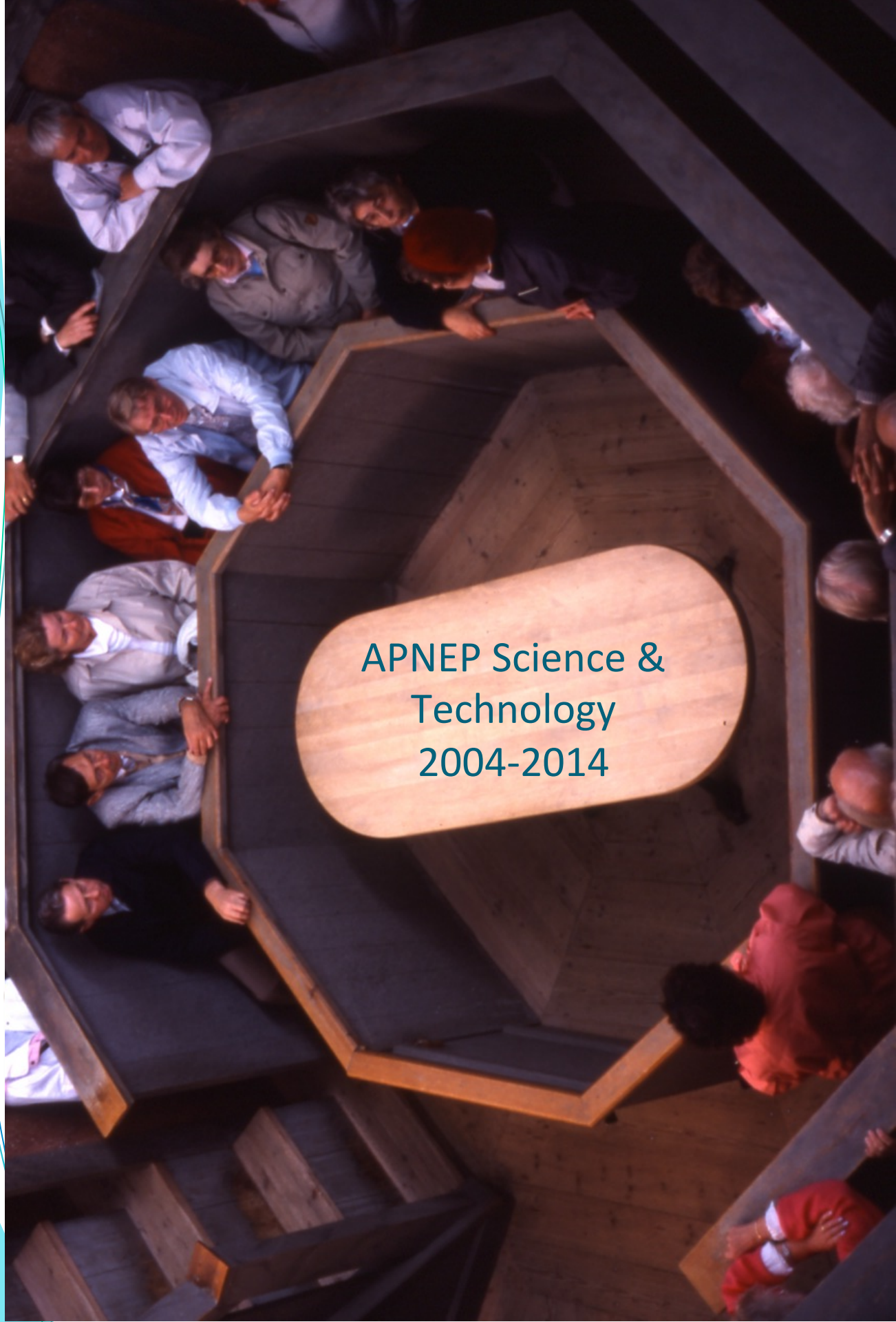
# An Interim Evaluation: A Decade of Science & Technology Coordination in the Albemarle-Pamlico National Estuary Partnership

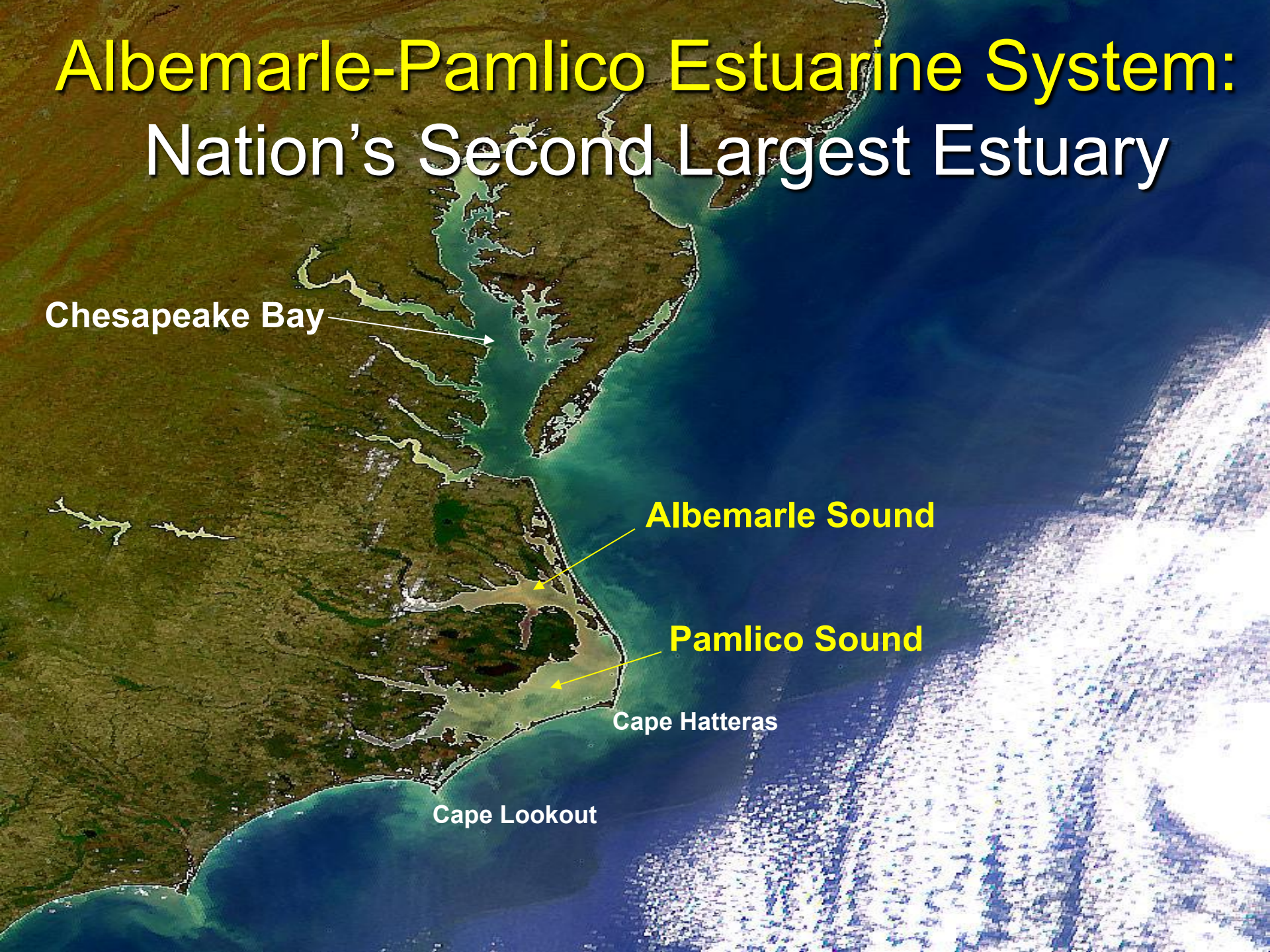
Dean E. Carpenter, D. Env.
Albemarle-Pamlico National Estuary Partnership

