Chesapeake Bay Oyster Restoration: The USACE Perspective- Past, Present, and Future

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USACE- Baltimore

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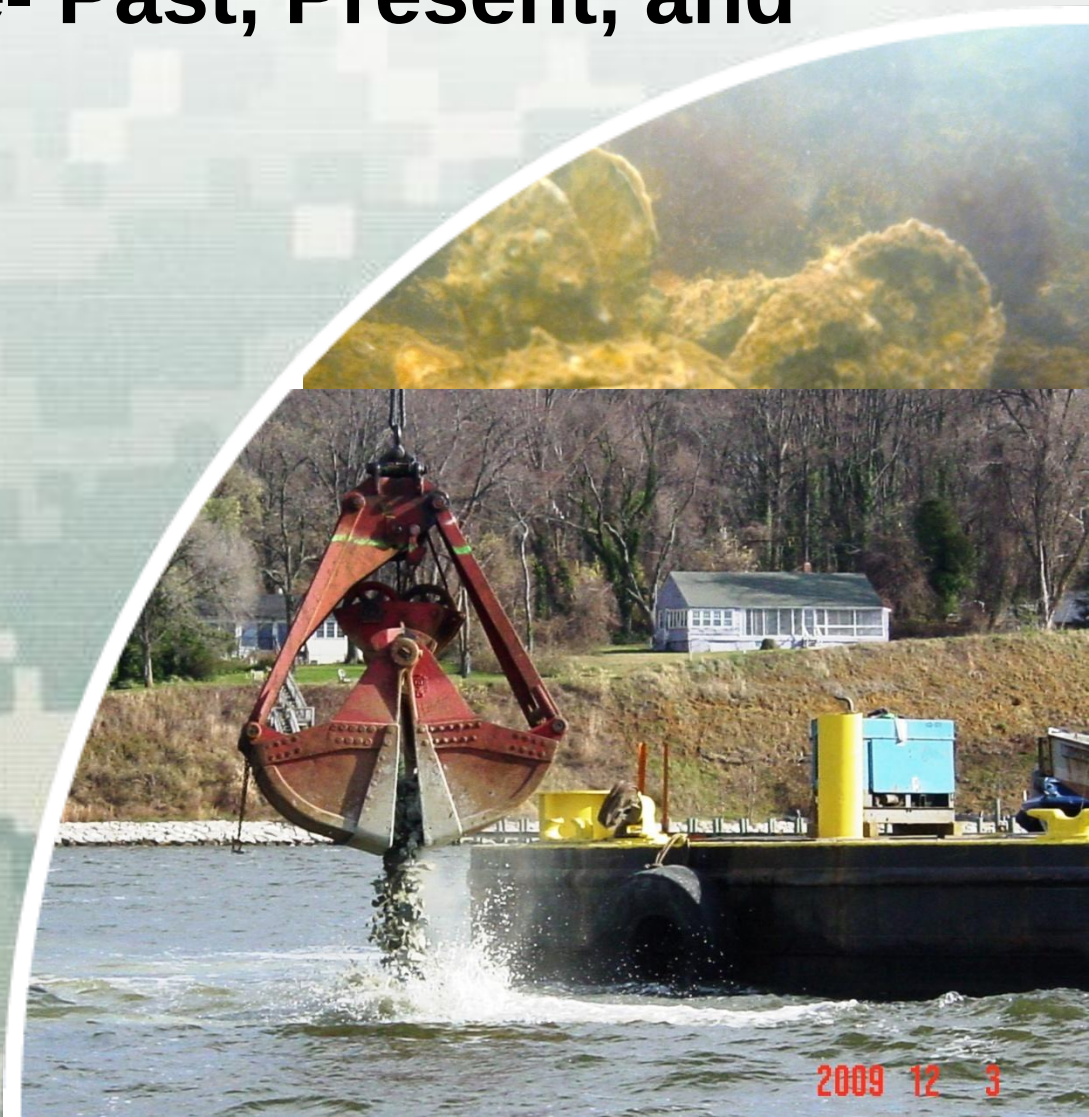

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Presentation Outline

- USACE's Oyster Restoration Program
  - Authority
  - Program History
  - Lessons Learned and Observations
- Native Oyster Restoration Master Plan
  - Purpose
  - Key Technical Issues Addressed
  - Plan Formulation
- Future of the USACE Oyster Restoration Program

USACE Oyster Restoration Program

- Program was established in Section 704(b) of the Water Resources Development Act of 1986
  - "…the construction of a reef for fish habitat in the Chesapeake Bay in Maryland"
  - Established project cost-sharing as 75% Federal, 25% non-Federal
  - Project construction up to $5 million Federal

- Amended in 1996, 2000, 2002, 2006, and 2007
  - Added Virginia to project location
  - Increased authorization limit to $50 million
  - Identifies specific type of construction activities (hatcheries, use of alternative substrate, etc.)
  - Purpose of restoration = establishing sanctuaries and harvest management areas
  - USACE activities to be consistent with other plans and strategies

USACE Oyster Restoration Program History

- FY1995 – First year of funding
- May 1996 – Technical report completed
- Construction summary, 1997-2010, for MD:
  - 450 acres of substrate placed
  - Locations: Magothy, Severn, and Patuxent Rivers
    Chester and Choptank Rivers, Eastern Bay
    Kedges Strait
  - Material used: Dredged fossil shell,1997-2006
    Alternative substrate, 2009-2010
  - Periodic project monitoring

- Construction summary, 2001-2010, for VA:
  - 389 acres of substrate (dredged fossil shell) placed
  - Locations: Tangier and Pocomoke Sounds
    Great Wicomico and Lynnhaven Rivers

Restoration Focus

Baltimore District

Restoration Type	Acres
Sanctuary (1999-2009)	**202 (45%)**
Fishery-oriented	**249 (55%)**
Unofficial Reserve (1997-2001)	29
Harvest Reserve (2002-2006)	152
Seed Bar (1997-1999)	68
TOTAL	451

Norfolk District

Restoration Type	Acres
Sanctuary (1999-2009)	**149 (38%)**
Fishery-oriented	**240 (62%)**
TOTAL	389

