# APNEP's Wetland Monitoring & Assessment: Phase I (2008-2010) Phase II (2011-2018) Phase III (2024-)

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Wetlands Monitoring & Assessment Workshop
Chowan University
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# APNEP Integrated Monitoring & Assessment Overview

- National Estuary Program (1987)
  - APES (1988-1994)
  - Strategic Plan: CCMP 1.0 (1994-2010)
  - Indicators, adaptive management and STAC (2004)
  - Monitoring & Assessment Teams: SAV, Water, Aquatic Fauna, Wetlands, Terrestrial, Air, Human Dimensions (late 2000s)
- CCMP 2.0 (2012-2022)
  - Ecosystem-Based Management, four-step iterative cycle (2012)
  - Monitoring objective, integrated monitoring action
  - MATs second push (late 2010s)
- CCMP 3.0 (2025-2030)
  - MATs third push with increased state & federal $ (mid 2020s)
  - Integrated monitoring network pilot(s) (beginning 2025)
  - Regional ecosystem assessment 2.0 (2025-2026)

# APNEP Integrated Monitoring Network Pilot(s)

- Candidate coastal landscapes/waterscapes
  - Currituck Sound & Back Bay
  - Core Sound
- Garner support
  - Partner discussions
- Establishing survey metrics & stations
  - Tier 2 (field-based)
  - Tier 3 (intensive monitoring)
  - SAV monitoring strategy implementation

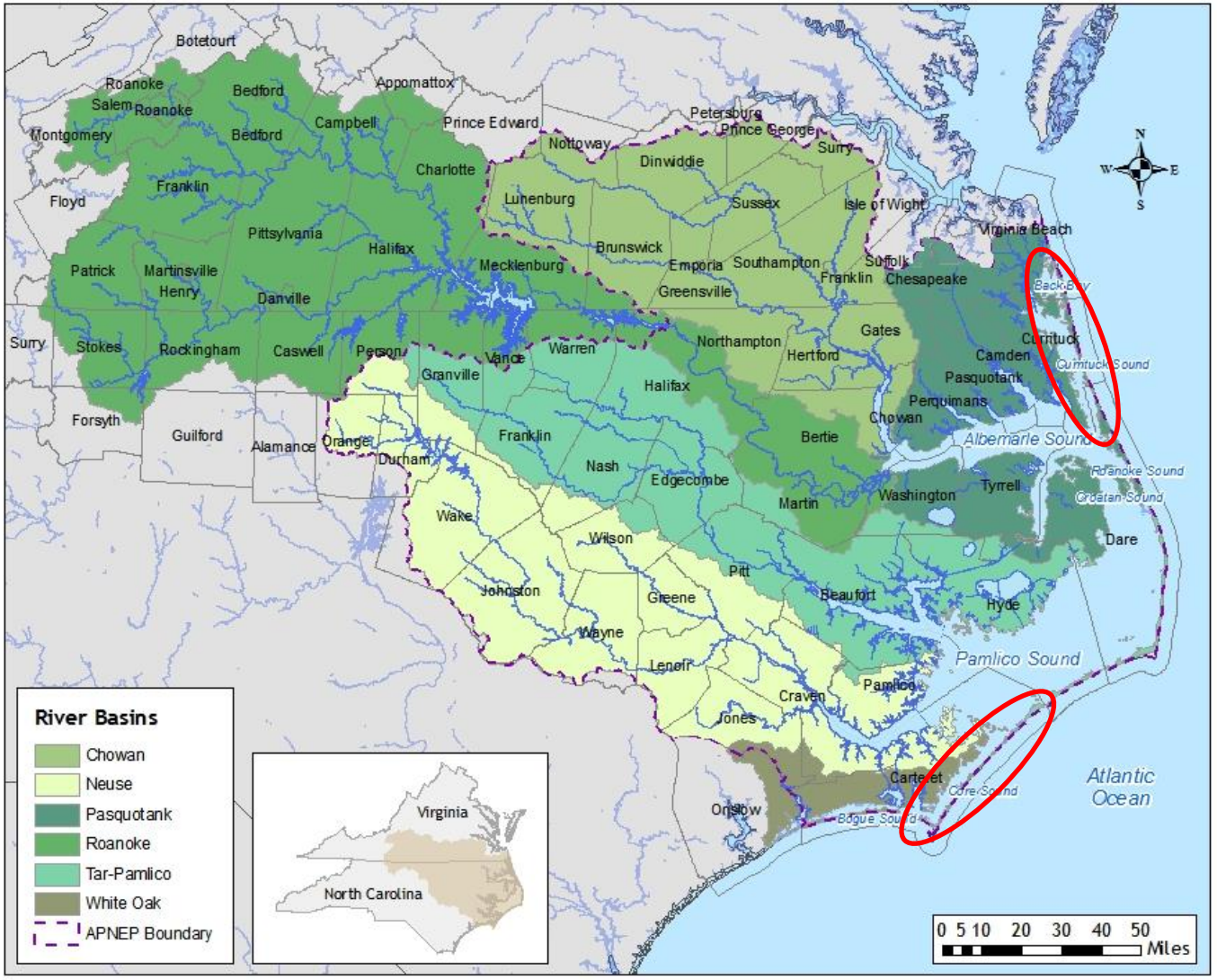
# APNEP Regional Ecosystem Assessment 2.0

