APNEP's Terrestrial Monitoring & Assessment Activity Phase I (2008-2010) and Pre-Phase II (2011-2016)

Dean Carpenter

Albemarle-Pamlico National Estuary Partnership

Terrestrial Monitoring & Assessment Workshop

Imperial Centre of Arts & Sciences, Rocky Mount

14 February 2018

APNEP Mission

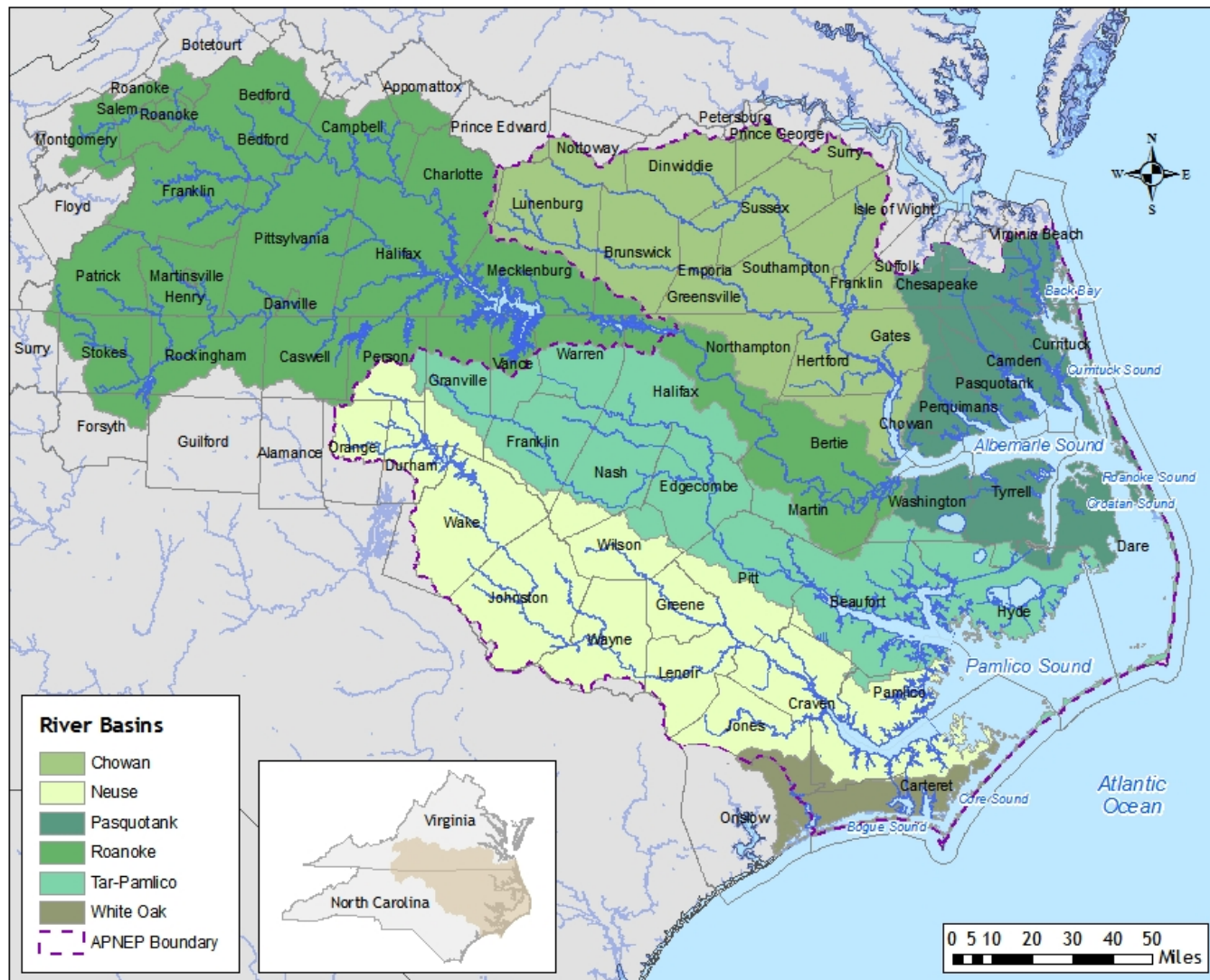"To identify, restore, and protect the significant resources of the Albemarle-Pamlico estuarine system."

APNEP Implementation Area and Management Institutions

APNEP Terrestrial Monitoring & Assessment (Phase I)

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

APNEP's Transition to Ecosystem-Based Management

- A holistic vision and plan that includes a comprehensive description of the A-P 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.

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.

