

Appendix K. Technical Requirements for Reporting and Simulating Oyster BMPs in the Phase 6 Watershed Model

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In June 2013 the Water Quality Goal Implementation Team (WQGIT) agreed that each BMP expert Panel would work with CBPO staff and the Watershed Technical Workgroup (WTWG) to develop a technical appendix for each expert report. The purpose of the technical appendix is to describe how the expert Panel’s recommendations will be integrated into the modeling tools including NEIEN, CAST and the Watershed Model.

This appendix covers the technical requirements for the following oyster BMPs:

- **Harvest-Assimilation:** Nitrogen and phosphorus assimilation in tissue of live oysters from endorsed licensed harvest using hatchery-produced oysters
- **Restoration-Assimilation:** Nitrogen and phosphorous assimilation in tissue and shell of live oysters from oyster reefs restored using hatchery produced oysters and substrate addition
- **Restoration-Denitrification:** Enhanced denitrification associated with oysters from oyster reefs restored using hatchery produced oysters and substrate addition

Technical requirements for each oyster BMP are outlined below.

K.1 Harvest-Assimilation

Q1: What types of licensed oyster harvest practices will be available for credit for nutrient reductions in the Phase 6 Model?

A1: The Panel recommends applying reduction credits in pounds (lbs) for nutrients assimilated in harvested oyster tissue for one licensed oyster harvest practice:

Practice F: Licensed oyster harvest using hatchery-produced oysters.

The enhancement activity is the planting of hatchery produced oysters in harvest areas. The form of nutrient removal is by removing oysters from the water via harvest. The reduction credits may only be applied to this practice based on the size, number, and type of oysters harvested.

Q2: What are the reduction credits for this licensed oyster harvest practice?

A2: The Panel recommends applying reduction credits in pounds (lbs) of nitrogen and phosphorous assimilated per million oysters (Table K.1). These reduction estimates were adapted from the Panel’s first report (Reichert-Nguyen et al. 2016). For this practice, the reduction estimates only apply to the harvest of diploid hatchery produced oysters. The total amount of nutrients assimilated depends on the size (shell height) of harvested oysters, whereby larger oysters assimilate more nutrients.

Table K.1 (Table 6.3 in report). Default nutrient reductions in pounds per one million harvested hatchery-produced oysters. Oyster size class based on shell height measurements.

BMP Name	Oyster size class (in)	Nitrogen (lbs./million oysters)	Phosphorus (lbs./million oysters)
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Diploid Licensed Oyster Harvest, Hatchery Produced 3.0 Inches	3.00-3.49*	198	22
Diploid Licensed Oyster Harvest, Hatchery Produced 4.0 Inches	3.50-4.49	331	44
Diploid Licensed Oyster Harvest, Hatchery Produced 5.0 Inches	4.50-5.49	485	44
Diploid Licensed Oyster Harvest, Hatchery Produced >5.0 Inches	≥ 5.50**	683	66
Diploid Licensed Oyster Harvest, Site-Specific Monitored	N/A	N/A	N/A

* Adjusted from 2.5-3.49. See text for details.

** Based on midpoint of 6.0 inches

The following conditions should be applied to estimate when and how many oysters are eligible for credit:

- **Maximum harvest allowance** – No more than 3% of hatchery produced oysters planted per planting.
- **Crediting time lag** – Oyster harvest becomes eligible for credit two years after enhancement unless an assessment is done demonstrating a timeframe less than two years is appropriate.
- **Maximum crediting timeframe** – Oyster harvest is eligible for credit for a maximum of five years after enhancement.

Q3: What credit may be given if the size of oysters harvested is not known?

A3: If the size of harvested oysters is not known, then the BMP matching the State’s minimum legal harvest size (3 inches in Maryland and Virginia – row 1 in Table 1) can be applied. States are expected to describe the minimum legal harvest requirements in their Quality Assurance Project Plan (QAPP).

Q4: How would an implementer receive credit for using site-specific reduction estimates?

A4: Site-specific reduction estimates can be estimated by establishing site-specific oyster tissue nutrient contents. The Panel recommends the process outlined in Section 6.2.5.3. Briefly, the implementer should:

- Define specific oyster size classes
- Sample oysters from the site across multiple seasons.
- Assess the average tissue dry weight for each size class based on 50 randomly selected oysters per size class and sampling period (following Mo & Neilson 1994, Carmichael et al. 2012).
- Multiply the average tissue dry weight for each size class by the default nitrogen percentage (8.2%) and phosphorus percentage (0.9%) in oyster tissue to determine the site-specific nitrogen and phosphorus content per oyster.

