Currituck Sound Ecosystem Restoration Study

Feasibility Scoping Meeting
2 September 2011

US Army Corps of Engineers
BUILDING STRONG®

Currituck Sound Ecosystem Restoration FSM Presentation

- Study Background
- Historic Overview
  - Marsh and Shallow Water
  - Submerged Aquatic Vegetation
  - Shorebird Nesting
  - Wading Bird Nesting
- Systems Context
- Existing Conditions
  - SAV/ Coastal Marsh and Shallow Water Complexes
  - Bird Nesting Islands
- Future without Project Conditions
  - SAV/ Coastal Marsh and Shallow Water Complexes
  - Bird Nesting Islands
- NER Plan Formulation
  - Problems and Opportunities
  - Planning Objectives and Constraints
  - Sighting of Restoration Opportunities
  - Measures
  - EBA
  - Additional Information
- Next Milestones
- Discussion

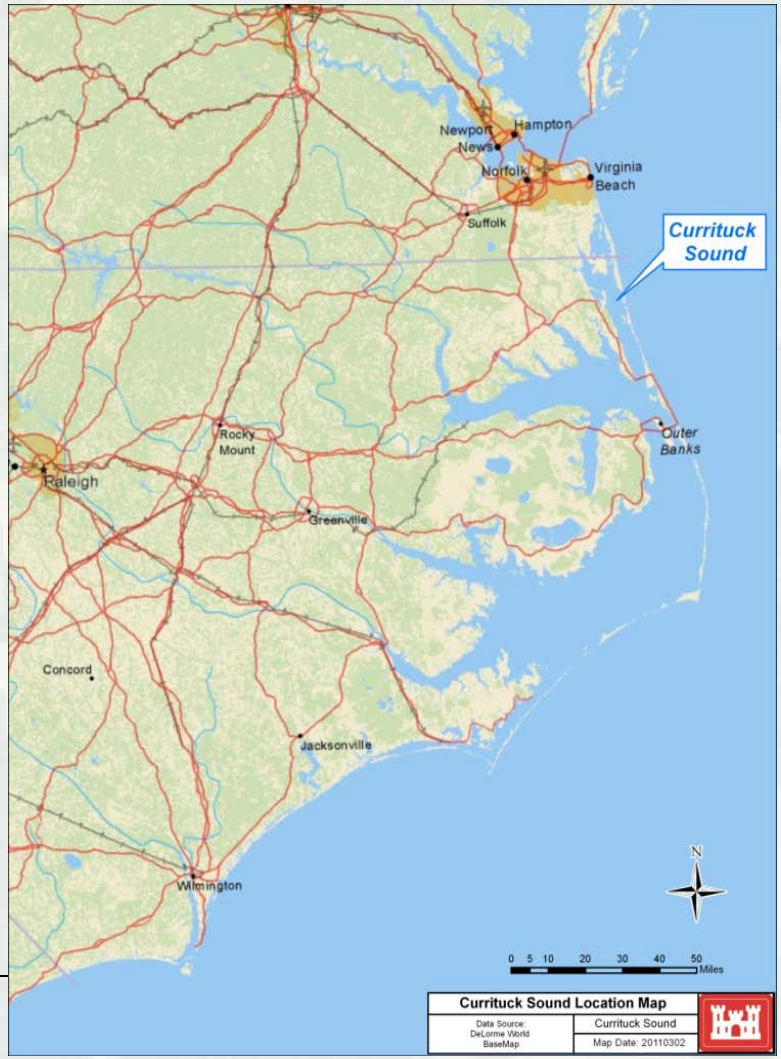
Historic Project Overview

Study Authority	March 11, 1998
Reconnaissance Report Approved	July 2001
Feasibility Cost Sharing Agreement	February 2004
ATR – FSM Package	September 2009
HQ Policy Review – FSM Package	March 2010
Policy Guidance Memorandum Received	May 2010
IPR 1	May 2010
IPR 2	December 2010
IPR 3	March 2011
Policy Compliance Memorandum	June 2011
Feasibility Scoping Meeting	September 2011

Currituck Sound Ecosystem Restoration Study

Currituck Sound Study Authority

"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that the Secretary of the Army is requested to review the report of the Division Engineer dated June 25, 1991, on Eastern North Carolina above Cape Lookout, North Carolina, and other pertinent reports, to determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of ***water quality, environmental restoration and protection, and related purposes*** *in Currituck Sound."*



Currituck Sound Ecosystem Restoration Study

Non-Federal Sponsor

State of North Carolina through the NC Environmental and Natural Resources - Division of Water Resources (NCDWR)

Currituck Sound Ecosystem Restoration Study

Coordination

North Carolina Department of Environmental and Natural Resources - Division of Water Resources (NCDWR) (non-federal Sponsor)
North Carolina Division of Marine Fisheries (NCDMF)
North Carolina Division of Water Quality (NCDWQ)
North Carolina Wildlife Resources Commission (NCWRC)
North Carolina Division Coastal Management (NCDCM)
North Carolina National Estuarine Research Reserve (NCNERR)
North Carolina Coastal Federation (NCCF)
Elizabeth City State University (ECSU)
US Fish and Wildlife Service (USFWS)
US Geological Survey (USGS)
Currituck County
Pasquotank River Basin Regional Council
Hampton Roads Planning District Commission
The Nature Conservancy (TNC)
Virginia Department of Environmental Quality
Virginia Department of Conservation & Recreation
National Audubon Society
National Oceanic and Atmospheric Administration (NOAA)
Local environmentalists and sportsmen
Albemarle Pamlico National Estuary Program
North Carolina Coastal Land Trust (NCCL)
Back Bay National Wildlife Refuge (BBNWR)
Mackay National Wildlife Refuge
Cape May Plant Materials Center
Virginia Department of Game and Inland Fisheries (VDGIF)
US Department of Agriculture

Background

Currituck Sound Study Area

- NE segment of Albemarle-Pamlico Sound
- Includes Currituck Sound, NC and Back Bay, VA and their surrounding watersheds
- Separated from the Atlantic by Outer Banks
- Sound is approximately 36 miles long, 3-8 mi wide and 153 mi^2 (~98,000 acres)
- Located predominately in Currituck and Dare Counties, NC and Virginia Beach County, VA
- Currituck Sound joins Back Bay in Virginia Beach, Virginia to the North and joins Albemarle Sound on the South
- Connected to the Atlantic Ocean through Albemarle Sound and Oregon Inlet

Background

Initial Scoping

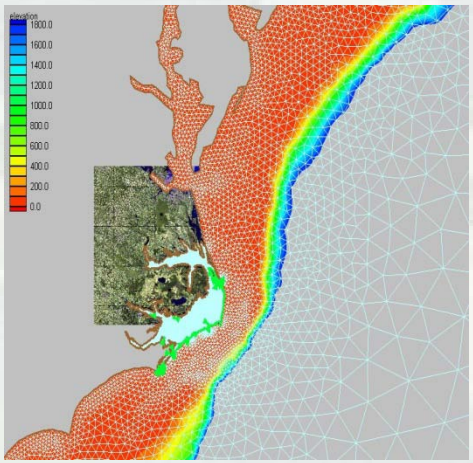
2001 Scoping suggested that poor WQ was a driver of ecosystem degradation

	HRPDC	Elizabeth City Citizen	NCDMF	NCDCM	NCDCR	USFWS	NCWRC	DWQ	USDC
Natural resource management	√								
SAV		√		√		√	√		√
Fisheries		√				√			√
Migratory Waterfowl		√				√	√		
Salinity		√				√			
Water Quality		√		√		√	√	√	√
Monitoring		√							
Flow of freshwater		√							
Tidal surges		√							
Water level		√		√					
Anadromous fish			√						√
Nursery areas			√						
Turbidity				√			√		
Ship losses/ wreck sights					√				
Protection of resource waters								√	
Essential fish habitats									√
Protection of wetlands									√

Background

Data Collection

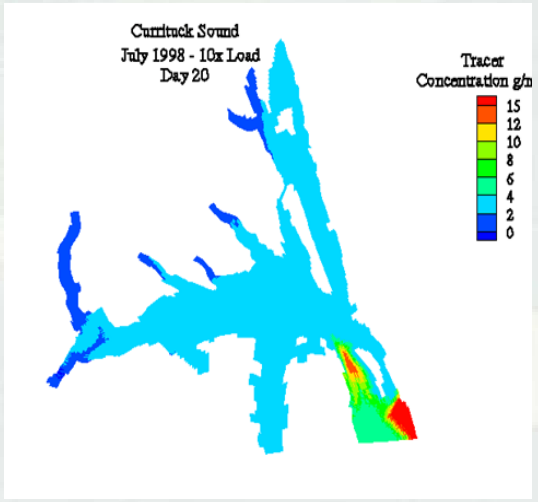
- Collaborative multi-agency data collection initiative
- Developed a hydrologic/hydrodynamic and water quality monitoring and modeling group
- Data collection facilitated development of coupled hydrodynamic and water quality models of Currituck Sound and vicinity
  - ADCIRC, CH3D, CE-QUAL-ICM

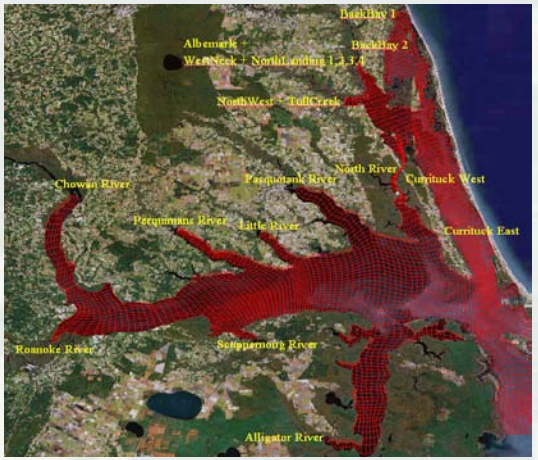


Background

Hydrodynamics

- **Wind driven Tide**
  - Wind direction, speed, and duration, are key factors in the tidal influence of Currituck Sound
  - Higher water levels result from a South wind and low water levels from North wind
- **Limited Flushing**
  - Simulated tracer concentrations in Currituck Sound were not influenced by Oregon inlet
  - Limited impact of the tributary inflows





