Photo: Oyster Recovery Partnership

Oyster Best Management Practice Expert Panel Recommendations

Webinar 2: Oyster Assimilation Protocols

February 14, 2023

This webinar will be recorded.

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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.

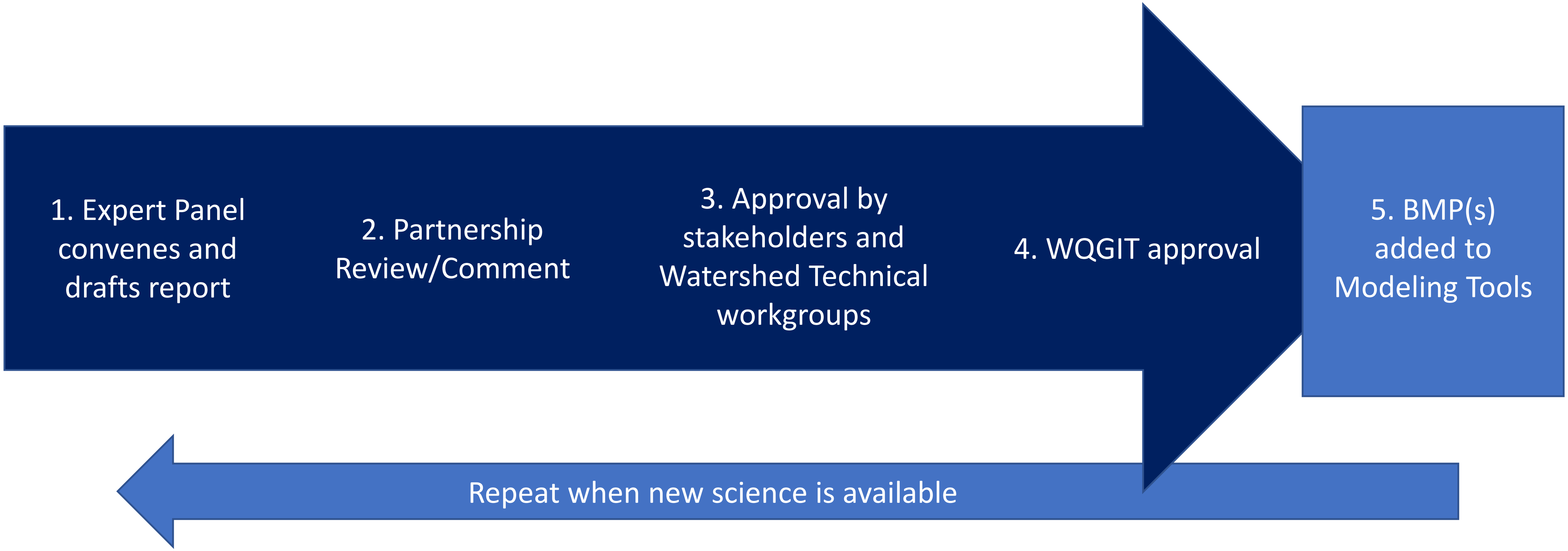
Webinar Agenda

- Introduction and Overview of BMP Panel Process
- Summary of Panel Recommendations
  - Restoration-Assimilation
  - Harvest-Assimilation
- Oyster BMP Summary
- 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

Oyster Best Management Practice Expert Panel Recommendations

Webinar 2: Oyster Assimilation Protocols

February 14, 2023

Jeff Cornwell
Panel Chair

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Olivia Caretti
Panel Coordinator

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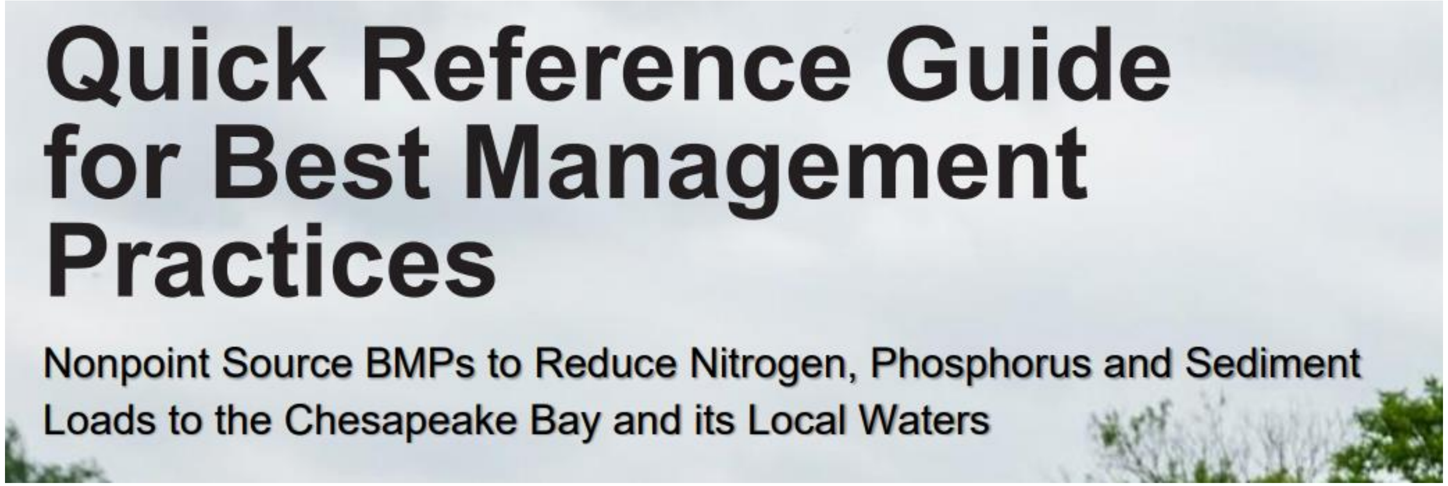
Best Management Practices (BMPs)