The implementer can also develop site-specific estimates of when and how many oysters are eligible for credit by establishing a site-specific credit time lag (Section 6.2.4) and site-specific spat survival rate (Section 6.2.3), respectively.

Q5: What should a state report to NEIEN to receive credit for the harvest-assimilation BMPs?

A5: States should report these parameters to NEIEN. Additional reporting details for the implementer are in Table 6.5 in the report.

- BMP Name: Select from list in Table K.1 above.
- Measurement Name:
 - Required (parent) - Oysters Harvested or Millions of Oysters Harvested, Unit = count, both measurements will be available in NEIEN
 - If site specific monitored
 - Required (child) – lbs TN, Unit = lbs
 - Required (child) – lbs TP, Unit = lbs
- NEIEN geographic BMP site location: [Latitude, Longitude; County; County (CBWS Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); State (CBWS Only)]
- Year eligible oysters are harvested

Q6: How will the practice be credited in the Phase 6 Watershed Model?

A6: The Phase 6 Model estimates nutrient loads in shoreline segments that can be reduced by shoreline and tidal water practices. Credit for the pounds of nutrients reduced by licensed oyster harvest will go to the shoreline segments closest to the harvest location. If geographic coordinates are not submitted, then the credit will be distributed amongst all shoreline segments in the reported geographic area.

Q7: How will credit be simulated for oysters grown at multiple locations?

A7: Hatchery produced oysters must be < 2 inches in shell height when planted on a harvest area to be eligible for credit.

Q8: Can this practice be submitted in non-tidal waters?

A8: No. This practice is only eligible in tidal waters.

Q9: Is this an annual practice?

A9: Yes. Credit can be received annually for oysters harvested 2-5 years after the enhancement activity. Only up to 3% of planted hatchery produced oysters are eligible for credit when harvested.

K.2 Restoration-Assimilation

Q1: What types of oyster reef restoration practices will be available for credit for nutrient reductions in the Phase 6 Model?

A1: The Panel recommends applying reduction credit in pounds (lbs) for nutrients assimilated in oyster tissue and shell for two oyster restoration practices:

Practice J: Oyster reef restoration using hatchery produced oysters.

Practice K: Oyster reef restoration using substrate addition.

The enhancement activity is the addition of substrate suitable for natural oyster recruitment and/or the addition of hatchery produced oysters to areas protected from harvest. The reduction credits may only

be applied to this practice based upon increases in live oyster tissue and shell biomass following restoration.

Q2: What are the reduction credits for the oyster reef restoration-assimilation practices?

A2: The Panel recommends applying reduction credits in pounds (lbs) of nitrogen and phosphorous assimilated per acre, based on an increase in live oyster tissue and shell biomass per unit area.

Q3: What is needed to calculate the reductions?

A3: Calculating the nutrient reductions requires the following:

- Baseline oyster tissue and shell biomass per unit area
- Post-restoration oyster tissue and shell biomass per unit area
- BMP site area

Q4. How are the reductions calculated?

A4. To calculate the nutrient reductions, the Panel recommends the following:

Step 1: Identify the BMP site location and determine the BMP site area

Step 2: Document the qualifying enhancement activity and its date, the type(s) of substrate used for restoration, and the baseline approach

Step 3: Assess baseline and post-restoration tissue and shell biomass and extrapolate it to determine total tissue and shell biomass estimates for the BMP site

Step 4: Determine the eligible appreciated tissue and shell biomass at the BMP site

Step 5: Convert eligible appreciated tissue and shell biomass to total nitrogen and phosphorus removed

Q5: What credit may be given if the baseline is not known for (a) progress scenarios, or (b) in hypothetical planning scenarios in the Watershed Model or CAST?

A5. (a) None. The Panel concluded that the empirical data available were too variable and sparse to recommend wide-ranging regional or Bay-wide default estimates. However, for small substrates the panel does provide a regression-based approach to simplify calculation of estimates for applicable projects.

(b) The existing planning-only BMP *oyster reef restoration – nutrient assimilation* can be used in a planning scenario within CAST based on planned acres of restoration activity. The planning-only version of oyster reef restoration – enhanced denitrification could be applied in addition to this, using planned acres of applicable projects.

Q6: How would an implementer receive credit for the restoration-assimilation practices?

A6: An implementer would receive reduction credit for nutrient assimilation if oyster tissue and/or shell biomass increased above the previously credited oyster tissue and/or shell biomass.

Q7: What should a state report to NEIEN to receive credit for the oyster reef restoration-assimilation BMP?

A7: States should report these parameters to NEIEN. Additional reporting details for the implementer are in Table 7.3 in the report.

