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

Dean Carpenter
Albemarle-Pamlico National Estuary Partnership

Wetlands Monitoring & Assessment Workshop
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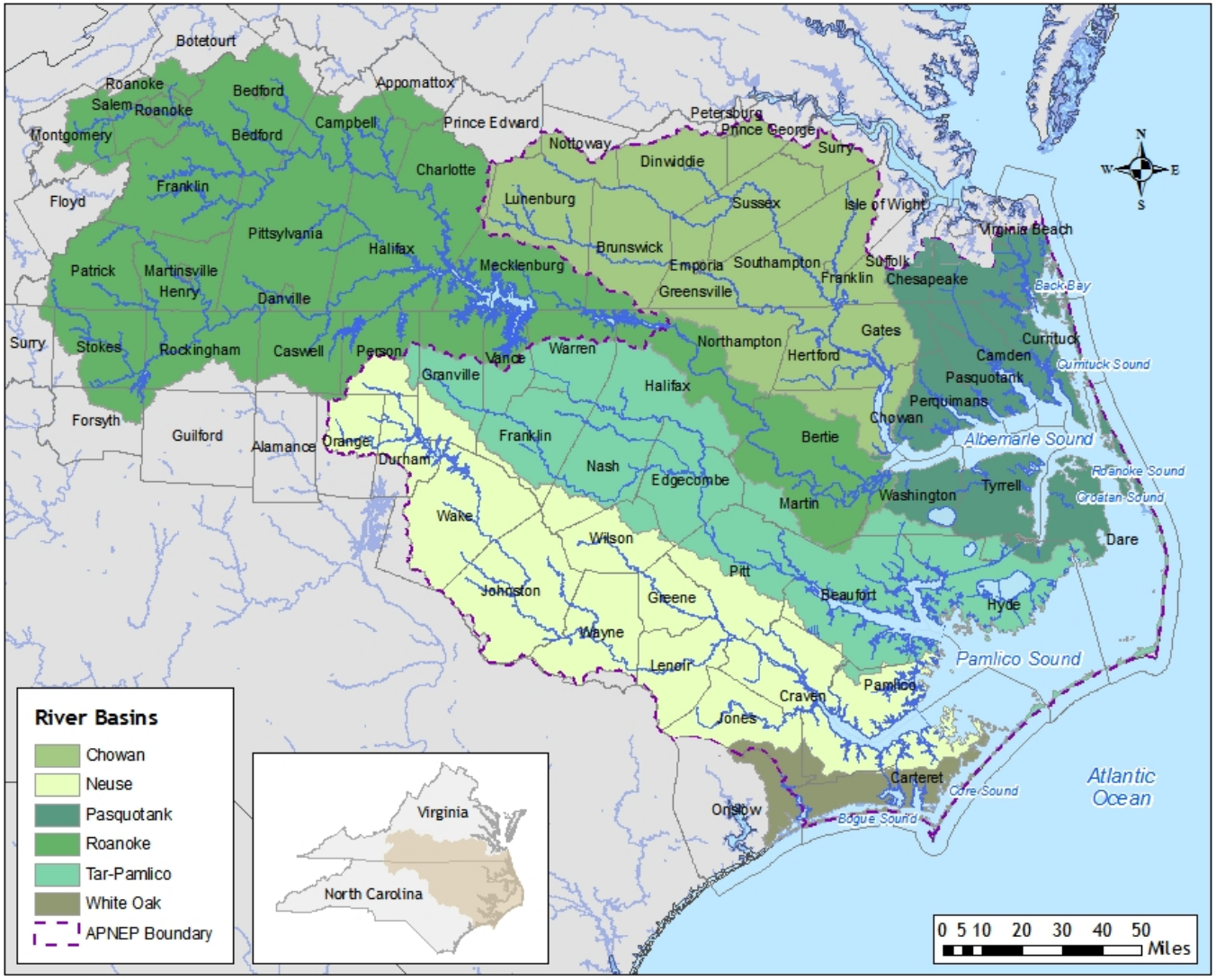
APNEP Mission