- Articulate goals, desired outcomes, and indicators
- Set targets & decision thresholds for ecosystem outcome indicators
- Derive management actions & objectives based on system-wide model

- Implement management actions
- Secure adequate funding for all cycle phases plus research
- Propose future management options

Plan

Manage

Assess

Monitor

- Identify success/failure of meeting ecosystem targets
- Evaluate performance of system-wide model
- Forecast change in ecosystem services based on plausible management scenarios

- Implement monitoring strategy / network
- Store data in accessible formats
- Propose future network improvements

APNEP Targets 2018-2019

- Regional Ecosystem Assessment 2.0
  - Indicator Specification 1.1
- Comprehensive Conservation & Management Plan (CCMP) 2.1
  - Ecosystem-Based Management (EBM) Plan 1.0
- Integrated Monitoring Strategy 1.0
  - Indicator Specification 1.1

APNEP Monitoring & Assessment 2008-2010

- APNEP staff adopt indicators/metrics in 2007
- Plan in 2008 to develop an integrated monitoring strategy for those indicators
- In concert with APNEP revising its Comprehensive Conservation & Management Plan (CCMP)
- Six APNEP resource monitoring & assessment teams

Regional Ecosystem Model
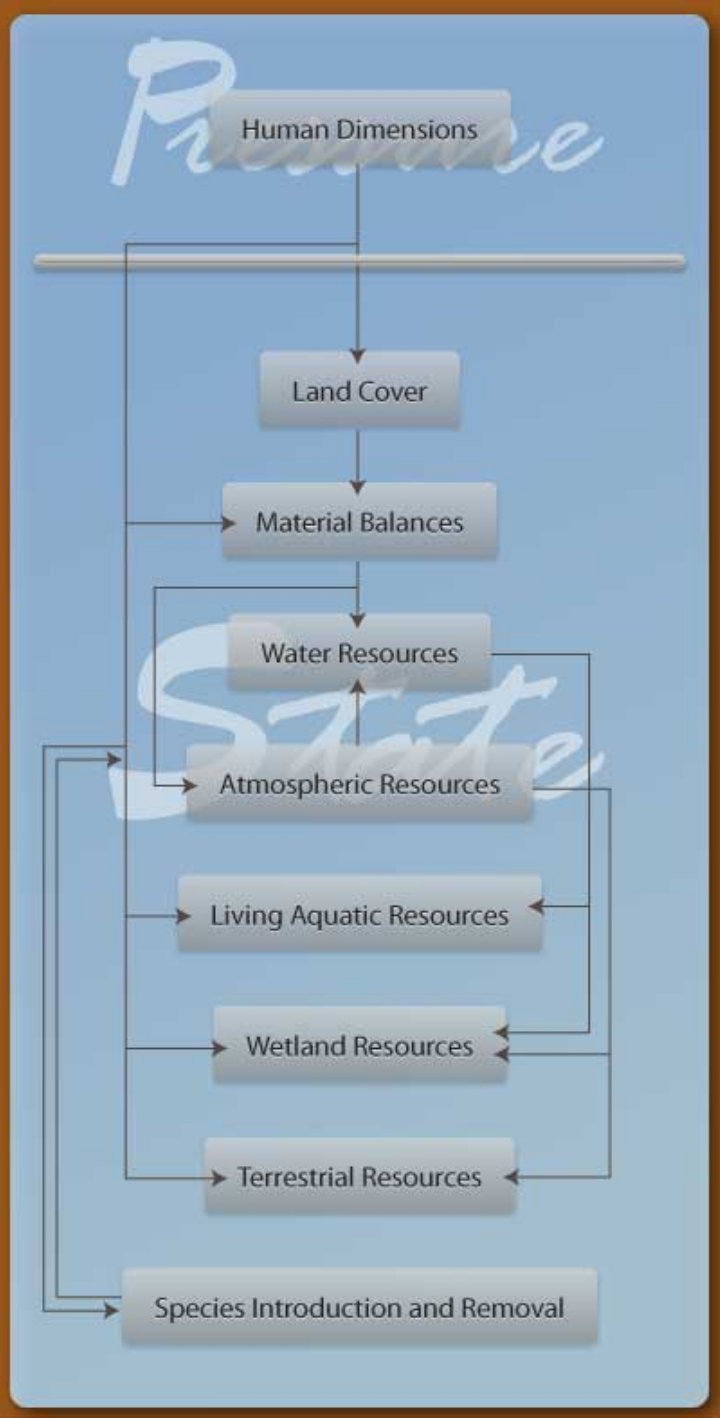
Terrestrial Monitoring & Assessment Team Representation (Phase I)

- APNEP
- NC-DENR
  - DPR
  - DLMR
  - MNS
  - NHP
- NC-WRC
- NC-DACS
  - FS
  - SWC
- NC-DOT

- Federal
  - EPA
  - FWS
  - NOAA
  - NPS
  - NRCS
  - SALCC
  - USFS
  - USGS

- STAC/ Ex-STAC
  - ECU
  - UNC-CH
  - UNC-CSI
  - UNC-W
  - NatureServe
  - NCSU
  - NCWF

EPA Indicator Development for Estuaries

- Program Planning
- Conceptual Model Development
- Indicator Specification
- Monitoring Program Development
- Implementation
- Reassessment

