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

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USACE- Baltimore
August 3, 2011
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

  - 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

<table>
<thead>
<tr>
<th>Restoration Type</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanctuary (1999-2009)</td>
<td>202 (45%)</td>
</tr>
<tr>
<td>Fishery-oriented</td>
<td>249 (55%)</td>
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<tr>
<td>Unofficial Reserve (1997-2001)</td>
<td>29</td>
</tr>
<tr>
<td>Harvest Reserve (2002-2006)</td>
<td>152</td>
</tr>
<tr>
<td>Seed Bar (1997-1999)</td>
<td>68</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>451</strong></td>
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</tbody>
</table>

### Norfolk District

<table>
<thead>
<tr>
<th>Restoration Type</th>
<th>Acres</th>
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</thead>
<tbody>
<tr>
<td>Sanctuary (1999-2009)</td>
<td>149 (38%)</td>
</tr>
<tr>
<td>Fishery-oriented</td>
<td>240 (62%)</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>389</strong></td>
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</table>
# Partners in Restoration

<table>
<thead>
<tr>
<th>Activity (3)</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Step 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site Selection</td>
<td>Bottom Survey</td>
<td>Reef Construction</td>
<td>Ground Truth</td>
<td>Produce &amp; Plant Oysters</td>
<td>Post Planting Monitoring</td>
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### Project Coordination - ORP

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>NOAA, MGS</td>
<td>Watermen, Corporation (NOAA, USACE, DNR)</td>
<td>UMD, ORP</td>
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<tr>
<td></td>
<td>($ DNR, NOAA)</td>
<td></td>
<td>UMCES, ORP (1)(2) ($ NOAA)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>UMD, DNR, Morgan, USNA</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>($ NOAA, DNR, USACE)</td>
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</tbody>
</table>

**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**
# Partners in Restoration

## Partners / Roles

**Project Coordination** - ORP

- **Site Selection**
  - All
  - NOAA, USACE
  - ($) USACE, NOAA

- **Bottom Survey**
  - Private Contractor
  - NOAA, USACE, VMRC

- **Reef Construction**
  - VIMS

- **Ground Truth**
  - NOAA

- **Produce & Plant Oysters**
  - Private Leaseholders, Watermen
  - VMRC, USACE, NOAA

- **Post Planting Monitoring**
  - 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**

[Building Strong Logo]
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
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  Jen Armstrong
Larry Oliver  Susan Conner
Anna Compton  Dave Schulte
Jeff Strahan  Angie Sowers

(Craig Seltzer- retired)

Questions?
NORMP 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?”

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EXTRA SLIDES- IF NEEDED DURING QUESTIONS
# NORMP- Salinity Zone Strategy

<table>
<thead>
<tr>
<th>Salinity (ppt)</th>
<th>OMP Salinity Zones (CBP 2004a)</th>
<th>Master Plan Salinity Zones</th>
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<tbody>
<tr>
<td></td>
<td>Low (1) 5 to 12</td>
<td>Zone 1 5 to 12</td>
</tr>
<tr>
<td></td>
<td>Moderate (2) 12 to 14</td>
<td>Zone 2 &gt;12</td>
</tr>
<tr>
<td></td>
<td>High (3) &gt;14</td>
<td></td>
</tr>
<tr>
<td>Disease Pressure</td>
<td>Low Moderate High</td>
<td></td>
</tr>
<tr>
<td>Survival Recruitment</td>
<td>Good Moderate Poor</td>
<td></td>
</tr>
<tr>
<td>Recruitmen</td>
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</tbody>
</table>

- 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
1. Develop Formulation White Papers
2. Adopt salinity-zone, disease, and reproduction strategies
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**NORMP 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?”
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

- 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

**Maryland**
- Winslow Survey 1878 \( M_W \)
- divided by
- Yates Survey 1906-1911 \( M_Y \)

\[ \text{MD Scale in all Trib's} = M_Y \times M_E \times \text{MPA} \]

**Virginia**
- 12,275 ac Moore Survey James R. 1900 \( V_M \)
- divided by
- 26,129 ac Baylor Survey James R. \( V_B \)

\[ \text{VA Scale in all Trib's} = V_B \times V_E \times \text{MPA} \]

- = 43% of Yates Polygons Contained Oyster Reefs (based upon Winslow survey) \( M_E \)
- Marine Protected Area (MPA) 20-40% of Historical Extent
- = 47% of Baylor Polygons Contained Oyster Reefs (based upon Moore survey) \( V_E \)
NORMP 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?”

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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
- 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?
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)

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