Photo: Oyster Recovery Partnership

Oyster Best Management Practice Expert Panel Recommendations

Webinar 1: Oyster Reef Enhanced Denitrification Protocols

February 7, 2023

This webinar will be recorded.

Oyster Recovery® Partnership | ORP

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Webinar Housekeeping

- Participants are muted automatically
- Closed captioning is enabled
- We are recording this session
- The recorded webinar link will be posted to the CBP event calendar (along with slides and all other materials)
- **Please enter your questions for the speakers into the Q&A**
  - Please provide a slide number if your question refers to a specific slide.

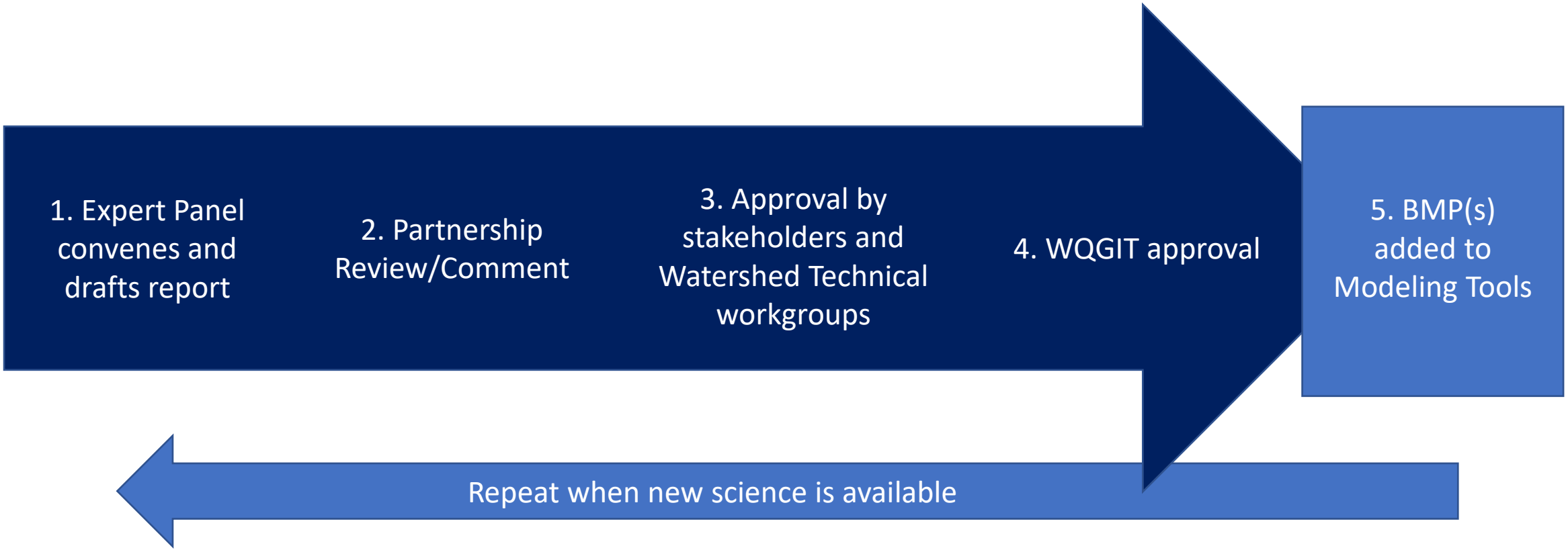
Webinar Agenda

- Introduction and Overview of BMP Panel Process
- Oyster BMP Panel Charge, Membership
- Summary of Oyster Practices
- Summary of Panel Recommendations – Enhanced Denitrification
- General Q&A

Note that:

- There are several Appendices for this report with additional detail
- Technical Appendix still under development

The “BMP Protocol” Process



Oyster BMP Approval Timeline

Jan 30 – Report posted

Feb 7 – Webinar 1: Recommendations for Oyster Reef Enhanced Denitrification Protocols

Feb 14 – Webinar 2: Recommendations for Oyster Assimilation Protocols

March 1 – Present at Fisheries GIT Meeting

March 10 – **Feedback due to** oysterBMPresponse@oysterrecovery.org

April-May – Revision, Additional presentations, Approval

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Oyster Best Management Practice Expert Panel Recommendations

Webinar 1: Oyster Reef Enhanced Denitrification Protocols

February 7, 2023

Jeff Cornwell
Panel Chair

University of Maryland
Center for Environmental Science

Olivia Caretti
Panel Coordinator

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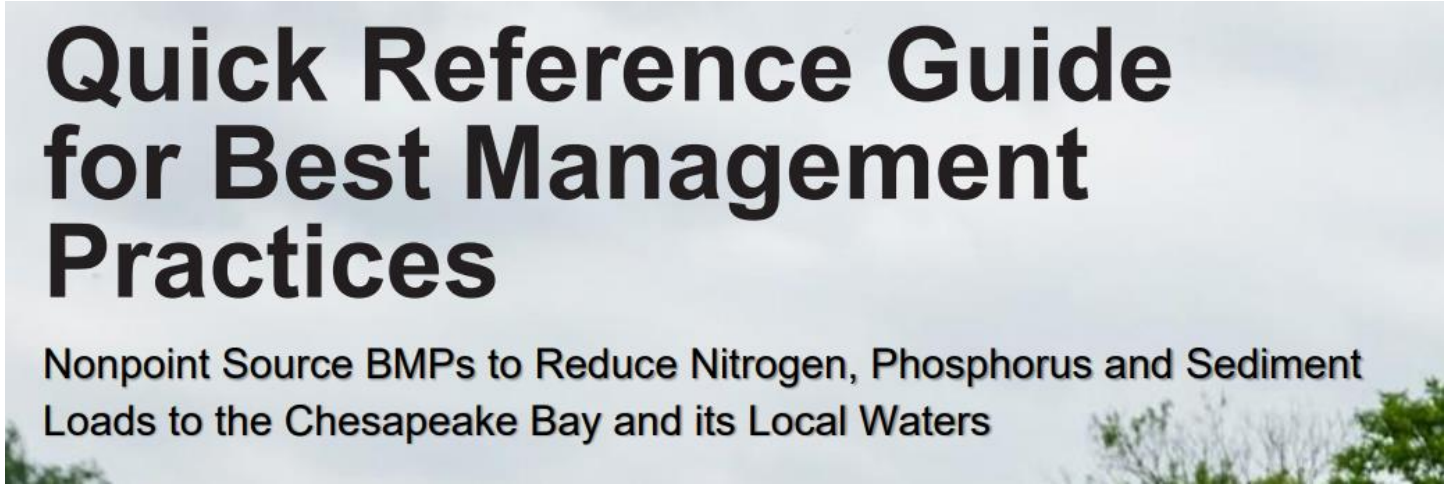
Best Management Practices (BMPs)

- Methods that are most effective and practical for preventing or reducing nutrient and sediment to achieve water quality goals
- 46+ categories of BMPs
- > 200 individual BMPs