Partners in Restoration

Oyster Recovery Partnership
ORP

Activity (3)	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
	Site Selection	Bottom Survey	Reef Construction	Ground Truth	Produce & Plant Oysters	Post Planting Monitoring
Partners / Roles	Project Coordination - ORP					
	All	NOAA, MGS ($) DNR, NOAA	Watermen, Corporation ($) NOAA, USACE, DNR	UMD, ORP ($) NOAA	UMCES, ORP (1)(2) ($) DNR, UMCES, NOAA	UMD, DNR, Morgan, USNA ($) NOAA, DNR, USACE
	Enforcement & Management Agency – NRP / DNR					
	Permits / Regulations – USACE Regulatory / DNR / MDE					
	Data Collection & Management – DNR / ORP / NOAA					

Notes: (1) In 2009, DNR (Piney Point), Morgan State, ORP & watermen conducting remote setting pilot projects; (2) Based on salinity regimes, oyster reefs may only receive shell rehabilitation (no spat) in higher salinity waters where a natural spat set could occur; (3) For aquaculture projects, watermen to be trained on all steps with guidance and technical support by partners; the steps may be modified to minimize watermen costs.

State Agency, Non-Profit, Federal Agency, University, Corporation

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	Site Selection	Bottom Survey	Reef Construction	Ground Truth	Produce & Plant Oysters	Post Planting Monitoring
Partners / Roles	Project Coordination - **ORP**					
	All	**NOAA, USACE** **($) USACE, NOAA**	**Private Contractor** **($) NOAA, USACE, VMRC**	**VIMS** **($) NOAA**	**Private Leaseholders, Watermen** **($) VMRC, USACE, NOAA**	**VIMS, USACE** **($) NOAA, VMRC, USACE**
	Enforcement & Management Agency – **VMRC**					
	Permits / Regulations – **USACE Regulatory / VMRC**					
	Data Collection & Management – **VIMS / USACE / NOAA**					

Notes: (1) Private individuals/companies have provided spat-on-shell for USACE projects; (2) Private leaseholders shell their leased areas, then sell wild spat-on-shell to Virginia for USACE projects.

State Agency, Non-Profit, Federal Agency, University, Corporation

Lessons Learned and Important Observations- Restoration

- Hatchery production has been developed substantially
- Illegal harvesting (poaching) is a critical threat- believed to have occurred on all MD restored sanctuaries
- Scale: past restoration efforts have been too small and scattered
    - ecosystem restoration efforts have focused on approximately 1% of Baylor grounds (VA) and 1.6% of Yates bars (MD) (ORET 2009)
    - past efforts insufficient to impact system\
- Restored reefs create a unique and ecologically valuable reef structure used by a diverse group of organisms (Rodney and Paynter 2006)

Lessons Learned and Observations- Construction and Design

- Early coordination of sites needed
  - Other fishery uses reduce potential restoration areas
- Spat planting density
  - High mortality (~50%) during first year
- Bar height is important to success
- Sedimentation rates are highly variable spatially
- Local infection levels drive disease
  - Bar cleaning to minimize disease showed limited value
  - Use disease free spat-on-shell; do not transplant wild oysters to low disease from high disease areas
- Predation is a concern in high salinity waters
- DO: limit construction to < 20 ft water depth
  - suspected cause of low growth and mortality in certain areas

Native Oyster Restoration Master Plan

- Goal:
  - *Long-term restoration goal:* Throughout the Chesapeake Bay, restore an abundant, self-sustaining oyster population that performs important ecological functions such as providing reef community habitat, nutrient cycling, spatial connectivity, and water filtration, among others, and contributes to an oyster fishery.
  - *Operational:* Identify tributaries/regions most likely to develop sustainable populations of oysters with the implementation of reef construction, seeding, and other oyster restoration activities.

Purpose

- The master plan will ensure that oyster restoration implemented by USACE is conducted in a logical, science-based, and cost-effective manner with the greatest potential for success in achieving the restoration goal.
- The master plan will present a strategic plan for pursuing long-term, wide-scale restoration throughout the Bay that complements the States' oyster restoration programs as well as other Bay-wide restoration efforts and future uses of the Chesapeake Bay.
- It will not define specific projects for specific locations.

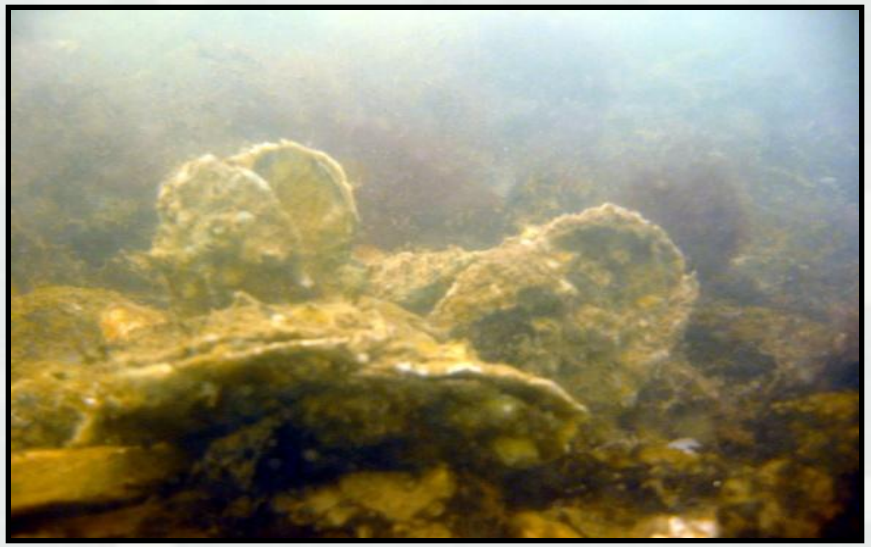
Plan Formulation

Answers Question: "Where (and at what scale) can restoration be accomplished considering physical and biological constraints, and what is the comparative effectiveness of each tributary to retain oyster larvae and become self-sustaining?"

