Briefing on the Oyster BMP Expert Panel's Recommendations in the Approved First Report

Presentation for the Trading and Offset Workgroup

November 15, 2017

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Acknowledgements

Role	Oyster BMP Expert Panel
Panelists	**Jeff Cornwell (Panel Chair)** and Larry Sanford (UMCES) Suzanne Bricker and Julie Rose (NOAA) Lynn Fegley (MDNR) Karen Hudson, Lisa Kellogg, and Mark Luckenbach (VIMS) Andrew Lacatell (TNC) Chris Moore (CBF) Matt Parker (Sea Grant at U. of MD) and Ken Paynter (U. of MD) Bill Wolinski (Talbot County of Public Works)
Chesapeake Bay Program/US EPA Advisors	Lucinda Power, Rich Batiuk, Lew Linker, Matt Johnston, Ralph Spagnolo, and Ed Ambrogio
Panel Support	Ward Slacum and Emily French (ORP), Carl Cerco (US Army Corps of Engineers), Paige Hobaugh, Emilie Franke, and Kyle Runion (CBP)
Data	Colleen Higgins, Kurt Stephenson, Bonnie Brown, Peter Kingsley-Smith, Steve Allen, Paige Ross, Roger Mann, and Melissa Southworth
Stakeholder Review	Citizen Advisory Committee, Chesapeake Bay Foundation, Chesapeake Bay Commission, Lynnhaven River Now, Southern Environmental Law Center and partners, Oyster Company of Virginia, and Norfolk Public Works

Filter-Feeders Can Help Improve Water Quality

Source: Screenshots from Chesapeake Bay Foundation time-lapsed video of an oyster reef

Shellfish Interest—Innovative Option to Help Improve Water Quality

Odd Lindahl, Rob Hart, Bodil Hernroth, Sven Kollberg, Lars-Ove Loo, Lars Olrog, Ann-Sofi Rehnstam-Holm, Jonny Svensson, Susanne Svensson and Ulf Syversen

Improving Marine Water Quality by Mussel Farming: A Profitable Solution for Swedish Society

Eutrophication of coastal waters is a serious environmental problem with high costs for society globally. In east-

LONG ISLAND SOUND STUDY

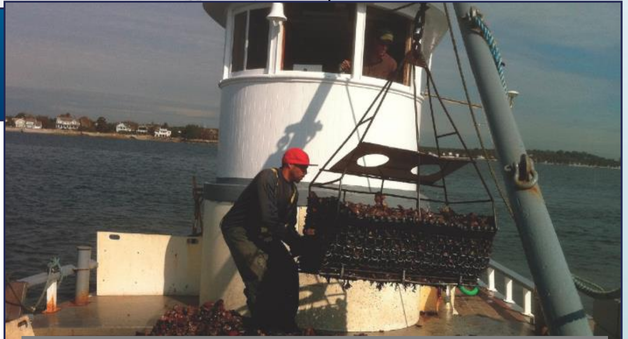
A PARTNERSHIP TO RESTORE AND PROTECT THE SOUND

Ribbed Mussel Pilot Study in the Bronx River, New York City

OVERVIEW

The New York State Office of the Attorney General, through the Bronx River Watershed Initiative, has funded Carter Newell, a commercial shellfish farmer, and Rocking the Boat, a local youth-development organization, to install a raft in the Bronx River with ropes to catch and grow ribbed mussels. These mussels naturally live along the Bronx River shoreline, but have lost most of their salt-marsh habitat as human populations and industry have expanded along the river. Ribbed mussels now exist at much lower abundance than they did historically.

Mussels feed on plankton, and when they grow they incorporate into their shells and meat nutrients that are in excess in the urban waters around New York City. These excess nutrients come from sources such as wastewater and storm runoff. When the mussels are harvested, this harvest will also remove the excess nutrients from the environment that have been incorporated ... improving water quality for other marine lif...



An Ecosystem Services Assessment Using Bioextraction Technologies for Removal of Nitrogen and Other Substances in Long Island Sound and the Great Bay/Piscataqua Region

Nutrient Bioextraction Workshop

International Workshop on Bioextractive Technologies for Nutrient Remediation

Sponsored by LISS, NOAA, NEIWPCC, and UCONN

In Chesapeake Bay

stac

Workshop to evaluate use of Shellfish for Nutrient Reduction in the Chesapeake Bay (2013)

City of Virginia Beach Virginia
A Community for a Lifetime

Request to consider denitrification rates for a "sanctuary oyster reef" BMP (2013)

Oyster Company of Virginia

Request for *in situ* nutrient remediation pilot between oyster farm and stormwater permittee (2015)

Plus additional requests

Questions Related to Using Oysters as a Tidal In-Water BMP

- **Science-Related: Reduction Effectiveness Determination**
  - Does existing data support nitrogen and phosphorus reduction estimates for the various oyster practices occurring in Chesapeake Bay?
  - How can the reduction be quantified and verified given the variability in oyster growth and survival?

- **Policy-Related: Removal Versus Sequestration**
  - Should reduction credit only be given when N and P is removed from the waterbody (e.g., tissue from harvested oysters, denitrification)?
  - Can buried biodeposits or sequestered nitrogen and phosphorus in oysters receive credit (e.g., oyster reef restoration practices)?
  - How to handle crediting N and P stored in shells given that shells should be returned to the Bay? Can credit be given for temporary removal?

Oyster BMP Expert Panel Charge

- **Panel convened on September 22, 2015; charged with:**
  - Establishing a nutrient and suspended sediment reduction effectiveness determination decision framework for oyster BMPs.
  - Determining the nutrient and suspended sediment reduction effectiveness of oyster practices using available science and established framework.

Recommendations in the First Report

The Panel's recommendations found in the first incremental report include:

- A **decision framework** to incrementally determine the nutrient (nitrogen and phosphorus) and suspended sediment reduction effectiveness of oyster practices for BMP application.

