

APNEP Monitoring Strategy Development

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APNEP Monitoring Elements

- APNEP Monitoring Conference 2000
- MAT Phase I 2008-2012
 - Monitoring Template
- MAT Phase II 2018-
 - Indicator Reports
 - **Monitoring Plans**
 - EPA's NEP monitoring guidance
 - Other NEPs monitoring plans
 - Large ecosystem programs

EPA-NEP: Monitoring Plan Essentials

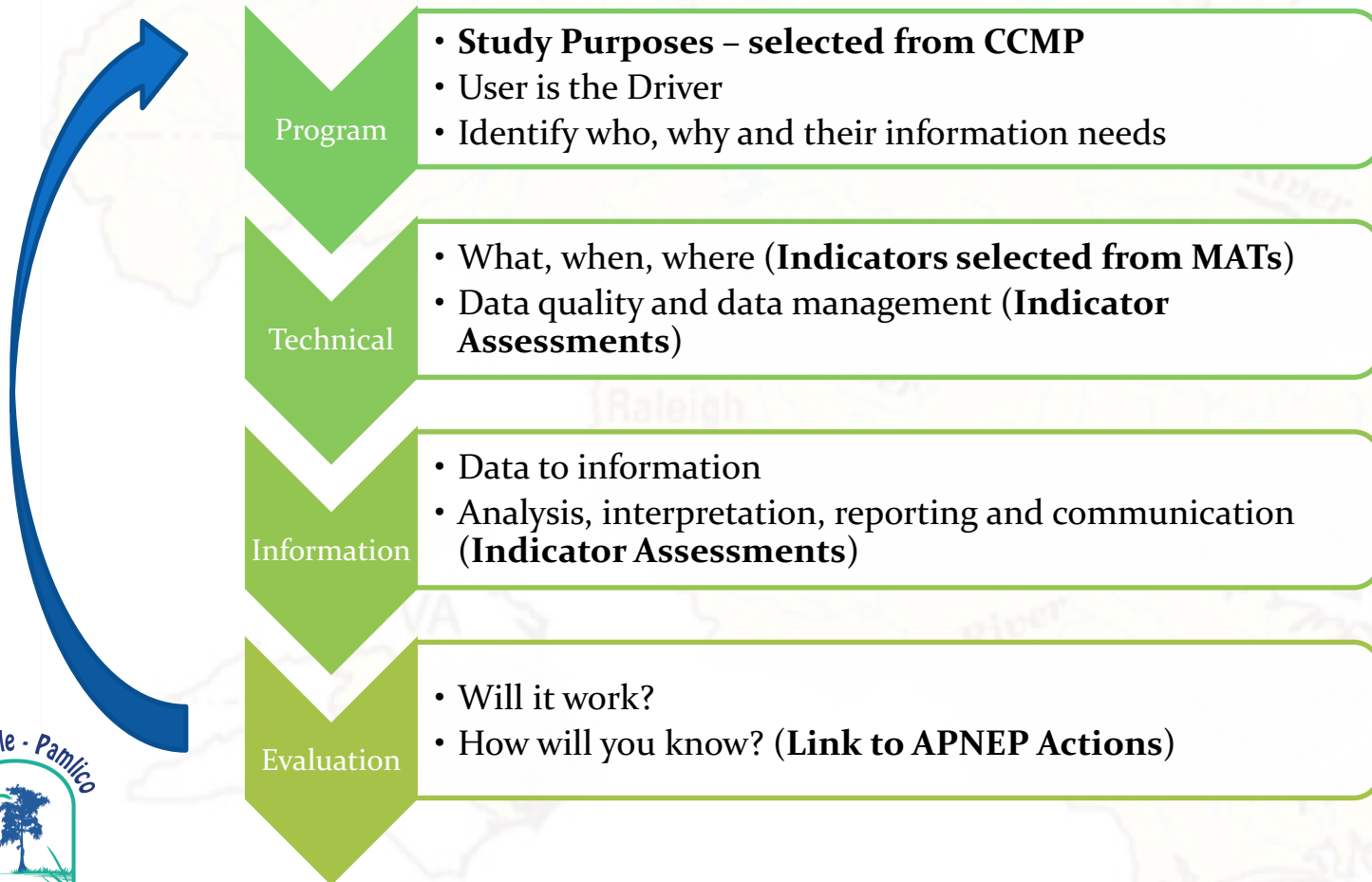
- Meets QA/QC requirements
- Identifies various parties' roles and responsibilities
- Has a timetable for collecting and reporting on data
- Identifies funding needs and/or commitments of the monitoring program
- Produces data to support an analysis of specific environmental conditions

EPA-NEP: Monitoring Plan Desirables

- Has a schedule for reviews/updates that is approved by the Management Conference
- Promote the establishment of monitoring by volunteer groups
- Produces sufficient data to support and comprehensive and integrated analysis of environmental conditions
- Seeks more efficient and cost-effective technologies for monitoring as appropriate
- Volunteer training



