Photo: Oyster Recovery Partnership

# Expert Panel Report on Oyster BMP for Restoration & Harvest

Sustainable Fisheries GIT

2023 Winter Meeting

March 1, 2023

*Olivia Caretti, Oyster Recovery Partnership*

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Chesapeake Bay Program
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# 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

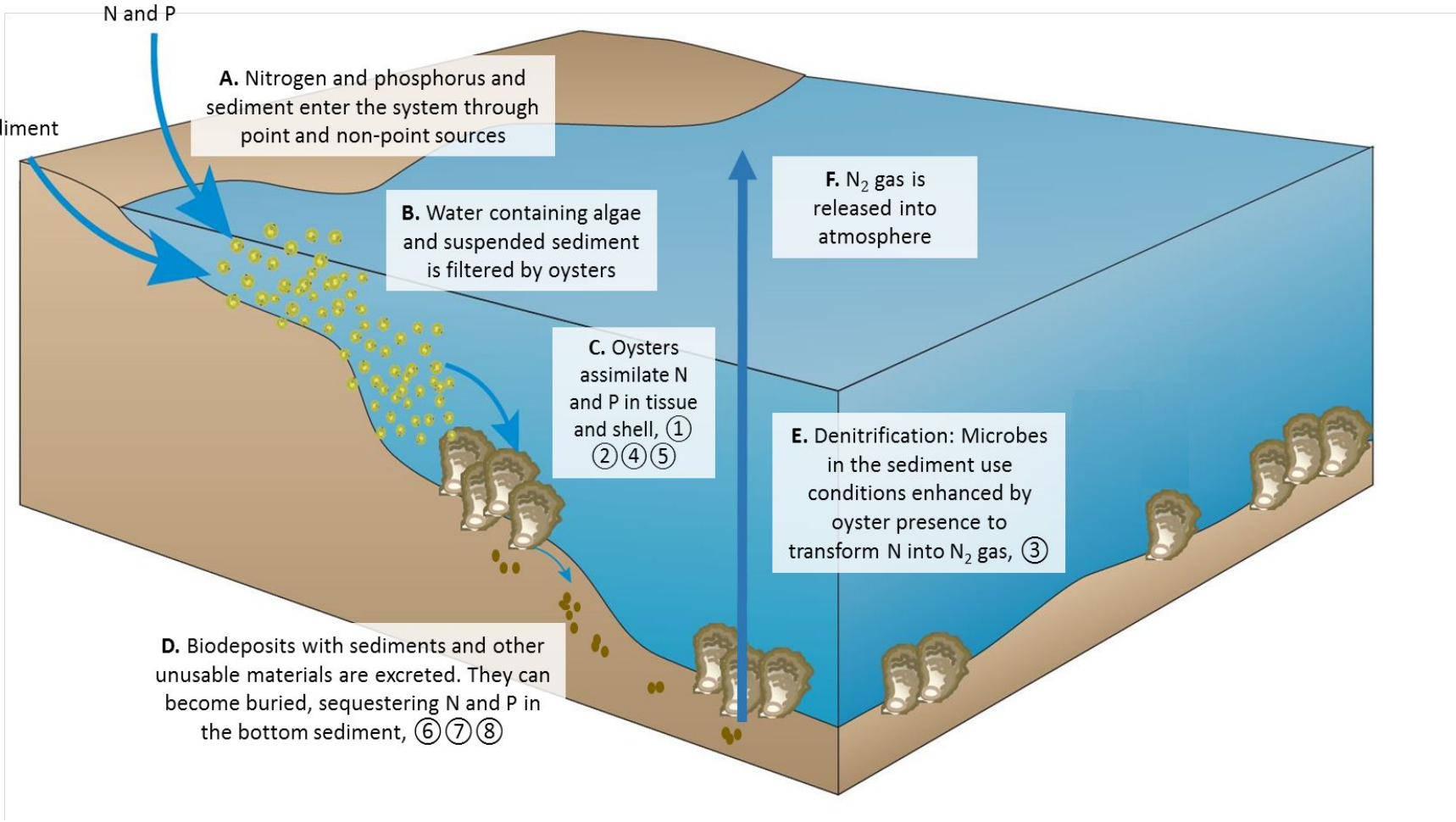
**March 1** – Present at Fisheries GIT Meeting

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

**April-May** – Revision, Additional presentations, Approval

# 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

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Jeff Sweeney/ Matt Johnson, US EPA Chesapeake Bay Program Office
Jeremy Hanson, US EPA Chesapeake Bay Program Office
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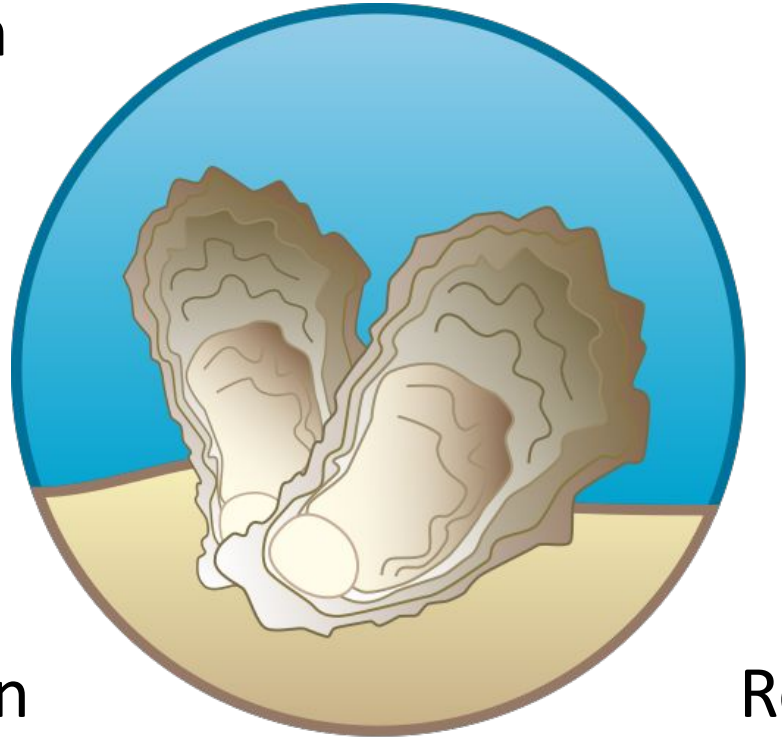
**Special Thanks to:** Lisa Kellogg (VIMS), Lynn Fegley (MDNR), Emily French (ORP), Elizabeth Franks (ORP), Paige Hobaugh (CBP), Emilie Franke (CBP), Kyle Runion (CBP), the many scientists who shared data to support this effort, support from Bay Program, modelers, and support staff