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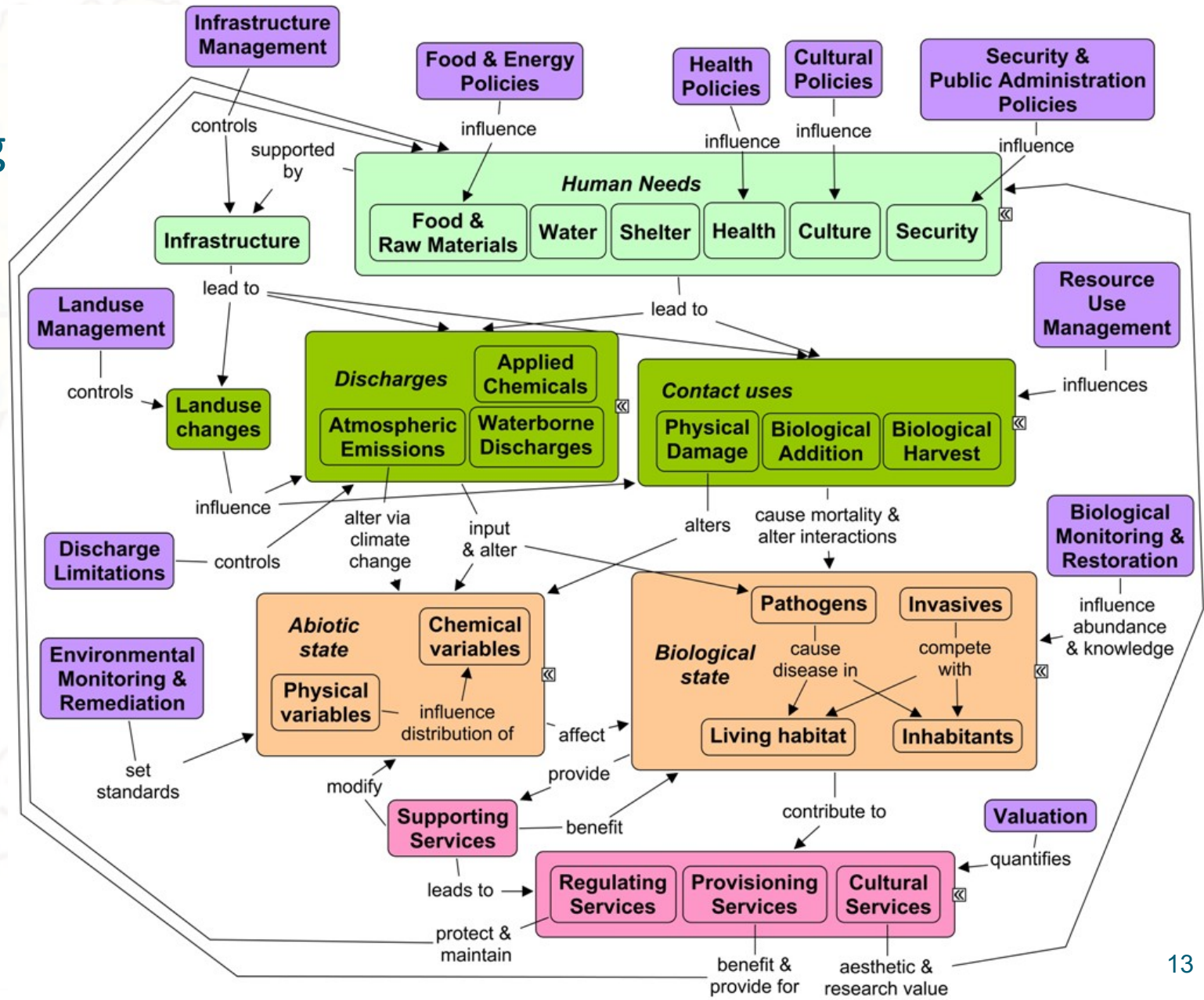
Lt. green = Drivers
Dk. Green = Pressure
Orange = State
Red = Ecosystem Services
Purple = Response

EPA-ORD-ESRP 2010

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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

