherback nesting numbers from 98 nests in 1989 to between 453 and 1,747 nests per season in the early 2000s (FWC 2009a; Stewart and Johnson 2006). Although the SNBS program provides information on distribution and total abundance statewide, it cannot be used to assess trends because of variable survey effort. Therefore, leatherback nesting trends are best assessed using standardized nest counts made at INBS sites surveyed with constant effort over time (1989-2010). Under the INBS program, approximately 30 percent of Florida's SNBS beach length is surveyed. The INBS nest counts represent approximately 34 percent of known leatherback nesting in Florida. An analysis of the INBS data has shown an exponential increase in leatherback sea turtle nesting in Florida since 1989. From 1989 through 2010, the annual number of leatherback sea turtle nests at the core set of index beaches ranged from 27 to 615 (FWC 2010b). Using the numbers of nests recorded from 1979 through 2009, Stewart et al. (2011) estimated a population growth of approximately 10.2 percent per year. In Puerto Rico, the main nesting areas are at Fajardo (Northeast Ecological Corridor) and Maunabo on the main island and on the islands of Culebra and Vieques. Nesting ranged from 51 to 456 nests between 2001 and 2010 (Diez 2011). In the U.S. Virgin Islands, leatherback nesting on Sandy Point National Wildlife Refuge on the island of St. Croix ranged from 143 to 1,008 nests between 1990 and 2005 (TEWG 2007; NMFS and Service 2007b).

Recovery Criteria

The U.S. Atlantic population of leatherbacks can be considered for delisting if the following conditions are met:

1. The adult female population increases over the next 25 years, as evidenced by a statistically significant trend in the number of nests at Culebra, Puerto Rico, St. Croix, U.S. Virgin Islands, and along the east coast of Florida;
2. Nesting habitat encompassing at least 75 percent of nesting activity in U.S. Virgin Islands, Puerto Rico, and Florida is in public ownership; and
3. All priority one tasks identified in the recovery plan have been successfully implemented.

Status and Distribution – Kemp's Ridley Sea Turtle

Nesting aggregations of Kemp's ridleys at Rancho Nuevo were discovered in 1947, and the adult female population was estimated to be 40,000 or more individuals based on a film by Andres Herrera (Hildebrand 1963, Carr 1963). Within approximately 3 decades, the population had declined to 924 nests and reached the lowest recorded nest count of 702 nests in 1985. Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches has increased 15 percent per year (Heppell et al. 2005), allowing cautious optimism that the population is on its way to recovery. This increase in nesting can be attributed to full protection of nesting females and their nests in Mexico resulting from a bi-national effort between Mexico and the U.S. to prevent the extinction of the Kemp's ridley, the requirement to use Turtle Excluder Devices (TEDs) in shrimp trawls both in the U.S. and Mexico, and decreased shrimping effort (NMFS et al. 2011, Heppell et al. 2005).

Recovery Criteria (only the Demographic Recovery Criteria are presented below; for the Listing Factor Recovery Criteria, see NMFS et al. 2011)

The recovery goal is to conserve and protect the Kemp's ridley sea turtle so that protections under the Act are no longer necessary and the species can be removed from the List of Endangered and Threatened Wildlife. Biological recovery criteria form the basis from which to gauge whether the species should be reclassified to threatened (i.e., downlisted) or delisted, whereas the listing factor criteria ensure that the threats affecting the species are controlled or eliminated.

Downlisting Criteria

1. A population of at least 10,000 nesting females in a season (as estimated by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained. Methodology and capacity to implement and ensure accurate nesting female counts have been developed.

2. Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico is attained to ensure a minimum level of known production through *in situ* incubation, incubation in corrals, or a combination of both.

Delisting Criteria

1. An average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season and annual nest counts) over a 6-year period distributed among nesting beaches in Mexico and the U.S. is attained. Methodology and capacity to ensure accurate nesting female counts have been developed and implemented.

2. Ensure average annual recruitment of hatchlings over a 6-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S into the future. This criterion may rely on massive synchronous nesting events (i.e., arribadas) that will swamp predators as well as rely on supplemental protection in corrals and facilities.

5) Analysis of the species/critical habitat likely to be affected

Barrier islands and inlets are complex and dynamic coastal systems that are continually responding to sediment supply, waves, and fluctuations in sea level. The location and shape of the beaches of barrier islands perpetually adjusts to these physical forces. Waves that strike a barrier island at an angle, for instance, generate a longshore current that carries sediment along the shoreline. Cross-shore currents carry sediment perpendicular to the shoreline. Wind moves sediment across the dry beach, dunes and island interior. During storm events, overwash may breach the island at dune gaps or other weak spots, depositing sediments on the interior and back sides of islands, increasing island elevation and accreting the soundside shoreline.

Tidal inlets play a vital role in the dynamics and processes of barrier islands. Sediment is transferred across inlets from island to island via the tidal shoals or deltas. The longshore sediment transport often causes barrier spits to accrete, shifting inlets towards the neighboring island. Flood tidal shoals that are left behind by the migrating inlet are typically incorporated into the soundside shoreline and marshes of the island, widening it considerably. Many inlets have a cycle of inlet migration, breaching of the barrier spit during a storm, and closure of the old inlet with the new breach becoming the new inlet. Barrier spits tend to be low in elevation, sparse in vegetation, and repeatedly submerged by high and storm tides.

The Service and the NMFS share Federal jurisdiction for sea turtles under the Act. The Service has responsibility for sea turtles on the nesting beach. NMFS has jurisdiction for sea turtles in the marine environment.

In accordance with the Act, the Service completes consultations with all Federal agencies for actions that may adversely affect sea turtles on the nesting beach. The Service's analysis only addresses activities that may impact nesting sea turtles, their nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea. NMFS assesses and consults with Federal agencies concerning potential impacts to sea turtles in the marine environment, including updrift and downdrift nearshore areas affected by sand placement projects on the beach.

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings on the beach within the proposed Action Area. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting or equipment on the beach, and behavior modification of nesting females during the nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs due to escarpment formation within the Action Area. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.

Some individuals in a population are more "valuable" than others in terms of the number of offspring they are expected to produce. An individual's potential for contributing offspring to future generations is its reproductive value. Because of delayed sexual maturity, reproductive longevity, and low survivorship in early life stages, nesting females are of high value to a population. The loss of a nesting female in a small recovery unit would represent a significant

loss to the recovery unit. The reproductive value for a nesting female has been estimated to be approximately 253 times greater than an egg or a hatchling (NMFS and Service 2008).
With regard to indirect loss of eggs and hatchlings, on most beaches, nesting success typically declines for the first year or two following sand placement, even though more nesting habitat is available for turtles (Trindell et al. 1998; Ernest and Martin 1999; Herren 1999). Reduced nesting success on constructed beaches has been attributed to increased sand compaction, escarpment formation, and changes in beach profile (Nelson et al. 1987; Crain et al. 1995; Lutcavage et al. 1997; Steinitz et al. 1998; Ernest and Martin 1999; Rumbold et al. 2001). In addition, even though constructed beaches are wider, nests deposited there may experience higher rates of wash out than those on relatively narrow, steeply sloped beaches (Ernest and Martin 1999). This occurs because nests on constructed beaches are more broadly distributed than those on natural beaches, where they tend to be clustered near the base of the dune. Nests laid closest to the waterline on constructed beaches may be lost during the first year or two following construction as the beach undergoes an equilibration process during which seaward portions of the beach are lost to erosion. As a result, the project may be anticipated to result in decreased nesting and loss of nests that are laid within the Action Area for two subsequent nesting seasons following the completion of the proposed sand placement. However, it is unknown whether nests that would have been laid in an Action Area during the two subsequent nesting seasons had the project not occurred are actually lost from the population, or if nesting is simply displaced to adjacent beaches. Regardless, eggs and hatchlings have a low reproductive value; each egg or hatchling has been estimated to have only 0.004 percent of the value of a nesting female (NMFS and Service 2008). Thus, even if the majority of the eggs and hatchlings that would have been produced on the project beach are not realized for up to 2 years following project completion, the Service would not expect this loss to have a significant effect on the recovery and survival of the species, for the following reasons: 1) some nesting is likely just displaced to adjacent non-project beaches, 2) not all eggs will produce hatchlings, and 3) destruction and/or failure of nests will not always result from a sand placement project. A variety of natural and unknown factors negatively affect incubating egg clutches, including tidal inundation, storm events, and predation.