APNEP charge: Design a monitoring program for measurable, trackable and identifiable outputs, outcomes, impacts, and results



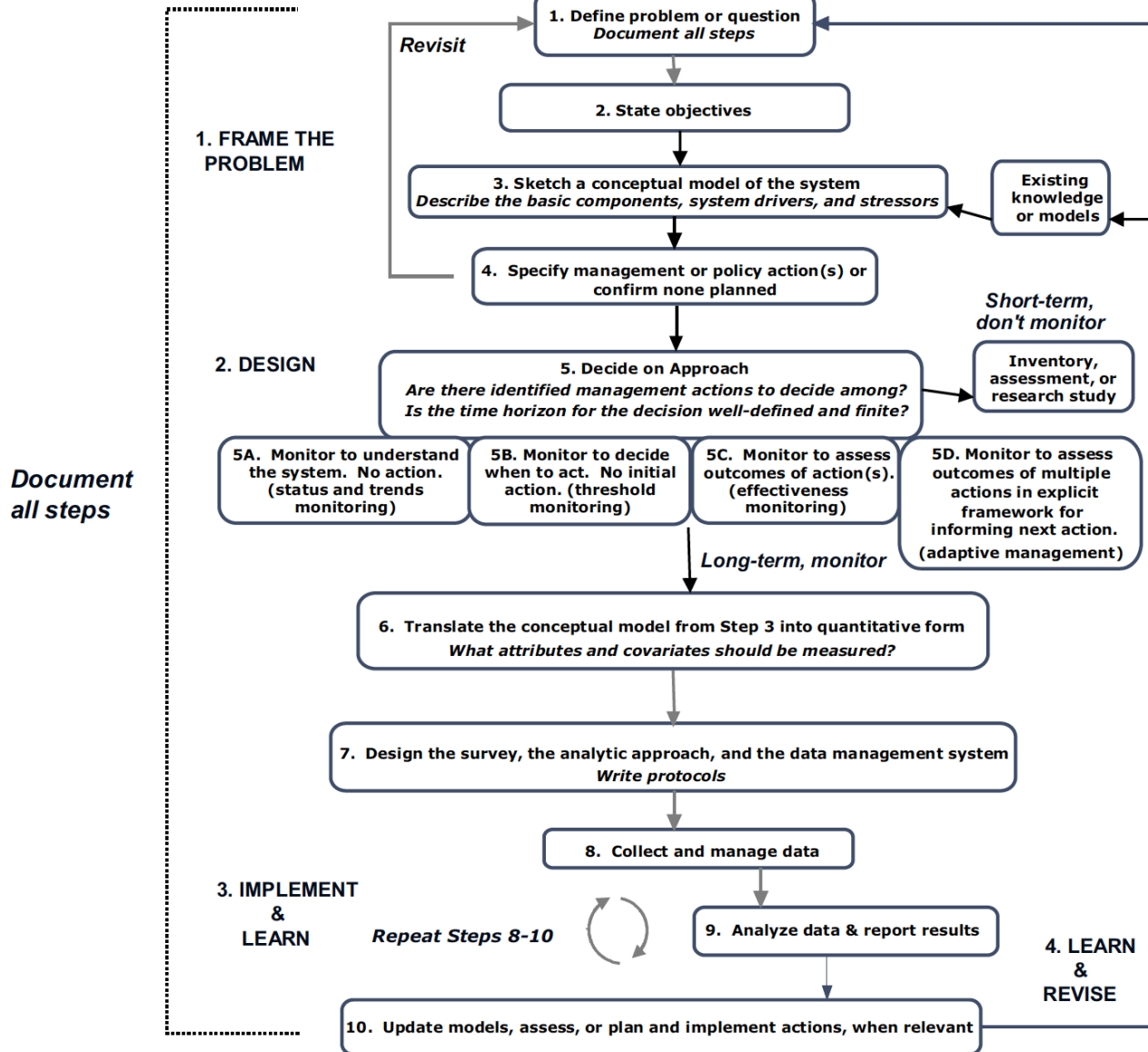
Adapted from Barb Horn, Colorado Parks and Wildlife

Monitoring Practice References

- NEP Monitoring Guidance (USEPA 1992)
- Practical Advice for Implementing Long-Term Ecosystem Monitoring (Sergeant et al. 2012)
- Ecosystem Monitoring for Ecosystem-Based Management: Using A Polycentric Approach to Balance Information Tradeoffs (Heenan et al. 2016)
- **A Road Map for Designing and Implementing A Biological Monitoring Program (Reynolds et al. 2016)**
- Effective Monitoring to Evaluate Ecological Restoration in the Gulf of Mexico (NRC 2017)