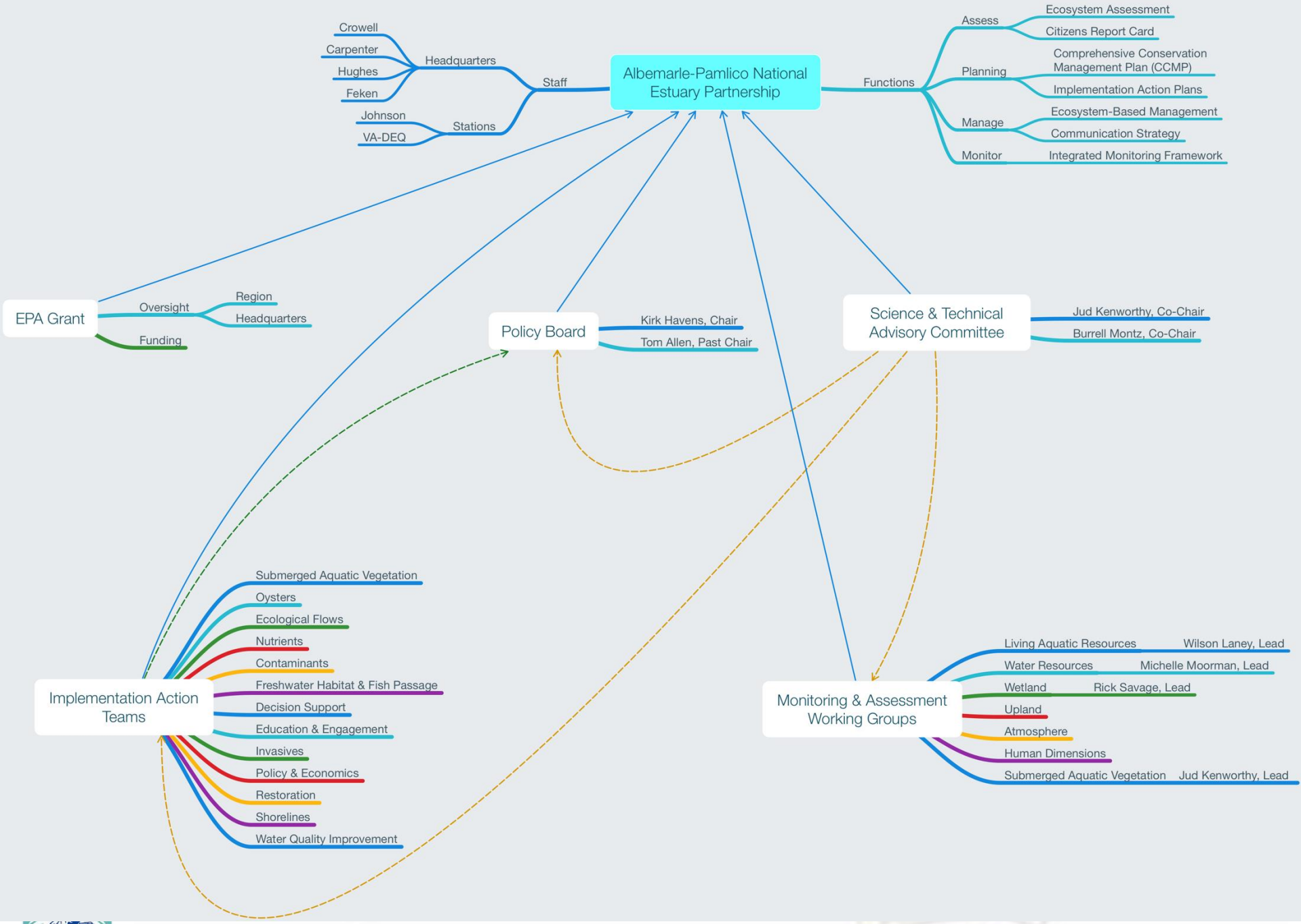
- Not starting from scratch (REA 1.0)
  - 20 indicator metrics
  - Status & trends (no reference values)
- Status & Trends
  - Reference values: blood pressure analogy
- Diagnostics
  - Ecoepidemiology
  - Tier 3 insights
- Forecasting
  - Scenario-based
- Comprehensive
  - Terrestrial, Wetlands, Human Dimensions

# APNEP Mission

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

# APNEP Implementation Area and Management Institutions




Albemarle-Pamlico National Estuary Partnership
Staff
Headquarters
Crowell
Carpenter
Hughes
Feken
Stations
Johnson
VA-DEQ
Functions
Assess
Ecosystem Assessment
Citizens Report Card
Planning
Comprehensive Conservation Management Plan (CCMP)
Implementation Action Plans
Manage
Ecosystem-Based Management
Communication Strategy
Monitor
Integrated Monitoring Framework
EPA Grant
Oversight
Region
Headquarters
Funding
Policy Board
Kirk Havens, Chair
Tom Allen, Past Chair
Science & Technical Advisory Committee
Jud Kenworthy, Co-Chair
Burrell Montz, Co-Chair
Implementation Action Teams
Submerged Aquatic Vegetation
Oysters
Ecological Flows
Nutrients
Contaminants
Freshwater Habitat & Fish Passage
Decision Support
Education & Engagement
Invasives
Policy & Economics
Restoration
Shorelines
Water Quality Improvement
Monitoring & Assessment Working Groups
Living Aquatic Resources
Wilson Laney, Lead
Water Resources
Michelle Moorman, Lead
Wetland
Rick Savage, Lead
Upland
Atmosphere
Human Dimensions
Submerged Aquatic Vegetation
Jud Kenworthy, Lead