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



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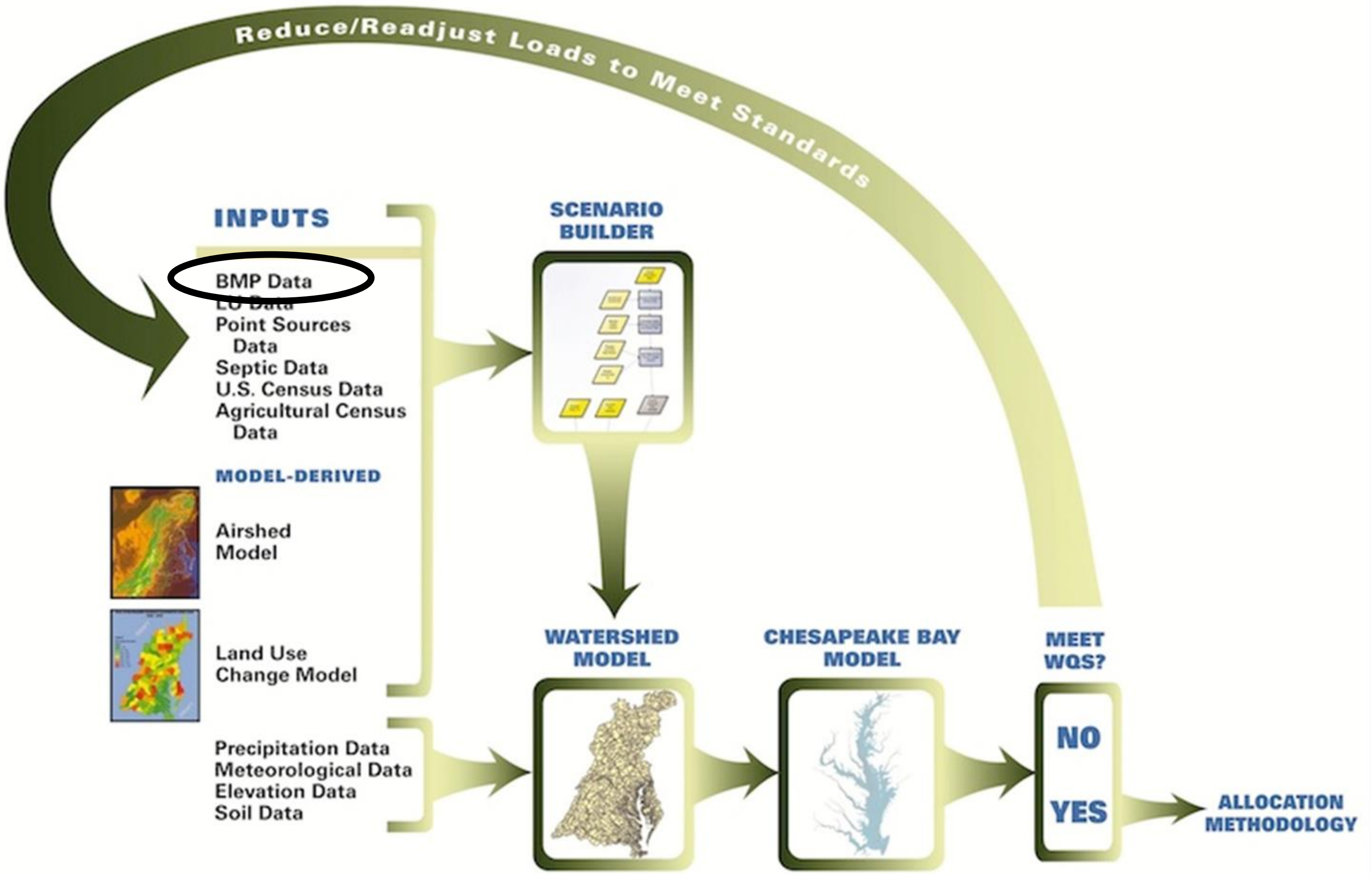
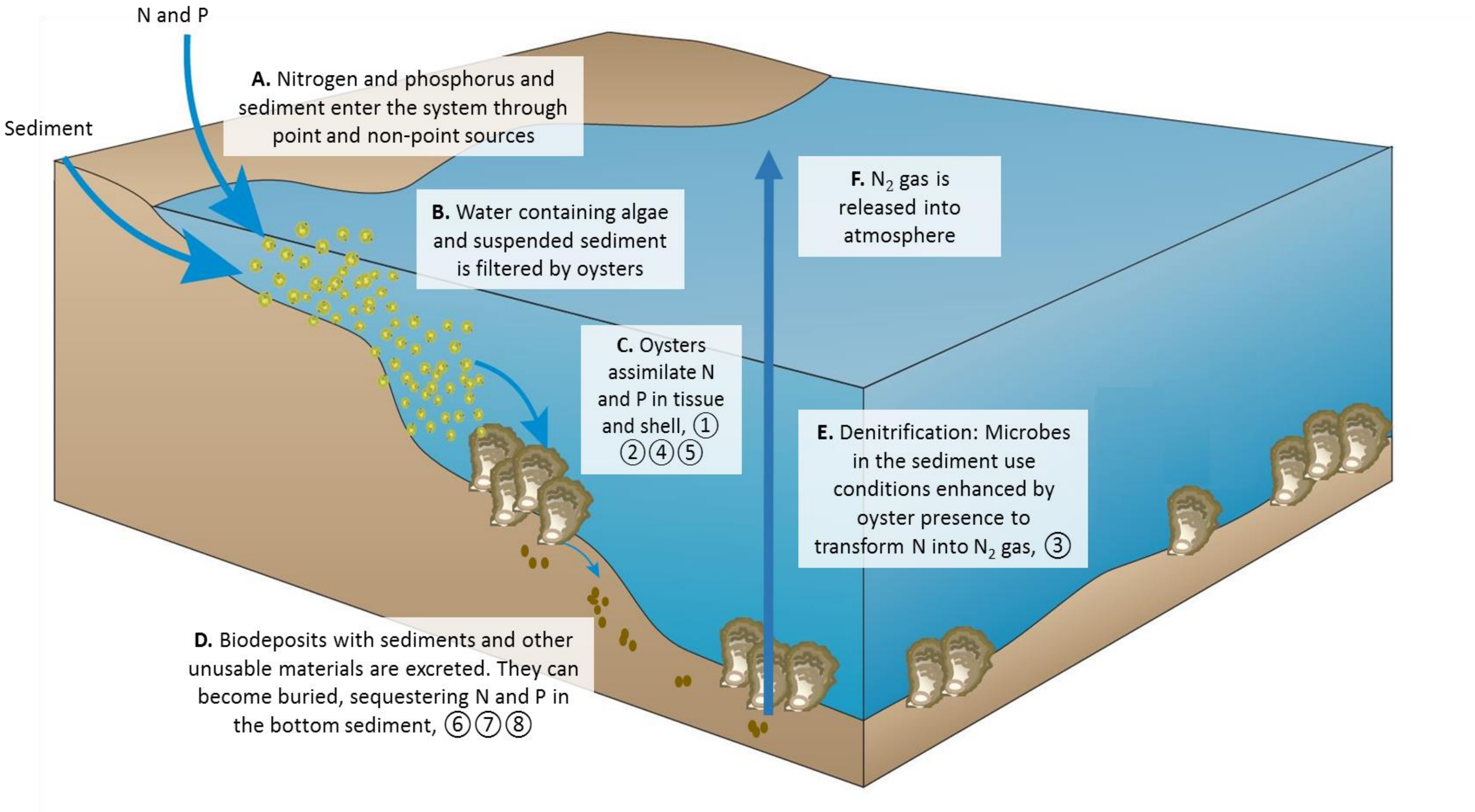
CBP Model Framework for the Chesapeake Bay TMDL



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

Oysters and Water Quality

Oysters can reduce nutrients and suspended sediment by filtering particles from water column



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
Larry Sanford, UMCES
Bill Wolinski, Talbot County Department of Public Works

Advisors & Coordinators

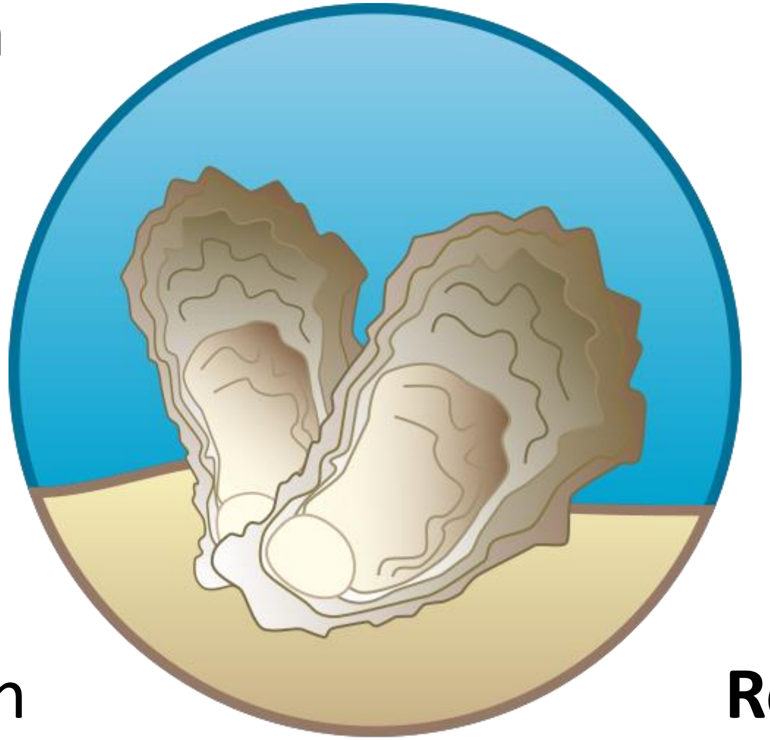
Lew Linker, US EPA Chesapeake Bay Program Office
Jeff Sweeney/ Matt Johnson, US EPA Chesapeake Bay Program Office
Jeremy Hanson, US EPA Chesapeake Bay Program Office
Lucinda Power, US EPA Chesapeake Bay Program Office
Olivia Caretti, Oyster Recovery Partnership
Julie Reichert-Nguyen, Oyster Recovery Partnership, NOAA Chesapeake Bay Office
Ward Slacum, Oyster Recovery Partnership

