APNEP Water Resources Monitoring Workshop

- Develop a monitoring strategy for Water Resource metrics within the APNEP region
- Regional ecosystem test module
- Metric-specific monitoring proposals

APNEP Background

- APNEP staff adopt indicators/metrics in December 2007
- Plan in 2008 to develop an integrated monitoring strategy for those indicators
- In concert with APNEP revising its Comprehensive Conservation & Management Plan (CCMP) in 2009
- "Living Aquatic Resources" goal first, monitoring design development address LAR indicators first

Water Resources Monitoring Workshop Invitees

- **APNEP (2)**
- **NC-DEH (2)**
- **NC-DFR**
- NC-DSWC
- **NC-DWQ**
- NC-DWR
- **NC-NERR**
- EPA
- FWS
- NOAA
- **NPS**
- **USGS (2)**

Ecosystem-Based Management

- Tenet: EBM improves natural resource management by forging more effective political connections among humans, nature, science, and government.*
- Alternative terminology: Landscape-Based Management

*Cortner & Moote. 1999. The Politics of Ecosystem Management. Page 1.

Information to Evaluate Natural Resource Policy

- Evaluation of the impact of conservation policy intervention lags other policy fields
- Paucity of data on the response of the species to which the intervention is targeted
- Poor understanding of the cost effectiveness of the relevant policy instruments
- Reduced opportunities for policy improvement
- Exposure of policy to criticism

APNEP Accepts Challenge?

- 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, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning?

Source: Kates et al. 2000. Sustainability science. Science 292(5517):641-642.

APNEP Ecosystem Assessment

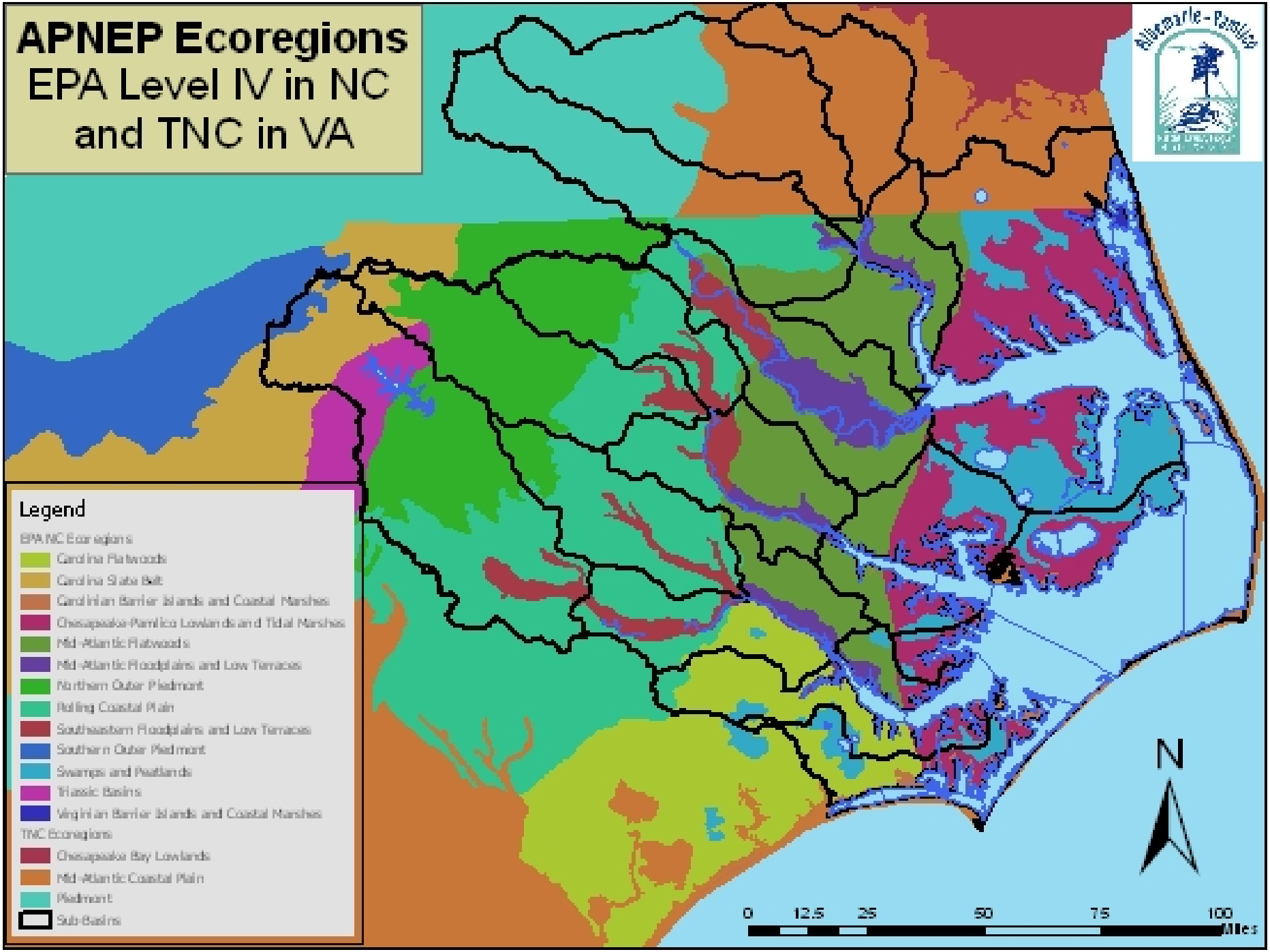
- Who will contribute?
  - APNEP federal, state, local partners
- What will the assessment contain?
  - Timely technical information within a decision support system to help answer seven policy-based questions: magnitude, extent, trend, cause, source, risk, and solutions
- When is the target date for the DSS?
  - ASAP! Last assessment was 1991