Course Map for Monitoring



Reynolds et al. 2016

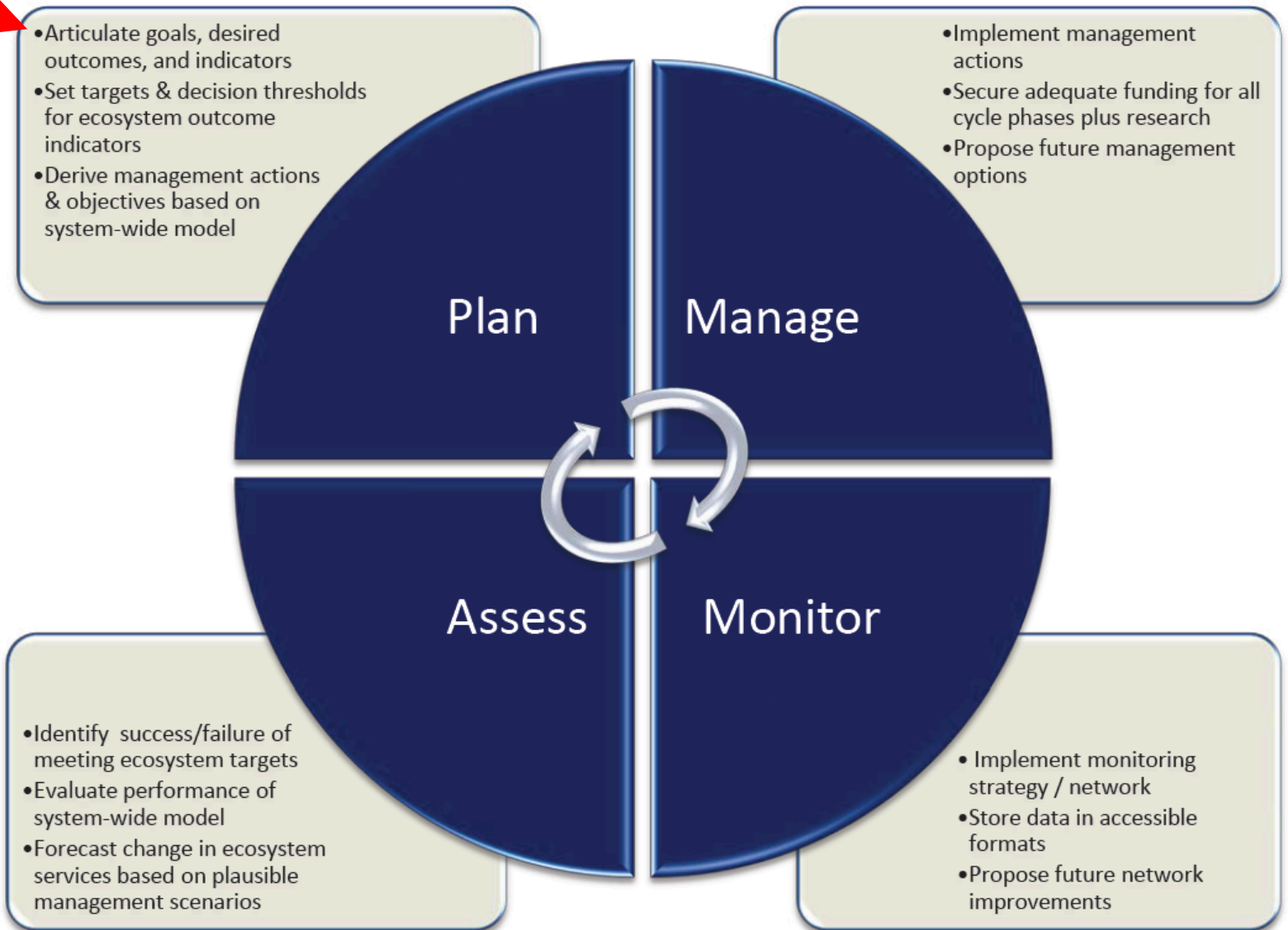


Step 1: Define Problem or Question

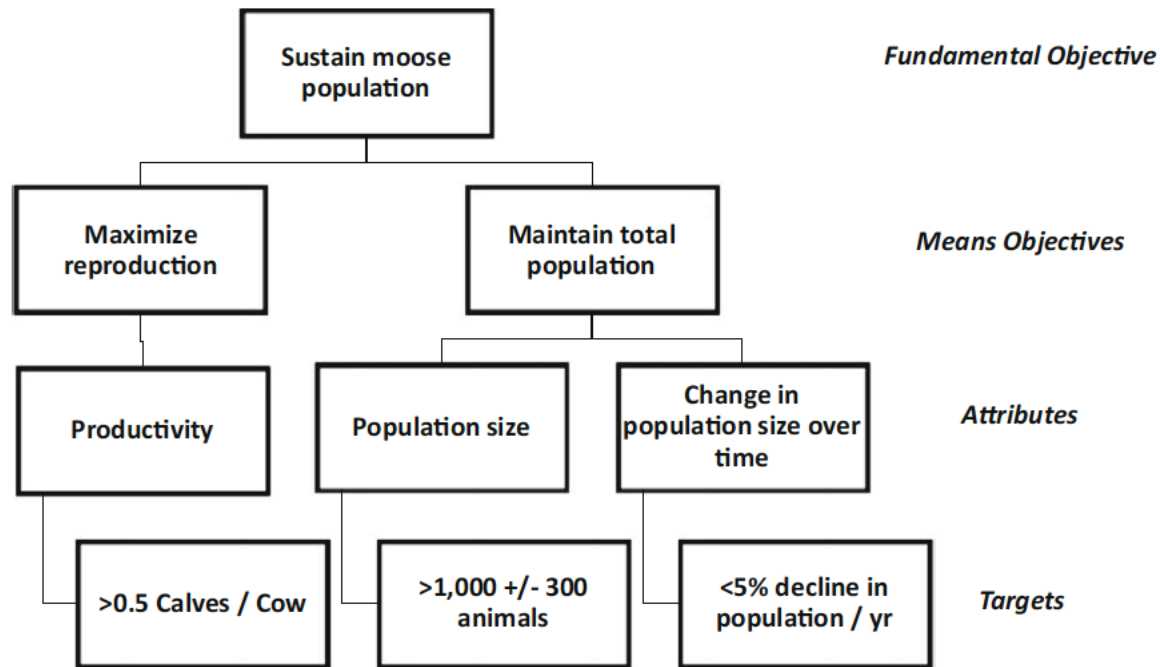
- *What is a healthy Albemarle-Pamlico Estuarine System (APES)?*
- *What is the status of the APES?*
- *What are the greatest challenges facing the APES?*
- *What actions should be taken to move toward healthier A-P Sounds over the next decade?*



Figure 2: APNEP's adaptive management cycle.



Outcomes-to-Objectives Hierarchy Case Study



Reynolds et al. 2016

Step 2: State the Objectives

Goal 1: A region where human communities are sustained by a functioning ecosystem.

- EO 1a: Waters are safe for personal contact
- EO 1b: Designated surface and ground water supplies are safe for human consumption
- EO 1c: Surface hydrologic regimes sustain regulated human uses
- EO 1d: Fish and game are safe for human consumption
- EO 1e: Opportunities for recreation and access to public lands and waters are protected and enhanced

Step 2: State the Objectives

Goal 2: A region where aquatic, wetland, and upland habitats support viable populations of native species.

- ❑ EO 2a: The biodiversity, function, and populations of species in aquatic, wetland, and upland communities are protected, restored, or enhanced.