1. Develop Formulation White Papers
2. Adopt salinity-zone, disease, and reproduction strategies
3. Identify distinct sub-segments of the Bay for evaluation and prioritization
4. Determine the appropriate scale at which restoration should be undertaken
5. Site evaluation and prioritization:
   - ► A layered formulation evaluation
   - ► Identify Tier I and II Bay segments

#1 Develop White Papers: Key Technical Issues Addressed

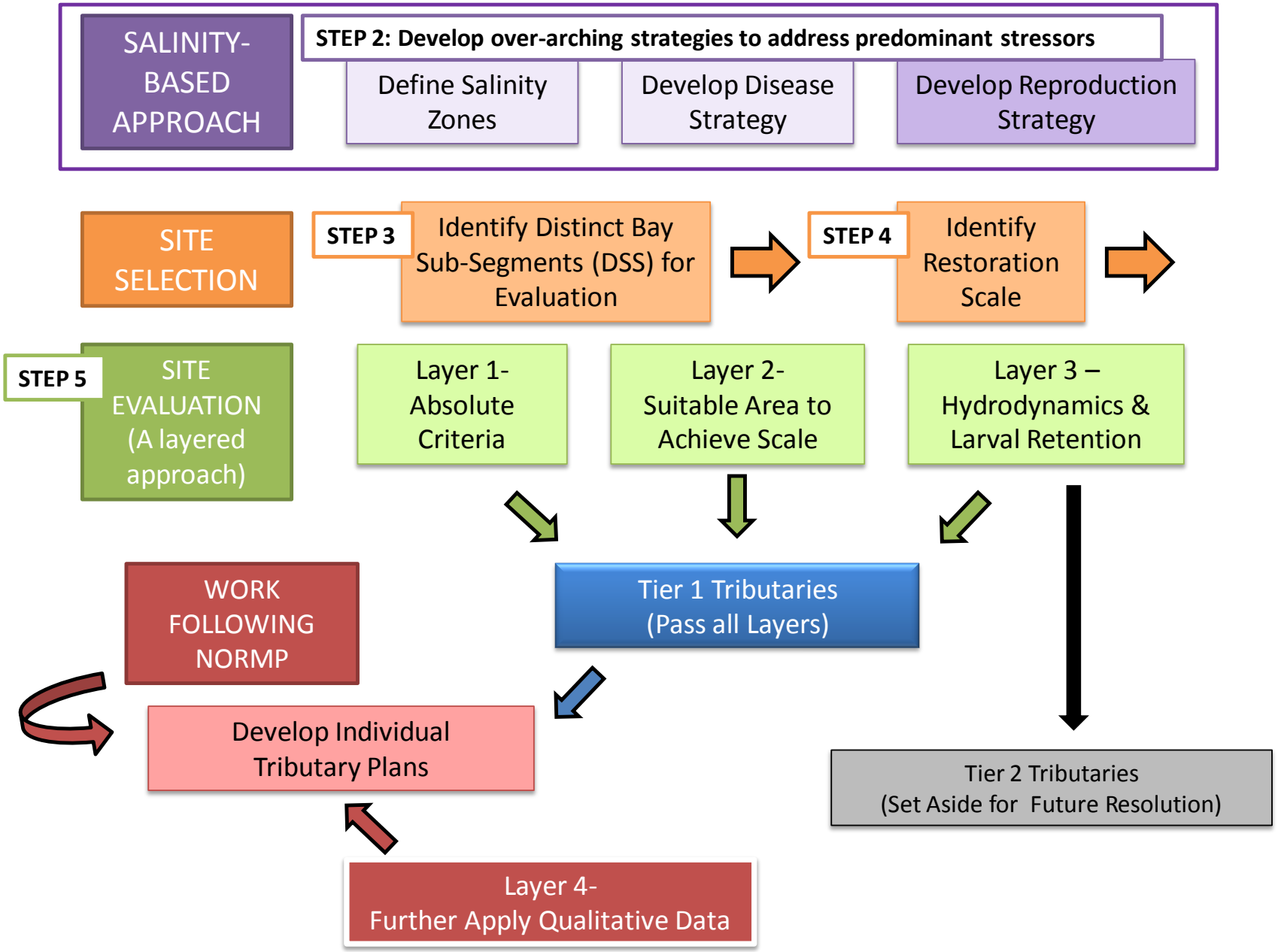
- Scale
- Disease
- Populations – bayscape setting
- Populations - individual reefs
- Physiochemical factors
- Hydrodynamics
- Reproduction

