Update on the Oyster BMP Expert Panel's Draft Recommendations for the Second Incremental Report

Fisheries GIT

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Innovation for a better future
University of Maryland
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Oyster Recovery Partnership | ORP

Chesapeake Bay Program
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Oyster BMP Expert Panel Charge

- Panel convened September 2015
- Charge
  - Establish a decision framework to determine the nutrient and suspended sediment reduction effectiveness of oyster BMPs
    - Framework built into 1st report, approved in December 2016
  - Use the framework to evaluate oyster practices with available science
    - Private oyster aquaculture BMPs for oyster tissue evaluated, resulted in approval (1st report)
    - First shellfish BMPs available for use to help meet water quality standards in Chesapeake Bay

In Today's Update

Recommendations the Panel has been working on:

- A strategy to determine the potential nitrogen and phosphorus reduction effectiveness associated with shell from oysters harvested from private aquaculture for BMP consideration.

- Rationale for site-specific estimates to determine the nitrogen reduction effectiveness related to the enhanced denitrification for oyster reef restoration and private oyster aquaculture practices.

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**
  - 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 from harvested oysters given that shells should be returned to the Bay? Can credit be given for temporary removal?

Incremental Recommendations

- 1st Report (approved)
- 2nd Report (in draft)
- 3rd Report (planned)

D - Default estimate recommended

S – Method for site-specific estimate recommended

? – Estimate determination pending until gaps are filled

R - Research gap

P - Policy gap

TBD - To be decided whether to undergo BMP consideration

X - Practice not endorsed for BMP consideration

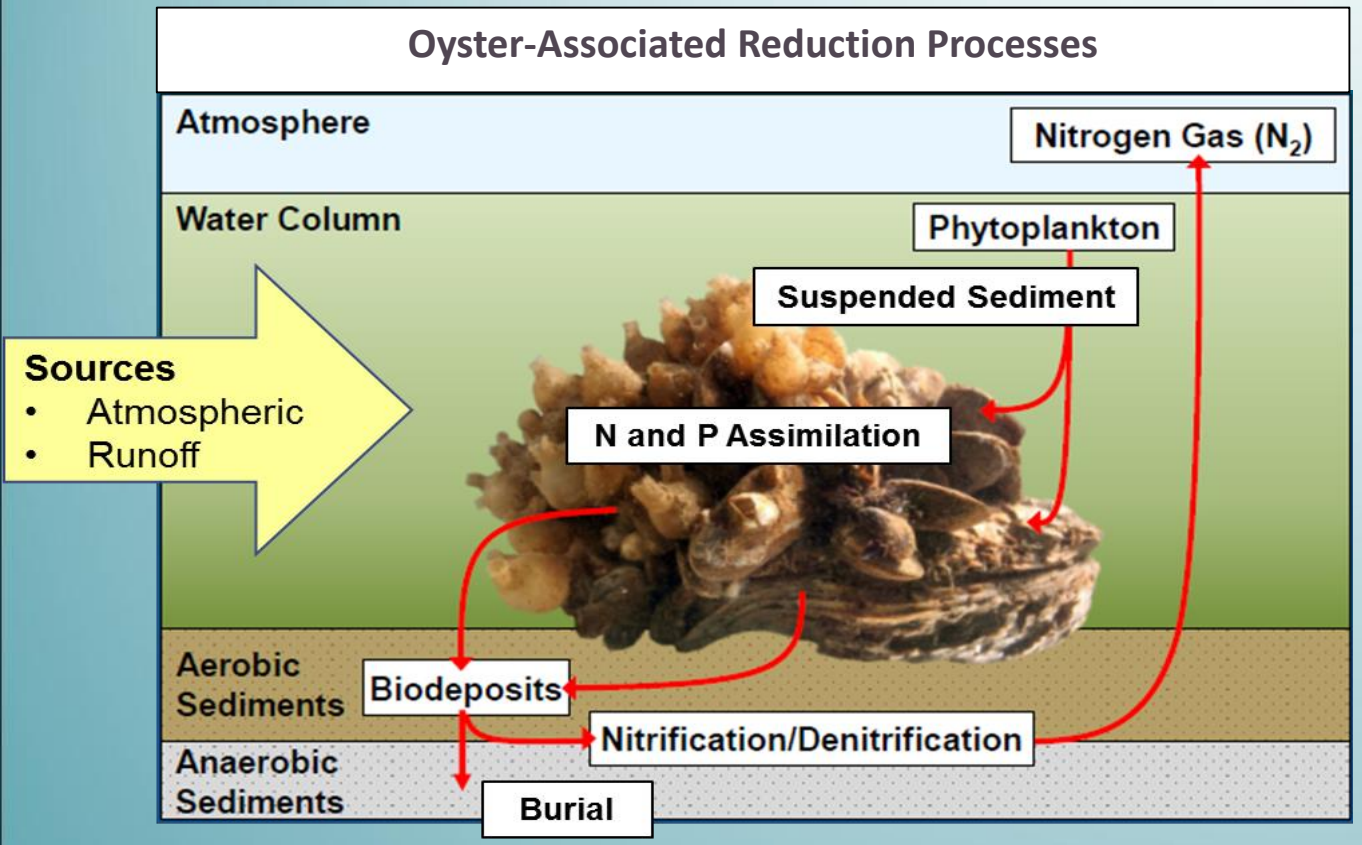
On hold - Sequestration policy/legal issue

