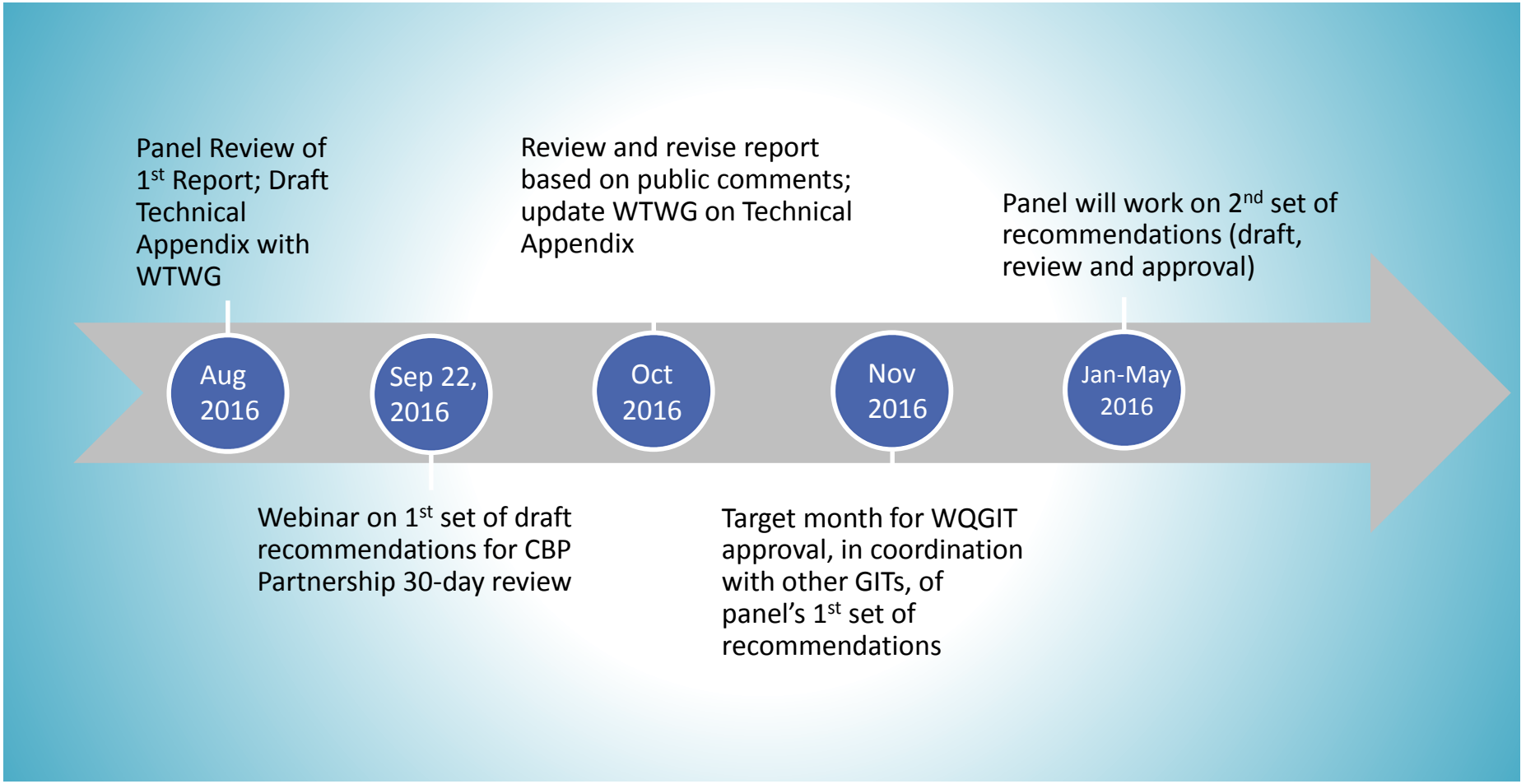
Oyster BMP Expert Panel Timeline



Panel's Planned Report Schedule

Oyster Practice Category/ Crediting Protocol Combinations	A. Off Bottom Propagated Oyster Aquaculture	B. Bottom Propagated Oyster Planting Aquaculture	C. Bottom Wild Seed Oyster Planting Aquaculture	D. Bottom Oyster Substrate Planting Aquaculture	E. Bottom Propagated Oyster Planting Stock Enhancement	F. Bottom Wild Seed Oyster Planting Stock Enhancement	G. Bottom Oyster Substrate Planting Stock Enhancement	H. Oyster Reef Restoration
1. Nitrogen Assimilation in Oyster Tissue	**1st**	**1st**	**1st**	**1st**	2nd	2nd	2nd	On hold
2. Nitrogen Assimilation in Oyster Shell	2nd	2nd	2nd	2nd	2nd	2nd	2nd	On hold
3. Enhanced Denitrification Associated with Oysters	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd
4. Phosphorus Assimilation in Oyster Tissue	**1st**	**1st**	**1st**	**1st**	2nd	2nd	2nd	On hold
5. Phosphorus Assimilation in Oyster Shell	2nd	2nd	2nd	2nd	2nd	2nd	2nd	On hold
