Oyster BMP Expert Panel – Oyster Reef Restoration Planning Estimates N and P Removal

July 8, 2019

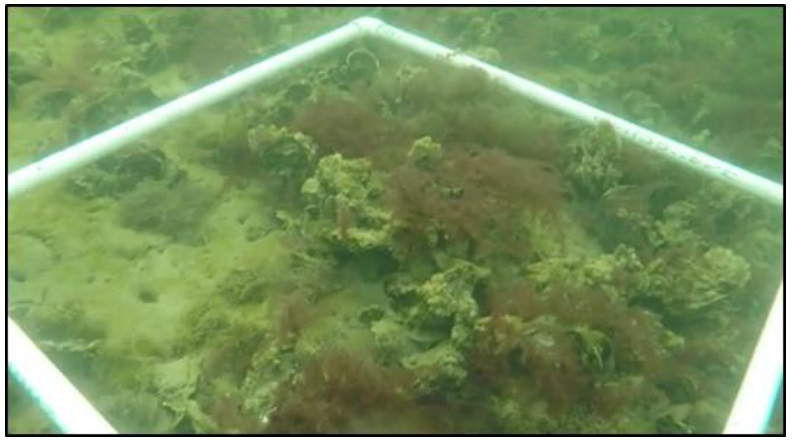
Presenters: Jeffrey Cornwell, Panel Chair,
Julie Reichert-Nguyen, Panel Coordinator
Representing many colleagues….

Approved Oyster Reef Restoration Practices for Interim BMP Use

Endorsed Oyster Practice Title	Practice Definition
J. Oyster reef restoration using hatchery-produced oysters	Planting oysters (e.g., spat-on-shell, single oysters) produced from hatchery techniques directly on the bottom or raised substrate to enhance oyster biomass in areas where removal is not permitted.
K. Oyster reef restoration using substrate addition	Planting oyster shells and/or alternative substrate directly on the bottom to attract recruitment of naturally occurring (wild) oyster larvae to enhance oyster biomass in areas where removal is not permitted.

Goal:

Provide defensible and conservative estimates of N and P reduction from assimilation in oyster tissue and shell and N reduction from enhanced denitrification associated with oyster reefs using Harris Creek data.