Background

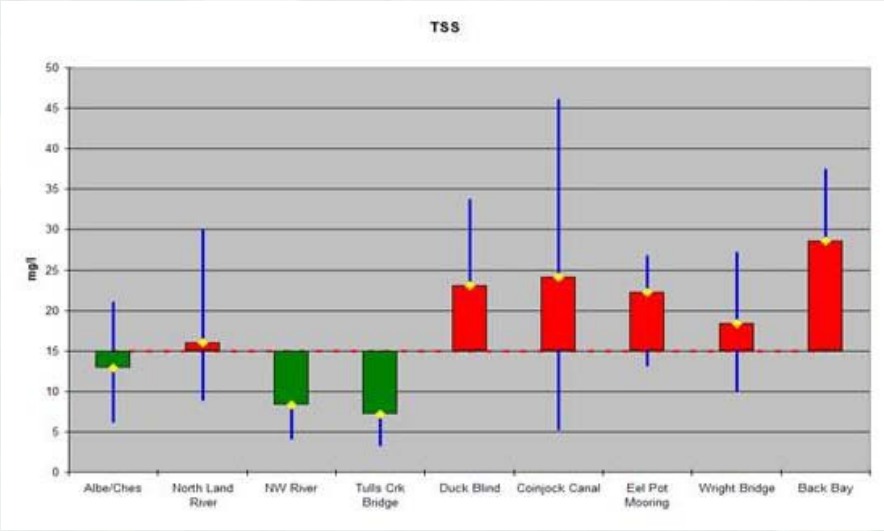
Water Quality

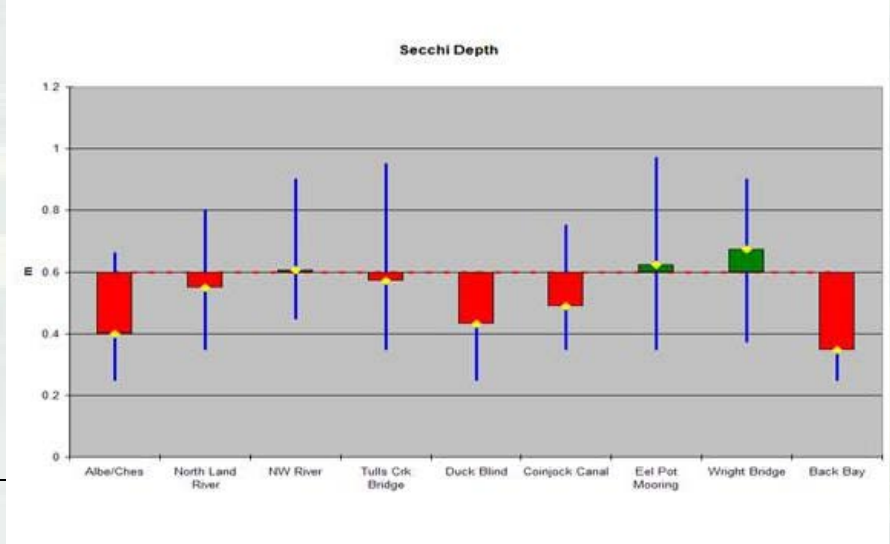
- Monitoring showed current nutrient loadings to the system are not as high as previously perceived and WQ is not as degraded as historically observed
  - Nitrogen and phosphorous values - within an acceptable range
  - Algal levels - normal
  - DO levels - low at times at certain locations but were not indicative of a major problem
  - light penetration - reduced by the presence of solids and algae in addition to color in the water column

Background

Suspended Solids

- SS concentrations in the open water - higher than SS in the tributaries
- Source of the SS from within the Sound - result of sediment re-suspension caused by high energy wind-wave events
- Re-suspension associated with loss of SAV



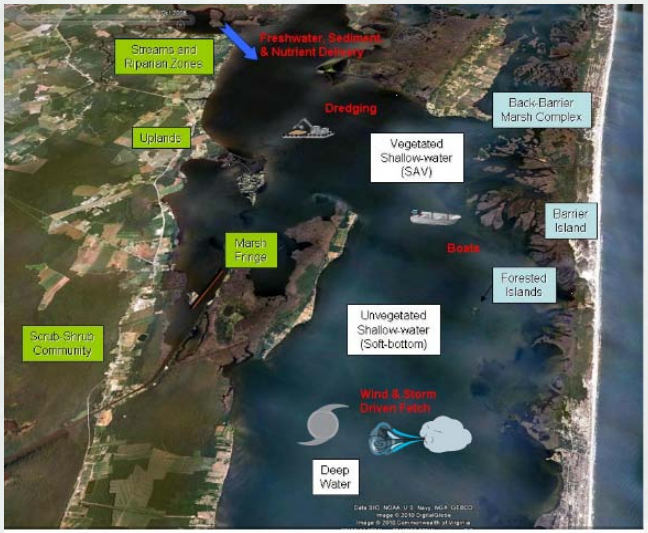


Background

Concept Model

- Coordinated with ERDC
- Describes the general functional relationships among essential components of ecosystem
- Helped identify significant ecological resources; conditions governing resources
- Documented drivers and stressors
- Helped tell the story of “how the system works”

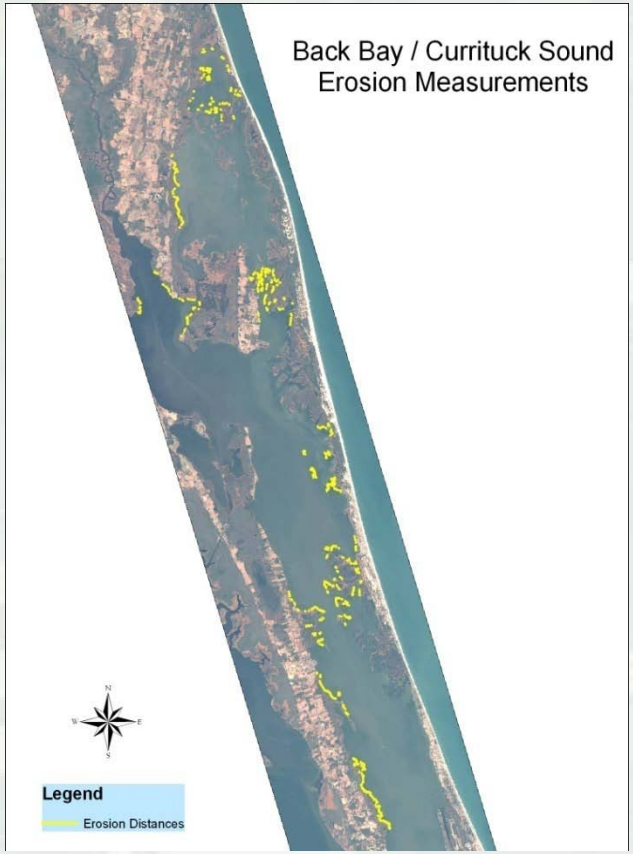
Drivers		
Fetch		
Land Use	Agricultural, Urban, Shore and Bank Protection	
Boating	Canals, Entrainment, Propeller Damage	
Dredging	Disposal Sites, Schedule	
Hydrologic Connectivity	Inlets, Island Overwash, Inland Flooding, Movement Barriers	
Physio-Chemical Processes Affected		
Direct Habitat Conversion	Hydrodynamics (Velocity, Depth, Wave Energy)	
Suspended Sediment (Turbidity)	Nutrients (Nitrogen, Phosphorous)	
Principal State Variables		
Salinity	Light	Substrate	Elevation	Invasive Plants
Biological Processes		
Reproduction	Survival	Colonization
Significant Resources		
Fisheries	Migratory, Estuarine Nursery, Estuarine Resident	
Waterbirds	Tree-Nesting, Sand-Nesting	
Waterfowl	Migratory, Resident	
Other Animals	Crustaceans, Turtles, Mammals	
Vegetation	Submerged Aquatic Vegetation, Back-Barrier Marsh, Marine Forest	



Background

Using GIS - it was determined that erosion is a significant problem within the Sound

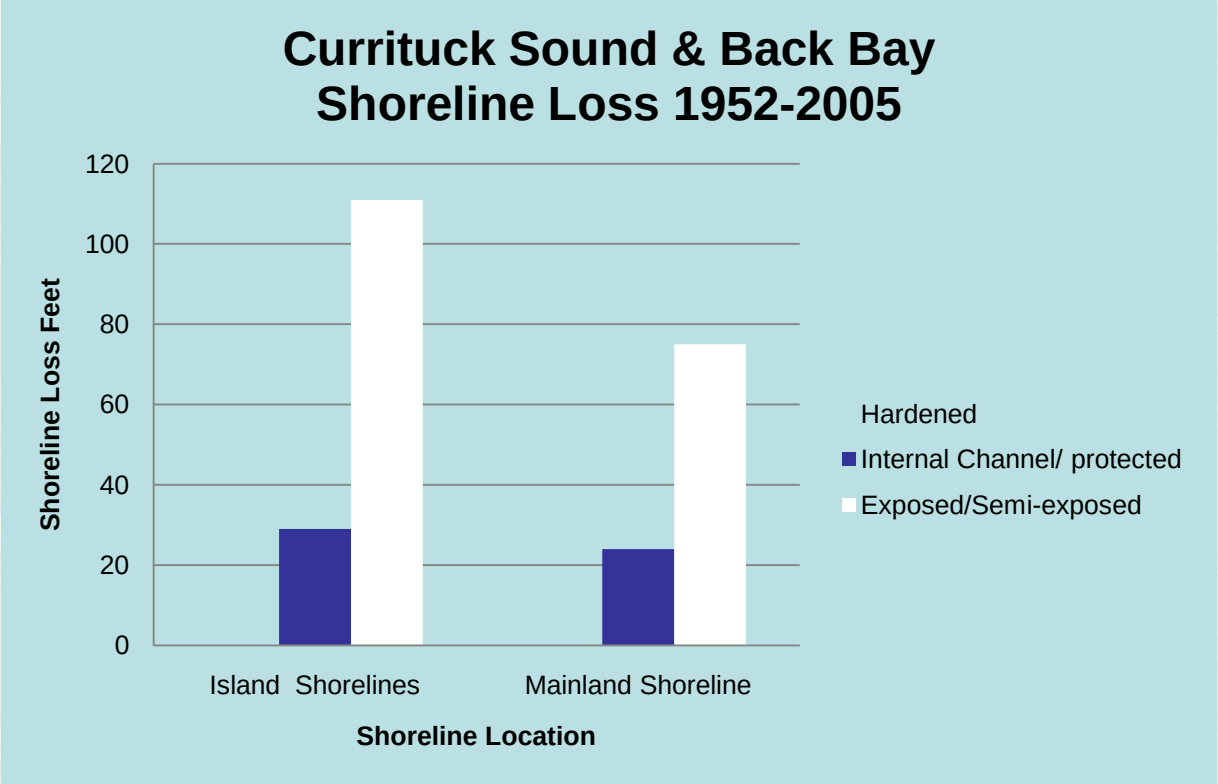
- 1952 imagery overlaid with 2005 imagery to measure the distance of eroding shoreline
- Analysis sites based on fetch, boat wakes, shoreline type, and exposure direction
- 905 erosion vectors created throughout the Sound