	Chesapeake Bay Oyster Practices											
	Private Oyster Aquaculture					Public Fishery				Oyster Reef Restoration		
Oyster Practice Category-Reduction Effectiveness Protocol Combination	A. Off-bottom private oyster aquaculture using hatchery-produced oysters	B. On-bottom private oyster aquaculture using hatchery-produced oysters	C. On-bottom private oyster aquaculture using transplanted wild oysters	D. On-bottom private oyster aquaculture using substrate addition	E. Private oyster aquaculture with no activity	F. On-bottom public fishery oyster production using hatchery-produced oysters	G. On-bottom public fishery oyster production using transplanted wild oysters	H. On-bottom public fishery oyster production using substrate addition	I. Public fishery with no activity	J. Oyster reef restoration using hatchery-produced oysters	K. Oyster reef restoration using substrate addition	L. Designated oyster reef no harvest area
1. Nitrogen Assimilation in Oyster Tissue	D/S	D/S	X	D/S	X	TBD	TBD	TBD	TBD	On hold	On hold	On hold
2. Nitrogen Assimilation in Oyster Shell	? R/P Gap	? R/P Gap	X	? R/P Gap	X	TBD	TBD	TBD	TBD	On hold	On hold	On hold
3. Enhanced Denitrification Associated with Oysters	S	S	X	S	X	TBD	TBD	TBD	TBD	S	S	? - P gap consensus not met
4. Phosphorus Assimilation in Oyster Tissue	D/S	D/S	X	D/S	X	TBD	TBD	TBD	TBD	On hold	On hold	On hold
5. Phosphorus Assimilation in Oyster Shell	? R/P Gap	? R/P Gap	X	? R/P Gap	X	TBD	TBD	TBD	TBD	On hold	On hold	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	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	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	On hold	On hold	On hold	On hold

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 is verifiable	Practical method exists, or could be developed, to track reduction effectiveness
4	Identified unintended consequences are manageable	Negative effects can be addressed so they don't outweigh environmental benefits

Reduction Effectiveness Protocols based on Oyster-Associated Nutrient/Suspended Sediment Reduction Processes



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

N and P Assimilation in Oyster Shell: Strategy to Determine the Reduction Effectiveness for Private Oyster Aquaculture Practices (DRAFT)

1. Can shell weight be reliably determined from shell length measurements?

Yes ✓ Can use same approach as tissue for default values

2. Can N and P content in shell be quantified?

Yes ✓

3. Can credit be given in a way that does not disincentivize shell recycling?

Yes ✓ Assume 100% of shell removed is returned to the Bay

4. Dissolution Approach: Can a reasonable estimate of dissolution losses be obtained from the literature?

No, not feasible at this time due to research gap

5. Is the loss rate feasible for a BMP?

?