During project construction, direct mortality of the developing embryos in nests within the Action Area may occur for nests that are missed and not relocated or marked for avoidance. The exact number of these missed nests is not known. However, in two separate monitoring programs on the east coast of Florida where hand digging was performed to confirm the presence of nests and thus reduce the chance of missing nests through misinterpretation, trained observers still missed about 6 to 8 percent of the nests because of natural elements (Martin 1992; Ernest and Martin 1993). This must be considered a conservative number, because missed nests are not always accounted for. In another study, Schroeder (1994) found that even under the best of conditions, about 7 percent of nests can be misidentified as false crawls by highly experienced sea turtle nest surveyors. Missed nests are usually identified by signs of hatchling emergences or egg or hatchling predation in areas where no nest was previously documented. Signs of hatchling emergence are very easily obliterated by the same elements that interfere with detection of nests. Regardless, eggs and hatchlings have a low reproductive value; each egg or hatchling has been estimated to have only 0.004 percent of the value of a nesting female (NMFS and Service 2008). Thus, even if, for example, the number of missed nests approaches twice the rate mentioned above, the Service would not expect this loss to have a significant effect on the recovery and survival of the species, for the following reasons: 1) not all eggs in all unmarked nests will produce hatchlings, and 2) destruction and/or failure of a missed nest will not always result from a construction project. A variety of natural and unknown factors negatively affect incubating egg clutches, including tidal inundation, storm events, predation, accretion of sand, and erosional processes. The loss of all life stages of sea turtles including eggs are considered "take" and minimization measures are required to avoid and minimize all life stages. During project construction, predators of eggs and nestlings may be attracted to the Action Area due to food waste from the construction crew.

B. ENVIRONMENTAL BASELINE

1) Status of sea turtle species within the Action Area

The loggerhead sea turtle nesting and hatching season for North Carolina beaches extends from May 1 through November 15. Incubation ranges from about 45 to 95 days. See **Table 12** for data on observed loggerhead sea turtle nests on Oak Island. Data was provided in the BA by NCWRC.

Table 12. Number of loggerhead nests observed between 2009 and 2014 on Oak Island and Holden Beach.

Year	Oak Island	Holden Beach
2005	60	44
2006	76	28
2007	50	17
2008	52	38
2009	56	23
2010	56	27
2011	63	30
2012	79	48
2013	93	73
2014	31	19

Critical Habitat Unit LOGG-T-NC-07

For the Northern Recovery Unit, the Service designated 393.7 km (244.7 miles) of Atlantic Ocean shoreline in North Carolina, South Carolina, and Georgia, encompassing approximately 86 percent of the documented nesting (numbers of nests) within the recovery unit.

This critical habitat unit is one of 38 designated critical habitat units for the Northern Recovery Unit of the Northwest Atlantic DPS. In North Carolina, 96.1 shoreline miles (154.6 km) of critical habitat for nesting loggerhead sea turtles was designated. Some of this acreage has been affected recently by activities such as beach nourishment, sandbag revetment construction, and groin construction. However, with the exception of beach nourishment activities and recreational activities, most of the critical habitat units in North Carolina remain relatively unaffected by development.

The green sea turtle nesting and hatching season North Carolina Beaches extends from May 15 through November 15. Incubation ranges from about 45 to 75 days. One green turtle nest was found on Holden Beach in both 2010 and 2013, and one nest was found on Oak Island in both 2007 and 2010 (data from NCWRC).

The leatherback sea turtle nesting and hatching season on North Carolina Beaches extends from April 15 through November 15. Incubation ranges from about 55 to 75 days. There was one leatherback nest reported on Holden Beach in 2010.

The Kemp's ridley sea turtle nesting and hatchling season on North Carolina Beaches appears to be similar to other species. Incubation ranges from 45 to 58 days. No nests have been reported on Holden Beach or Oak Island. However, Kemp's ridley sea turtles are known to occasionally nest throughout the state, and a Kemp's ridley stranded in April 2014 near the Holden Beach pier (http://www.hbturtlewatch.org/news/news-detail.php?2014-04-30-17-30-12-101).

2) Factors affecting the species environment within the Action Area

A wide range of recent and on-going beach disturbance activities have altered the proposed Action Area and, to a greater extent, the North Carolina coastline, and many more are proposed along the coastline for the near future. **Table 6** (page 54) lists the most recent projects, within the past 5 years.

Nourishment activities widen beaches, change their sedimentology and stratigraphy, alter coastal processes and often plug dune gaps and remove overwash areas.

Inlet dredging activities alter the sediment dynamics on adjacent shorelines and stabilize these dynamic environments; beach disposal of dredge material further alters the natural habitat adjacent to inlets. Estuarine dredging of navigational channels can alter water circulation patterns and sediment transport pathways, as well as increase the frequency and magnitude of boat wakes; sound-side sand or mud flats may be impacted by increased erosion rates as a result.

Beach scraping can artificially steepen beaches, stabilize dune scarps, plug dune gaps, and redistribute sediment distribution patterns. Artificial dune building, often a product of beach scraping, removes low-lying overwash areas and dune gaps. As chronic erosion catches up to structures throughout the Action Area, artificial dune systems are constructed and maintained to protect beachfront structures either by sand fencing or fill placement. Beach scraping or bulldozing has been frequent on North Carolina beaches in recent years, in response to storms and the continuing retreat of the shoreline with rising sea level. These activities primarily occur during the winter months. Artificial dune or berm systems have been constructed and maintained in several areas. These dunes make the artificial dune ridge function like a seawall that blocks natural beach retreat, evolution, and overwash.

Inlet stabilization projects, such as jetties and groins, reduce the dynamics of overwash areas adjacent to inlets.

The Service and NMFS share Federal jurisdiction for sea turtles under the Act. The Service has responsibility for sea turtles on the nesting beach. NMFS has jurisdiction for sea turtles in the marine environment. Activities proposed in this formal consultation would involve only impacts to sea turtles in the terrestrial environment, which includes the following life stages: nesting sea turtles, nests and eggs, and hatchlings as they emerge from the nest and crawl to the sea.

Threats to Sea Turtles

Coastal Development

Loss of sea turtle nesting habitat related to coastal development has had the greatest impact on nesting sea turtles. Beachfront development not only causes the loss of suitable nesting habitat, but can result in the disruption of powerful coastal processes accelerating erosion and interrupting the natural shoreline migration (National Research Council 1990b). This may in turn cause the need to protect upland structures and infrastructure by armoring, groin placement, beach emergency berm construction and repair, and beach nourishment, all of which cause changes in, additional loss of, or impact to the remaining sea turtle habitat.

Hurricanes and Storms

Hurricanes and other large storms were probably responsible for maintaining coastal beach habitat upon which sea turtles depend through repeated cycles of destruction, alteration, and recovery of beach and dune habitat. Hurricanes and large storms generally produce damaging winds, storm tides and surges, and rain, which can result in severe erosion of the beach and dune systems. Overwash and blowouts are common on barrier islands.

Hurricanes and other storms can result in the direct loss of sea turtle nests, either by erosion or washing away of the nests by wave action and inundation or “drowning” of the eggs or pre-emergent hatchlings within the nest, or indirectly by causing the loss of nesting habitat. Depending on their frequency, storms can affect sea turtles on either a short-term basis (nests lost for one season and/or temporary loss of nesting habitat) or long term, if frequent (habitat unable to recover). The manner in which hurricanes affect sea turtle nesting also depends on their characteristics (winds, storm surge, rainfall), the time of year (within or outside of the nesting season), and where the northeast edge of the hurricane crosses land.

Because of the limited remaining nesting habitat in a natural state with no immediate development landward of the sandy beach, frequent or successive severe weather events could threaten the ability of certain sea turtle populations to survive and recover. Sea turtles evolved under natural coastal environmental events such as hurricanes. The extensive amount of predevelopment coastal beach and dune habitat allowed sea turtles to survive even the most severe hurricane events. It is only within the last 20 to 30 years that the combination of habitat loss to beachfront development and destruction of remaining habitat by hurricanes has increased the threat to sea turtle survival and recovery. On developed beaches, typically little space remains for sandy beaches to become reestablished after periodic storms. While the beach itself moves landward during such storms, reconstruction or persistence of structures at their pre-storm locations can result in a loss of nesting habitat.

Erosion

A critically eroded area is a segment of shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. It is important to note that for an erosion problem area to be critical there must be an existing threat to or loss of one of four specific interests – upland development, recreation, wildlife habitat, or important cultural resources.