- **Default reduction effectiveness estimates** for the "Nitrogen Assimilated in Oyster Tissue" and "Phosphorus Assimilated in Oyster Tissue" reduction effectiveness protocols for oyster practices in the following oyster practice categories:
  - Off-bottom private oyster aquaculture using hatchery-produced oysters
  - On-bottom private oyster aquaculture using hatchery-produced oysters
  - On-bottom private oyster aquaculture using substrate addition

- **Methodology** to establish **site-specific** estimates.

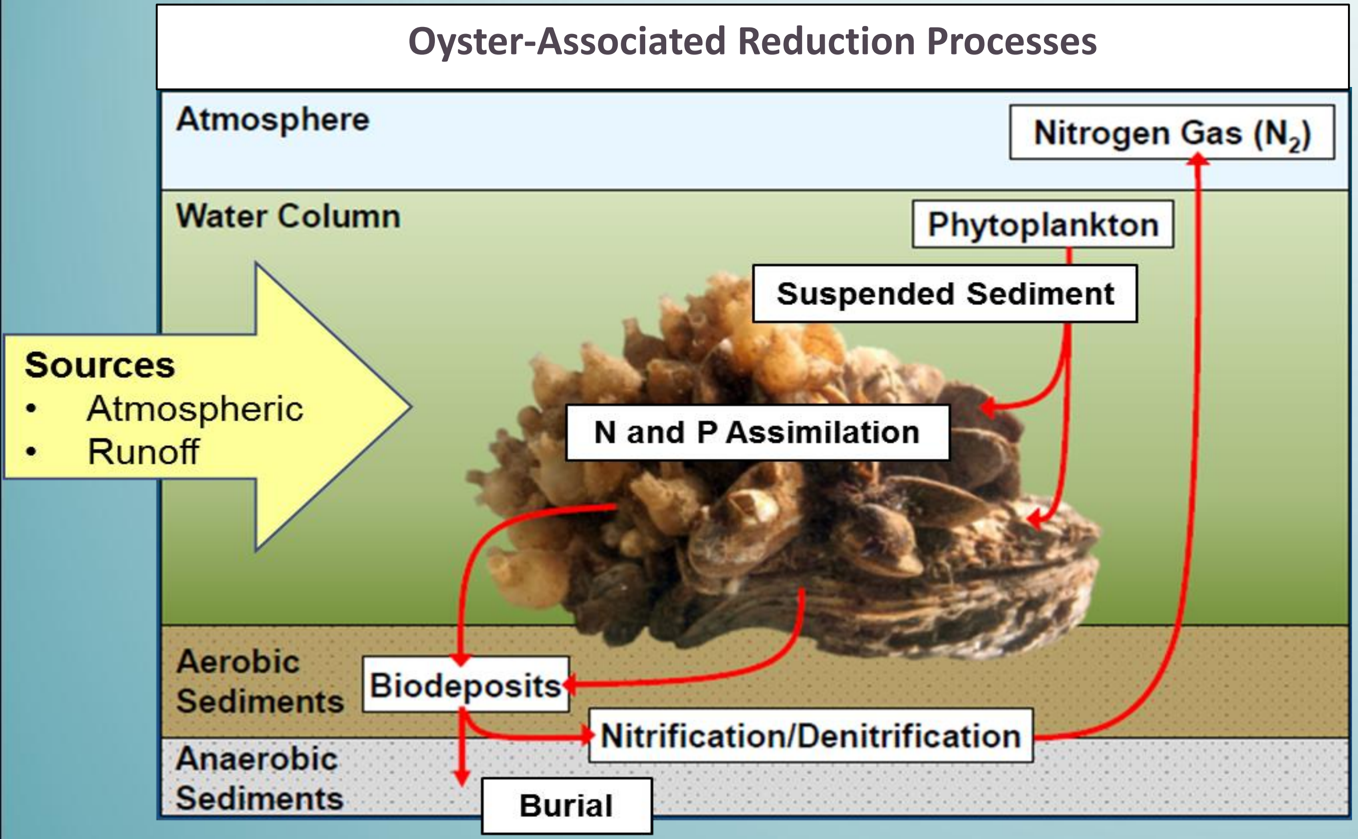
Decision Points from the Oyster BMP Reduction Effectiveness Decision Determination Framework

Step	Decision Points	Description
1	Identify practices and oyster-associated reduction processes suitable for BMP Consideration	Practice must include an enhancement activity that could result in the overall production of new oysters and reduction process must occur with practice
2	Sufficient science exists to determine reduction	Quality and scope of data can generate a reasonably constrained estimate
3	Estimate verifiable	Practical method exists, or could be created, to track reduction effectiveness
4	Identified Unintended Consequences Manageable	Negative effects can be addressed so they don't outweigh environmental benefits

Decision Framework—Chesapeake Bay Oyster Practices

Oyster Fate	Oysters removed (harvested) from Bay									Oysters remain in Bay		
Fisheries Management Approach	Private oyster aquaculture (permitted)					Public fishery				Oyster reef restoration (sanctuaries)		
Oyster Culture Type/Ploidy	Hatchery-produced oysters (diploid or triploid)		Wild oysters (diploid)			Hatchery-produced oysters (diploid)	Wild oysters (diploid)			Hatchery-produced oysters (diploid)	Wild oysters (diploid)	
Activity/Culture Method	Grown off the bottom using some sort of gear	Grown on the bottom using no gear	Moving wild oysters from one location to another	Addition of substrate to the bottom to enhance recruitment of wild oyster larvae	None	Addition of hatchery-produced oysters (e.g. spat-on-shell)	Moving wild oyster from one location to another	Addition of substrate to enhance recruitment of wild larvae	None	Sanctuary creation followed by addition of hatchery-produced oysters	Sanctuary creation followed by addition of substrate	Sanctuary creation
Oyster Practice Title	Off-bottom private oyster aquaculture using hatchery-produced oysters	On-bottom private oyster aquaculture using hatchery-produced oysters	On-bottom private oyster aquaculture using transplanted wild oysters	On-bottom private oyster aquaculture using substrate addition	Private oyster aquaculture with no activity	On-bottom public fishery oyster production using hatchery-produced oysters	On-bottom public fishery oyster production using transplanted wild oysters	On-bottom public fishery oyster production using substrate addition	Public fishery with no activity	Active oyster reef restoration using hatchery-produced oysters	Active oyster reef restoration using wild oysters	Passive oyster reef restoration
***Panel Recommends for BMP Consideration**	**Yes**	**Yes**	No	**Yes**	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Oyster-Associated Nutrient/Suspended Sediment Reduction Processes Identified



