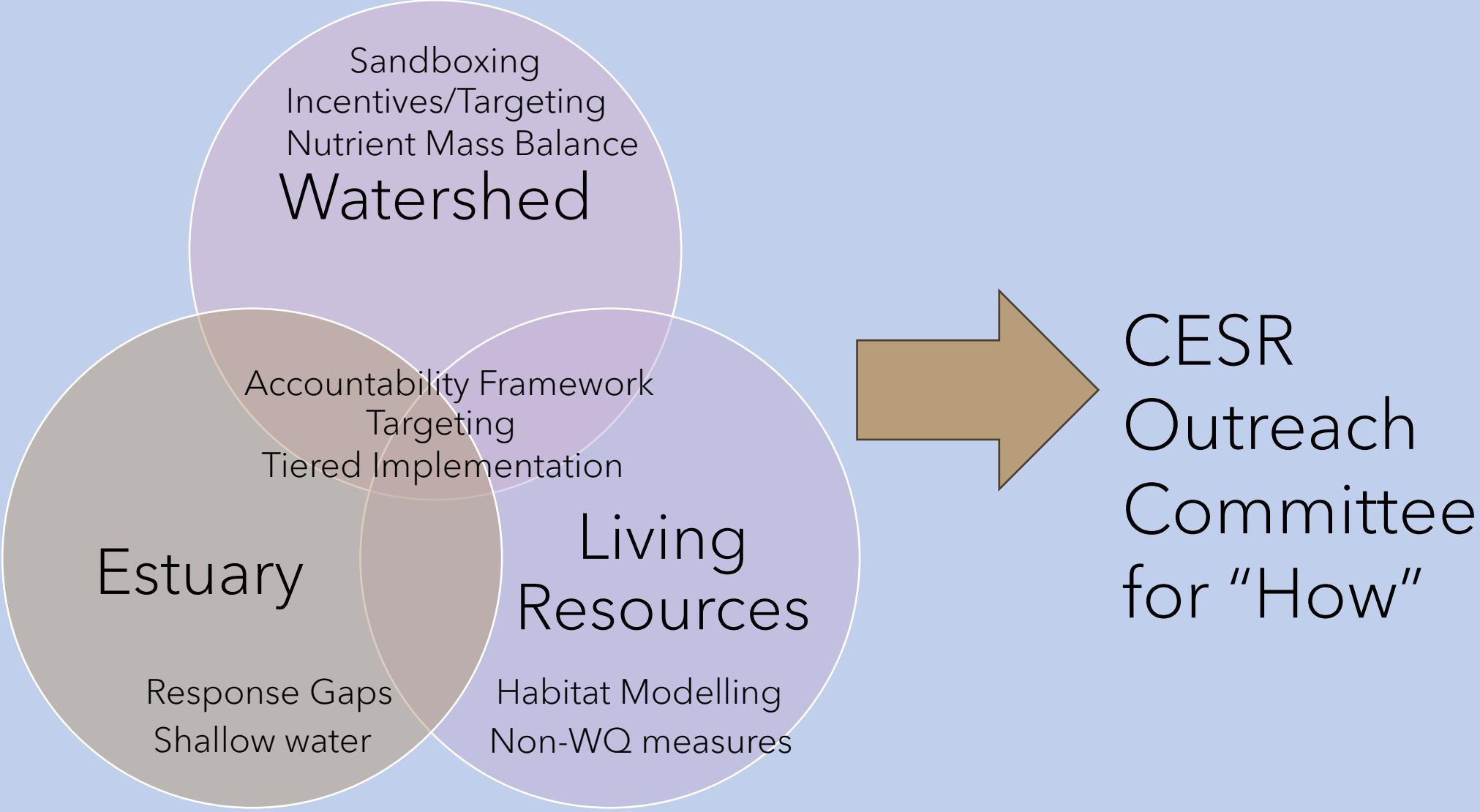

Tiered Implementation of the Bay TMDL

Kurt Stephenson and Denice Wardrop

Discussion with STAC, 4 December 2024

Kurt Stephenson, Denice Wardrop, Leonard Shabman, Lee McDonnell, Gary Shenk, Kenny Rose, Mark Monaco, William Dennison, Jeremy Testa, Rich Batiuk, Zach Easton

Evolution Opportunities



Basic premise to “Tiered TMDL”

CESR Finding: 100% achievement of Bay WQ standards is distant & uncertain

CESR Implication: One option was to consider “tiered TMDL” that prioritizes implementation across space and time to maximize living resource response (CESR, pp. 82-83) --- e.g. “provide the most potential lift to living resources while working toward the final TMDL goal”

Response to date: Overwhelmingly positive, but questions arose about “how” to implement (B25).