APNEP Objectives-Metrics Hierarchy

- Modules
- Categories
- Dimensions
- Metrics

Candidate Terrestrial Indicators

Module	Category	Dimension	Indicator	
VIII: Terrestrial Resources	VIII-A: Incidents of Concern	VIII-A-1: Altered Fire Regime	VIII-A-1-a	Fire Severity, Frequency, and Extent
		VIII-A-2: Insects, Diseases and Parasites	VIII-A-2-a	Disease Outbreak Severity, Frequency, and Extent
		VIII-A-3: Storms Damage	VIII-A-3-a	Frequency and Extent of Vegetation and Soil Loss
		VIII-A-4: Bioaccumulation	VIII-A-4-a	Bird Egg Contamination
	VIII-B: Habitat Adequacy	VIII-B-1: Overall Habitat Adequacy	VIII-B-1-a	Rare Organism Presence
			VIII-B-1-b	Rare Community Presence
	VIII-C: Living Resource Status	VIII-C-1: Forest Type Extent and Location	VIII-C-1-a	Longleaf/Natural Upland Pine Extent, Location (LC)
			VIII-C-1-b	Natural Upland/Mesic Hardwood Extent, Location (LC)
			VIII-C-1-c	Maritime Forests Extent, Location (LC)
		VIII-C-2: Forest Age-Structure	VIII-C-2-a	Longleaf/Natural Upland Pine Age-Structure
			VIII-C-2-b	Natural Upland/Mesic Hardwood Age-Structure
			VIII-C-2-c	Maritime Forests Age-Structure
	VIII-D: Species of Particular Concern	VIII-D-1: Mammals	VIII-D-1-a	Black Bear Population
			VIII-D-1-b	Deer Population
			VIII-D-1-c	Bat Population
		VIII-D-2: Birds	VIII-D-2-a	Turkey Population
			VIII-D-2-b	Raptor (Eagles/Ospreys) Population
			VIII-D-2-c	Land Bird Population
		VIII-D-3: Reptiles	VIII-D-3-a	Reptile Species TBD Population
		VIII-D-4: Amphibians	VIII-D-4-a	Amphibian Species TBD Population
		VIII-D-5: Plants	VIII-D-5-a	Ephemeral Pool Breeders
	VIII-E: Soil Quality	VIII-E-1: Soil Condition	VIII-E-1-a	Extent of Highly Eroded Soils
			VIII-E-1-b	Soil Organic Matter
		VIII-E-2: Soil Toxicity	VIII-E-2-a	Brownfield Extent
			VIII-E-2-b	Toxicant Body Burdens in Soil Fauna Species (TBD)
II: Land Cover	II-A: Cover Type Extent	II-A-1: Regional Coverage	II-A-1-a	Area by Land Cover Class
		II-A-2:Coastal Margin	II-A-II-a	Natural Coast Buffer: Undeveloped Dunes and Shorelines
	II-B: Spatial Relationships	II-B-1: Connectivity	II-B-1-a	Landscape Connectivity Index
		II-B-2: Patchiness	II-B-2-a	Landscape Complexity Index
		II-B-3: Proximity	II-B-3-a	Landscape Proximity Index
III: Material Balances	III-B: Terrestrial Element of Carbon Cycle	III-B-2: Sequestered Carbon	III-B-2-a	Stored Carbon in Terrestrial Biota
	III-C: Terrestrial Element of Nutrient Cycle	III-C-1: Nitrogen	III-C-1-a	Nitrogen Cycle Condition
		III-C-2: Phosphorus	III-C-2-a	Phosphorus Cycle Condition
		III-C-3: Sulfur	III-C-3-a	Sulfur Cycle Condition
	III-D: Terrestrial Element of Sediment Cycle	III-D-1: Soil	III-D-1-a	Prevalence of Highly Eroded Lands
		III-D-2: Sedimentation	III-D-2-a	TBD
	III-E: Terrestrial Element of Toxicants Cycle	III-D-1: Metals Contaminants	III-D-1-b	Mercury Prevalence in Biota
		III-D-2: Non-Metals Contaminants	III-D-2-a	Toxicant (TBD) Prevalence in Biota
IX: Species Introduction & Removal	IV-A: Invasive Terrestrial Species	IV-A-1: Land Mammals	IV-A-1-a	Wild Hog Population Estimates; Notable Local Populations
		IV-A-2: Birds	IV-A-2-a	TBD Species Population Status/Occurrences
		IV-A-3: Reptiles	IV-A-3-a	TBD Species Population Status/Occurrences
		IV-A-9: Arachnids	IV-A-9-a	TBD Species Population Status/Occurrences
		IV-A-11: Terrestrial Insects	IV-A-11-a	TBD Species Population Status/Occurrences
		IV-A-13: Terrestrial Flora	IV-A-13-a	Privet Population Status/Occurrences
			IV-A-13-b	Microstegium Population Status/Occurrences
			IV-A-13-c	Kudzu Population Status/Occurrences
	IV-B: Vulnerable Terrestrial Species	IV-B-1: Land Mammals	IV-B-1-a	Red Wolf Population Status/Occurrences
		IV-B-2: Birds	IV-B-2-a	Quail, Grassland bird Community Status
		IV-B-3: Reptiles	IV-B-3-a	TBD Species Population Status/Occurrences
		IV-B-4: Amphibians	IV-B-4-a	TBD Species Population Status/Occurrences
		IV-B-9: Arachnids	IV-B-9-a	TBD Species Population Status/Occurrences
		IV-B-11: Terrestrial Insects	IV-B-11-a	TBD Species Population Status/Occurrences
		IV-B-13: Terrestrial Flora	IV-B-13-a	TBD Species Population Status/Occurrences

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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

APNEP EBM Transition Team

Policy Board

Science & Technical Advisory Committee

Citizens Advisory Committee

State Planner

Federal Planner

EBM Tech Transfer

Staff

Step 1: Articulate program goals

- Objectives 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)