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

Elements of the Oyster BMP Toolset

Aquaculture-Assimilation
Approved

Harvest-Assimilation
Under Review

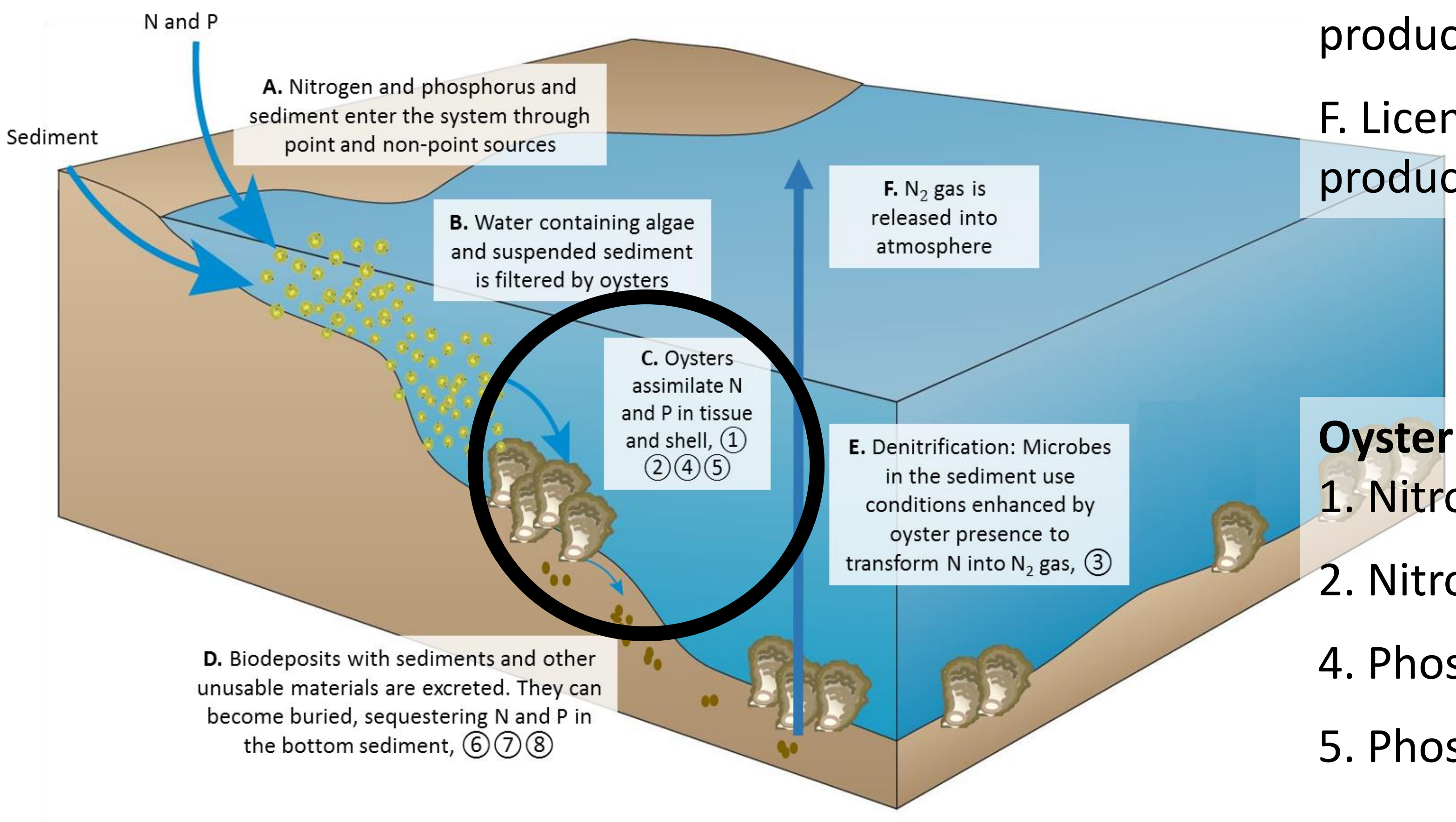


Restoration-Denitrification
Under Review

Restoration-Assimilation
Under Review

Graphic: UMCES Integrated Application Network

Today: Assimilation Recommendations



Oyster Practices

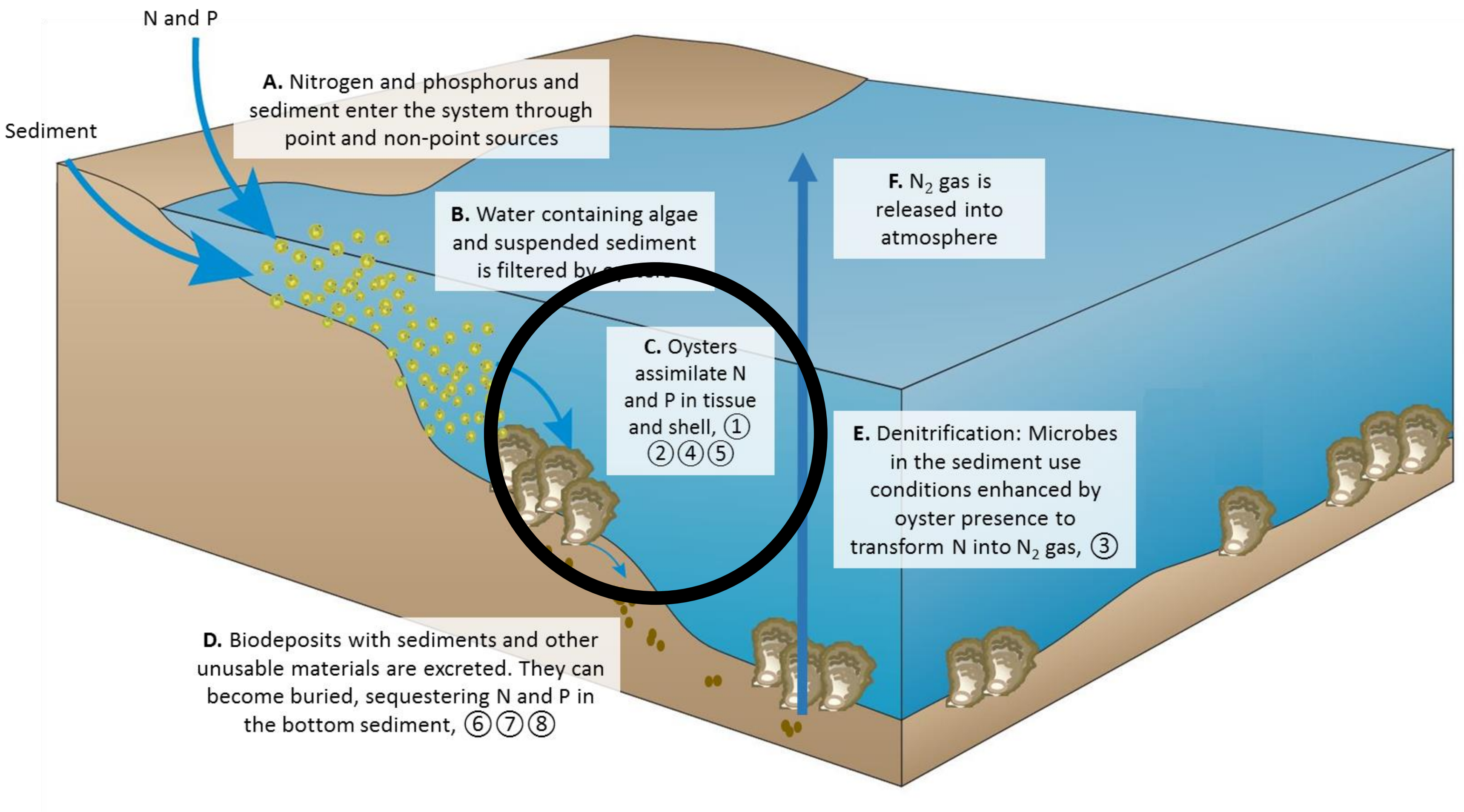
J & K. Oyster reef restoration using (J) hatchery-produced oysters & (K) substrate addition

F. Licensed oyster harvest using hatchery-produced oysters

Oyster Protocols

1. Nitrogen Assimilation in Oyster Tissue
2. Nitrogen Assimilation in Oyster Shell
4. Phosphorus Assimilation in Oyster Tissues
5. Phosphorus Assimilation in Oyster Shell

Restoration-Assimilation



Oyster Practice(s): Oyster reef restoration using (J) hatchery-produced oysters & (K) substrate addition