Brief Refresher on Bay Water Quality Standards

Designated Use: Support of Aquatic Life (Living Resources)

Numeric Criteria

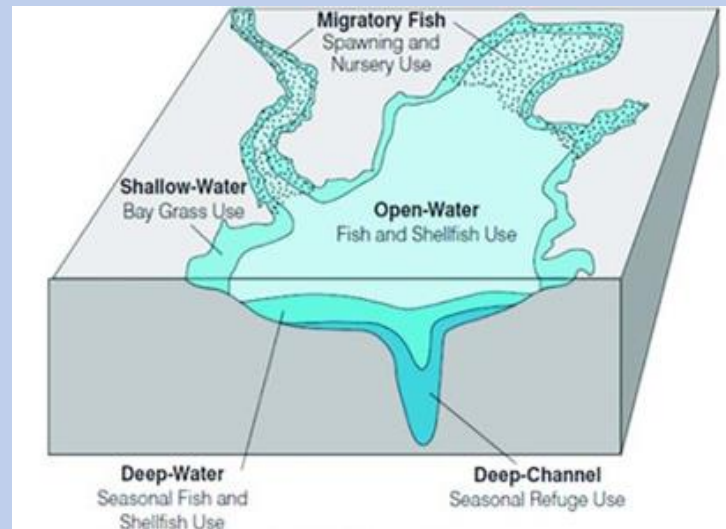
Dissolved Oxygen (DO)
(30 day avg, 7 day avg,
instantaneous):

Water Clarity/Aquatic
Vegetation

Chlorophyll a

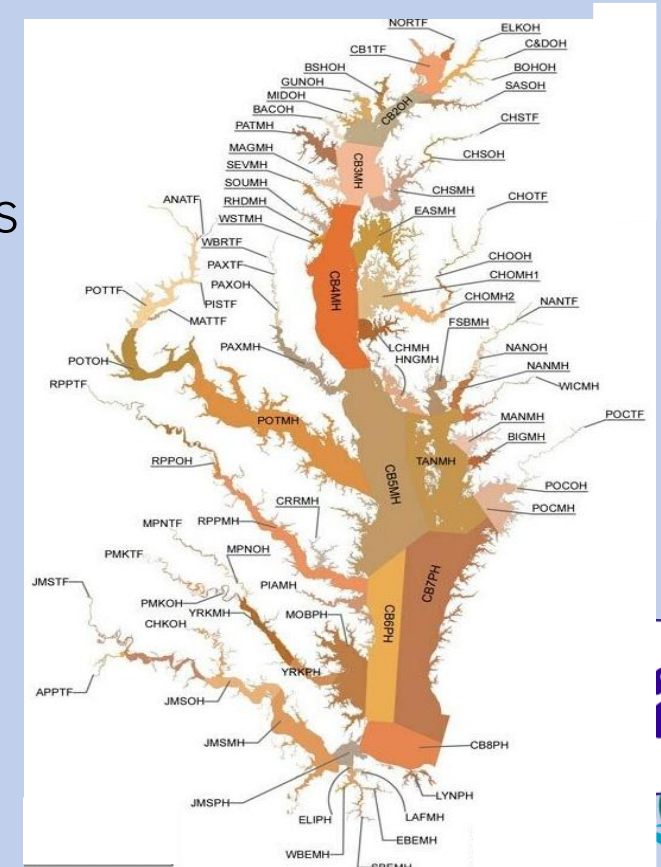
within

5 Bay habitats



across

92 "segments"



Definition

A tiered approach to TMDL implementation establishes staggered timelines, with interim goals that prioritize pollutant load reductions to local (segment/habitat) regions of the Bay that can provide the greatest anticipated benefit to living resources