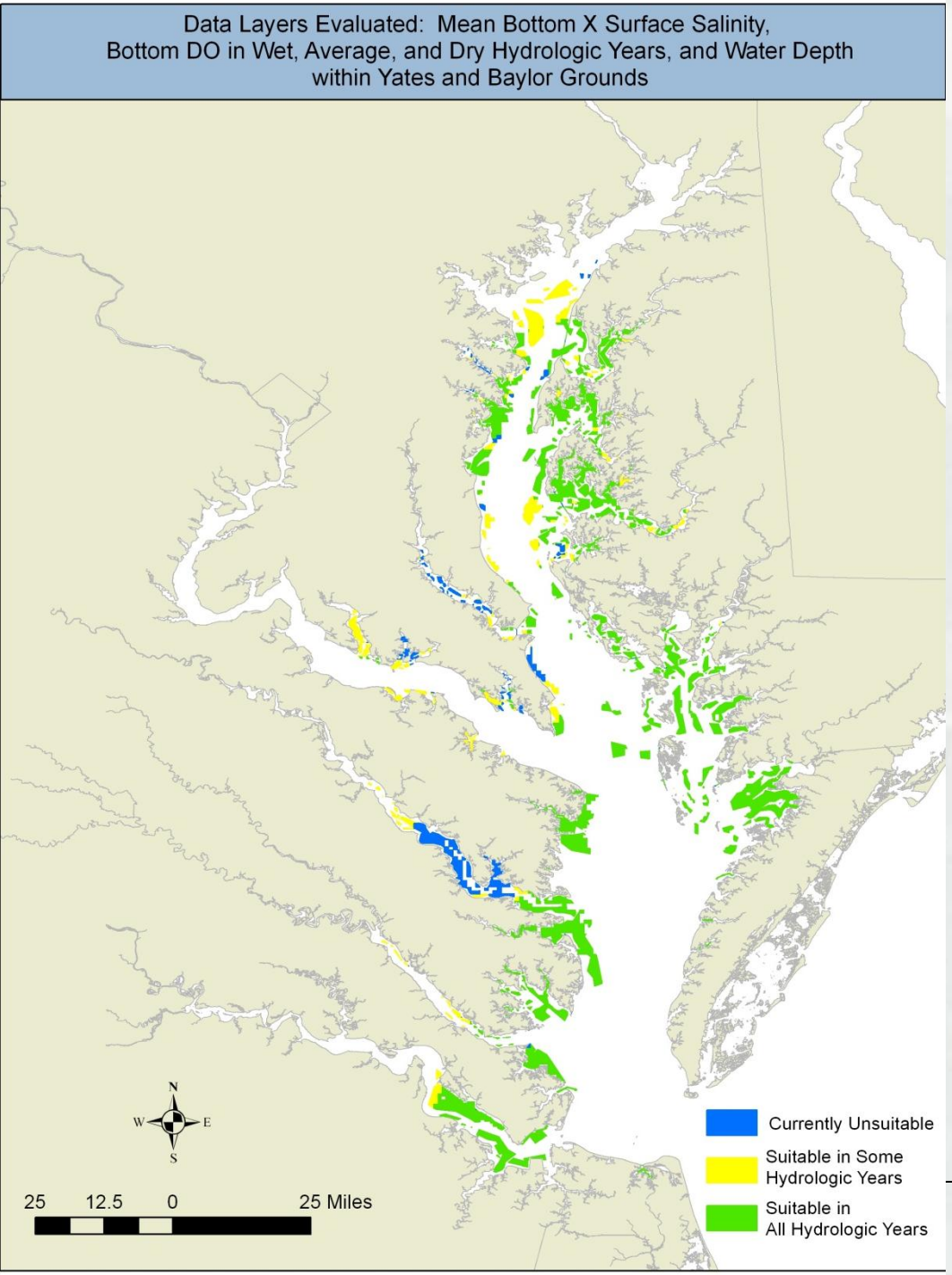


Significance to Oyster Restoration and Master Plan

Scientific Basis and State of Knowledge

Application to the Master Plan


SALINITY-BASED APPROACH
STEP 2: Develop over-arching strategies to address predominant stressors
Define Salinity Zones
Develop Disease Strategy
Develop Reproduction Strategy
SITE SELECTION
STEP 3
Identify Distinct Bay Sub-Segments (DSS) for Evaluation
STEP 4
Identify Restoration Scale
STEP 5
SITE EVALUATION (A layered approach)
Layer 1- Absolute Criteria
Layer 2- Suitable Area to Achieve Scale
Layer 3 – Hydrodynamics & Larval Retention
WORK FOLLOWING NORMP
Tier 1 Tributaries (Pass all Layers)
Develop Individual Tributary Plans
Tier 2 Tributaries (Set Aside for Future Resolution)
Layer 4- Further Apply Qualitative Data



Suitability Analysis Results

- Salinity
  - Surface
  - Bottom
- Bottom DO
- Water depth
- Yates/Baylor Grounds
- Total VA suitable area = 122,000 acres
- Total MD suitable area = 228,000 acres

What is the Future of USACE Program?

- Work with NOAA and other agencies on action plan for E.O. 13508 and specific tributary plans
- Incorporate external peer review into future USACE oyster restoration decision documents
- Analyze the environmental benefits of rotational harvest areas as well as the commercial benefits of sanctuaries
- For now, continue construction and monitoring as in the past
- Continue discussions to gain buy-in from partners so that shared resources can be used effectively
- Once master plan is approved, ecosystem restoration focus will be on tributary scale restoration
  - Expect each tributary restoration to take several years given restoration target
  - Sanctuary designations will need to be in place
  - Incorporate proactive adaptive management

THANK YOU FROM THE USACE MASTER PLAN TEAM

Claire O'Neill
Larry Oliver
Anna Compton
Jeff Strahan
Jen Armstrong
Susan Conner
Dave Schulte
Angie Sowers

(Craig Seltzer- retired)

Questions?

NORMP Plan Formulation

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EXTRA SLIDES- IF NEEDED DURING QUESTIONS

NORMP- Salinity Zone Strategy

OMP Salinity Zones (CBP 2004a)			
	Low (1)	Moderate (2)	High (3)
Salinity (ppt)	5 to 12	12 to 14	>14
Disease Pressure	Low	Moderate	High
Survival	Good	Moderate	Poor
Recruitment	Poor	Moderate	Good

Master Plan Salinity Zones		
Salinity (ppt)	Zone 1	Zone 2
	5 to 12	>12

- Due to scale of analysis and variability of salinity over timescales, combined three zones into two zones for analysis
- Plans will take into consideration that >8 ppt is needed for reproduction, but >5 ppt supports growth

Disease Strategy

- A network of permanent sanctuaries spanning salinity zones to develop population-level disease resistance (long-term)
- Focus initial efforts in retentive systems (trap estuaries where possible) to concentrate and magnify larval production
- Avoid domesticated oyster strains such as DEBY and CROSSBred for stock enhancement
- Use a rotating broodstock approach for hatchery production
- Plant sites with spat from disease-resistant parent stock either from hatcheries or obtained from the wild population

Disease Strategy (con't)

- Incorporate adult wild oyster broodstock that have survived disease into plantings
- Restrict movement of wild broodstock and spat-on-shell to areas with a similar or higher salinity regime
- Use "incubator reefs" (trap estuaries) to provide a seed source for restoration work
  - Transplant spat-on-shell produced on incubator reefs to restoration sites within the same or greater salinity

Reproduction Strategy

- Low to moderate salinity zones (<12 ppt salinity) – low and intermittent recruitment events, often separated by many years
  - Provide substrate as needed
  - Substrate should be stocked immediately following planting to avoid degradation
  - Monitor (pre- and post-construction) to assess natural recruitment, population, and condition, to determine the need for additional stocking
  - Monitor and, as needed, restock at same rate, 2 to 3 years following initial planting to provide a multi-age population

Reproduction Strategy (con't)

- High salinity zones (>12 ppt salinity) – higher, more consistent spat sets
  - Provide substrate as needed; where natural recruitment is sufficient, may not need seeding
  - Plant substrate immediately prior to spawning season
  - Stock and aggregate large natural oysters harvested from areas with demonstrated disease tolerance to enhance fertilization success
  - Monitor (pre- and post-construction) to assess natural recruitment, population, and condition, to determine the need for additional stocking
  - Where natural recruitment is not occurring and substrate degradation is occurring, consider adding new material and/or restocking