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

Assessment matrix — Goals, factors, and management actions

	Goal 1: human communities sustained by functioning system — safe contact	safe consume	support activities	fish/game safe	access protected	sustained harvesting	Goal 2: habitats protected, enhanced, restored, supporting native species — aquatic community	wetland community	upland community	estuarine habitats	freshwater habitats	upland habitats	non-native	Goal 3: water quantity and quality — hydrologic regime	nutrients and germs	toxics	#	identify	protect	restore	prevent	collaborate	monitor
biological factors																							
fauna																							
manage non-native species introduction and impacts							M-M	M-M	M-M	L-M	L-L	M-L	■				3		x				
preserve/protect RTE species							M-M										1		x				
preserve and restore shellfish communities (reefs)										H-H							1		x	x			
management of native/non-native grazers (deer)												H-M					1		x				
management of predators (red wolf, coyote, domestic animals)												L-M					1		x				
flora																							
manage non-native species introduction and impacts							M-M	M-M	M-M	M-M	L-L	M-L	■				4		x				
preserve/protect RTE species							M-M										1		x				
preserve and restore submerged aquatic vegetation										H-M/L							1		x	x			
preserve and restore coastal wetlands										H-M							1		x	x			
preserve and restore coastal forests											■						1		x	x			
management of native forests, shrub/scrub communities (fire management)												H-M					1		x				
microorganisms																							
manage sources and loads of pathogens	H-M	H-M		H-M									L-L		■		3		x				
manage introduction/spread of pathogens							M-M	L-L					L-L				1		x				
physical factors																							
structure																							
preserve/establish public access to public lands and waters				H-H													1		x				
manage landuse to minimize conflict/negative impacts on use diversity							H-M										1		x				
manage conversion of aquatic habitats							H-H				H-H						2		x				
manage wetland buffer conversion								H-M									1		x				
preserve wetland migration opportunities								H-M/L									1		x				
maintain hubs and corridors for green infrastructure									H-M								1		x				
identify critical conservation areas									H-M	H-H							2	x					
manage floodplain and riparian area conversion												H-M					1		x				
manage channel modification											H-H						1		x				
green infrastructure												H-M					1		x				
hydrology																							
MIF adequate to support all desired uses			H-M														1						
manage consumptive uses of water							H-H										1		x				
preserve natural hydrographs							■	H-M	H-M		L-H						2		x				
temperature																							
manage alteration of natural temperature regimes							L-L				L-H						2		x				
control modification of riparian vegetation											L-M						1		x				
chemical factors																							
salinity																							
pH																							
nutrients																							
implement TMDL management for nutrients							M-M		M-M						H-M/L		2		x				
toxics																							
manage sources and loads	L-L	■	H-M		H-H		L-M				L-M					H-M	1		x				
human factors																							
use objectives																							
establish appropriate use designation for waters	H-H	H-H		H-H										H-H			4	x					
establish and implement public access/use plan					H-H												1	x					
manage potential use conflicts that reduce sustainability of natural capital						H-M											1	x	x				
manage potential use impacts on habitat diversity and quality							H-M		H-M								2	x	x				
manage landuse in wetlands and wetland buffers								H-H									1		x				
identify and control incompatible uses (receiving waters, shipping, recreation, etc.)			H-H										■				1	x	x				
land use management (maintain green infrastructure)												H-H					1	x	x		x		
forestry management												H-H					1		x				
manage consumptive uses														H-H			1		x				
management of agricultural pollutant sources															H-M		1		x				
management of developed land pollutant sources (stormwater)															■								
modification of system																							
establish/implement TMDL for pollutants	H-H	H-H		H-M													2	x	x				
avoid privatization of public lands and access points					H-M												1	x			x		
manage conversion of habitats that reduce diversity or productivity						■			H-M								1		x				
manage dredging, filling, and water withdraw							H-H										1		x				
manage hydrology modification			M-H						H-M		H-M						2		x				
manage permanent conversion of wetland buffers									H-M								1		x	x			
manage landuse/green infrastructure									H-M								1		x		x		
manage channel modification											H-H						1		x				
manage floodplain/riparian land conversion											H-M				H-M		1		x	x			
manage road development												H-H					1		x				
manage development												H-H					1		x				
manage dam construction														M-H			1		x				
manage flood plain conversion														H-M			1		x			x	
knowledge																							
technical understanding of health risks (sources, thresholds)	M-H	H-H		H-H													2	x					
technical understanding of use thresholds for sustainability							M-M	H-M	M-M								1	x					
technical understanding of system trajectory and implications for sustainable uses							H-M		M-M								2	x					
technical understanding of landuse impacts on wetland function								M-M									1	x					
technical knowledge of structure-function relationship									M-M	M-M							2	x					
technical understanding of critical blue infrastructure										M-M							1	x					
technical understanding of green infrastructure requirements												M-M					1	x					
technical understanding of non-native species impacts													H-M				1	x					
technical understanding of MIF requirements														H-M			1	x					
tech understanding of TMDLs to meet WQ standards															M-M/L		1	x					
technical understanding of compound toxicities																H-M	1	x					
technical understanding of source/route of introduction																H-M	1	x					
public understanding of monitoring and advisories	H-H	H-H		H-H													3						x
public appreciation of the values of natural capital							M-M	M-M/L	M-M		M-L	M-L					1						x
public appreciation of the thresholds for sustainable use			M-M/L				H-M		H-M			M-M					2						x
public understanding of actions that negatively impact							H-M										1						x
public appreciation of need/methods for control of non-native introduction													■				1						x
public appreciation of MIF needs														M-L			1						x
public appreciation of risks and need for management															M-L/M	M-M	1						x
policy understanding of need for monitoring	H-H	H-H	M-H	H-M													3						x
policy understanding of need for regulation	H-H	H-H	M-H	H-M		H-L	H-M	H-H	H-M	M-M	M-M		M-L		M-M	H-M	3						x