6. Suspended Sediment Reduction Associated with Oysters	On hold	On hold	On hold	On hold	On hold	On hold	On hold	On hold
7. Enhanced Nitrogen Burial Associated with Oysters	On hold	On hold	On hold	On hold	On hold	On hold	On hold	On hold
8. Enhanced Phosphorus Burial Associated with Oysters	On hold	On hold	On hold	On hold	On hold	On hold	On hold	On hold

1st Recommendation Report

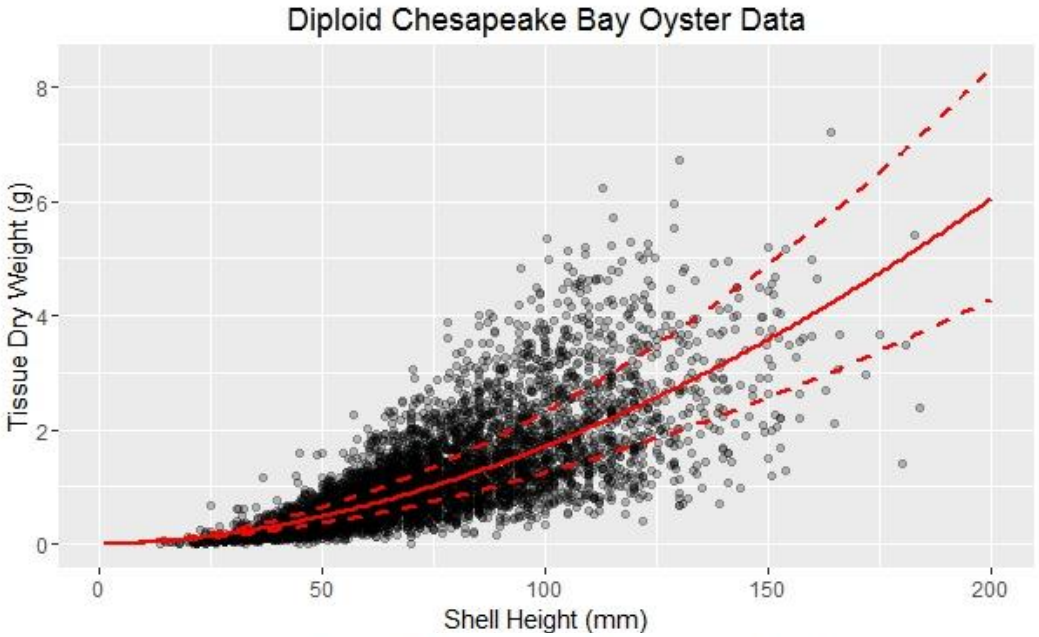
The Panel's recommendations found in this first incremental report include:

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

- The 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 Propagated Oyster Aquaculture"
  - "Bottom Propagated Oyster Planting Aquaculture"
  - "Bottom Wild Seed Oyster Planting Aquaculture"
  - "Bottom Oyster Substrate Planting Aquaculture"

- The default reduction effectiveness estimates are based on using a regression equation to convert oyster shell height to tissue dry weight using the midpoint of predetermined oyster size class ranges and multiplying by the recommended % nitrogen and % phosphorus content in oyster tissue.