6. Recommend appropriate sequestration estimate that includes deduction for dissolution

Waiting on resolution of legal issue concerning sequestration for in water BMPs

Method to Determine Conservative Default Values for the Amount of Nitrogen and Phosphorus Stored in Oyster Shell

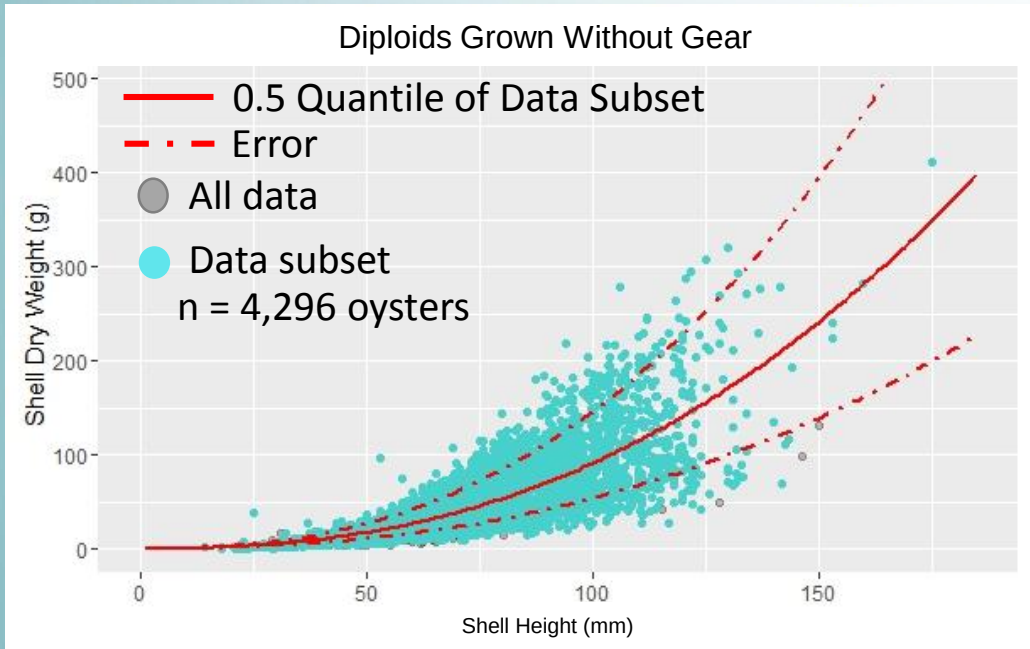
Step 1: Determine the oyster shell height to shell dry weight relationship using quantile regression.

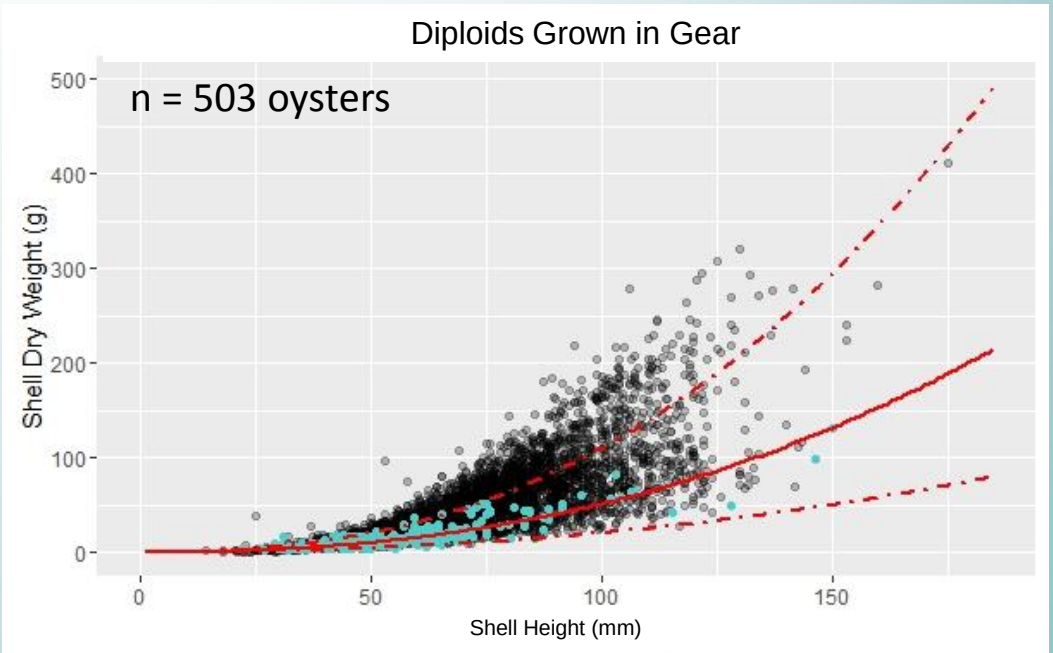
- Shell dry weight needed to determine the amount of N and P stored in shell.
- Quantile regression uses the median of the data—less influenced by extremes (good statistical approach to use with highly variable data).
- Allows for consideration of various oyster growth influencing factors: ploidy, culture method and type, location/environment, and season.