Marsh Erosion

Background

Marsh Erosion



Background

Public Meetings - September 28 & 29, 2010

- Present study findings
- Solicit feedback on problems

NOI for preparation and release of a Draft EIS published in the *Federal Register* (volume 76, number 125) on June 29, 2011

Background

Evaluation of Problems

IDENTIFIED PROBLEMS		SCREENING CRITERIA (Y, N, MAYBE)			
		Is it Fixable?	Is it a Problem?	Within Scope of the Study?	Problem Addressed by Others?
WATER QUALITY AND HYDROLOGIC CONNECTIVITY	**Nutrient Loading**				
	Septic Leakage	YES	MAYBE	MAYBE	YES
	Princess Ann Road Causeway And Corey's Ditch - Loss of Marsh Sheetflow	YES	YES	YES	NO
	Population Growth and Development	NO	YES	NO	NO
	Agriculture Land-use Practices	YES	MAYBE	YES	YES
	Turbidity				
	Pulsed Upstream Sediment Loadings (i.e. High Rain Events) from Farming, Development, etc.	YES	MAYBE	YES	MAYBE
	Wind Driven Re-suspension of Sediment Within Currituck Sound	YES	YES	YES	NO
	Change in Sediment Composition (i.e. Organic Inputs from Erasian Milfoil Die-off)	YES	YES	YES	NO
	Sedimentation from Shoreline Erosion	YES	NO	YES	YES
	Salinity				
	Dredging of Navigational Channels	NO	NO	YES	NO
	Great Bridge Lock	MAYBE	MAYBE	NO	YES
	North Landing River Lock	MAYBE	MAYBE	NO	YES
	Coinjock Canal	MAYBE	MAYBE	NO	NO
	Diversion of Freshwater Flows (Decrease Freshwater Input to the System)	MAYBE	MAYBE	NO	NO
	Drought	NO	MAYBE	NO	NO
	Saltwater Pumping	YES	NO	NO	NO
	Canal #2	MAYBE	MAYBE	NO	NO
	Diversion of Great Dismal Swamp Inputs	MAYBE	MAYBE	NO	NO
	Joyce Creek	MAYBE	MAYBE	NO	
	Freshwater Diversion and Withdrawals for Consumption	NO	YES	NO	NO
	Connectivity				
	Closing of Inlets	YES	MAYBE	YES	NO
WETLAND LOSS	Mainland Shoreline Erosion- marshes	YES	YES	YES	NO
	Marsh Island Erosion/Loss	YES	YES	YES	MAYBE
	Wetland Conversion to Agriculture, Forestry, and Developed Lands	NO	YES	MAYBE	YES
	Ditching and Draining of Wetlands	YES	YES	MAYBE	NO
	Decline in Freshwater Wetlands	YES	YES	YES	NO
	Decline in Coastal Emergent Marsh	YES	YES	YES	MAYBE
SEDIMENT	Minimal Flushing - Accumulation of Upland and Riverine Sediments	MAYBE	MAYBE	NO	NO
	Contaminated Sediments	YES	MAYBE	YES	YES
	Anthropogenic Blockage of Coarse Sediment Influx to the System (i.e. Overwash Events)	YES	YES	YES	NO
DREDGING	Historic Unconfined Disposal of Sediment (i.e. Sidecast Dredging)	YES	YES	NO	NO
	Need for Dredging to Fulfill Authorized Depths - Turbidity Associated with Vessel Activity	YES	YES	NO	NO
	No Capacity Within Current Confined Disposal Facilities (CDF's)	YES	YES	NO	NO
BIOTA	Seasonal Die-Off of SAV	NO	NO	NO	NO
	Waterfowl Decline	YES	YES	YES	NO
	SAV Decline	YES	YES	YES	NO
	Exotic Species (i.e. Phragmites australis, Eurasian watermilfoil)	YES	YES	YES	MAYBE
	Lack of Ecosystem Function (i.e. Connectivity Between Habitats)	YES	MAYBE	YES	NO
	Decline in Black Bass Populations	YES	NO	NO	NO
	Decline in Biodiversity	YES	YES	YES	NO
	Decline in Nesting Island Habitat	YES	MAYBE	YES	NO
	Blockage to Anadromous Fish Spawning Habitat	YES	MAYBE	YES	MAYBE
	Vessel Prop wash and Wake Impacts to SAV	YES	YES	NO	NO
	Decline in Fish Habitat Diversity	YES	YES	YES	NO

The following problems were carried forward for further consideration:

- Sediment loading from upstream during high discharge events
- Loss of marsh sheetflow
- Loss of connectivity with the ocean through inlet closures
- Shoreline erosion – mainland marshes and islands
- Decline in wetlands – freshwater and coastal -
- Blockage of coarse sediments from entering system
- Decline of SAV and other important habitat
- Decline in species biodiversity
- Decline in waterfowl
- Increase in exotic and invasive species

Background

Problem Statement

Alteration of the natural coastal processes in the CSER area has resulted in the creation of a unique wind-tide driven oligohaline back barrier ecosystem. This ecosystem, which once supported an abundance of submerged aquatic vegetation, coastal marshes, and islands and associated wildlife and fisheries, has been degraded as a result of anthropogenic activities in the Sound and surrounding watershed. Areal extent of these keystone habitats has declined, weakening their interconnectedness and altering energy regimes throughout the Sound thereby reducing their capacity for self repair. This facilitates a negative feedback that continues to destabilize the ecosystem by reinforcing change and causing continued site alteration.

Historic Overview

Currituck Sound

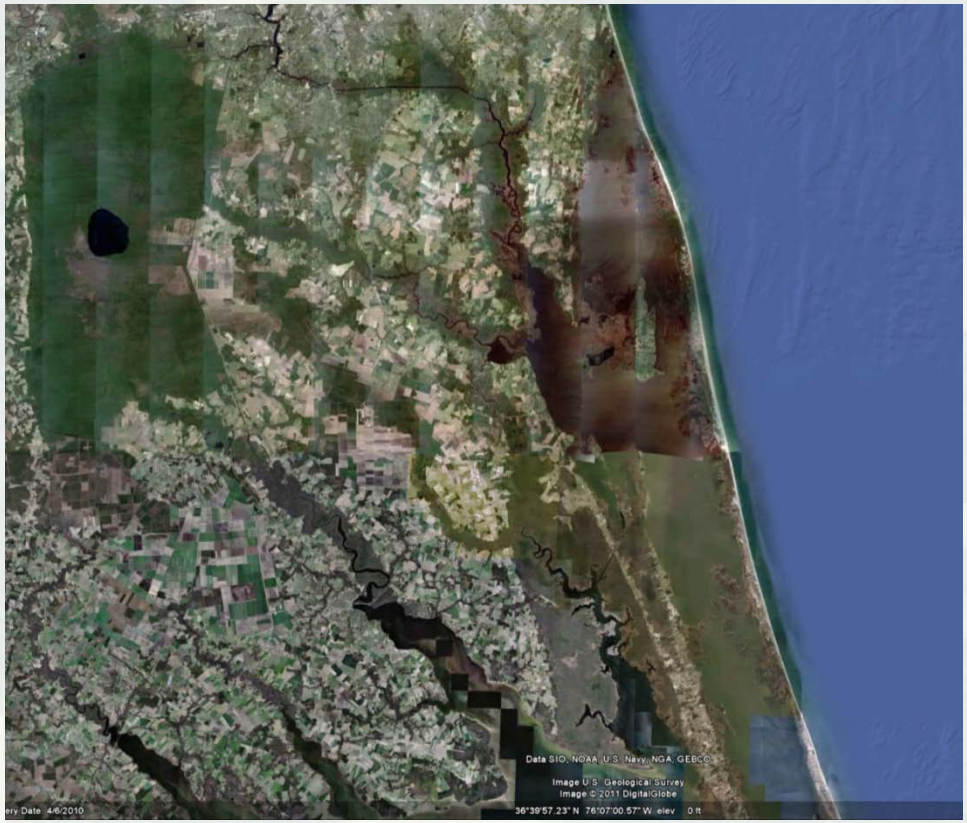
- Salt water system connected to the Atlantic Ocean by series of inlets
- Five known historic inlets from early 1600's to early 1800's
- Last inlet closed mid-1800's (Caffey's)
- Hydrology also affected by other anthropogenic(i.e navigation channels) and natural events (storms)