 - ❖ Sustain aquatic floral and faunal taxa: diadromous fishes, spotted seatrout, bottlenose dolphin, blue crab, aquatic macroinvertebrates
 - ❖ Sustain wetland floral and faunal taxa: wetland birds
 - ❖ Sustain upland floral and faunal taxa: upland birds, black bear, bats, amphibians, reptiles, terrestrial insects

Step 2: State the Objectives

- ❑ EO 2b: The extent and quality of upland, freshwater, estuarine and near-shore marine habitats fully support biodiversity and ecosystem function.
 - Sustain upland habitats: maritime forest, longleaf/natural upland pines, natural upland/mesic hardwoods, riparian vegetation, urban trees, soils
 - Sustain freshwater habitats: wetland vegetation, ephemeral pools
 - Sustain estuarine habitats: SAV, wetland vegetation
 - Sustain near-shore marine habitats:

Step 2: State the Objectives

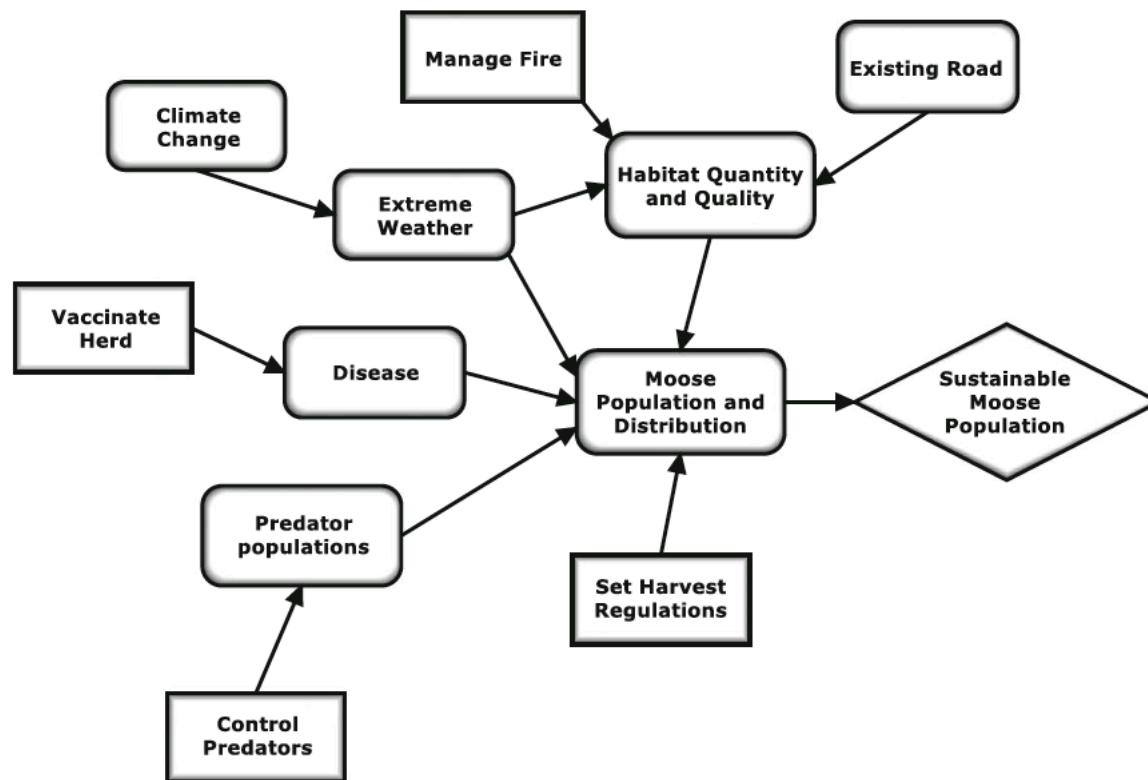
- ❑ EO 2c: Non-native invasive species do not significantly impair native species' viability or function, or impair habitat quality, quantity, and the processes that form and maintain habitats.
 - Control invasive aquatic floral and faunal taxa: Eurasian watermilfoil, Hydrilla
 - Control invasive wetland floral and faunal taxa: ?
 - Control invasive upland floral and faunal taxa: Privet, *Microstegium*, Autumn Olive; Feral Hog, House Sparrow, European Starling, Eurasian Collared Dove