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

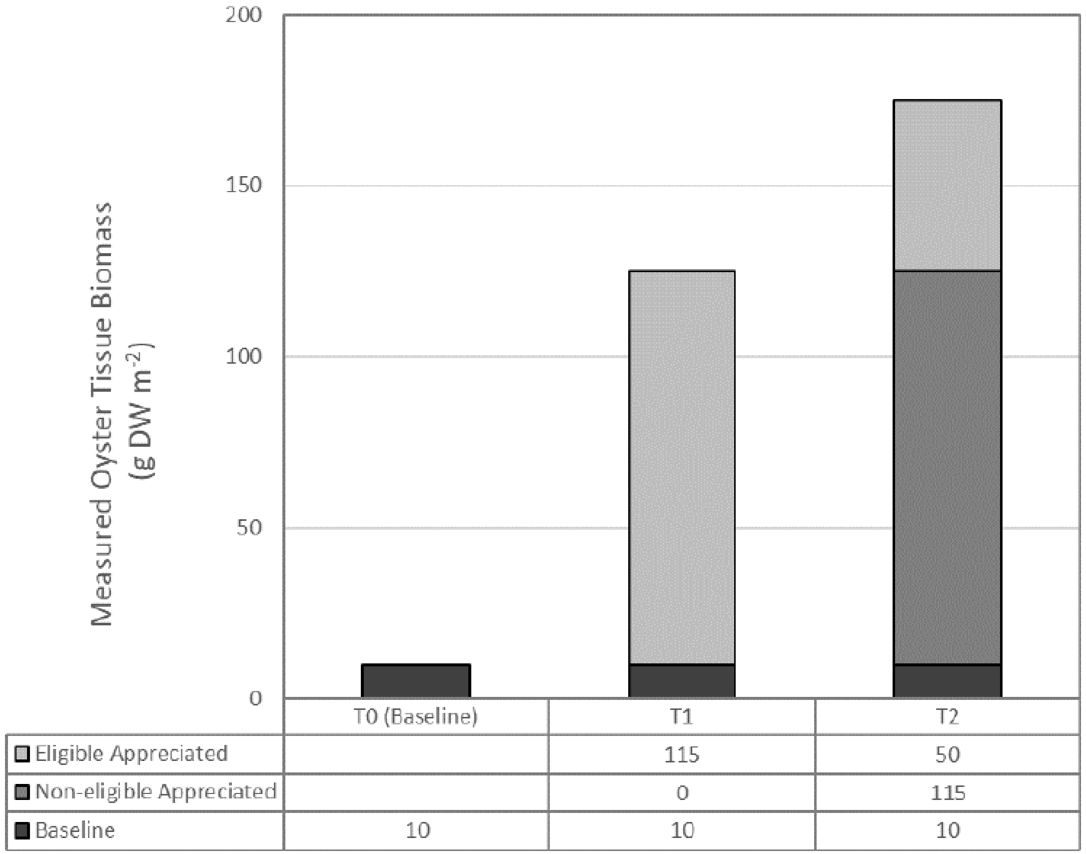
Recognizing Pollutant Reductions via In-situ Oyster Filtration Under the Clean Water Act

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

The Panel's Approach

- **Oyster tissue & shell biomass** are used to estimate removal of N & P
- Net removal at reef-scale as long as oyster biomass is stable or increasing
- Only **appreciated biomass** is credited
- Credit can be received **incrementally** when biomass is assessed



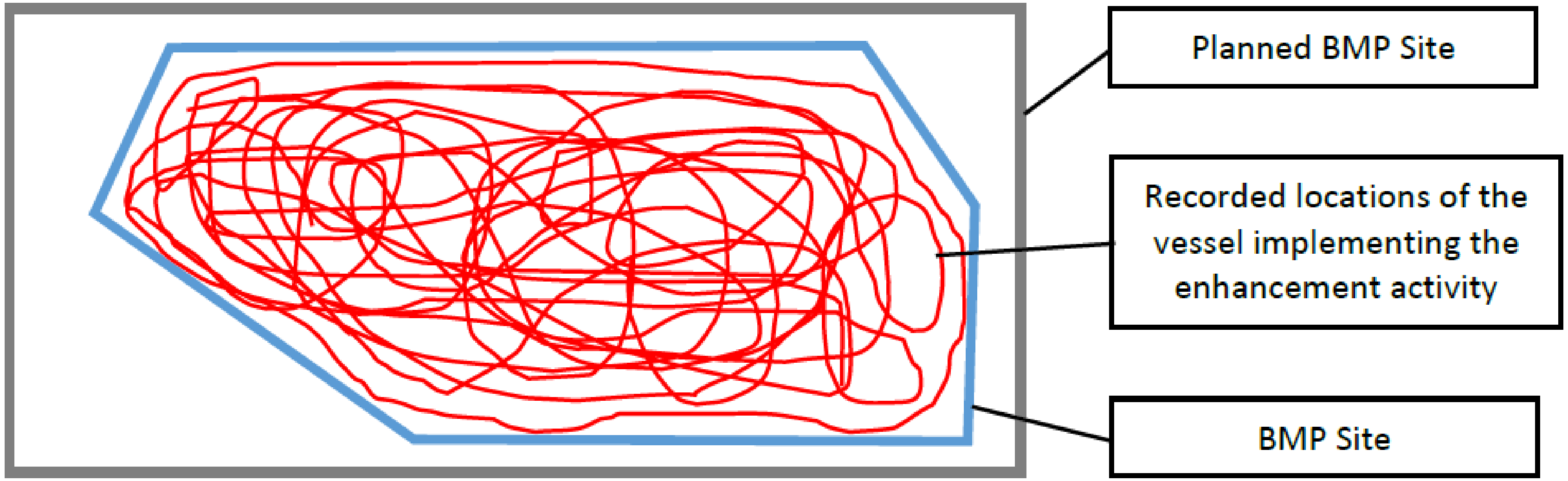
Qualifying Conditions

- Qualifying enhancement activity occurred
- BMP site protected from harvest
- Planted oysters should be < 1in
- Baseline biomass determined using appropriate approach and adhere to baseline conditions
- Biomass estimates must be based on **field surveys**, be representative of BMP site
- Biomass extrapolated appropriately to BMP site (substrate type)
- Only nutrients associated with **appreciated biomass** are eligible

Reduction Effectiveness: Determination Steps

1. Identify BMP site and determine BMP site area
2. Document qualifying enhancement activity
3. Determine appropriate baseline approach
4. Assess baseline and post-restoration biomass, extrapolate to determine total biomass for the BMP site
5. Determine eligible appreciated biomass
6. Convert eligible appreciated biomass to total N & P removed

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

Large Substrates

3. Determine Baseline Approach

Pre-restoration Biomass

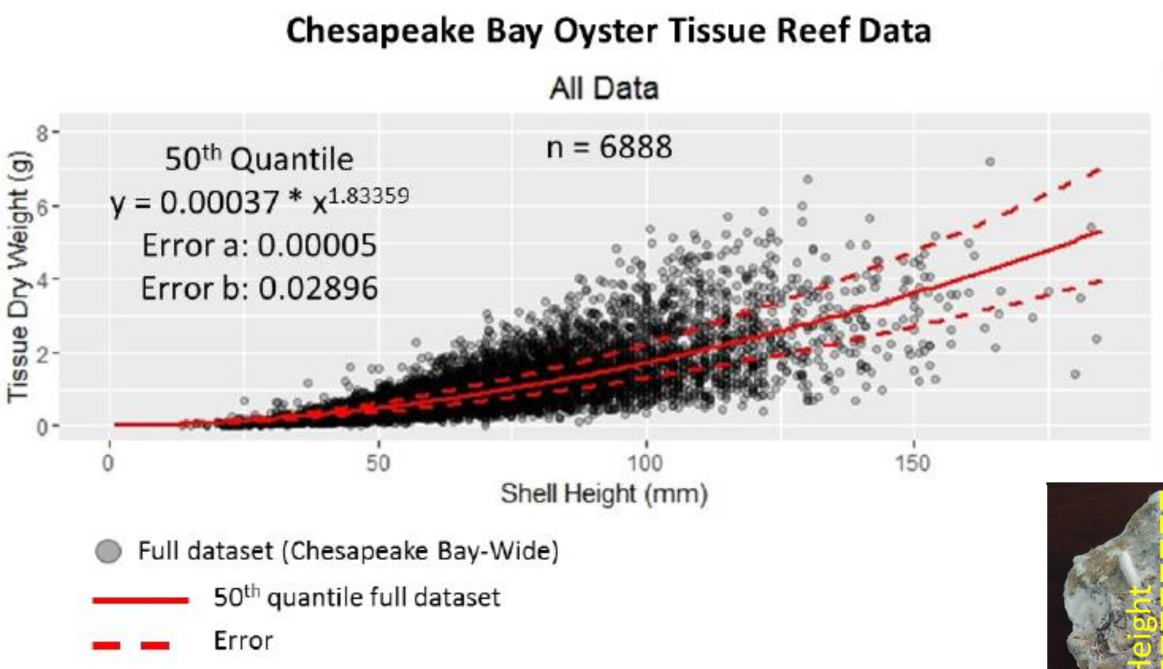
- Biomass measured at BMP Site
- Within 2 years prior to restoration