1775

Historic Overview

Basin

- Significant population and development in the northern portion of the study area and along the outer banks
- Predominance of historic and current agricultural land use throughout the watershed
- 2 major tributaries supply majority of freshwater to Sound:
  - North Landing River – drains 117 $mi^{2;}$ channelized entire length; part of AIWW
  - Northwest River drains 196 mi^2



Historic Overview

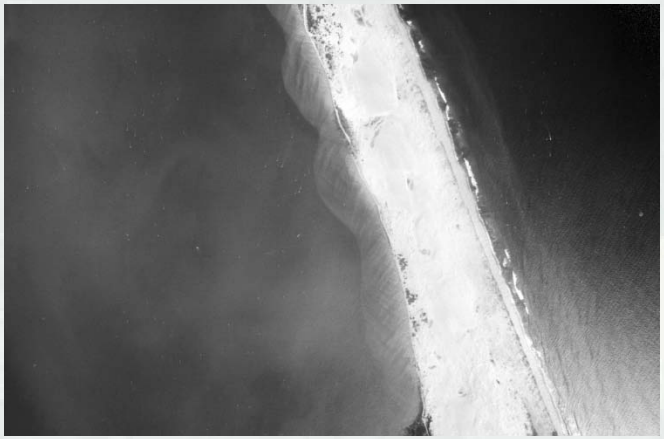
Habitat - General

- Upon closure of historic inlets >100 mi^2 of lunar tidal brackish marsh converted to wind tide driven fresh (<0.5 ppt) to oligohaline (0.5-5 ppt) system
- Transition to freshwater fisheries and increased waterfowl use
- Significant shifts diversity and abundance

- Now **rare** and **nationally significant habitat**
    - SAV/ Coastal Marsh and Shallow Water Complexes
        - Supports large sport fishing and hunting industry unique Currituck Sound
        - Only remaining wading bird rookery island provides critical nesting habitat

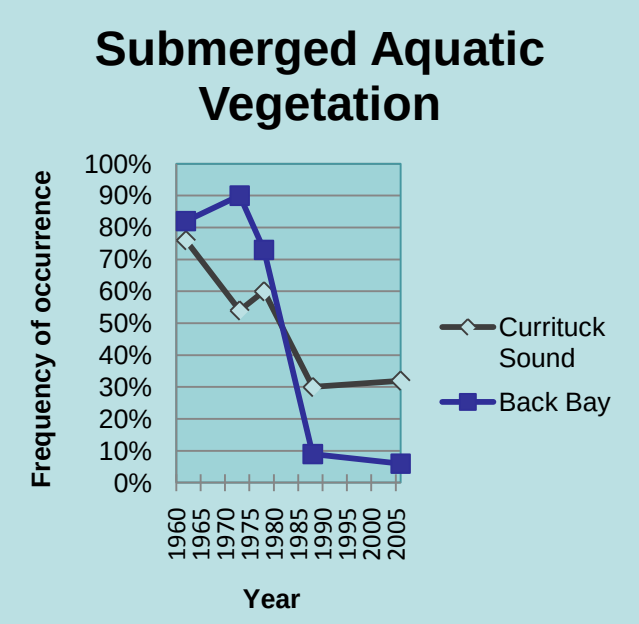
Historic Overview

- Back barrier marsh complexes - starved of coarse sediment loads from overwash & wind driven transport
- Sandy habitat for shorebirds - converted to a vegetated & stabilized community
- Loss of back barrier marsh and bird nesting habitat do to erosion
- Significant portions of marshes invaded by *Phragmites australis*
- Prior to the mid-1980s, NC had lost ~50 % of original wetlands acreage.



Historic Overview

- Three significant declines in SAV since 1920's
  - 1920's: decline after lock opening & enlargement of Chesapeake and Albemarle Canal
  - Mid-1960's: major decline of SAV in Back Bay
    - first observance of *Eurasian watermilfoil* (1964) - Dominate species (1967)
  - Late 1970's: < ½ of early 1970's population
    - Changes in biomass & distribution attributed primarily to increased turbidity & turbulence resulting from unusual weather during the early growing season of 1978
- Continued decline in SAV since the late 1970's

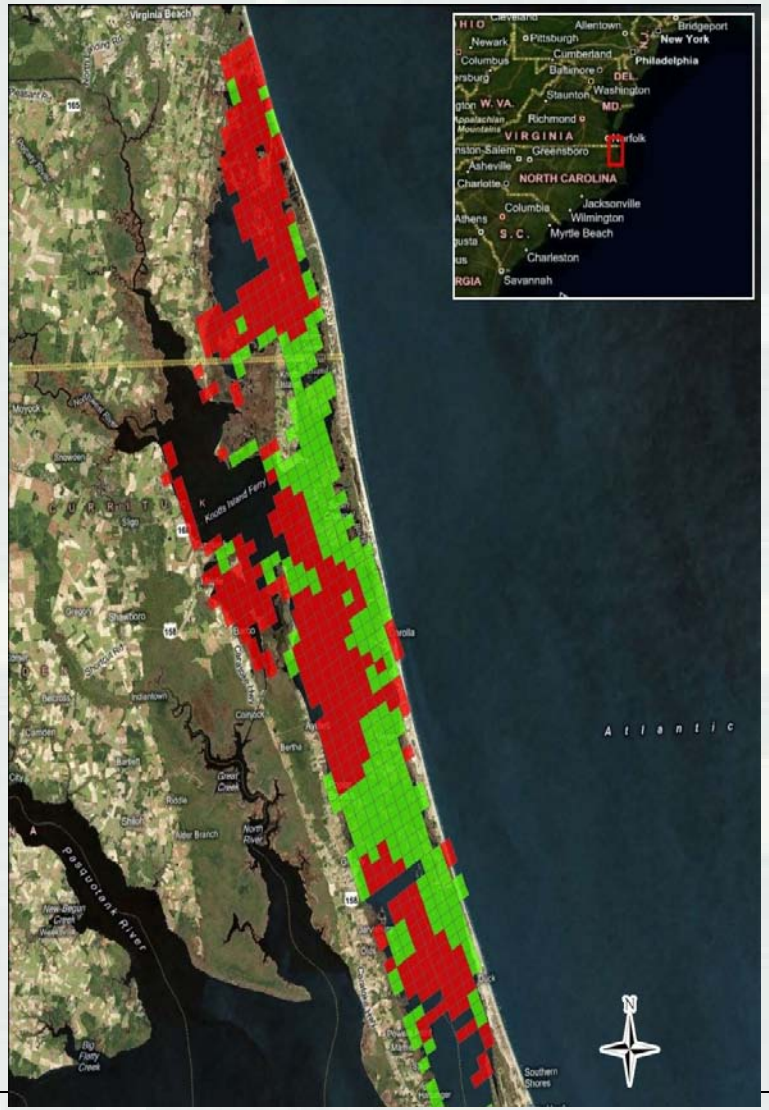


Historic Overview

- The *Eurasian watermilfoil* boom –
  - Outcompeted native species
  - Short term habitat improvement
  - Increase in freshwater fish species abundance
  - Long term decline in habitat sustainability
- 1980's Significant mass die-off of *Eurasian watermilfoil*
  - Substrate was left devoid of vegetation
  - More vulnerable to re-suspension of sediment
  - Organic load to the system
  - Increased clarity issues

Historic Overview

Habitat - Submerged Aquatic Vegetation



SAV present in 1960's but absent in 2003

SAV present in in 2003

BUILDING STRONG®

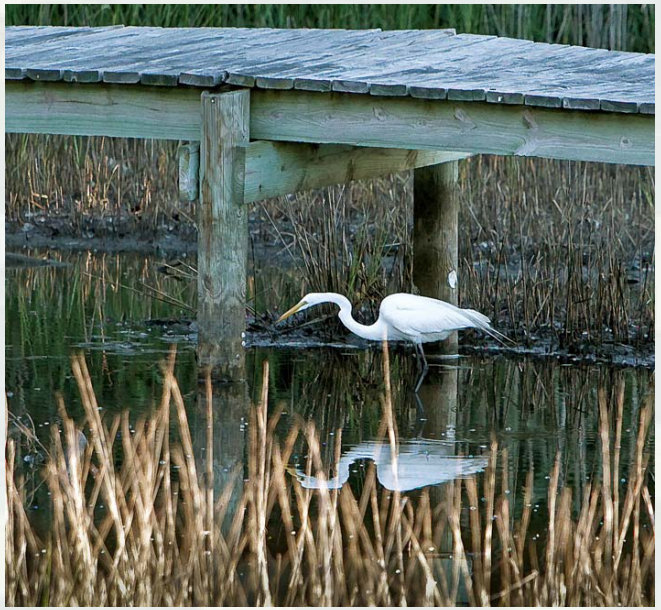
Historic Overview

Habitat – Shorebird Nesting

- Historically, gulls and tern nesting colonies were on natural beaches
- Expansive beach development has degraded areas for nesting
- New alternative estuarine island nesting sites resulted from island building for dredged material disposal.
- Most current nesting occurs in the estuary & almost half of all nesting sites are on man altered substrate since the 1970s.