Reduction Effectiveness Protocols
1. **Nitrogen Assimilation in Oyster Tissue**
2. Nitrogen Assimilation in Oyster Shell
3. Enhanced Denitrification Associated with Oysters
4. **Phosphorus Assimilation in Oyster Tissue**
5. Phosphorus Assimilation in Oyster Shell
6. Sediment Reduction Associated with Oysters
7. Enhanced Nitrogen Burial Associated with Oysters
8. Enhanced Phosphorus Burial Associated with Oysters

Eventual Determination of the Overall Reduction Potential of Oyster Practices – Private Oyster Aquaculture Example

	Practice-Protocol Combinations	Off-Bottom Culture	On-Bottom Culture	Bottom Substrate Addition
*	1. Nitrogen Assimilation in Oyster Tissue	#	#	#
*	2. Nitrogen Assimilation in Oyster Shell	TBD	TBD	TBD
*	3. Enhanced Denitrification Associated with Oysters	TBD	TBD	TBD
**	4. Phosphorus Assimilation in Oyster Tissue	#	#	#
**	5. Phosphorus Assimilation in Oyster Shell	TBD	TBD	TBD
***	6. Sediment Reduction Associated with Oysters	On Hold	On Hold	On Hold
*	7. Enhanced Nitrogen Burial Associated with Oysters	On Hold	On Hold	On Hold
**	8. Enhanced Phosphorus Burial Associated with Oysters	On Hold	On Hold	On Hold

If the protocols under evaluation result in an approved estimate, then that reduction value can be added to already approved protocols for that practice addressing the same pollutant

Approved Oyster BMPs

- **Several oyster aquaculture BMPs were <u>approved</u> by the Chesapeake Bay Program on December 19, 2016 (details in the Panel's 1st report):**
  - Provides estimates for the amount of nitrogen and phosphorus stored in oyster tissue for various sized oysters for private oyster aquaculture practices.

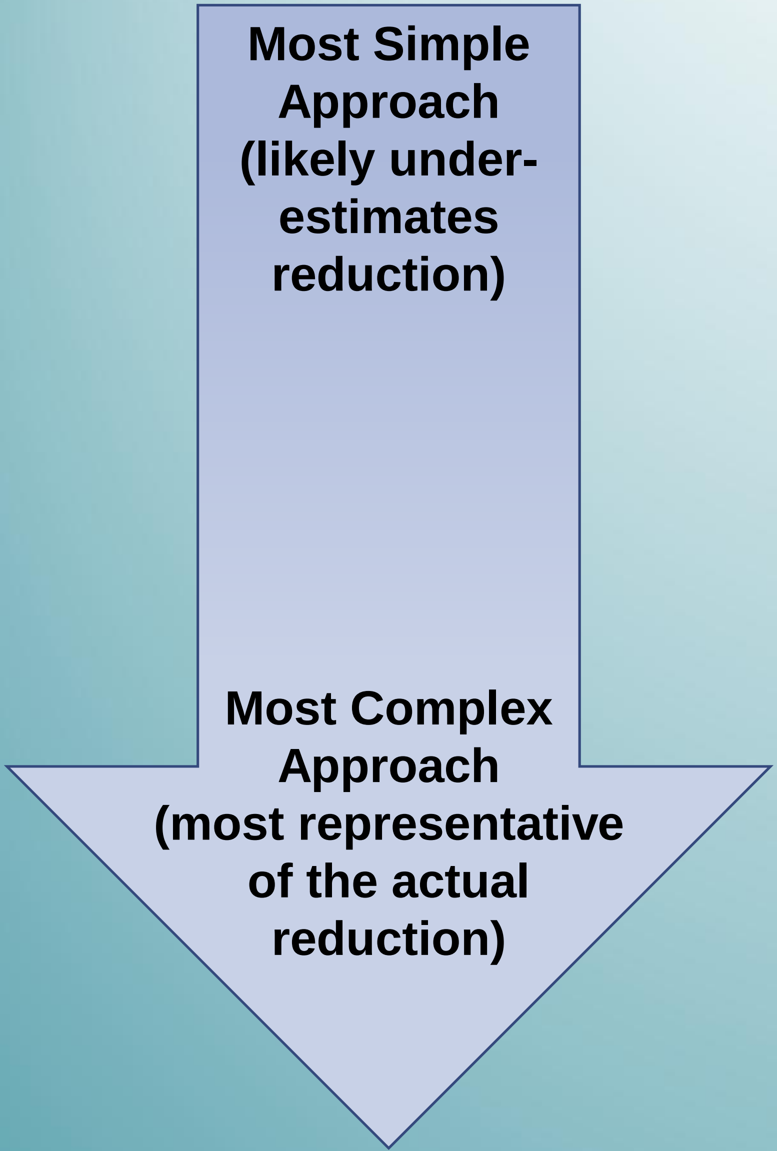
Decision Points	Nitrogen Assimilation Oyster Tissue	Phosphorus Assimilation Oyster Tissue
Step 1 - Suitable for BMP Consideration	YES	YES
Step 2 - Sufficient Science	YES	YES
Step 3 – Verifiable	YES	YES
Step 4 – Identified Unintended Consequences Manageable	YES	YES

Endorsed Oyster Aquaculture Practices

- **Off-Bottom Culture**: with gear, such as near bottom cages or floating rafts, using hatchery-produced oysters.