Step 2: State the Objectives

Goal 3: A region where water quantity and quality maintain ecological integrity.

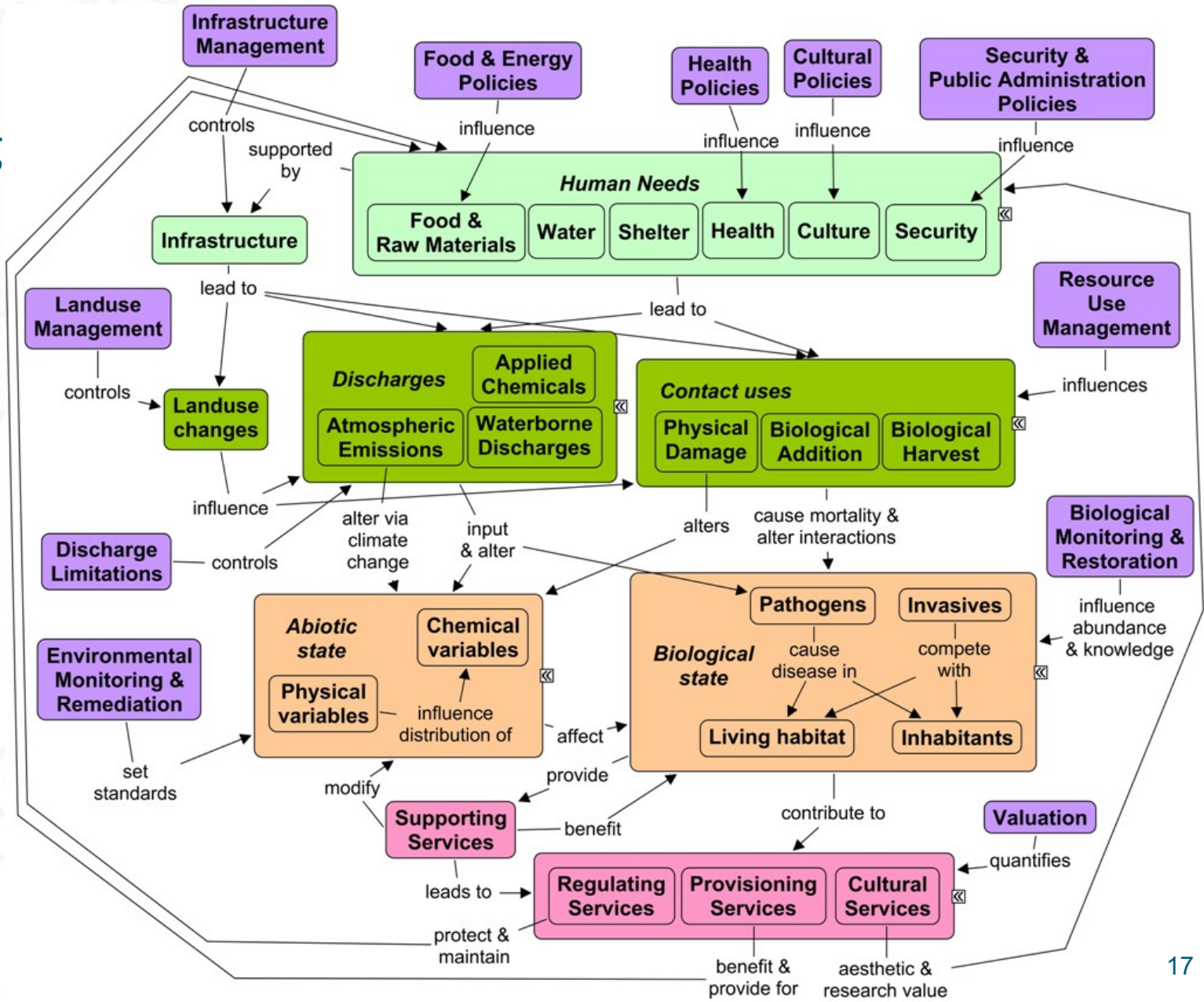
- EO 3a: Appropriate hydrologic regimes support ecological integrity
- EO 3b: Nutrients and pathogens do not harm species that depend on the waters
- EO 3c: Toxics in waters and sediments do not harm species that depend on the waters
- EO 3d: Sediments do not harm species that depend on the waters