Historic Overview

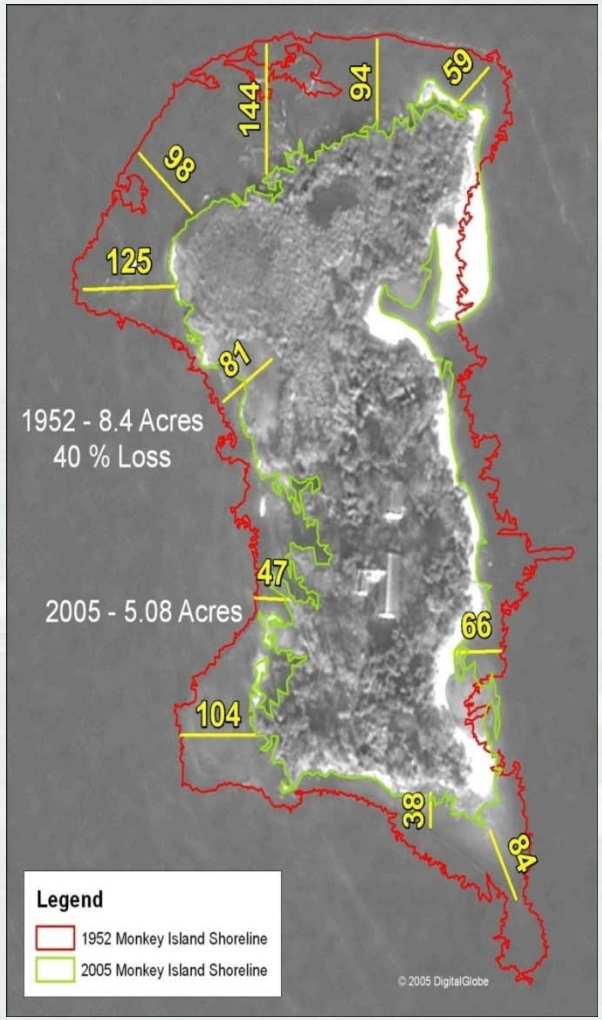
- Historically most heronries in coastal swamps
- Logging has degraded or eliminated areas for nesting
- It is believed historically - multiple wading bird nesting sites throughout Currituck Sound
- Monkey Island currently only remaining wading bird nesting habitat in study area
- Monkey island -
  - 1952 - 8.4 ac,
  - 2005 - 5.1 ac
  - 2010 - 4.4 ac



Note: For constructed wading bird nesting islands, a size range of 5-25 ac is recommended

Historic Overview

Habitat – Wading Bird Nesting



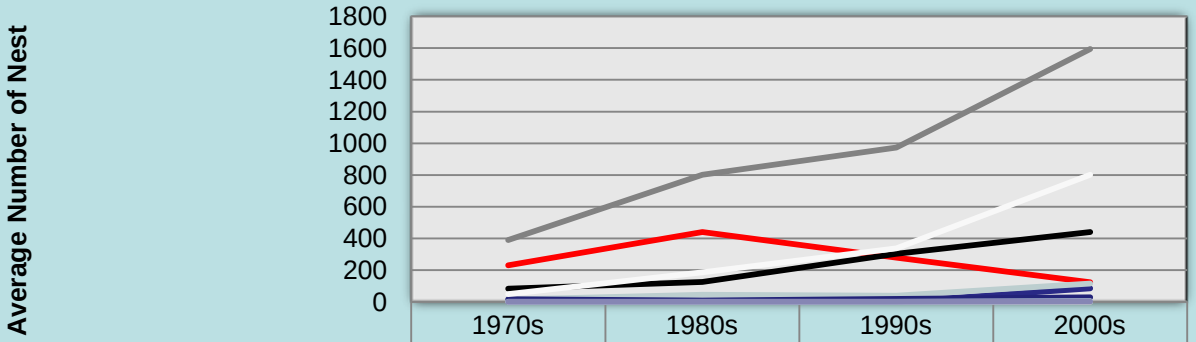
Comparison of 1952 to 2005 shorelines at Monkey Island using aerial imagery and measurement of erosion vectors

Historic Overview

Habitat – Wading Bird Nesting

Monkey Island, Currituck Sound NC

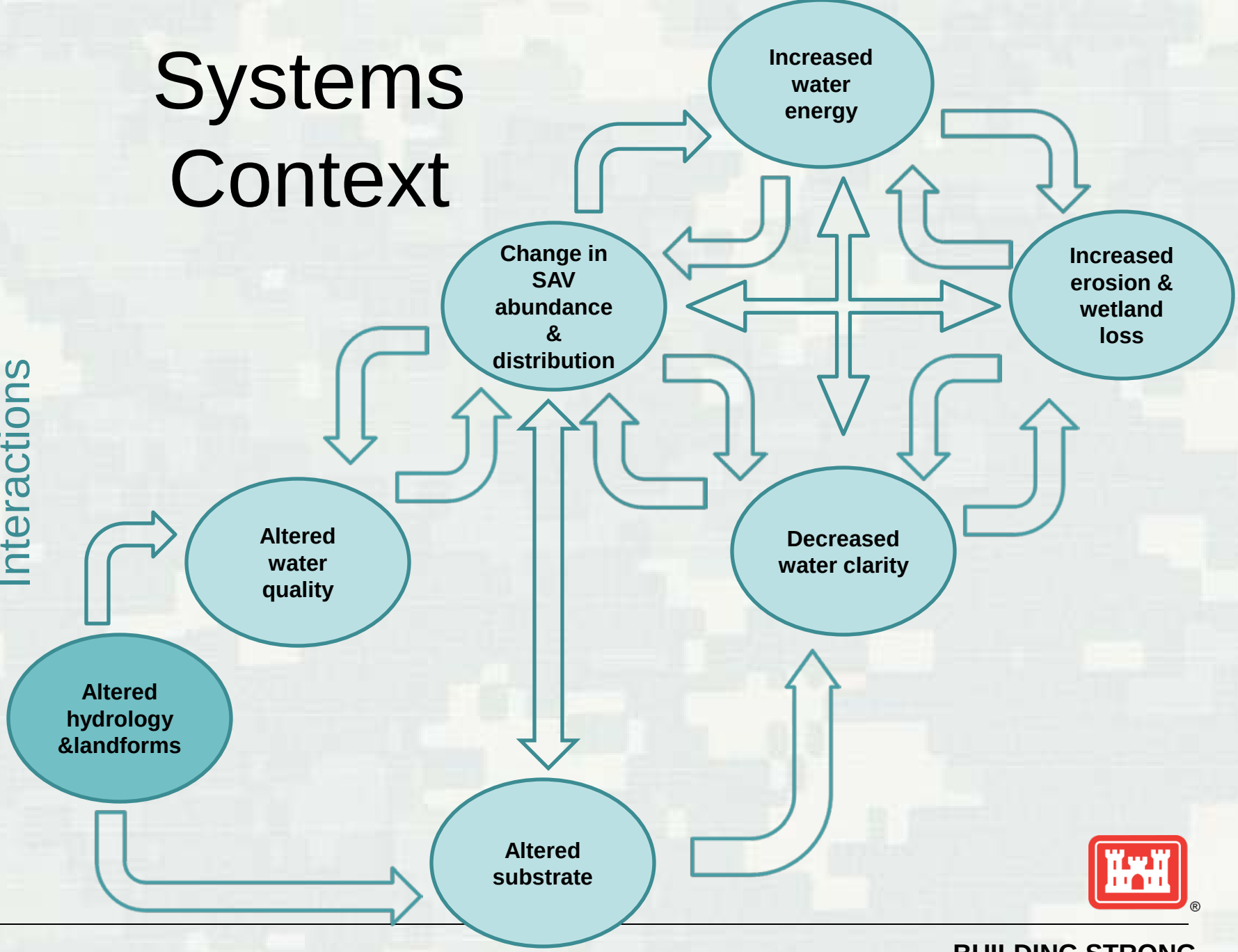
Number of Nests by Species



	1970s	1980s	1990s	2000s
Cattle Egret	230	441	278	123
Glossy Ibis	0	0	0	84
Great Blue Heron	0	0	0	0
Little Blue Heron	83	125	302	439
Snowy Egret	14	44	39	115
Tricolored Heron,	15	8	17	27
White Ibis	0	0	0	3
Black-crowned Night-Heron	0	0	0	1
Great Egret	48	185	338	802
Total	390	802	973	1594

Systems Context

Conceptual Model of Ecosystem Interactions



Systems Context

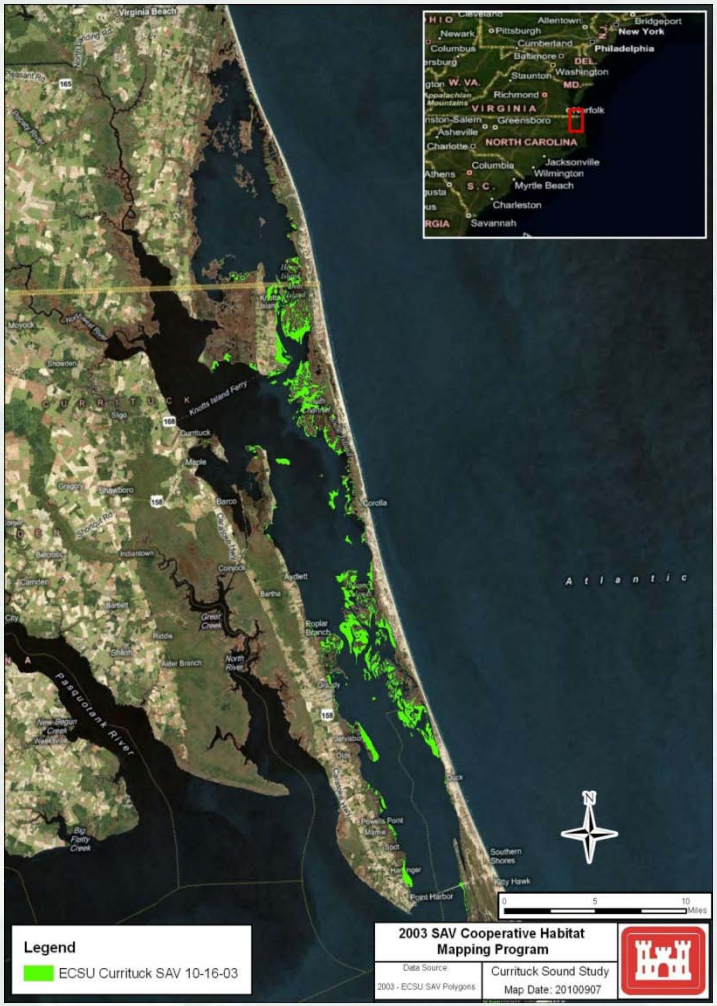
As a consequence of the intricate interactions and dependencies of the SAV and coastal marsh habitats, degradation and/or loss of one habitat has a huge negative implication to the other and to system quality. As a result, they cannot be considered as separate systems.