- BMP type/name: Oyster reef restoration – assimilation
- Measurements

- Required (parent) - site area or restoration area, Unit = acres, both measurements will be available in NEIEN
- Required (child) – lbs TN, Unit = lbs
- Required (child) – lbs TP, Unit = lbs
- Optional(child) - appreciated oyster tissue and shell biomass, Unit = lbs
- Optional(child) – no. of structures, Unit = count
- NEIEN geographic BMP site location: [Latitude, Longitude; County; County (CBWS Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); State (CBWS Only)]
- Year of post-restoration biomass assessment in which oyster tissue and shell biomass appreciated above previously credited biomass

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

A8: The Phase 6 Model estimates nutrient loads in shoreline segments that can be reduced by shoreline and tidal water practices. Credit for the pounds of nutrients reduced by oyster restoration practices will go to the shoreline segments closest to the restoration location. If geographic coordinates are not submitted, then the credit will be distributed amongst all shoreline segments in the reported geographic area.

Q9: Can this practice be submitted in non-tidal waters?

A9: No. This practice is only eligible in tidal waters.

Q10: Is this an annual practice?

A10: Yes. Credit for appreciated oyster tissue and shell biomass must be applied within 12 months of the most recent post-restoration biomass assessment. Credit for newly appreciated biomass can only be applied one time.

Q11: Are there any qualifying conditions or other key criteria for this practice to be eligible for nutrient reductions in the Watershed Model?

A11: The Panel recommends the following qualifying conditions (Subchapter 7.5):

- An enhancement activity using hatchery produced oysters and/or substrate addition must occur throughout the BMP site area
- Default oyster biomass regressions can only be used for reefs restored using small substrate(s)
- The BMP site area must lie within an area protected from harvest
- At the time of planting, shell height of hatchery produced oysters must be < 1 inch. For oysters > 1 inch, only incremental growth beyond the planting size can be credited
- Baseline oyster biomass must be determined using the appropriate approach and adhere to baseline conditions
- All biomass estimates must be based on field data collected within 12 months of crediting using a survey design that ensures estimates are representative of the entire BMP site
- Biomass must be extrapolated appropriate to the scale of the BMP site
- Only nutrients associated with eligible appreciated biomass may be credited

Q12: When are oyster restoration projects eligible for credit?

A12: Credit can be given for any eligible restoration activity and gains in biomass after the creation of the TMDL in 2009 (Subchapter 7.4). Any eligible oyster restoration projects that occurred prior to 2009 can be eligible for reductions if they have the Panel-recommended data to determine gains in oyster biomass, AND if the Management Board decision from 2016 is reversed for oyster restoration practices.

K.3 Restoration-Denitrification

Q1: What types of oyster reef restoration practices will be available for credit for nutrient reductions in the Phase 6 Model?

A1: The Panel recommends applying reduction credit in pounds (lbs) for nitrogen removed from the water via enhanced denitrification associated with two oyster restoration practices:

Practice J: Oyster reef restoration using hatchery produced oysters.

Practice K: Oyster reef restoration using substrate addition.

The enhancement activity is the addition of substrate suitable for natural oyster recruitment or the addition of hatchery produced oysters to areas protected from harvest. The reduction credits may only be applied to this practice based on increases in oyster tissue biomass following restoration using small substrate in subtidal areas.

Q2: What are the reduction credits for the oyster reef restoration-denitrification practices?

A2: The Panel recommends applying reduction credits in pounds (lbs) of nitrogen per acre per year, based on the enhanced denitrification rates associated with an increase in oyster tissue biomass per unit area relative to baseline oyster tissue biomass.

Q3: What is needed to calculate the TN reductions?

A3: Calculating the TN reductions requires the following:

- Baseline oyster tissue biomass per unit area
- Post-restoration oyster tissue biomass per unit area
- Panel’s default lookup table to estimate enhanced nitrogen removal per unit area per year (Table K.2)
- BMP site area

Table K.2 (Table 8.6 in report). Partial lookup table for use in determining the annual enhanced denitrification rates. For full lookup table, see Appendix G.