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

APNEP Implementation Area and Management Institutions



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

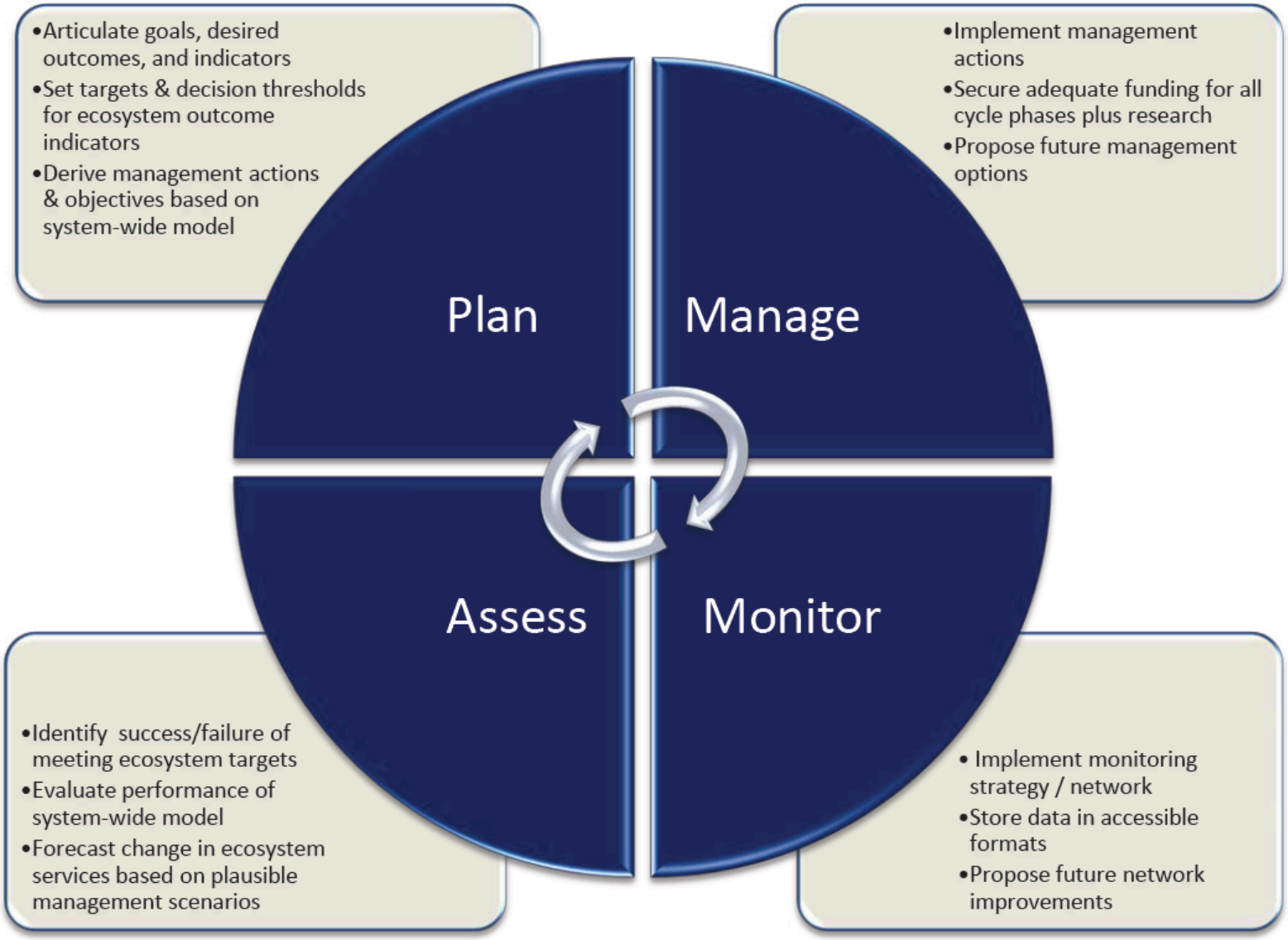
APNEP's Transition to Ecosystem-Based Management

- 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.