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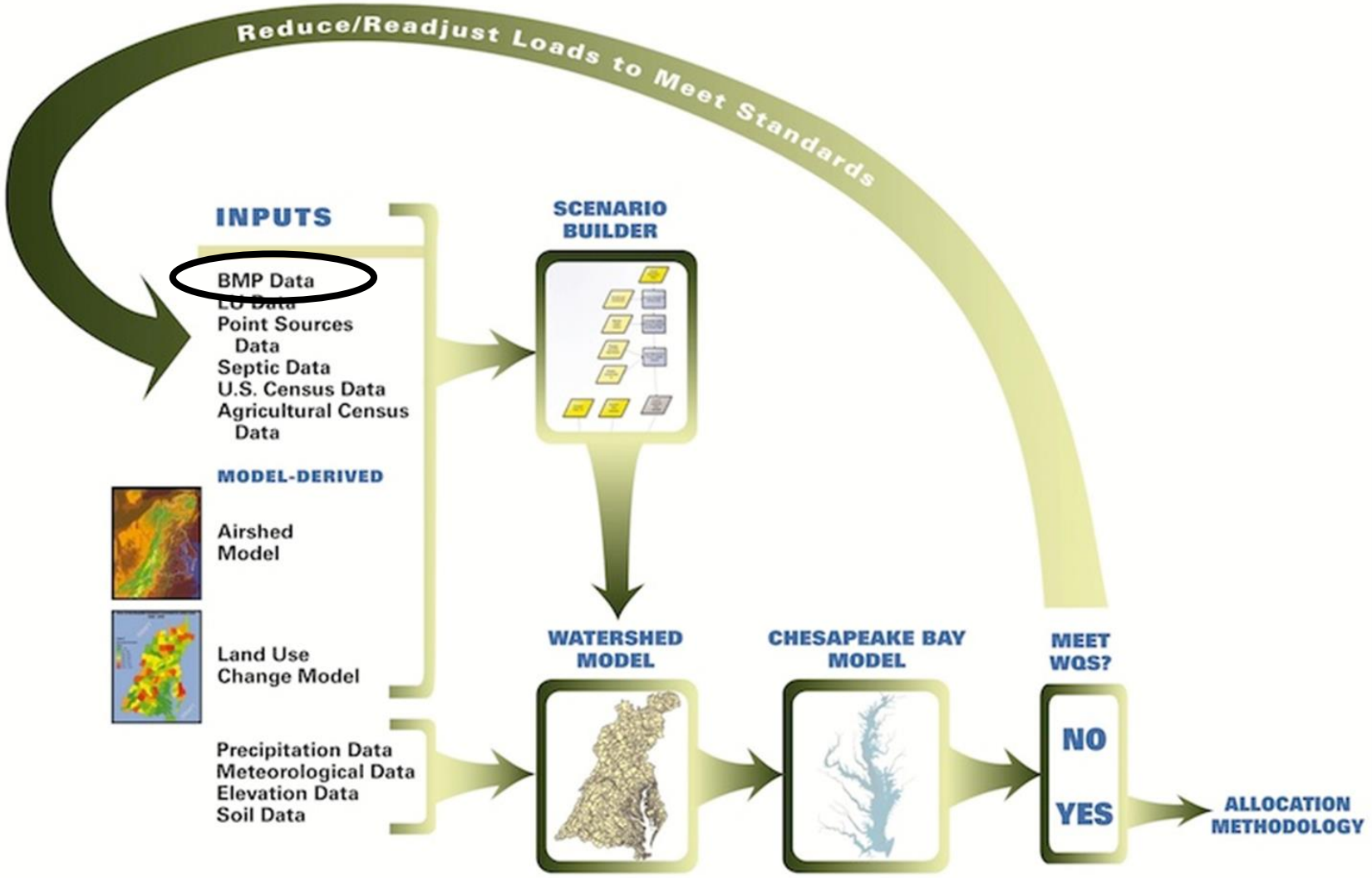
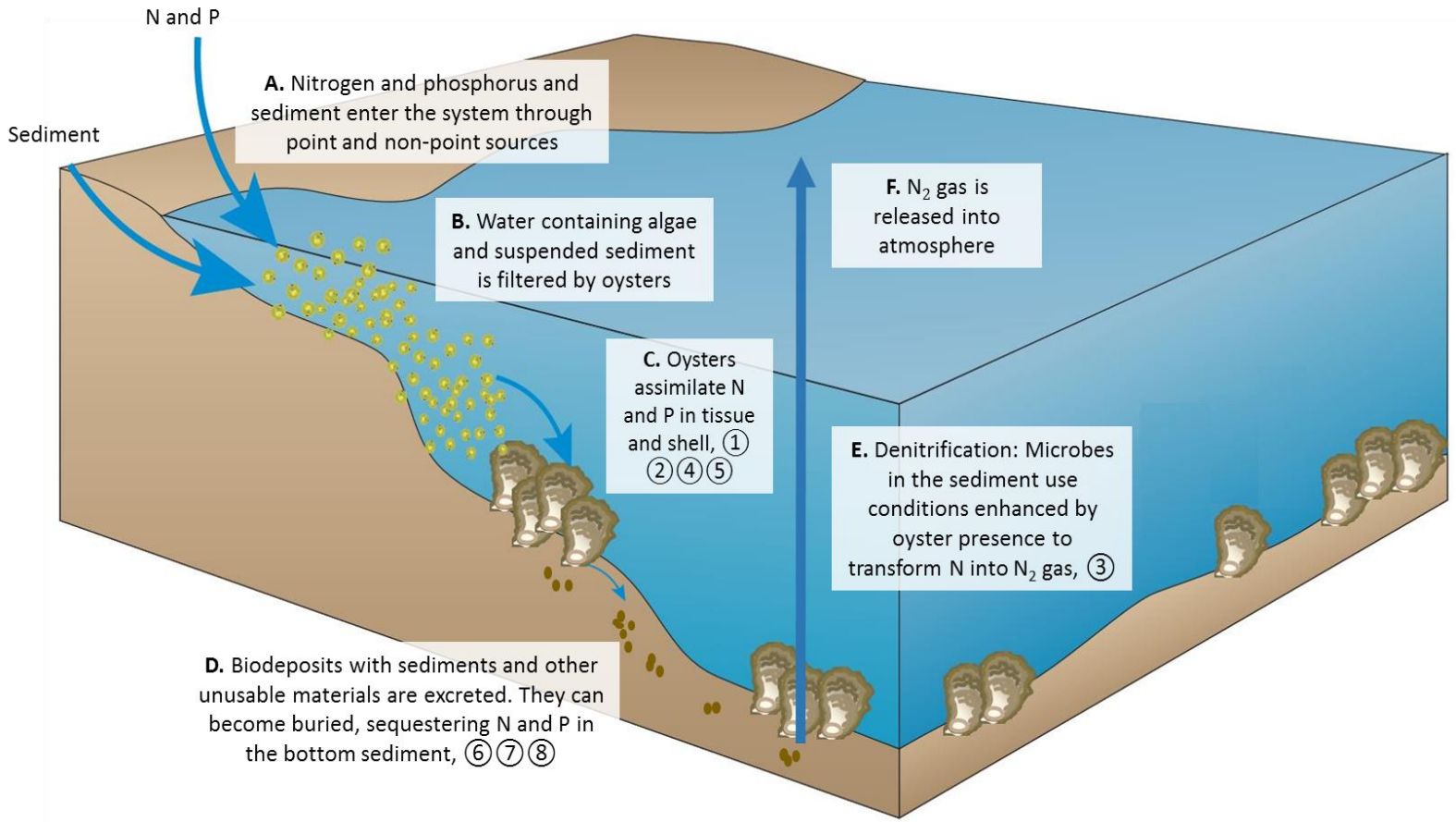
CBP Model Framework for the Chesapeake Bay TMDL