For this Study – these systems will be referred to as **Submerged Aquatic Vegetation/ Coastal Marsh and Shallow Water Complexes**

Existing Conditions

Habitat- SAV/ Coastal Marsh and Shallow Water Complexes

- SAV - significant natural resource in the study area
- SAV habitat - close to shore and among marsh islands
- Majority on the back side of the barrier beaches - associated with the lee-side of the marsh communities
- 9,857 acres of SAV Back Bay and Currituck Sound in 2001
- Back Bay - approximately 5% of its SAV distributions of 25 years ago

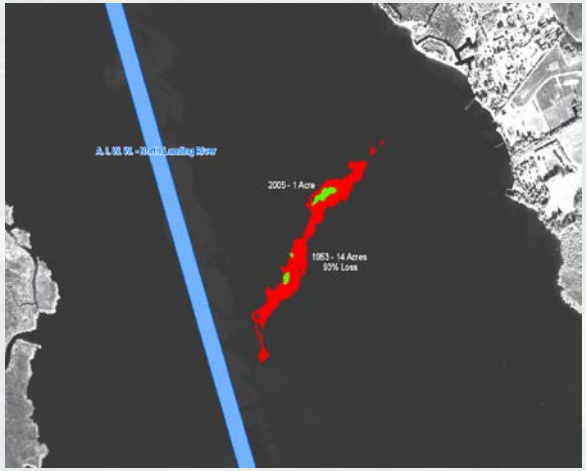


BUILDING STRONG®

Existing Condition

Within the study area, large areas of marsh that once provided wind breaks (which reduce fetch and calm shallow waters), bird rookeries, and aquatic habitat have eroded away.

Documentation of Land Loss
- 1951-52 USGS aerial photography
- 2005 Satellite images
- 3 high quality image pairs analyzed



Faraby Island Marsh Loss.
The red areas represent land loss since 1963

Site Name	Type	1952-53 Acres	2005 Acres	Acres lost	Percent Loss
Faraby Island	Marsh Island	14	1	13	93%
Porpoise Point	Mainland Marsh	278	225	53	19%
Monkey Island	Wooded Island	8	5	3	38%

Existing Conditions

Development, beach driving, and associated disturbance factors on Currituck Banks have eliminated the piping plover and American oystercatcher from the study area and significant declines in least tern numbers are also evident

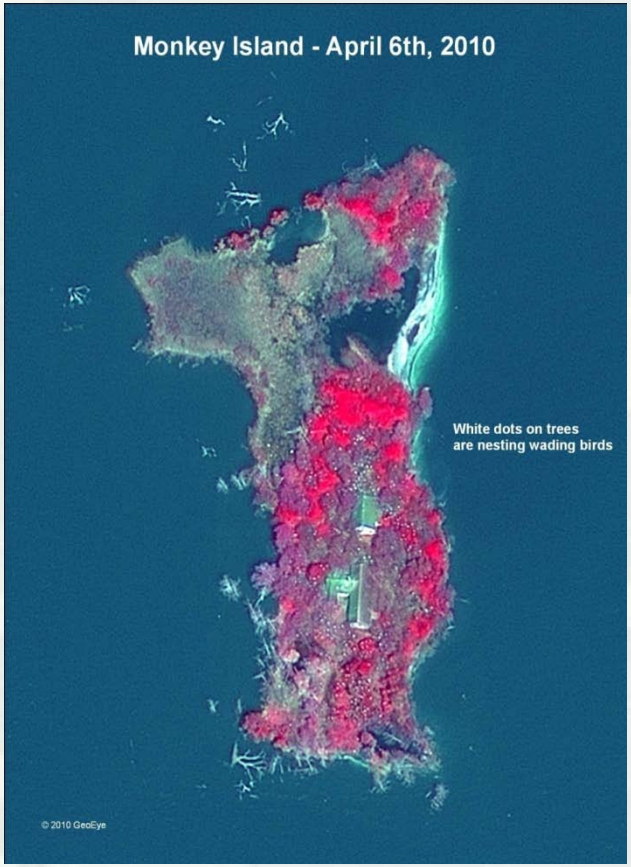
- In 1992 – 4 least tern colonies existed with 3-6 nests at each site; 2004 – 2 nests; and in 2010 – 1 nest.

Terns generally prefer bare or nearly bare substrates

Existing Conditions

Habitat – Bird Nesting Islands

- Monkey Island supports herons, egrets, and ibis
- Often holds the largest little blue heron colony in the state
- Continued erosion of Monkey Island is currently decreasing the amount of available nesting habitat
- Nest crowding is apparent and is increasing.
- Increased accumulation bird feces could kill vegetation through soil acidification reducing appropriate nesting trees
- Monkey Island supports tidal wetlands and shelters about 3 acres of SAV from wind and wave attack



Future Without Project

- Based on coastal land loss tends ~ 430 ac of estuarine marsh could be lost in the Currituck Sound Study Area every 6 years, or 3,600 acres over a 50 year period of analysis

- The possibility of submergence and marsh loss due to increased sea level and/or land subsidence has been identified as a concern for the marshes of the project area as well as the lower meso-tidal and micro-tidal marsh environments of the surrounding region.

- In Currituck Sound and Back Bay wind and wave erosion is causing extensive wetland shoreline and marsh island loss which is expected to worsen with continued sea level rise

    - In Back Bay the SLAMM model suggests that due to the effects of increased salinity water depth, and wind fetch 2000 ac of estuarine marsh could be lost by 2050 (FWS)

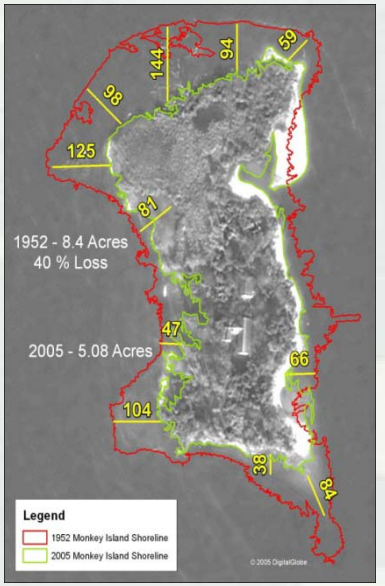
Future Without Project

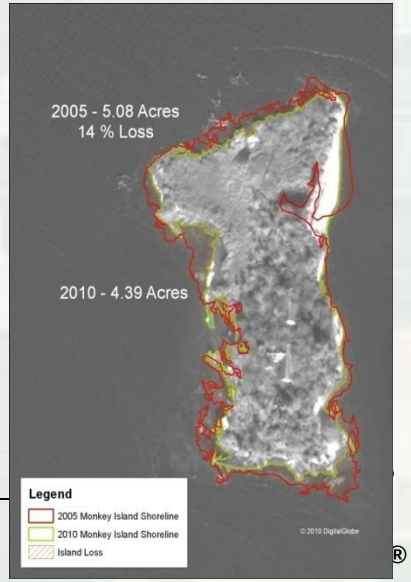
- Continuation of current SAV population trend of relatively stable populations well below historic potential
- Without a increased and /or sustainable "native" SAV population throughout the Sound, future *Eurasian watermilfoil* events could cause significant disruption to the system due to its boom/bust habit

Future Without Project

Habitat – Bird Nesting Islands

- Assuming a continued erosion rate of 0.14 ac/year and 2015 project construction date, Monkey Island would be expected to be less than 4 acres at the beginning of a federal project and under a no action scenario the island could be gone within the 50 year period of analysis.
  - Continued erosion of Monkey Island will decreased the amount of available nesting habitat for wading birds
  - Without action to stop island loss, impacts would be expected to result initially in fewer nests and eventually in rookery abandonment, when potential tree nesting site were no longer available.





NER Plan Formulation

Problems

• SAV have significantly declined since the late 1970's thereby reducing spawning habitat and/or nursery habitat for a variety of freshwater, anadromous, shellfish, and estuarine fish species as well as a primary food source for wintering waterfowl.

• Coastal marshes and shallow water habitats in Currituck Sound and Back Bay waters have been lost to erosion or invaded by exotic plant and animal species.

• Loss of interconnectedness of SAV and coastal marsh and shallow water habitats has resulted in a decline in ecosystem/habitat quality and function.

• Loss of marsh islands, coastal swamps, and natural beaches have resulted in a loss of wading bird and shorebird nesting habitat across the sound

• A **historic** decline in water quality (i.e. nutrient and sediment loading) from residential development, agriculture, and dredging activities, has left the sound in an impaired state

• There has been a decrease in water clarity primarily due to the re-suspension of bottom sediments during wind events.