APNEP Targets 2017-2018

- 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

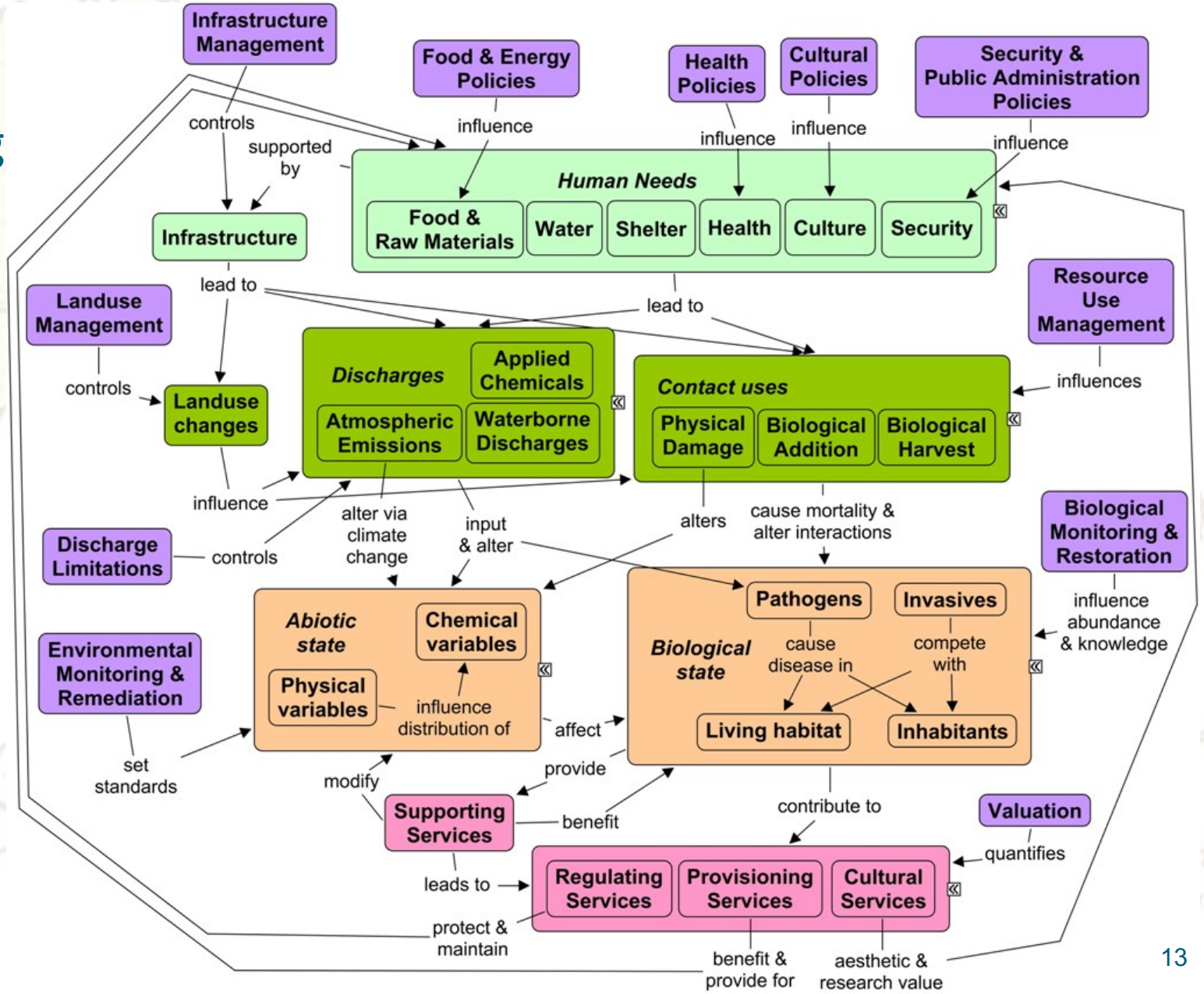
Wetland Resources Monitoring & Assessment Team Representation (Phase I)