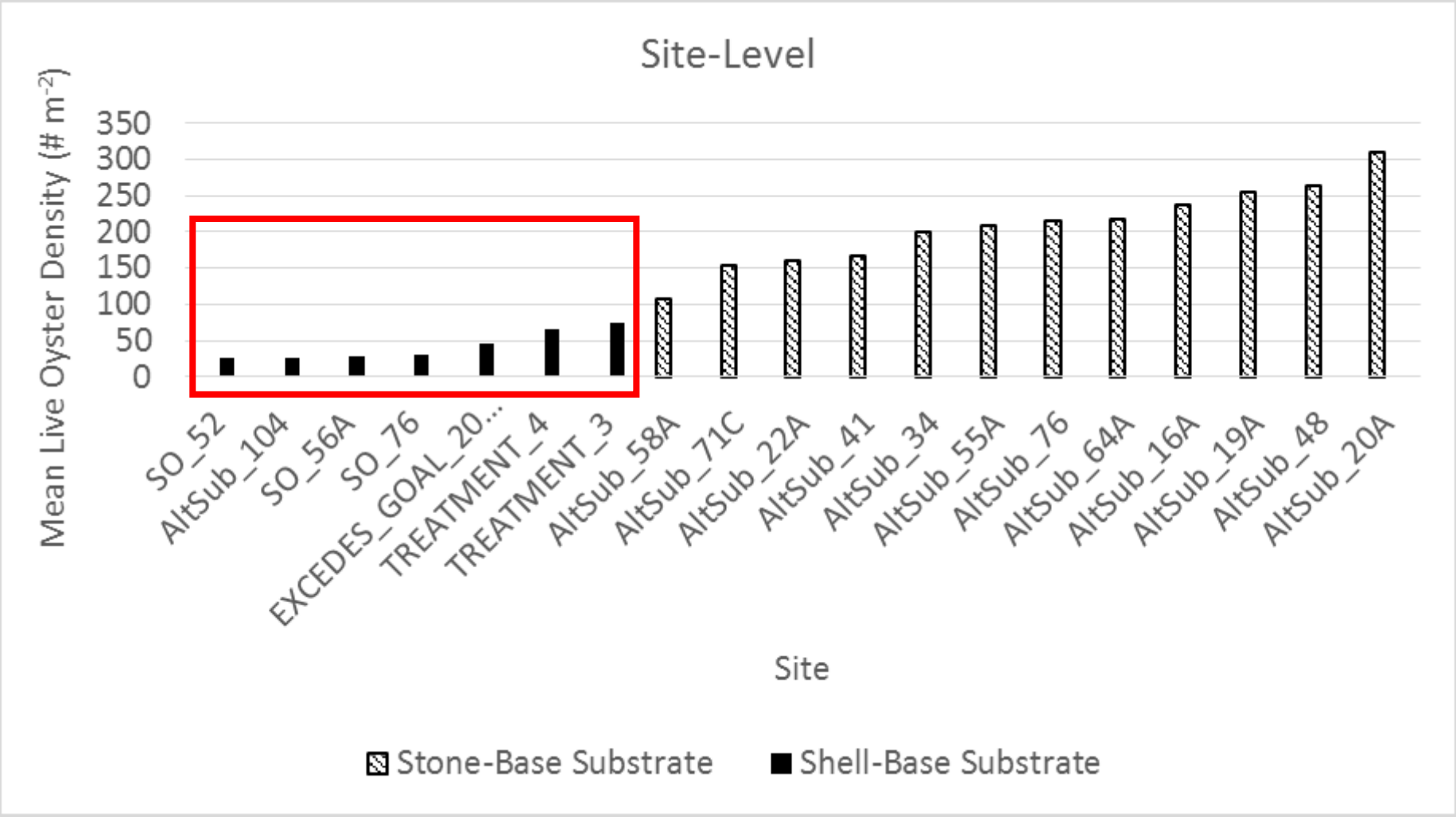


Planning Estimates for Oyster Reef Restoration BMPs Related to Nitrogen and Phosphorus Assimilation Based on Harris Creek Data and Draft Recommendations from the Oyster BMP Expert Panel

Julie Reichert-Nguyen and Ward Slacum, Oyster Recovery Partnership

Harris Creek Data Three Years Post Restoration Activities

2017/2018 Sampling

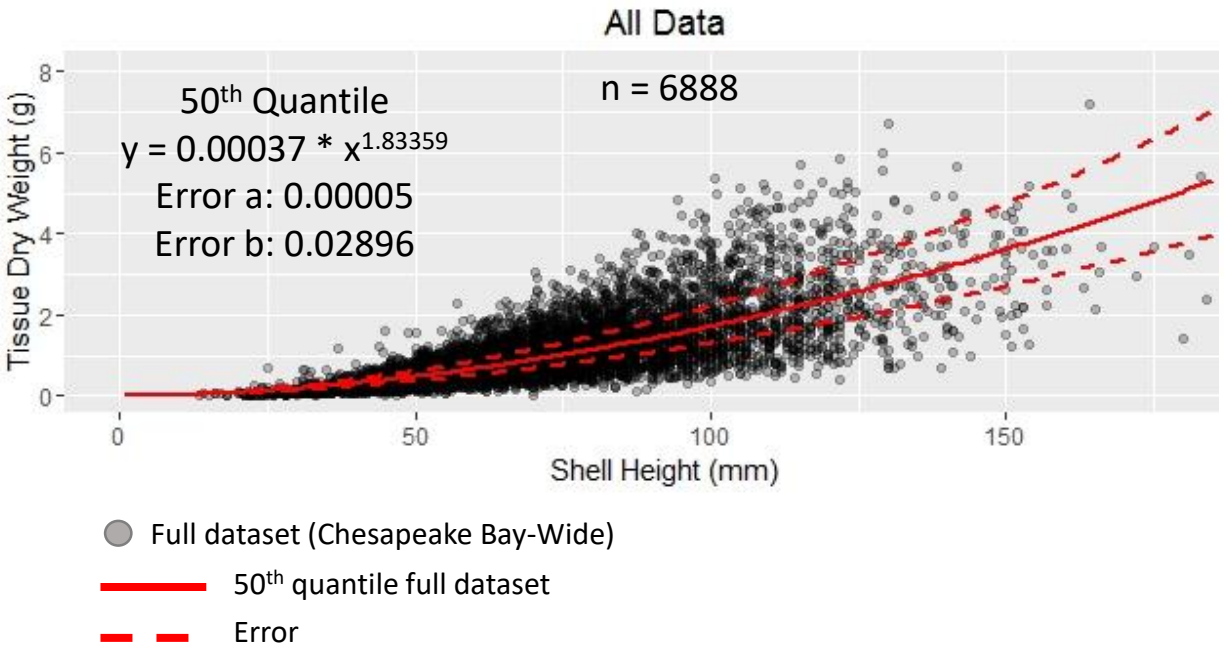


We are taking a conservative approach….