NORMP Plan Formulation – Stocking

- Stocking rate by salinity zone
  - Salinity influences fecundity and recruitment
    - Some high salinity reefs may not require stocking
    - Low salinity reefs projected to require multiple stocking events to establish multi-age population with male and females
    - Recommended planting density- 4 to 5 million spat per acre
  - Estimate the need to stock all low salinity reefs and 50% of high salinity reefs
  - Climatic events (freshets and droughts) may affect the frequency of restocking, which would affect cost

NORMP Plan Formulation

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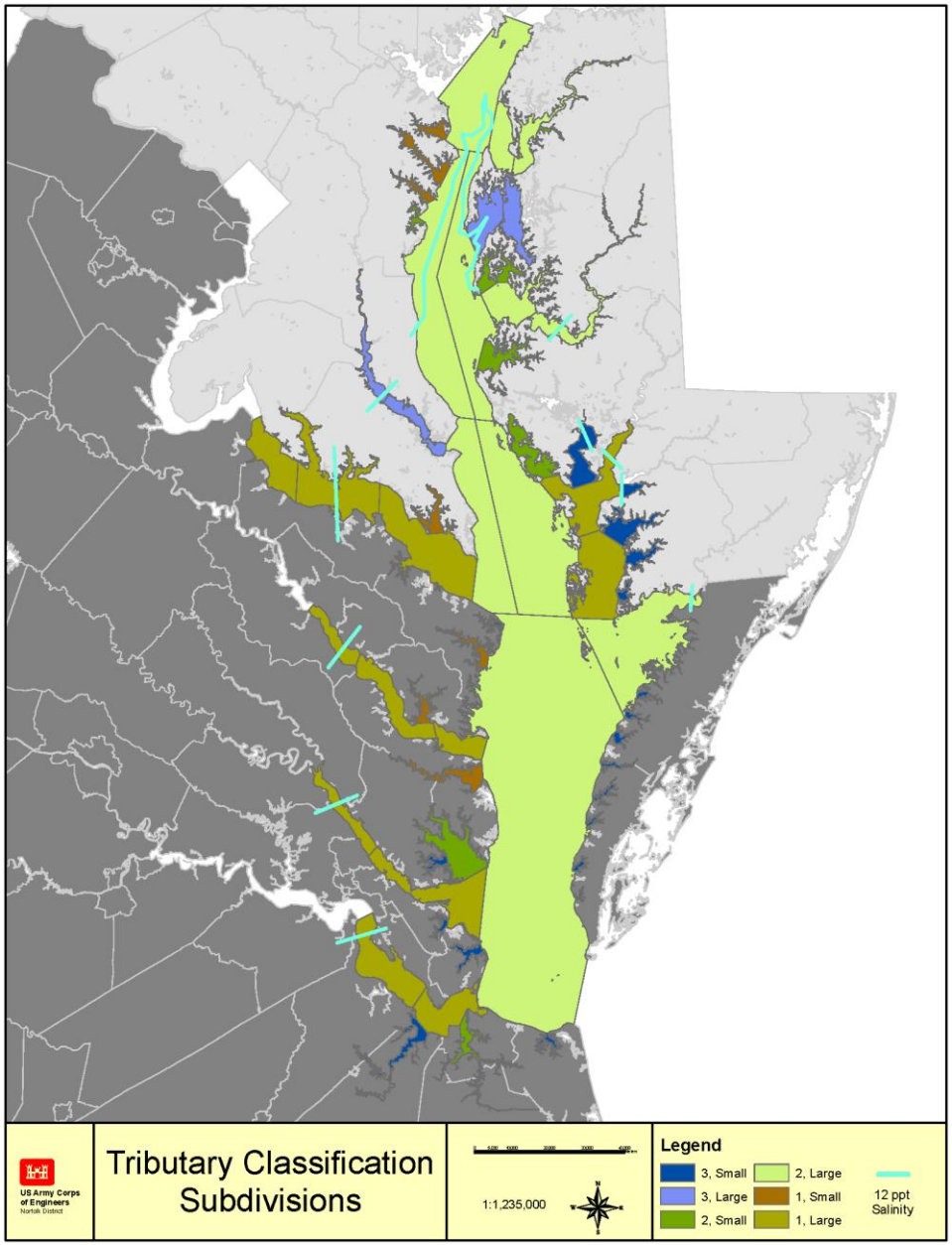

Distinct Sub-Segment Delineations

VA- 29 segments
MD- 34 segments

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NORMP – Scale Issue

- Scale for the master plan is defined as the approximate number of acres of habitat in a given distinct sub-segment required to develop a self-sustaining oyster population.

- How do we do this?
  - Step 1- Define historic habitat baseline
  - Step 2- Identify what percent of historic habitat needs to be restored to achieve goals