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

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 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 Diebacks	VII-A-2-a	Saltmarsh Diebacks
			VII-A-2-b	Estuarine Shorezone 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 Plant 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 (Invasiv 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

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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

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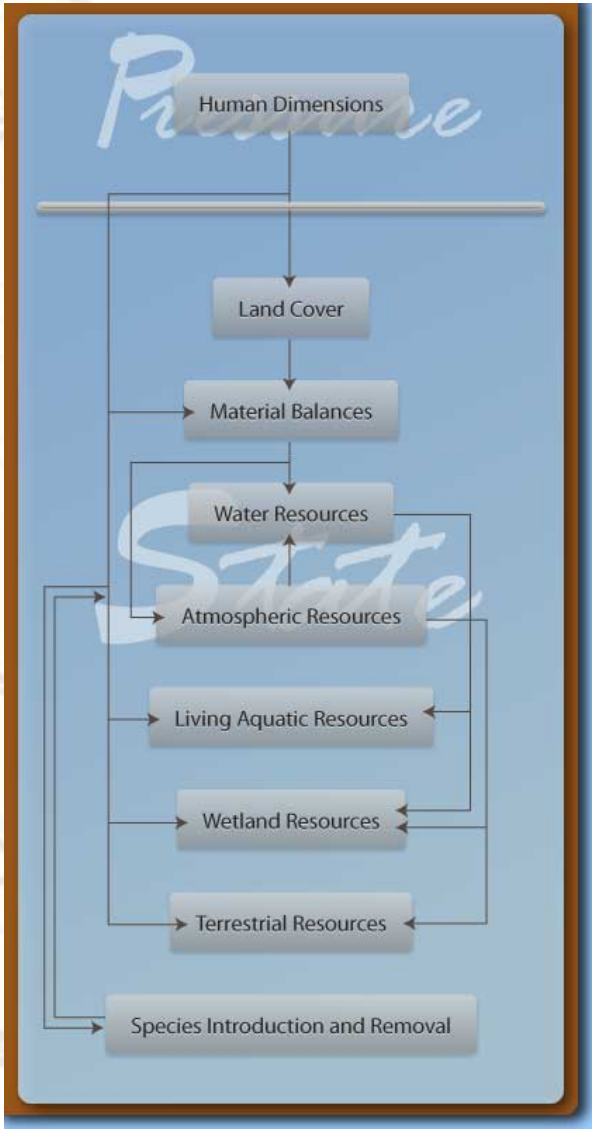
Step 1: Articulate program goals