http://www.chesapeakebay.net/groups/group/modeling_team

Oysters and Water Quality



Through filtration, oysters contribute to biogeochemical cycling in estuaries

Oyster BMP Expert Panel Members

Jeff Cornwell (Chair), UMCES
Suzanne Bricker, NOAA National Centers for Coastal Ocean Science
Andy Lacatell, The Nature Conservancy
Mark Luckenbach, Virginia Institute of Marine Science
Frank Marenghi, Maryland DNR
Chris Moore, Chesapeake Bay Foundation
Matt Parker, Maryland Sea Grant
Ken Paynter, UMD Marine, Estuarine, Environmental Sciences
Julie Rose, NOAA Northeast Fisheries Science Center
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Bill Wolinski, Talbot County Department of Public Works

Advisors & Coordinators

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Special Thanks to: Lisa Kellogg (VIMS), Lynn Fegley (MDNR), Emily French (ORP), Elizabeth Franks (ORP), Paige Hobaugh (CBP), Emilie Franke (CBP), Kyle Runion (CBP), the many scientists who shared data to support this effort, support from Bay Program, modelers, and support staff

Oyster BMP Panel Charge

Charge 1. Identify and define oyster practices for BMP consideration. (1st report)

Charge 2. Develop decision framework for incremental approval of oyster BMPs (1st report)

Charge 3. Develop recommendations on N, P, and SS reduction through oyster practices based on existing science

Charge 2: Decision Framework

Decision framework for incremental approval of oyster BMPs

Step 1. Determine oyster practices and protocols for evaluation.

Does an enhancement activity increase oyster production?

Step 2. Determine the reduction effectiveness estimate based on current scientific understanding.

- Number/rate of reduction
- Equation and method to calculate the estimate

Do sufficient data exist?

Step 3. Provide verification guidelines.

Does a practical method exist, or created, to track reduction?

Step 4. Identify any unintended consequences and determine if they can be addressed.

Are there positive or negative impacts on the environment?

Charge 1: Oyster Practices

The Panel identified and defined 12 Oyster Practices

First Report (2016) | **This Report**

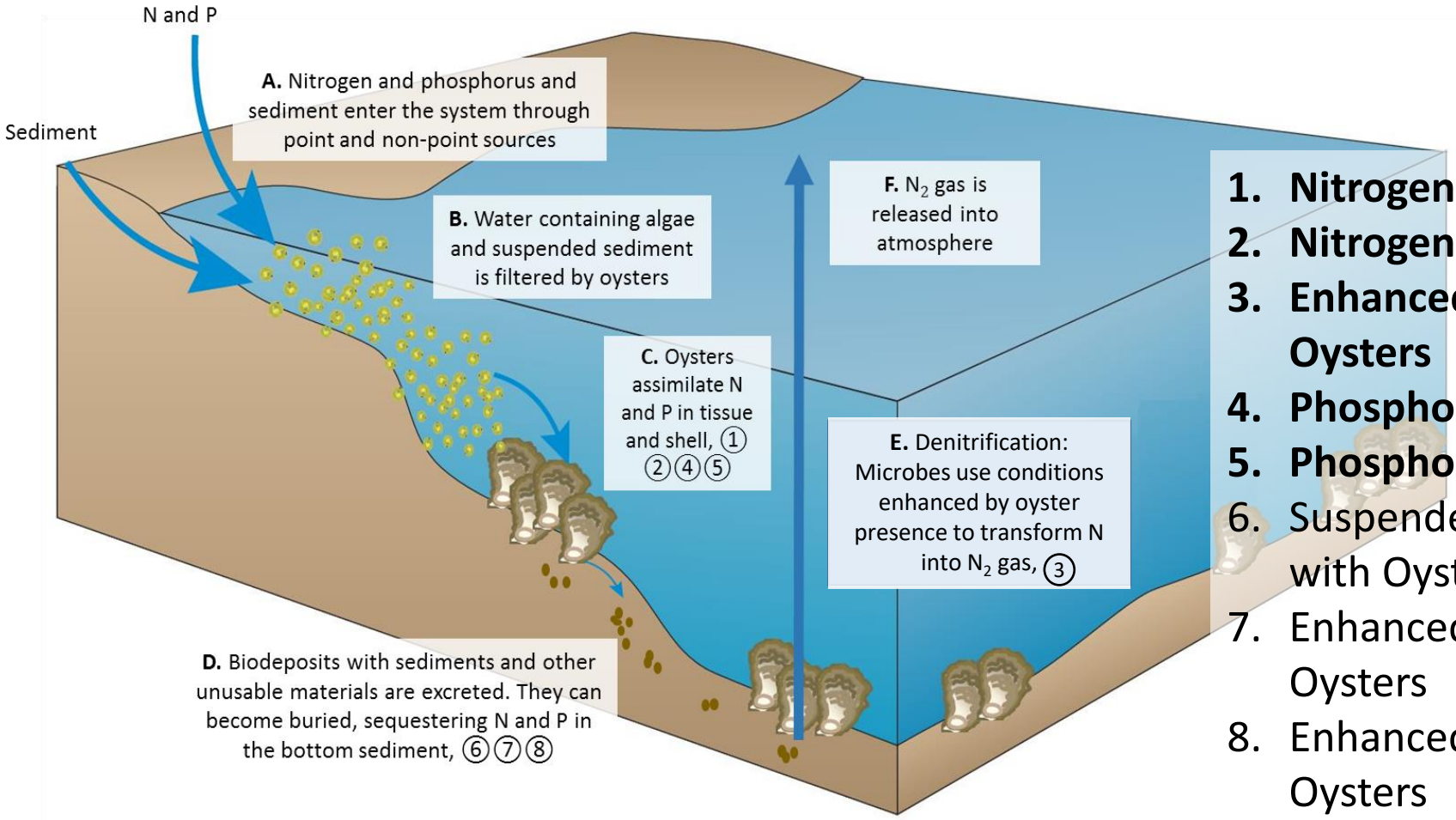
Oyster Fate	Oysters removed (harvested from Bay					Oysters remain in Bay						
Fisheries Management Approach	Oyster cultivation					Conservation						
	Private oyster aquaculture (POA)					Licensed oyster harvest (LOH)				Oyster reef restoration (ORR)		
Description	Oyster harvest from State-issued water column and bottom leases					Oyster harvest from State-managed fishing areas				No harvest allowed		
Access to Oysters	Lease-holder					License-holder				State resource management agency		
Oyster Type	Hatchery-produced oysters (HPO)		Wild oysters			HPO	Wild oysters			HPO	Wild oysters	
Activity	HPO grown off the bottom using gear	HPO grown on the bottom using no gear	Moving wild oysters from one location to another	Addition of substrate to enhance recruitment of wild oyster larvae	None	Addition of HPO	Moving wild oysters from one location to another	Addition of substrate to enhance recruitment of wild oyster larvae	None	Designate no-harvest area followed by addition of HPO	Designate no-harvest area followed by addition of substrate	Designate no-harvest area with no additional activity
Oyster Practice	**A. Off-bottom POA using HPO**	**B. On-bottom POA using HPO**	C. On-bottom POA using transplanted wild oysters	**D. On-bottom POA using substrate addition**	E. POA with no activity	**F. LOH using HPO**	G. LOH using transplanted wild oysters	H. LOH using substrate addition	I. LOH with no activity	**J. ORR using HPO**	**K. ORR using substrate addition**	L. ORR using no-harvest area designation only
Recommended for BMP?	**Yes**	**Yes**	No	**Yes**	No	**Yes**	No	Later	No	**Yes**	**Yes**	Later