- **Bottom Culture**: no gear using hatchery-produced oysters (oysters are planted directly on the bottom).
- **Bottom with Substrate Addition**: placing oyster shell or alternative substrate, such as granite, on the bottom to build habitat to support wild oysters.

Estimate Options—Offers Scientifically-Defensible Flexibility to Implementing Programs



Option A: Apply appropriate minimum default estimate when size class and ploidy information is missing

Option B: Use default estimates (e.g., estimates based on ploidy identification and size class verification measurements)

Option C: Use site-specific estimate based on Panel's recommended methodology

Approved Private Oyster Aquaculture BMPs – Qualifying Conditions

The Panel agreed that the qualifying conditions described below would apply to both the default and the site-specific estimates:

- Only includes oysters that are removed (harvested) moving forward from the time the BMP is approved/implemented for reduction effectiveness credit in the TMDL. This baseline condition was proposed by the CBP Partnership Management Board and the Panel concurs with their decision.

- Oysters had to have been grown from initial sizes < 2.0 inches shell height.

- Oysters have to be alive when removed to count toward the reduction effectiveness.

Panel’s Method to Determine Conservative Default N and P Reduction Effectiveness Oyster Tissue Estimates

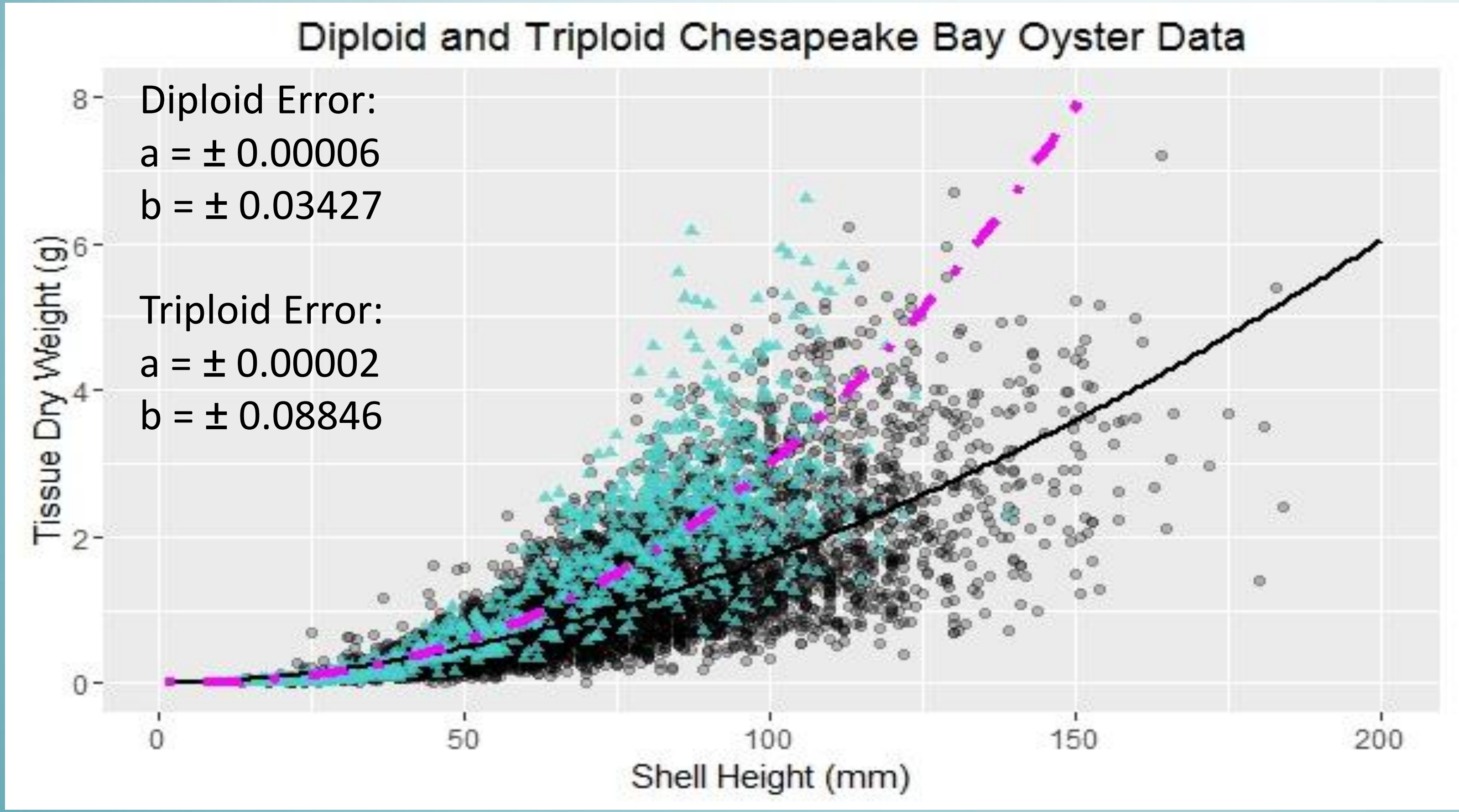
Step 1: Determine the oyster shell height to tissue dry weight quantile regression equations for diploid and triploid oysters

- Analysis included consideration of various oyster growth influencing factors: ploidy, culture method and type, location/environment, and season.
- Quantile regression uses the median of the data—less influenced by extremes (good statistical approach to use with highly variable data).