Beachfront Lighting

Artificial lights along a beach can deter females from coming ashore to nest or misdirect females trying to return to the surf after a nesting event. A significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Artificial beachfront lighting may also cause disorientation (loss of bearings) and misorientation (incorrect orientation) of sea turtle hatchlings. Visual signs are the primary sea-finding mechanism for hatchlings (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991). Artificial beachfront lighting is a documented cause of hatchling disorientation and misorientation on nesting beaches (Philibosian 1976; Mann 1977; Witherington and Martin 1996). The emergence from the nest and crawl to the sea is one of the most critical periods of a sea turtle's life. Hatchlings that do not make it to the sea quickly become food for ghost crabs, birds, and other predators, or become dehydrated and may never reach the sea. In addition, research has documented significant reduction in sea turtle nesting activity on beaches illuminated with artificial lights (Witherington 1992). During the 2010 sea turtle nesting season in Florida, over 47,000 turtle hatchlings were documented as being disoriented (FWC/FWRI 2011).

Predation

Predation of sea turtle eggs and hatchlings by native and introduced species occurs on almost all nesting beaches. Predation by a variety of predators can considerably decrease sea turtle nest hatching success. The most common predators in the southeastern U.S. are ghost crabs (Ocypode quadrata), raccoons (Procyon lotor), feral hogs (Sus scrofa), foxes (Urocyon cinereoargenteus and Vulpes vulpes), coyotes (Canis latrans), armadillos (Dasypus novemcinctus), and fire ants (Solenopsis invicta) (Dodd 1988; Stancyk 1995). In the absence of nest protection programs in a number of locations throughout the southeast U.S., raccoons may depredate up to 96 percent of all nests deposited on a beach (Davis and Whiting 1977; Hopkins and Murphy 1980; Stancyk et al. 1980; Talbert et al. 1980; Schroeder 1981; Labisky et al. 1986).

Beach Driving

The operation of motor vehicles on the beach affects sea turtle nesting by interrupting or striking a female turtle on the beach, headlights disorienting or misorienting emergent hatchlings, vehicles running over hatchlings attempting to reach the ocean, and vehicle tracks traversing the beach that interfere with hatchlings crawling to the ocean. Hatchlings appear to become diverted not because they cannot physically climb out of the rut (Hughes and Caine 1994), but because the sides of the track cast a shadow and the hatchlings lose their line of sight to the ocean horizon (Mann 1977). The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to dehydration and depredation during migration to the ocean (Hosier et al. 1981). Driving on the beach can cause sand compaction which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings, decreasing nest success and directly killing pre-emergent hatchlings (Mann 1977; Nelson and Dickerson 1987; Nelson 1988).

The physical changes and loss of plant cover caused by vehicles on dunes can lead to various degrees of instability, and therefore encourage dune migration. As vehicles move either up or down a slope, sand is displaced downward, lowering the trail. Since the vehicles also inhibit plant growth, and open the area to wind erosion, dunes may become unstable, and begin to migrate. Unvegetated sand dunes may continue to migrate across stable areas as long as vehicle traffic continues. Vehicular traffic through dune breaches or low dunes on an eroding beach may cause an accelerated rate of overwash and beach erosion (Godfrey et al. 1978). If driving is required, the area where the least amount of impact occurs is the beach between the low and high tide water lines. Vegetation on the dunes can quickly reestablish provided the mechanical impact is removed.

Climate Change

The varying and dynamic elements of climate science are inherently long term, complex, and interrelated. Regardless of the underlying causes of climate change, glacial melting and expansion of warming oceans are causing sea level rise, although its extent or rate cannot as yet be predicted with certainty. At present, the science is not exact enough to precisely predict when and where climate impacts will occur. Although we may know the direction of change, it may not be possible to predict its precise timing or magnitude. These impacts may take place gradually or episodically in major leaps.

Climate change is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level, according to the Intergovernmental Panel on Climate Change Report (IPCC 2007a). The IPCC Report (2007a) describes changes in natural ecosystems with potential widespread effects on many organisms, including marine mammals and migratory birds. The potential for rapid climate change poses a significant challenge for fish and wildlife conservation. Species' abundance and distribution are dynamic, relative to a variety of factors, including climate. As climate changes, the abundance and distribution of fish and wildlife will also change. Highly specialized or endemic species are likely to be most susceptible to the stresses of changing climate. Based on these findings and other similar studies, the U.S. Department of the Interior (DOI) requires agencies under its direction to consider potential climate change effects as part of their long-range planning activities (Service 2007).

In the southeastern U.S., climatic change could amplify current land management challenges involving habitat fragmentation, urbanization, invasive species, disease, parasites, and water management. Global warming will be a particular challenge for endangered, threatened, and other "at risk" species. It is difficult to estimate, with any degree of precision, which species will be affected by climate change or exactly how they will be affected. The Service will use Strategic Habitat Conservation planning, an adaptive science-driven process that begins with explicit trust resource population objectives, as the framework for adjusting our management strategies in response to climate change (Service 2006). As the level of information increases relative to the effects of global climate change on sea turtles and its designated critical habitat, the Service will have a better basis to address the nature and magnitude of this potential threat and will more effectively evaluate these effects to the range-wide status of sea turtles.

Temperatures are predicted to rise from 1.6°F to 9°F for North America by the end of this century (IPCC 2007a, b). Alterations of thermal sand characteristics could result in highly female-biased sex ratios because sea turtles exhibit temperature dependent sex determination (e.g., Glen and Mrosovsky 2004; Hawkes et al. 2008).

Along developed coastlines, and especially in areas where shoreline protection structures have been constructed to limit shoreline movement, rising sea levels will cause severe effects on nesting females and their eggs. Erosion control structures can result in the permanent loss of dry nesting beach or deter nesting females from reaching suitable nesting sites (National Research Council 1990a). Nesting females may deposit eggs seaward of the erosion control structures potentially subjecting them to repeated tidal inundation or washout by waves and tidal action.

Based on the present level of available information concerning the effects of global climate change on the status of sea turtles and their designated critical habitat, the Service acknowledges the potential for changes to occur in the Action Area, but presently has no basis to evaluate if or how these changes are affecting sea turtles or their designated critical habitat. Nor does our present knowledge allow the Service to project what the future effects from global climate change may be or the magnitude of these potential effects.

Recreational Beach Use

Human presence on or adjacent to the beach at night during the nesting season, particularly recreational activities, can reduce the quality of nesting habitat by deterring or disturbing and causing nesting turtles to avoid otherwise suitable habitat. In addition, human foot traffic can make a beach less suitable for nesting and hatchling emergence by increasing sand compaction and creating obstacles to hatchlings attempting to reach the ocean (Hosier et al. 1981).

The use and storage of lounge chairs, cabanas, umbrellas, catamarans, and other types of recreational equipment on the beach at night can also make otherwise suitable nesting habitat unsuitable by hampering or deterring nesting by adult females and trapping or impeding hatchlings during their nest to sea migration. The documentation of non-nesting emergences (also referred to as false crawls) at these obstacles is becoming increasingly common as more recreational beach equipment is left on the beach at night. Sobel (2002) describes nesting turtles being deterred by wooden lounge chairs that prevented access to the upper beach.

Sand Placement

Sand placement projects may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on sea turtle nest site selection, digging behavior, clutch viability, and hatchling emergence (Nelson and Dickerson 1987; Nelson 1988).

Beach nourishment projects create an elevated, wider, and unnatural flat slope berm. Sea turtles nest closer to the water the first few years after nourishment because of the altered profile (and perhaps unnatural sediment grain size distribution) (Ernest and Martin 1999; Trindell 2005)

Beach compaction and unnatural beach profiles resulting from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Sand compaction may increase the length of time required for female sea turtles to excavate nests and cause increased physiological stress to the animals (Nelson and Dickerson 1988b). These impacts can be minimized by using suitable sand.

A change in sediment color on a beach could change the natural incubation temperatures of sea turtle nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments should resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

In-water and Shoreline Alterations

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties or groins. Jetties are built perpendicular to the shoreline and extend through the entire nearshore zone and past the breaker zone to prevent or decrease sand deposition in the channel (Kaufman and Pilkey 1979). Groins are also shore-perpendicular structures that are designed to trap sand that would otherwise be transported by longshore currents and can cause downdrift erosion (Kaufman and Pilkey 1979).

These in-water structures have profound effects on adjacent beaches (Kaufman and Pilkey 1979). Jetties and groins placed to stabilize a beach or inlet prevent normal sand transport, resulting in accretion of sand on updrift beaches and acceleration of beach erosion downdrift of the structures (Komar 1983; Pilkey et al. 1984). Witherington et al. (2005) found a significant negative relationship between loggerhead nesting density and distance from the nearest of 17 ocean inlets on the Atlantic coast of Florida. The effect of inlets in lowering nesting density was observed both updrift and downdrift of the inlets, leading researchers to propose that beach instability from both erosion and accretion may discourage sea turtle nesting.