# Elements of the Oyster BMP Toolset

Aquaculture-Assimilation
Approved



Harvest-Assimilation
*Under Review*

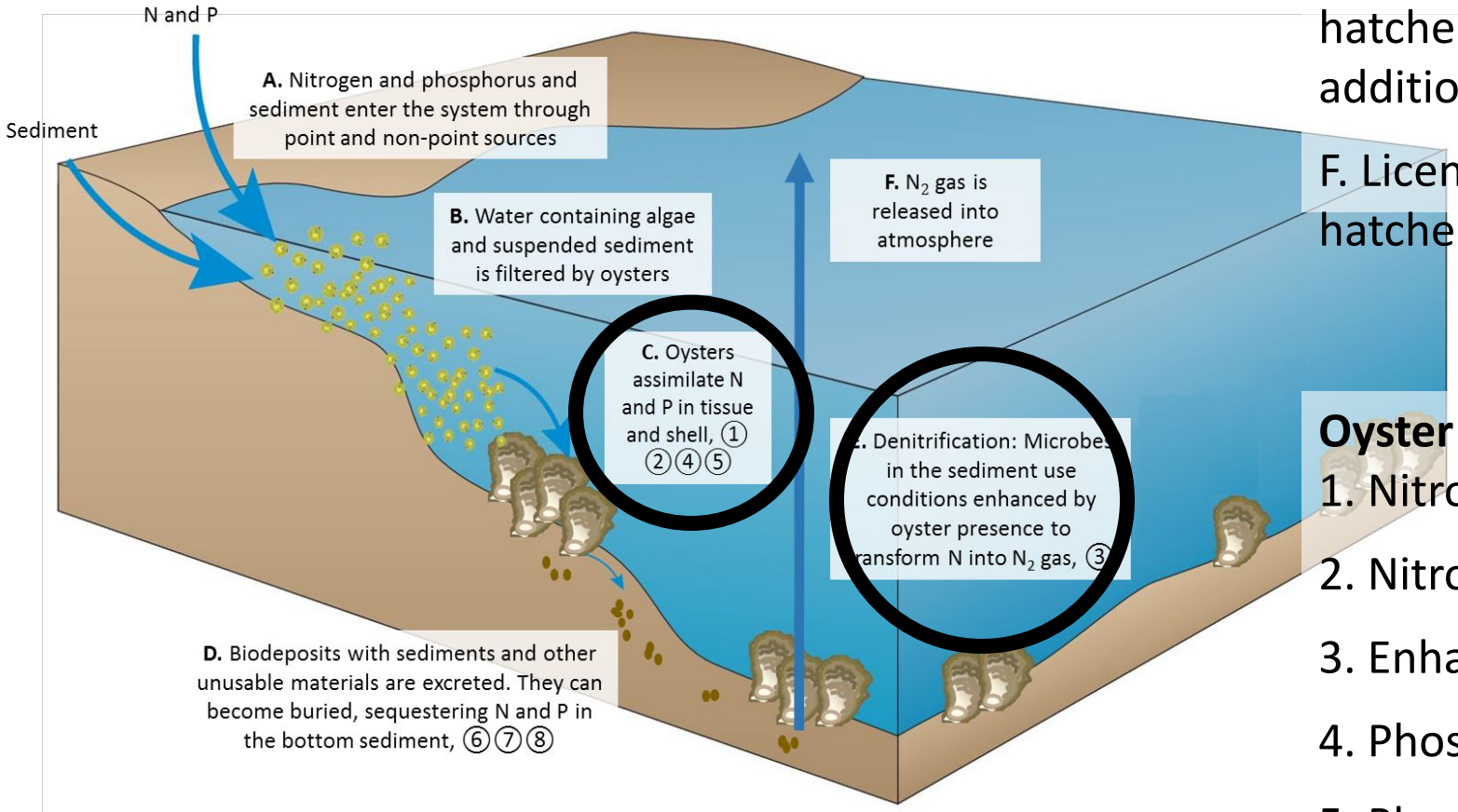
Restoration-Denitrification
*Under Review*