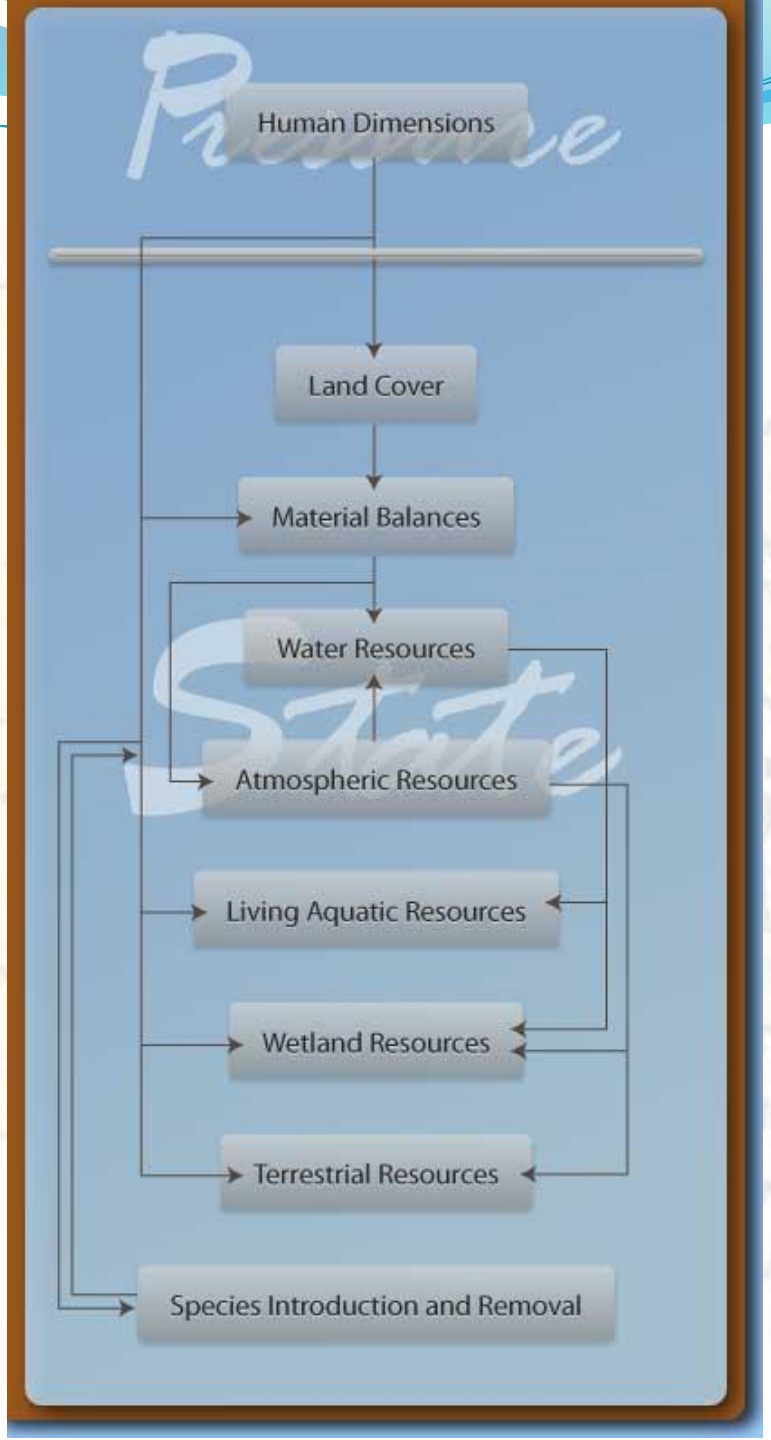
# APNEP Indicator Definition

"A numerical value derived from actual measurements of a pressure, state or ambient condition, exposure, ecological condition, or measure of human health or wellbeing over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment in the A-P region."

# APNEP Indicator Criteria

- Utilization: Address a key process or property, and answers (or makes an important contribution toward answering) an important question about conditions in the A-P region
- Objectivity: Developed and presented in an accurate, clear, complete, and unbiased manner
- Integrity: Underlying data should be characterized by sound collection methodologies and data management systems adequate to protect its integrity, and to comply with quality assurance procedures
- Availability: Data should be available and timely, or will likely be available in the future, to maintain the indicator's utility
- Representation: Trends should accurately represent the underlying trends in the target population
- Clarity: The indicator should be clearly defined and reproducible. The specific data used and the specific assumptions, analytical methods, and statistical procedures employed are clearly stated

# Regional Ecosystem Model



# APNEP Objectives-Metrics Hierarchy

- Modules
- Categories
- Dimensions
- Metrics

# APNEP Wetland Resources Monitoring & Assessment (Phase I)

- Develop a monitoring strategy for Wetland Resource metrics within the APNEP region
- Metric-specific monitoring proposals
- Indicators to be featured in the 2012 APNEP Regional Ecosystem Assessment

# Wetland Resources Monitoring & Assessment Team Representation (Phase I)

- APNEP
- NC-DENR
  - DCM
  - DFR
  - DMF
  - DWQ
  - DWR
  - EEP
  - NERR
- NC-WRC
- Federal
  - COE
  - EPA
  - FWS
  - NOAA
  - NPS
  - USGS
- STAC/ Ex-STAC