- 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

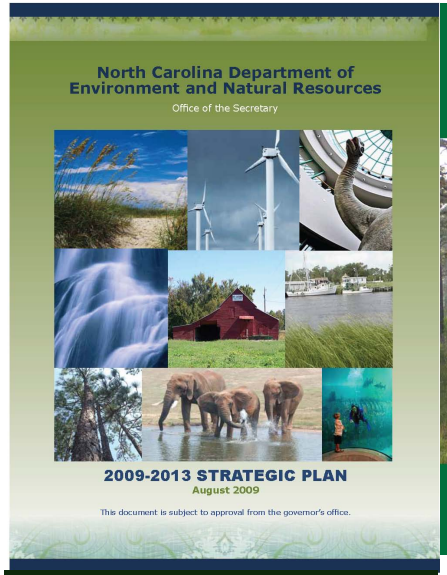


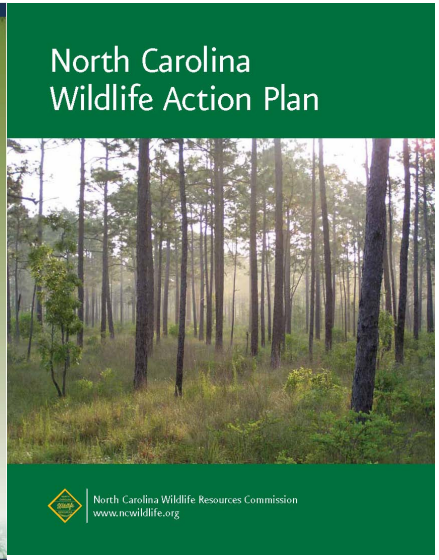
	Goal 1: human communities sustained by functioning system						Goal 2: habitats protected, enhanced, restored, supporting native species							Goal 3: water quantity and quality									
	safe contact	safe consume	support activities	fish/game safe	access protected	sustained harvesting	aquatic community	wetland community	upland community	estuarine habitats	freshwater habitats	upland habitats	non-native	hydrologic regime	nutrients and germs	toxics		identify	protect	restore	preve nt	collab orate	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-H			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											2		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)																			x				
• 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		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-H											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	H-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		H-H													3					x	
• policy understanding of need for regulation	H-H	H-H	M-H	H-M	M-M	H-L	H-M	H-H	H-M	M-M	M-M		M-L		M-M	H-M	3					x	

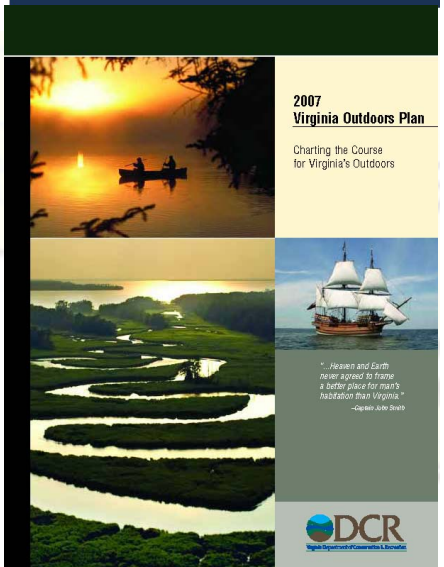
H-H	
H-M	
H-M/L	
H-L	
M-H	
M-M	
M-L	
L-H	
L-M	
L-L	

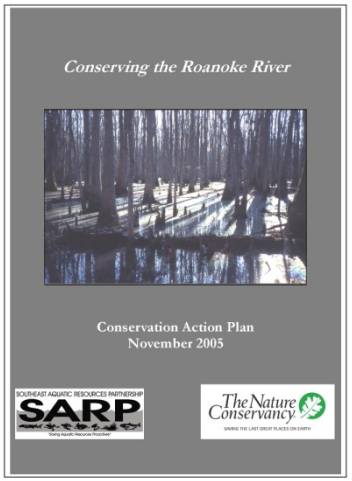
EBM Step 3: Assess current management efforts –identify gaps

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









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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

Outcomes	Actions					Workgroups
1a	A1.1	B1.1	C1.1	D1.1	E1.1	Freshwater Habitats and Fish Passage
1b	A1.2	B1.2	C1.2	D1.2	E1.2	Policy & Economics
1c	A2.1	B1.3	C1.3	D1.3	E1.3	Decision Support Tools
1d	A2.2	B1.4	C1.4	D1.4	E2.1	Education & Engagement
1e	A2.3	B1.5	C1.5	D1.5	E2.2	Water Quality Improvements
2a	A2.4	B2.1	C2.1	D2.1		Shorelines
2b	A2.5	B2.2	C2.2	D2.2		Contaminant Management
2c	A3.1	B2.3	C2.3	D2.3		Invasives
3a	A3.2	B2.4	C3.1	D3.1		Restoration Strategies
3b	A3.3	B2.5	C3.2	D3.2		Monitoring Networks
3c		B2.6	C3.3	D3.3		Oysters
3d		B3.1	C4.1			SAV
		B3.2	C4.2			Flows
		B3.3	C4.3			
			C4.4			
			C5.1			
			C5.2			
			C5.3			

