More than a Mollusk: Using GIS to Effectively Repopulate Oyster Habitats in the South River, MD (A Tributary of the Chesapeake Bay)

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It all started with a question:

What are those cages?
Discussion Points

• Background
• Restoration Efforts
• Study Area
• Oyster Restoration Workflow Process
  • Phase Workflow
  • Phase Results
• Next Steps
• Acknowledgements and Resources
Oyster Habitats

- Over 150 Varieties of Oysters Worldwide
- Majority of Oysters from Nova Scotia to Gulf of Mexico
- Locations within the Maryland Area of the Chesapeake Bay and Tributaries
- Focus on South River, MD
Environmental Impact

• Single Oyster Filters 50 gallons per day
• Reduces Water Turbidity
• Improves Light Penetration
• Reduces Anoxia/Increased Oxygen
• Removes Nitrogen
• Provides habitat for an abundance of other creatures
Economic Impact

- Post Civil War: Largest Industry in the world
- Present Day: 1% of Post Civil War Levels
- Past 18 years: avg of 4.6 million per year to MD economy
- Healthy reefs allow for greater numbers of other fished species in MD.
- Oyster Aquaculture Boosts Economy

Photos Clockwise from Upper Left: Oyster House, Maryland Historical Society 1891; On the Water, Maryland Historical Society 1915; Oyster Farming and Shucking 2012, Baltimore Sun; Oysters, Baltimore Sun 2012
Economic Impact

Examples of Oyster Aquaculture Sites in the Chesapeake Bay

Rappahannock River Oyster Company Sites: Google 2017
Ecosystem stressors to Oysters

Water Quality Stressors
- Salinity too high/low
- High Temperature
- Low Dissolved Oxygen
- Incoming silt buries reef faster than it can grow
- Loss of spawning due to low density

Disease
Predation

Ecosystem benefits provided by Oysters

Improved Water Quality
Nutrient uptake, sequestration and filtration
Reduced sediment resuspension
Substrate for hard bottom bentos & refuge for other biota

Oyster Ecosystem Impacts, NOAA
Restoration Efforts

Large Scale
- NOAA, US Army Corps of Engineers, Chesapeake Bay Foundation, Oyster Recovery Partnership, Maryland DNR
- Large Scale Oyster Recycling and Collection Efforts
- Oyster Substrate Planting
- Advanced Bottom Mapping for Site Selection and Monitoring Effort
- Government Grants

Small Scale
- Local Organizations and Non Profit Groups
- “Marylanders Grow Oysters” Program
- Reef, Oyster and Water Sample Collection and Analysis
- Privately Funded
- Volunteers

Photos Clockwise from Upper Left: Sonar Map of Oyster Bottom, NOAA; Oyster Recovery Collection Site, Oyster Recovery Partnership; Robert-Lee-Header planting substrate, Oyster Recovery Partnership.

Photos Clockwise from Upper Left: Monitoring Spat, South River Federation; Oyster Baskets, West River Oyster; Planting Oysters, South River Federation.
Study Area

• South River, Maryland
  • 86 miles of Shoreline
  • 10 miles Marsh to Bay
  • ~ 10 Square Miles of water surface

• South River Federation (SRF) Focus
  • Stream and Wetlands
  • Living Shorelines
  • Rain Gardens
  • Oyster Restoration
Oyster Restoration Workflow

PHASE I: Identification of Suitable Oyster Husbandry Candidates along the South River

PHASE II: Identification of Suitable Oyster Reef Siting Candidates within the South River

PHASE III: Monitoring efforts of existing reef sites and those created from Phase II efforts.
Methodology

• Research & Collaboration
• Data Collection
• Data Preparation
• Phased Production and Analysis Efforts
• Deliverables
Research and Collaboration

- Telephone and Email Interviews
- Meetings with the SRF mission managers
- Search for available data sources
- Review similar previous project findings
Data Collection

Federal Data
• NOAA, NGA, USGS, NASA, US Army Corps of Engineers

State/Local Data
• Maryland GIS, Anne Arundel Co. GIS, Maryland Department of Natural Resources

Organizational Data
• Chesapeake Bay Conservancy, South River Federation

Commercial Data
• Navionics, Garmin
Phase I

**Water Zones**
- Bathymetry
- Dissolved Oxygen
- Salinity

**Oyster Husbandry Past Candidates**

**Oyster Husbandry Suitability Candidate Area**

Diagram:
- Zone Data
  - Salinity Poly to Raster
    - Bottom Depth
  - Surface Salinity
  - DO2 Poly to Raster
    - Surface Dissolved O2

- Process Rasters via Map Algebra Function
- Oyster Husbandry Suitability (OHS)
- Raster to Polygon
  - OHS Polygon
    - Clip Piers to Polygon
      - All South River Piers

- Clipped South River Piers
Phase I Results

Past participation shows efforts spread out along entirety of the river regardless of the quality of water in each area.

Match address points to pier data to provide focused outreach to those property owners with piers that match suitable water quality areas based on the data.

This focused effort assures that areas which can provide the greatest oyster growth has the opportunity to yield more oysters for reef building in Phase II.
Phase II

Water Zones

Dissolved Oxygen
Salinity
Temperature
pH Levels
Quality Water Zones
Bottom Surface Composition

Zone Data

Temperature Poly to Raster
Salinity Poly to Raster
DO2 Poly to Raster
pH Poly to Raster

Bottom Temp
Bottom Salinity
Bottom DO2
Bottom pH

Process Rasters via Map Algebra

Water Quality Sites

Process Rasters via Map Algebra

Final Sites

Bottom Surface Raster
Phase II Results

- The workflow provides a means for testing combined layer suitability
- Model allows for easy reprocessing of data if criteria changes or different criteria is desired
- Can produce additional questions of oyster reef siting or possibly reveal other factors that cause possible favorable areas to be unfavorable
Phase III

Traditional Monitoring Techniques

Drone/Aerial/Satellite Monitoring

Sonar/Side Scan Monitoring

Sechi Water Clarity Monitoring

Water Collection

Oyster Health Monitoring

Glebe Bay

Standard Deviation of Oyster Reef

Oyster Monitoring Through Landsat 8

AA 702
Next Steps

South River Federation Deliverables

• Finalized process chart and full documentation of methodology

• Development of an Oyster Siting Tool Toolbox

• All processed files (Raster, SHP, etc.) in GDB and Shapefile formats

• Soft and hard copies of all requested maps

• Incorporation of data collection through use of Arc Collector with Portal
Acknowledgements

• PSU Advisors Justine Blanford and Fritz Kessler

• Chesapeake Bay Foundation Jackie Shannon

• South River Federations Kirk Mantay, Jesse Illiff, Nancy Merrill, Sarah Giordano
References

• South River Federation | protect, preserve, restore and celebrate the South River. (n.d.). Retrieved September 06, 2016, from http://www.southriverfederation.net/


• Ewart, John W., Ford, Susan E. “History and Impact of MSX and Dermo Diseases on Oyster Stocks in the Northeast Region”, Northeastern Regional Aquaculture Center Fact Sheet No. 200 – 1993.


• Jackie Shannon, CBF.org, Oyster Restoration Questions, 13 October, 2016


• Mid-Atlantic Tributary Assessment Coalition, 2011. Sampling and data analysis protocols for Mid-Atlantic tidal tributary indicators.
QUESTIONS?