APNEP Ecosystem Assessment

- Where are the areas to be assessed?
  - Region and sub-regions
- Why will the assessment be developed?
  - To support the APNEP-CCMP, NC-CHPP, NC/VA basinwide planning
  - To evaluate restoration success, APNEP must have a reliable pre-restoration baseline for ecosystem condition
- How will the assessment be constructed?
  - Plan and implement a regional ecosystem assessment infrastructure. The “engine” of this infrastructure would be a long-term ambient monitoring program.

Spatial Assessment Continuum

- Global
- Sub Global: North America
- Regional: South Atlantic Large Marine Ecosystem
- Basin: APES
- Watershed
- Local


APNEP Ecoregions
EPA Level IV in NC
and TNC in VA
Albemarle-Pamlico
Legend
EPA NC Ecoregions
Carolina Flatwoods
Carolina Slate Belt
Carolinian Barrier Islands and Coastal Marshes
Chesapeake-Pamlico Lowlands and Tidal Marshes
Mid-Atlantic Flatwoods
Mid-Atlantic Floodplains and Low Terraces
Northern Outer Piedmont
Rolling Coastal Plain
Southeastern Floodplains and Low Terraces
Southern Outer Piedmont
Swamps and Peatlands
Triassic Basins
Virginian Barrier Islands and Coastal Marshes
TNC Ecoregions
Chesapeake Bay Lowlands
Mid-Atlantic Coastal Plain
Piedmont
Sub-Basins
N
0 12.5 25 50 75 100
Miles

Temporal Assessment Continuum

- Century
- Decade
- Annual
- Monthly
- Daily

Governance Assessment Continuum

- Global
- National
- Regional: North Carolina and Virginia
- State
- County
- Municipalities