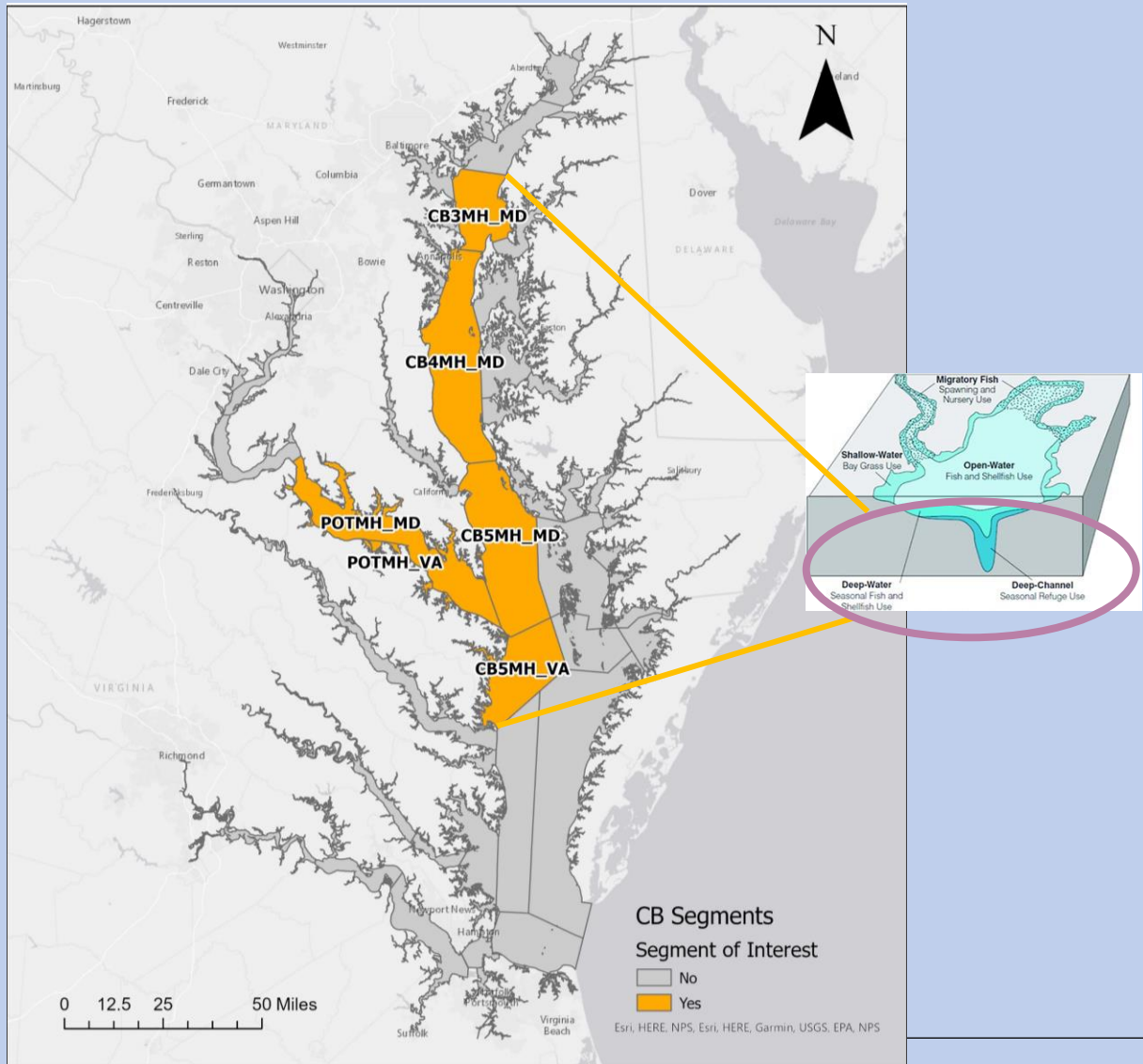
Approaches to Implementing the Chesapeake Bay TMDL

Table 1: Approaches to Implementing the Chesapeake Bay TMDL

	Tiered Approach	Conventional Approach
Planning priorities for nutrient reduction	Local areas for living resource benefit	Deep channel dissolved oxygen in the mainstem of the Bay
What type of implementation?	Water quality + other habitat factors	Water quality
What is the implementation horizon?	10-15 yrs for interim goals	10-15 yrs for final TMDL target
What are final TMDL nutrient and sediment targets?	Same	Same
What are TMDL permittee obligations?	Same	Same



Existing Approach to TMDL Implementation



Temporal:

15-year deadline (with milestones)