Restoration-Assimilation
*Under Review*



Graphic: UMCES Integrated Application Network

# Recommended Practices & Protocols




**Oyster Practices**

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

F. Licensed oyster harvest using hatchery-produced oysters

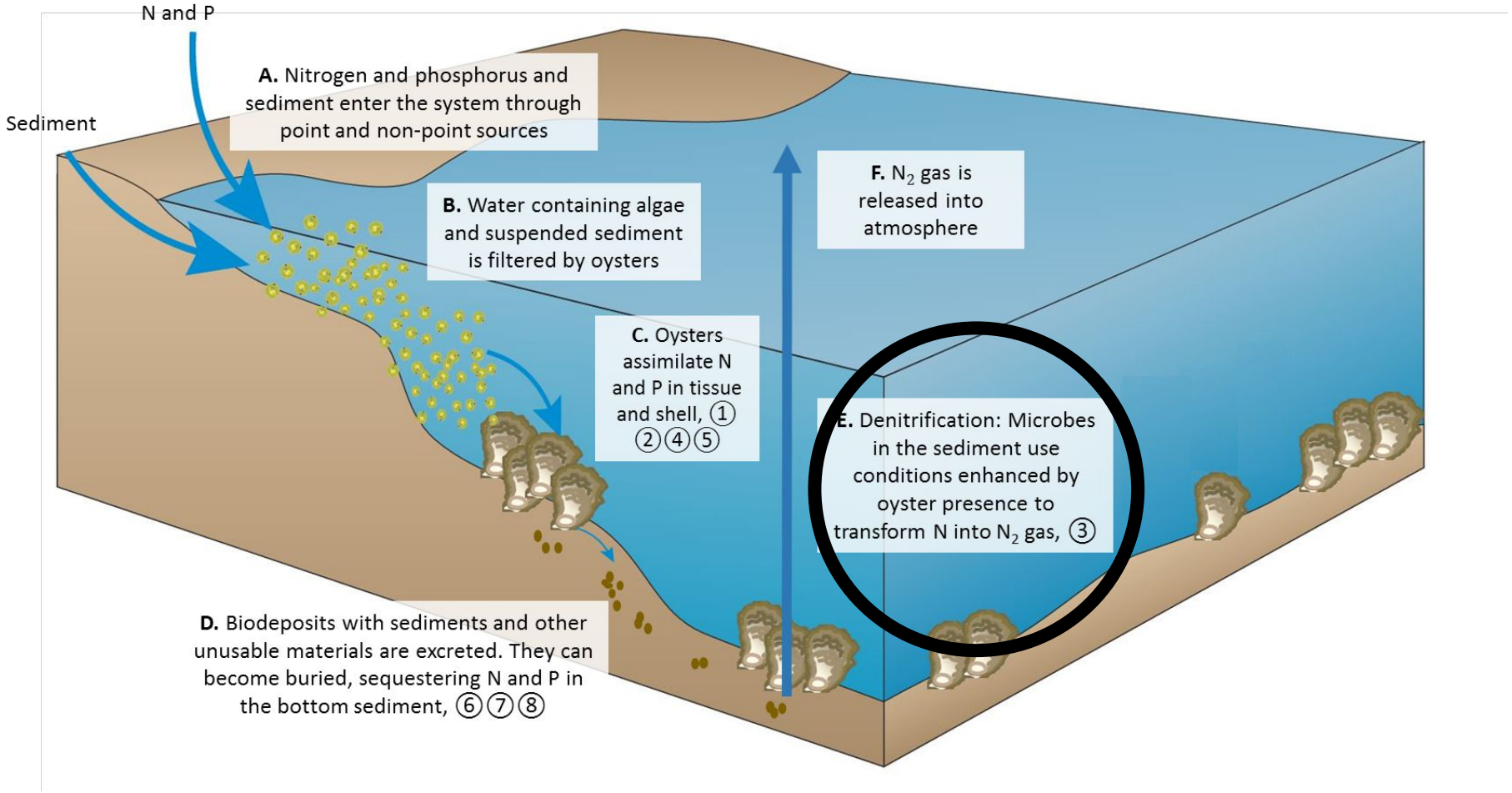
**Oyster Protocols**

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

# Oyster BMP Approach


- Oyster biomass required to estimate reduction
  - Restoration: Biomass increases on reef
  - Harvest: Biomass harvested
- Qualifying conditions ensure that reduction occurs at BMP site
- Default estimates use data representative of Bay
- Guidelines provided for when and how to develop site-specific estimates
  - Restoration: Large substrates