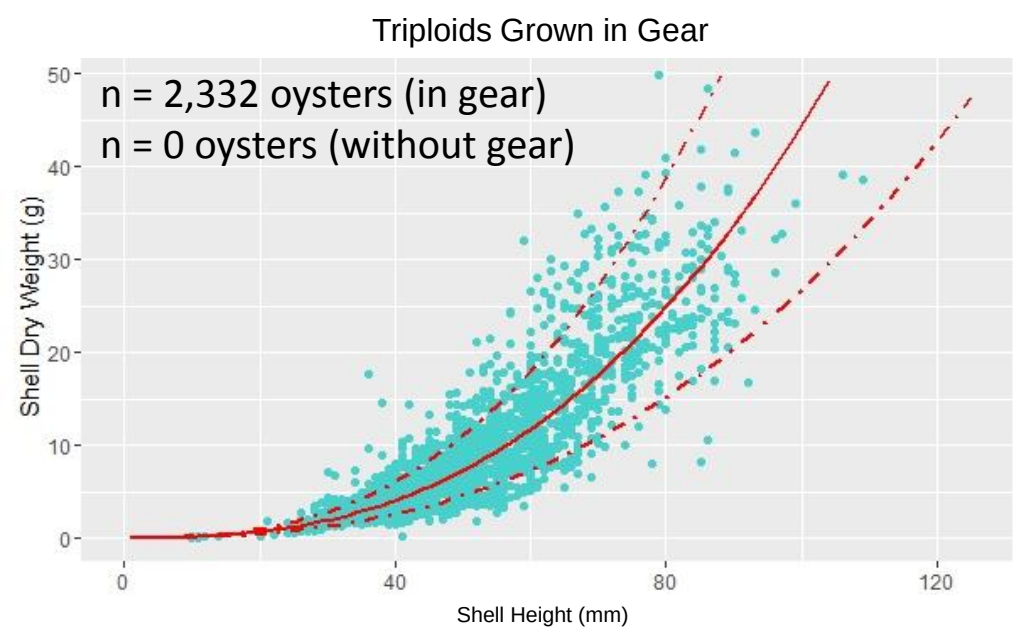
Step 2: Oyster size class ranges from first report are used to calculate the oyster shell dry weight with regression equations from Step 1.

Step 3: The amount of N and P sequestered for the different size classes is determined by multiplying the shell weights from Step 2 by percent nitrogen and phosphorus content in oyster shell.

Method to Determine Amount of N and P Stored in Shell







Panel conclusions so far:

- Agreed that there is sufficient data to reliably determine shell weights from shell height data.
- Agreed that ploidy (diploid and triploid) and culture methods (with and without gear) should have separate regression equations.
- Season and location effects currently being evaluated
- Literature review showed that **average N content in shell = 0.20% and P = 0.04%**

Evaluation of Shell Dissolution Literature

- Five studies evaluated loss of carbonate shell structure but not the loss of N and P, and some studies did not differentiate between shell loss from dissolution and shell loss from burial.