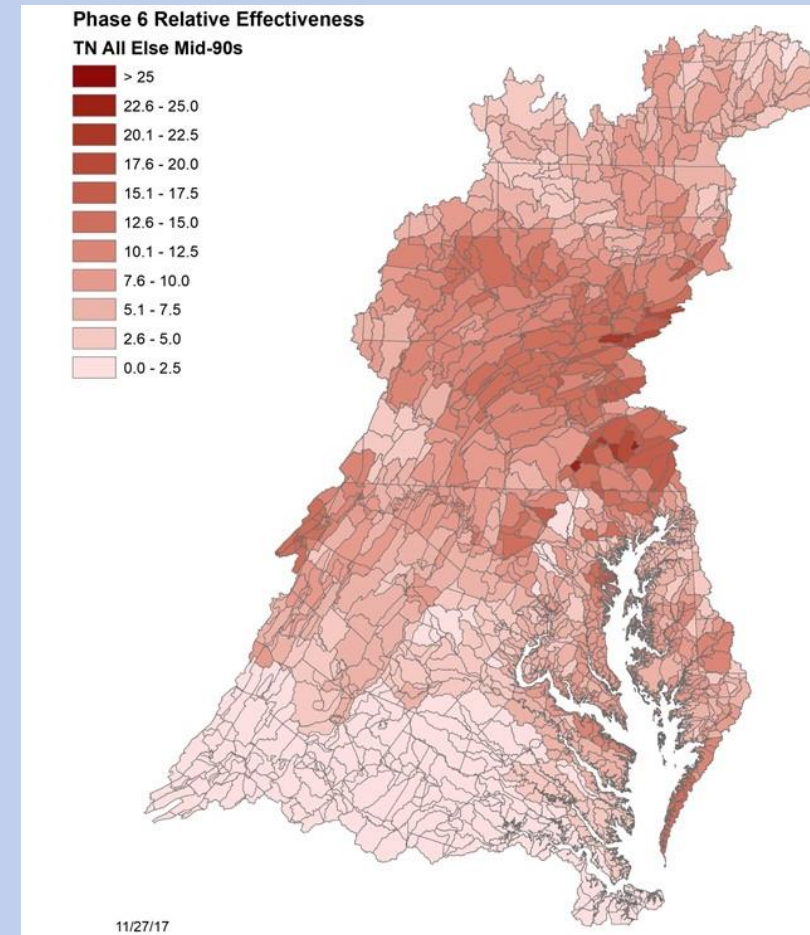
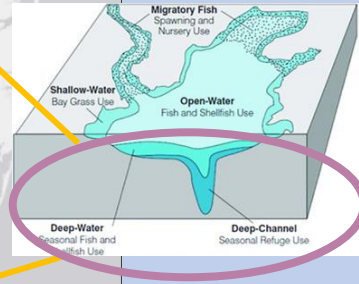
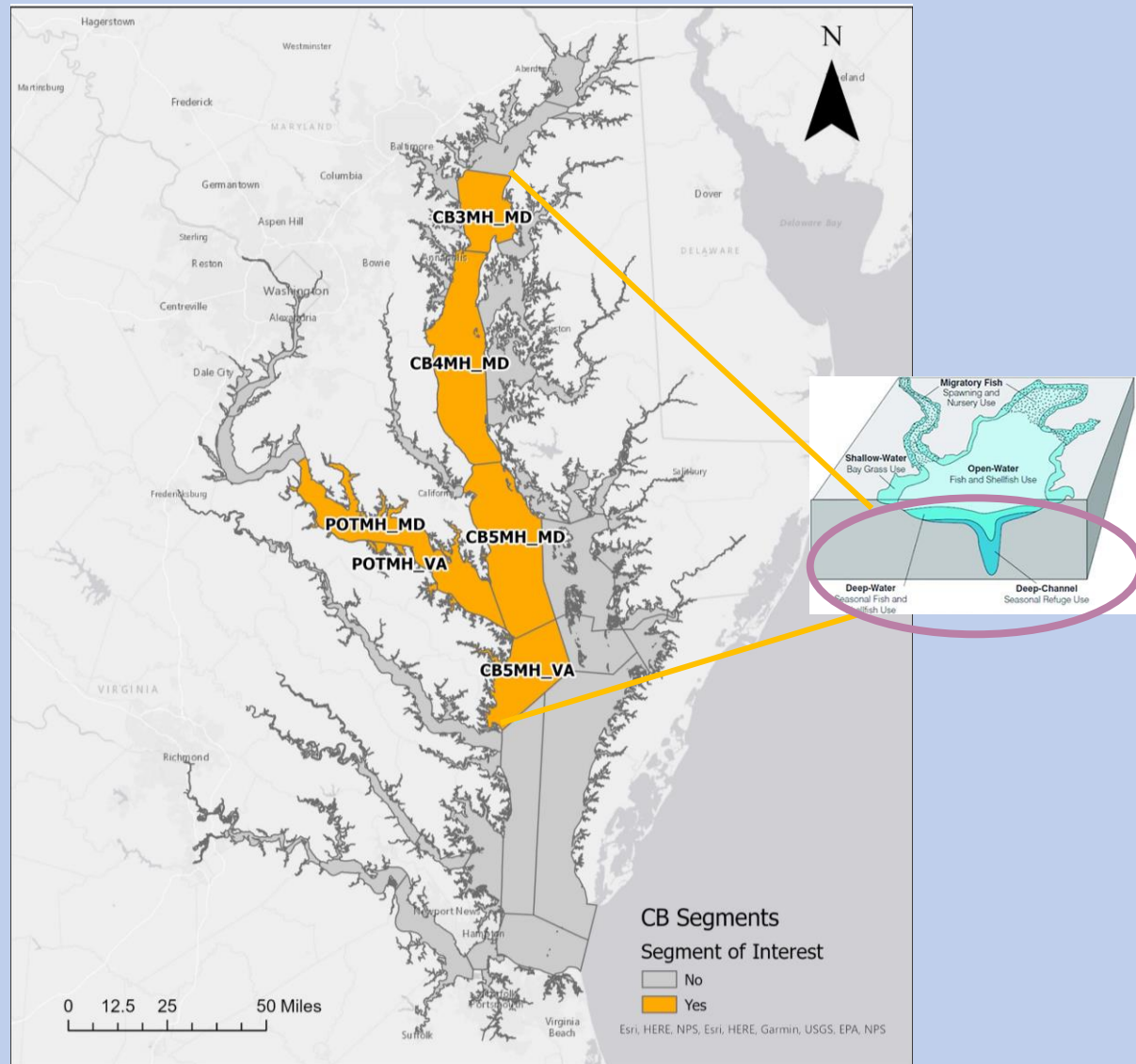
Spatial:

Nutrient load targets set to 100% WQS, focus on most challenging to achieve: DO criteria in deep water habitats in 4 segments (orange, left).