Legend:

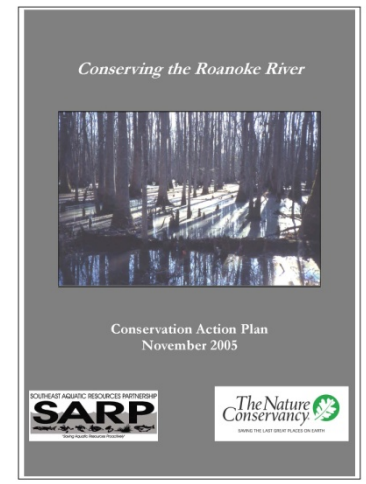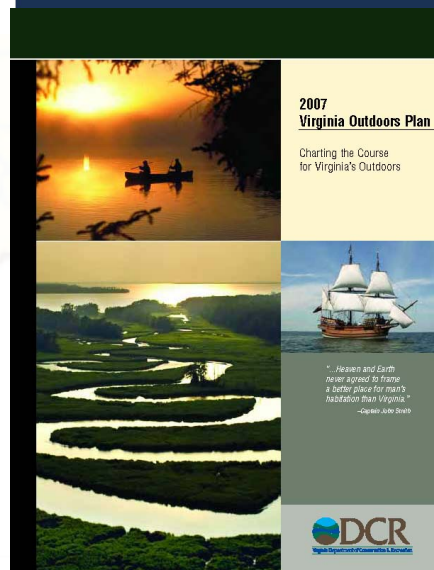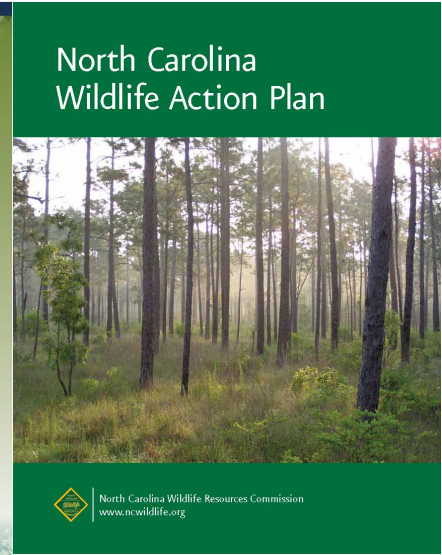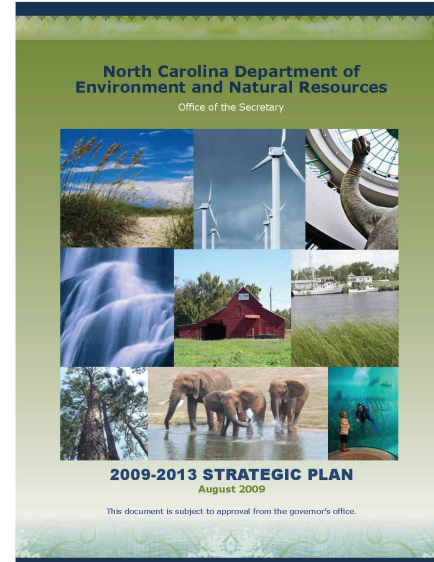| Code	Color
H-H	red
H-M	orange
H-M/L	gray
H-L	
M-H	blue
M-M	blue
M-L	
L-H	gray
L-M	gray
L-L	gray

EBM 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

North Carolina Department of Environment and Natural Resources
Office of the Secretary

2009-2013 STRATEGIC PLAN
August 2009

This document is subject to approval from the governor's office.