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

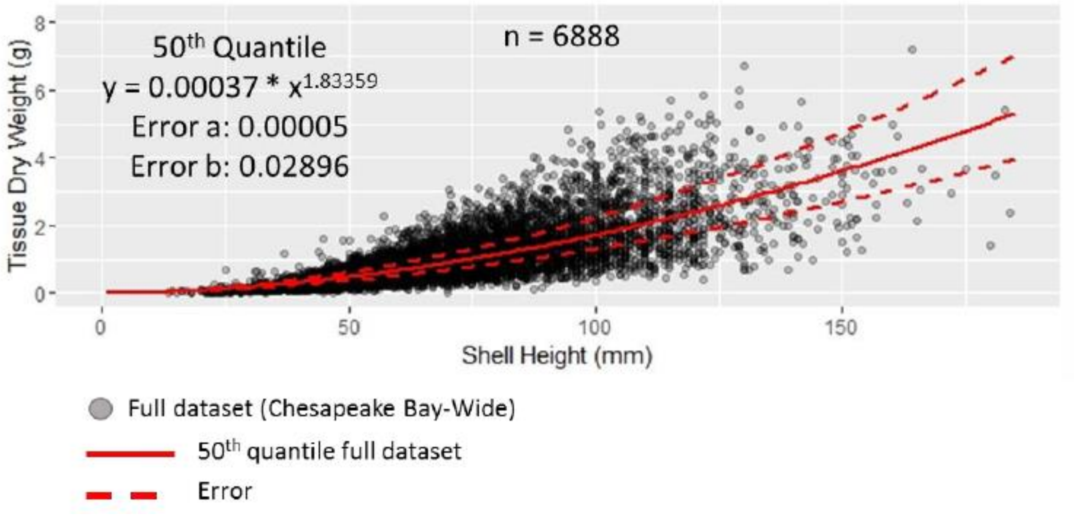
1. **Default regression** (small substrate only)



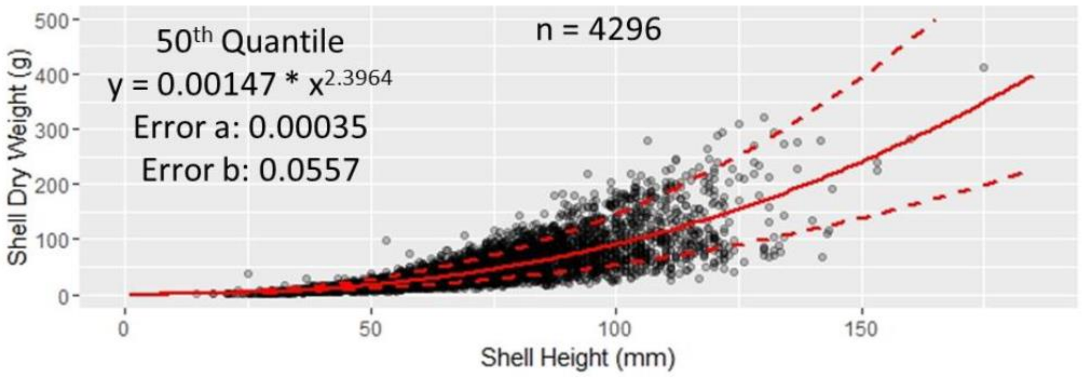
2. Direct measurement
3. Site-specific regression

Default Biomass Regressions

Chesapeake Bay Oyster Tissue Reef Data



Chesapeake Bay Oyster Shell Reef Data



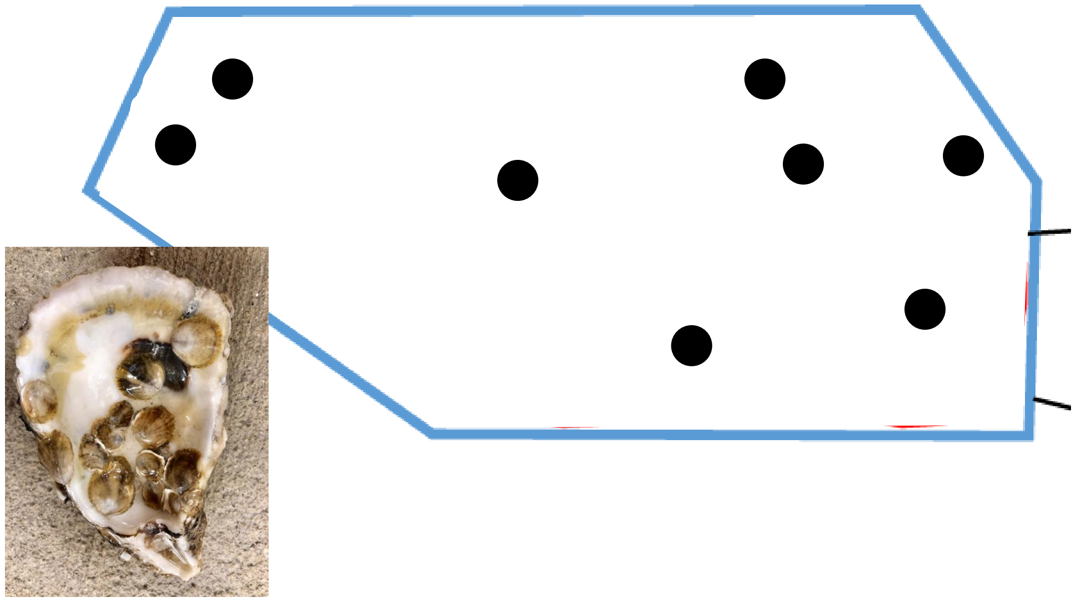
Refer to **Appendix E** for more details

- Comprehensive dataset, natural and restored reefs
- Best represents conditions Bay-wide – location (salinity, tide) and season
- 50th quantile is conservative approach