# Candidate Wetland Resource Indicators

| Module | Category | Dimension | Indicator | |
|---|---|---|---|---|
| VII: Wetland Resources | VII-A: Wetland Incidents of Concern | VII-A-1: Altered Fire Regime in Wetlands | VII-A-1-a | Fire Severity, Frequency, and Extent in Wetlands |
| | | VII-A-2: Wetland Vegetation Dieb acks | VII-A-2-a | Saltmarsh Dieb acks |
| | | | VII-A-2-b | Estuarine Shoreline Area and Composition |
| | | VII-A-3: Amphibian Deformities in Wetlands | VII-A-3-a | Amphibian Deformity Incidences in Wetlands |
| | | VII-A-4: Bioaccumulation in Wetlands | VII-A-4-a | Wetland Bird Egg Contamination |
| | VII-B: Wetland Habitat | VII-B-1: General Wetland Habitat Condition | VII-B-1-a | Rare Wetland Organism Presence |
| | | | VII-B-1-b | Rare Wetland Community Presence |
| | | | VII-B-1-c | Wetland Community Representation |
| | | | VII-B-1-d | Wetland Patch Condition |
| | | | VII-B-1-e | Permitted Wetland Losses |
| | | | VII-B-1-f | Wetland Restoration |
| | | VII-B-2: Hydrologic Integrity in Wetlands | VII-B-2-a | Hydrogeomorphic & Condition Modification in Wetlands |
| | VII-C: Living Resource Populations in Wetlands | VII-C-1: Wetland Mammals | VII-C-1-a | Black Bear Populations in Wetlands & Uplands |
| | | | VII-C-1-b | Bobcat Populations in Wetlands |
| | | VII-C-2: Wetland Birds | VII-C-2-a | Waterbird Community Structure |
| | | | VII-C-2-b | Shorebird Community Structure |
| | | | VII-C-2-c | Landbird Community Structure |
| | | | VII-C-2-d | Waterfowl Community Structure |
| | | VII-C-3: Wetland Amphibians | VII-C-3-a | Ephemeral Pool Breeders |
| | VII-D: Wetland Soil/Sediment Condition | VII-D-1: Wetland Soil Condition/ Oxidation | VII-D-1-a | Subsidence in Wetland Soils |
| II: Land Cover | II-A: Wetland Cover Type Extent | II-A-3: Wetlands | II-A-3-a | Area by Wetland Class |
| | II-B: Spatial Relationships in Wetlands | II-B-1: Wetland Connectivity | II-B-1-a | Wetland Connectivity Index |
| | | II-B-2: Wetland Patchiness | II-B-2-a | Wetland Complexity Index |
| | | II-B-3: Wetland Proximity | II-B-3-a | Wetland Proximity Index |
| | II-C: Future Wetland Landscapes | II-C-1: Tomorrow's Riparian Zones | II-C-1-a | Land Use/Land Cover Under 5' Elevation |
| | | II-C-2: Tomorrow's Shorelines | II-C-2-a | Impaired Landward Migration of Coastal Wetlands |
| III: Material Balances | III-B: Wetland Element of Carbon Cycle | III-B-2: Sequestered Carbon | III-B-2-a | Stored Carbon in Wetland Soils & Vegetation |
| | III-C: Wetland Element of Nutrient Cycle | III-C-1: Nitrogen | III-C-1-a | Stored Nitrogen in Wetland Soils & Vegetation |
| | | III-C-2: Phosphorus | III-C-2-a | Stored Phosphorus in Wetland Soils & Vegetation |
| | | III-C-3: Sulfur | III-C-3-a | Stored Sulfur in Wetland Soils & Vegetation |
| | III-D: Wetland Element of Sediment Cycle | III-D-1: Sedimentation | III-D-1-a | Sedimentation in Wetlands |
| | III-E: Wetland Element of Toxicants Cycle | III-E-1: Metals Contaminants | III-E-1-b | Mercury Prevalence in Wetland Biota |
| | | III-E-2: Non-Metals Contaminants | III-E-2-a | Toxicant (TBD) Prevalence in Wetland Biota |
| IX: Species Introductions & Removals | IX-A: Invasive Wetland Species | IX-A-1: Invasive Wetland Mammals | IX-A-1-a | Nutria Population Estimates, Notable Local Populations |
| | | IX-A-2: Invasive Wetland Birds | IX-A-2-a | Brown-headed cowbird, European starling (Invasive Comm.) |
| | | IX-A-3: Invasive Wetland Reptiles | IX-A-3-a | Invasive Wetland Reptile TBD Species Population Status/Occurrences |
| | | IX-A-4: Invasive Wetland Amphibians | IX-A-4-a | Invasive Wetland Amphibian TBD Species Population Status/ Occurrences |
| | | IX-A-9: Invasive Wetland Arachnids | IX-A-9-a | Invasive Wetland Arachnid TBD Species Population Status/ Occurrences |
| | | IX-A-10: Invasive Wetland Crustaceans | IX-A-10-a | Invasive Wetland Crustacean TBD Species Population Status/Occurrences |
| | | IX-A-11: Invasive Wetland Insects | IX-A-11-a | Invasive Wetland Insect TBD Species Population Status/Occurrences |
| | | IX-A-13: Invasive Wetland Flora | IX-A-13-a | Phragmites australis Population Status/Occurrences, Alligator Weed (Invasive Comm.) |
| | IX-B: Vulnerable Wetland Species | IX-B-1: Vulnerable Wetland Mammals | IX-B-1-a | River Otter Species Population Status/Occurrences |
| | | IX-B-2: Vulnerable Wetland Birds | IX-B-2-a | King rail, Piping plover, Swainson's warbler, Black duck Population, Status/Occurrences |
| | | IX-B-3: Vulnerable Wetland Reptiles | IX-B-3-a | Vulnerable Wetland Reptile Species Population Status/Occurrences |
| | | IX-B-4: Vulnerable Wetland Amphibians | IX-B-4-a | Vulnerable Wetland Amphibian TBD Species Population Status/Occurrences |
| | | IX-B-9: Vulnerable Wetland Arachnids | IX-B-9-a | Vulnerable Wetland Arachnid TBD Species Population Status/Occurrences |
| | | IX-B-10: Vulnerable Wetland Crustaceans | IX-B-10-a | Vulnerable Wetland Crustacean TBD Species Population Status/Occurrences |
| | | IX-B-11: Vulnerable Wetland Insects | IX-B-11-a | Vulnerable Wetland Insect TBD Species Population Status/Occurrences |
| | | IX-B-13: Vulnerable Wetland Flora | IX-B-13-a | Vulnerable Wetland Flora TBD Species Population Status/Occurrences |

Albemarle-Pamlico National Estuary Program North Carolina

# A-P Ambient Monitoring Program

- Precise goals and specific measures for monitoring policy effectiveness should be designed and tested at the time that a policy is implemented
- Status Quo: APNEP 2000 monitoring survey update

# APNEP Monitoring Proposal

- Justification for indicator
- Goal of sampling/monitoring program
  - What the optimum sampling/monitoring program will achieve and why that is important
- Existing sampling/monitoring program
  - Objectives - What the existing program is designed to measure.
    - Example: *Conduct periodic aerial mapping to monitor dramatic change of SAV presence over 5-year increments in four of six APES regions*
  - Methods
  - Costs
  - Data quality control (data quality objective)
  - Data analysis, statistical methods and hypotheses