# Restoration-Denitrification

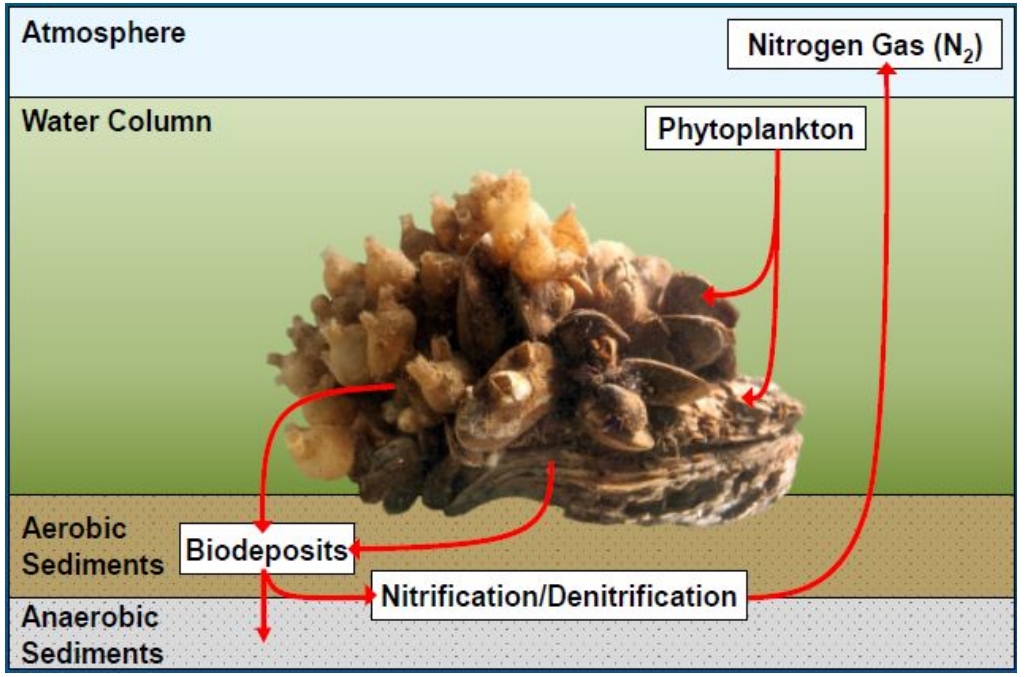



**Oyster Practice(s):** Oyster reef restoration using (J) hatchery-produced oysters & (K) substrate addition

# 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

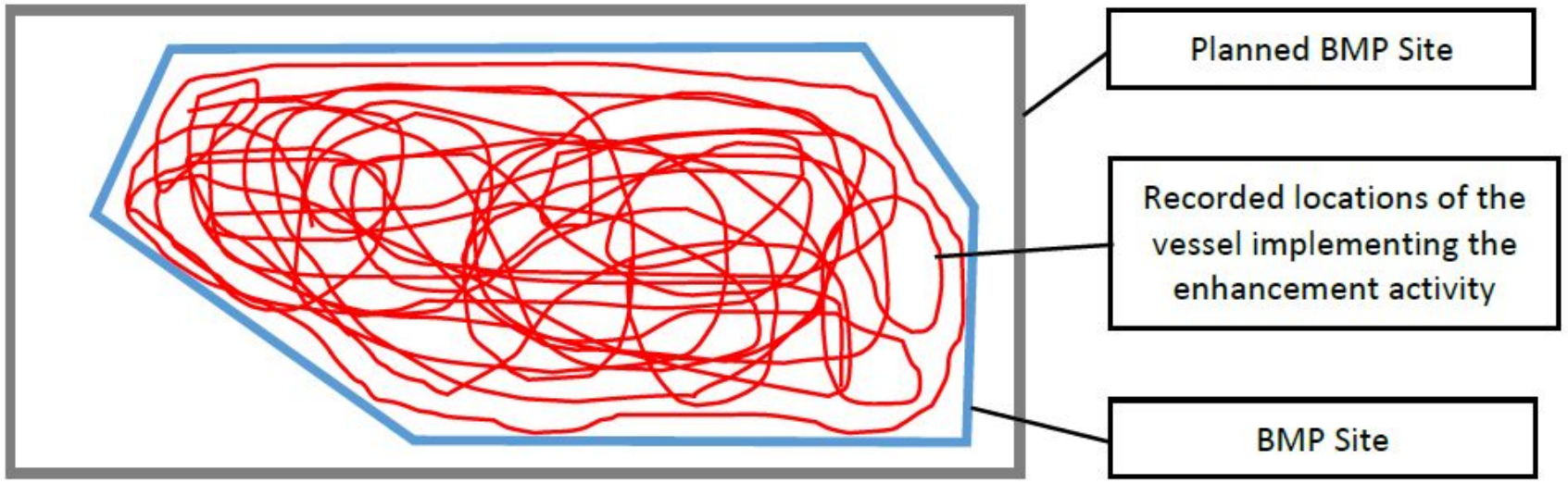



Kellogg et al. 2013

# 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


## Large Substrates



# 3. Determine Baseline Approach

**Pre-restoration Biomass**

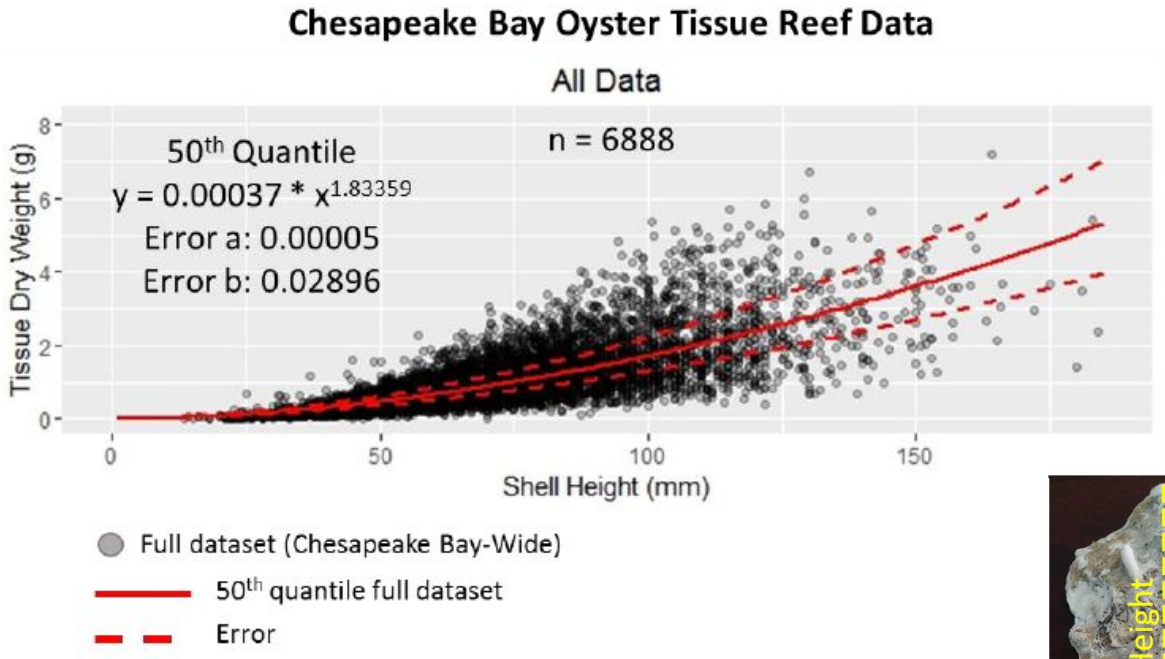
- Biomass measured at BMP Site
- Within 2 years prior to restoration