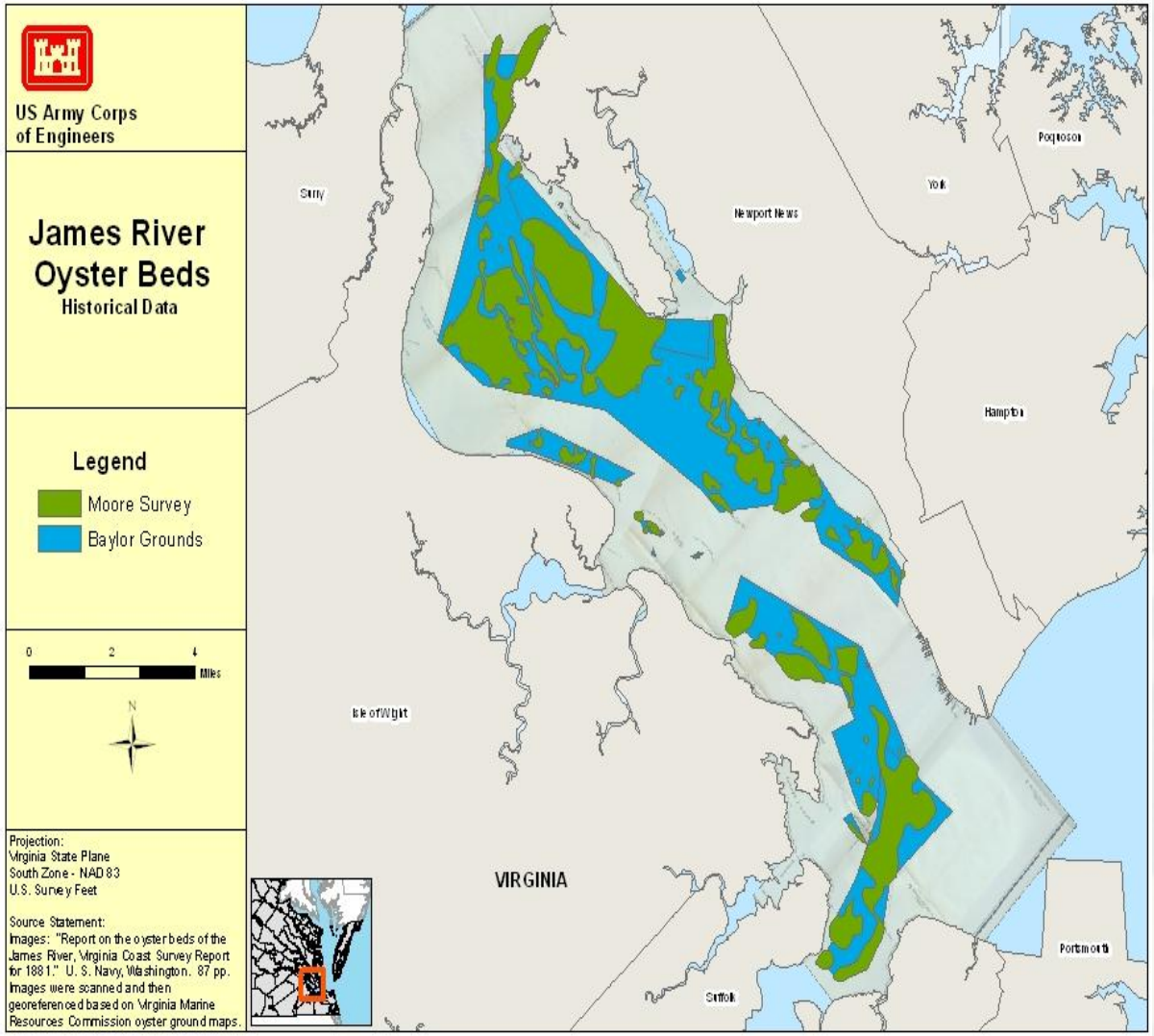
Scale- What do we know?

- Baylor (1894) and Yates (1906-1911) – the most comprehensive surveys of oyster grounds in VA and MD, respectively
- Based on ORET (2009), ecosystem restoration efforts have focused on approximately 1% of Baylor grounds (VA) and 1.6% of Yates bars (MD)
- Marine protected areas (MPA) typically protect 20 to 70% of habitat
- There are various descriptive accounts of historic oyster bar coverage, but no investigations into what acreage needs to be restored to recover sustainability
- Great Wicomico River project has restored approximately 40% of the original reef acreage in the tributary

Scale- Step 1: Historic Baseline

•Determine how much of ‘historic’ acreage was true oyster habitat.

•By comparing Baylor to Moore (1900) only 47% of the Baylor grounds contained oyster habitat