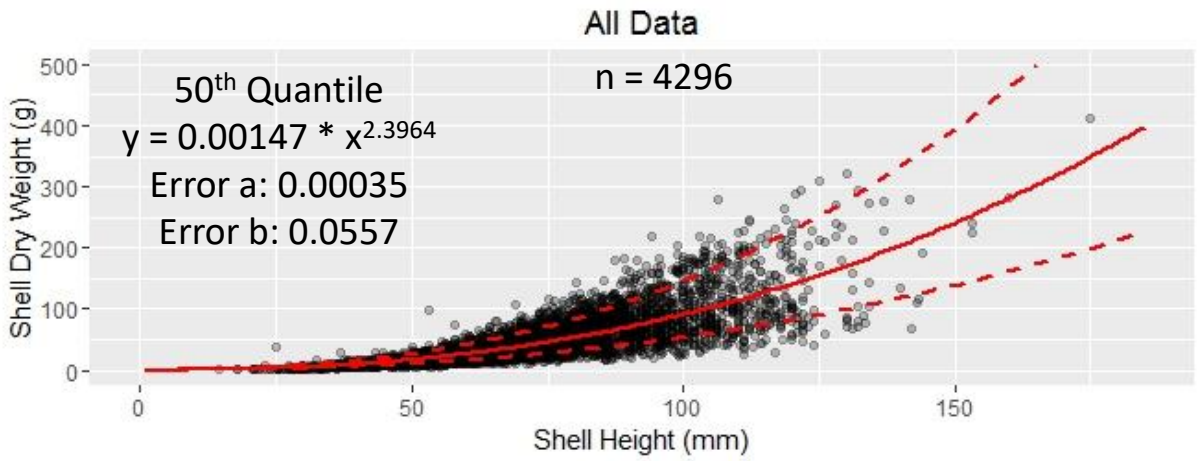
Calculating N & P Assimilation In Tissue & Shell

- Used the Oyster BMP Expert Panel's recommended Chesapeake Bay-wide shell height to dry weight regression equations (in draft).

Chesapeake Bay Oyster Tissue Reef Data



Chesapeake Bay Oyster Shell Reef Data



- The average nitrogen (tissue: 8.2%, shell: 0.2%) and phosphorus (tissue: 0.9%, shell: 0.04%) percent contents were used to calculate the amount sequestered in the live oyster tissue and shell biomass (tissue percent contents approved by CBP, Cornwell et al. 2016; shell percent contents in draft).

N & P Assimilation Interim BMPs—Combined Tissue & Shell
Based on 2017/2018 Harris Creek Data (Shell-Base Sites)

Oyster Reef Restoration-Assimilation Estimates for Planning		
Live Oyster Tissue + Shell Reduction Effectiveness	lbs acre^{-1} year^{-1} (max duration = 3 years)	
Treatment Category	Nitrogen	Phosphorus
Shell-Base + SOS n = 7 sites Mean Live Density = 42 oysters m^{-2}	24	4

- Planning estimates are one time credits expressed as annual rates. Can be applied for a total of three years on acres where substrate (shell or alternative substrate, such as granite or stone) and/or hatchery-produced SOS were planted.
- The total N and P reduction (tissue plus shell) ~ 74 lbs acre^{-1} and 12 lbs acre^{-1}, respectively.
- Represents a mean live oyster tissue and shell biomass of ~ 45 and 2300 g m^{-2}, respectively, three years post-restoration.

N & P Assimilation Conclusions

- The N and P reduction effectiveness for the oyster reef restoration-assimilation BMPs are driven by oyster tissue and shell biomass
  - Data from Harris Creek provided the largest dataset to determine conservative planning estimates
  - Reflects potential oyster tissue and shell biomass three years post restoration

- Planning estimates can be applied more broadly for other restoration projects in the Chesapeake Bay for planning purposes

- Should not be used to calculate the N and P reduction for crediting purposes
  - Oyster densities, and consequently, tissue and shell biomass, can vary quite significantly depending on the restoration activity and location
  - For crediting purposes, site-specific data should be acquired to determine the oyster tissue and shell biomass following the Oyster BMP Expert Panel's recommendations

- Planning estimates can apply for a max duration of three years
  - Unknown at this time whether there are additional increases in oyster tissue and shell biomass beyond three years post restoration.