NER Plan Formulation

Problems

PROBLEM	OPPORTUNITY
Loss of Submerged Aquatic Vegetation / Coastal Marsh and Shallow Water Habitat Complexes	Re-establish native SAV bed by planting and/or seeding Reclamation of lost acres of back barrier and mainland marsh and marsh islands within the Sound or the creation of new marsh habitat Protect the shorelines of existing, restored, and created marshes Establish multi-functional habitats and dredged material disposal islands that allow proper maintenance of the AIWW and provide protected areas to establish SAV Control and manage the invasive species, *Phragmites australis* and *Myriophyllum spicatum* (Eurasian Watermilfoil), in order to sustain a diverse native habitat
Loss of Estuarine Islands and Waterbird Nesting Habitat	Protect and restore existing significant wading bird nesting habitats (i.e. Monkey Island). Reclaim lost acres of back barrier and mainland marsh or create new marsh shorebird habitat
Historic Decline in Water Quality and Clarity	Restore native SAV beds and stabilize sediment and cycle nutrients Create riparian buffers to help improve water quality by reducing turbidity, suspended solids, and nutrient loading Create/restore marsh island and back barrier marsh features to help reduce fetch and minimize wave induced re-suspension of sediment

NER Plan Formulation

Planning Objectives

- Increase submerged aquatic vegetation/coastal marsh complex habitat throughout Currituck Sound and Back Bay to a sustainable acreage over the 50 year period of analysis, as measured by an increase in average annual habitat units

- Provide protection against future erosion and loss of existing and restored submerged aquatic vegetation/coastal marsh complex habitat throughout the Currituck Sound and Back Bay over the 50 year period of analysis

- Increase and sustain the extent of diverse nesting-bird habitats within the Currituck Sound study area over the 50 year period of analysis, as measured by an increase in average annual habitat units

NER Plan Formulation

Constraints

- Induced flooding
- Adverse effects to navigation channels
- Negative impacts to threatened and endangered species
- Violation of established water quality standards in the study area
- Negative impacts to existing critical and high quality habitat
- Availability of suitable substrate for certain restoration measures
- Costly real estate

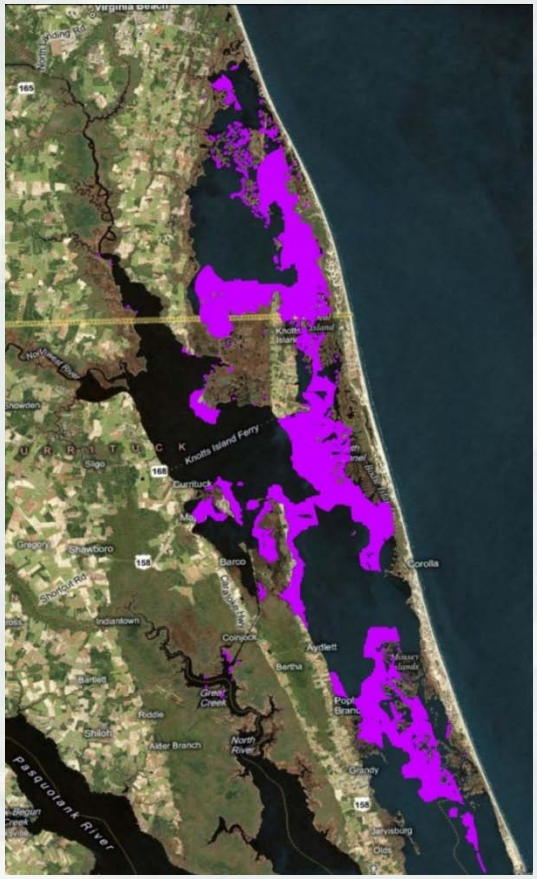
NER Plan Formulation

Siting

Marsh Focus Areas

SDSS was used to identify areas which no longer contain these habitats & present high opportunity for restoration

GIS-based method for scaling, weighting, and combining multiple, spatially explicit variables for the purpose of identifying distinct areas within a larger landscape that present good opportunities for restoration of a particular resource

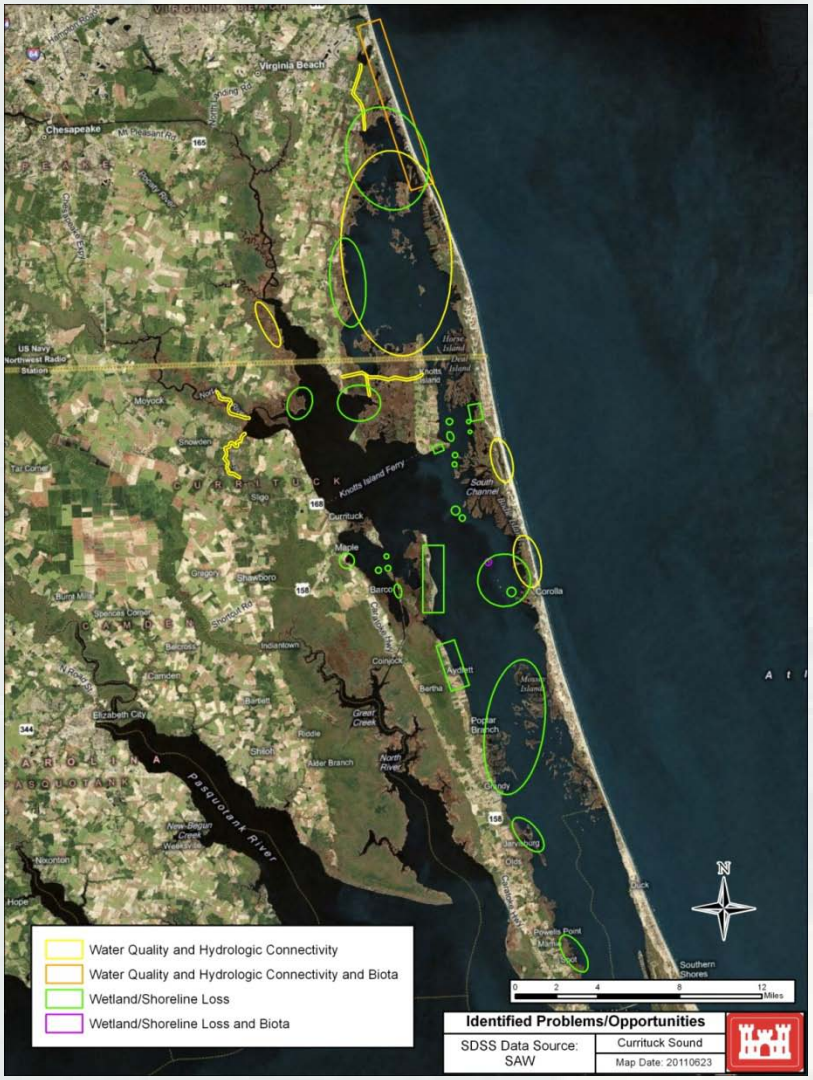


Nesting Island Focus Areas

NER Plan Formulation

Siting - Identified Problem Areas

Meetings were held with Federal, state, and local agencies, and stakeholders to obtain input on restoration needs and opportunities



NER Plan Formulation

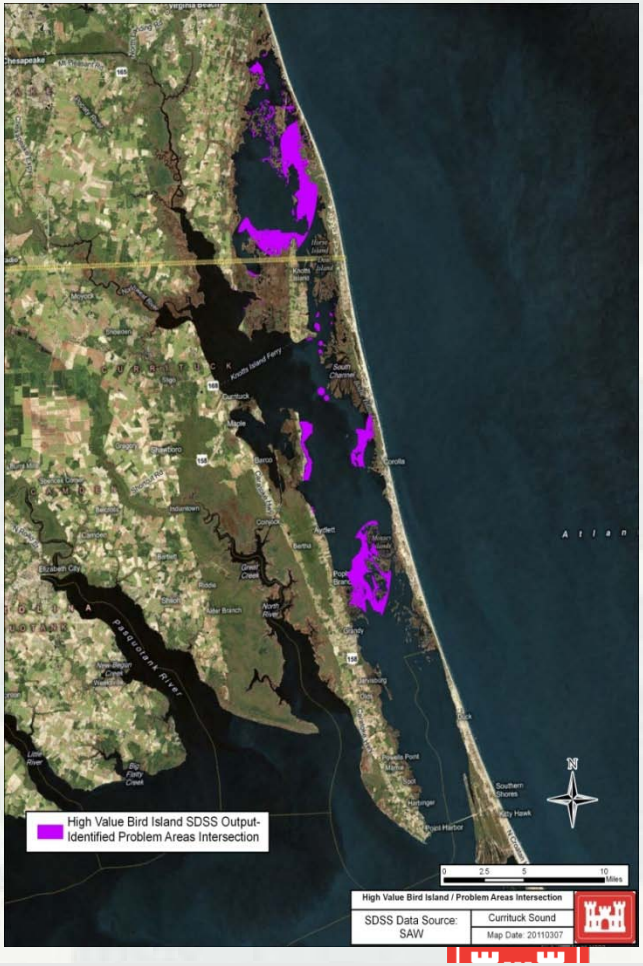
Siting- Restoration Focus Areas

Marsh Focus Areas

Locations:
- most degraded
- posing an opportunity
- need for restoration by the stakeholders

Overlaid on the map of areas identified as “high opportunity” for restoration by the SDSS

From the regions of overlap, general restoration opportunity areas were identified