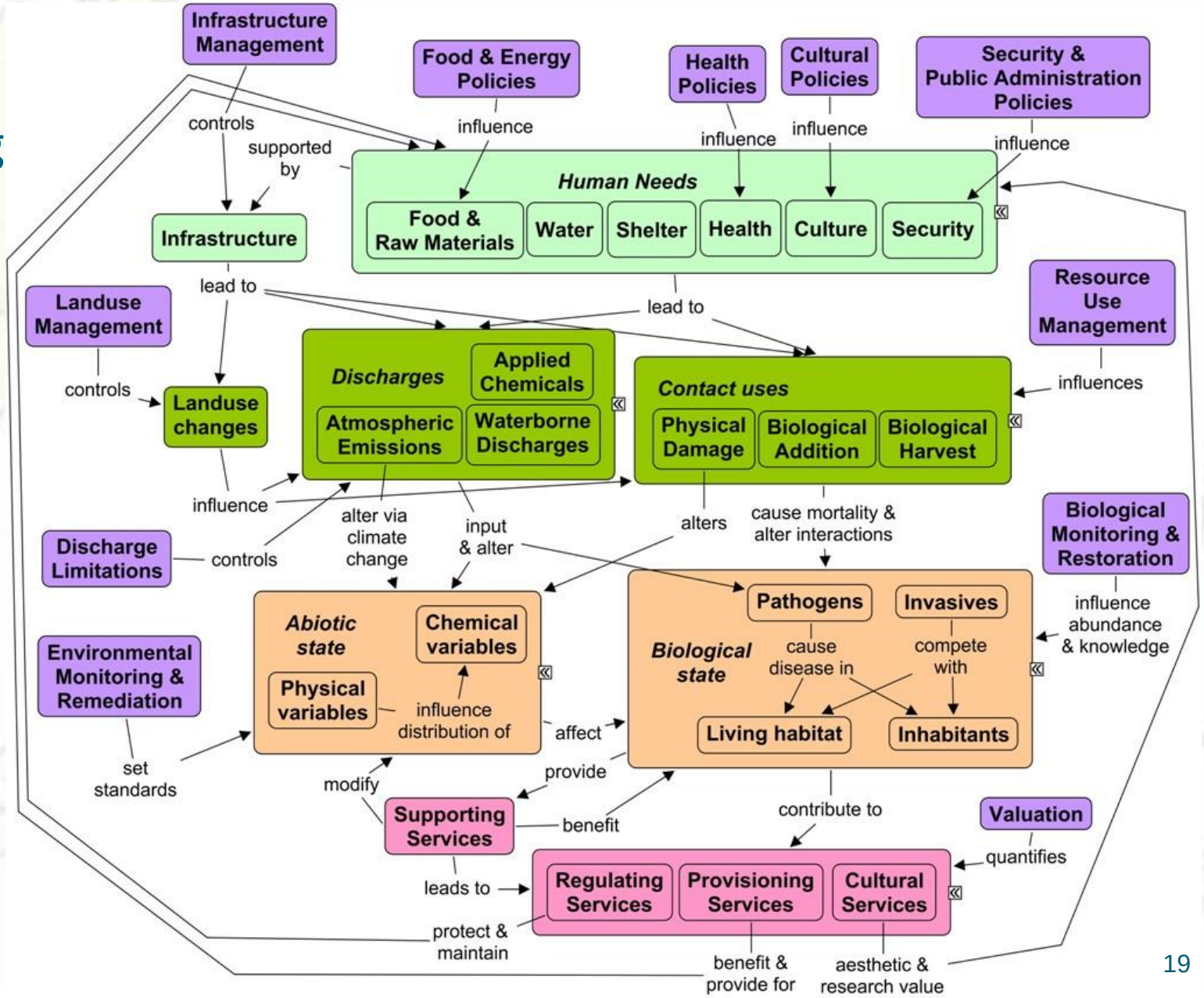
# APNEP Monitoring Proposal

- Enhanced sampling/monitoring program
  - Objectives - what the enhanced sampling/monitoring program is designed to measure.
    - Example: *Estimate the areal distribution and abundance of SAV along the western shorelines of APES and be capable of detecting significant change in SAV distribution and abundance*
  - Methods
  - Costs
  - Data quality control (data quality objective)
  - Data analysis, statistical methods and hypotheses
- Reference(s)
- Contact Person

# Monitoring Integration Continuum

- Independence: Knowledge of partners monitoring strategies
- Cooperation: Taking advantage of common geography, timing
- Collaboration: Opportunities to leverage partners' monitoring networks
- Integration: Working toward a common set of regional ecosystem objectives