Oyster Practice Definitions – This Report

Category	Oyster Practice	Description
Practice F	Licensed oyster harvest using hatchery-produced oysters	Planting oysters produced from hatchery techniques directly on the bottom to enhance the stock in State-designated fishing areas for eventual removal from the water by individuals holding the proper licenses.
Practice J	Oyster reef restoration using hatchery-produced oysters	Planting oysters produced from hatchery techniques directly on the bottom or on suitable substrate to enhance oyster biomass where removal is not permitted.
Practice K	Oyster reef restoration using substrate addition	Planting oyster shells and/or alternate substrate directly on the bottom to attract recruitment of naturally occurring oyster larvae to enhance oyster biomass in areas where removal is not permitted.

Charge 3: Recommendations for reductions

Oyster-Associated 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 Tissues**
5. **Phosphorus Assimilation in Oyster Shell**
6. Suspended Sediment Reduction Associated with Oysters
7. Enhanced Nitrogen Burial Associated with Oysters
8. Enhanced Phosphorus Burial Associated with Oysters

Key Legal Decision for Oyster Restoration BMPs

Can in-situ, permanent removal of sediment, nitrogen, and phosphorus pollutants from the estuarine water column via oyster filtration be recognized and credited as pollutant removal under the Clean Water Act?

Appendix C. EPA Legal Opinion

Recognizing Pollutant Reductions via In-situ Oyster Filtration Under the Clean Water Act

EPA Region III approved implementation of an “in-water” BMP associated with oyster N & P removal. This is the first BMP within the estuary.

The Panel’s work would not have moved forward without this designation

Charge 3: Decision Outcomes to Date

	Private Oyster Aquaculture					Licensed Oyster Harvest				Oyster Reef Restoration		
Oyster Practice Category x Crediting Protocol	A. Off-bottom private aquaculture using hatchery-produced oysters	B. On-bottom private aquaculture using hatchery-produced oysters	C. On-bottom private aquaculture using transplanted wild oysters	D. On-bottom private aquaculture using substrate addition	E. Private oyster aquaculture with no activity	F. Licensed harvest using hatchery-produced oysters	G. Licensed harvest using transplanted wild oysters	H. Licensed harvest using substrate addition	I. Licensed harvest with no activity	J. Reef restoration using hatchery-produced oysters	K. Reef restoration using substrate addition	L. Reef restoration using no harvest area designation only
1. Nitrogen assimilation in tissue	**1st Approved**	**1st Approved**	1st Not Endorsed	**1st Approved**	1st Not Endorsed	**2nd Complete**	2nd Not Endorsed	Later	2nd Not Endorsed	**2nd Complete**	**2nd Complete**	2nd Policy Issue
2. Nitrogen assimilation in shell	2nd Research Gap	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	Later	2nd Not Endorsed	**2nd Complete**	**2nd Complete**	2nd Policy Issue
3. Enhanced denitrification	2nd Research Gap	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	Later	2nd Not Endorsed	**2nd Complete**	**2nd Complete**	2nd Policy Issue
4. Phosphorus assimilation in tissue	**1st Approved**	**1st Approved**	1st Not Endorsed	**1st Approved**	1st Not Endorsed	**2nd Complete**	2nd Not Endorsed	Later	2nd Not Endorsed	**2nd Complete**	**2nd Complete**	2nd Policy Issue
5. Phosphorus assimilation in shell	2nd Research Gap	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	2nd Research Gap	2nd Not Endorsed	Later	2nd Not Endorsed	**2nd Complete**	**2nd Complete**	2nd Policy Issue
6. Suspended sediment reduction	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later
7. Enhanced nitrogen burial	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later
8. Enhanced phosphorus burial	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later	Later