STAC Summer Meeting
UNC Chapel Hill Institute of Marine Sciences
29 July 2014


APNEP Science &
Technology
2004-2014

# In my beginning (and at the interim)…2003

# Albemarle-Pamlico Estuarine System:
## Nation's Second Largest Estuary



# Regional Ecosystem Services: Provisioning

- Food for humans and animals (e.g., fish, shellfish, seagrasses, livestock, grains)
- Salt
- Minerals and oil resources
- Construction materials (e.g., sand, rock, coral, lime, wood)
- Biodiversity (e.g., genetic stock for biotechnology, medicinal)

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# Regional Ecosystem Services: Supporting, Regulating, Cultural

- Shoreline protection (e.g., storms, erosion)
- Storing and cycling nutrients
- Biodiversity
- Water quality
- Recreation
- Tourism
- River and marine transport

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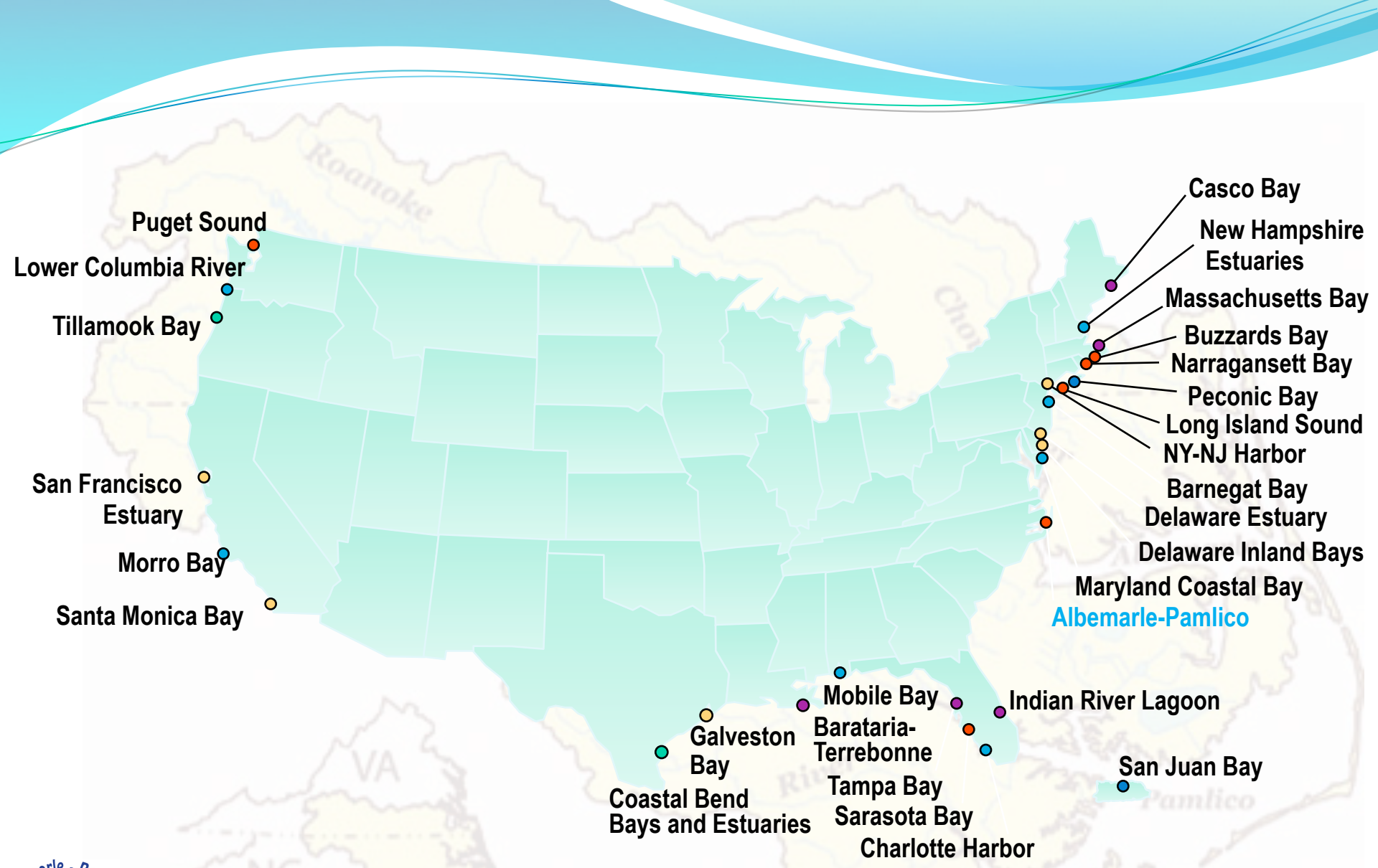
# Urban Land Cover Dynamics: 1982-1997

- Chowan = 62.1%
- Albemarle = 86.2%
- Tar-Pamlico = 87.2%
- Neuse = 89.3%
- Bogue-Core Sounds = 102.4%
- Roanoke = 136.1%
- Pamlico Sound = 138.2%




# Estuaries in the Program

# APNEP Mission

"To identify, restore, and protect the significant resources of the Albemarle-Pamlico estuarine system."