Following construction, the presence of groins and jetties may interfere with nesting turtle access to the beach, result in a change in beach profile and width (downdrift erosion, loss of sandy berms, and escarpment formation), trap hatchlings, and concentrate predatory fishes, resulting in higher probabilities of hatchling predation. In addition to decreasing nesting habitat suitability, construction or repair of groins and jetties during the nesting season may result in the destruction of nests, disturbance of females attempting to nest, and disorientation of emerging hatchlings from project lighting.

Threats to loggerhead sea turtle terrestrial habitat

Recreational beach use: beach cleaning, human presence (e.g., dog beach, special events, piers, and recreational beach equipment);

Beach driving: essential and nonessential off-road vehicles, all-terrain vehicles, and recreational access and use;

Predation: depredation of eggs and hatchlings by native and nonnative predators;

Beach sand placement activities: beach nourishment, beach restoration, inlet sand bypassing, dredge material disposal, dune construction, emergency sand placement after natural disaster, berm construction, and dune and berm planting;

In-water and shoreline alterations: artificial in-water and shoreline stabilization measures (e.g., in-water erosion control structures, such as groins, breakwaters, jetties), inlet relocation, inlet dredging, nearshore dredging, and dredging and deepening channels;

Coastal development: residential and commercial development and associated activities including beach armoring (e.g., sea walls, geotextile tubes, rock revetments, sandbags, emergency temporary armoring); and activities associated with construction, repair, and maintenance of upland structures, stormwater outfalls, and piers;
Artificial lighting: direct and indirect lighting, skyglow, and bonfires;

Beach erosion: erosion due to aperiodic, short-term weather-related erosion events, such as atmospheric fronts, northeasters, tropical storms, and hurricanes;

Climate change: includes sea level rise;

Habitat obstructions: tree stumps, fallen trees, and other debris on the beach; nearshore sand bars; and ponding along beachfront seaward of dry beach;

Human-caused disasters and response to natural and human-caused disasters: oil spills, oil spill response including beach cleaning and berm construction, and debris cleanup after natural disasters;

Military testing and training activities: troop presence, pyrotechnics and nighttime lighting, vehicles and amphibious watercraft usage on the beach, helicopter drops and extractions, live fire exercises, and placement and removal of objects on the beach.

C. EFFECTS OF THE ACTION

1) Factors to be considered

Proximity of action: Sand placement activities would occur within and adjacent to nesting habitat for sea turtles and dune habitats that ensure the stability and integrity of the nesting beach. Specifically, the project would potentially impact loggerhead, green, leatherback, and Kemp's ridley nesting females, their nests, and hatchling sea turtles.

Distribution: Sand placement activities may impact nesting and hatchling sea turtles and sea turtle nests occurring along 3,148 lf of shoreline on Oak Island.

The Service expects the proposed construction activities could directly and indirectly affect the availability of habitat for nesting and hatchling sea turtles.

Timing: The timing of the sand placement activities could directly and indirectly impact nesting females, their nests, and hatchling sea turtles when conducted between May 1 and November 15.

Nature of the effect: The effects of sand placement activities may change the nesting behavior of adult female sea turtles, diminish nesting success, and cause reduced hatching and emerging success. Sand placement can also change the incubation conditions within the nest. Any decrease in productivity and/or survival rates would contribute to the vulnerability of the sea turtles nesting in the southeastern United States.

Duration: The sand placement activity is a one-time activity expected to take up to four months to complete. Thus, the direct effects would be expected to be short-term in duration. Indirect effects from the activity may continue to impact nesting and hatchling sea turtles and sea turtle nests in subsequent nesting seasons.

Disturbance frequency: Sea turtle populations in the southeastern United States may experience decreased nesting success, hatching success, and hatchling emerging success that could result from the sand placement activities being conducted at night during one nesting season, or during the earlier or later parts of one or two nesting seasons.

Sand placement activities as a result of shore protection activities typically occur once every 3 to 5 years. Dredging and sand placement typically occurs during the winter work window, but can occur at any time during the year based on availability of funding and of dredges to conduct the work.

Disturbance intensity and severity: Depending on the timing of sand placement activities during the sea turtle nesting season, effects to the sea turtle populations in the southeastern United States could be important.

2) Analyses for effects of the action

The Action Area encompasses 3,148 linear feet of shoreline on the Atlantic coast of North Carolina.

Beneficial Effects: The placement of sand on a beach with reduced dry foredune habitat may increase sea turtle nesting habitat if the placed sand is highly compatible (i.e., grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach that is designed and constructed to mimic a natural beach system may benefit sea turtles more than an eroding beach it replaces.

Direct Effects: Potential adverse effects during the project construction phase include disturbance of existing nests, which may have been missed by surveyors and thus not marked for avoidance, disturbance of females attempting to nest, and disorientation of emerging hatchlings. In addition, heavy equipment will be required to re-distribute the sand to the original natural beach template. This equipment will have to traverse the beach portion of the Action Area, which could result in harm to nesting sea turtles, their nests, and emerging hatchlings.

Placement of sand on a beach in and of itself may not provide suitable nesting habitat for sea turtles. Although sand placement activities may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during project construction. Sand placement activities during the nesting season can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings. While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about 7 percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

a. Equipment during construction

The use of heavy machinery on beaches during a construction project may also have adverse effects on sea turtles. Equipment left on the nesting beach overnight can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure.

The operation of motor vehicles or equipment on the beach to complete the project work at night affects sea turtle nesting by: interrupting or colliding with a nesting turtle on the beach, headlights disorienting or misorienting emergent hatchlings, vehicles running over hatchlings attempting to reach the ocean, and vehicle ruts on the beach interfering with hatchlings crawling to the ocean. Apparently, hatchlings become diverted not because they cannot physically climb out of a rut (Hughes and Caine 1994), but because the sides of the track cast a shadow and the hatchlings lose their line of sight to the ocean horizon (Mann 1977). The extended period of travel required to negotiate tire ruts may increase the susceptibility of hatchlings to dehydration and depredation during migration to the ocean (Hosier et al. 1981). Driving directly above or over incubating egg clutches or on the beach can cause sand compaction, which may result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings, as well as directly kill pre-emergent hatchlings (Mann 1977; Nelson and Dickerson 1987; Nelson 1988).

The physical changes and loss of plant cover caused by vehicles on vegetated areas or dunes can lead to various degrees of instability and cause dune migration. As vehicles move over the sand, sand is displaced downward, lowering the substrate. Since the vehicles also inhibit plant growth, and open the area to wind erosion, the beach and dunes may become unstable. Vehicular traffic on the beach or through dune breaches or low dunes may cause acceleration of overwash and erosion (Godfrey et al. 1978). Driving along the beachfront should be between the low and high tide water lines. To minimize the impacts to the beach, dunes, and dune vegetation, transport and access to the construction sites should be from the road to the maximum extent possible. However, if vehicular access to the beach is necessary, the areas for vehicle and equipment usage should be designated and marked.

b. Artificial lighting as a result of an unnatural beach slope on the adjacent beach

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philibosian 1976; Mann 1977; FWC 2007). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches.

The unnatural sloped beach adjacent to the structure exposes sea turtles and their nests to lights that were less visible, or not visible, from nesting areas before the sand placement activity, leading to a higher mortality of hatchlings. Review of over 10 years of empirical information from beach nourishment projects indicates that the number of sea turtles impacted by lights increases on the post-construction berm. A review of selected nourished beaches in Florida (South Brevard, North Brevard, Captiva Island, Ocean Ridge, Boca Raton, Town of Palm Beach, Longboat Key, and Bonita Beach) indicated disorientation reporting increased by approximately 300 percent the first nesting season after project construction and up to 542 percent the second year compared to pre-nourishment reports (Trindell et al. 2005).

Specific examples of increased lighting disorientations after a sand placement project include Brevard and Palm Beach Counties, Florida. A sand placement project in Brevard County, completed in 2002, showed an increase of 130 percent in disorientations in the nourished area. Disorientations on beaches in the County that were not nourished remained constant (Trindell 2007). This same result was also documented in 2003 when another beach in Brevard County was nourished and the disorientations increased by 480 percent (Trindell 2007). Installing appropriate beachfront lighting is the most effective method to decrease the number of disorientations on any developed beach including nourished beaches. A shoreline protection project was constructed at Ocean Ridge in Palm Beach County, Florida, between August 1997 and April 1998. Lighting disorientation events increased after nourishment. In spite of continued aggressive efforts to identify and correct lighting violations in 1998 and 1999, 86 percent of the disorientation reports were in the nourished area in 1998 and 66 percent of the reports were in the nourished area in 1999 (Howard and Davis 1999).

c. Nest relocation

Besides the potential for missing nests during surveys and a nest relocation program, there is a potential for eggs to be damaged by nest movement or relocation, particularly if eggs are not relocated within 12 hours of deposition (Limpus et al. 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus et al. 1979; Ackerman 1980; Parmenter 1980; Spotila et al. 1983; McGehee 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard et al. 1984), mobilization of calcium (Packard and Packard 1986), mobilization of yolk nutrients (Packard et al. 1985), hatchling size (Packard et al. 1981; McGehee 1990), energy reserves in the yolk at hatching (Packard et al. 1988), and locomotory ability of hatchlings (Miller et al. 1987).