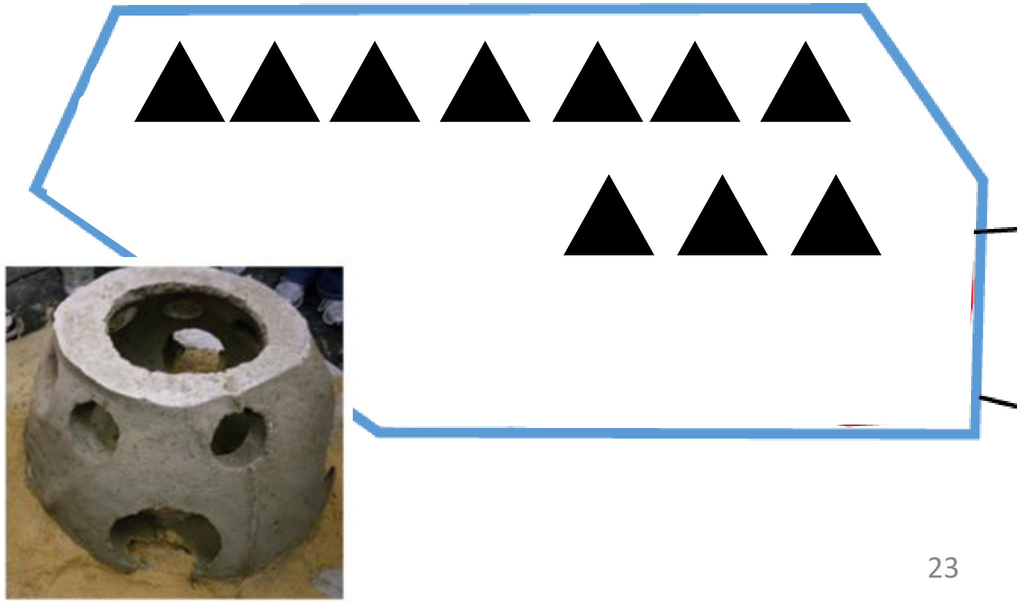
Extrapolate Biomass to BMP Site

Extrapolating biomass to BMP Site varies by substrate type

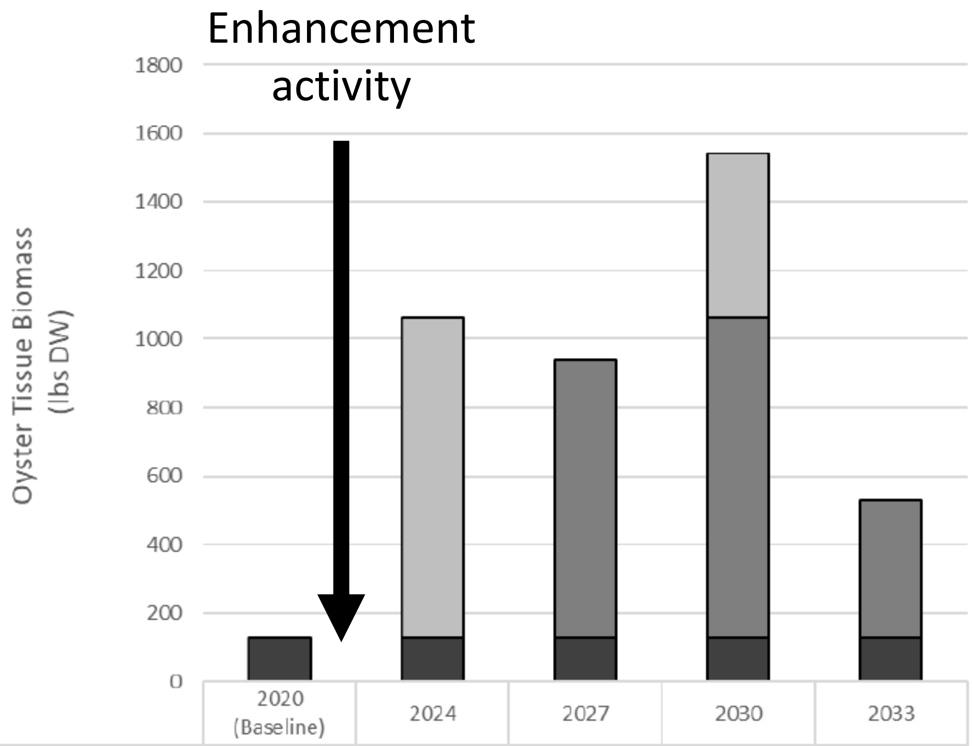
Small substrates – per unit area
(multiply by area)



Large substrates – per structure
(multiply by # structures)



5. Determine Eligible Appreciated Biomass & 6. Estimate N & P Removed



	2020 (Baseline)	2024	2027	2030	2033
Appreciated - Eligible		937	0	480	0
Appreciated - Not Eligible		0	815	937	403
Baseline Biomass	125	125	125	125	125

Use percent N & P content to convert to N & P removed

Parameter	Percent N	Percent P
Tissue	8.2	0.9
Shell	0.2	0.04

- Post-restoration biomass > baseline biomass AND > previous maximum biomass
- Eligible appreciated biomass can be measured and credited over lifetime of BMP site

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. Appreciated biomass
5. Total N & P removed

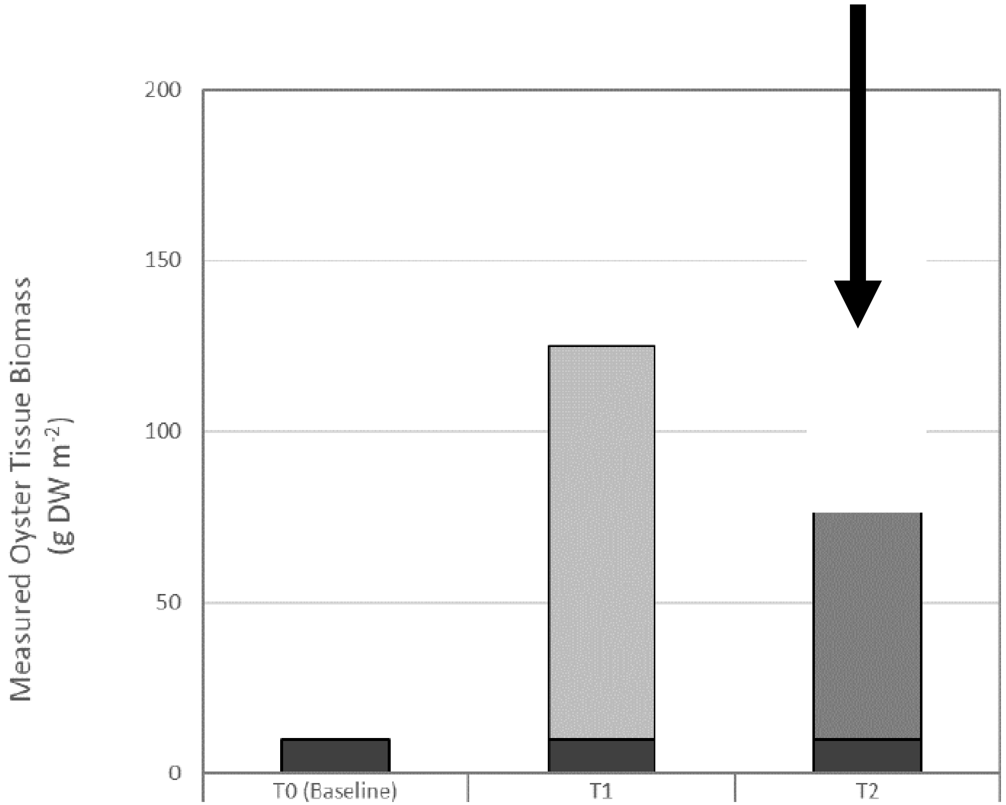
Table 7.3

Step #	Information Type	Example
1	BMP site location	See appended map and GIS file
	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}
	Mean biomass: Shell	631 g DW m^{-2}
	Method for extrapolating to entire BMP site	Multiply by total m^2 and convert to lbs
	Total biomass for the BMP site: Tissue	125 lbs DW
	Total biomass for the BMP site: Shell	5,630 lbs DW
	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}
	Mean biomass: Shell	5,960 g DW m^{-2}
	Extrapolation method	Multiply by total m^2 and convert to lbs
	Total biomass for the BMP site: Tissue	1,062 lbs DW
	Total biomass for the BMP site: Shell	53,178 lbs DW

Unintended Consequences

- Over crediting can occur if biomass drops below previously credited biomass

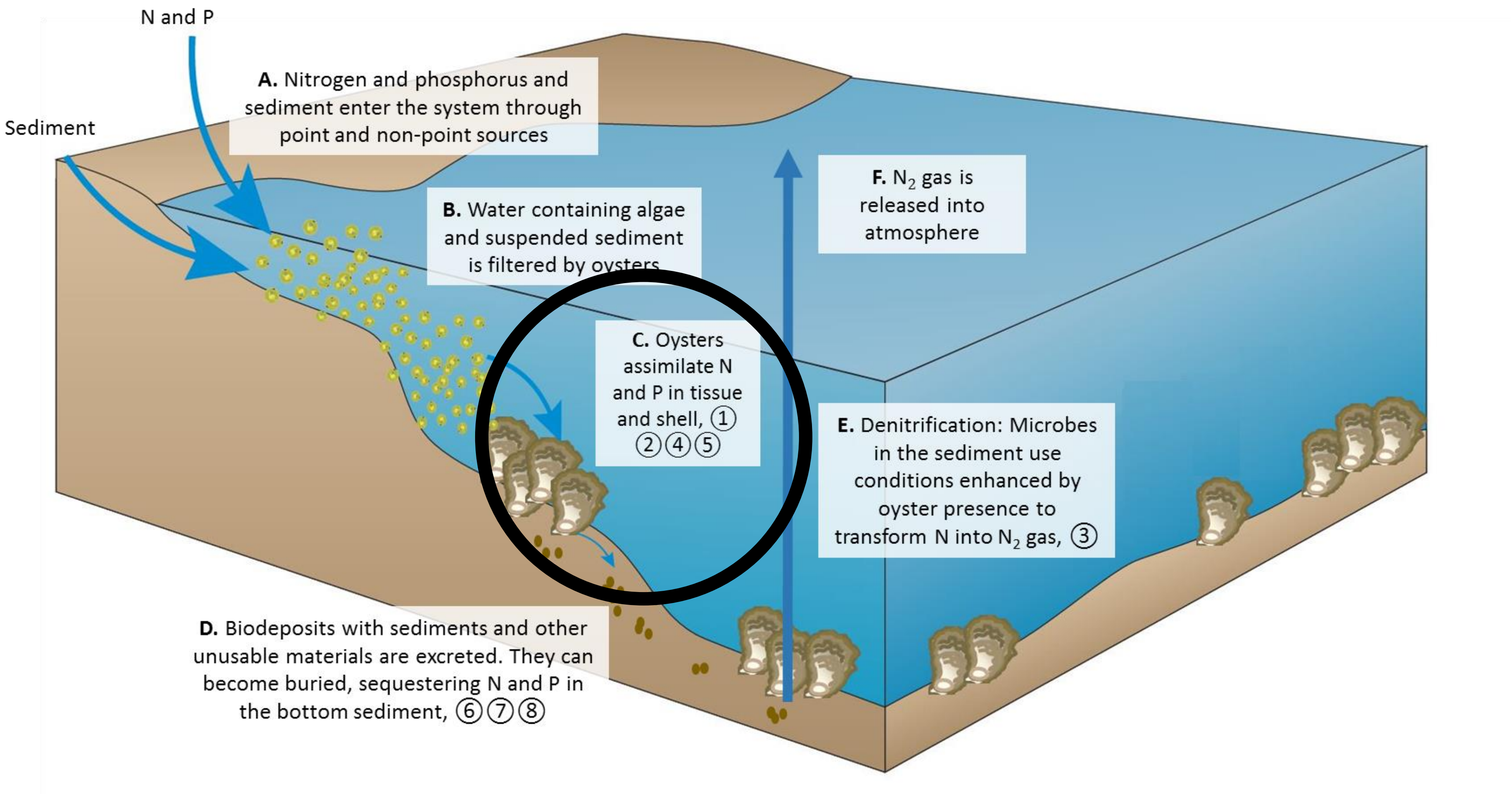
- Unlikely since many other organisms, materials, processes removing nutrients at reef-level that aren't credited