1st report

This report

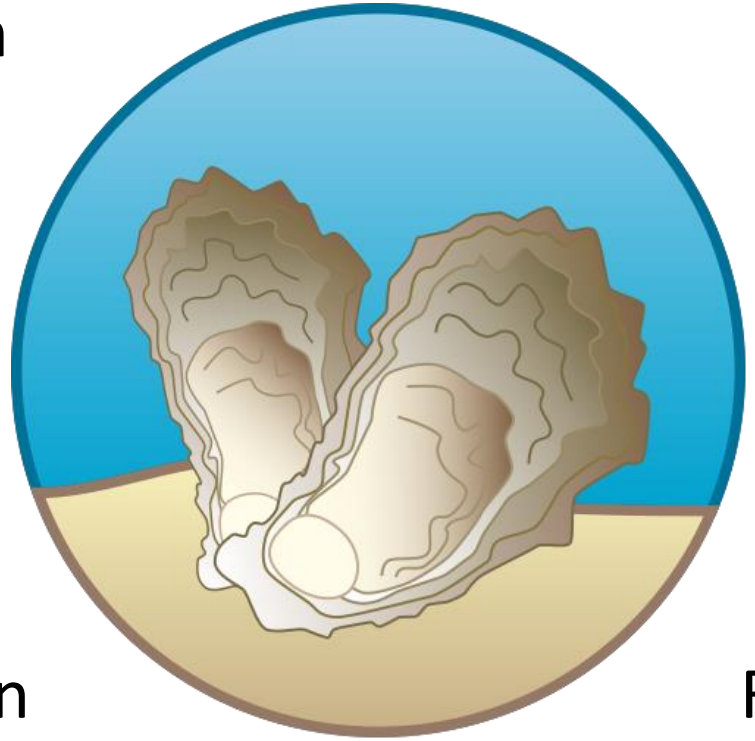
Not considered

Reviewed 45

Recommendations for 12

Elements of the Oyster BMP Toolset

Aquaculture-Assimilation
Approved



Harvest-Assimilation
Under Review

Restoration-Denitrification
Under Review

Restoration-Assimilation
Under Review

Graphic: UMCES Integrated Application Network

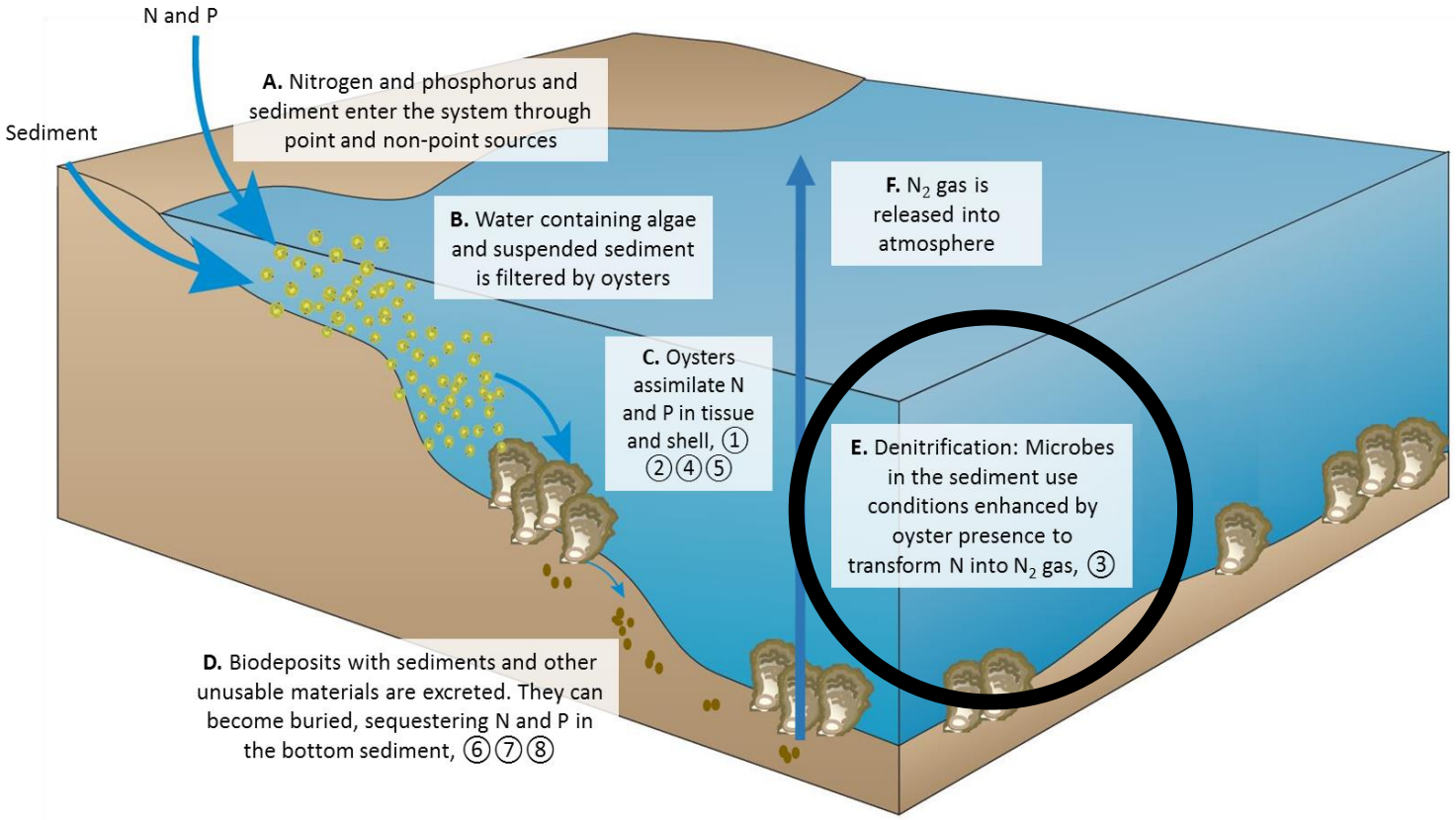
Today: Restoration-Denitrification Recommendations

<u>Oyster Practices:</u>

- **J.** Oyster reef restoration using hatchery-produced oysters
- **K.** Oyster reef restoration using substrate addition