**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

Data Locations Used for Tissue Regression Equation

# 5. Determine denitrification enhancement per unit area

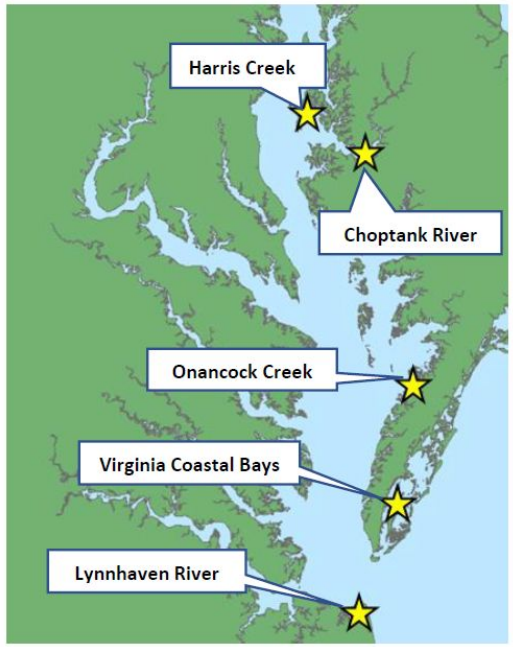
Recommended Approaches:

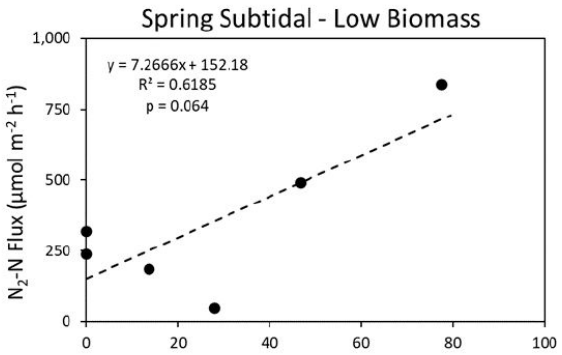
1. **Default estimates** regardless of location (Panel generated)
2. **Site-specific estimates** developed by BMP implementer, in coordination with the State and CBP, using the Panel's recommended method

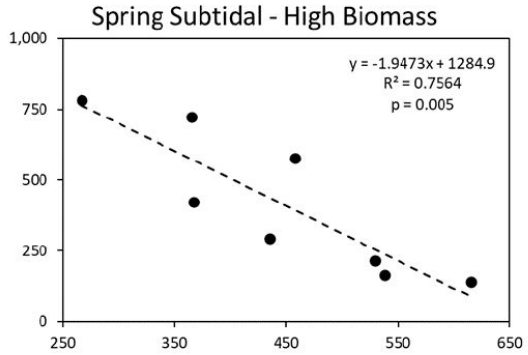
- Directly measuring denitrification is challenging
- Denitrification rates directly related to **oyster tissue biomass**

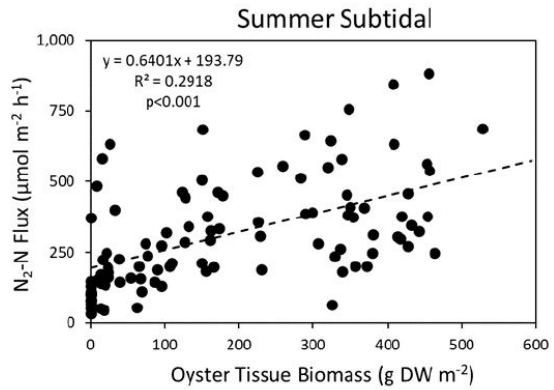
# 5. Determine denitrification enhancement per unit area

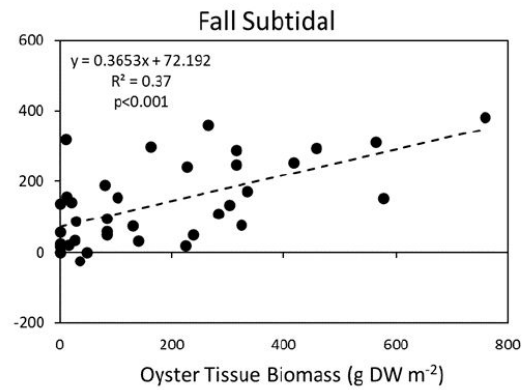
Season-specific regressions were used to generate **annual denitrification rates** as a function of oyster tissue biomass