Enhanced Nitrogen Removal (lbs acre ⁻¹ yr ⁻¹)		Post-restoration Oyster Biomass Range (g DW m ⁻²)												
		15 - 24.9	25 - 34.9	35 - 44.9	45 - 54.9	55 - 64.9	65 - 74.9	75 - 84.9	85 - 94.9	95 - 104.9	105 - 114.9	115 - 124.9	125 - 134.9	135 - 144.9
Baseline Oyster Biomass Range (g DW m ⁻²)	0 - 14.9	29	51	74	97	120	143	165	169	172	176	179	183	186
	15 - 24.9		23	46	68	91	114	137	140	144	147	151	154	158
	25 - 34.9			23	46	68	91	114	118	121	124	128	131	135
	35 - 44.9				23	46	68	91	95	98	102	105	109	112
	45 - 54.9					23	46	68	72	75	79	82	86	89
	55 - 64.9						23	46	49	53	56	59	63	66
	65 - 74.9							23	26	30	33	37	40	44
	75 - 84.9								3	7	10	14	17	21
	85 - 94.9									3	7	10	14	17
	95 - 104.9										3	7	10	14
	105 - 114.9											3	7	10
	115 - 124.9												3	7
	125 - 134.9													3

Q4. How are the TN reductions calculated?

A4. To calculate the TN reductions, the Panel recommends the following:

- Step 1. Identify the BMP site location and determine the BMP site area
- Step 2. Document the qualifying enhancement activity and the date it occurred
- Step 3. Determine the appropriate baseline approach
- Step 4. Assess baseline and post-restoration tissue biomass
- Step 5. Determine denitrification enhancement per unit area using either the biomass-based default denitrification rates per unit area or site-specific measured denitrification rates
- Step 6. Determine the total nitrogen removal attributable to enhanced denitrification using the estimated denitrification enhancement per unit area and the BMP site area

Q5: What credit may be given if the baseline is not known for (a) progress scenarios, or (b) in hypothetical planning scenarios in the Watershed Model or CAST?

A5. (a) None. The Panel concluded that the empirical data available were too variable and sparse to recommend wide-ranging regional or Bay-wide default estimates for nitrogen removed via enhanced denitrification (see literature review in Subchapter 8.1). Instead, the panel is recommending an approach that can use Table K.2 (Table 8.6 in report) to generate site-specific estimates of enhanced denitrification based on changes in oyster biomass that are measured to report the assimilation BMP.

(b) The existing planning-only *oyster reef restoration – enhanced denitrification* BMP can be used in a planning scenario within CAST based on planned acres of restoration activity. The planning-only version of *oyster reef restoration – nutrient assimilation* could be applied in addition to this, using planned acres of applicable projects.

Q6: How would an implementer receive credit for the restoration-denitrification practices?

A6: An implementer would receive reduction credit for enhanced denitrification if oyster tissue biomass increased above the baseline oyster tissue biomass. Credits can be applied annually for 3 years after a post-restoration biomass assessment.

Q7: What should a state report to NEIEN to receive credit for the restoration-denitrification BMP?

A7: States should report these parameters to NEIEN. Additional reporting details for the implementer are in Table 8.7 in the report.

- BMP type/name: Oyster reef restoration – enhanced denitrification
- Measurements
 - Required (parent) - site area or restoration area, Unit = acres, both measurements will be available in NEIEN
 - Required (child) – lbs TN, Unit = lbs
 - Optional(child) - annual reduction from enhanced DNF, Unit = lbs
- NEIEN geographic BMP site location: [Latitude, Longitude; County; County (CBWS Only); Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); State (CBWS Only)]
- Year the annual enhanced DNF occurred

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

A8: The Phase 6 Model estimates nutrient loads in shoreline segments that can be reduced by shoreline and tidal water practices. Credit for the pounds of nutrients reduced by oyster restoration practices will go to the shoreline segments closest to the restoration location. If geographic coordinates are not submitted, then the credit will be distributed amongst all shoreline segments in the reported geographic area.

Q9: Can this practice be submitted in non-tidal waters?

A9: No. This practice is only eligible in tidal waters.

Q10: Is this an annual practice?

A10: Yes. Credits can be applied annually for up to 3 years after the most recent post-restoration biomass assessment.

Q11: Are there any qualifying conditions or other key criteria for this practice to be eligible for TN reductions in the Watershed Model?

A11: The Panel recommends the following qualifying conditions (Subchapter 8.5):

- An enhancement activity using hatchery produced oysters and/or substrate addition must occur throughout the BMP site area
- The BMP site area must lie within an area protected from harvest
- Default oyster biomass regressions and default enhanced DNF rates can only be used for subtidal reefs restored using small substrate(s)
- All biomass estimates must be based on field data collected using a survey design that ensures estimates are representative of the entire BMP site
- Only live oyster tissue biomass is eligible for credit
- The post-restoration oyster tissue biomass must be greater than the baseline oyster tissue biomass

Q12: When are oyster restoration projects eligible for credit?

A12: Credit can be given for any eligible restoration activity after the creation of the TMDL in 2009 (Subchapter 8.4).