In a 1994 Florida study comparing loggerhead hatching and emerging success of relocated nests with nests left in their original location, Moody (1998) found that hatching success was lower in relocated nests at nine of 12 beaches evaluated. In addition, emerging success was lower in relocated nests at 10 of 12 beaches surveyed in 1993 and 1994. Many of the direct effects of beach nourishment may persist over time.

Indirect Effects: Many of the direct effects of beach nourishment may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

a. Changes in the physical environment

Beach nourishment projects create an elevated, wider, and unnatural flat slope berm. Sea turtles nest closer to the water the first few years after nourishment because of the altered profile (and perhaps unnatural sediment grain size distribution) (Ernest and Martin 1999; Trindell 2005).

Beach compaction and unnatural beach profiles resulting from beach nourishment activities could negatively impact sea turtles regardless of the timing of projects. Very fine sand or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987; Nelson and Dickerson 1988a). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer 1980; Raymond 1984; Nelson and Dickerson 1987; Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and cause increased physiological stress to the animals (Nelson and Dickerson 1988b). Nelson and Dickerson (1988c) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling (minimum depth of 36 inches) compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for only up to 1 year. Thus, multi-year beach compaction monitoring and, if necessary, tilling would help to ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments should resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

b. Escarpment formation

On nourished beaches, steep escarpments may develop along their water line interface as they adjust from an unnatural construction profile to a more natural beach profile (Coastal Engineering Research Center 1984; Nelson et al. 1987). Escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). Researchers have shown that female sea turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (e.g., in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

c. Increased susceptibility to catastrophic events

Nest relocation within a nesting season may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn 1998; Wyneken et al. 1998).

d. Increased beachfront development

Pilkey and Dixon (1996) stated that beach replenishment frequently leads to more development in greater density within shorefront communities that are then left with a future of further replenishment or more drastic stabilization measures. Dean (1999) also noted that the very existence of a beach nourishment project can encourage more development in coastal areas. Following completion of a beach nourishment project in

Miami during 1982, investment in new and updated facilities substantially increased tourism there (National Research Council 1995). Increased building density immediately adjacent to the beach often resulted as much larger buildings that accommodated more beach users replaced older buildings. Overall, shoreline management creates an upward spiral of initial protective measures resulting in more expensive development that leads to the need for more and larger protective measures. Increased shoreline development may adversely affect sea turtle nesting success. Greater development may support larger populations of mammalian predators, such as foxes and raccoons, than undeveloped areas (National Research Council 1990a), and can also result in greater adverse effects due to artificial lighting, as discussed above.

3) Species' response to a proposed action

The Service determined there is a potential for long-term adverse effects on sea turtles as a result of sand placement. However, the Service acknowledges the potential benefits of the sand placement project, since it provides additional sea turtle nesting habitat. Nonetheless, an increase in sandy beach may not necessarily equate to an increase in suitable sea turtle nesting habitat.

The following summary illustrates sea turtle responses to and recovery from a nourishment project comprehensively studied by Ernest and Martin (1999). A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on natural or pre-nourished beaches. This reduction in nesting success is most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (e.g., beach profile, sediment grain size, beach compaction, frequency and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on untilled, hard-packed sands increases significantly relative to natural conditions. However, tilling (minimum depth of 36 inches) is effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to natural levels (Ernest and Martin 1999).

During the first post-construction year, nests on nourished beaches are deposited significantly seaward of the toe of the dune and significantly landward of the tide line than nests on natural beaches. More nests are washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped natural beaches. This phenomenon may persist through the second post-construction year monitoring and result from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occur as the beach equilibrates to a more natural contour.

The principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin (1999) indicated that changes in beach profile may be more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

D. Cumulative Effects

This project occurs on non-federal lands. Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion.

It is reasonable to expect continued shoreline stabilization and beach renourishment projects in this area in the future since erosion and sea-level rise increases would impact the existing beachfront development.

VII. CONCLUSION

Piping Plovers

After reviewing the current status of the northern Great Plains, Great Lakes, and Atlantic Coast wintering piping plover populations, the environmental baseline for the Action Area, the effects of the proposed activities, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the piping plover. For the piping plover, dredging and sand placement activities will affect 3.49 acres of critical habitat and 3,148 lf of shoreline. It is the Service's biological opinion that implementation of these actions, as proposed, is not likely to adversely modify piping plover critical habitat. Although 3.49 acres of the approximately 90-acre critical habitat unit will be destroyed by the project, the rest of the critical habitat unit should remain functional to serve the intended conservation role for the piping plover.

Red Knot

After reviewing the current status of the migrating and wintering red knot populations, the environmental baseline for the Action Area, the effects of the proposed dredging and sand placement, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the red knot.

Seabeach Amaranth

After reviewing the current status of the seabeach amaranth population, the environmental baseline for the Action Area, the effects of the proposed sand placement, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that implementation of these actions, as proposed, is not likely to jeopardize the continued existence of the seabeach amaranth.

Sea Turtles

After reviewing the current status of the nesting loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle, the environmental baseline for the Action Area, the effects of the proposed sand placement, the proposed Conservation Measures, and the cumulative effects, it is the Service's biological opinion that the placement of sand is not likely to jeopardize the continued existence of the loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle. The Service has determined that the project is not likely to destroy or adversely modify designated critical habitat for nesting loggerhead sea turtles.

The conservation of the five loggerhead recovery units in the Northwest Atlantic is essential to the recovery of the loggerhead sea turtle. Each individual recovery unit is necessary to conserve genetic and demographic robustness, or other features necessary for long-term sustainability of the entire population. Thus, maintenance of viable nesting in each recovery unit contributes to the overall population. The NRU, one of the five loggerhead recovery units in the Northwest Atlantic occurs within the Action Area. The NRU averages 5,215 nests per year (based on 1989-2008 nesting data). Of the available nesting habitat within the NRU, construction will occur and/or will likely have an effect on 3,148 lf of nesting shoreline.

Generally, green, leatherback and Kemp's ridley sea turtle nesting overlaps with or occurs within the beaches where loggerhead sea turtles nest on both the Atlantic and Gulf of Mexico beaches. Thus, for green, leatherback, and Kemp's ridley sea turtles, sand placement activities will affect 3,148 lf of shoreline.

Research has shown that the principal effect of sand placement on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year or two following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequency of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below in Sections VIII and IX are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the Applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the Applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impacts on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of state law or regulation, or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE

Amount or Extent of Take – Piping Plover

It is difficult for the Service to estimate the exact number of piping plovers that could be migrating through or wintering within the Action Area at any point in time and place during and after project construction and maintenance events. Disturbance to suitable habitat resulting from dredging and placement of sand would affect the ability of an undetermined number of piping plovers to find suitable foraging and roosting habitat during construction and maintenance for an unknown length of time after construction.

The Service anticipates that directly and indirectly an unspecified amount of piping plovers in 3.49 acres of critical habitat and along 3,148 lf of shoreline, all at some point, potentially usable by piping plovers, could be taken in the form of habitat loss as a result of this proposed action; however, incidental take of piping plovers will be difficult to detect for the following reasons:

(1) harassment to the level of harm may only be apparent on the breeding grounds the following year; and
(2) dead plovers may be carried away by waves or predators.

The level of take of this species can be anticipated by the proposed activities because:

(1) piping plovers migrate through and winter in the Action Area;
(2) the dredging of intertidal shoals is a direct loss of piping plover critical habitat;
(3) the placement of the constructed beach is expected to affect the coastal morphology and prevent early successional stages, thereby precluding the maintenance and creation of additional recovery habitat;
(4) increased levels of pedestrian disturbance may be expected; and
(5) a temporary reduction of food base will occur.

The Service has reviewed the biological information and other information relevant to this action. The take is expected in the form of harm and harassment because of: (1) decreased fitness and survivorship of plovers due to loss and degradation of foraging and roosting habitat; (2) decreased fitness and survivorship of plovers attempting to migrate to breeding grounds due to loss and degradation of foraging and roosting habitat.

Amount or Extent of Take – Red Knot

It is difficult for the Service to estimate the exact number of red knots that could be migrating through or wintering within the Action Area at any one point in time and place during project construction. Disturbance to suitable habitat resulting from both construction and sand placement activities within the Action Area would affect the ability of an undetermined number of red knots to find suitable foraging and roosting habitat during any given year.