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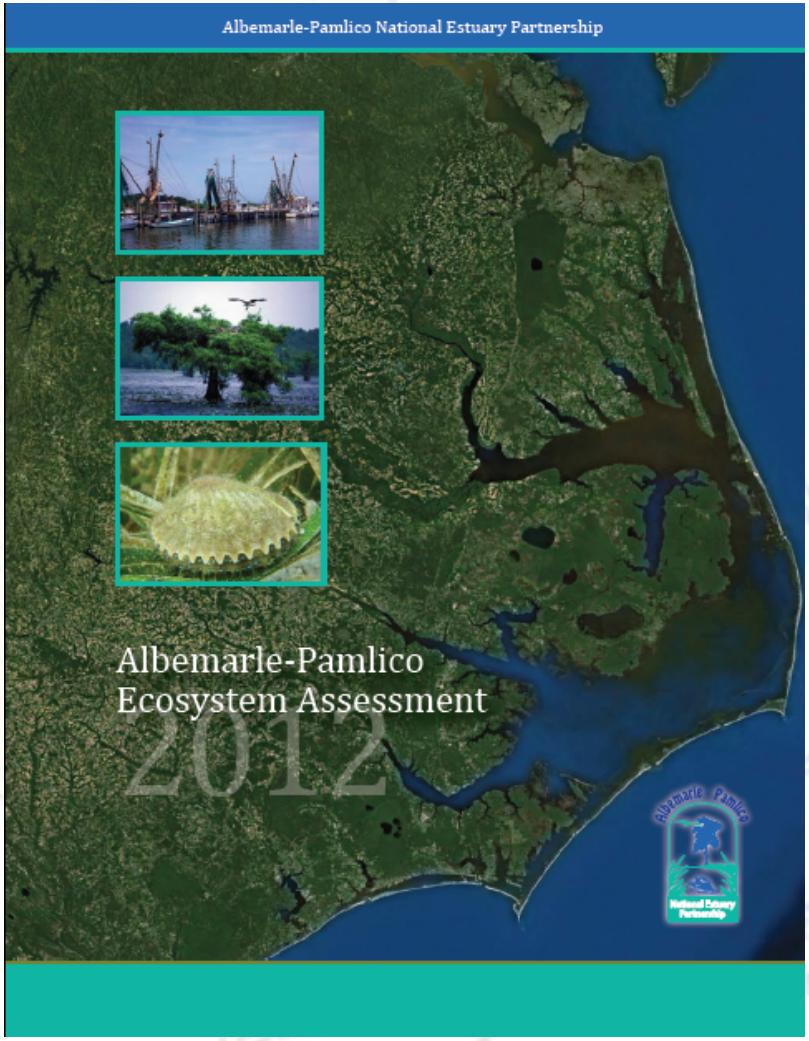
Step 5: Develop monitoring program