North Carolina Wildlife Action Plan

North Carolina Wildlife Resources Commission
www.ncwildlife.org

2007 Virginia Outdoors Plan

Charting the Course for Virginia's Outdoors

"...Heaven and Earth never agreed to frame a better place for man's habitation than Virginia."
—Captain John Smith

DCR

Conserving the Roanoke River

Conservation Action Plan
November 2005

SARP

The Nature Conservancy

Implement CCMP

- Fourth CCMP question
- Ten-year horizon
- 58 CCMP actions
- Super-Aggregated into five components
- Aggregated into 15 CCMP objectives

2b. The extent and quality of upland, freshwater, estuarine and near-shore marine habitats fully support biodiversity and ecosystem function

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

Albemarle-Pamlico National Estuary Partnership

Albemarle-Pamlico
Ecosystem Assessment
2012
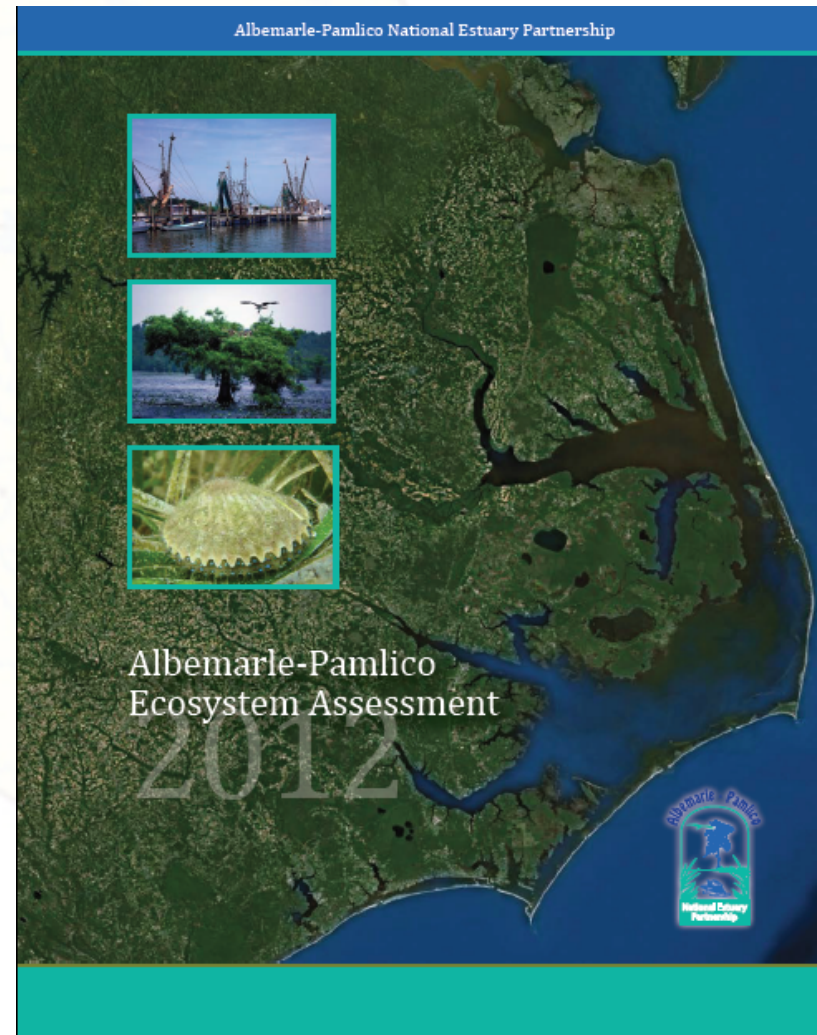
APNEP Ecosystem Assessment
Coasts, Sounds, & Near Marine: Chemical & Physical Characteristics