The Service anticipates that directly and indirectly an unspecified amount of red knots along 3,148 feet of shoreline, all at some point, potentially usable by red knots, could be taken in the form of harm and harassment as a result of this proposed action; however, incidental take of red knots will be difficult to detect for the following reasons:

(3) harassment to the level of harm may only be apparent on the breeding grounds the following year; and
(4) dead red knots may be carried away by waves or predators.

The level of take of this species can be anticipated by the proposed activities because:

(6) red knots migrate through and winter in the Action Area;

(7) the placement of the constructed beach is expected to affect the coastal morphology and prevent early successional stages, thereby precluding the maintenance and creation of additional recovery habitat;
(8) increased levels of pedestrian disturbance may be expected; and
(9) a temporary reduction of food base will occur.

The Service has reviewed the biological information and other information relevant to this action. The take is expected in the form of harm and harassment because of: (1) decreased fitness and survivorship of red knots due to loss and degradation of foraging and roosting habitat; (2) decreased fitness and survivorship of red knots attempting to migrate to breeding grounds due to loss and degradation of foraging and roosting habitat.

Amount or Extent of Take – Loggerhead, Green, Leatherback, and Kemp's ridley Sea Turtles

The Service anticipates 3,148 lf of nesting beach habitat could be taken as a result of this proposed action.

Take is expected to be in the form of: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey, nest mark and avoidance program, or egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey, nest mark and avoidance, or egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) misdirection of nesting and hatchling turtles on beaches adjacent to the sand placement or construction area as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the Action Area during the nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) Destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service.

Incidental take is anticipated for the 3,148 lf of beach that has been identified. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) the turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey, nest mark and avoidance, or egg relocation program (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and prevent an unknown number of females from accessing a suitable nesting site.

However, the level of take of these species can be anticipated by the sand placement activities on suitable turtle nesting beach habitat because: (1) turtles nest within the Action Area; (2) construction will likely occur during a portion of the nesting season; (3) the renourishment project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting hatchling turtles.

EFFECT OF THE TAKE

Piping Plovers

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the piping plover species. The Service has determined that the proposed project will not result in destruction or adverse modification of critical habitat for the piping plover. Incidental take of piping plovers is anticipated to occur within 3.49 acres of critical habitat and along approximately 3,148 feet of shoreline.

Red Knot

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the red knot species. Incidental take of red knots is anticipated to occur within 3.49 acres of intertidal habitats and along approximately 3,148 feet of shoreline.

Seabeach Amaranth

In the accompanying biological opinion, the Service determined that the potential of the project to damage or destroy seabeach amaranth is not likely to result in jeopardy to the seabeach amaranth species. Damage or destruction of seabeach amaranth plants is anticipated to occur along approximately 3,148 feet of shoreline.

Loggerhead, Green, Leatherback, and Kemp's ridley Sea Turtles

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the loggerhead sea turtle, green sea turtle, leatherback sea turtle, and Kemp's ridley sea turtle species. The Service has determined that the proposed project will not result in destruction or adverse modification of critical habitat for the loggerhead sea turtle. Incidental take of nesting and hatchling sea turtles is anticipated to occur along 3,148 feet of shoreline.

VIII. REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take of piping plovers, red knot, seabeach amaranth, and sea turtles. Unless specifically addressed below, these RPMs are applicable for the initial dredging and placement of sand, and for any maintenance activities for the life of the permit. If the Applicant is unable to comply with the RPMs and Terms and Conditions, the Corps as the regulatory authority may inform the Service why the

RPM or Term and Condition is not reasonable and prudent for the specific project or activity and request exception under the biological opinion.

RPMs – All Species

1. After initial construction, and for the life of the permit, all maintenance dredging and sand placement activities must be conducted within the winter work window (November

16 to March 31), unless necessitated by an emergency condition and allowed after consultation with the Service.

2. All derelict coastal armoring geotextile material and other debris must be removed from the beach to the maximum extent possible, prior to construction.
3. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure.

4. Predator-proof trash receptacles must be installed and maintained at all beach access points used for the project construction, to minimize the potential for attracting predators of piping plovers.

5. Pipeline placement must be coordinated with NCDCM, the USACE, the USFWS Raleigh Field Office and the NCWRC.

RPMs - Piping Plover and Red Knot

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers are present. Construction operations shall not begin until individual plovers have exited the work area for the day.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds and other shorebirds during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later. Based on results of the monitoring, continued bird monitoring may also be required during maintenance events. Post-construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the USACE, USFWS, NCDCM, and NCWRC.

RPMs – Loggerhead, Green, Leatherback, and Kemp's Ridley Sea Turtles

1. Only beach compatible fill must be placed on the beach or in any associated dune system.

Beach compatible fill must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior sand placement activity. In general, fill material that meets the requirements of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

2. During dredging operations, material placed on the beach shall be inspected daily to ensure compatibility. If during the sampling process non-beach compatible material, including large amounts of shell or rock, is or has been placed on the beach all work shall stop immediately and the NCDCM and the USACE will be notified by the permittee and/or its contractors to determine the appropriate plan of action.

3. From May 1 through November 15, to the maximum extent practicable, excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day.

4. If any nesting turtles are sighted on the beach during construction, construction activities must cease immediately until the turtle has returned to the water, and the sea turtle permit holder responsible for nest monitoring has marked for avoidance or relocated any nest(s) that may have been laid. If a nesting sea turtle is observed at night, all work on the beach will cease and all lights will be extinguished (except for those absolutely necessary for safety) until after the female has finished laying eggs and returned to the water.

5. If any work on the beach is conducted during the sea turtle nesting season (May 1 through November 15), the Applicant shall submit a lighting plan for the equipment and dredge that will be used in the project. The plan shall include a description of each light source that will be visible on or from the beach and the measures implemented to minimize this lighting.

6. Daily nesting surveys (before 9 am) for sea turtle nests are required if any portion of the sand placement occurs during the period from May 1 through November 15. If sand is placed on the beach at night, a nighttime monitor must survey the beach area that is affected that night, prior to the morning's normal nesting activity survey. No construction or sand placement activity may commence until completion of the sea turtle nesting survey each morning. If nests are constructed in the project area during the nesting season, the nests must be marked and either avoided until completion of the project or relocated.

7. From May 1 through November 15, construction equipment must not be stored on the beach. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. Pipes placed parallel to the dune must be 5 to 10 feet away from the toe of the dune if the width of the beach allows.

8. Demobilization of equipment from the beach must be conducted only during daylight hours, after the daily survey for sea turtle nests has been completed. Any nests that are identified must be marked for avoidance and avoided during all demobilization activities.

9. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, and within 30 days prior to May 1 for two subsequent years after any construction or sand placement event.

10. Sand compaction must be monitored at least twice after each sand placement event. Sand compaction must be monitored in the project area immediately after completion of any sand placement event and one time after project completion between October 1 and May 1.

11. Sea turtle nesting surveys must be conducted within the project area between May 1 and November 15 of each year, for at least two consecutive nesting seasons after completion of each sand placement activity (2 years post-construction monitoring after initial
12. construction and each maintenance event).

13. A report describing the fate of sea turtle nests and hatchlings and any actions taken, must be submitted to the Raleigh Field Office following completion of the proposed work for each year when a sand placement activity has occurred.

IX. TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. Unless addressed specifically below, the terms and conditions are applicable for the initial dredging and placement of sand, and for any maintenance activities for the life of the permit.

Terms and Conditions – All Species

1. After initial construction, and for the life of the permit, all maintenance dredging and sand placement activities must be conducted within the winter work window (November 16 to March 31), unless necessitated by an emergency condition and allowed after consultation with the Service.

2. All derelict coastal armoring geotextile material and other debris must be removed from the beach to the maximum extent possible, prior to any construction.

3. Conservation Measures included in the permit application/project plans must be implemented in the proposed project. If a RPM and Term and Condition address the same requirement, the requirements of the RPM and Term and Condition take precedent over the Conservation Measure.

4. Predator-proof trash receptacles must be installed and maintained during construction at all beach access points used for the project construction and any maintenance events, to minimize the potential for attracting predators of piping plovers. All contractors conducting the work must provide predator-proof trash receptacles for the construction workers. All contractors and their employees must be briefed on the importance of not littering and keeping the Action Area free of trash and debris. See the Appendix for examples of suitable receptacles.

5. Pipeline placement must be coordinated with NCDCM, the USACE, the USFWS Raleigh Field Office and the NCWRC.

Terms and Conditions – Piping Plovers and Red Knots

1. All personnel involved in the construction or sand placement process along the beach shall be trained to recognize the presence of piping plovers prior to initiation of work on the beach. Before start of work each morning, a visual survey must be conducted in the area of work for that day, to determine if piping plovers and red knots are present. If plovers or red knots are present in the work area, careful movement of equipment in the early morning hours should allow those individuals to move out of the area. Construction operations shall not begin until individual plovers have exited the work area for the day.