# DPSER Modeling



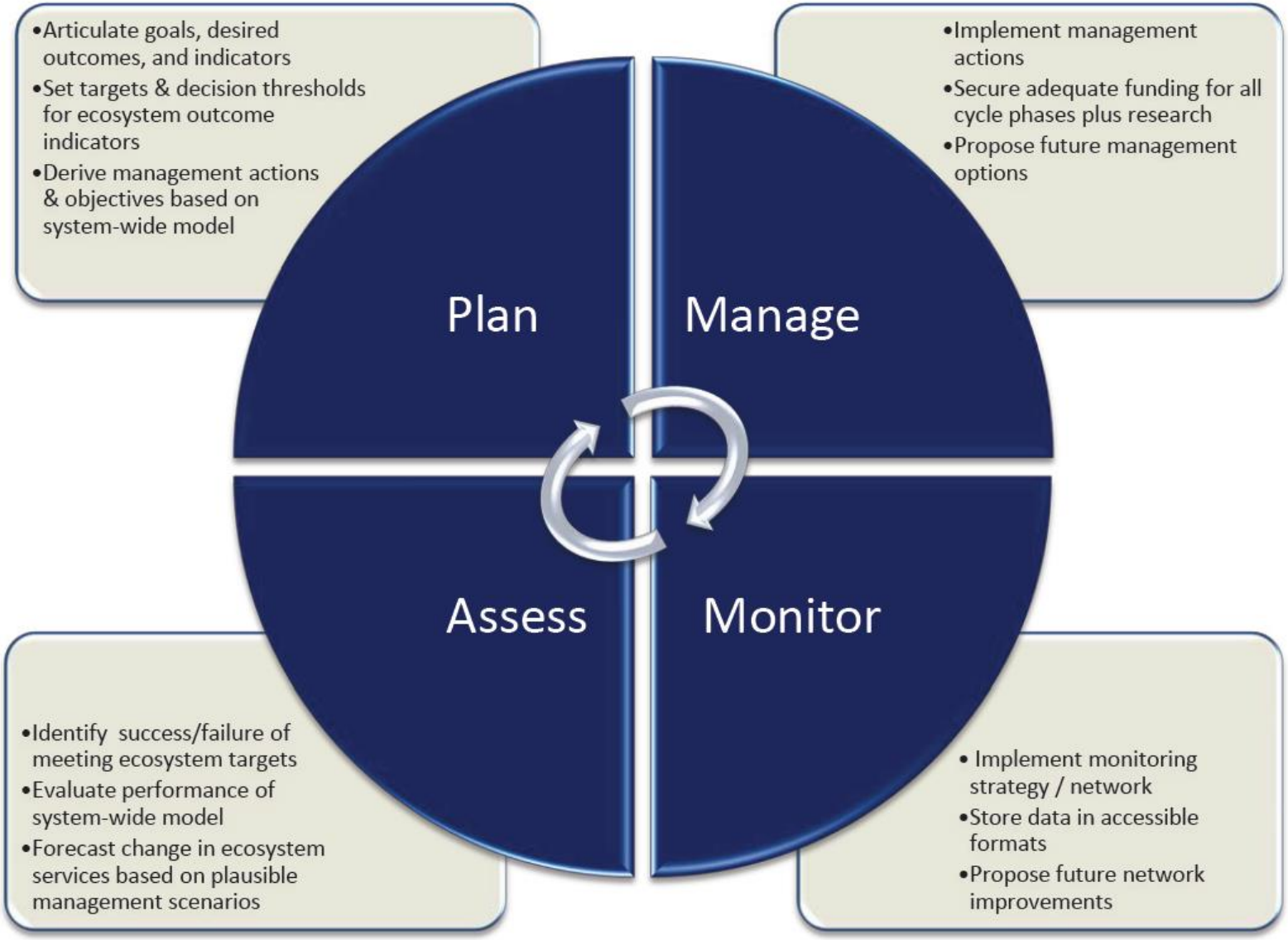

Lt. green = Drivers
Dk. Green = Pressure
Orange = State
Red = Ecosystem Services
Purple = Response

EPA-ORD-ESRP 2010

# 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**

# Figure 2: APNEP's adaptive management cycle.



# CCMP's Four Questions

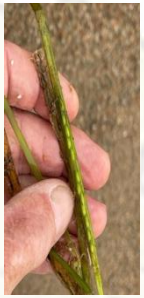
- **What is a healthy Albemarle-Pamlico Estuarine System?**
- **What is the status of Albemarle-Pamlico Estuarine System?**
- **What are the biggest threats to Albemarle-Pamlico Estuarine System?**
- **What actions should be taken that will move us from where we are today to a healthier Albemarle-Pamlico Sounds by 2030?**

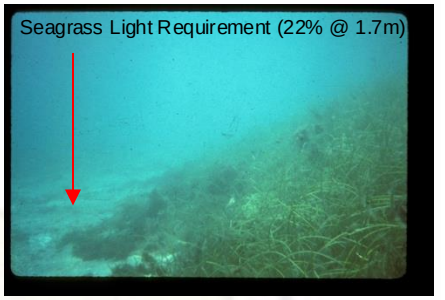
# Step 5: Develop monitoring program

- 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

TIER 3

Addresses a greater number of properties at a much smaller number of locations or index sites.



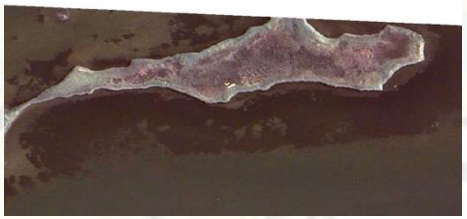



TIER 2

Ecosystem properties at a higher resolution over large geographic areas, generally using ground-based approaches.

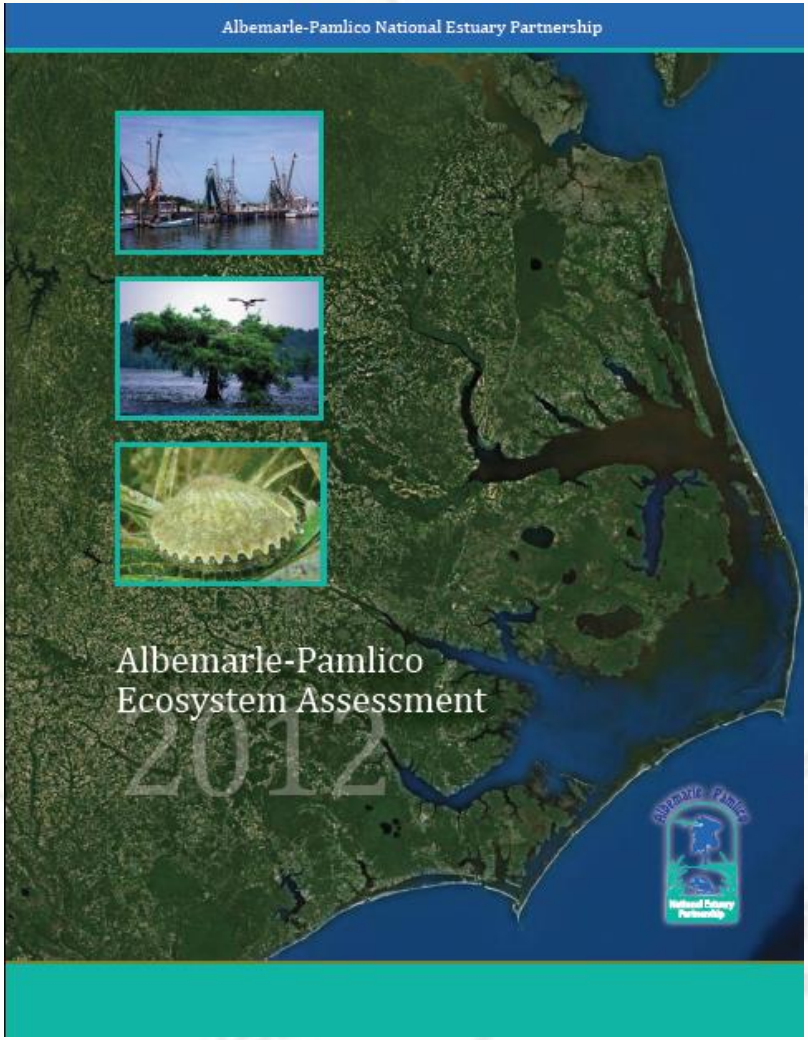
TIER 1

Characterize a few ecosystem properties over very large spatial scales, typically using airborne or satellite remote sensing methods.