- *Ocean Shoreline Migration*
  - Why Is Ocean Shoreline Migration Important?
  - What Does This Indicator Report?
  - What Do the Data Show?
  - Why Can't This Entire Indicator Be Reported at This Time?
  - Understanding the Data
  - 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
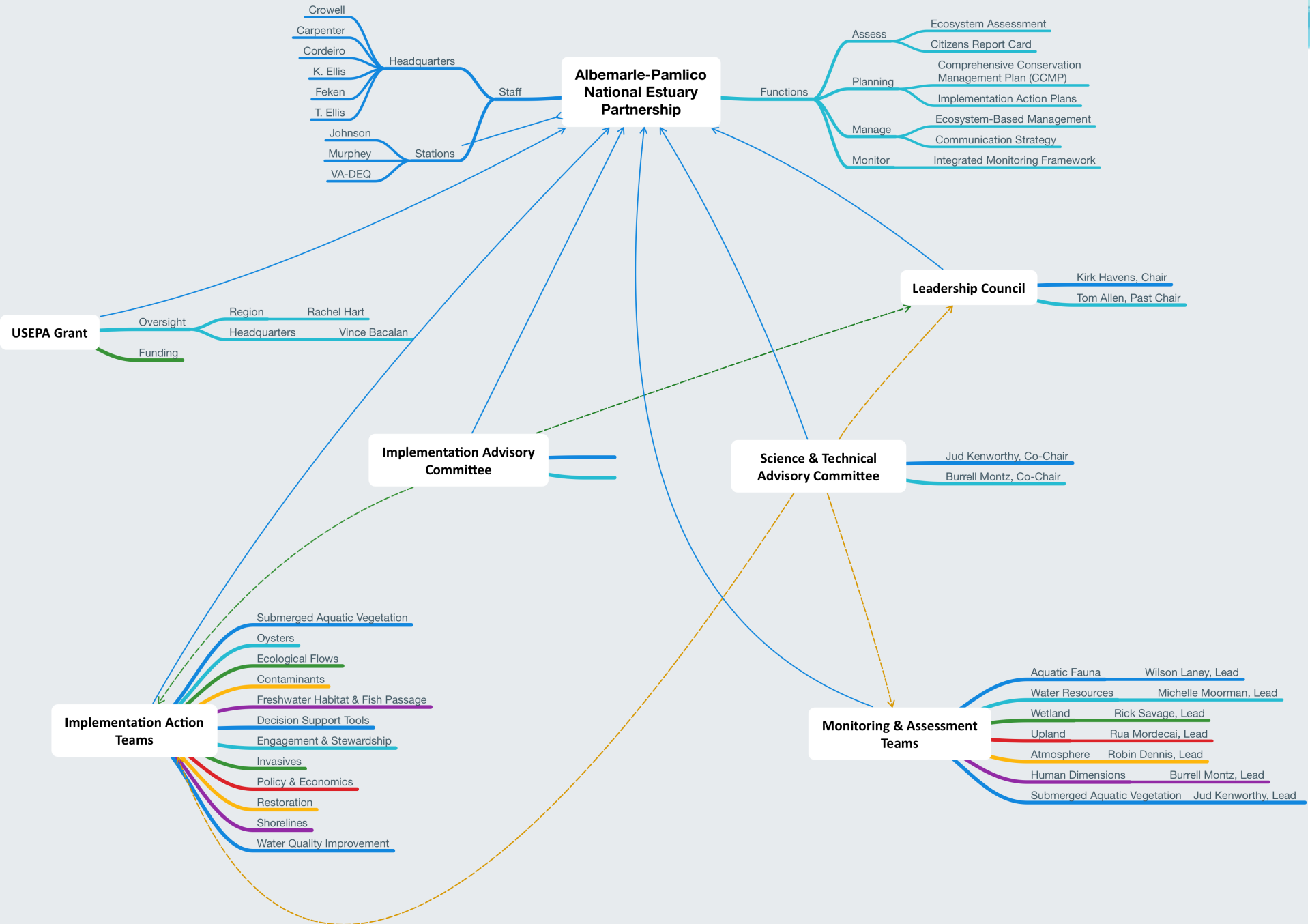
Bioregional Assessment Questions

- 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)

Step 7: Manage adaptively

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

Crowell
Carpenter
Cordeiro
K. Ellis
Feken
T. Ellis
Headquarters
Johnson
Murphey
Stations
VA-DEQ

Staff

Albemarle-Pamlico National Estuary Partnership

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

Leadership Council
Kirk Havens, Chair
Tom Allen, Past Chair

USEPA Grant
Oversight
Region — Rachel Hart
Headquarters — Vince Bacalan
Funding

Implementation Advisory Committee

Science & Technical Advisory Committee
Jud Kenworthy, Co-Chair
Burrell Montz, Co-Chair

Implementation Action Teams
Submerged Aquatic Vegetation
Oysters
Ecological Flows
Contaminants
Freshwater Habitat & Fish Passage
Decision Support Tools
Engagement & Stewardship
Invasives
Policy & Economics
Restoration
Shorelines
Water Quality Improvement

Monitoring & Assessment Teams
Aquatic Fauna — Wilson Laney, Lead
Water Resources — Michelle Moorman, Lead
Wetland — Rick Savage, Lead
Upland — Rua Mordecai, Lead
Atmosphere — Robin Dennis, Lead
Human Dimensions — Burrell Montz, Lead
Submerged Aquatic Vegetation — Jud Kenworthy, Lead

National Estuary Partnership

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Indicator Planning Decisions

- **What indicator(s) map to each environmental outcome?**

- **What are the fair, good, and excellent health target values for each ecosystem outcome indicator?**

- **What is the expected trajectory of an indicator value, based on how CCMP actions are implemented?**

- **What is the "trigger" value for a given interval since action steps are implemented, outside of which means the system is not behaving as forecast and change in business (e.g., research, revised action step, partner commitment) is required?**

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 2022?**

Terrestrial Monitoring & Assessment Refs

- USDA Land Clearing in Eastern North Carolina Chowan-Pasquotank River Basins study (1978)
- NC-NHP Natural Area Inventory, Counties of North Carolina (1981-)
- NC-NHP Assessment of Terrestrial Habitat Quality and Landscape Integrity in the Albemarle-Pamlico Estuarine Study Area Using Habitat Specialist Animals as Indicator Species (2003)
- ECU Shoreline Change Within the Albemarle-Pamlico Estuarine System, North Carolina (2008)
- USGS Mapping Watershed Potential to Contribute Phosphorus from Geologic Materials to Receiving Streams, Southeastern United States (2010)
- USFS Timber Harvesting Effects on Water Quality and Quantity in the Headwaters of the Neuse River Basin (2016)