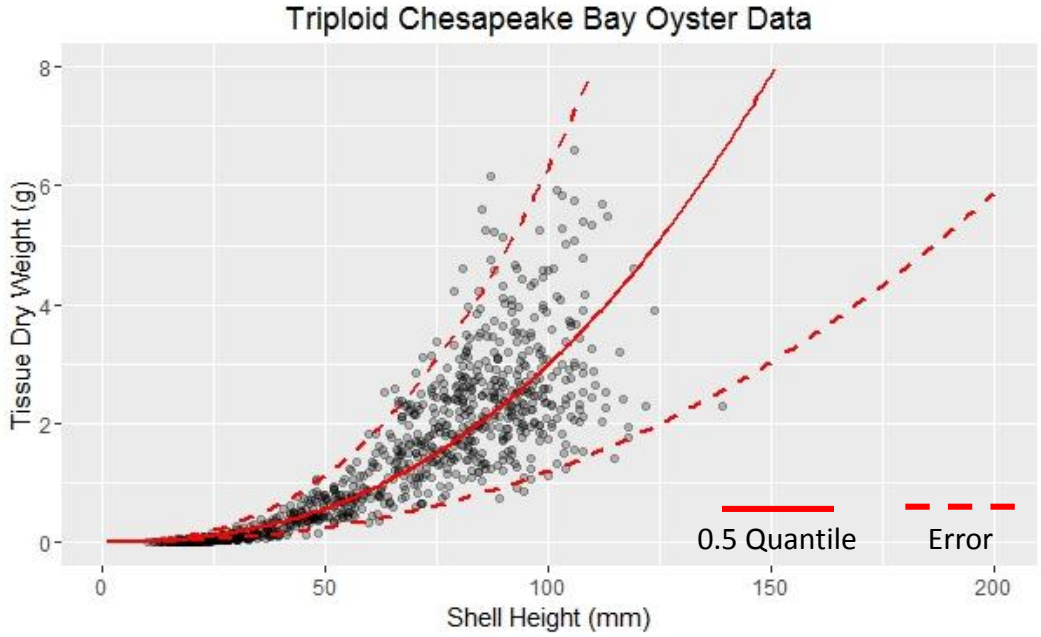
Separate Regression Equations for Diploids and Triploids



Equation: $y = ax^b$
y = Tissue Dry Weight (g)
x = Shell Height (mm)