Scale

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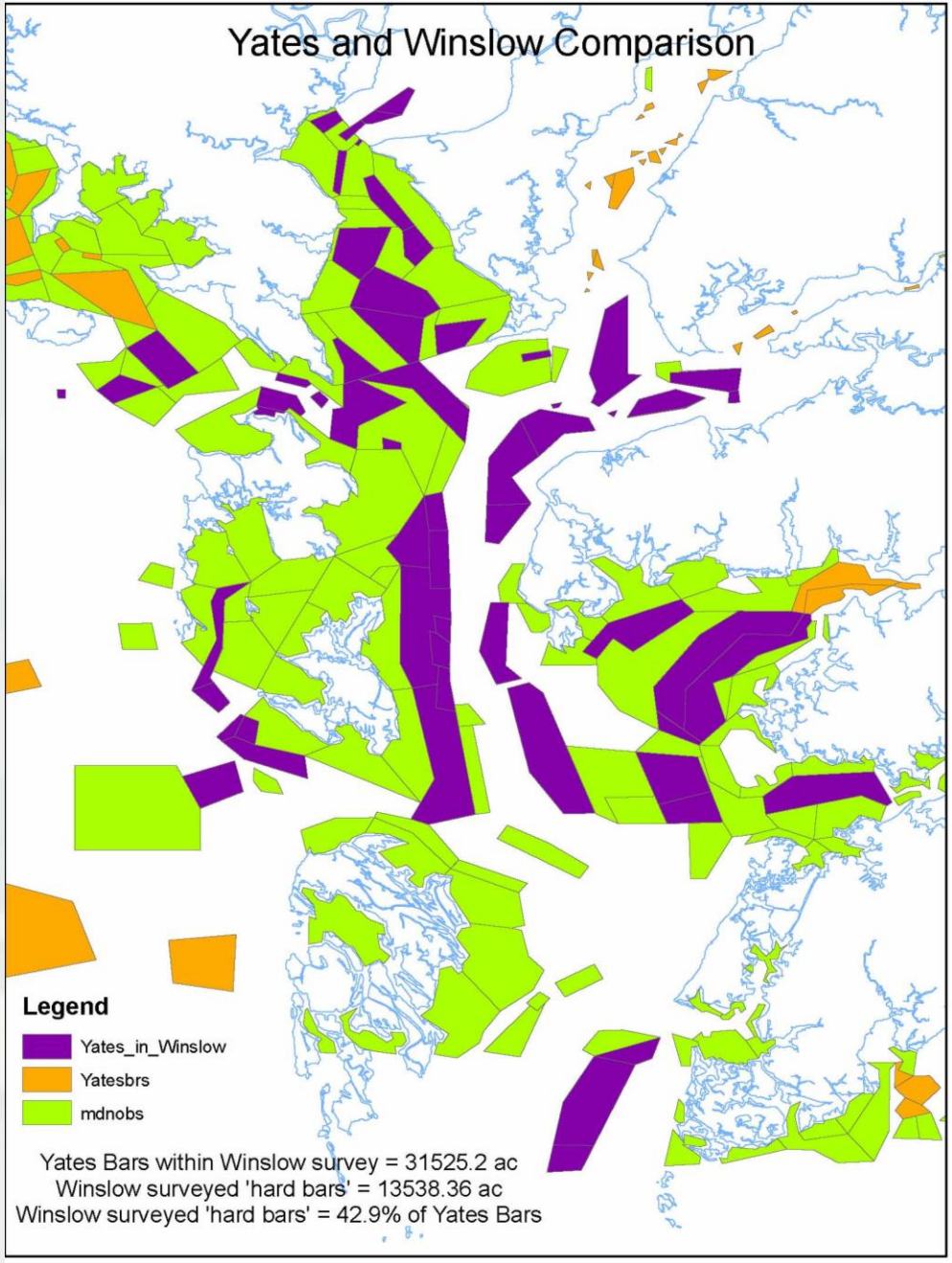
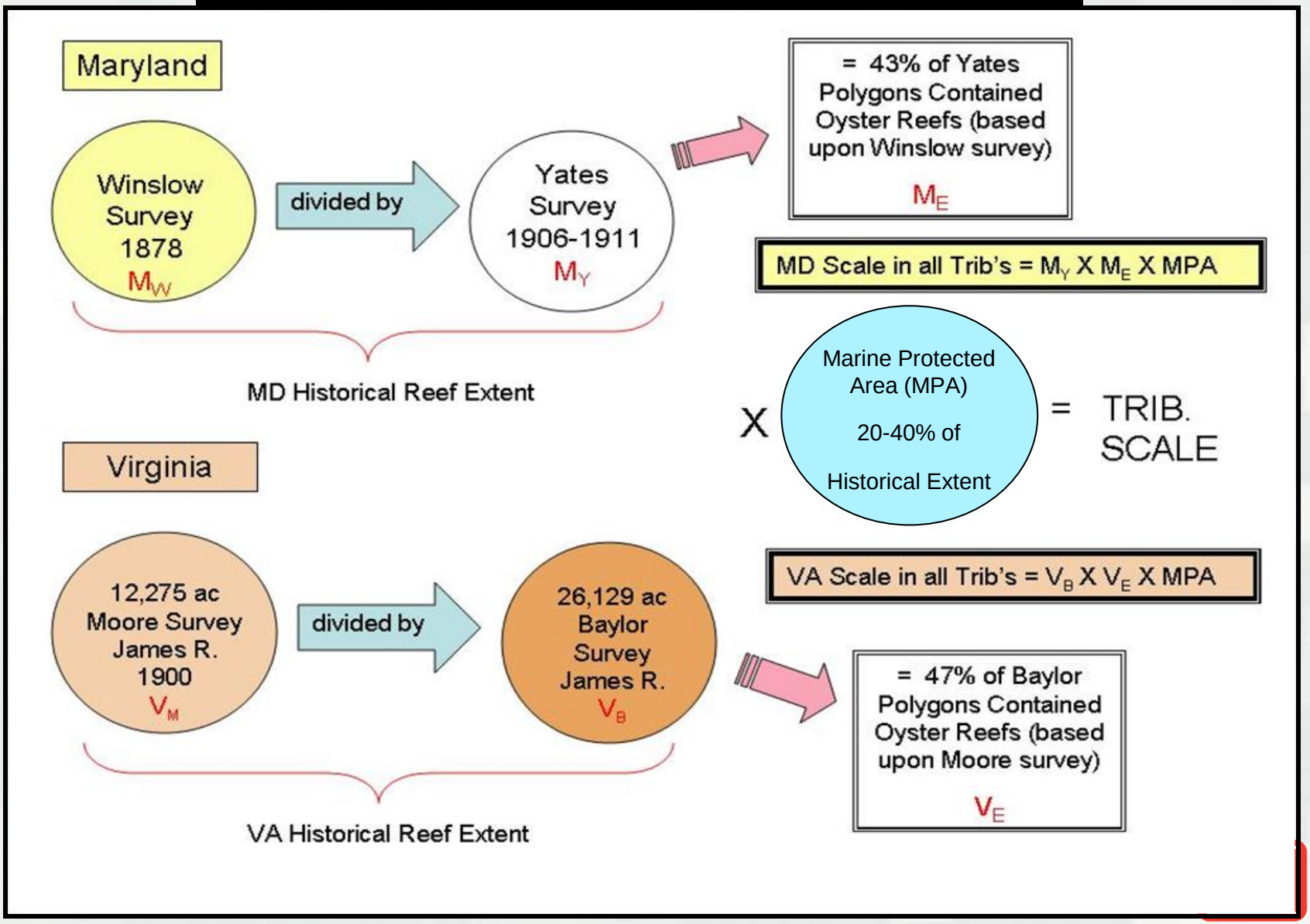
•By comparing Yates to Winslow (1881) only 43% of the Baylor grounds contained oyster habitat



Scale- Step 2: Identify restoration target

- No definitive information available
- A reasonable estimate is required to identify the relative scope and costs of the master plan:
  - Marine protected areas typically range from 20 to 70%
  - Large-scale sanctuaries will be needed
  - Great Wicomico only current example still thriving after 6 years
- Restoration goal = 20-40% of historic (corrected) habitat
  - Percentage is expected to vary in specific tributary plans
  - Historic reef extent is considered prior to application of 20-40%
  - Larger-scale reefs may be needed in lower salinity waters
  - Historic (corrected) habitat multiplied by 20-40% = restoration target = 8-16% of Yates/Baylor Grounds