Ecosystem Science

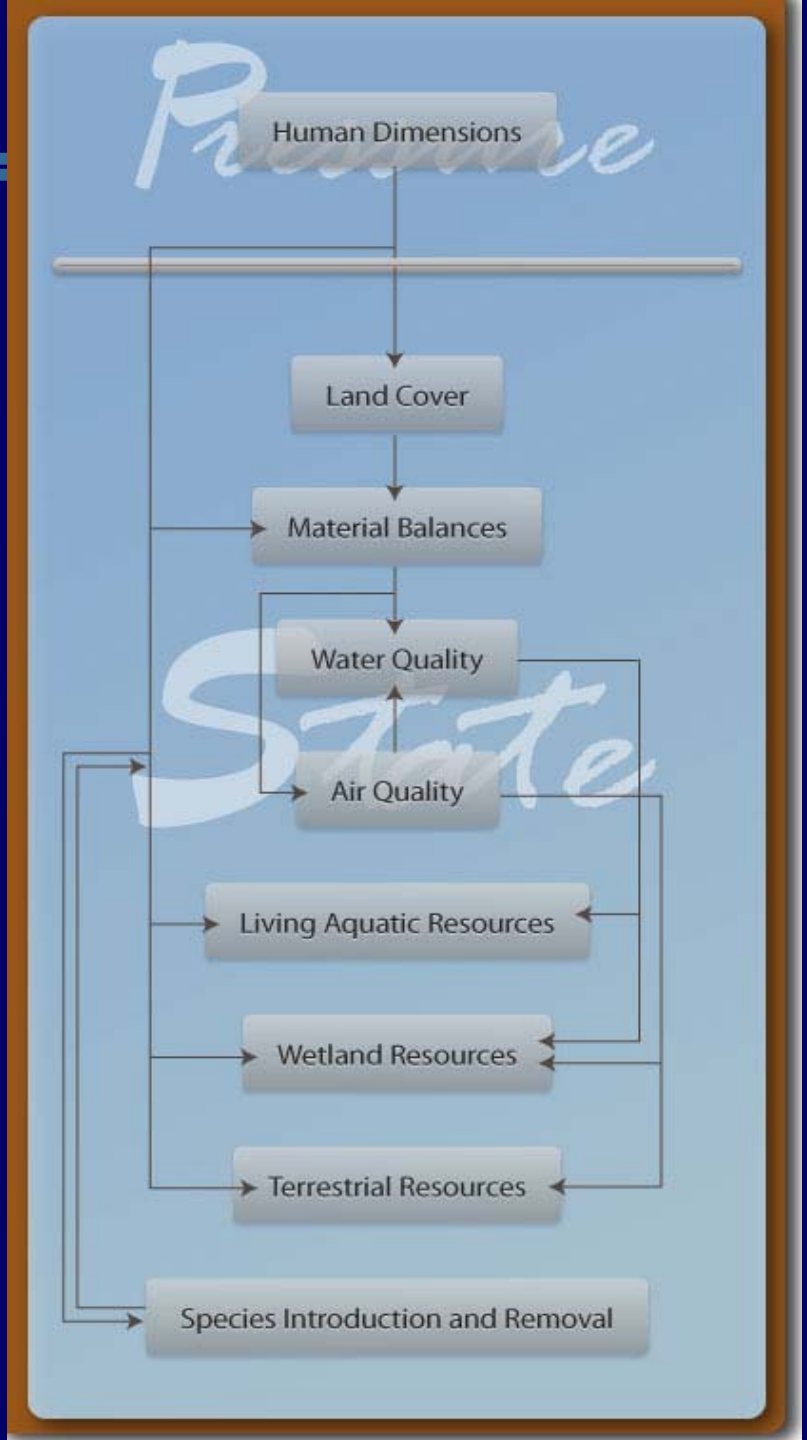
- Tenet: Integrated and comprehensive nature of ecosystem science is critical to ecosystem management at the landscape scale.

Cortner & Moote. 1999. The Politics of Ecosystem Management. Page 25.