# APNEP Host Organization

- NC Department of Environment & Natural Resources (1987-2014)
  - Assistant Secretary for Natural Resources (2003-2013)
    - Natural Resources Planning Group (2006-2009)
    - Office of Conservation, Planning, and Community Affairs (2009-2013)
  - Secretary (2013)
    - Office of Land & Water Stewardship

# What APNEP doesn't measure, APNEP doesn't manage…2004-2007

# APNEP Science & Technology Initiative

"To facilitate the effective use of science, technology, training, and information in the planning, management, and evaluation of ecosystems within the APNEP region"

# Science & Technology Advisory Committee (STAC)

- By-Laws
  - Public & private membership
  - 36 seats, staggered terms
  - Executive Board
  - No state agency representation
- Operational Guidelines
  - 2-3 meetings annually
  - Presentations & discussion

| Goal | Environmental Outcome | Outcome Type | Provisional Indicator |
|---|---|---|---|
| 1: Human Communities | 1A: Waters are safe for personal contact. | Swimming | Beach Action Days/Closings by Water Body Type Sounds, Freshwater River, Lake, Brackish River) |
| | 1B: Designated surface and ground water supplies are safe for human consumption. | Potable Surface Waters | WQ Standard Violations (Surface) |
| | | Potable Groundwaters | Drinking Water Standard Violations (Water-supply Aquifers) |
| | | | Nutrient Concentrations in Land Use Categories (Shallow Aquifer) |
| | 1C: Surface hydrologic regimes sustain regulated human uses. | Water Supply | Flows, Severity, Frequency, Duration of Droughts & Floods |
| | 1D: Fish and game are safe for human consumption. | Edible Harvest | Fish Consumption Advisories |
| | | | Shellfish (& Swimming) Area Closures |
| | 1E: Opportunities for recreation and access to public lands and waters are protected and enhanced. | | Access, Water Trails |
| | | | Number of Visitations & People Who Use Coastal Areas |
| | | | Number of Tourists to Coastal Regions |
| | | | Water Access Number & Location |

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| | | | |
|---|---|---|---|
| **2: Native Species** | **2A: The biodiversity, function, and populations of species in aquatic, wetland, and upland communities are protected, restored, or enhanced.** | **Aquatic Taxa: Marine Mammals** | Bottlenose Dolphin Range and Population Condition |
| | | **Aquatic Taxa: Finfish** | Fish Stock Condition (SSB and Age Structure) by Commercial and Recreational Species |
| | | | River Herring & American Shad Population Condition by Ecologically Important Species |
| | | | Atlantic Sturgeon Occurrences and Population Status |
| | | | Freshwater: Carolina Madtom Occurrences and Population Status |
| | | **Aquatic Taxa: Herptofauna** | Diamondback Terrapin Range and Population Condition |
| | | | Freshwater Turtles Range and Population Condition |
| | | | Sea Turtles Range and Population Condition |
| | | | Neuse River Waterdog Range and Population Condition |
| | | **Aquatic Taxa: Crustaceans** | Blue Crab Spawning Stock Biomass |
| | | | North Carolina Spiny Crayfish Occurrence |
| | | **Aquatic Taxa: Bivalve Molluscs** | Eastern Oyster Bed Extent and Densities |
| | | | Dwarf Wedge Mussel Range and Population Condition |
| | | **Aquatic Taxa: Freshwater Invertebrate** | Invertebrate IBI Index |
| | | **Wetland Taxa: Birds** | Waterbird Community Structure |
| | | | Shorebird Community Structure |
| | | | Landbird Community Structure |
| | | | Waterfowl Community Structure |
| | | | King rail, Piping plover, Swainson's warbler, Black duck Population Status/Occurrences |
| | | **Wetland Taxa: Herptofauna** | Herptofauna Community Structure (e.g., Ephemeral Pool Breeders) |
| | | **Wetland Taxa: Invertebrates** | Vulnerable Wetland Invertebrate TBD Species Population Status/Occurrences (Dragonflies, damselfies, fingernail clams?) |
| | | **Wetland Taxa: Vegetation** | Area by Wetland Class |

| | | | |
|---|---|---|---|
| **2: Native Species** | **2A: The biodiversity, function, and populations of species in aquatic, wetland, and upland communities are protected, restored, or enhanced.** | **Upland Taxa: Mammals** | Black Bear Population in Uplands |
| | | | Bat Population |
| | | **Upland Taxa: Birds** | Interior Land Bird TBD Population |
| | | | Quail, Grassland Bird Community Status |
| | | **Upland Taxa: Herptofauna** | Box Turtle Population Status/ Occurrences |
| | | **Upland Taxa: Vegetation** | Longleaf/Natural Upland Pine Extent, Location (LC) |
| | | | Natural Upland Hardwood Extent, Location (LC) |
| | | | Maritime Forests Extent, Location (LC) |
| | | | **Area by Upland Land Cover Class** |
| | | **Upland Taxa: Invertebrates** | Firefly Population Status/Occurrences |
| | | **Aquatic Stressors** | **Fish Kills** |
| | | | Total Toxicant Body Burdens in Aquatic Species (TBD) |
| | | **Wetland Stressors** | Fire Severity, Frequency, and Extent in Wetlands |
| | | | **Estuarine Shorezone Area and Composition** |
| | | | Amphibian Deformity Incidences in Wetlands |
| | | | Impaired Landward Migration of Coastal Wetlands |
| | | **Upland Stressors** | Fire Severity, Frequency, and Extent |
| | | | Natural Coast Buffer: Undeveloped Dunes and Shorelines |
| | | | Landscape Connectivity Index |
| | | | Landscape Proximity Index |
| | | | Extent of Highly Eroded Lands |

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| | | | |
|---|---|---|---|
| **2: Native Species** | **2B: The extent and quality of upland, freshwater, estuarine and near-shore marine habitats fully support biodiversity and ecosystem function.** | **Estuarine/Marine Habitats (Stressors)** | SAV Area/Zone/Density/Potential/Phenology by Species |
| | | | Water Quality in SAV Habitats & Shellfish Waters |
| | | **Freshwater Habitats (Stressors)** | Freshwater Hard Bottom |
| | | | Quality & Extent of Anadromous Fish Spawning/Nursery Areas |
| | | | Inaccessible Fish Spawning Area by Obstruction Type |
| | | **Wetland Habitats (Stressors)** | Wetland Community Representation |
| | | | Hydrological Alteration in Wetlands |
| | | **Upland Habitat Index (Stressors)** | Extent of Highly Eroded Soils |
| | | | Total Conservation Land |
| | | | Total Woodland Area; Area of Specific Forest Types |
| | | **Habitat Management** | Permitted Wetland Losses |
| | | | Wetland Restoration |
| | **2C: Non-native invasive species do not significantly impair native species' viability or function, nor impair habitat quality, quantity, and the processes that form and maintain habitats.** | **Invasive Aquatic Plant Species** | Eurasian Watermillfoil Population Status/ Occurrences |
| | | | Hydrilla Population Status/Occurrences |
| | | **Invasive Wetland Plant Species** | Phragmites australis Population Status/ Occurrences, Alligator Weed (Invasive Comm) |
| | | **Invasive Wetland Faunal Species** | Nutria Population Estimates; Notable Local Populations |
| | | **Invasive Upland Plant Species** | Privet Population Status/Occurrences |
| | | | Microstegium Population Status/ Occurrences |
| | | | Kudzu Population Status/Occurrences |
| | | | Ailanthus altissima Status/Occurrences |
| | | | Paulownia tomentosa Status/Occurrences |
| | | **Invasive Upland Faunal Species** | Feral Hog Population Estimates; Notable Local Populations |
| | | | Fire Ants Population Status/Occurrences |