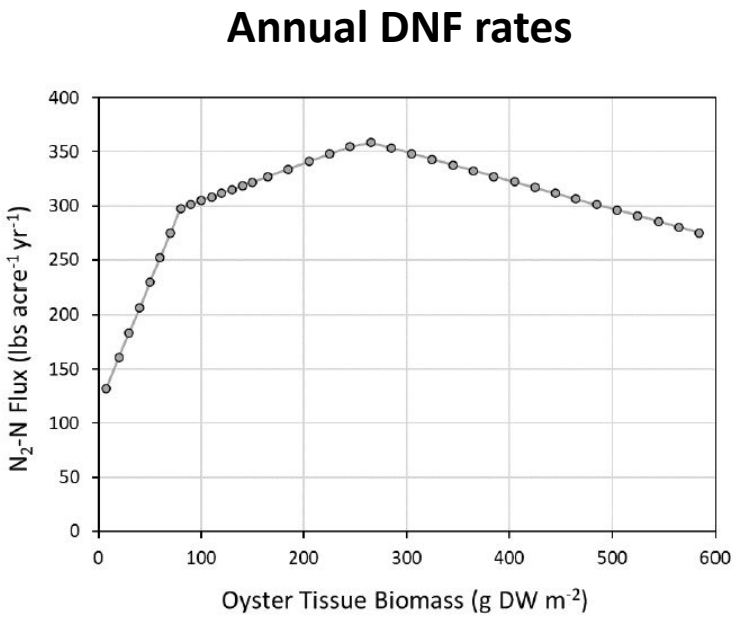


# 5. Determine denitrification enhancement per unit area

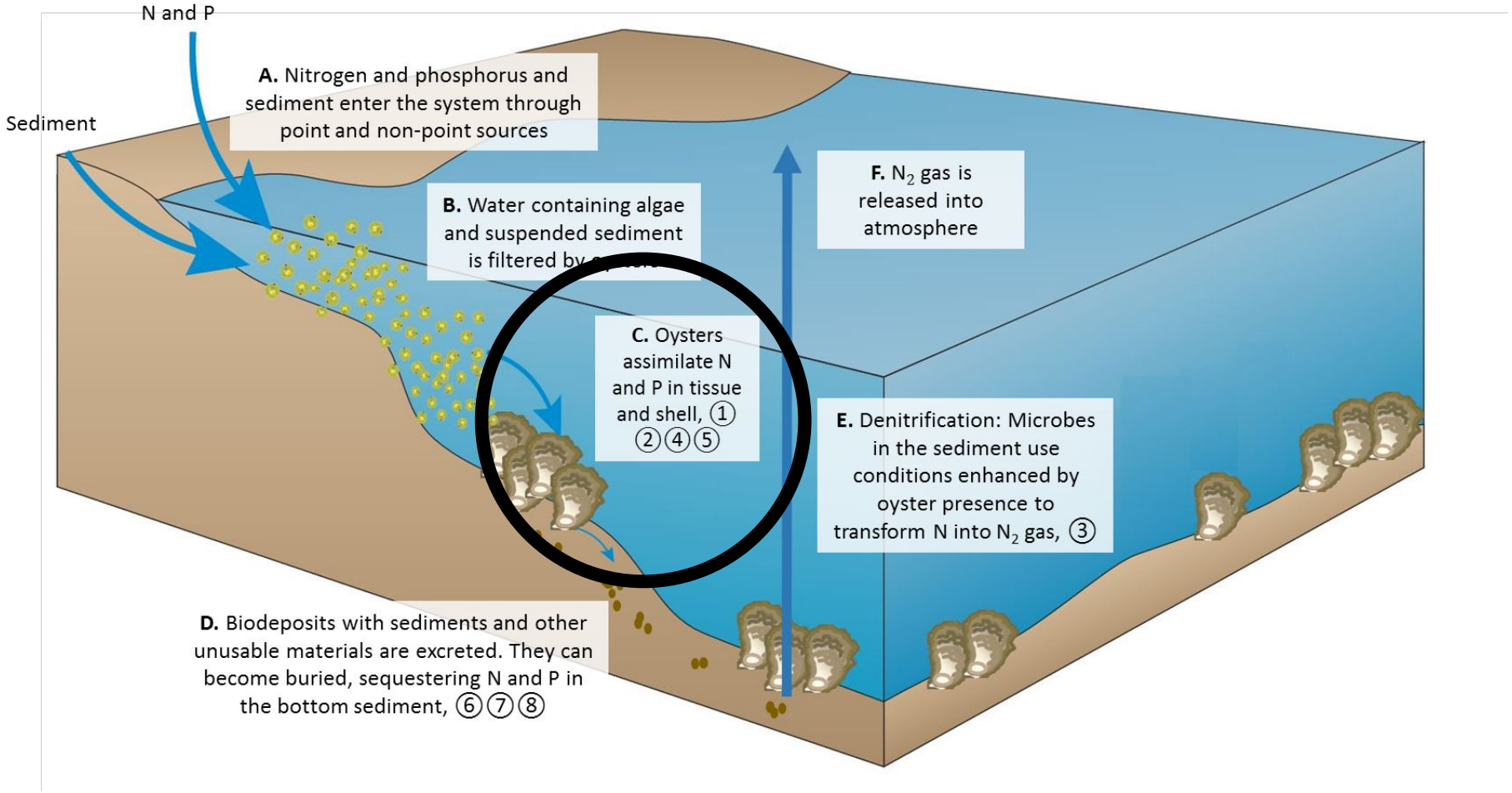
Annual denitrification rates used to construct **lookup table**