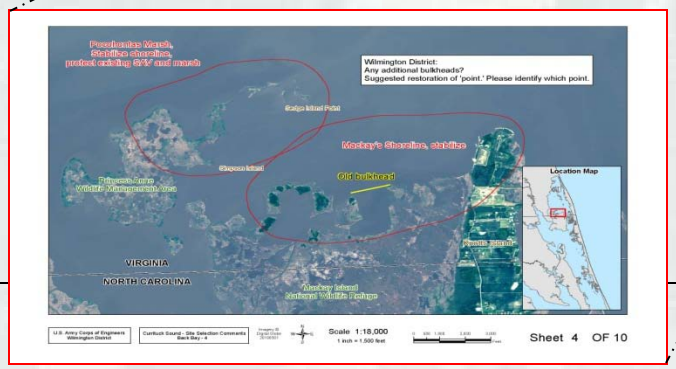


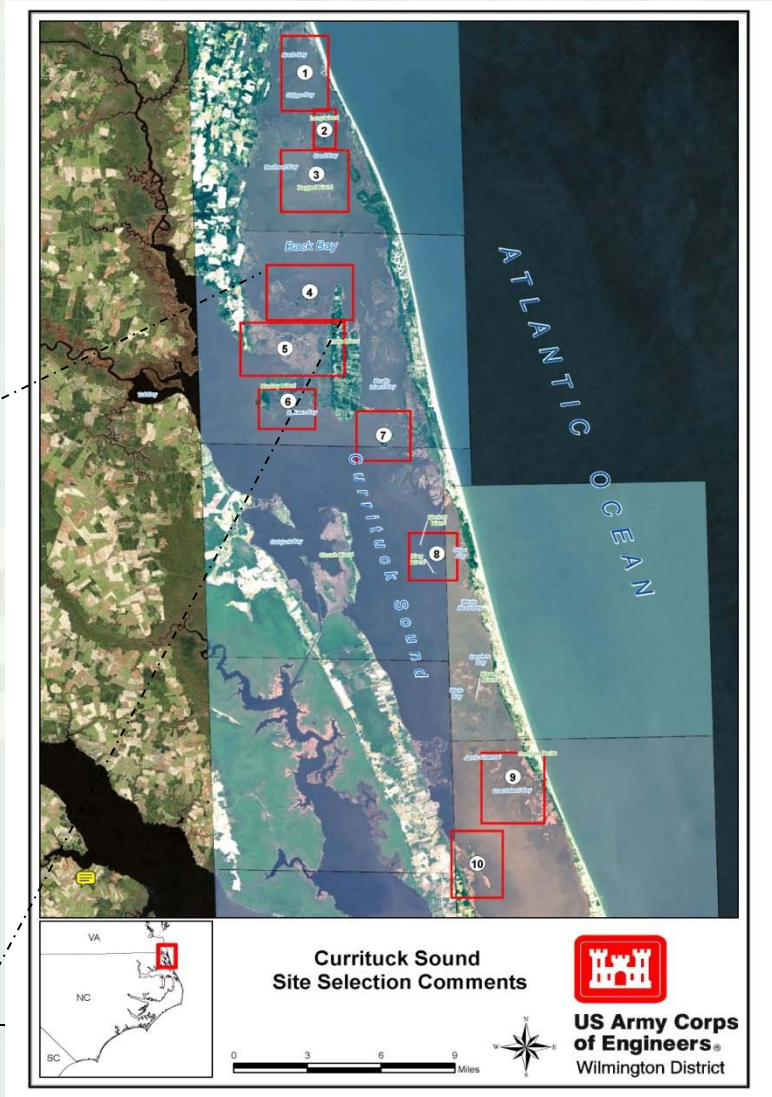
Nesting Island Focus Areas

NER Plan Formulation

Siting- Restoration Opportunities

- Web-meeting held with agency and non-governmental organizations
- Present the results of the SDSS
- Obtain assistance in further distinguishing degraded functions & values & opportunities within the identified sites
- Participants identified very specific restoration opportunities within each general area





NER Plan Formulation

Measures

Nonstructural:

- Habitat restoration
  - Control of Phragmites
  - Vegetative Plantings

Structural:

- Sediment Supply and Distribution (Marsh, Sand Island, Nesting Island)
  - Channel Dredging and Placement
  - Sediment Delivery from Distant Sources
- Shore Protection
  - Breakwaters/Bulkheads
  - Marsh toe protection structures
  - Sills
- Hydrologic Restoration/Connectivity
  - Removal of existing impediments to sheetflow
  - Removal of existing impediments to overwash
  - Reestablish tidal exchange through the creation of inlets
  - Culverts

NER Plan Formulation

Evaluation Criteria

Achievement of Planning Objectives - The measure, when implemented alone or in combination with other measures can support one or more of the ecosystem objectives for this study. The more objectives supported, the more holistic the solution.

Avoidance of Constraints – The measure avoids or has minimal impact to existing infrastructure, T&E Species, wetlands, navigation, and flooding

Sustainability – There is opportunity for the measure to be sustainable in that it is capable of adapting to sea level rise or is relatively resilient to coastal disturbances.

Impacts to Socioeconomic Resources - Avoidance of negative impacts to vital socioeconomic resources including cultures, community, infrastructure, business and industry, and flood protection.

MEASURE/SCREENING CRITERIA	Achievement of Planning Objectives	Avoidance of Constraints	Sustainability	Avoids Impacts to Socioeconomic Resources
Control of *Phragmites*	YES	YES	YES	YES
Vegetative Plantings (SAV)	YES	YES	YES	YES
Vegetative Planting (Marsh)	YES	YES	YES	YES
Channel Dredging and Placement (Marsh)	YES	YES	MAYBE	YES
Thin layer dispersal of sediment (Marsh)	YES	MAYBE	MAYBE	YES
Channel Dredging and Placement (Sand Island)	YES	YES	YES	YES
Sediment Delivery from Distant Sources (Sand Island)	YES	YES	YES	YES
Restoration of ocean overwash processes (Sand Island)	YES	MAYBE	NO	MAYBE
Channel Dredging and Placement(WBI)	YES	YES	YES	YES
Sediment Delivery from Distant Sources(WBI)	YES	YES	YES	YES
Breakwaters	YES	YES	YES	YES
Marsh toe protection structures	YES	YES	YES	YES
Sills	YES	YES	YES	YES
Removal of existing impediments to sheet flow	YES	MAYBE	YES	YES
Removal of existing impediments to overwash	YES	NO	YES	MAYBE
Reestablish tidal exchange through the creation of inlets	YES	MAYBE	MAYBE	NO
Culverts	YES	YES	YES	YES

NER Plan Formulation

Additional Information

Additional information is currently being collected for each site. Once this information is obtained, all possible measures and combination of measures that meet our objective and engineering requirements will be analyzed to identify the best combination of measures for each restoration site.

These site-specific combinations *will* form the basis for the assembly of preliminary alternatives and will be evaluated further in the evaluation and analysis of alternatives leading to determination of the NER or Tentatively Selected Plan..

NER Plan Formulation

Environmental Benefits Analysis

A preliminary EBA will be conducted on first round restoration alternatives at identified potential restoration sites.

Modified USEPA Salt Marsh Model used to assess and evaluate SAV/Coastal Marsh and shallow water complexes habitat values

(1) marsh habitat types
(2) marsh morphology
(3) marsh size
(4) degree of anthropogenic modification
(5) vegetative heterogeneity
(6) surrounding land use
(7) Connectivity
(8) vegetation types

Habitat Suitability Indices developed by USFWS for the purpose of documenting the quality and quantity of available habitat for selected wildlife and fish species marsh habitat types

(1) sand nesters - least tern
(2) tree nesters - white ibis and great egret

Because both models provide a comparable output metric (habitat unit), the outputs can simply be added together to calculate a total output for any alternative

* Model Review Plan has been approved and review of EPA model for a one-time use is in progress

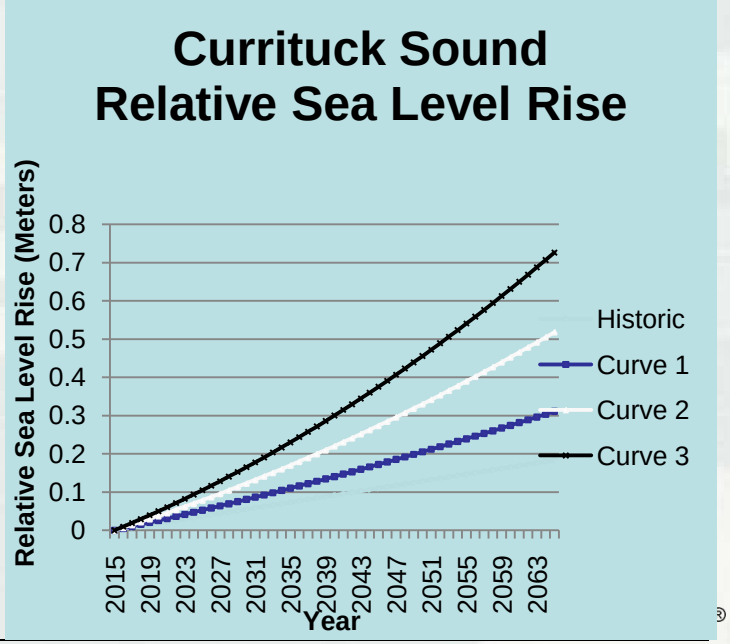
NER Plan Formulation

- Results of preliminary EBA runs will be combined with preliminary cost estimates will be entered into the IWR Planning Suite Program to generate all possible combinations of independent and/or or dependent sets of management measures for each identified restoration opportunity site
- Non-cost effective opportunities will be eliminated
- Data will be collected for each remaining site and associated measures to refine design, costs, and benefits
- If multiple measures or combinations of measure exist at a site, IWR will be run for that site to chose the best buy plan for the site
- Once a single alternative is identified for each restoration opportunity site, IWR will be run with refined costs and benefits to determine a final array of best buy plans for the Sound
- Best Buy plans will be further evaluated to select a NER plan

NER Plan Formulation

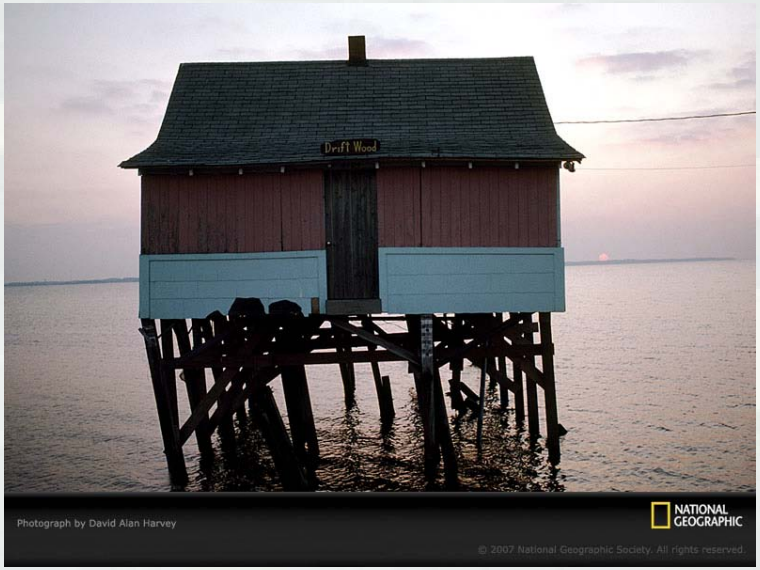
Additional Information

- Eco – PCX has submitted a Review Plan Endorsement Memo to SAD for the MSC Commander's approval
- Model Review Plan has been approved and review of EPA model for a one-time use is in progress
- Sea Level Rise
  - In accordance with ER 1165-2-211



Next Milestones

AFB Read-Ahead to SAD/HQ	March 2012
AFB Conference	May 2012
Draft Report to SAD/HQ	October 2012
Public Review, Draft Report	March 2013
DE Notice, Final Report	August 2013
CWRB	October 2013



Questions and Discussion