Step 2: Establish oyster size class ranges for the shell height midpoints that will be used to calculate the oyster soft tissue dry weight

Step 3: Establish and apply the percent nitrogen and phosphorus content in oyster tissue to determine the reduction effectiveness estimates

Default Calculation: Shell Height to Dry Tissue Weight Regression Equations for Diploids and Triploids



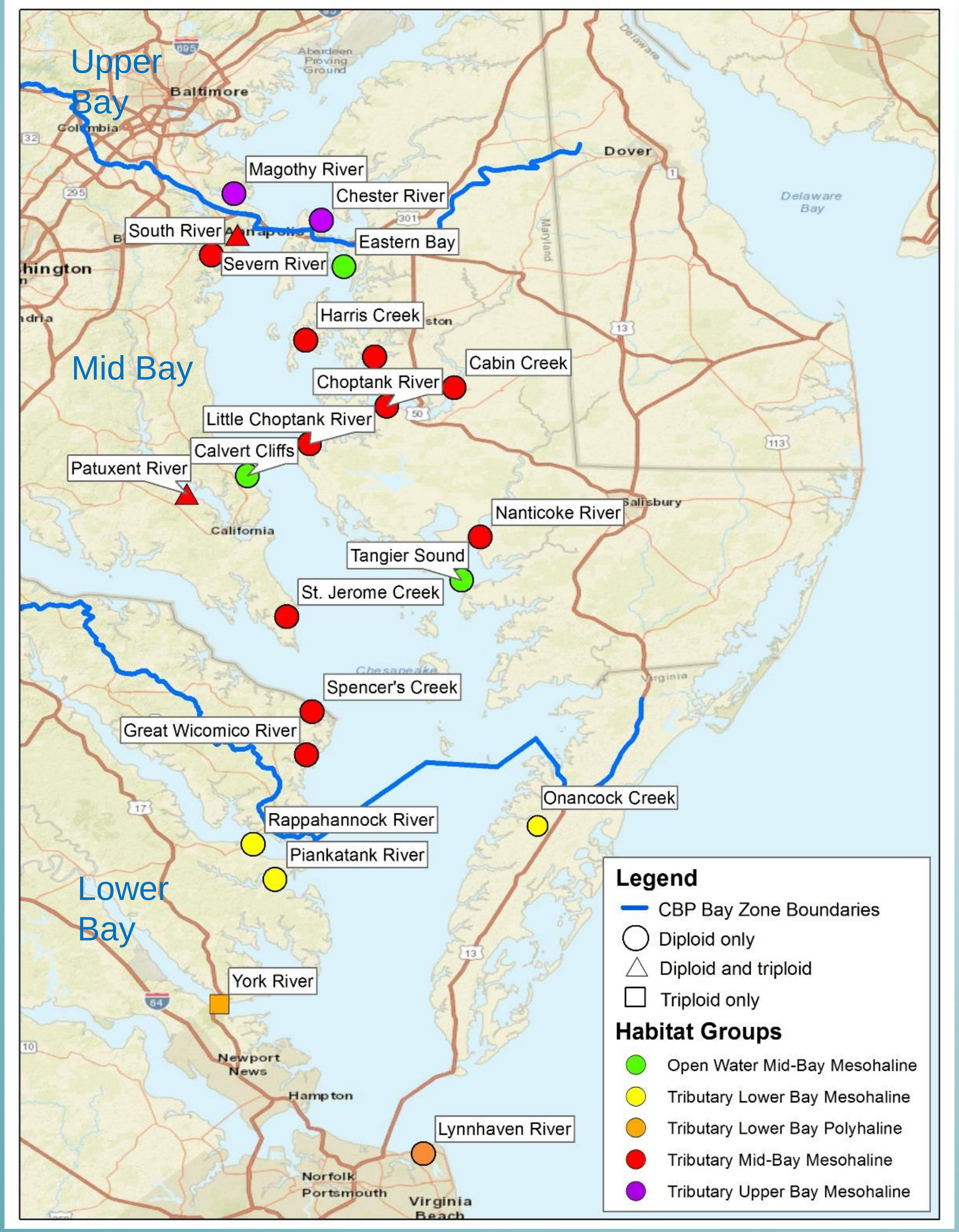
Diploid 0.5 Quantile Curve, $y = 0.0004x^{1.82}$ (n = 5,750 oysters)

Triploid 0.5 Quantile Curve, $y = 0.00005x^{2.39}$ (n = 1,066 oysters)

△ Triploid data ● Diploid data

Conclusions:

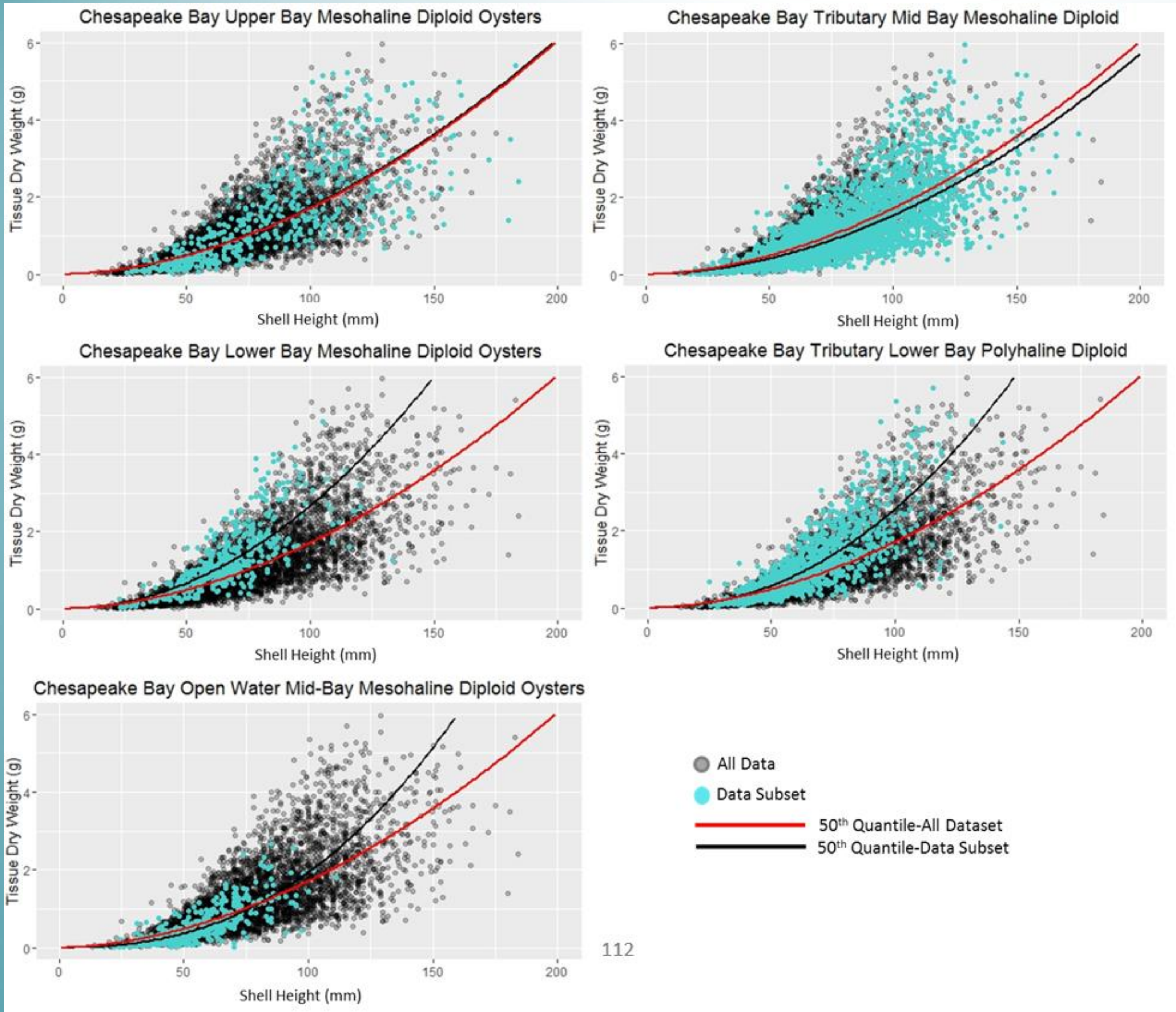
- Enough data were available to establish shell height to tissue dry weight regression equations.
- Differences in biomass between diploid and triploid oysters warranted the use of separate regression equations.
- 50^{th} quantile conservatively accounts for differences in culture method and type (off-bottom/on-bottom, hatchery-produced/wild) location/environment, and season; see report for details).



Data Locations Used for Regression Equations

- 22 general locations (1 triploid only site, 19 diploid only sites, and 2 sites with triploid and diploid oyster data).

- Location/, the oyster data were also grouped by where the location fell in the Chesapeake Bay Program Bay zones (Upper, Mid, and Lower) and by the its salinity characteristic (mesohaline or polyhaline).



Influencing Factor Evaluation Example: Location/Environmental Condition

- 4 of the 5 habitat group curves matched or were steeper than 50th quantile of curve of entire dataset.
- Tributary Mid Bay Mesohaline Diploid group curve only slightly below full dataset curve.

Default Reduction Effectiveness Estimates for N and P Assimilated in Oyster Tissue

Nitrogen: 8.2% average nitrogen content in oyster tissue dry weight (based on 7 studies in waterbodies along the Atlantic Coast; used the average of the site means for studies outside of Chesapeake Bay; site-specific averages were used for studies within Chesapeake Bay)

Phosphorus: 0.9% average phosphorus content in oyster tissue dry weight (based on 3 studies in Chesapeake Bay; same averaging approach as nitrogen, but only studies in Chesapeake Bay were found)

Default Oyster Tissue Estimates								
Oyster Size Class Range (inches)	Size Class Midpoint (inches)	Size Class Midpoint (mm)	Diploid Size Class Midpoint Dry Weight (g)	Triploid Size Class Midpoint Dry Weight (g)	Content in Oyster Tissue (g/oyster)			
					Diploid		Triploid	
					Nitrogen	Phosphorus	Nitrogen	Phosphorus
2.0 - 2.49	2.25	57	0.63	0.79	0.05	0.01	0.06	0.01
2.5 - 3.49	3	76	1.06	1.56	0.09	0.01	0.13	0.01
3.5 - 4.49	4	102	1.81	3.16	0.15	0.02	0.26	0.03
4.5 - 5.49	5	127	2.70	5.33	0.22	0.02	0.44	0.05
≥ 5.5	6	152	3.74	8.20	0.31	0.03	0.67	0.07

Reduction Effectiveness Estimates for N and P Assimilated in Oyster Tissue (Summarized for TMDL Application from Panel's Findings)

BMP Name	Lbs N Reduced/1,000,000 Oysters Harvested	Lbs P Reduced/1,000,000 Oysters Harvested
Diploid Oyster Aquaculture 2.25 Inches	**110**	**22**
Diploid Oyster Aquaculture 3.0 Inches	**198**	**22**
Diploid Oyster Aquaculture 4.0 Inches	331	44
Diploid Oyster Aquaculture 5.0 Inches	485	44
Diploid Oyster Aquaculture ≥ 5.5 Inches	683	66
Triploid Oyster Aquaculture 2.25 Inches	**132**	**22**
Triploid Oyster Aquaculture 3.0 Inches	**287**	**22**
Triploid Oyster Aquaculture 4.0 Inches	573	66
Triploid Oyster Aquaculture 5.0 Inches	970	110
Triploid Oyster Aquaculture ≥ 5.5 Inches	1,477	154
Site-Specific Monitored Oyster Aquaculture	NA	NA

1 pound (Lbs) ~ 0.45 kg

Above BMPs would be reported annually and are only eligible in tidal waters (to qualify oysters had to be < 2 inches when planted and alive when removed).

Methodology for Site-Specific Estimates

The Panel is recommending an option where the BMP implementer can apply for a site-specific estimate.