| 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**

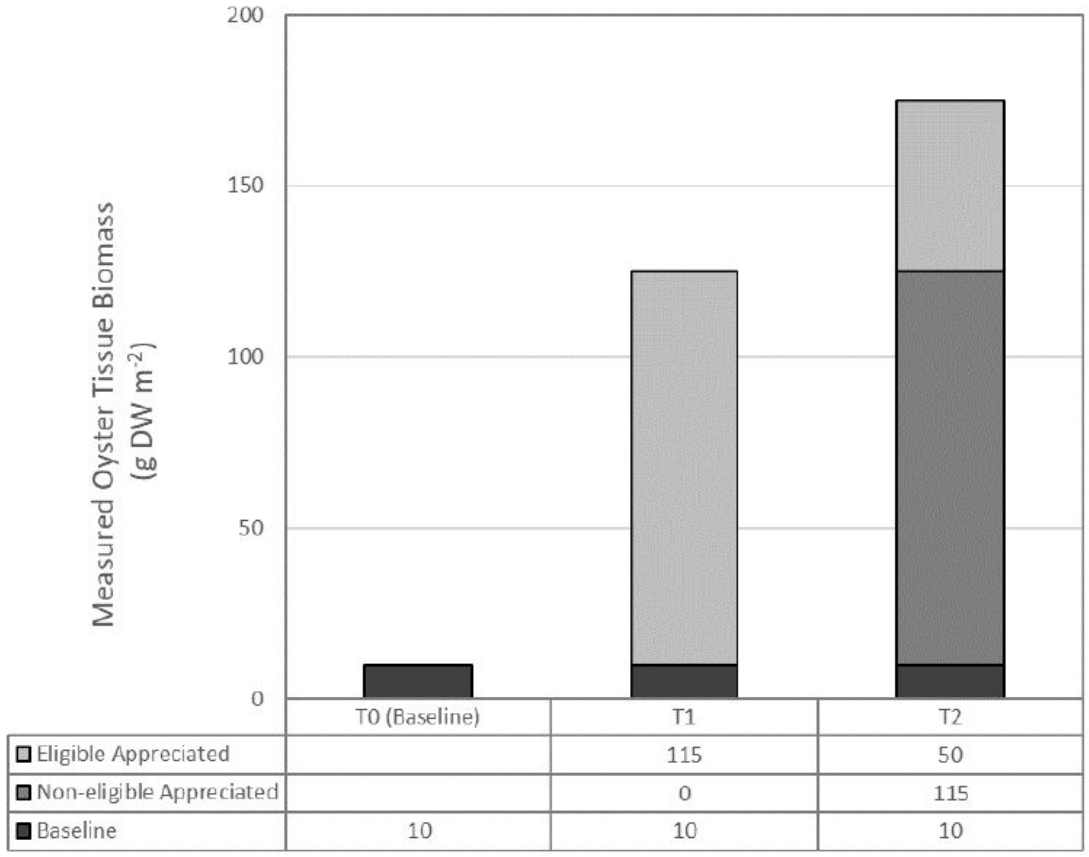
# Restoration-Assimilation




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

# The Panel's Approach

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

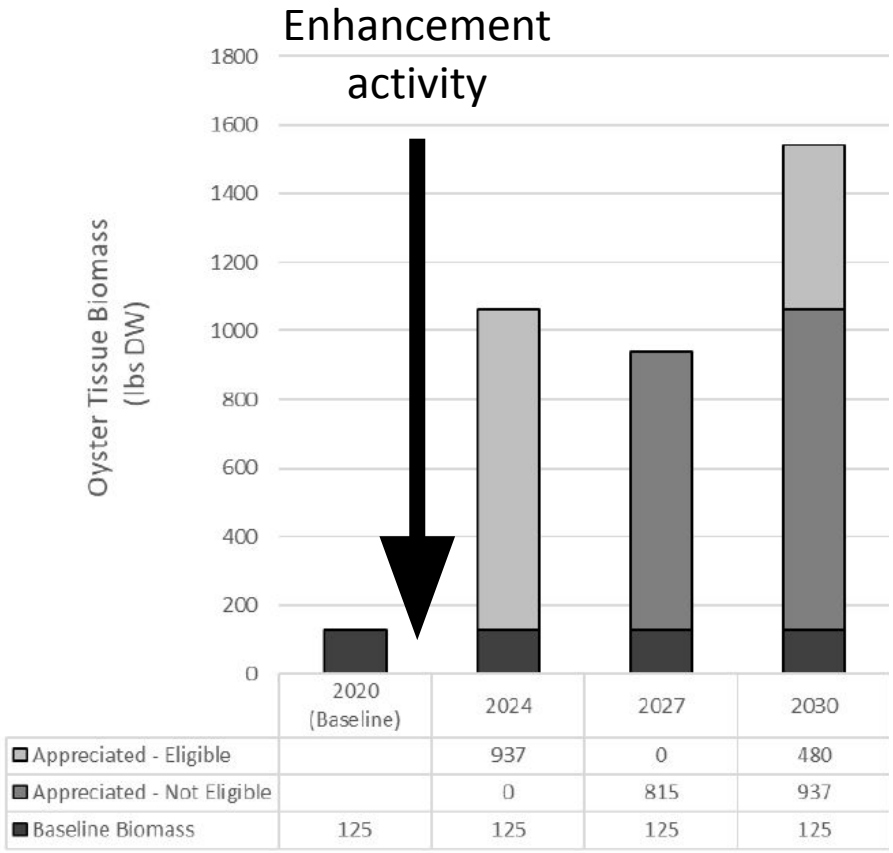



| | T0 (Baseline) | T1 | T2 |
|---|---|---|---|
| Eligible Appreciated | | 115 | 50 |
| Non-eligible Appreciated | | 0 | 115 |
| Baseline | 10 | 10 | 10 |