# 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



# 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

# 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

# Step 7: Manage adaptively

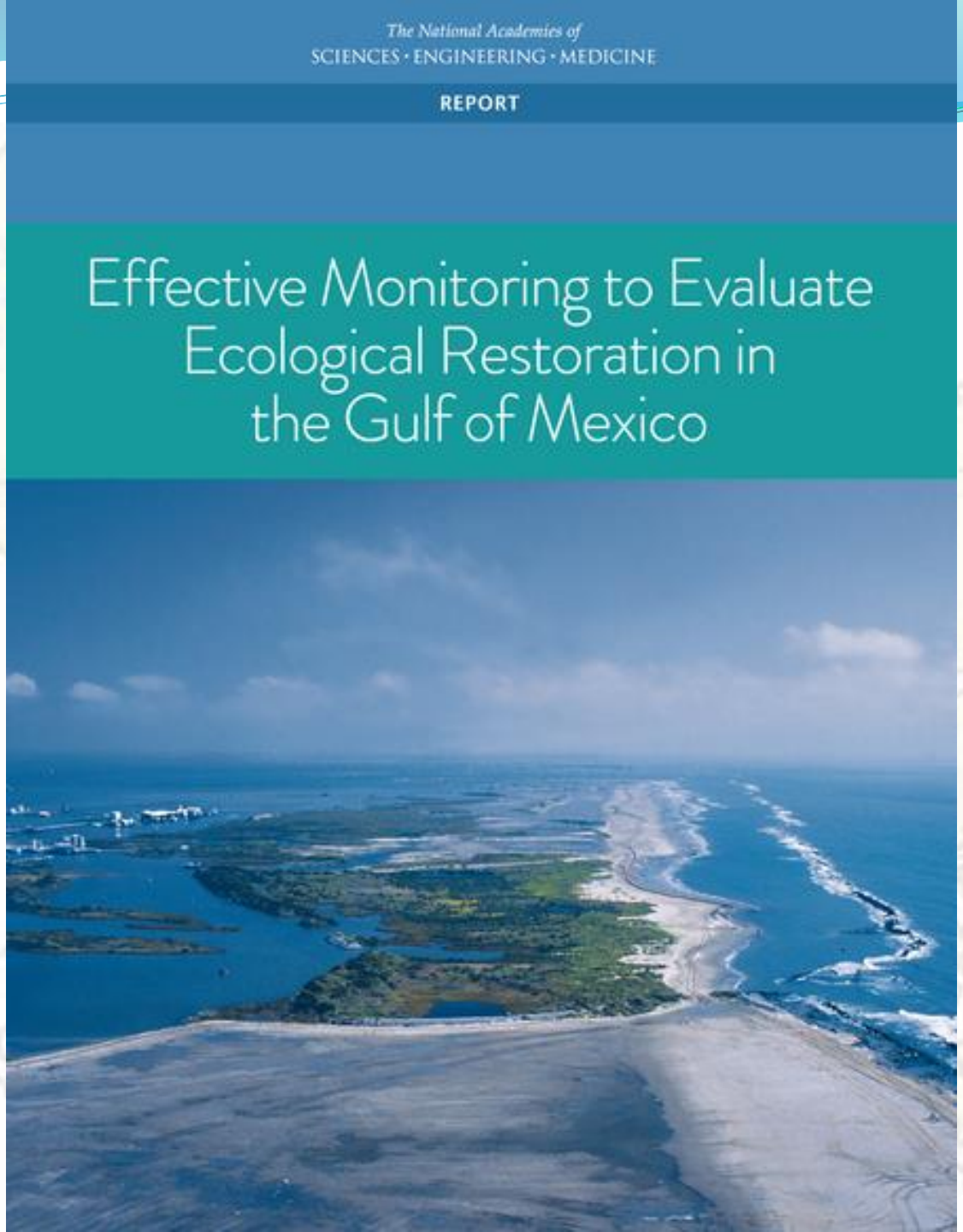
- Most difficult step?
- Senior management engagement
- Trigger levels in plan