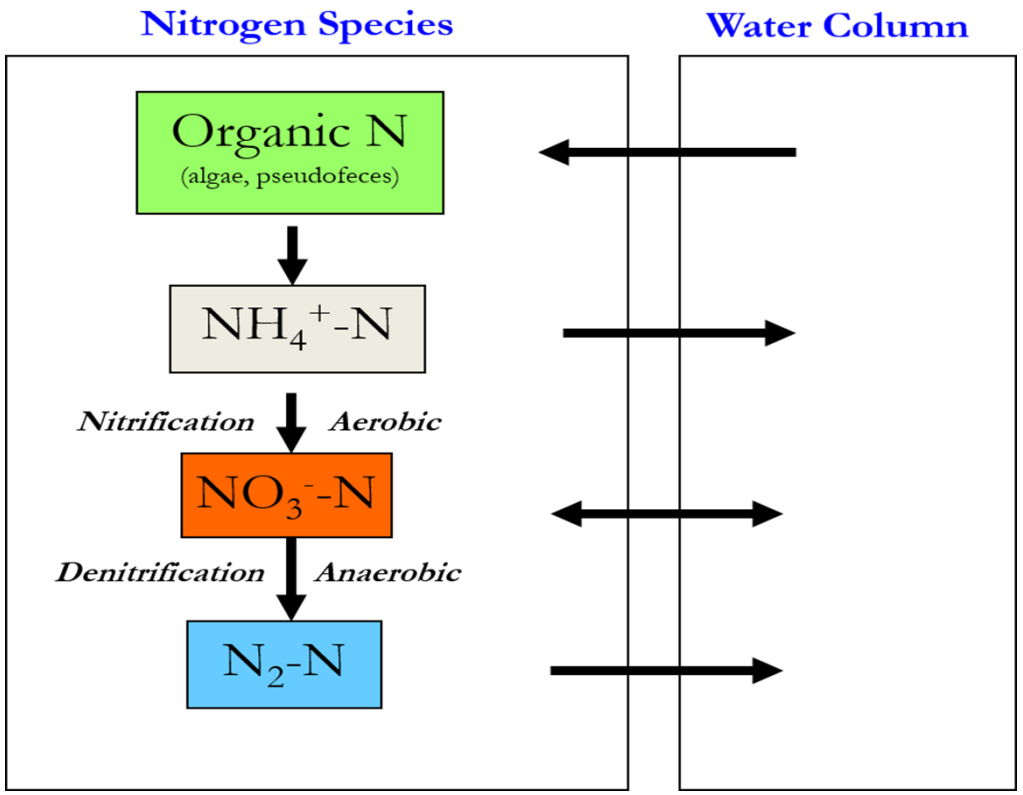
<u>Oyster Protocols:</u>

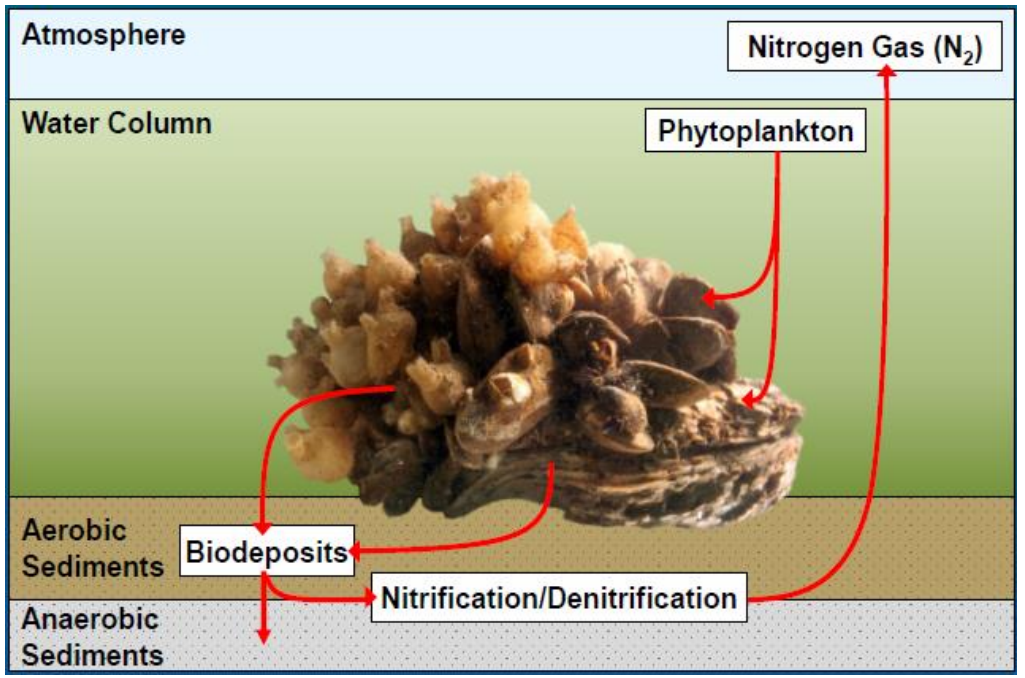
- **3.** Enhanced denitrification associated with oysters



Denitrification

- The ultimate fate of reactive nitrogen entering the Chesapeake Bay is exported to the ocean in dissolved form, as particles, or in motile organisms, burial in sediment, or **production of N_2 gas through the process of denitrification**.
- Oysters result in (much) higher rates of N_2 production relative to sediments



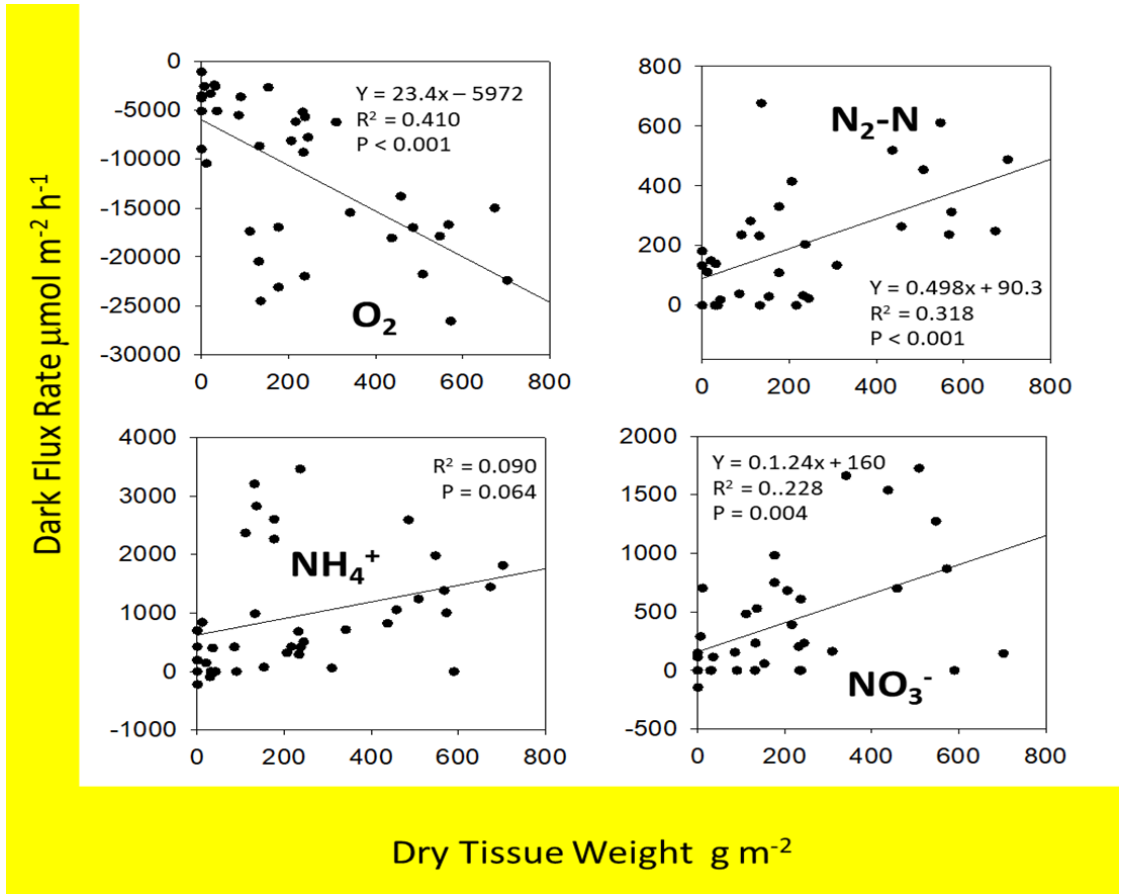


Kellogg et al. 2013

The Panel's Approach

- **Oyster tissue biomass** is used to help estimate removal of N and N_2 under different conditions

- Denitrification is an ongoing process
- If the reef biomass does not decrease substantially, the credit will be **continuous**.
- Re-evaluate biomass every 3 years