Restoration-Assimilation Summary

- **Oyster tissue & shell biomass** are used to estimate removal of N & P
- Only **appreciated biomass** is credited
- Credit can be received **incrementally** when biomass is assessed

Harvest-Assimilation



Oyster Practice(s): Licensed oyster harvest using hatchery-produced oysters (F)

The Panel's Approach

- **Oyster tissue biomass** is used to estimate removal of N & P
- Aquaculture BMP approach
- Challenging to assess baseline biomass
- The Panel developed strict qualifying conditions to account for this

Photo: Jay Flemming

Qualifying Conditions

- Qualifying enhancement activity occurred (hatchery-produced oysters)
- BMP site must be open to licensed oyster harvest
- Planted oysters should be < 2in
- At time of harvest, oysters should be alive, of legal harvest size, harvested from BMP site
- Oysters must be harvested within **harvest crediting timeframe**

Reduction Effectiveness: Determination Steps

1. Identify BMP site and determine BMP site area
2. Document qualifying enhancement activity
3. Determine maximum harvest allowance using default or site-specific spat survival rate
4. Determine harvest crediting timeframe
5. Determine N & P removed via harvest

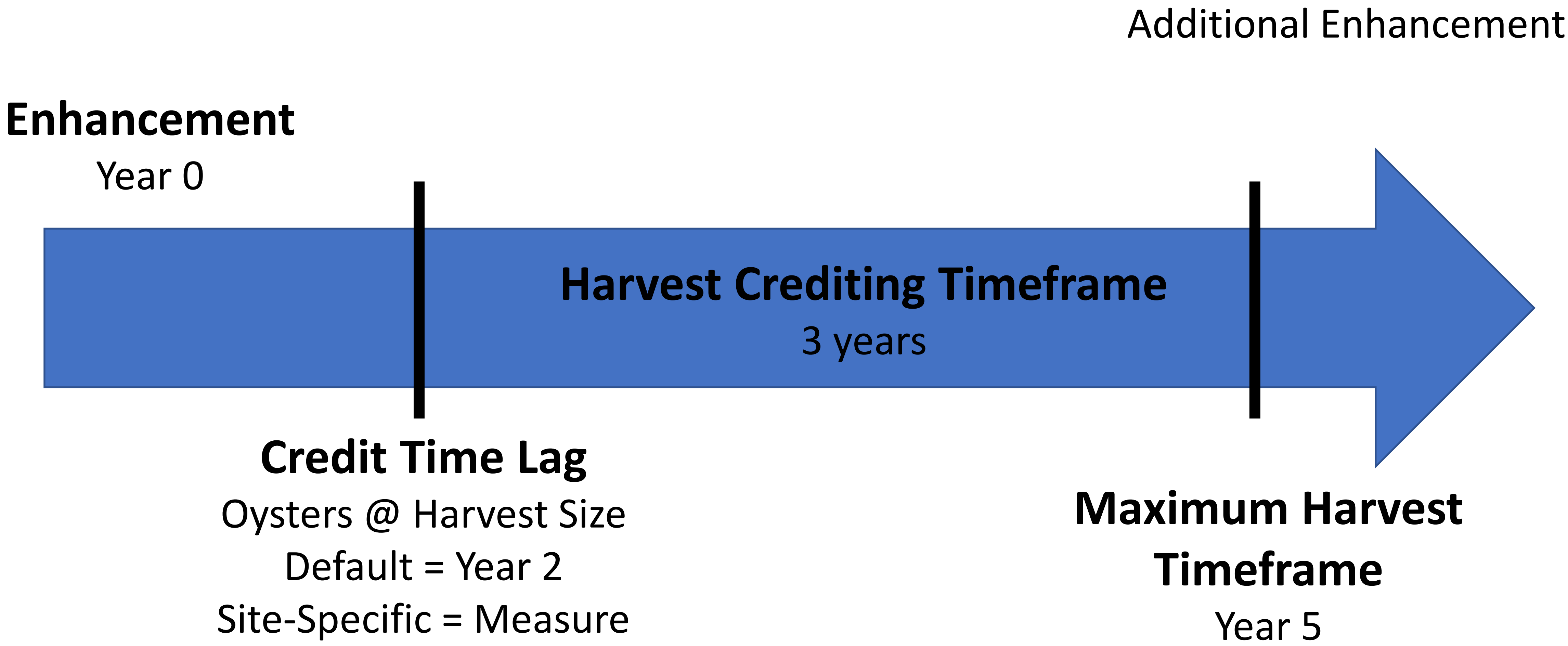
3. Maximum Harvest Allowance

- Avoid crediting pre-existing oyster populations that are harvested along with hatchery-produced oysters
- Generated a cap on how many planted oysters could receive credit

Average **spat survival rate** from time of planting to harvest

- **Default = 3%**
- Site-specific survival rate can be measured

4. Harvest Crediting Timeframe



5. Determine N & P Removed from Harvest

- Oyster tissue biomass
- Default tissue content
  - N & P content depends on harvest size
  - Extrapolate based on # oysters harvested
- Site-specific tissue content

- If oysters not measured, use 3in size class

Table 6.4. Recommended default nitrogen and phosphorus content of diploid oyster tissue. Oyster size class based on shell height measurements.

Oyster size class (in)	Midpoint (in)	Midpoint (mm)	Tissue dry weight (g $oyster^{-1}$)	Content in oyster tissue (g $oyster^{-1}$) Nitrogen	Content in oyster tissue (g $oyster^{-1}$) Phosphorus
3.00-3.49	3	76	1.06	0.09	0.01
3.50-4.49	4	102	1.81	0.15	0.02
4.50-5.49	5	127	2.70	0.22	0.02
≥ 5.50	6	152	3.74	0.31	0.03

Table 6.5. Default nutrient reductions

Oyster size class (in)	Nitrogen (lbs./million oysters)	Phosphorus (lbs./million oysters)
3.00-3.49*	198	22
3.50-4.49	331	44
4.50-5.49	485	44
≥ 5.50**	683	66

Reporting Guidelines

Specific information associated with each Reduction Effectiveness Determination step

1. BMP site and BMP site area
2. Enhancement activity information
3. Maximum oyster harvest allowance
4. Harvest crediting timeframe
5. Total oysters harvested, eligible for credit, and N & P removed