Diploid: $y = 0.0004x^{1.82}$

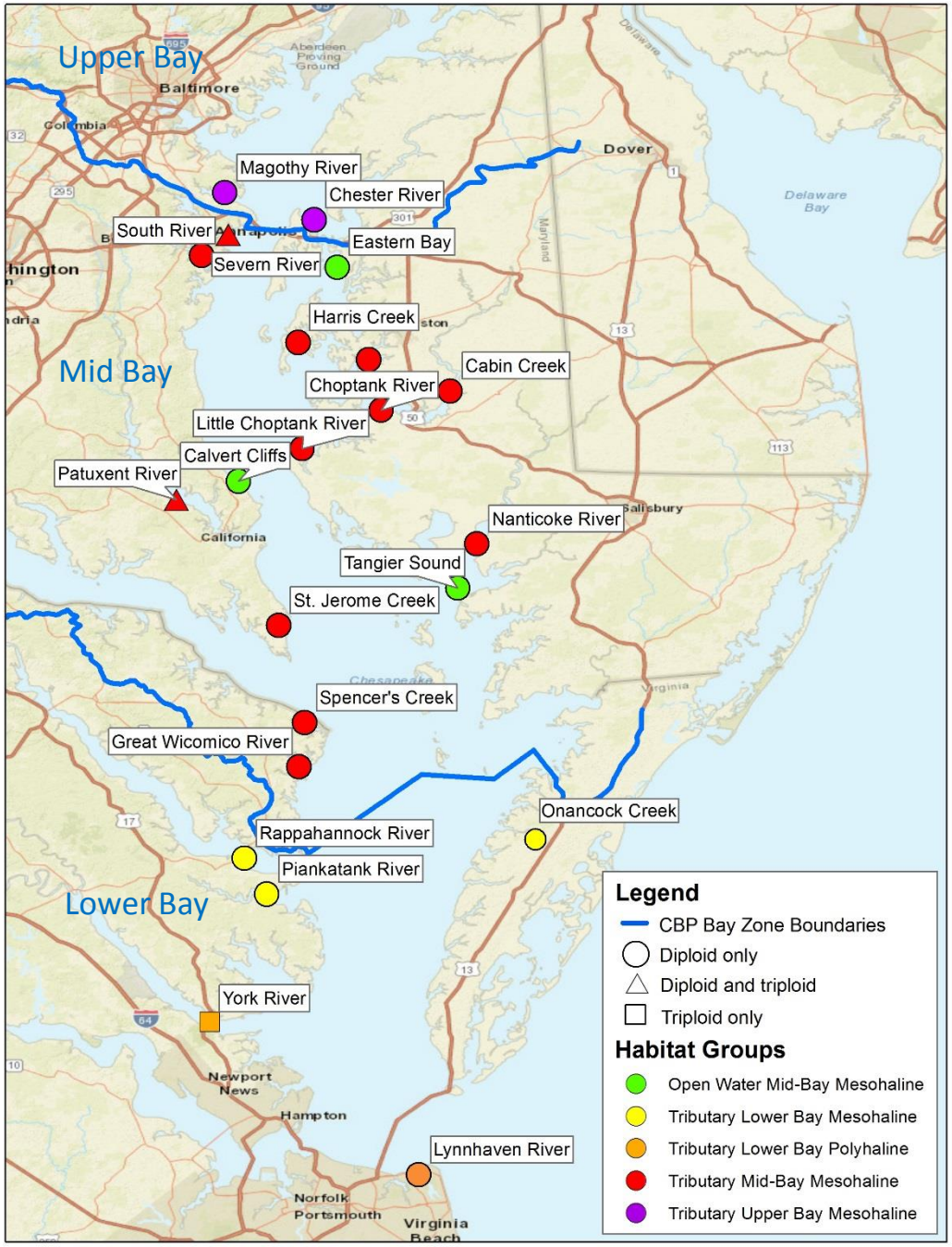
Error a = 0.00006
Error b = 0.03427



Triploid $y = 0.00005x^{2.39}$

Error a = 0.00002
Error b = 0.08846

Regression equations based on 50th quantile

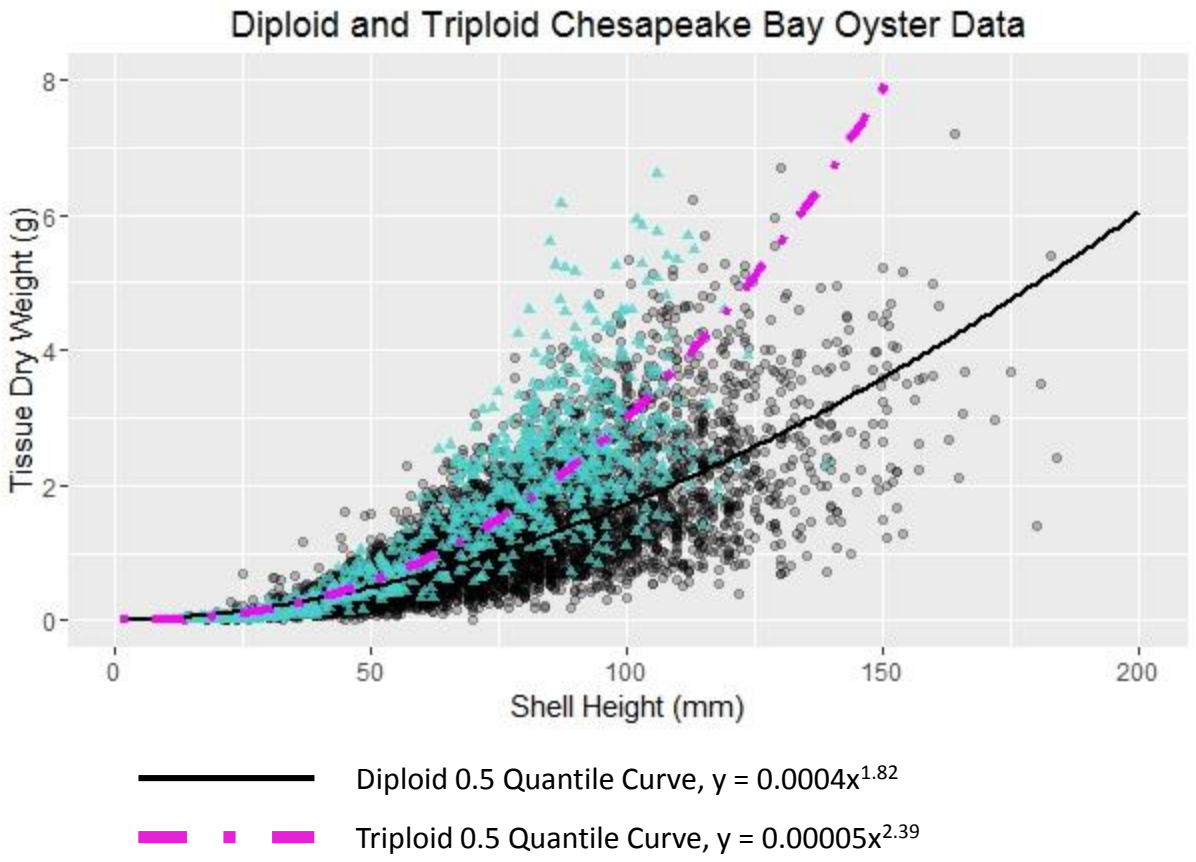


Data Locations Used for Regression Equations

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

- To look at the potential influence of site and environmental condition on the oyster shell height to tissue dry weight regression, the oyster data was 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).

Overall, triploid oysters had more biomass at smaller shell heights than diploid oysters



Oyster Size Classes and Midpoints to Apply with Regression Equations

Oyster Size Class Range (Shell Height in inches)		Oyster Size Class Range (Shell Height in mm)	Approximate Shell Height Midpoint (in inches)	Shell Height Midpoint to Use with Regression Equation (Shell Height in mm)
i.	**2.0 - 2.49**	~50 - 63	2.25	57
ii.	**2.5 - 3.49**	~64 - 88	3.0	76
iii.	**3.5 - 4.49**	~89 - 114	4.0	102
iv.	**4.5 - 5.49**	~115 - 139	5.0	127
v.	**≥ 5.5***	≥ 140	6.0	152

*Midpoint based on 5.5-6.49 range

Reduction Effectiveness Estimates for N and P Assimilated in Oyster Tissue

Oyster Size Class Range	Diploid Tissue Dry Weight (g/oyster)*	Default Diploid N Content (g/oyster)***	Default Diploid P Content (g/oyster)****
A. 2.0 - 2.49	0.63	0.05	0.01
B. 2.5 - 3.49	1.06	0.09	0.01
C. 3.5 - 4.49	1.81	0.15	0.02
D. 4.5 - 5.49	2.70	0.22	0.02
E. ≥ 5.5	3.74	0.31	0.03