Nutrient effectiveness across watershed set based on DO impact in these areas

Existing Approach to TMDL Implementation

Estimated effectiveness of N reductions on deep water main channel segments



Tiering TMDL Implementation

Chesapeake Bay Priority Living Resource Areas

Using GIS to Identify Habitat Hot Spots



We direct the Chesapeake Bay Program to ... conduct an analysis and prepare a protocol ... to determine whether nutrient goals and reduction efforts can be further targeted to areas of persistent high loadings, especially where evidence indicates a linkage to critical living resources or human health concerns.
Chesapeake Executive Council,
Directive 97-1

Water Column Species

- American Shad
Alosa sapidissima
- Atlantic Menhaden
Brevoortia tyrannus
- Bay Anchovy
Anchoa mitchilli
- Striped Bass
Morone saxatilis
- White Perch
Morone americana
- Alewife
Alosa pseudoharengus
- Hickory Shad
Alosa mediocristis
- Yellow Perch
Perca flavescens
- Blueback Herring
Alosa aestivalis
- Chain Pickerel
Esox niger
- Largemouth Bass
Micropterus salmoides

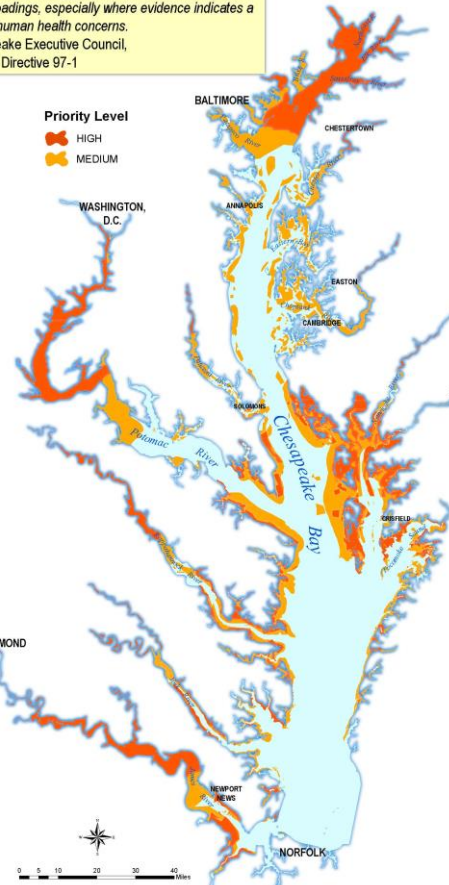


Methodology

The Chesapeake Bay Program's target species listed in *Habitat Requirements for Chesapeake Bay Living Resources*, Second Edition which had habitat requirements that could be directly affected by nutrient over enrichment (e.g., dissolved oxygen) or sediments (e.g., light penetration) were arrayed by water column and bottom as their principal habitats. These included all the fish and shellfish species in that document, with several fish species and related layers added for which we had new potential habitat information. Priority areas for Submerged Aquatic Vegetation (SAV) were considered separately.

In the case of species with potential habitat distribution maps for multiple life stages, composite maps were produced by combining the individual GIS layers for each life stage. For species with separate spring and summer potential habitat distributions, a composite map was produced reflecting the combined extent of seasonal-based habitats.

Keeping the water column and bottom species separate at the beginning, the composite maps for each of the 11 species were overlaid. Each species' potential habitat was weighted equally as there was no straightforward justification for applying a weighting scheme.



Priority Level
 HIGH
 MEDIUM

CREDITS:
Map and Analysis:
 John Wolf, National Park Service
 Chesapeake Bay Program Office
 610 Green Ave., Suite 100
 Annapolis, Maryland 21403
 Pat Hodder
 Location Age, LLC
 Washington, DC
Composite PLRA maps derived from data from the following sources:
 Funtunba, S. L., J. A. Mahrholz, S. J. Jordan, and D. Riley (eds), 1992. *Habitat Requirements for Chesapeake Bay Living Resources*. Second Edition.
 Safety range data interpolated from 1985-1987 spring and summer Chesapeake Bay monitoring data.
 Potential aquatic habitat defined using modified Vohr grounds, Bayker grounds, water bare areas, and oyster structures.
 Tier II SAV areas (CBP and Virginia Institute for Marine Science)
Aquatic Resources Graphics:
 Symbols courtesy of the Integration and Application Network (an online web resource), University of Maryland Center for Environmental and Chesapeake Bay Program.