Sketch a Conceptual Model of the System



Reynolds et al. 2016

DPSER Modeling



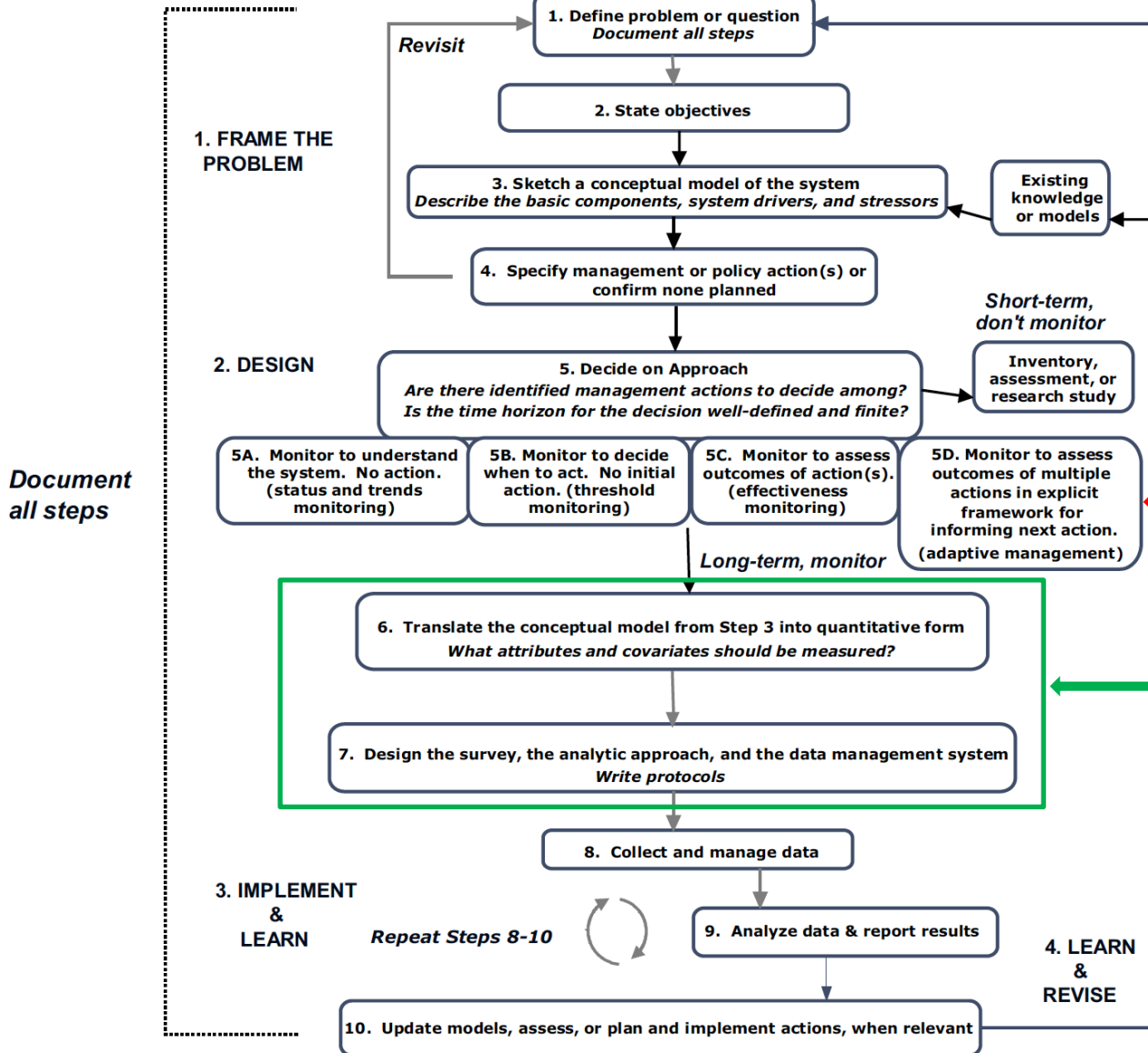
Lt. green = Drivers
 Dk. Green = Pressure
 Orange = State
 Red = Ecosystem Services
 Purple = Response