EPA Indicator Development for Estuaries

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

Regional Ecosystem Model



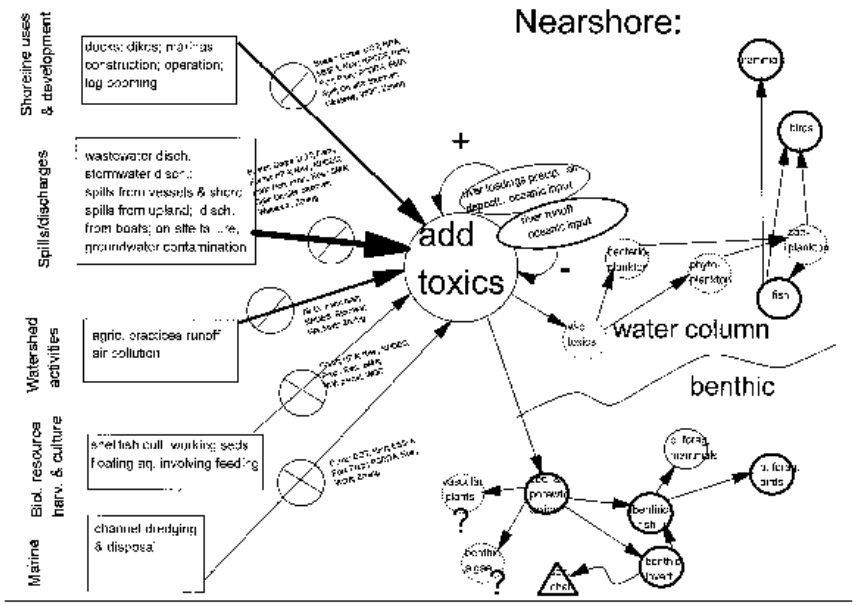


Figure 3. Stressor-based conceptual sub-model for toxics in the nearshore environment. Weighting of line around ecosystem component circles indicates amount of monitoring data available.

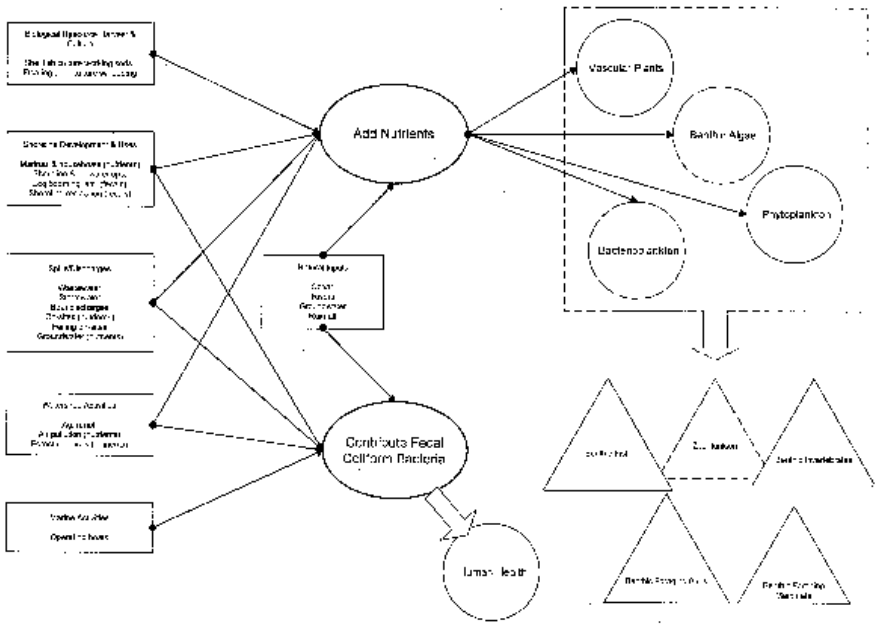


Figure 6. Conceptual model of nutrient and pathogen stresses in Puget Sound.