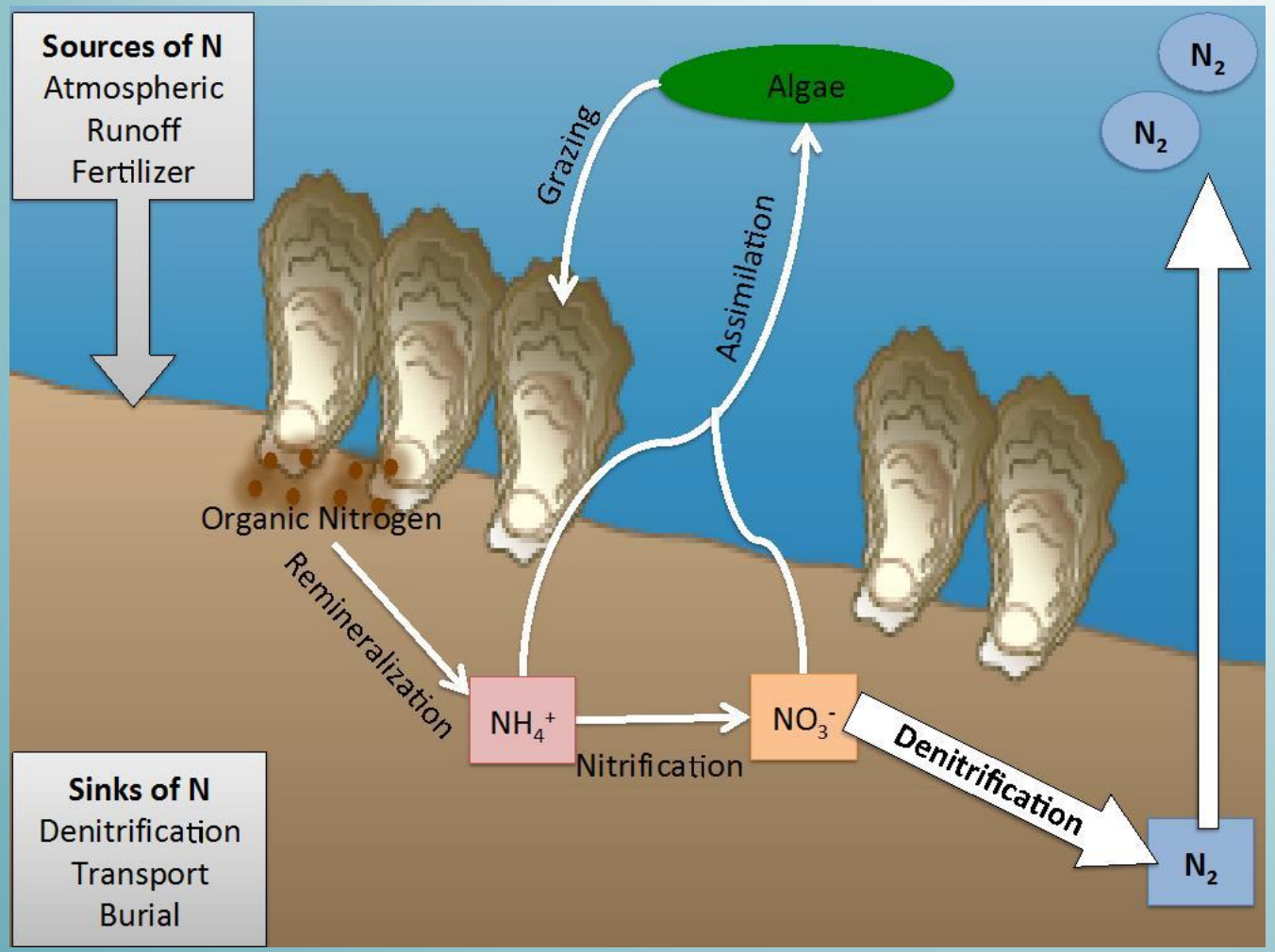
- One study (Waldbusser et al. 2011) measured carbonate dissolution rates directly, but may not adequately account for what is happening in the field because it was a laboratory study over a short period of time.

- With existing science, the Panel is not confident in assigning a default reduction to account for N and P that may dissolve back into the water when shells are returned to the Bay.

Conclusions So Far: N and P Assimilated in Oyster Shell Protocol for Private Oyster Aquaculture

- There is a potential reduction associated with the amount of N and P sequestered in harvested shell, but the reduction effectiveness can't be determined at this time due to lack of information on dissolution rates for shells returned to the Bay.
- Panel recommends separate shell height to shell weight regression equations for diploid with gear and diploid without gear.
- Panel recommends a separate triploid regression equation using available triploid with gear data.
- Literature review showed that **average N content in shell = 0.20% and P = 0.04%**

Enhanced Denitrification Associated with Oysters – Concept



- Algae contains nitrogen, which can become bioavailable though remineralization.
- Oysters filter algae from the water column, decreasing the potential for remineralization and transferring the process to the sediments via biodeposits.
- Through this process, denitrification can be enhanced (N_2 gas is released).
- Enhanced denitrification is defined as the amount of new denitrification that can occur because of the presence of oysters.