EPA-ORD-ESRP 2010



Factor	Rating	Action	Who's Responsible?	Indicator	Expected Response	Learning	Adaptation
Biological/factors: fauna							
manage non-native species introduction and impacts	M-M	B2.6	NC-WRC, NC-DWF, NC-DWR, VA-DGIF, USFWS, NOAA, USDA, NC-DEQ, VA-NHP, NC-DACS				
preserve/protect RTE species	M-M	C3.1	NC-DWR, NC-DACS, NC-WRC, USFWS, NOAA, VA-DGIF, NC-NHP, VA-NHP, USDA, NC-DCM, NC-DWF				
Biological/factors: flora							
manage non-native species introduction and impacts	M-M	B2.6	NC-WRC, NC-DWF, NC-DWR, VA-DGIF, USFWS, NOAA, USDA, NC-DEQ, VA-NHP, NC-DACS	SAV			
preserve/protect RTE species	M-M	C3.1	NC-DWR, NC-DACS, NC-WRC, USFWS, NOAA, VA-DGIF, NC-NHP, VA-NHP, USDA, NC-DCM, NC-DWF				
Biological/factors: microorganisms							
manage introduction/spread of pathogens	L-L	B1.2 C1.4	NC-DWR, VA-DEQ, VA-DCR, NC-DWF, NC-DCM, EPA, NC-CWMTF, VA-WQJF, SRF NC-DWR, VA-DEQ, NC-CWMTF, VA-WQJF, SRF, EPA	Water Column Pathogens			
Physical/factors: structure							
manage conversion of aquatic habitats	H-H	C6.1 C6.3	NC-WRC, VA-DGIF, USACE, NOAA, USFWS, NFWF, SACL, American Rivers, NC-DWF, NCCF, TNC, NC-DWR NC-DWF, NC-WRC, VA-DGIF, USACE, NOAA, USFWS, NFWF, NC-DCM, CTNC, NCCF	SAV			
Physical/factors: hydrology							
preserve natural hydrographs	H-M	B2.1	TNC, NC-WRC, VA-DGIF, NC-NHP, VA-NHP, USFWS, SACL, NC-SWC, VA-DSM, NC-DWF	Natural Hydrology & Flow			
Chemical/factors: nutrients							
implement TMDL management for nutrients	M-M	C1.2	NC-DWQ, VA-DWQ, VA-DCR, NC-CWMTF, NC-SWC, EPA	Dissolved Nutrients, Microbiota, Atmospheric Nutrients			
Chemical/factors: toxics							
manage sources and loads	L-M	B1.1 C1.1 C1.2	NC-DWR, VA-DEQ, VA-DCR, EPA, NC-CWMTF, VA-WQJF NC-DWQ, VA-DWQ, NC-CWMTF, EPA, NC-DACS, NC-SWC, VA-DSM NC-DWQ, VA-DWQ, VA-DCR, NC-CWMTF, NC-SWC, EPA	Dissolved Metals, Sediment Condition, Harmful Algal Blooms, Water Column Emerging			
manage potential use impacts on habitat diversity and quality	H-M	B2.5	NC-DCM, NC-WRC, NC-DWF, NC-DWR, VA-DEQ, EPA, NOAA, USFWS, VA-DGIF, USACE				