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

A-P INDICATORS: LINKS TO REGIONAL ECOSYSTEM MODEL

Module	Category	Dimension	Indicator	CCMP Indicator	STAC Indicator	ASC Indicator	ACE-INC Indicator
1: Human Population							
	Regional Population				Demographic Structure		
		Human Presence	Total population in basin		Human Presence		
		Human Urban Presence	Total urban population		Human Presence		
		Population by demographic class			Demographic Structure		
		Localized population change			Human Presence		
		Human waste production					
2: Human Needs							
	Food						
	Water						
		Drinking water uses					
		Water supply infrastructure					
	Fiber						
		Housing			Housing Price & Affordability		
	Fuel						
		Energy supply infrastructure					
	Health						
	Economy						

APNEP Objectives-Metrics Hierarchy

- Modules
- Categories
- Dimensions
- Metrics

Water Quality & Hydrological: I

- **Water Quality Threats (Load)**
  - Atmospheric Deposition
    - See Air Quality & Atmospheric Process Module
  - Loading: Nutrients
    - Nutrient Loading from Land: Nitrogen/ Phosphorus
  - Loading: Oxygen-Depleting Substances
    - Loads Versus Assimilative Capacity
  - Loading: Sediment
    - Sediment Loads
  - Loading: Toxicants
    - Toxicant Loads
    - Tissue Concentrations

Water Quality & Hydrological: II-a

- **Surface Water Quality (In Column)**
  - Water Quality Degradation
    - Amount and Extent of Impaired Waters
    - Water Quality Standard Violations
    - Acute Water Quality Problem Sites
  - Water Quality in High-Value Sites
    - Water Quality in Nursery Areas
    - Water Quality in SAV Habitats and Shellfish Waters
  - Nutrient Sensitive Waters
    - Nutrient Concentrations in Nutrient Sensitive Waters

Water Quality & Hydrological: II-b

- **Surface Water Quality (In Column)**
  - Physical Contaminants
    - Dissolved Oxygen Standard Violations
    - Sediment Standard Violations
    - Salinity Concentration
    - Estuarine Debris
    - Underwater Acoustics
  - Algae
    - Chlorophyll-a Concentration
  - Pathogens
    - Shellfish and Swimming Area Closures
  - Toxicants
    - Toxicant Standards Violations
    - Metals Standards Violations
  - Emerging Contaminants
    - Nanoparticles
    - Personal Care and Pharmaceutical By-Products

Water Quality & Hydrological: III

- **Ground Water Quality**
  - Water Quality Degradation
    - TBD
  - Physical Contaminants
    - TBD
  - Pathogens
    - TBD
  - Toxicants
    - TBD
  - Emerging Contaminants
    - TBD

Water Quality & Hydrological: IV

- **Sediment Quality**
  - Sediment Toxicants
    - Sediment Criteria Exceedances
  - Sediment Nutrients
    - Sediment Nutrient Concentration

Land Cover: I

- Cover Type Extent
  - Regional Coverage
    - Area by Land Cover Class

Land Cover: II

- Spatial Relationships
  - Connectivity
    - Landscape Connectivity Index
  - Patchiness
    - Landscape Complexity Index
  - Proximity
    - Landscape Proximity Index

Land Cover: III & IV

- Landscape Vulnerability
  - Sea Level
    - Sea Level; Relative Sea Level
    - Infrastructure Investments: Amount of Infrastructure Affected by SLR
    - Shoreline/Beach Width: SLR & Inundation Frequency