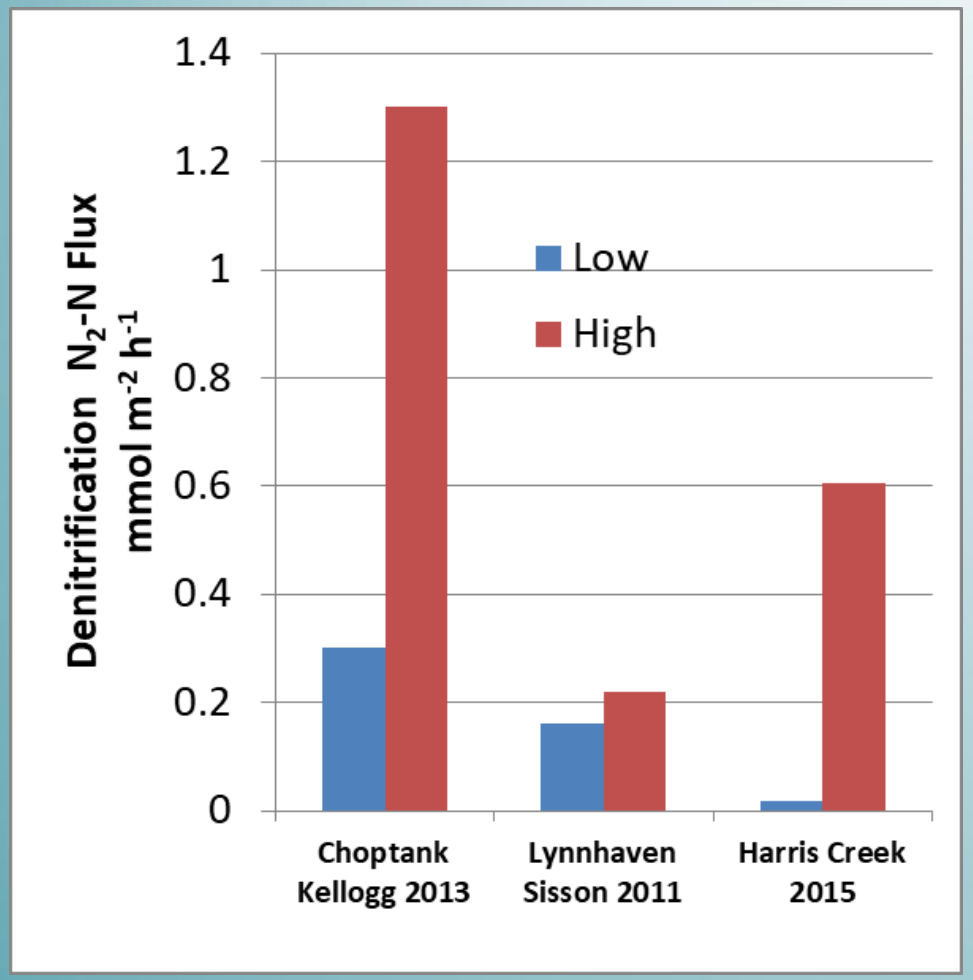
Image Credit: Ashely Smyth, jappliedecologyblog.wordpress.com/2015/05/20/location-matters-for-oyster-reef-ecosystem-services/

Enhanced Denitrification Associated with Oysters – Data Availability and Challenges

- Direct measurement of net flux of N_2-N per unit area is needed
  - Denitrification would be measured at an area with oysters and a control site without oysters to calculate the nitrogen reduction potential from enhanced denitrification at the site level.
- In the Chesapeake Bay, we have more data on denitrification associated with oyster restoration and aquaculture than any other region.
  - There are still a relatively few studies.
  - Given variability in data, site-specific estimates are recommended at this time until adequate data become available to determine a default rate.
- Determining the total nitrogen reduction potential from enhanced denitrification requires knowing the fate of biodeposits.
  - Biodeposits could be denitrified elsewhere (few data exist for this parameter—research gap); measured denitrification likely underestimates the reduction.