If piping plovers are observed, the observer shall make a note on the Quality Assurance form for that day, and submit the information to the Corps and the Service's Raleigh Field Office the following day. See REPORTING REQUIREMENTS, below.

2. A bird monitoring plan must be developed to monitor piping plover, red knot, waterbirds, colonial waterbirds, and other shorebirds during and after construction. Monitoring must be conducted for a minimum of three (3) full years past the completion of construction, or until the end of the shorebird nesting season (August 31) of the third year after construction, whichever is later. Based on results of the monitoring, continued bird monitoring may also be required during maintenance events. Post-construction monitoring may only be ceased after the review of at least three years' worth of data and approval by the USACE, USFWS, NCDCM, and NCWRC.
    a. The bird monitoring plan must be submitted for review and approval to the USACE, USFWS, NCDCM, and NCWRC, at least 15 days prior to the anticipated start of construction.
    b. During construction, bird monitoring must be conducted weekly. For at least three years after construction is completed, bimonthly (twice-monthly) bird surveys shall be conducted in all intertidal and shoreline areas along Lockwood Folly Inlet. Transects shall be established to encompass, at a minimum, all intertidal areas in the vicinity of Eastern Channel and Lockwoods Folly Inlet on both sides of the inlet (Oak Island, Sheep Island, and Holden Beach), and the ocean shoreline from Lockwoods Folly Inlet east to approximately 6001 West Beach Drive (or the eastern end of the westernmost sand placement area).
    c. Field observations must be conducted during daylight hours, and primarily during high tide.
    d. Shorebird identification, especially when in non-breeding plumage, can be difficult. The person(s) conducting the survey must demonstrate the qualifications and ability to identify shorebird species and be able to provide the information listed below. The bird monitoring plan should include the collection and reporting of the following:
        i. Date, location, time of day, weather, and tide cycle when survey was conducted;
        ii. Latitude and longitude of observed piping plover and red knot locations (decimal degrees preferred);
        iii. Any color bands observed on piping plovers or red knots or other birds;
        iv. Behavior (e.g., foraging, roosting, preening, bathing, flying, aggression, walking, courtship, copulation);

v. Landscape features(s) where birds are located (e.g., inlet spit, tidal creeks, shoals, lagoon shoreline);
vi. Habitat features(s) used by birds when observed (e.g., intertidal, fresh wrack, old wrack, dune, mid-beach, vegetation);
vii. Substrata used by birds (e.g., sand, mud/sand, mud, algal mat); and
viii. The amount and type of recreational use (e.g., people, dogs on or off leash, vehicles, kite-boarders).

e. All monitoring information shall be provided in standardized form on an Excel spreadsheet. Monitoring results shall be submitted (datasheets, maps, database) on standard electronic media (e.g., CD, DVD) to the Raleigh Field Office. Please see REPORTING REQUIREMENTS below, for more information.

Terms and Conditions – Sea Turtles

1. Only beach compatible fill must be placed on the beach or in any associated dune system. Beach compatible fill must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior sand placement activity. Beach compatible fill must be sand solely of natural sediment and shell material, containing no construction debris, toxic material, large amounts of gravel or rock, or other foreign matter. The beach compatible fill must be similar in both color and grain size distribution (sand grain frequency, mean and median grain size and sorting coefficient) to the native material in the Action Area. Beach compatible fill is material that maintains the general character and functionality of the material occurring on the beach and in the adjacent dune and coastal system. In general, fill material that meets the requirements of the North Carolina Technical Standards for Beach Fill (15A NCAC 07H .0312) is considered compatible.

2. During dredging operations, material placed on the beach shall be inspected daily to ensure compatibility. If during the sampling process non-beach compatible material, including large amounts of shell or rock, is or has been placed on the beach all work shall stop immediately and the NCDCM and the USACE will be notified by the permittee and/or its contractors to determine the appropriate plan of action.

3. From May 1 through November 15, to the maximum extent practicable, excavations and temporary alteration of beach topography will be filled or leveled to the natural beach profile prior to 9:00 p.m. each day.

4. If any nesting turtles are sighted on the beach during construction, construction activities must cease immediately until the turtle has returned to the water, and the sea turtle permit holder responsible for nest monitoring has marked for avoidance or relocated any nest(s) that may have been laid. If a nesting sea turtle is observed at night, all work on the beach will cease and all lights will be extinguished (except for those absolutely necessary for safety) until after the female has finished laying eggs and returned to the water.

5. If any work on the beach is conducted during the sea turtle nesting season (May 1 through November 15), the Applicant shall submit a lighting plan for the equipment and dredge that will be used in the project. The plan shall include a description of each light source that will be visible on or from the beach and the measures implemented to minimize this lighting.

6. Direct lighting of the beach and nearshore waters must be limited to the immediate construction area during the nesting season and must comply with safety requirements. Lighting on all equipment must be minimized through reduction, shielding, lowering, and appropriate placement to avoid excessive illumination of the water's surface and nesting beach while meeting all Coast Guard, Corps EM 385-1-1, and OSHA requirements. Light intensity of lighting equipment must be reduced to the minimum standard required by OSHA for General Construction areas, in order to not misdirect sea turtles. Shields must be affixed to the light housing and be large enough to block light from all on-beach lamps from being transmitted outside the construction area or to the adjacent sea turtle nesting beach (**Figure 6**).

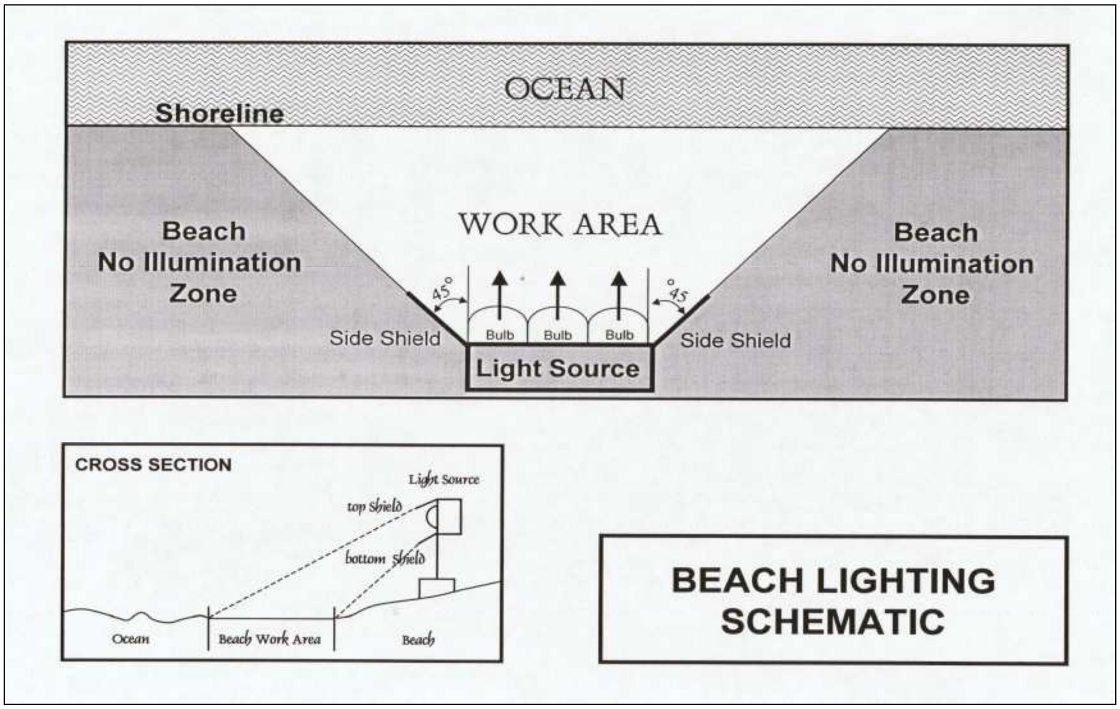


Figure 6. Beach lighting schematic.