Materials Balances: I & II

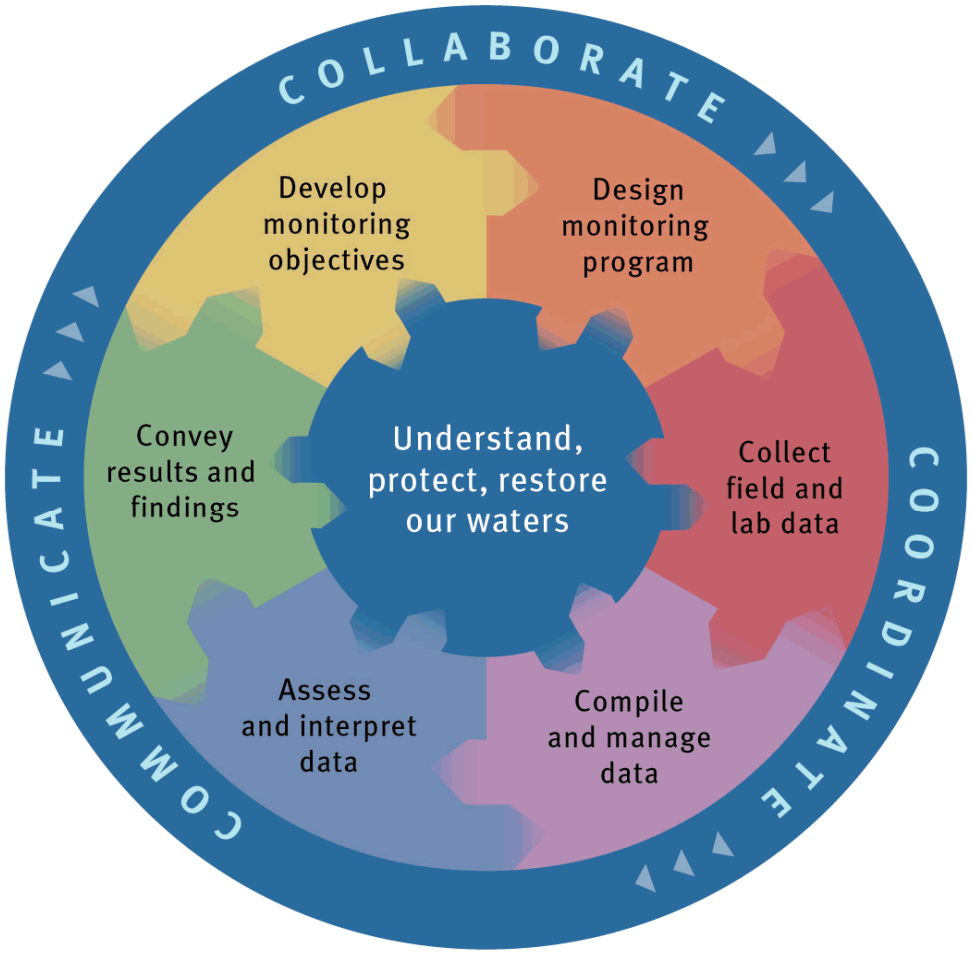
- Water
  - Mainstem Hydrograph
    - Flows
    - Severity, Frequency, Duration of Droughts & Floods
  - Sounds Water Balance
    - Estuarine Residence Time
  - Ground Water Levels
    - Ground Water Levels
- Carbon
  - Carbon Emissions
    - Carbon Emissions by Sector
  - Sequestered Carbon
    - Stored Carbon by Ecosystem Component

Materials Balances: III & IV

- Nutrients
  - Nitrogen
    - Nitrogen Cycle Condition
    - Airborne Delivery of Fixed Nitrogen
  - Phosphorus
    - Phosphorus Cycle Condition
  - Sulfur
    - Sulfur Cycle Condition
- Sediment
  - Soil
    - Prevalence of Highly Eroded Lands
  - Sedimentation
    - TBD

Materials Balances: V

- Toxicants
  - Metals Contaminants
    - Mercury Deposition
    - Mercury Prevalence in Biota
  - Non-Metals Contaminants
    - Toxicant (TBD) Discharges
    - Toxicant (TBD) Prevalence in Biota



Framework for Monitoring

NEP Monitoring Plan Outline

- Define monitoring objectives & performance criteria
- Identify testable hypotheses
- Specify monitoring variables, including sampling locations, monitoring frequency, field and laboratory methods and QA/QC procedures
- Specify data management system and statistical tests to analyze the monitoring data
- Describe the expected performance of the initial sampling design
- Provide a timetable for analyzing data and assessing program performance

USEPA. 1992. Monitoring Guidance for the National Estuary Program. EPA 842-B-92-004

Initial APNEP Indicator-Metric Proposal

- Monitoring objective
- Measurable goals
- Data quality objectives
- Data analysis, statistical methods and hypothesis
- Data Source

Trowbridge P. 2004. New Hampshire Estuaries Project Monitoring Plan. New Hampshire Department of Environmental Services.