- The oyster BMP implementer works with the reporting jurisdiction and CBP Partnership to define:
  - Practice-specific oyster size class categories if using different categories than the default estimate
  - Two timeframes set by the State to reflect seasonal differences ~ 6 months apart.

- Once approved by the CBP Partnership, the operation will have 50 random oysters per size class per season analyzed to determine the average tissue dry weight.
  - Samples are sent to a lab that uses standardized methods to acquire the tissue dry weight in grams (e.g., tissue heated at 60°C until samples reach constant weight).

- The average tissue dry weight for each size class is multiplied by the default 8.2% N content and 0.9% P content in oyster tissue to determine the site-specific reduction effectiveness estimates.

- Review and approval of site-specific estimates follow a similar approach as the re-evaluation procedure of existing estimates described in the CBP Partnership BMP Expert Review Protocol. Same goes for re-evaluation of the site-specific estimates.

- Once approved by the CBP Partnership, the estimate would be applicable for that practice as long as they continue growing oysters under the same conditions when the reduction effectiveness evaluation was made.

Recommended Reporting and Verification Guidelines

Individual oysters would be the preferred reporting unit. However, since there are varying units (e.g., bushels, boxes) currently being used to report oyster harvest, the Panel recommends that the following information be reported to account for this in order to offer flexibility to reporting jurisdictions (i.e., State agencies) in verifying the reduction effectiveness in a scientifically-defensible manner.

1. *Type and total # of containers*- The type (bushel, box,) and total # of containers used to package oysters.
2. *Average # of oysters in each container type*- Needed to figure out the total # of removed oysters to apply the reduction effectiveness estimates to on an annual basis.
   - **Verification Guideline:** Quantify average # of oysters in a container by counting and documenting the total # of oysters in 10 containers two times a year (~ 6 months apart) to account for seasonal differences.
3. *The average size of oysters in each container type*- Needed to figure out which oyster size class estimate to use.
   - **Verification Guideline:** Quantify the average size of oysters in containers by measuring the shell heights of 50 randomly selected oysters from representative containers two times a year (~ 6 months apart) to account for seasonal differences.

Recommended Default Approach to Deal with Missing Verification and Ploidy Information

Missing Verification Measurements

Panel Recommendation: If average oyster shell heights and average numbers of oysters in containers are not known then a default approach where the minimum legal size of oysters and State documented information specifying the average number of minimum legal sized oysters can be packaged in a specific container is used.

Example: State minimum legal harvestable size is 3 inches and they define bushels as 300 individual oysters. If verification measurements are missing, then all bushels would be multiplied by 300 and individual oysters assigned to the 2.5-3.49 inch oyster size class reduction effectiveness estimate for diploids.

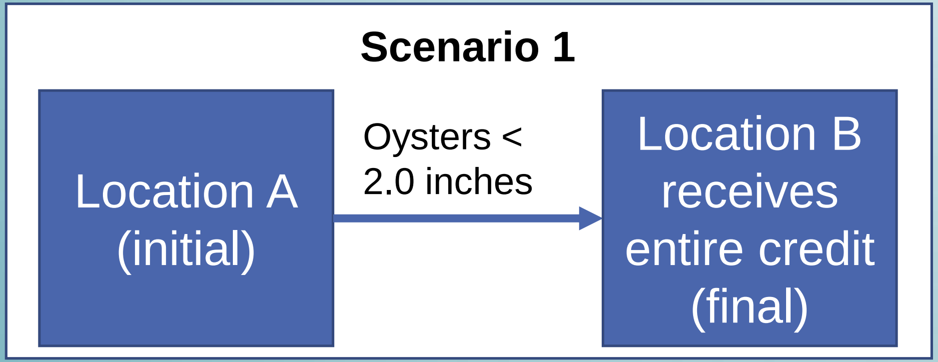
Missing Ploidy Designation

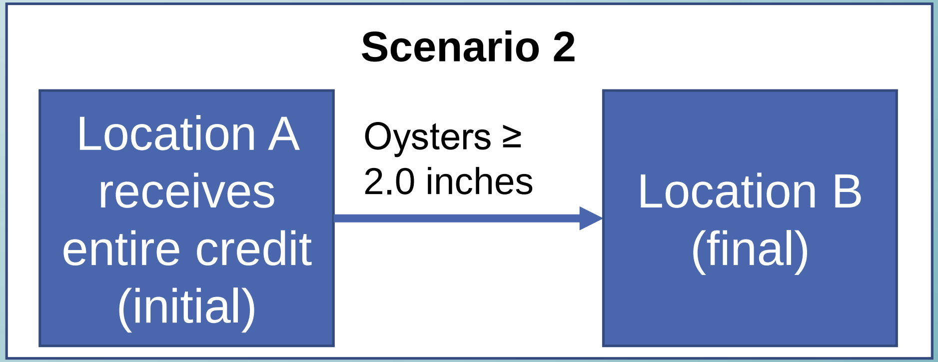
Panel Recommendation: If ploidy is missing, then apply the diploid estimates.