Oyster Size Class Range	Triploid Tissue Dry Weight (g/oyster)**	Default Triploid N Content (g/oyster)***	Default Triploid P Content (g/oyster)****
A. 2.0 - 2.49	0.79	0.06	0.01
B. 2.5 - 3.49	1.56	0.13	0.01
C. 3.5 - 4.49	3.16	0.26	0.03
D. 4.5 - 5.49	5.33	0.44	0.05
E. ≥ 5.5	8.20	0.67	0.07

Calculated using the recommended 50th quantile regression equation using the shell height midpoint where

*Diploid: tissue dry weight (g) = 0.0004 * Shell Height (mm)$^{1.82}$

**Triploid: tissue dry weight (g) = 0.00005 * Shell Height (mm) $^{2.39}$

*** 8.2% average nitrogen content in oyster tissue dry weight (based seven 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)

****0.9% average phosphorus content in oyster tissue dry weight (based on three studies in Chesapeake Bay; same averaging approach as N, but only studies in Chesapeake Bay were found).

Nitrogen Example
(Oysters Grown in One Location)

Diploid Example	g N Removed	kg N Removed	lbs N removed
1,000,000 Size A Oysters x 0.05 g N oyster^{-1}	50,000	50	110
2,000,000 Size B Oysters x 0.09 g N oyster^{-1}	180,000	180	397
1,000,000 Size C Oysters x 0.15 g N oyster^{-1}	150,000	150	330
Total	380,000	380	**837**

Triploid Example	g N Removed	kg N Removed	lbs N removed
1,000,000 Size A Oysters x 0.06 g N oyster^{-1}	60,000	60	132
2,000,000 Size B Oysters x 0.13 g N oyster^{-1}	260,000	260	573
1,000,000 Size C Oysters x 0.26 g N oyster^{-1}	260,000	260	573
Total	580,000	580	**1,278**

Triploid oysters have more biomass than same size diploid oysters resulting in more N removed

Phosphorus Example
(Oysters Grown in One Location)

Diploid Example	g P Removed	kg P Removed	lbs P removed
1,000,000 Size A Oysters x 0.01 g N oyster^{-1}	10,000	10	22
2,000,000 Size B Oysters x 0.01 g N oyster^{-1}	20,000	20	44
1,000,000 Size C Oysters x 0.02 g N oyster^{-1}	20,000	20	44
Total	50,000	50	**110**

Triploid Example	g P Removed	kg P Removed	lbs P removed
1,000,000 Size A Oysters x 0.01 g N oyster^{-1}	10,000	10	22
2,000,000 Size B Oysters x 0.01 g N oyster^{-1}	20,000	20	44
1,000,000 Size C Oysters x 0.03 g N oyster^{-1}	30,000	30	66
Total	60,000	60	**132**

Triploid oysters have more biomass than same size diploid oysters resulting in more N removed

Methodology for Site-Specific Estimate

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

- The site-specific estimate will be based on determining the average tissue dry weight of 50 oysters per oyster size class category within 2 seasons that are 6 months apart.
  - The operation will first work with the State to define their practice-specific size class categories if using different categories than the default estimate and what timeframe to represent the two seasons (should be representative of summer and winter). The State will run these by the CBP.
  - Once approved by the State and CBP, the operation will have 50 random oysters per size class per season analyzed to determine the average tissue dry weight.
  - Panel recommends that the BMP implementer sends the samples to a lab that uses standardized methods to acquire the tissue dry weight (tissue heated at 60°C for 72 hours).
  - The average tissue dry weight for each size class will be multiplied by the 8.2% nitrogen content and 0.9% phosphorus content in oyster tissue to determine the reduction effectiveness.

- The estimate is good for 5 years and then should be re-evaluated.

Movement of Oysters

- If the operation plans to move oysters they are growing to a different waterbody segment then they have to document at what size class the oysters were at when removed from each location. The credit will be given for the number of oysters at the final removal location partitioned by their size class biomass midpoint when they were removed at each grow-out location.

    - Verification Guideline: When moved, 50 random oysters are measured and the average is used to determine what size class they are in before being transplanted into the new location.