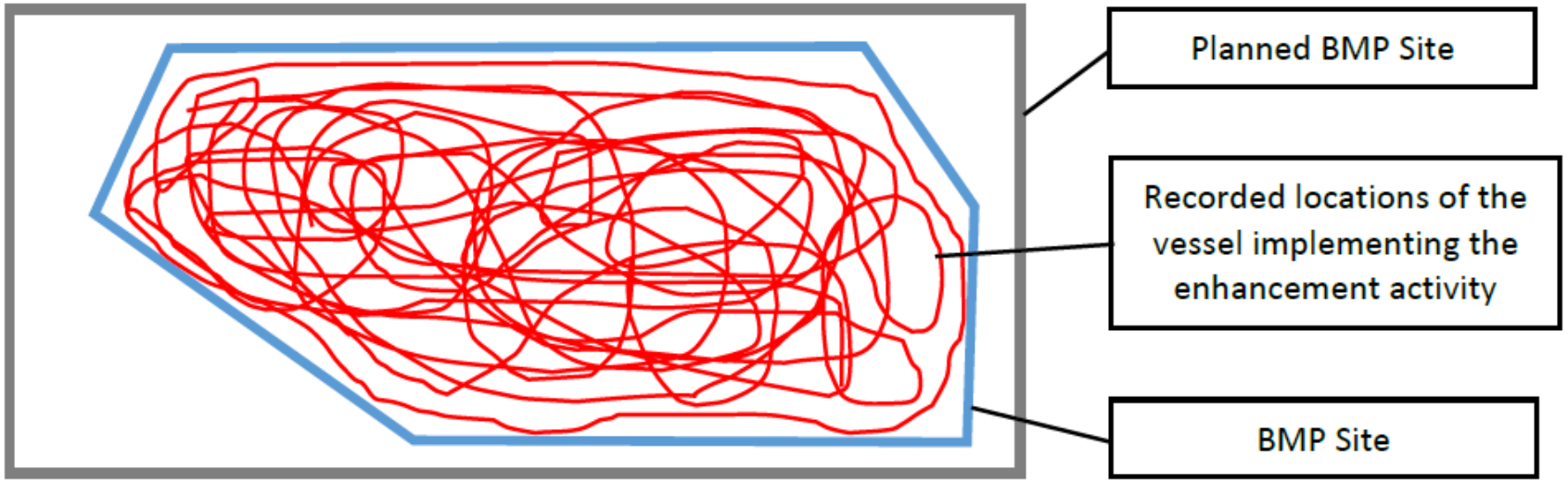
Qualifying Conditions

- Qualifying enhancement activity occurred
- BMP site protected from harvest
- Baseline biomass determined using appropriate approach and adhere to baseline conditions
- Biomass estimates must be based on **field surveys**, be scientifically/statistically robust
- For default estimates, reef must be **subtidal** and restored using **small substrates only**
- Only live **oyster tissue biomass** eligible for credit
- Post-restoration tissue biomass > baseline

Reduction Effectiveness: Stepwise Determination

1. Identify the BMP site and determine BMP site area
2. Document qualifying enhancement activity
3. Determine appropriate baseline approach
4. Assess baseline and post-restoration tissue biomass
5. Determine denitrification enhancement per unit area
6. Determine total nitrogen removal attributable to enhanced DNF using enhancement per unit area and BMP site area

1. Identify the BMP Site



BMP site – actual location of enhancement activities

2. Document Qualifying Enhancement Activities

Addition of **hatchery-produced oysters** and/or **suitable substrate**

Small Substrates

Oyster Recovery Partnership

Large Substrates

J. Cornwell, UMCES HPL

P. Kingsley-Smith, SC DNR

3. Determine Baseline Approach

Pre-restoration Biomass

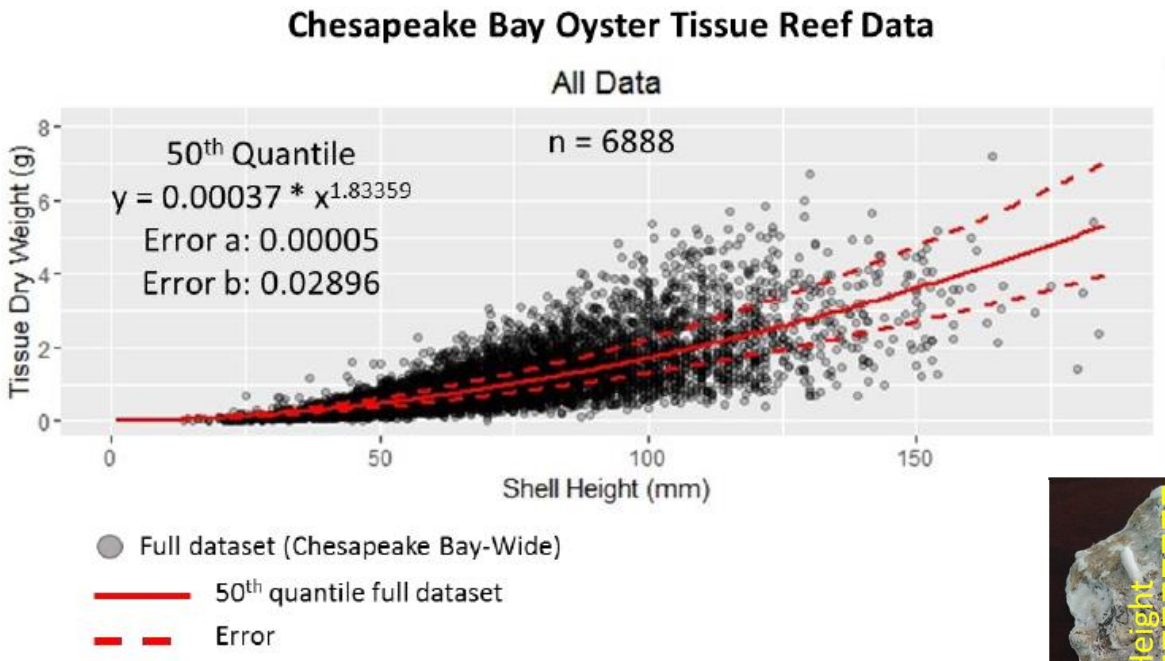
- Biomass measured at BMP Site
- Within 2 years prior to restoration

Representative Site

- Non-restored site representative of BMP site
- Within same basin
- Data collected concurrent with first post-restoration survey at BMP site

4. Baseline and Post-restoration Biomass

1. **Default regression** (small substrate only)



2. Direct measurement

3. Site-specific regression

Data Locations Used for Tissue Regression Equation

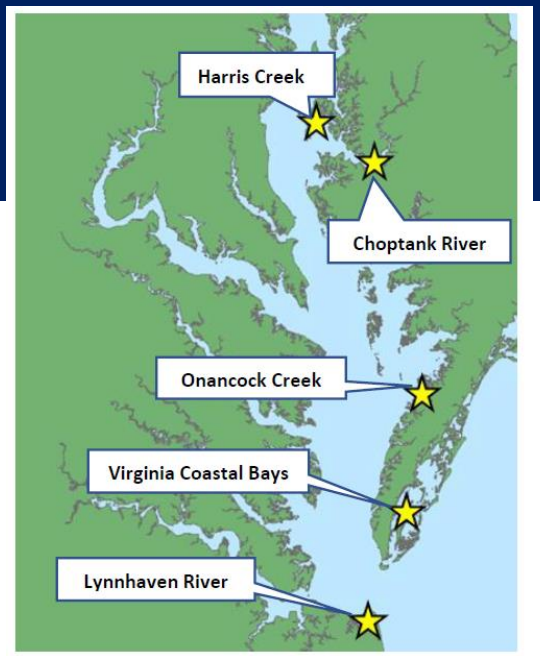
5. Determine denitrification enhancement per unit area

Recommended Approaches:

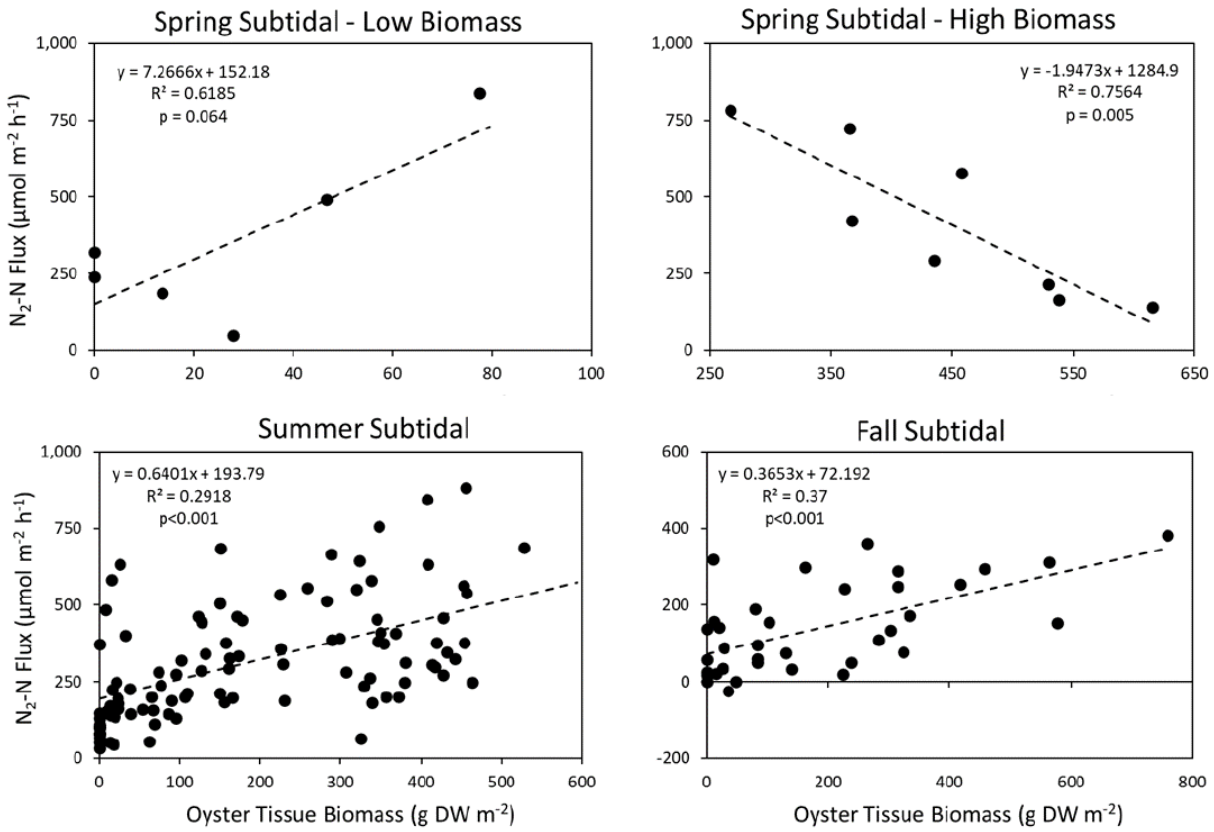
1. **Default estimates** regardless of location (Panel generated)
2. **Site-specific estimates** developed by BMP implementer, in coordination with the State and CBP, using the Panel's recommended method

- Directly measuring denitrification is challenging
- Denitrification rates directly related to **oyster tissue biomass**

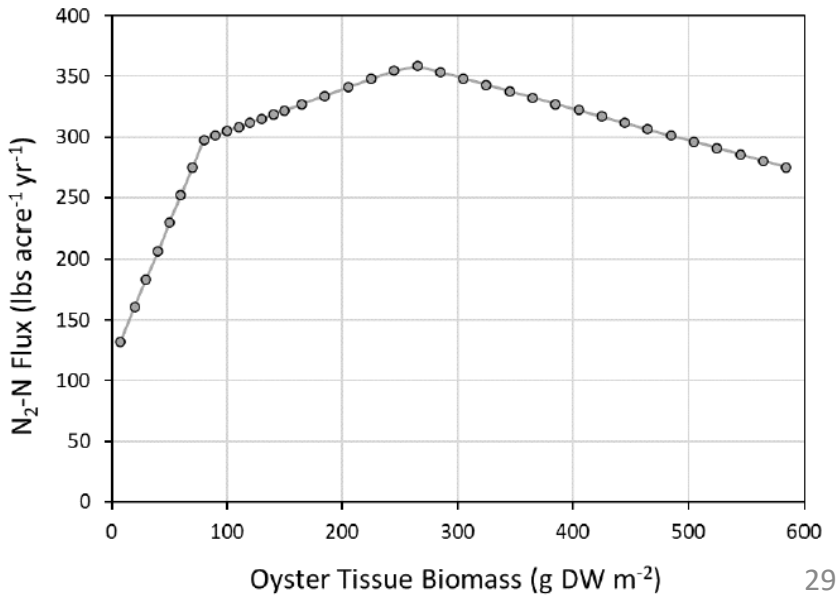
Generating Default Estimates



Season-specific regressions were used to generate **annual denitrification rates** as a function of oyster tissue biomass



Annual DNF rates



Generating Default Estimates

Annual denitrification rates used to construct **lookup table**

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

Enhanced N removal = Post-restoration biomass – Baseline biomass

Total N removed = Enhanced N * BMP site area

Reporting Guidelines

Specific information associated with each Reduction Effectiveness Determination step

1. BMP site and BMP site area
2. Restoration information
3. Biomass (baseline and post-restoration) and methods
4. DNF approach
5. Total Enhancement

Table 8.7

Step #	Information Type	Example
1	BMP site location	Geospatial information (GIS shapefile)
	Area of the BMP site	1 acre
2	Date(s) of activity (mm/dd/yy)	09/21/21
	Type(s) of substrate	Diploid spat-on-shell
	Substrate category	Small
	Amount of substrate	1,000 Maryland bushels of spat-on-shell
	Number of hatchery-produced oysters planted	9,500,000
	Size of oysters at time of planting (mm)	10
	Baseline approach	Pre-restoration
3	Baseline biomass	
	Sampling points	See appended map and GIS file
	Sampling date(s)	07/15/20
	Sampling method	Patent tong
	Spatial scale of sample with units	1 m^2
	Number of samples collected	5
	Method used to assess biomass	Default regression
	Method used to calculate mean biomass	Average of all samples
	Mean biomass: Tissue	14 g DW m^{-2}
	Post-restoration biomass	
	Sampling date(s)	08/01/24
	Sampling method	Patent tong
	Spatial scale of sample with units	1 m^2
	Number of samples collected	5
	Method used to assess biomass	Default regression
	Method used to calculate mean biomass	Average of all samples
	Mean biomass: Tissue	119 g DW m^{-2}
4	Approach used to estimate denitrification enhancement	Default
	Annual enhanced denitrification per acre	179 lbs $acre^{-1}$ $year^{-1}$
5	Total annual denitrification enhancement	179 lbs $year^{-1}$

Unintended Consequences

- The Panel's review of published data found no instances where the restoration of subtidal oyster reefs using small substrates resulted in a decrease in net denitrification at the restoration site.
- In some circumstances, the efficiency of the process may be variable.
- We have less information on potential effects of large substrates (e.g., engineered structures).

Summary

- The Panel has determined that the process of denitrification in restored oyster reefs results in a net removal of nitrogen and merits inclusion as a BMP
- Crediting in restored oyster reefs can be carried out using "default" rates or by site-specific rates (i.e. denitrification measurements). For large substrates, in lieu of a lot more data, crediting is available only for site-specific data.

Webinar Part 2: Tuesday February 14th 11:00 – 1:00

Recommendations for Oyster Assimilation Protocols

Feedback accepted through Friday March 10th

Thank you for joining!

Please enter your questions in the Q&A

Contact Olivia Caretti with feedback & additional questions: oysterBMPresponse@oysterrecovery.org