Scale- Calculation Summary



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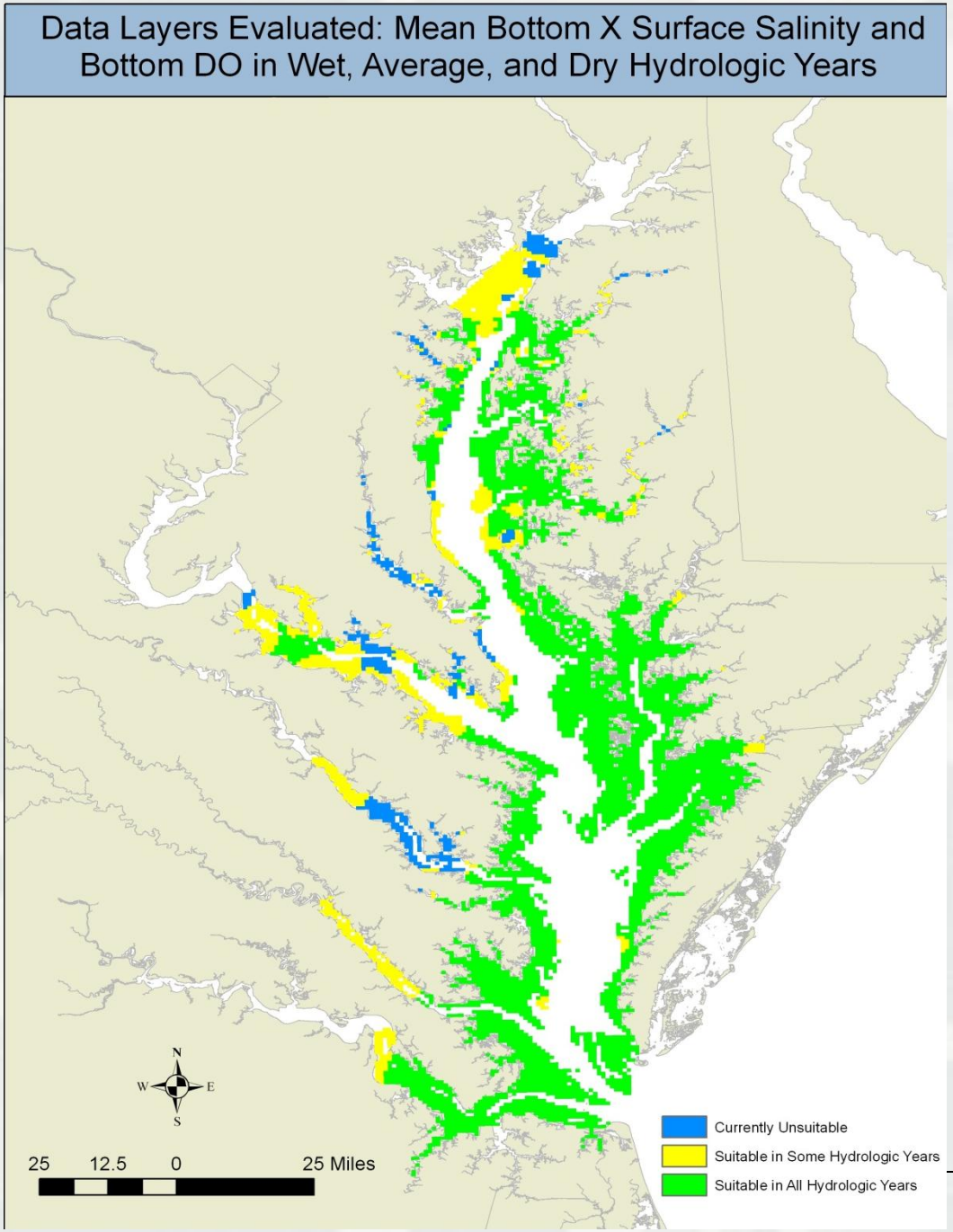
NORMP Plan Formulation – Tributary Prioritization

- Layer 1 – Evaluate the absolute criteria to determine which areas are capable of sustaining oyster populations
- Layer 2 – Determine if a distinct sub-segment (or tributary) has enough suitable area to achieve stated restoration goals (scale)
- Layer 3 – Evaluate hydrodynamics criteria (secondary criteria)
- Layer 4 – Consider qualitative data (tertiary criteria)

NORMP Plan Formulation – Tributary Prioritization

- Layer 1: Absolute criteria
  - Salinity >5 ppt
    - Average growing season (surface and bottom)
  - Average summer dissolved oxygen (DO) ≥5 mg/L
    - Reflects habitat quality and oyster survival
  - Water depth <20 feet
  - Historic upstream limit of oyster reefs
- GIS used to overlay data layers
- Considered wet (2003-2004), dry (2001-2002), and average rainfall years (2005-2006).
- Point data were gathered from the MDNR, MDE, Alliance for Chesapeake Bay, Virginia Department of Health/Division of Shellfish Sanitation, and the CBP.



Suitability Analysis Results

- Salinity
  - Surface
  - Bottom
- Bottom DO
- Water depth
- Total VA suitable area = 580,000 acres
- Total MD suitable area = 518,000

NORMP Plan Formulation – Tributary Prioritization

- Layer 2: Scale
  - Is there enough suitable area within the distinct sub-segment (or tributary) to meet the estimated restoration target?

NORMP Plan Formulation – Tributary Prioritization

- Layer 3: Hydrodynamics
  - Approach:
    - No comprehensive evaluation of hydrodynamics across the Chesapeake Bay
    - Approach- determine a qualitative hydrodynamic rating for each distinct sub-segment or tributary
  - Hydrodynamics issues addressed
    - Recognize importance of both retention and recruitment in re-establishing the oyster population
    - Factor recruitment into the hydrodynamic evaluation
    - Consider historic recruitment and salinity zone

NORMP Plan Formulation – Tributary Prioritization

- Hydrodynamic rating (qualitative) based on documented retention as well as modeling
  - Documented:
    - Scientific literature
    - Best bar identification by Maryland Department of Natural Resources
    - Historic spatset data
    - Current restoration activities
  - Modeled:
    - Larval transport modeling – self-recruitment metric of large tributaries
    - Larval transport modeling – self-recruitment of sub-basins
    - Small tributary flushing time and geomorphology
    - Larval transport modeling – particle accumulation zones

NORMP Plan Formulation – Tributary Prioritization

- Layer 4: Qualitative data (Tertiary criteria)

Criteria To Be Further Considered During Development of Specific Tributary Plans	
Physiochemical	freshets, local water quality (DO, salinity, temperature)
Physical	bottom that can support oysters; water flow; sedimentation
Biological	phytoplankton resources; harmful algal blooms; proximity, position, and quantity of existing broodstock populations
Regulatory	harvesting closure areas; sanctuary locations
Miscellaneous Considerations	watershed suitability; position relative to other estuarine habitats

NORMP vs. Other Recent Plans

- Consistency with other current plans
  - Overall NORMP goal consistent with other oyster plans
  - Plans considered:
    - Chesapeake Bay Program's 2004 Oyster Management Plan
    - Virginia Blue Ribbon Panel, 2007
    - Chesapeake Bay Action Plan
    - Maryland Oyster Advisory Commission, 2009
    - Executive Order 13508, "Strategy for Protecting and Restoring the Chesapeake Bay Watershed," May 2009
    - Maryland Oyster Restoration and Aquaculture Development Plan, December 2009
    - Final Programmatic EIS for Oyster Restoration in Chesapeake Bay, June 2009