    - Example:
        - Diploid oysters are removed from Location 1 and moved to Location 2—50 random oysters were measured and the average shell height = 2.3 mm
        - 1,000,000 diploid oysters are removed from Location 2 for harvest—50 random oysters were measured and the average shell height = 3.5 mm
        - Location 1 N reduction credit = 1,000,000*0.05 grams = **50,000 grams**
        - Location 2 N reduction credit = 1,000,000*0.15 grams = 150,000 grams minus 50,000 grams = **100,000 grams**

Unit of Measurement

- In Chesapeake Bay commercial fishermen and aquaculturists are required to quantify and report monthly oyster harvest to state management agency.

- Harvest is reported according to how oysters are packaged and sold which includes units of bushels, counts of oysters in boxes, or individual oysters (http://dnr2.maryland.gov/fisheries/Pages/aquaculture/harvest-reporting.aspx; http://mrc.virginia.gov/regulations/FR610.shtm;).

- For aquaculture, the unit of sale can vary based on the method of harvest or how an individual business markets and sells its product.

- Bottom Oyster Planting- Oysters packaged in bushel baskets will typically have a range of shell heights.

- Off Bottom Oyster Aquaculture- Harvesters typically grade the product so that batches of oysters of similar size can be harvested and marketed. Cage cultured oysters are generally packaged and sold in boxes or as individuals.

Application and Verification Guidelines

- The common element among these practices is that oysters are actively culled to a specific size by the processor to ensure they are legal or to group them uniformly for sale.

- Therefore the most reasonable expectation for oyster aquaculture nutrient reduction effectiveness crediting is to report the number of oysters harvested similar to how harvest is reported to the states.

Two crediting methods are proposed to account for oysters reported in various units.

- **Oysters of variable shell heights are packaged together in one container (more relevant to bottom growers):**
    - Oysters packaged in bushel baskets are typically culled just to make sure they are legal and therefore a range shell heights will be represented in a bushel basket.
        - **Verification Guideline:** Measure 50 randomly chosen oysters two times a year to determine the size of oysters to be credited for nutrient removal. Measurements will be conducted twice a year determined by the State to reflect the summer and winter seasons and potentially different sizes. Nutrient reduction effectiveness estimates will be applied to the oyster size category where the average shell height of all measured oysters falls.
        - Growers using this method will only be able to report in one size class category (unless oysters were moved; if so, then they will partition the credit to the appropriate locations)

- **Oysters of uniform size are packaged in separate containers (more relevant to off bottom growers):**
    - Oysters packaged in boxes and as individuals are typically sold at specific sizes for marketing.
        - Verification Guideline: Measures 50 random oysters per size class they want credit for from the summer and winter seasons. Measurements will be conducted twice a year determined by the State to reflect the summer and winter seasons and potentially different sizes. Nutrient reduction effectiveness estimates will be applied to the total number of oysters harvested within each oyster size category the implementer is reporting in.
        - Growers using this method can report in multiple size class categories.

Reporting

- Suggestions from Panel
  - Growing diploid or triploid oysters
  - Type of operation to determine which oyster practice category
  - Central coordinates (latitude and longitude) of grow-out location
  - Oyster size class category if 2.0” or greater when placed at grow-out location
  - Central coordinates (latitude and longitude) of any grow-out locations oysters are transferred to (if applicable)
  - Oyster size class category when placed at transfer location(s)
  - Month/year removed from final grow-out location
  - Number of live oysters by bushels or boxes removed per size class from final grow-out location.

- On Bottom—Current Operation: Growers choose what sizes they want to harvest as long as it’s greater than the minimum size set by regulations. Typically they put a mix of sizes into 1 bushel basket.
  - It would be up to the grower if they want to implement a change in their practice to separate out the different sizes, but however they separate it, if reporting in bushels, the average would still be used to determine which size class category it falls under for crediting (see verification guidelines in previous slide). The credit will be based on the midpoint of the size class category, not the average.

Reduction Effectiveness 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 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.