Recommended Application Guideline—Movement of Oysters

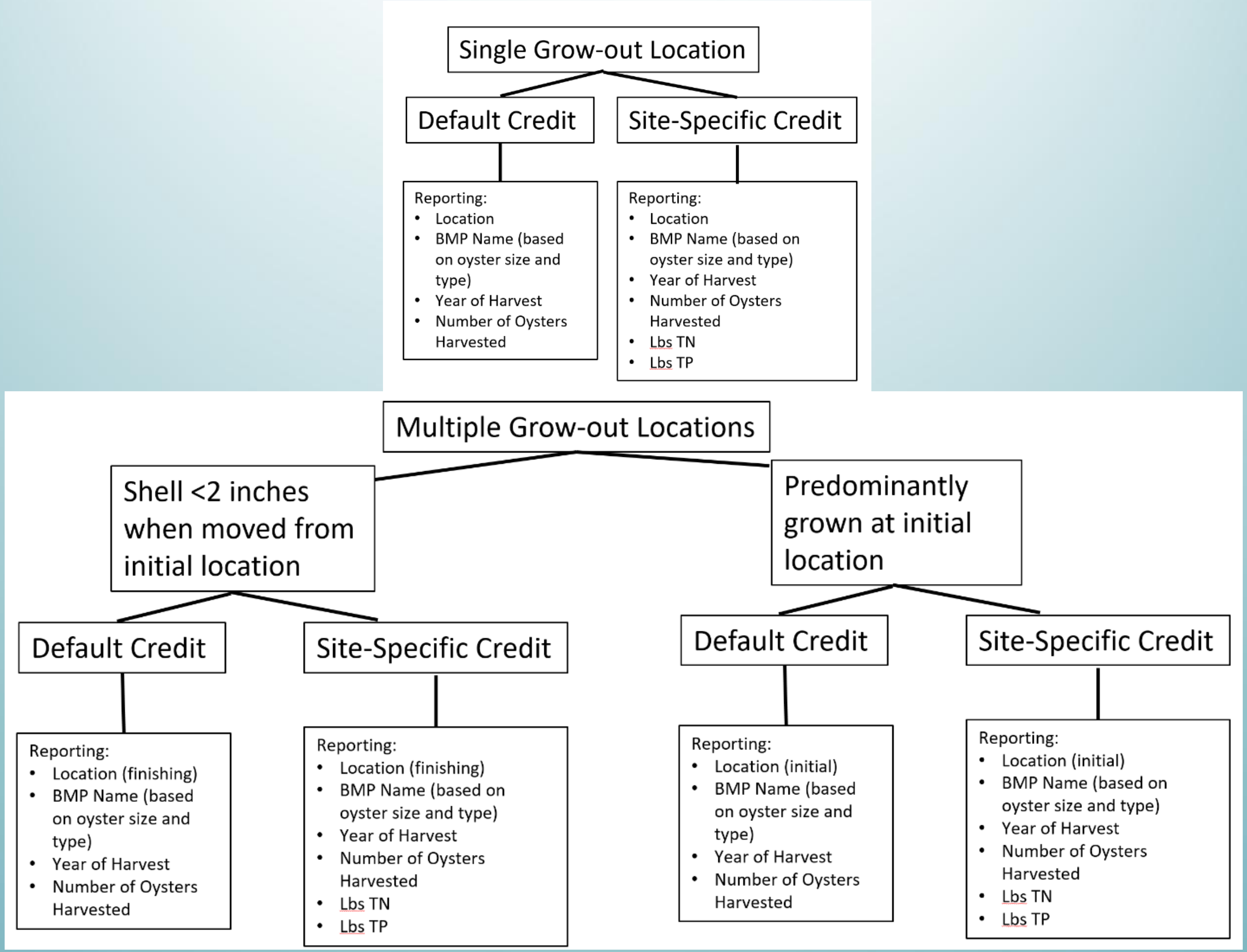
The Panel identified instances where oysters are moved from their initial grow-out location to another location in the Bay or elsewhere. Reasons for moving the oysters include:

- Changing the taste by moving oysters to an area with higher salinity
- Water quality problems in the initial grow-out location.





Technical Appendix: Reporting Requirements



Technical Appendix: Additions by WTWG—Approved on December 1, 2016

Q8: How will the practice be credited in the Phase 6 Watershed Model?

A8: The Phase 6 Model will have an estimated nutrient load in tidal segments that can be reduced by shoreline and tidal water practices.

- The pounds of nutrients reduced by this practice will be credited as a reduction to the nutrient loads in the nearest shoreline/tidal segments to the practice location.
- If latitude and longitude are not submitted, then the practice benefits will be distributed amongst all shoreline/tidal segments in the geography submitted.

The WTWG will work with the Modeling Workgroup to determine if a cap on load reductions is appropriate for this and other site-specific pound reduction BMPs including stream restoration, shoreline management, and algal flow-ways.

Panel Next Steps

- **November 27, 2017— Upcoming Panel Update to Chesapeake Bay Program on:**
  - A framework to determine the potential nitrogen and phosphorus reduction effectiveness associated with shell from harvested oysters for BMP consideration.
  - Site-specific methodologies to determine the nitrogen reduction effectiveness related to the enhanced denitrification protocol for oyster reef restoration and private oyster aquaculture practices.
- **January 2018—Planned release of Panel's 2nd incremental draft report for 30-day review**
  - Opportunity for the Chesapeake Bay Program Partnership and public/stakeholders to provide comments on the Panel's recommendations.
- **December 2017—Tentative timeframe to resolve sequestration/biodeposition policy/legal question for in-water BMPs**
  - BMP consideration for shell assimilation, burial, and suspended sediment reduction protocols would depend on these conclusions.

Conclusions

- The Panel's reduction effectiveness determination framework allows reduction protocols to be established incrementally offering more timely approval and option to implement oyster BMPs.

- The endorsed private oyster aquaculture BMPs are the first shellfish BMPs to be approved for use in cleaning up the Chesapeake Bay:
  - They can now be selected by jurisdictions (counties, states) to help them meet their TMDL water quality requirements.
  - They have the potential to complement (not replace) traditional land-based BMPs.
  - Establishing reduction effectiveness options based on conservative approaches offers flexibility for implementing programs while safe-guarding the achievement of water quality goals.
  - Opens the door for the oyster aquaculture industry to participate in water quality programs.
  - Could provide additional business incentives and marketing opportunities for the industry, while supporting water quality goals.

- Policy questions and implementation procedures will need to be addressed/developed related to the application of approved oyster BMPs.

How to Keep Informed of Panel Efforts

ORP webpage summarizing Panel effort

oysterrecovery.org/water-quality-improvement

First report available at

oysterrecovery.org/oyster-bmp-first-report/

Contact Information: jreichert@oysterrecovery.org

QUESTIONS?