A Planning Estimate for an Oyster Reef Restoration Enhanced Denitrification Rate Based on Harris Creek Data

Jeffrey Cornwell, UMCES

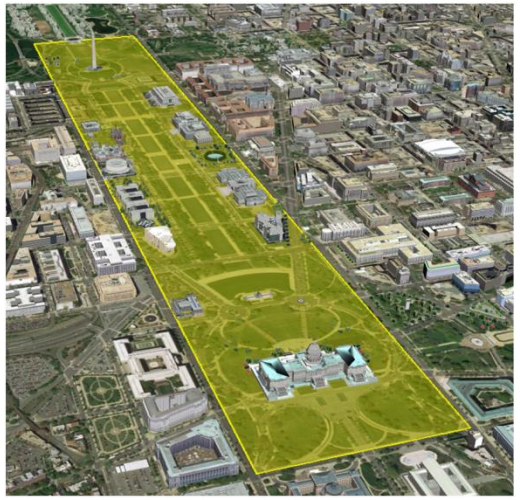
M. Lisa Kellogg, VIMS

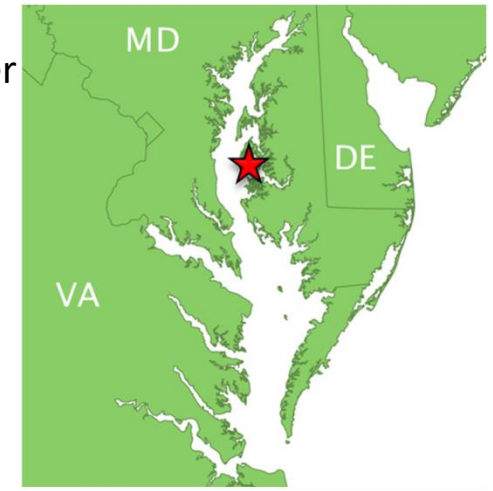
Michael S. Owens, UMCES

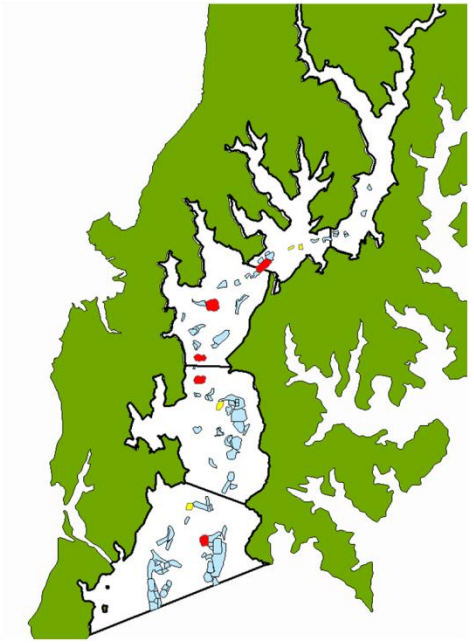
Julie Reichert-Nguyen, Oyster Recovery Partnership