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| | | | |
|---|---|---|---|
| **3: Water Quantity & Quality** | **3A: Appropriate hydrologic regimes support ecological integrity.** | | Amount & Extent of Impaired Waters |
| | | | WQ Standard Violations |
| | | | Dissolved Oxygen Standard Violations |
| | | | Flows, Severity, Frequency, Duration of Droughts & Floods |
| | | | (Shallow) Ground Water Levels |
| | **3B: Nutrients and pathogens do not harm species that depend on the waters.** | | Amount & Extent of Impaired Waters |
| | | | WQ Standard Violations |
| | | | Chlorophyll-a Concentration |
| | | | Nitrogen & Phosphorus Loading |
| | | | Nutrient Concentrations in NSW |
| | | | Sediment Nutrient Concentration |
| | **3C: Toxics in waters and sediments do not harm species that depend on the waters.** | | Amount & Extent of Impaired Waters |
| | | | Toxicant Standards Violations |
| | | | Metals Standards Violations |
| | | | Sediment Quality Triad |
| | **III-D: Sediments do not harm species that depend on the waters.** | | Amount & Extent of Impaired Waters |
| | | | Sediment Standard Violations |
| | | | Soil Loss from Agricultural Lands & Forests |
| | | | Average Secchi Depth |

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| Category | Dimension | Indicator Type | Provisional Indicator |
|---|---|---|---|
| Ecosystem Stressors | Base Stressors | Human Population | Human Population |
| | | Land Use, Land Cover | Total Area of Impervious Cover |
| | | | Land Use/Cover Extent by Type (Urban, Altered, Total) |
| | Atmospheric Stressors | Air Chemistry | Total Inorganic Nitrogen Deposition |
| | | | Total Inorganic Sulfur & Nitrogen Deposition |
| | | | Ground-Level Ozone Concentrations |
| | | | Mercury Deposition |
| | | Air Physics | Ambient Air Temperature |
| | | | Precipitation |
| | | | Storm Frequency & Severity |
| | Liquid Stressors | Liquid Waste Generation | Wastewater Per Capita |
| | | | Number of Open Liquid-Waste Lagoons |
| | | | Livestock Waste Production |
| | | Sea Level Rise | Sea Level/Relative Sea Level |

# What again are we managing and have we been effective? …2008-2012

# CCMP's Four Questions

- **What is a healthy Albemarle-Pamlico Estuarine System?**
- **What is the status of Albemarle-Pamlico Estuarine System?**
- **What are the biggest threats to Albemarle-Pamlico Estuarine System?**
- **What actions should be taken that will move us from where we are today to a healthier Albemarle-Pamlico Sounds by 2020?**

# APNEP's Transition to Ecosystem-Based Management

- A **holistic vision and plan** that includes a comprehensive description of the Albemarle-Pamlico system and articulation of multiple management objectives.
- A community that has **effective engagement** of policy makers, managers, scientists, & stakeholders.
- A process that includes effective **adaptive management** to address a changing system.
- A **framework** that includes appropriate authority, implementation area, management institutions, financial resources, and effective communications.

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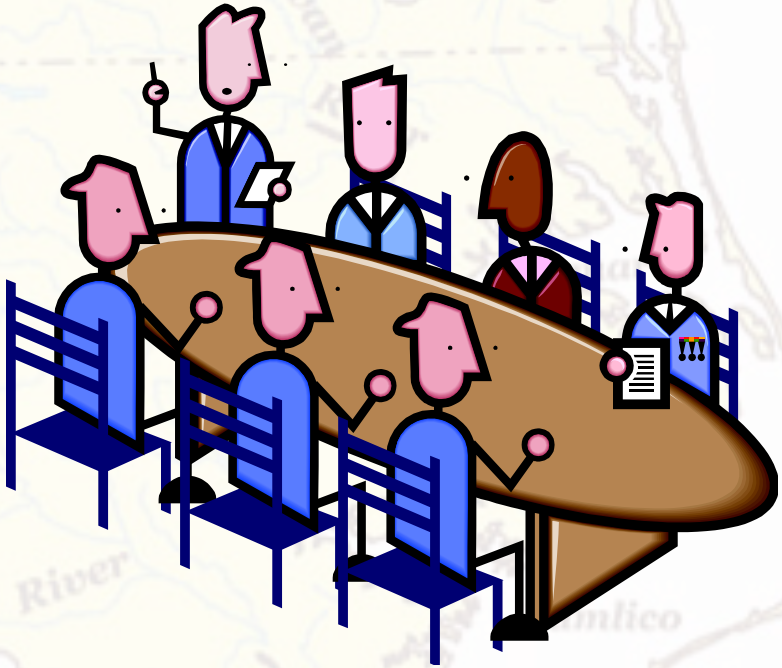
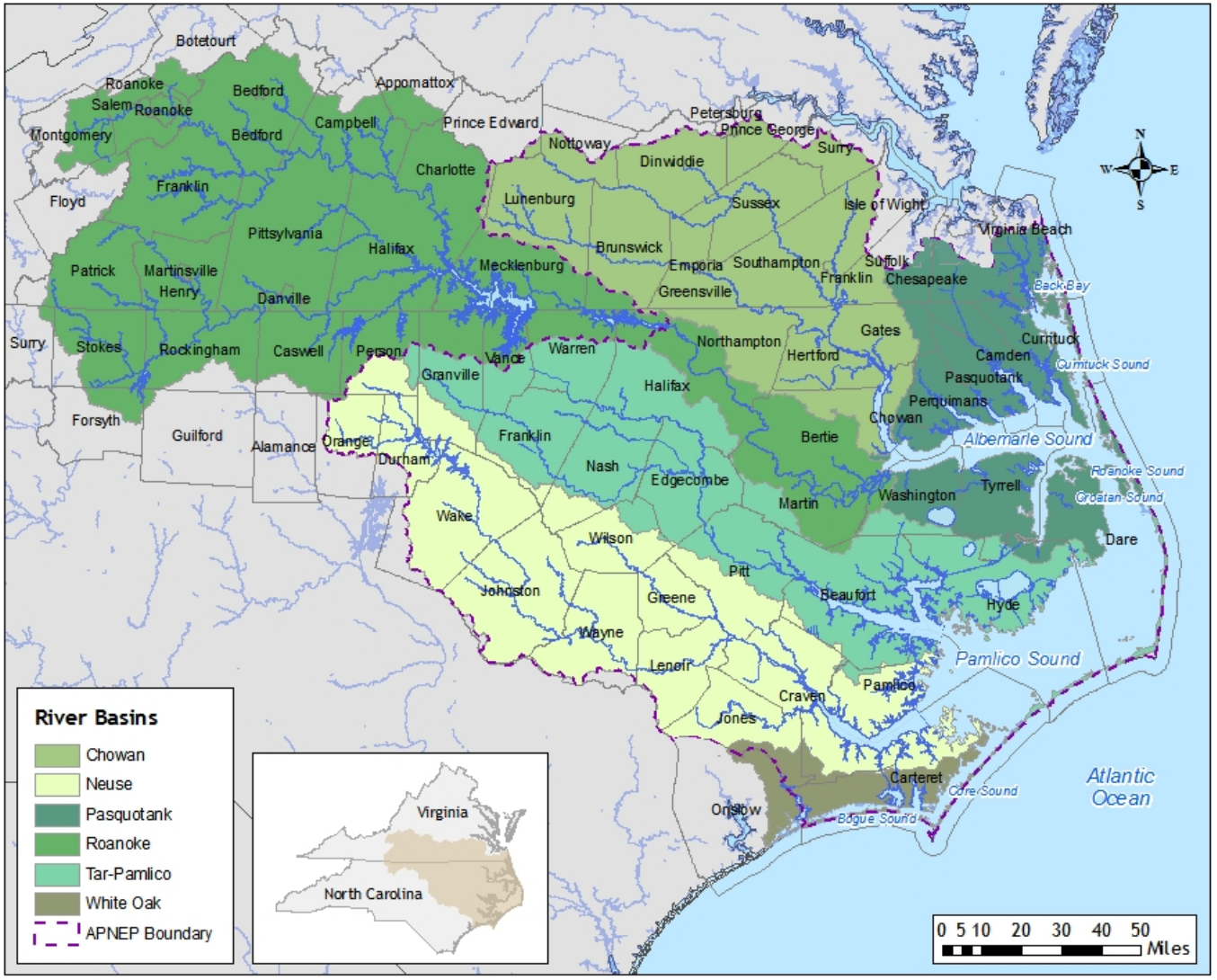
# Gaining "Appropriate Authority" to Undertake EBM