7. Daily nesting surveys (before 9 am) for sea turtle nests are required if any portion of the sand placement occurs during the period from May 1 through November 15. If sand is placed on the beach at night, a nighttime monitor must survey the beach area that is affected that night, prior to the morning's normal nesting activity survey. No construction or sand placement activity may commence until completion of the sea turtle nesting survey each morning. If nests are constructed in the project area during the nesting season, the nests must be marked and either avoided until completion of the project or relocated.
    a. Nesting surveys must be initiated by May 1 and must continue through the end of the project. If nests are constructed in areas where they may be affected by construction activities, the eggs must be relocated to minimize sea turtle nest burial, crushing of eggs, or nest excavation.
    b. Nesting surveys and nest marking will only be conducted by personnel with prior experience and training in these activities, and who are duly authorized to conduct such activities through a valid permit issued by the Service or the NCWRC.
    c. Only those nests that may be affected by construction or sand placement activities will be relocated. Nest relocation must not occur upon completion of the project. For demobilization, nests will be marked and avoided. Nests requiring relocation

must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Relocated nests must not be placed in organized groupings. Relocated nests must be randomly staggered along the length and width of the beach in settings that are not expected to experience daily inundation by high tides or known to routinely experience severe erosion and egg loss, predation, or subject to artificial lighting. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests.

d. Nests deposited within areas where construction activities have ceased must be marked for avoidance and left in situ unless other factors threaten the success of the nest. Nests must be marked with four stakes at a 10-foot distance around the perimeter of the nest for the buffer zone. The turtle permit holder must install an on-beach marker at the nest site and a secondary marker at a point as far landward as possible to assure that future location of the nest will be possible should the on-beach marker be lost. No activities that could result in impacts to the nest will occur within the marked area. Nest sites must be inspected daily to assure nest markers remain in place and the nest has not been disturbed by the project activity.

8. From May 1 through November 15, construction equipment must not be stored on the beach. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. Pipes placed parallel to the dune must be 5 to 10 feet away from the toe of the dune if the width of the beach allows. If pipes are stored on the beach, they must be placed in a manner that will minimize the impact to nesting habitat and must not compromise the integrity of the dune systems.
9. Demobilization of equipment from the beach must be conducted only during daylight hours, after the daily survey for sea turtle nests has been completed. Any nests that are identified must be marked for avoidance as described in number 7.d. above, and avoided during all demobilization activities.

10. Visual surveys for escarpments along the Action Area must be made immediately after completion of sand placement, and within 30 days prior to May 1 for two subsequent years after any construction or sand placement event. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled and the beach profile must be reconfigured to minimize scarp formation by the dates

listed above. Any escarpment removal must be reported by location. If the sand placement activities are completed during the early part of the sea turtle nesting and hatching season (May 1 through May 30), escarpments must be leveled immediately, while protecting nests that have been relocated or left in place. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service or NCWRC will provide a brief written authorization within 30 days that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service's Raleigh Field Office.

11. Sand compaction must be monitored at least twice after each sand placement event. Sand compaction must be monitored in the project area immediately after completion of any sand placement event and one time after project completion between October 1 and May 1. Out-year compaction monitoring and remediation are not required if the placed material no longer remains on the dry beach. Within 7 days of completion of sand placement and prior to any tilling (if needed), a field meeting shall be held with USFWS, NCWRC and the USACE to inspect the project area for compaction and determine whether tilling is needed.
    a. If tilling is needed, the area must be tilled to a depth of 36 inches. All tilling activities shall be completed prior to May 1 of any year.
    b. Tilling must occur landward of the wrack line and avoid all vegetated areas that are 3 square feet of greater, with a 3 square feet buffer around all vegetation.
    c. If tilling occurs during the shorebird nesting season (after April 1, shorebird surveys are required prior to tilling per the Migratory Bird Treaty Act.
    d. A summary of the compaction assessments and the actions taken shall be included in the annual report to NCDCM, the USACE and the USFWS Raleigh Field Office.
    e. These conditions will be evaluated and may be modified if necessary to address and identify sand compaction problems.

12. Sea turtle nesting surveys must be conducted within the project area between May 1 and November 15 of each year, for at least two consecutive nesting seasons after completion of each sand placement activity (2 years post-construction monitoring after initial construction and each maintenance event). Acquisition of readily available sea turtle nesting data from qualified sources (volunteer organizations, other agencies, etc.) is

acceptable. However, in the event that data from other sources cannot be acquired, the permittee will be responsible to collect the data. Data collected by the permittee for each nest should include, at a minimum, the information in the table, below. This information will be provided to the Raleigh Field Office in the annual report, and will be used to periodically assess the cumulative effects of these projects on sea turtle nesting and hatchling production and monitor suitability of post construction beaches for nesting. Please see REPORTING REQUIREMENTS below.

Parameter	**Measurement**	**Variable**
Number of False Crawls	Visual Assessment of all false crawls	Number/location of false crawls in nourished areas; any interaction of turtles with obstructions, such as sand bags or scarps, should be noted.
Nests	Number	The number of sea turtle nests in nourished areas should be noted. If possible, the location of all sea turtle nests should be marked on a project map, and approximate distance to scarps or sandbags measured in meters. Any abnormal cavity morphologies should be reported as well as whether turtle touched sandbags or scarps during nest excavation.
Nests	Lost Nests	The number of nests lost to inundation or erosion or the number with lost markers.
Nests	Relocated nests	The number of nests relocated and a map of the relocation area(s). The number of successfully hatched eggs per relocated nest.
Lighting Impacts	Disoriented sea turtles	The number of disoriented hatchlings and adults

13. A report describing the fate of sea turtle nests and hatchlings and any actions taken, must be submitted to the Raleigh Field Office following completion of the proposed work for each year when a sand placement activity has occurred. Please see REPORTING REQUIREMENTS below, for more information.

X. REPORTING REQUIREMENTS

Information required in the above Terms and Conditions should be submitted to the following address:

Pete Benjamin, Supervisor
Raleigh Field Office
U.S. Fish and Wildlife Service
Post Office Box33726
Raleigh, North Carolina 27636-3726
(919) 856-4520

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the USFWS Law Enforcement Office below. Additional notification must be made to the USFWS Ecological Services Field Office identified above and to the NCWRC at (252) 241-7367. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Tom Chisdock
U.S. Fish and Wildlife Service
160 Zillicoa St.
Asheville, NC 28801
828-258-2084

XI. COORDINATION OF INCIDENTAL TAKE STATEMENT WITH OTHER LAWS, REGULATIONS, AND POLICIES

The USFWS will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 USC S 703-712), if such take is in compliance with the terms and conditions specified herein. Take resulting from activities that are not in conformance with the Corps permit or this biological opinion (e.g. deliberate harassment of wildlife, etc.) are not considered part of the proposed action and are not covered by this incidental take statement and may be subject to enforcement action against the individual responsible for the act.

XII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

For the benefit of the piping plover, the Service recommends the following conservation recommendations:

1. Construction activities for this project and similar future projects should be planned to take place outside the shorebird nesting season.

2. The Applicant should maintain suitable piping plover migrating and wintering habitat. Natural accretion at inlets should be allowed to remain. Accreting sand spits on barrier islands provide excellent foraging habitat for migrating and wintering plovers.

3. A conservation/education display sign would be helpful in educating local beach users about the coastal beach ecosystem and associated rare species. The sign could highlight the piping plovers life history and basic biology and ways recreationists can assist in

species protection efforts (e.g., keeping pets on a leash, removing trash to sealed refuse containers, etc.). The Service would be willing to assist the Applicant in the development of such a sign, in cooperation with NCWRC, interested non-governmental stakeholders (i.e., National Audubon Society), the Corps, and the other interested stakeholders (i.e., property owners, etc.).

For the benefit of sea turtles, the Service recommends the following conservation recommendations:

1. Construction activities for this project and similar future projects should be planned to take place outside the main part of the sea turtle nesting and hatching season, as much as possible.

2. Appropriate native salt-resistant dune vegetation should be established on the restored dunes.

3. Educational signs should be placed where appropriate at beach access points explaining the importance of the area to sea turtles and/or the life history of sea turtle species that nest in the area.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

XIII. REINITIATION NOTICE – CLOSING STATEMENT

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion or the project has not been completed within five years of the issuance of this biological opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

For this biological opinion, the incidental take will be exceeded when the stabilization of beach extends beyond the project's authorized boundaries (3,148 lf of beach and/or 3.49 acre of intertidal shoals). Incidental take of an undetermined number of adult, young, or eggs of sea turtles, piping plovers, red knots, and seabeach amaranth plants has been exempted from the prohibitions of section 9 by this opinion.

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Appendix

EXAMPLES OF PREDATOR PROOF TRASH RECEPTACLES

Example of predator proof trash receptacle at Gulf Islands National Seashore. Lid must be tight fitting and made of material heavy enough to stop animals such as raccoons.

Example of trash receptacle anchored into the ground so it is not easily turned over.

Example of predator proof trash receptacle at Perdido Key State Park. Metal trash can is stored inside. Cover must be tight fitting and made of material heavy enough to stop animals such as raccoons.

Example of trash receptacle must be secured or heavy enough so it is not easily turned over.