Course Map for Monitoring



Reynolds et al. 2016

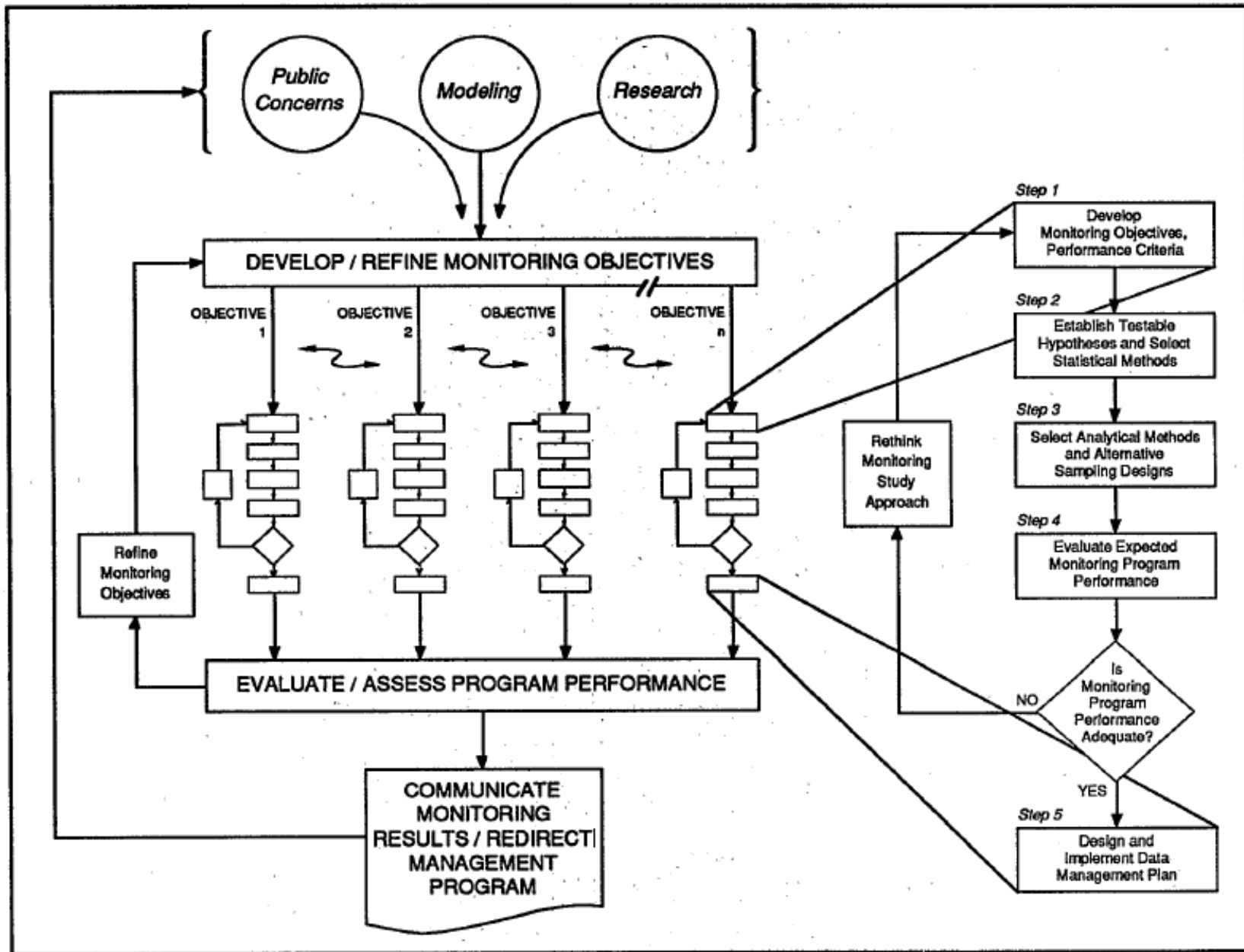


Monitoring Design Framework for NEPs: Five Steps

1. Develop Monitoring Objectives and Performance Criteria
2. Establish Testable Hypotheses and Select Statistical Methods
3. Select Analytical Methods and Alternative Sampling Designs
4. Evaluate Expected Monitoring Study Performance
5. Implement Monitoring Study and Data Analysis

Monitoring Design Framework for NEPs: Elements of Systems Approach

1. Define the Objective
2. Establish Information Needs
3. Establish the Objectives of Individual Program Components
4. Evaluation of Trade-Offs
5. Feedback to Initial Design Step



Assessing Restoration Efficacy in a Regional Context

“...beginning of a movement toward *integrated monitoring*, where formerly isolated efforts are conducted with awareness of other related but independently conducted types of monitoring. This idea goes beyond incorporating outside metrics into a particular monitoring scheme...instead involves a number of practitioners each focused on different ecosystem components in a comparable manner in an effort to assess overall restoration progress in a complementary manner.” (NRC 2017)

Monitoring Plan Tactics I

- Utilize existing monitoring by our partners
- Identify components of the monitoring strategy
 - Focus areas
 - Associated specific monitoring questions
 - Standard EPA criteria like responsibilities
 - Identified gaps and recommendations
 - Reporting schedule/platforms such as ecosystem assessment, symposium, online GIS visuals

Monitoring Plan Tactics II

- Priorities driven by specific monitoring questions associated with each CCMP outcome
- Focus initial development on the water quality components of the CCMP outcomes, along with submerged aquatic vegetation (SAV)
- Work with STAC ad-hoc monitoring subcommittee to develop this approach further

Human Communities Goal

- Waters Safe for Personal Contact
- Water Supplies Safe for Consumption

Native Species Goal: Estuarine Habitats

SAV

Water Goal: Ecological Integrity

- Nutrients & Pathogens
- Toxics in Waters & Sediments
- Sediments

Exogenic Unmanaged Pressures (ExUP)

- pH
- Water Flow Regime
- Emergence Regime
- Thermal Regime
- Salinity Regime
- Wave Exposure

Endogenic Managed Pressures (EnMP)

- Thermal Regime (Local)
- Salinity Regime (Local)
- Water Flow Rate Changes (Local)
- Nitrogen + Phosphorus Enrichment
- Introduction of Microbial Pathogens
- Introduction of Non-Synthetic Compounds
- Introduction of Synthetic Compounds
- Siltation
- Abrasion
- Input of Organic Matter
- Smothering
- Substratum Loss
- pH (Local)
- Death or Injury by Collision
- Litter
- Introduction of Radionuclides
- Barriers to Species Movement
- Electromagnetic Changes
- Wave Exposure (Local)
- Introduction of Non-Indigenous Species and Translocations
- Introduction of Other Substances
- Selective Extraction of Non-Living Resources
- Underwater Noise
- Selective Extraction of Species
- Emergence Regime (Local)



Figures on right side adapted from Elliot et al. 2017