- Presentation to Policy Board (May 2009)
- Theme of Science & Technical Advisory Committee meeting (July 2009)
- Formed EBM Proposal Team (August 2009)
- Proposal to Policy Board (December 2009)
- Progress Reports to Policy Board (September 2010, June 2011)



# APNEP Implementation Area and Management Institutions

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# APNEP EBM Transition Team

- Policy Board
- Science & Technical Advisory Committee
- Citizens Advisory Committee
- State Planner
- Federal Planner
- EBM Tech Transfer
- Staff

# APNEP's Seven Steps to EBM Enlightenment

- Articulate **program goals**
- Develop **system level model** for goal attainment
- Assess current management efforts –identify **gaps**
- Develop **management strategy**
- Develop **monitoring program**
- **Assess** performance
- **Manage adaptively**

# Step 1: Articulate program goals

- Objective Hierarchy Structure
  - Goal-Objective-Management Action-Step (1994)
  - Goal-Subgoal-Objective-Management Action (2008-2010)
  - Goal-Outcome + Component-Objective-Action (2012)
- Objectives Hierarchy Content
  - Five Goals, 15 Objectives, 49 Actions (1994)
  - Three goals, 12 Outcomes + 5 Components, 15 Objectives, 58 Actions (2012)

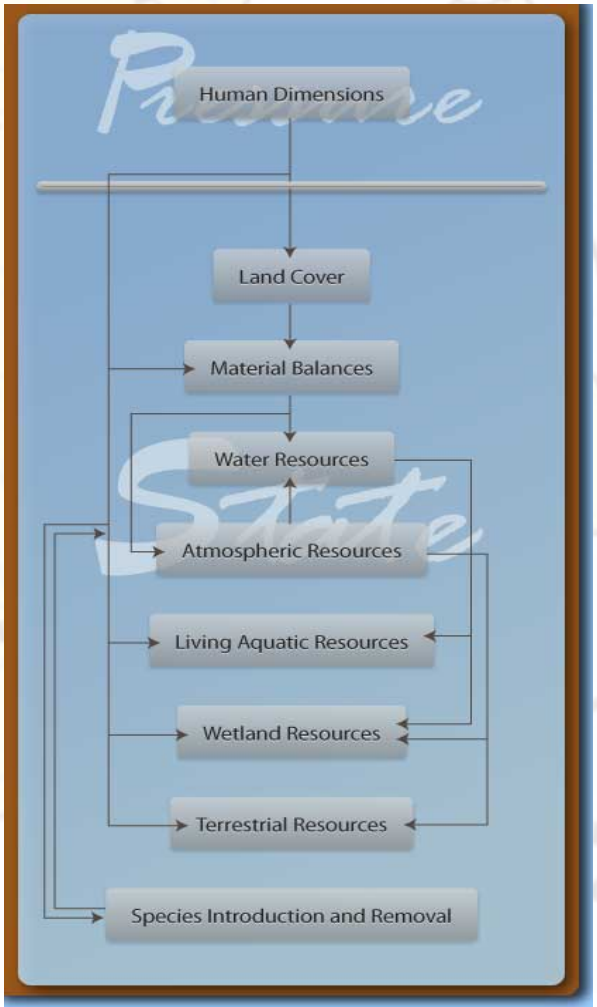
# APNEP's Ecosystem Health Goals

- **A region where human communities are sustained by a functioning ecosystem**
- **A region where aquatic, wetland, and upland habitats support viable populations of native species**
- **A region where water quantity and quality maintain ecological integrity**