APNEP Indicator-Metric Proposal

- Introduction
- Monitoring objective under present sampling program
- Existing program costs
- Monitoring objectives under enhanced sampling program
- Estimated minor enhancement costs
- Estimated major enhancement costs
- Measurable goal
- Data quality objectives under present sampling program
- Data quality objectives under enhanced sampling program
- Data analysis, statistical methods and hypothesis
- Data Sources
- Reference(s)
- Contact Person

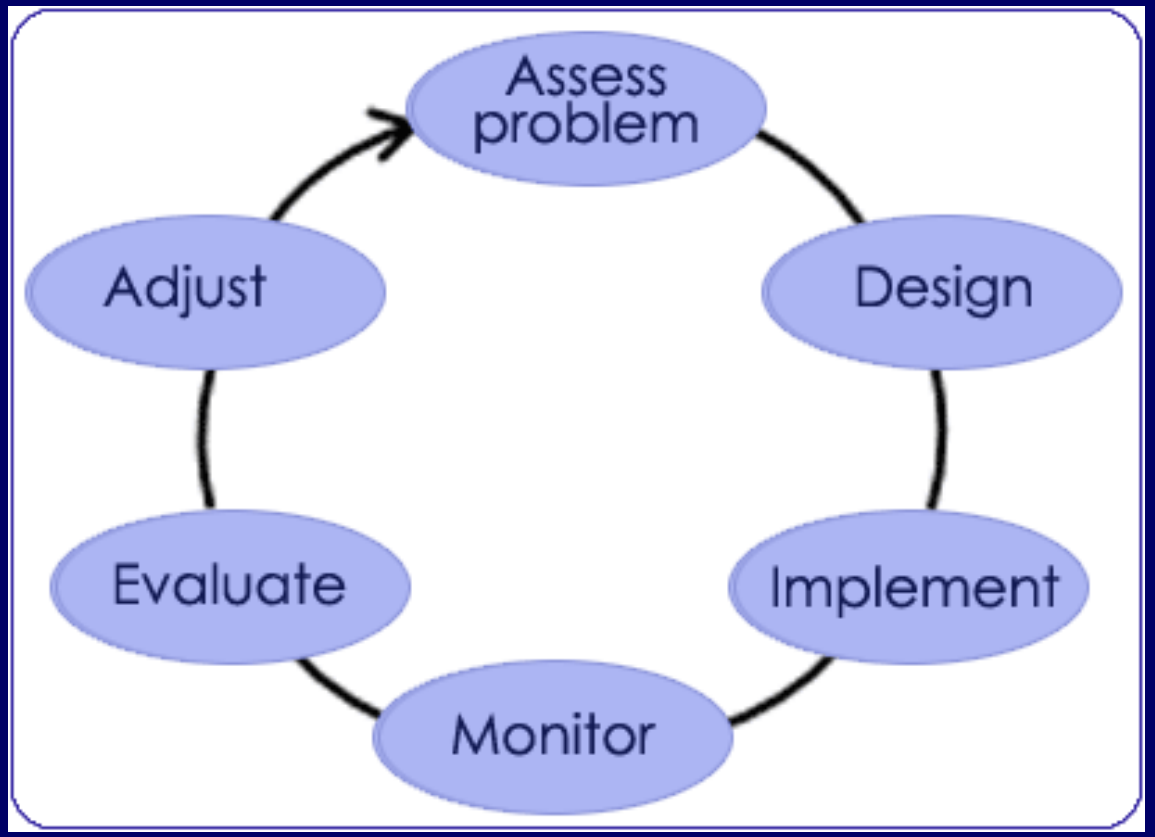
A-P Ambient Monitoring Program

- 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

Monitoring Integration Continuum

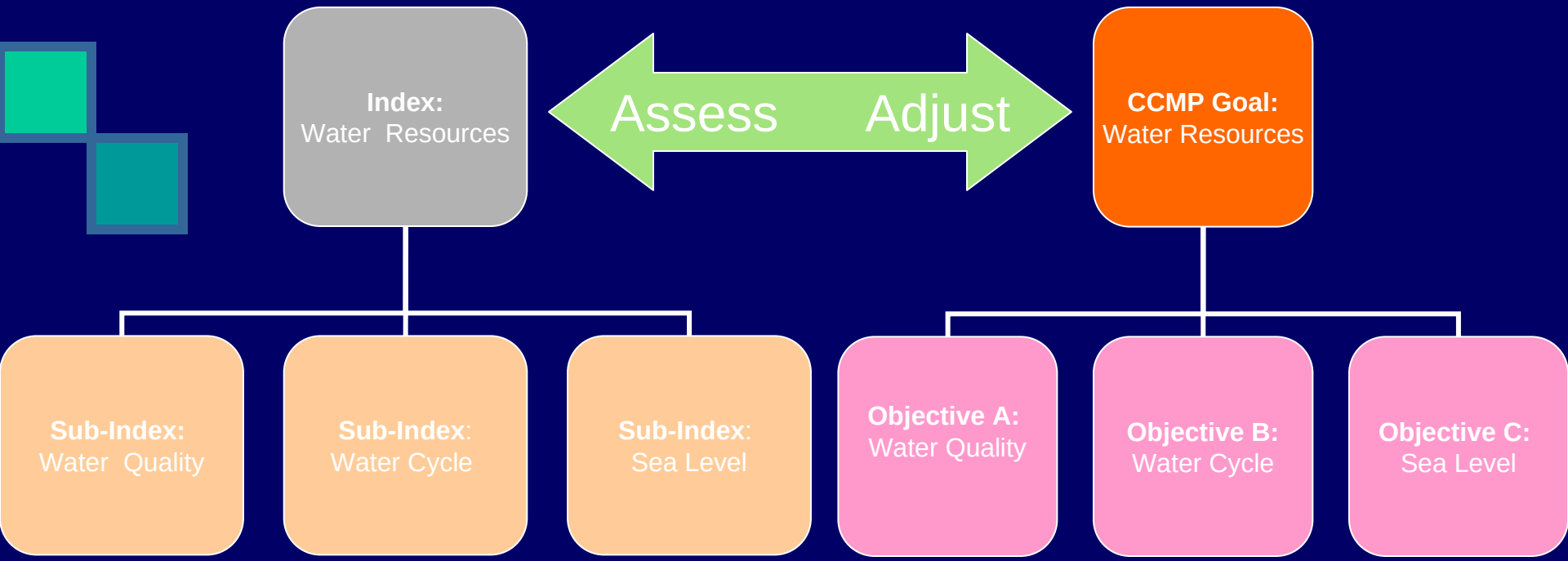
- Independence: Knowledge of partners monitoring strategies
- Cooperation: Taking advantage of common geography, timing
- Collaboration: Opportunities to leverage partners' monitoring networks
- Integration: Working toward a common set of regional ecosystem objectives

APNEP CCMP 2009 - ?: A New Paradigm of *Adaptive* Ecosystem Management



Source: Department of the Interior at www.doi.gov/.../AdaptiveManagement/whatis.html

An Integrated Framework



Indicators Framework

CCMP Framework

Regional Ecosystem Goods

- 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)

Regional Ecosystem Services

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

DSS Construction Phase I

- Initial Objective: An integrated GIS environmental database portal
- IT Objective: Spatially-enabled content management system
  - First compilation: NC-DENR- and VA-DEQ/DCR/DFG/DF- sponsored environmental data
  - Second compilation: environmental databases from other North Carolina and Virginia agencies
  - Third compilation: federal, university (non-DENR funded), local databases

DSS = Digital Basin (Landscape)

- Ecosystem State
  - Land Cover
  - Material Balance
  - Atmospheric
  - Water Quality
  - Living Aquatic Resources
  - Wetlands
  - Terrestrial
  - Species Introductions & Removals
- Human Dimensions
- Management Actions
- Uncertainty