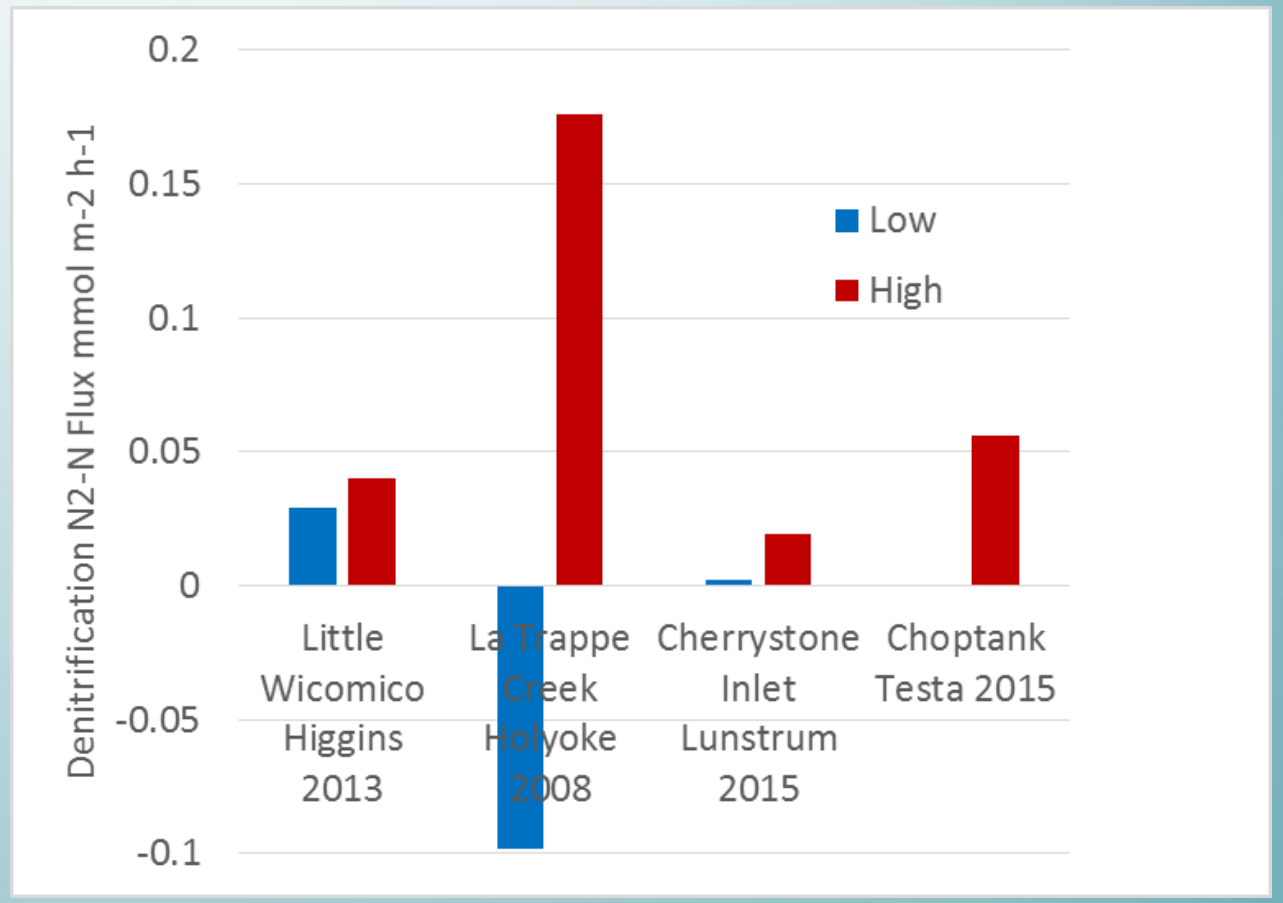
Denitrification Literature Review – High Variability