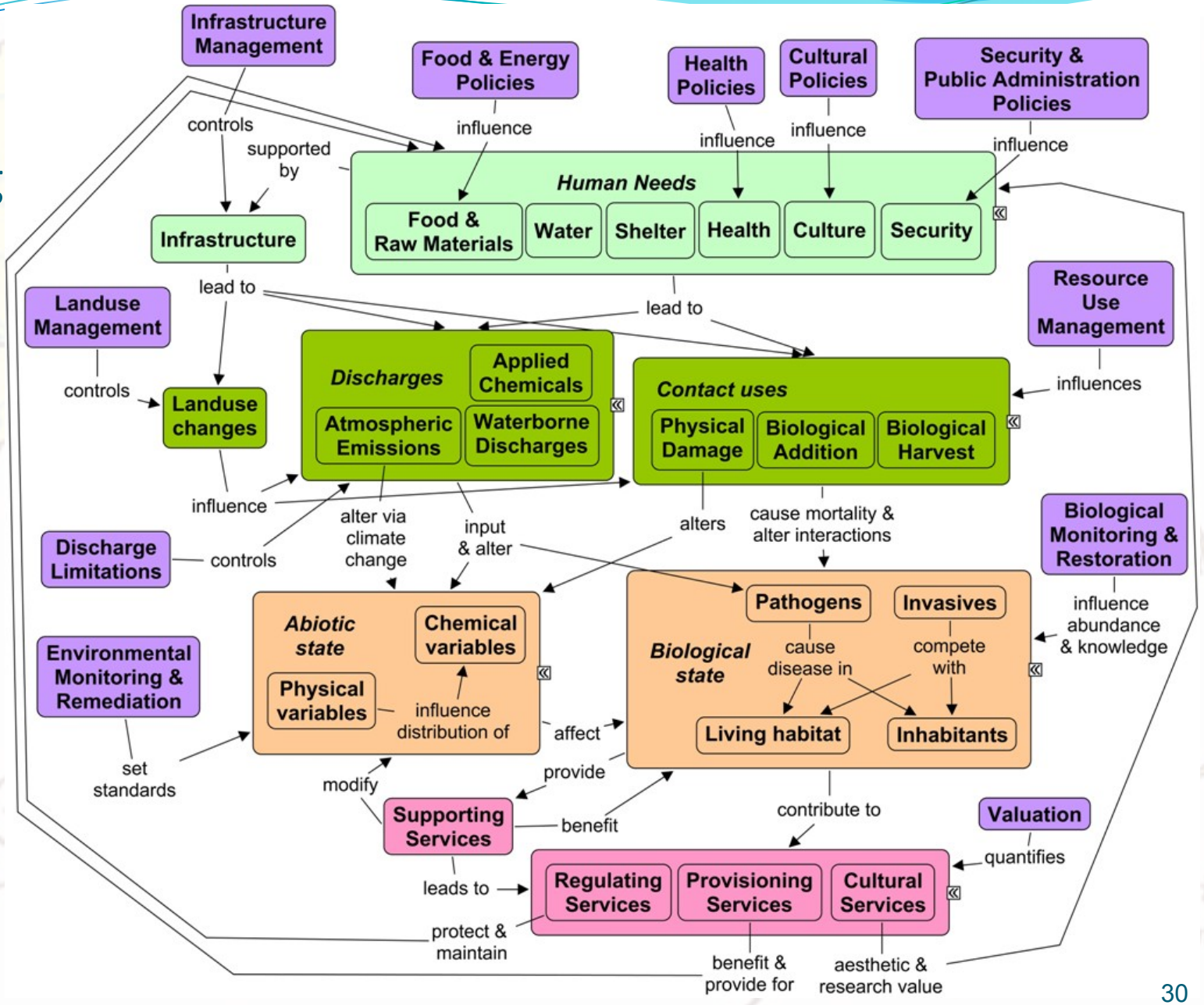
# Step 2: Develop system level model for goal attainment

Ecological management actions (stressor mitigation) can impact multiple ecosystem endpoints

Multiple stressors (including other endpoints) impact directly and indirectly ecosystem endpoints



# DPSER Modeling




Lt. green = Drivers
Dk. Green = Pressure
Orange = State
Red = Ecosystem Services
Purple = Response

EPA-ORD-ESRP 2010

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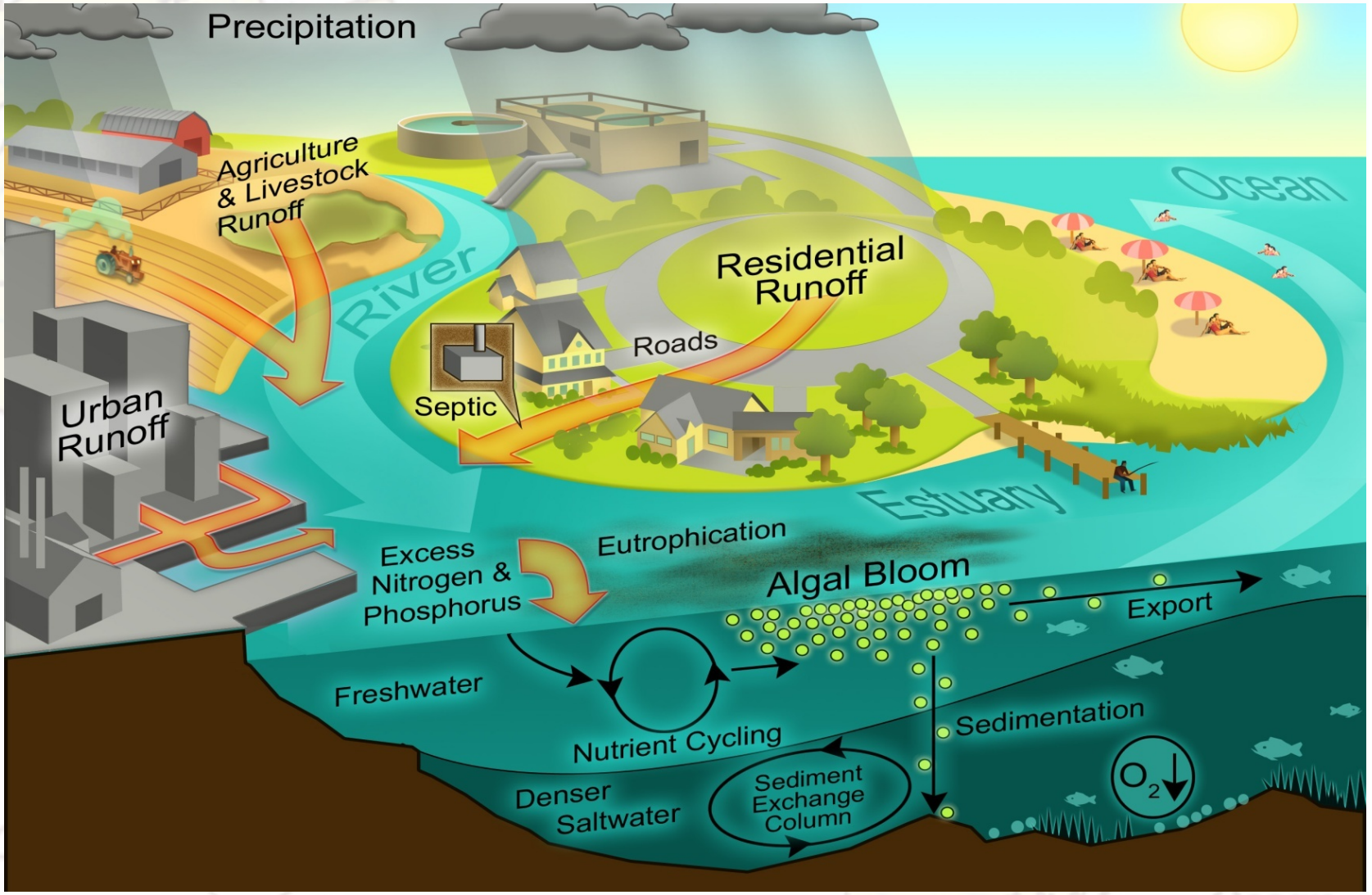
Conceptual Model of Nutrient Cycle