Table 6.6

Step #	Information Type	Example
1	BMP site location	GIS layer with polygon for BMP site and latitude and longitude for all vertices provided as a separate file
	Name of licensed oyster harvest area	Cedar Point, Broad Creek, MD
2	Enhancement activity	Spat-on-shell planting
	Date(s) of activity (mm/dd/yy)	05/14/19, 06/02/19, 07/17/19
	Ploidy	Diploid
	Number of hatchery-produced oysters planted	50,000,000
	Size of hatchery-produced oysters at time of planting (mm)	10
3	Method used to determine maximum harvest allowance	Default
	Maximum oyster harvest allowance	1,500,000
	Number of oysters previously credited	0
4	Method used to determine time lag	Default
	Length of time lag	2 years
	Oyster harvest crediting timeframe start date	05/14/19
	Oyster harvest crediting timeframe end date	05/14/24
5	Months when harvest occurred	October - March
	Harvest season	2021/2022
	Oyster reporting units	Bushels
	Oysters per reporting unit	300
	Harvest reported	1,000 bushels
	Total number of oysters harvested	300,000
	Number of harvested oysters eligible for credit	300,000
	Method used to convert oyster tissue to nutrients	Default
	Nitrogen removed (lbs)	59.4
	Phosphorus removed (lbs)	6.6

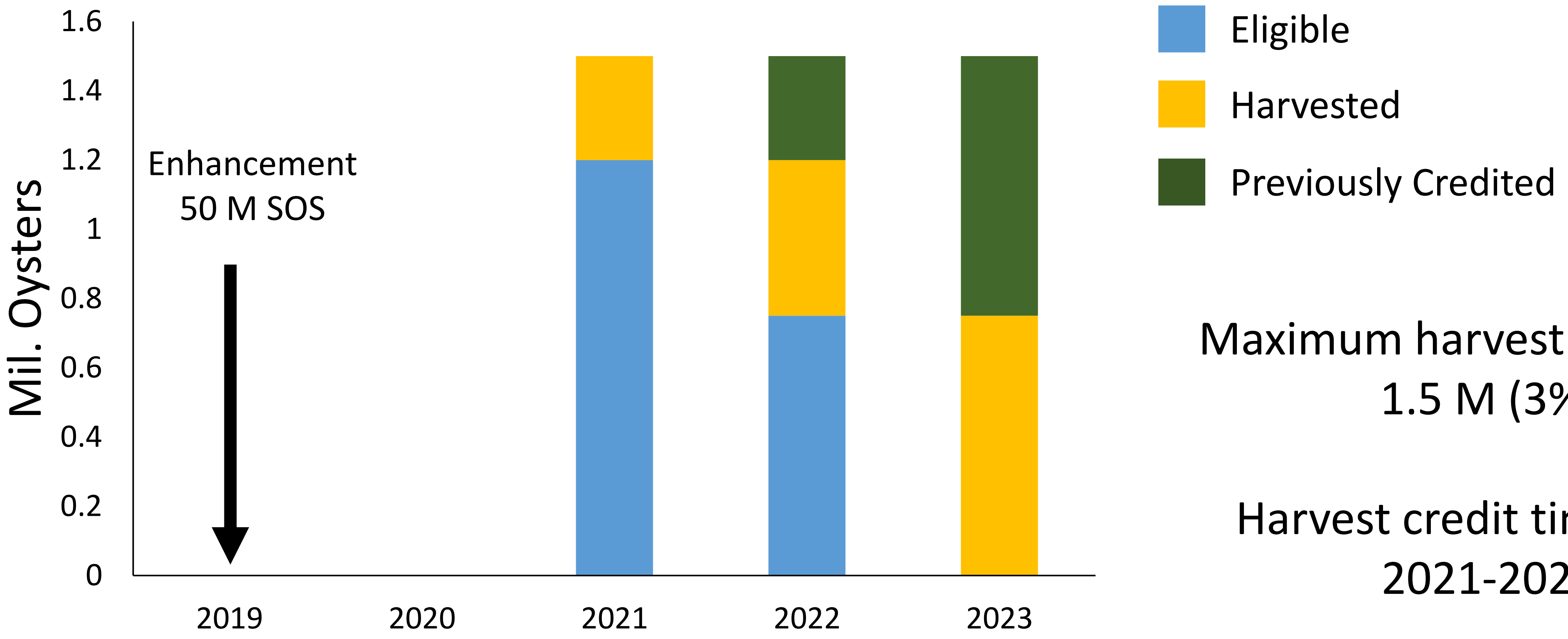
Harvest-Assimilation Example

Maximum oyster harvest allowance = 3%

Table 6.7. Example of tracking plantings starting with the scenario from Table 6.6.

Year:	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Spat Planted (millions)	50.00	25.00	0		25.00	0	0	0	0	0	100.00
Maximum oyster harvest allowance[1] (millions)	1.50	0.75	0	0	0.75	0	0	0	0	0	3.00

Harvest-Assimilation Example



Maximum harvest allowance
1.5 M (3%)

Harvest credit timeframe
2021-2023

Additional harvest > 1.5M not eligible for credit

Refer to table 6.8 to see how to account for multiple plantings

Harvest-Assimilation Example

All 1.5M eligible oysters were harvested for total removal of…

Table 6.5. 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)
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

Harvest Season	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	***Total***
Nitrogen (lbs)	0	0	59.4	89.1	148.5	***297***
Phosphorus (lbs)	0	0	6.6	9.9	16.5	***33***

Unintended Consequences

Negative

- The Panel identified no negative unintended consequences

Positive

- Planting diploid oysters can increase natural recruitment in harvest areas
- Plantings that use spat-on-shell maintain a positive shell budget
- Additional ecosystem benefits are possible

Harvest-Assimilation Summary

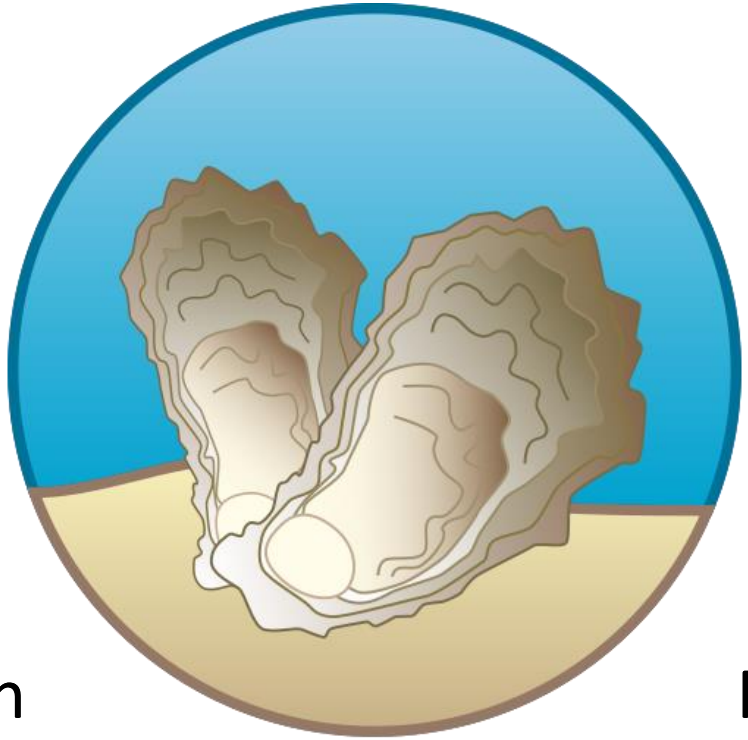
- Different application of aquaculture BMP, which is approved
  - Calculated N & P tissue content in oysters at harvest size(s)
- Challenging to assess baseline biomass
  - Panel developed strict qualifying conditions to minimize over crediting harvest

Photo: Southern Maryland News

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

Oyster BMP Summary

- The Panel concluded there was **sufficient science** to support development of 3 new oyster BMPs
- **Oyster biomass data** are required to estimate reduction and verify that enhancement activity led to increase in oysters
- Panel developed tools and **default estimates** to estimate reduction
  - Guidance available for when and how to generate site-specific estimates
- Panel developed comprehensive verification guidelines and **qualifying conditions** to minimize over crediting

Oyster BMP Summary

Future research

- Large substrates (e.g., engineered structures)
- Denitrification on intertidal reefs
- Spatial and seasonal variability in denitrification
- Spat survivorship estimates on harvested reefs
- N & P assimilation in harvested shell
- Denitrification associated with other practices (aquaculture/harvest)


Thank you for joining!

Please enter your questions in the Q&A

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

Feedback is due March 10th