- ### SAV
- Submerged Aquatic Vegetation
- ### Bottom Species
- Atlantic Croaker
Micropogonias undulatus
 - Cattfish
 - Spot
Leiostomus xanthurus
 - Summer Flounder
Paralichthys dentatus
 - Blue Crab
Callinectes sapidus
 - Postlarval Blue Crab
Callinectes sapidus
 - Soft Shelled Clam
Mya arenaria
 - Hard Shelled Clam
Mercenaria mercenaria
 - Eastern Oyster
Crassostrea virginica
 - Atlantic Sturgeon
Acipenser oxyrinchus
 - Speckled Sea Trout
Cynoscion nebulosus

way. The team then visually examined the resultant map and drew polygons around the 14 areas—the designated draft **Priority Living Resource Areas**—that had the most extensive and contiguous high priority shading. The medium priority areas were included on the map because they were also important living resource habitats.

Priority areas for Submerged Aquatic Vegetation (SAV) were determined by the SAV Workgroup using the VIMS SAV aerial survey data base, examining changes in SAV area over 1992-1997, and SAV status as a percentage of Tier II area in 1997 by the 78 CBP segments. Changes over 1992-1997 were used because many SAV trends changed direction at about that time, and the more recent changes were of the greatest interest. Priority SAV areas were those segments that lost over 60 hectares of SAV from 1992 to 1997, and segments that had no SAV mapped in 1997. These layers were not combined with the fish and shellfish layers shown here because they were based on different data and used different spatial scales. They were visually compared to the Priority Living Resource Areas (PLRA) defined based on the fish and shellfish layers, and all of the SAV priority areas were also identified as PLRAs, with the exception of four small Maryland tributaries that lacked SAV in 1997 but were not identified as PLRAs (the Back, Rhode, West, and Pocomoke rivers).

With the water column and bottom habitat overlay maps still separate, team members looked for regions with clusters of common total numbers of target species habitats overlaying each other that reflected natural "break points" between otherwise contiguous geographical concentrations. The team assigned specific range designations (and, therefore, different colors) for the respective polygons that fell within the following ranges: areas with 9-11 species were assigned as high priority for both water column and bottom overlay maps with area containing 7-8 species and 8 species, respectively, designated as medium priority in the water column and bottom overlay maps. Areas with less than these total number species overlaid dropped out.

Then the water column and bottom habitat maps were themselves overlaid to produce the draft **Priority Living Resources Areas** map. The high priority areas for both water column and bottom were combined so that an area was shaded as high priority if it appeared in either layer; the two medium priority layers were combined the same