Modified from H. Paerl

# Outcome: Nutrients and pathogens do not harm the species that depend on the waters

- ***Biological Factors***
  - ***Fauna***
  - ***Flora***
  - ***Microorganisms***
    - **pathogen source control**
      - **human (septic)**
      - **animal (pasture, CAFO manure management)**
      - **wildlife population (?)**
- ***Physical Factors***
  - ***Structure***
  - ***Hydrology***
  - ***Temperature***

# Outcome: Nutrients and pathogens do not harm the species that depend on the waters

- ***Chemical Factors***
  - ***Salinity***
  - ***pH***
  - ***Nutrients***
    - **Load controls for nitrogen and phosphorus (air deposition, runoff, groundwater, point source)**
- ***Human Factors***
  - ***Use objectives***
    - **Management of agricultural pollutant sources**
    - **Management of developed land pollutant sources (stormwater)**
    - **Water body use designation (WQ standard development)**
  - ***Modification of system***
    - **Land-use management (particularly riparian lands)**
  - ***Knowledge***
    - **Technical understanding of Contaminant Management Strategies to meet WQ standards**
    - **Public appreciation of risks and need for management**
    - **Policy appreciation of regulatory needs**

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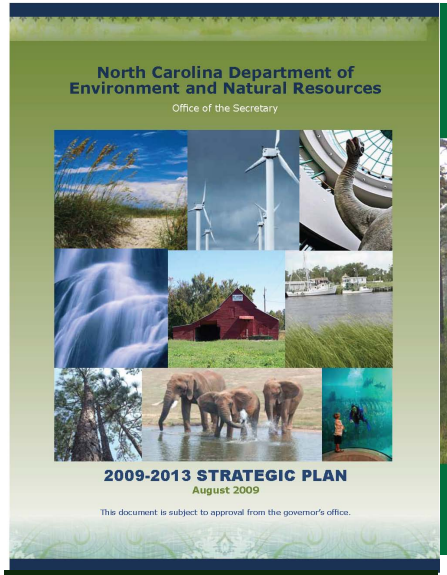
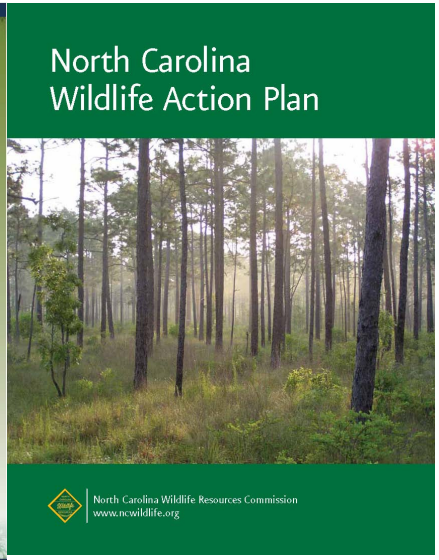
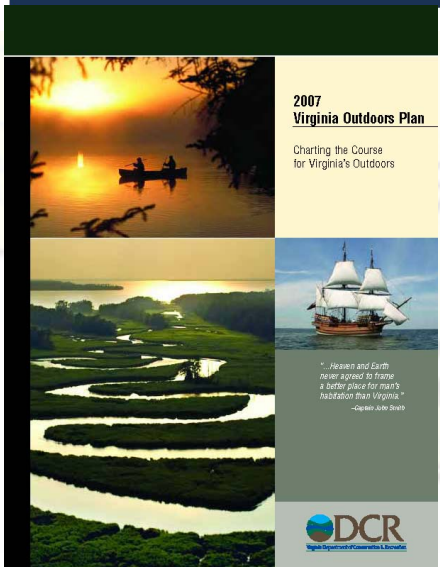
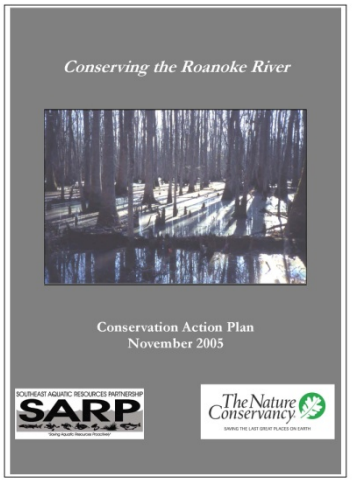
# Step 3: Assess current management efforts –identify gaps

- Directed by conceptual models
- Survey of partners' strategic/action plans
  - Specificity and publication date
  - Action extraction
  - Align with APNEP outcomes/strategies
- Interview senior management

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# Step 4: Develop management strategy

- Stakeholder Questions
- Management Objectives
- Actions with Partner Responsibilities
- APNEP Management Conference Review
- Public Input
- CCMP Publication