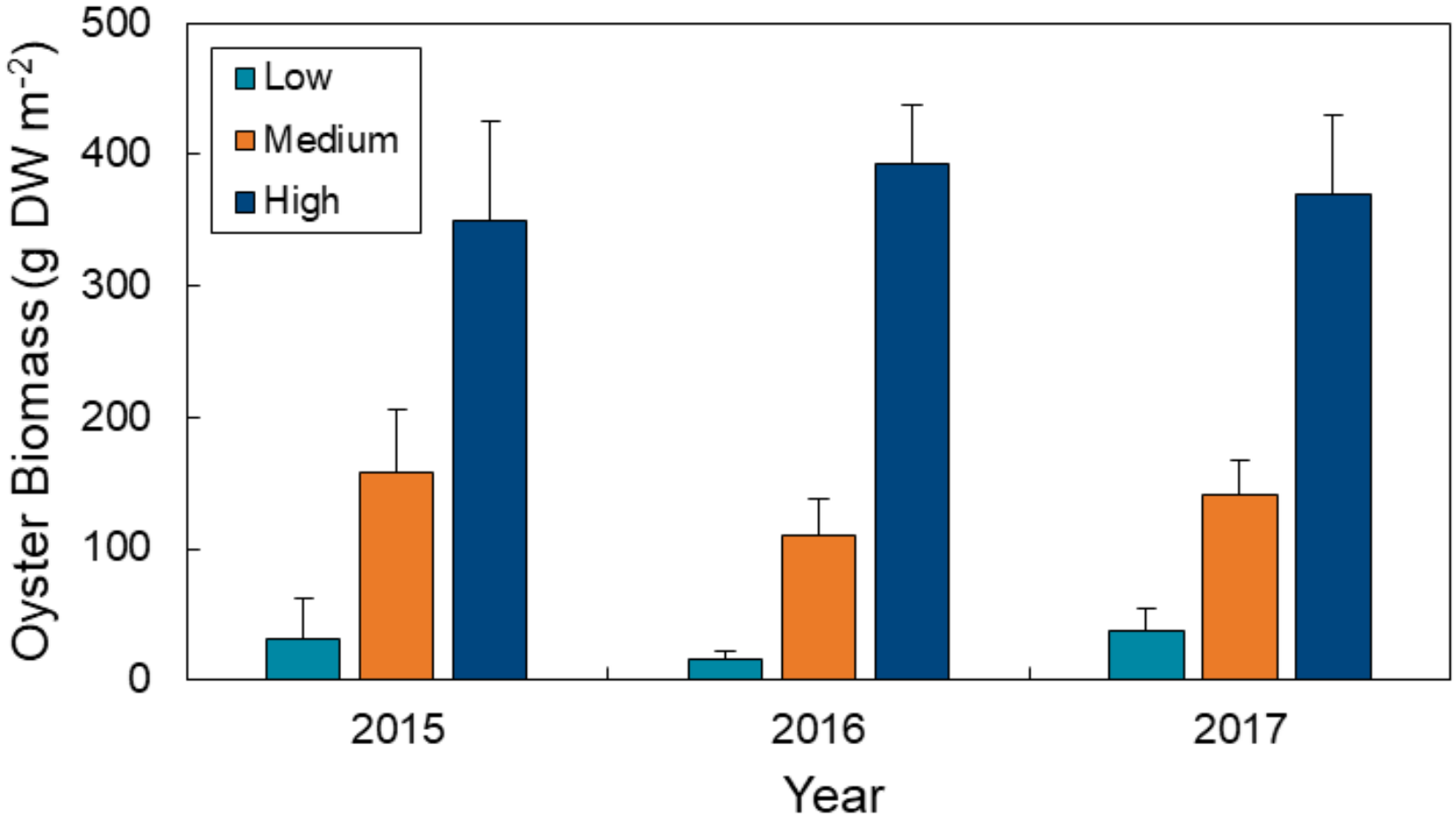
Harris Creek, MD

- ~350 acres planted with juvenile oysters set on oyster shell
- Cost ≈ $28 million
- What are the benefits?









Biomass class definition for denitrification analysis. The data used here are from summer tray incubations used for the determination of oyster biomass and do not include the accumulation of shell and organisms other than oysters. Categories used were low (<75 g DW m^{-2}), medium (75 - 225 g DW m^{-2}), and high (> 225 g DW m^{-2}) based on summer data (June-August).

	Enhanced Dark Denitrification Reef Rate ($\mu mol\ m^{-2}\ h^{-1}$)			Enhanced Light Denitrification Reef Rate ($\mu mol\ m^{-2}\ h^{-1}$)		
Oyster Tissue Biomass Category	***Spring***	***Summer***	***Fall***	***Spring***	***Summer***	***Fall***
Low	58	122	-13	140	210	0
Medium		248	41		259	51
High	370	296	67	674	367	99
Mean hours per day	9.7	9.7	12.2	14.3	14.3	11.8

	Daily Denitrification Reef Enhancement ($\mu mol\ m^{-2}\ d^{-1}$)			Denitrification Reef Enhancement during Measured Timeframe ($\mu mol\ m^{-2}\ 184\ d^{-1}$)
Oyster Tissue Biomass Category	***Spring***	***Summer***	***Fall***	***Sum of Season x Eligible Crediting Days***
Low	2,558	4,183	-160	454,425
Medium		6,112	1,096	629,202
High	13,218	8,115	1,980	1,277,154
Eligible Crediting Days	31	92	61	184

	Net Denitrification Reef Enhancement ($lbs\ acre^{-1}\ y^{-1}$)			
Oyster Tissue Biomass Category	***Spring***	***Summer***	***Fall***	***Annual Total Based on 184 Eligible Crediting Days***
Low	10	48	-1	**57**
Medium		70	8	79
High	51	93	15	160

Enhanced Denitrification Conclusions

- The most conservative estimate for nitrogen removal via denitrification comes from the low oyster tissue biomass estimate of 57 lbs N $acre^{-1}$ y^{-1}
  - Based on 184-day timeframe of measured values
  - Appropriate for extrapolation to the whole Harris Creek restoration area and for other restoration sites in Chesapeake Bay for planning purposes

- Should not be used to calculate the N reduction for crediting purposes
  - Site-specific estimates are needed to address variability in denitrification values

- Note: N reduction from assimilation and enhanced denitrification protocols are additive