Temporal
 Intermediate goal: 10-15 years

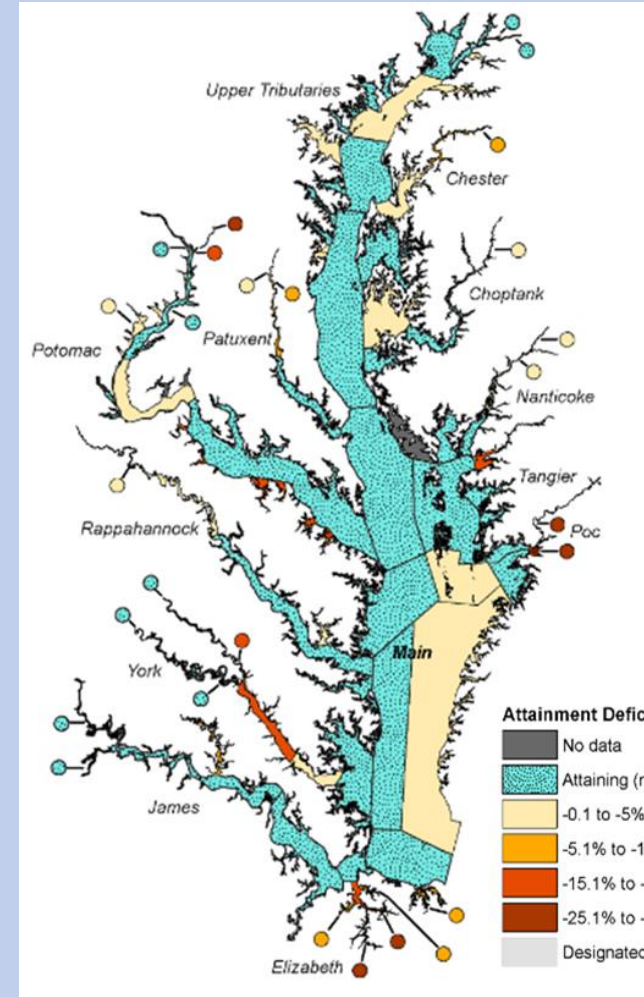
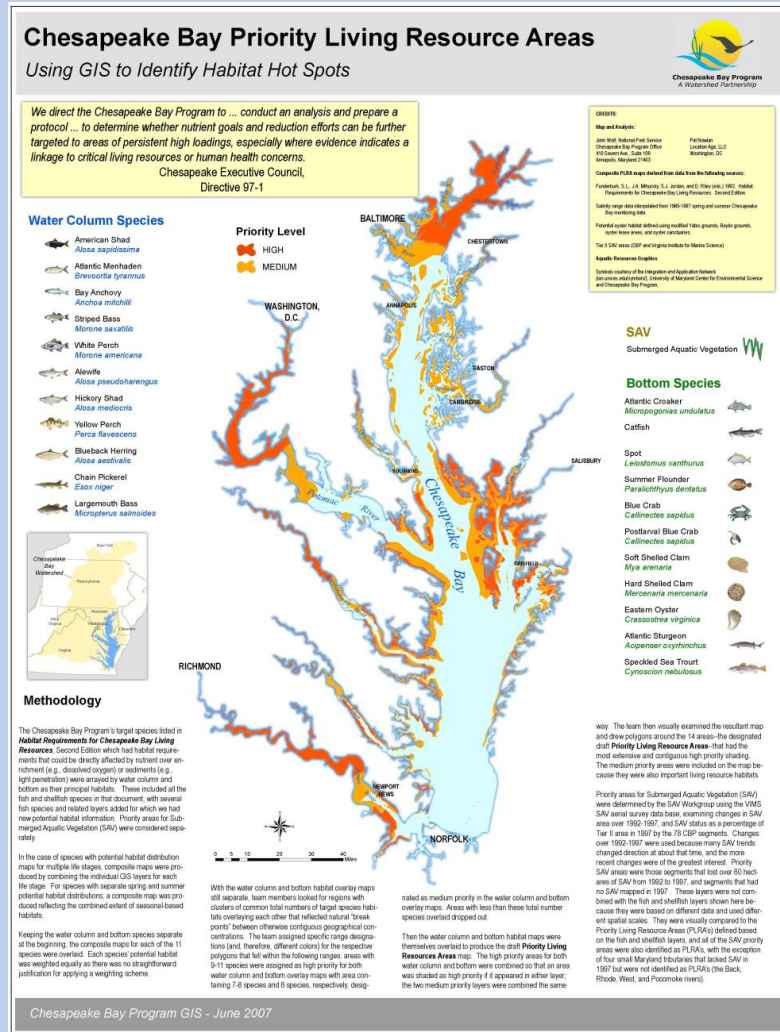
Spatial:
 Establish interim nutrient and sediment targets based on places where water quality is factor for living resource potential (red & orange, left), while acknowledging:

- interdependence across areas (including progress in main channel);
- importance of local, non-WQ living resource factors/stressors.

Tiering TMDL Implementation: Where can WQ improvements improve living resource habitats