- 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



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

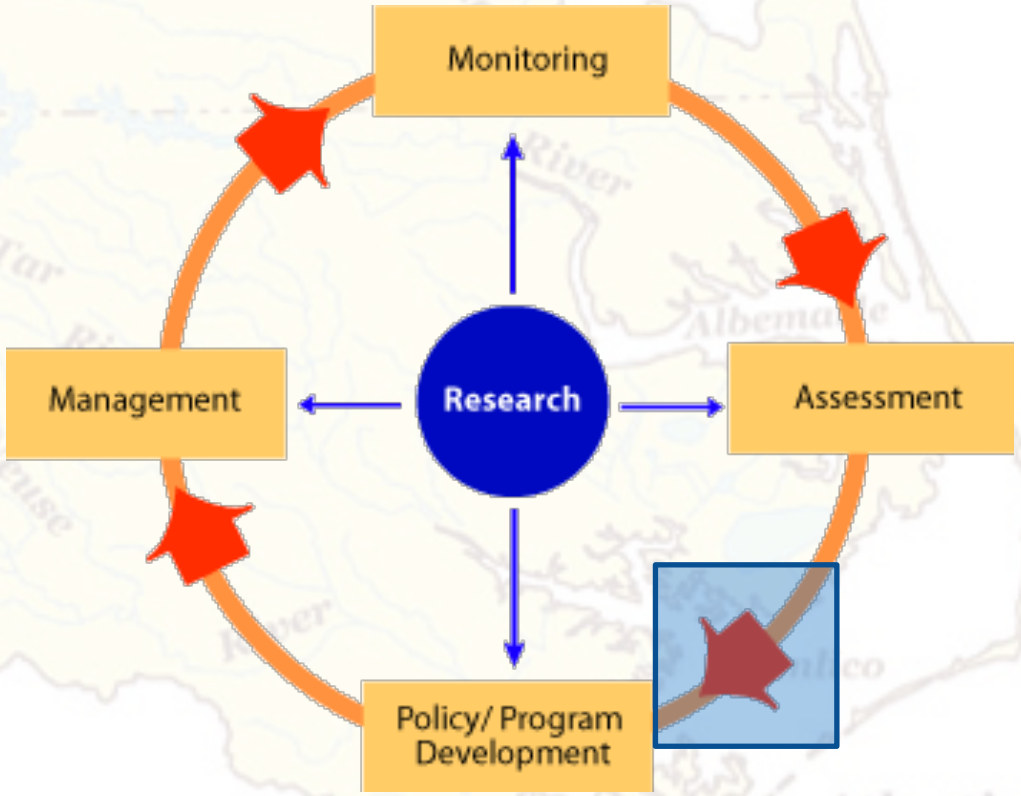
Bioregional Assessment Questions

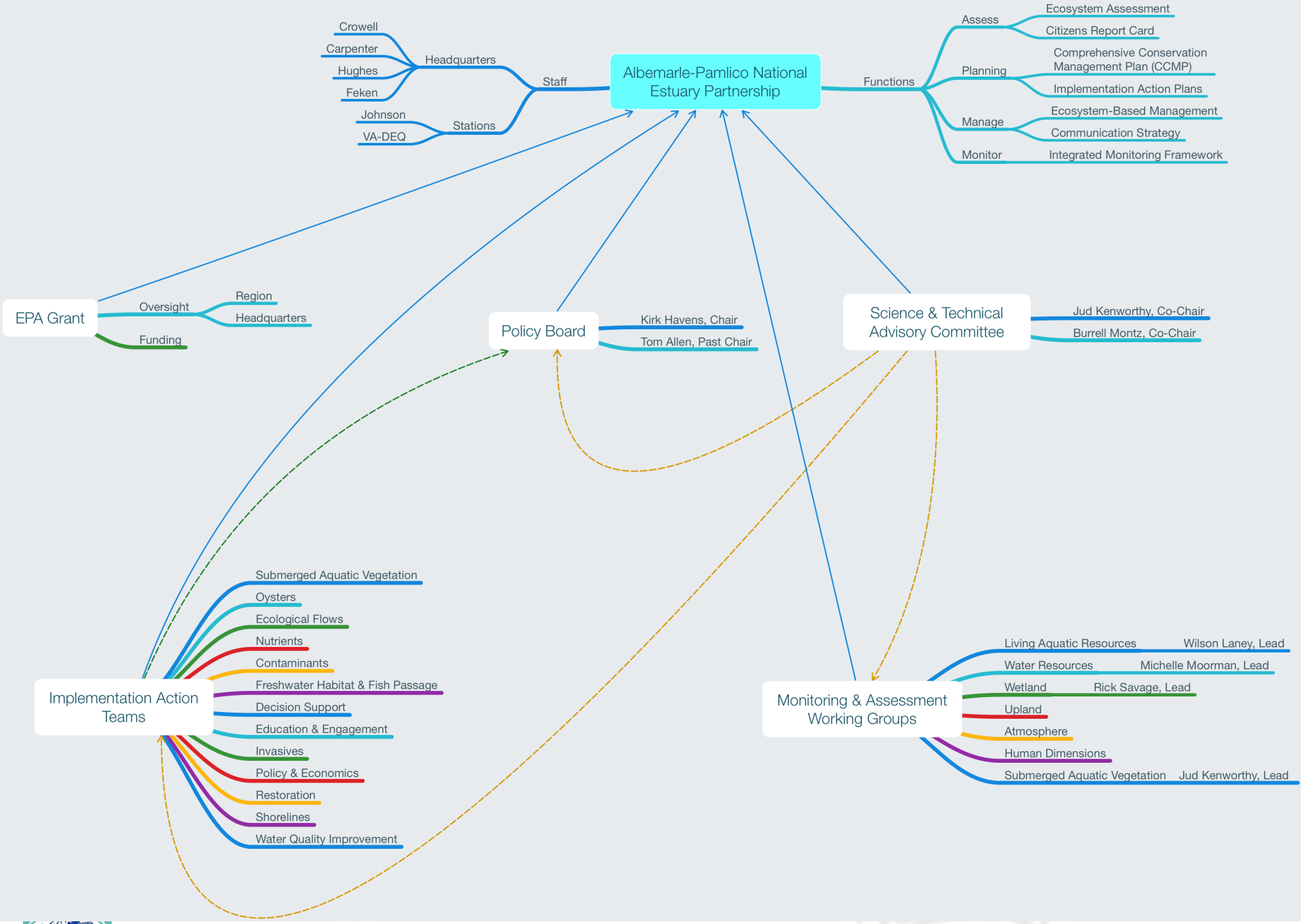
- What were historic ecological, social, and economic conditions, trends, and variability?
- What are current ecological, social, and economic conditions?
- What are trends and risks under current policies and management?
- What policy choices will achieve ecological sustainability consistent with social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




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 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	III-B-1-a	Stored Carbon in Water Column & Sediments	US-EPA-Reg4									
			III-B-2-a	Stored Carbon in Tree Biomass	USFS-Climate Change									
			III-A-1-a	Carbon Emissions by Sector	NC-DENR-DAQ, VA-DEQ-AQ									
			III-A-2-a	Carbon Storage by Vegetation & Soil	US-EPA-ORD, NCSU									
		Nutrient Cycles	III-C-1-a	Nitrogen Cycle Condition	USFS-FIA									
			III-B-1-a	Total Inorganic Nitrogen Deposition	US-EPA-ORD									
			III-C-2-a	Phosphorus Cycle Condition	USGS									
			III-C-3-a	Sulfur Cycle Condition	USFS-FIA									
		Toxics Cycles	III-B-1-a	Stored Elements in Wetland Soils	UNC-CH-IMS									
			III-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 (e.g., 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, damselfies, 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									
			III-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, nor 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		III-B-1-a	Stored Elements in Wetland Soils	UNC-CH-IMS									
			III-B-1-b	Stored Elements in Wetland Vegetation	UNC-CH-IMS									
	III-D: Sediments do not harm species that depend on the waters		III-D-1-a	Sedimentation in Wetlands	ECU									

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?**

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

Albemarle-Pamlico
National Estuary Program
North Carolina

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REPORT

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Albemarle-Pamlico
National Estuary Program
North Carolina