Chesapeake Bay, Restoration-Related



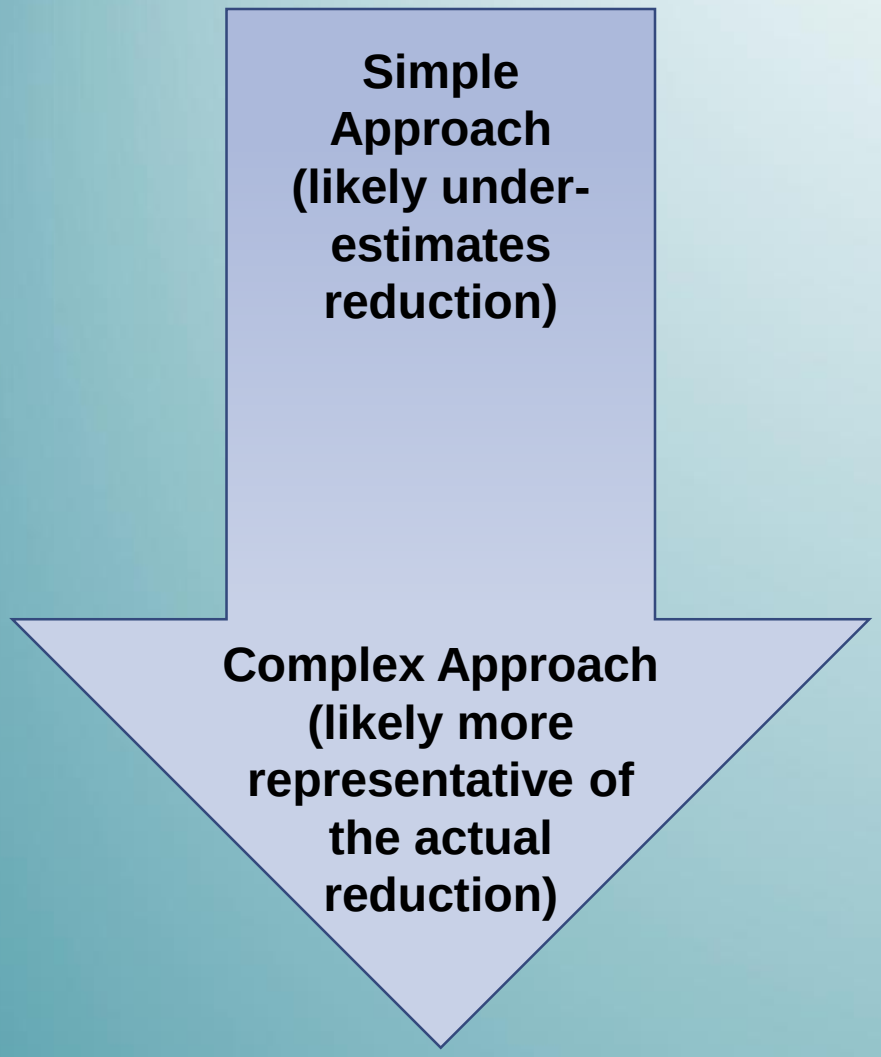
Low = minimum rate observed
High = maximum rate observed

Chesapeake Bay, Aquaculture-Related



Conclusion: Minimum data and high variability supports the need for site-specific estimates at this time.

Enhanced Denitrification Associated with Oysters – Reduction Effectiveness Determination Strategy



Simple: Apply the method that would capture the minimum enhanced denitrification rates based on literature methods (oyster site minus control site DNF rates).

Complex: Apply method that would also take into consideration the fate of biodeposits (method does not exist; research gap).

Enhanced Denitrification Associated with Oysters – Measurements Needed for Simple Approach

- Oyster site and nearby control site (suitable for oyster growth/restoration and outside the area of expected oyster practice impact).
- Different seasons to capture seasonal variability.
- A minimum number of replicates at oyster and control sites during each season to understand variability.
- All measurements should include dark incubation; if area gets sufficient light for photosynthesis, then light incubations should also be done or daylight hours should not be counted.
- Measurement to define “oyster presence” (e.g., oyster biomass).

Conclusions So Far: Enhanced Denitrification Associated with Oysters

- At present, site-specific estimates of enhanced denitrification are needed because few studies have directly measured net flux of N_2-N per unit area and resulting data are highly variable.
- If future studies identify significant relationships between oyster site characteristics and denitrification rates, default enhanced denitrification estimates could be developed.
- Accurately estimating total denitrification enhancement requires knowing the fate of all biodeposits produced, an assessment that is beyond the scope of current measurement techniques. However, the Panel believes comparison of oyster sites to control sites likely underestimates total enhancement, making this a conservative approach.
  - Panel currently working on strategies to incorporate data variance to ensure estimates are conservative.

Panel Next Steps

- **December 2017—Tentative timeframe to resolve sequestration legal question for in-water BMPs**
  - BMP consideration for shell assimilation and burial protocols would depend on these conclusions.

- **January/February 2018—Tentative 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.

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?