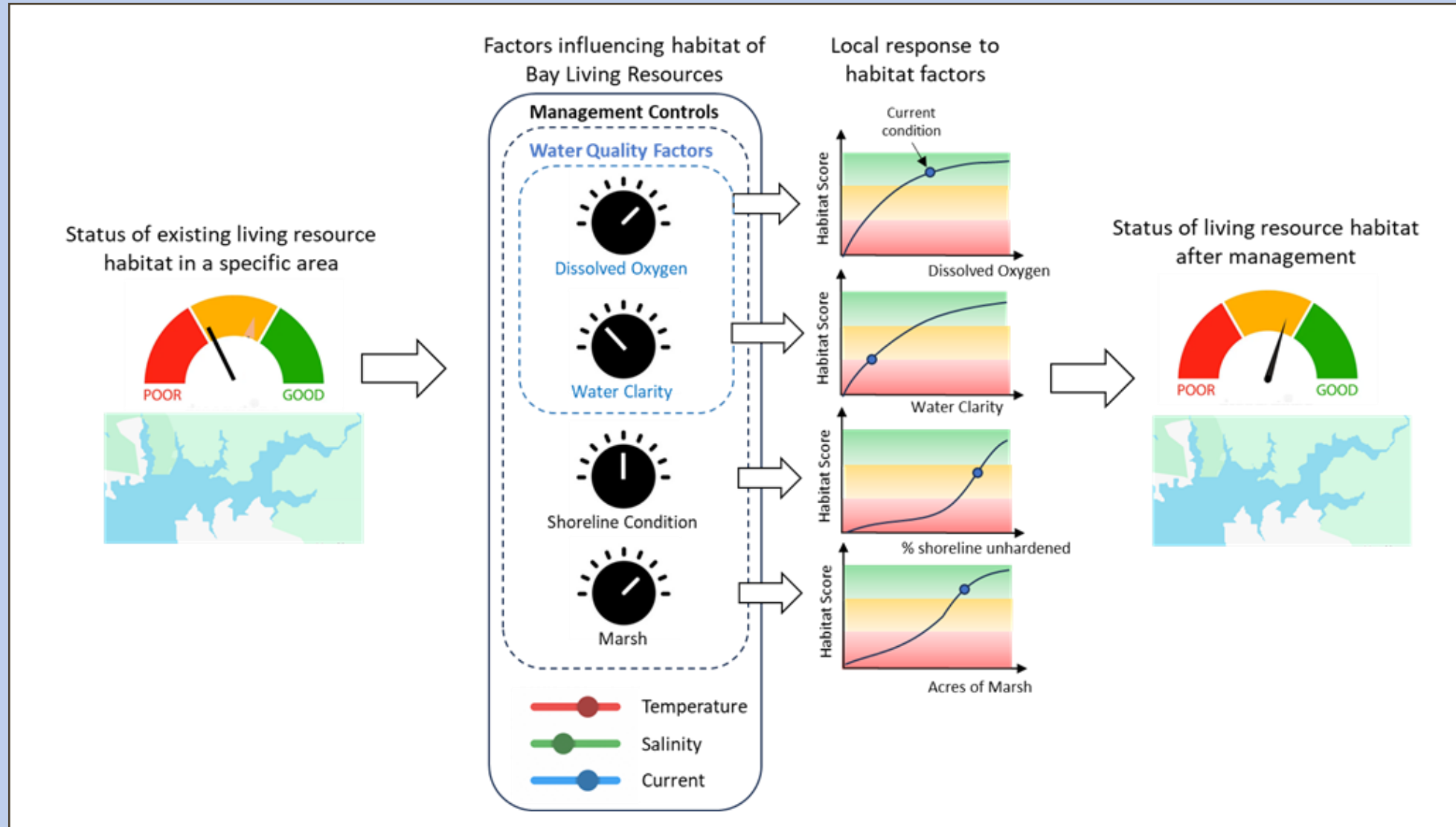
Critical Habitats

Water quality conditions in those habitats
(ex open water DO)



Open Water DO Attainment Status, 2014-16
(Source: Zhang et al. 2018)

Assessing local water quality, stressor, and habitat conditions



Tiered approach will require different approaches to planning and scientific/technical analysis



Panel A: Tiered Implementation of Bay TMDL



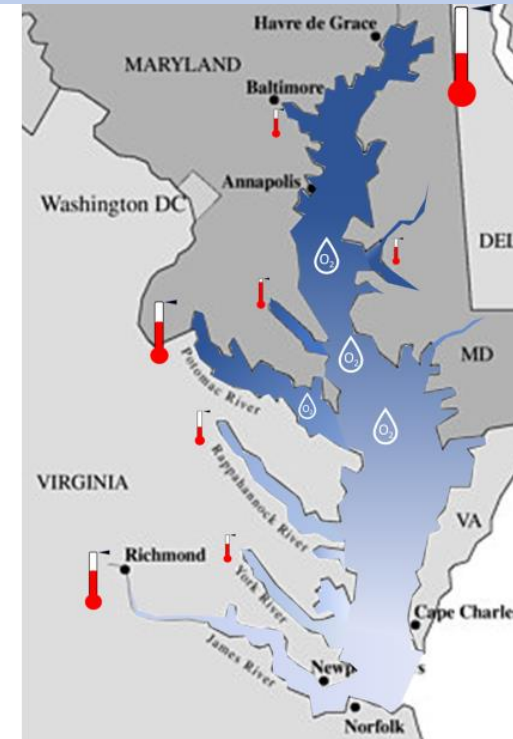
Identify areas where water quality (DO, water clarity) improvements can improve high priority living resource habitats



Identify influence of upstream N, P or sediment on local water quality



Set interim nutrient & sediment targets to achieve water quality improvements in priority areas. Interim limits are also progress toward final targets (Panel B).



Panel B: Conventional Implementation of Bay TMDL



Identify areas that will be necessary for full attainment of water quality criteria (DO in deep water habitats in main channel)



Identify influence of upstream N, P or sediment on main channel deep water dissolved oxygen



Set nutrient & sediment targets that fully attain water quality standards.

From Concept to Implementation

1. Conduct habitat suitability analysis
2. Assess living resource habitat improvement potential of various segment/habitat combinations (dials) (local conditions to response to stressors reductions)
3. Identify relative contribution of upstream and estuarine N, P and sediment on segment-habitat nutrient levels
4. Set interim N, P, and S targets based on 1-3 (policy decision).
5. A future WIP planning process that includes consideration of other factors that impact living resource habitat and that includes incentives to adapt to observable outcomes (stressor-response)