# 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

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

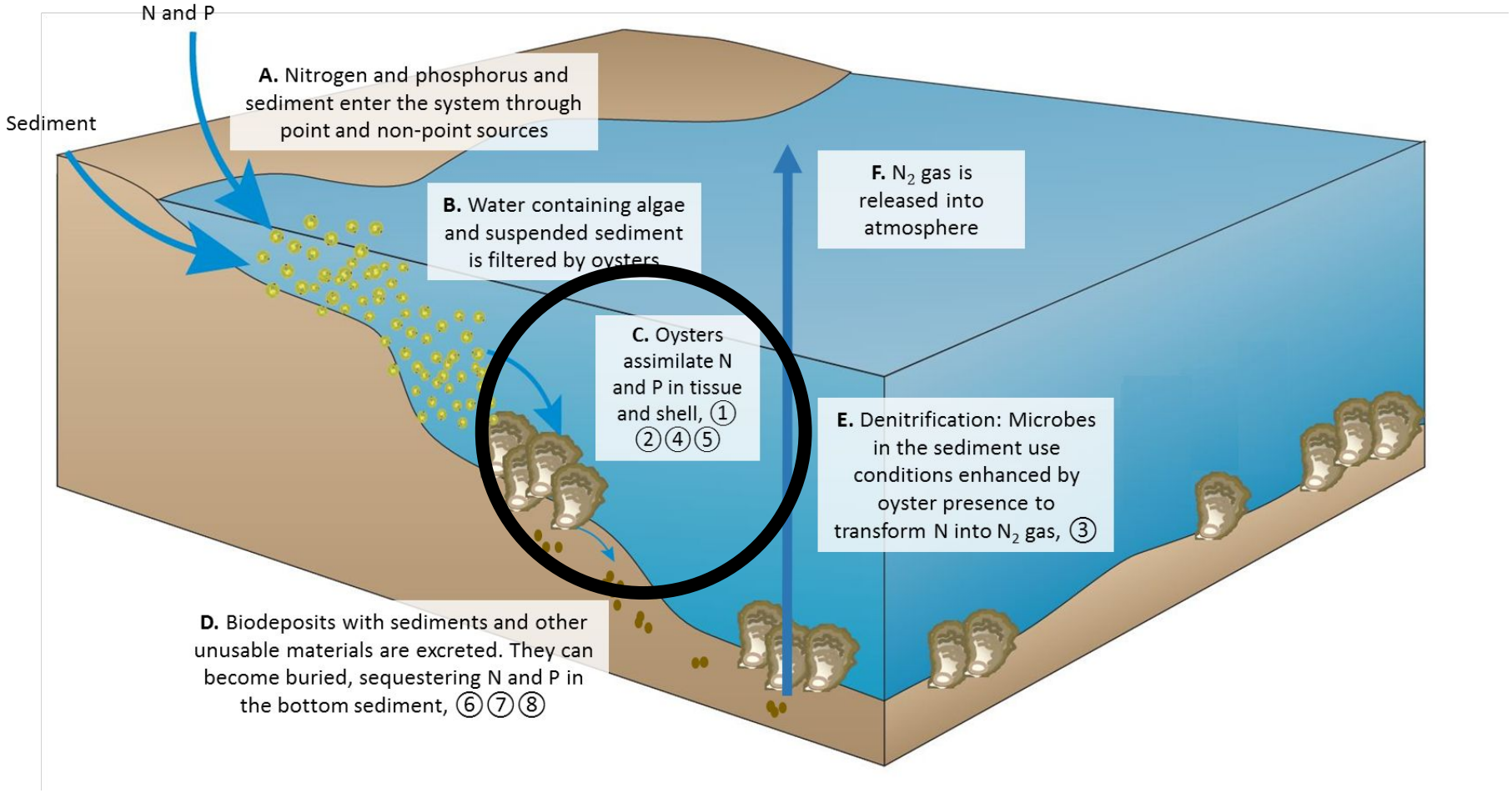



Use percent N & P content to convert to N & P removed

| 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

# 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


**Enhancement**
Year 0

Additional Enhancement

**Harvest Crediting Timeframe**
3 years

**Credit Time Lag**
Oysters @ Harvest Size
Default = Year 2
Site-Specific = Measure

**Maximum Harvest Timeframe**
Year 5

# 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.

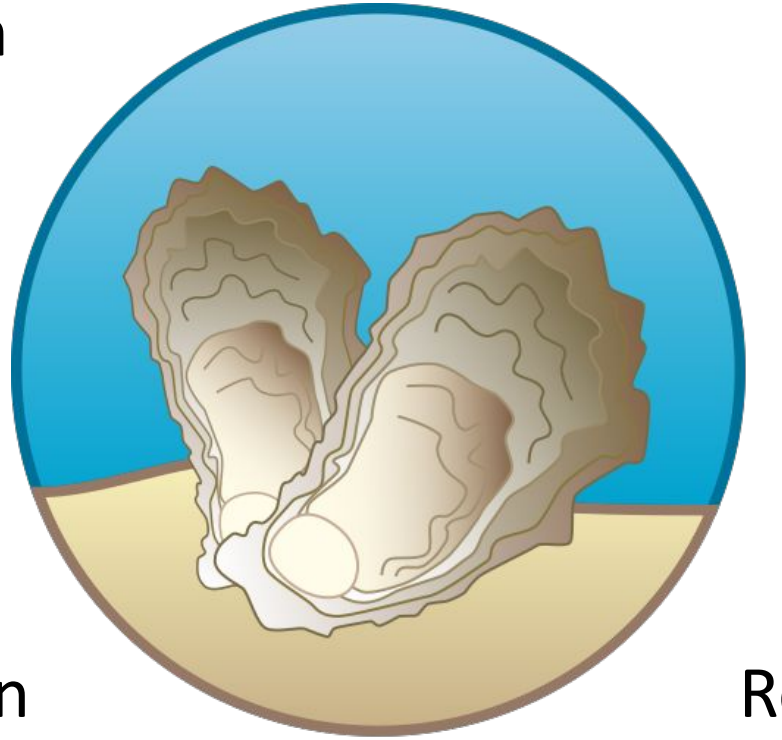
| Oyster size class (in) | Midpoint (in) | Midpoint (mm) | Tissue dry weight (g oyster$^{-1}$) | Content in oyster tissue (g oyster$^{-1}$) | |
|---|---|---|---|---|---|
| | | | | Nitrogen | Phosphorus |
| 3.00-3.49 | 3 | 76 | 1.06 | 0.09 | 0.01 |
| 3.50-4.49 | 4 | 102 | 1.81 | 0.15 | 0.02 |
| 4.50-5.49 | 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 |

# 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
- Unintended consequences were minimal

# 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)

# Feedback is due March 10th

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