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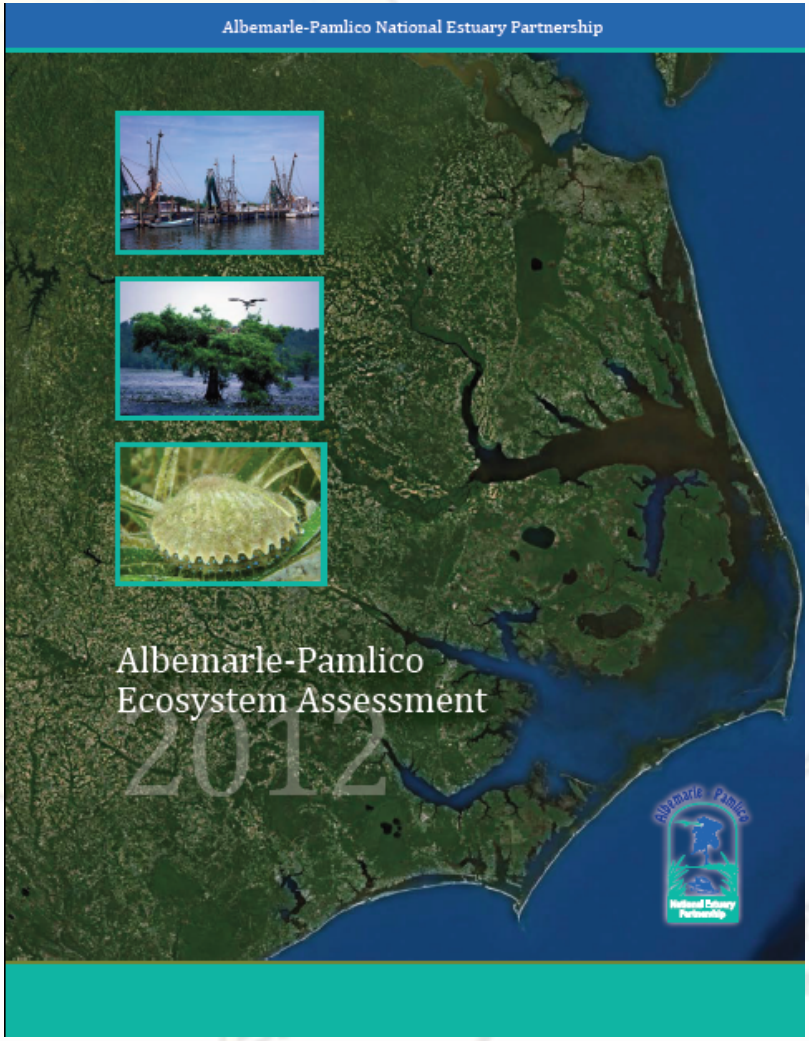
# Step 5: Develop monitoring program

- Linking candidate indicators to CCMP outcomes
- Indicator-specific monitoring strategies
  - Justification for indicator
  - Goal of sampling/monitoring program
  - Existing sampling/ monitoring program
  - Enhanced sampling/ monitoring program
  - Reference(s)
- Integrated monitoring strategy

# Step 6: Assess performance

- "Interim" regional ecosystem assessment (2012)
  - Select provisional indicators
  - Status & trends from 1995 to present
  - Heinz Center format
- Phase 2 assessment
  - Diagnosis
- Phase 3 assessment
  - Forecasting



# Assessment Planning

- "The greatest challenge in developing a large-scale biogeographic assessment is the synthesis and subsequent analysis of spatial data collected at different scales for varied objectives."

  Source: NOAA 2003, citing Gotway and Young 2002

# APNEP Ecosystem Assessment

## Coasts, Sounds, Near Marine: Extent & Pattern

- *Phragmites australis*
  - Why Is the Extent of the Wetland Plant Species *Phragmites australis* Important?
  - What Will This Indicator Report?
  - What Do the Data Show?
  - Why Can't This Entire Indicator Be Reported at This Time?
  - Discussion
  - Technical Notes

# Bioregional Assessment Questions

- What were historic ecological, social, and economic conditions, trends, and variability?
- What are current ecological, social, and economic conditions?
- What are trends and risks under current policies and management?
- What policy choices will achieve ecological sustainability consistent with social well-being?
- What are the implications of these choices?

Source: Erman 1999

# Adapt yet implement … 2013-?

# Step 7: Manage adaptively

- Most difficult step?
- Senior management engagement
- Trigger levels in plan

# Core Questions of Science and Technology for Sustainability

- Can scientifically meaningful "limits" or "boundaries" be defined that would provide effective warning of conditions beyond which the nature-society systems incur a significantly increased risk of serious degradation?
- What systems of incentive structures – including markets, rules, norms and scientific information – can most effectively improve social capacity to guide interactions between nature and society toward more sustainable trajectories?

# Core Questions of Science and Technology for Sustainability II

- How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?
- How can today's relatively independent activities of research planning, observation, assessment, and decision support be better integrated into systems for adaptive management and societal learning?

Source: Harvard's Forum on S & T for Sustainability

NCDENR

Employee Sign In

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## About APNEP

Our mission is to identify, protect, and restore the significant resources of the Albemarle-Pamlico estuarine system.

Read more...

Soundings

Grants

Calendar

**Featured Content:** | 2013 Symposium Proceedings | Comprehensive Conservation & Management Plan | 2012 Ecosystem Assessment

## Soundings

*A fresh take on the region's salty affairs*

### The 2013 Albemarle-Pamlico Ecosystem Symposium: Embarking on a New Voyage

*By Lindsey Smart, APNEP Project Coordinator*
*November 20, 2013*

The Albemarle-Pamlico National Estuary Partnership (APNEP) has realized significant milestones and embarked on several

## Echoes

*News and information from the Albemarle-Pamlico region and beyond*

more information/disclaimer

- A new approach to polluted waters in NC
  - 1/22/14 8:58 AM
- NC holds public meetings on shellfish habitat
- Magazine readers pick Currituck OBX as best beach
- Shrimp plan meeting established
- Cultch planting meetings set
- Crowd packs meeting on Corps' dredge plan
- Scientists to begin mapping submerged plant life along N.C. coast
- State park program explores animals in the wild
- Corps hopper dredge steams to Oregon Inlet for double duty


Dear Ecologist,
Is there a term for a boundary that separates two groups of organisms? For example if a species of flowers are separated by a river and the

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## RESOURCES

**Soundings Blog**

**... For Educators**

- Ask An Ecologist
- Lesson Plans
- Shad In The Classroom
- Teacher Institute
- Education Grants
- Kids Page

**Maps**

**...For Local Governm**

- Planning Tools
- Risk Analysis For Water Infrastructure

**Grants**

**...For Scientists**

- Assessments
- Models
- Monitoring
- Research
- Monitoring & Assessment Teams
- Science & Technical Advisory Committee
- Science & Technology Liaisons

**Calendar**

**Document Library**

- Authority And Guiding Documents
  - Comprehensive Conservation And Management Plan
- Conference Proceedings
- Partner Plans
- Research And Policy Reports
- Technical Issue Papers
- Work Plans
  - FY 2013 Workplan
  - FY 2014 Workplan

*A fresh take on the region's salty affairs*

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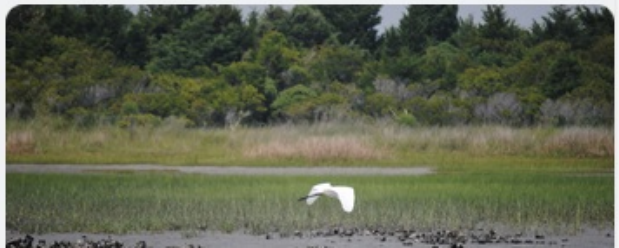

The Albemarle-Pamlico National Estuary Partnership (APNEP) has

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# On Course?