# APNEP Ecosystem Health Indicators Related to Wetlands: September 2016

| | | | | | | | Reporting Scales | | | | Monitoring Scales | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Space | | Time | | Space | | Time | |
| Category | Dimension | Indicator Type | Code | Provisional Indicator | Key Partner | Units | Extent | Resolution | Extent | Frequency | Extent | Resolution | Extent | Frequency |
| Ecosystem Stressors | Elemental Cycles | Carbon Cycle | II-B-1-a | Stored Carbon in Water Column & Sediments | US-EPA-Reg4 | | | | | | | | | |
| | | | II-B-2-a | Stored Carbon in Tree Biomass | USFS-Climate Change | | | | | | | | | |
| | | | II-A-1-a | Carbon Emissions by Sector | NC-DENR-DAQ, VA-DEQ-AQ | | | | | | | | | |
| | | | II-A-2-a | Carbon Storage by Vegetation & Soil | US-EPA-ORD, NCSU | | | | | | | | | |
| | | Nutrient Cycles | II-C-1-a | Nitrogen Cycle Condition | USFS-FIA | | | | | | | | | |
| | | | II-B-1-a | Total Inorganic Nitrogen Deposition | US-EPA-ORD | | | | | | | | | |
| | | | II-C-2-a | Phosphorus Cycle Condition | USGS | | | | | | | | | |
| | | | II-C-3-a | Sulfur Cycle Condition | USFS-FIA | | | | | | | | | |
| | | Toxics Cycles | II-B-1-a | Stored Elements in Wetland Soils | UNC-CH-IMS | | | | | | | | | |
| | | | II-B-1-b | Stored Elements in Wetland Vegetation | UNC-CH-IMS | | | | | | | | | |
| 2: A region where aquatic, wetland, and upland habitats support viable populations of native species | 2A: The biodiversity, function, and populations of species in aquatic, wetland, and upland communities are protected, restored, or enhanced | Wetland Taxa: Mammals | VII-C-1-a | Mammal Community Structure (e.g., Black Bear, Bobcat) | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | IX-B-1-a | River Otter Species Population Status/Occurrences | NC-WRC, VA-DGIF | | | | | | | | | |
| | | Wetland Taxa: Birds | VII-C-2-a | Waterbird Community Structure | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | VII-C-2-b | Shorebird Community Structure | US-FWS-SEVANENC | | | | | | | | | |
| | | | VII-C-2-c | Landbird Community Structure | US-FWS-SEVANENC | | | | | | | | | |
| | | | VII-C-2-d | Waterfowl Community Structure | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | IX-B-2-a | King rail, Piping plover, Swainson's warbler, Black duck Population Status/Occurrences | US-FWS-SEVANENC | | | | | | | | | |
| | | Wetland Taxa: Herptofauna | VII-C-3-a | Herptofauna Community Structure (eg., Ephemeral Pool Breeders) | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | IX-B-3-a | Vulnerable Wetland Herptofauna Species Population Status/Occurrences | NC-WRC, VA-DGIF | | | | | | | | | |
| | | Wetland Taxa: Invertebrates | IX-B-9-a | Vulnerable Wetland Invertebrate TBD Species Population Status/Occurrences (Dragonflies, damselflies, fingernail clams?) | NC-WRC, VA-DGIF | | | | | | | | | |
| | | Wetland Taxa: Vegetation | II-A-3-a | Area by Wetland Class | NC-EEP, US-FWS-SEVANENC, NC-DWQ-NCCREWS | | | | | | | | | |
| | | | IX-B-13-a | Vulnerable Wetland Flora TBD Species Population Status/Occurrences | NC-DENR-NHP, VA-DCR-NHP | | | | | | | | | |
| | | Wetland Stressors | VII-A-1-a | Fire Severity, Frequency, and Extent in Wetlands | NC-DENR-DFR | | | | | | | | | |
| | | | VII-A-2-a | Saltmarsh Diebacks | US-NOAA-NC | | | | | | | | | |
| | | | VII-A-2-b | Estuarine Shorezone Area and Composition | ECU | | | | | | | | | |
| | | | VII-A-3-a | Amphibian Deformity Incidences in Wetlands | NC-WRC, US-FWS-SEVANENC | | | | | | | | | |
| | | | VII-A-4-a | Wetland Bird Egg Contamination | US-FWS-SEVANENC | | | | | | | | | |
| | | | II-B-1-a | Wetland Connectivity Index | ECU | | | | | | | | | |
| | | | II-B-2-a | Wetland Complexity Index | ECU | | | | | | | | | |
| | | | II-B-3-a | Wetland Proximity Index | ECU | | | | | | | | | |
| | | | II-C-2-a | Impaired Landward Migration of Coastal Wetlands | NC-DENR-DCM | | | | | | | | | |
| | 2B: The extent and quality of upland, freshwater, estuarine, and near-shore marine habitats fully support biodiversity and ecosystem function | Wetland Habitats (Stressors) | VII-B-1-a | Rare Wetland Organism Presence | NC-DENR-NHP, VA-DCR-NHP | | | | | | | | | |
| | | | VII-B-1-b | Rare Wetland Community Presence | NC-DENR-NHP, VA-DCR-NHP | | | | | | | | | |
| | | | VII-B-1-c | Wetland Community Representation | NC-DENR-NHP, VA-DCR-NHP | | | | | | | | | |
| | | | VII-B-1-d | Wetland Plant Condition | US-EPA-Reg4 | | | | | | | | | |
| | | | VII-B-2-a | Hydrological Alteration in Wetlands | NC-DWQ, US-DOD-ACE, US-DA-NRCS | | | | | | | | | |
| | | | VII-D-1-a | Relative Elevation of Wetland Soils | US-GS-NC | | | | | | | | | |
| | | | II-E-1-b | Water Quality Toxicant Concentrations (e.g., Mercury, Non-Metals Prevalence in Wetland Biota) | NC-DENR-DWQ, VA-DEQ | | | | | | | | | |
| | | Habitat Management | VII-B-1-e | Permitted Wetland Losses | US-DOD-ACE | | | | | | | | | |
| | | | VII-B-1-f | Wetland Restoration | NC-DENR-EEP | | | | | | | | | |
| | 2C: Non-native invasive species do not significantly impair native species' viability or function, or impair habitat quality, quantity, and the processes that form and maintain habitats | Invasive Wetland Plant Species | IX-A-13-a | Phragmites australis Population Status/Occurrences, Alligator Weed (Invasive Comm) | APNEP | | | | | | | | | |
| | | Invasive Wetland Faunal Species | IX-A-1-a | Nutria Population Estimates; Notable Local Populations | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | IX-A-2-a | Brown-headed cowbird, European starling (Invasiv Comm) | US-FWS-SEVANENC | | | | | | | | | |
| | | | IX-A-3-a | Invasive Wetland Herptofauna TBD Species Population Status/Occurrences | NC-WRC, VA-DGIF | | | | | | | | | |
| | | | IX-A-9-a | Invasive Wetland Invertebrate TBD Species Population Status/Occurrences | NC-WRC, VA-DGIF, US-FWS-SEVANENC | | | | | | | | | |
| 3: A region where water quantity and quality maintain ecological integrity | 3B: Nutrients and pathogens do not harm species that depend on the waters | | II-B-1-a | Stored Elements in Wetland Soils | UNC-CH-IMS | | | | | | | | | |
| | | | II-B-1-b | Stored Elements in Wetland Vegetation | UNC-CH-IMS | | | | | | | | | |
| | II-D: Sediments do not harm species that depend on the waters | | II-D-1-a | Sedimentation in Wetlands | ECU | | | | | | | | | |

# Wetland Monitoring & Assessment Refs

- FWS/EPA Status & Trends Five Mid-Atlantic States (1986)
- APNEP/ECU Fringe Wetlands in Albemarle and Pamlico Sounds (1989)
- FWS Regional Wetlands Concept Plan (1992)
- EPA Volunteer Wetland Monitoring (2001)
- FWS Coastal Wetlands Status & Trends in Eastern US (2008)
- FWS Wetlands Status & Trends in US 2004-2009 (2013)
- EPA Coastal Wetlands Initiative: South Atlantic Review (2013)
- NERR SWMP Wetland Monitoring Protocol (2013)
- Regional Coastal Wetlands Monitoring Group (2015-2016)
- National Wetland Condition Assessment 2011 (2016)
- National Wetland Condition Monitoring 2016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