



# **Overview of the Finalized Oyster BMP Crediting Report**

Olivia Caretti

Oyster Recovery Partnership

CBP Sustainable Fisheries GIT Summer Meeting

July 21, 2022



## Panel Members

Jeff Cornwell (Chair)

Suzanne Bricker

Lisa Kellogg

Andy Lacatell

Mark Luckenbach

Frank Marenghi

Chris Moore

Matt Parker

Ken Paynter

Julie Rose

Larry Sanford

Bill Wolinski

UMD Center for Environmental Science

NOAA, National Centers for Coastal Ocean Science

Virginia Institute of Marine Science

The Nature Conservancy

Virginia Institute of Marine Science

Maryland Department of Natural Resources

Chesapeake Bay Foundation

Maryland Sea Grant (UMD)

UMD Marine, Estuarine, Environmental Sciences

NOAA Northeast Fisheries Science Center

UMD Center for Environmental Science

Talbot County Department of Public Works

## Advisors, Coordinators, & Support Staff

Lew Linker

Jeff Sweeney/ Jeremy Hanson

Ralph Spagnolo

Lucinda Power

Rich Batiuk

Julie Reichert-Nguyen

Ward Slacum

Paige Hobaugh

US EPA Chesapeake Bay Program Office

US EPA Chesapeake Bay Program Office

US EPA Region III

US EPA Chesapeake Bay Program Office

US EPA Chesapeake Bay Program Office

Oyster Recovery Partnership

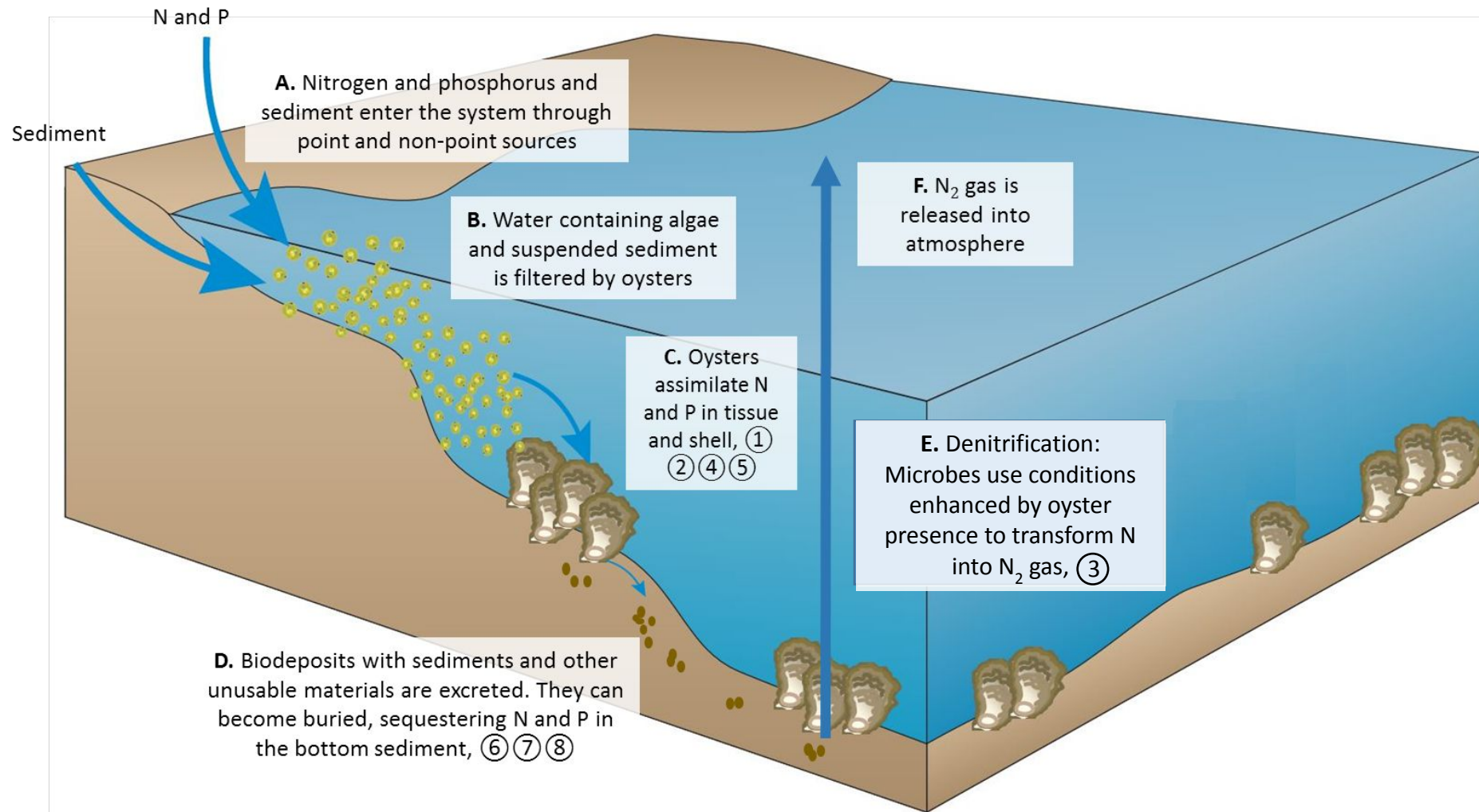
Oyster Recovery Partnership

Chesapeake Bay Program



# Oysters as a BMP

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



# Oyster BMP Panel Charge

**Charge 1.** Identify and define oyster practices for BMP consideration.

**Charge 2.** Develop decision framework for incremental approval of oyster BMPs

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

# Oyster BMP 1<sup>st</sup> Report: Charge 1

The Panel identified 96 oyster practice-protocol combinations for BMP consideration

- 12 Oyster Practices:
  - Private oyster aquaculture (5)
  - Licensed oyster harvest (4)
  - Oyster reef restoration (3)
  
- 8 Oyster Protocols:
  - Assimilation in tissue and/or shell (4)
  - Enhanced denitrification (1)
  - Nutrient and sediment burial (3)

# Oyster BMP 1<sup>st</sup> Report: Charge 2

## 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.

Do sufficient data exist?

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



**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?

# Oyster BMP 1<sup>st</sup> Report: Oyster Aquaculture BMPs

- Reviewed 10 practice-protocol combinations for ***private oyster aquaculture practices***
- Provided recommendations for 6 combinations

3 Practices	<b>Practice A &amp; B:</b> Off-bottom and on-bottom private oyster aquaculture using hatchery produced oysters <b>Practice D:</b> On-bottom private oyster aquaculture using substrate addition
2 Protocols	<b>Protocol 1.</b> Nitrogen assimilation in oyster tissue <b>Protocol 4.</b> Phosphorous assimilation in oyster tissue

# Oyster BMP 2<sup>nd</sup> Report

- Reviewed 45 practice-protocol combinations for ***licensed oyster harvest*** and ***oyster reef restoration practices***
- Provide recommendations for 12 combinations

3 Practices	<b>Practice F:</b> Licensed oyster harvest using hatchery produced oysters <b>Practice J &amp; K:</b> Oyster reef restoration using hatchery produced oysters & substrate addition.
5 Protocols	<b>Protocol 1 &amp; 2.</b> Nitrogen assimilation in oyster tissue & shell <b>Protocol 4 &amp; 5.</b> Phosphorous assimilation in oyster tissue & shell <b>Protocol 3.</b> Enhanced denitrification associated with oysters



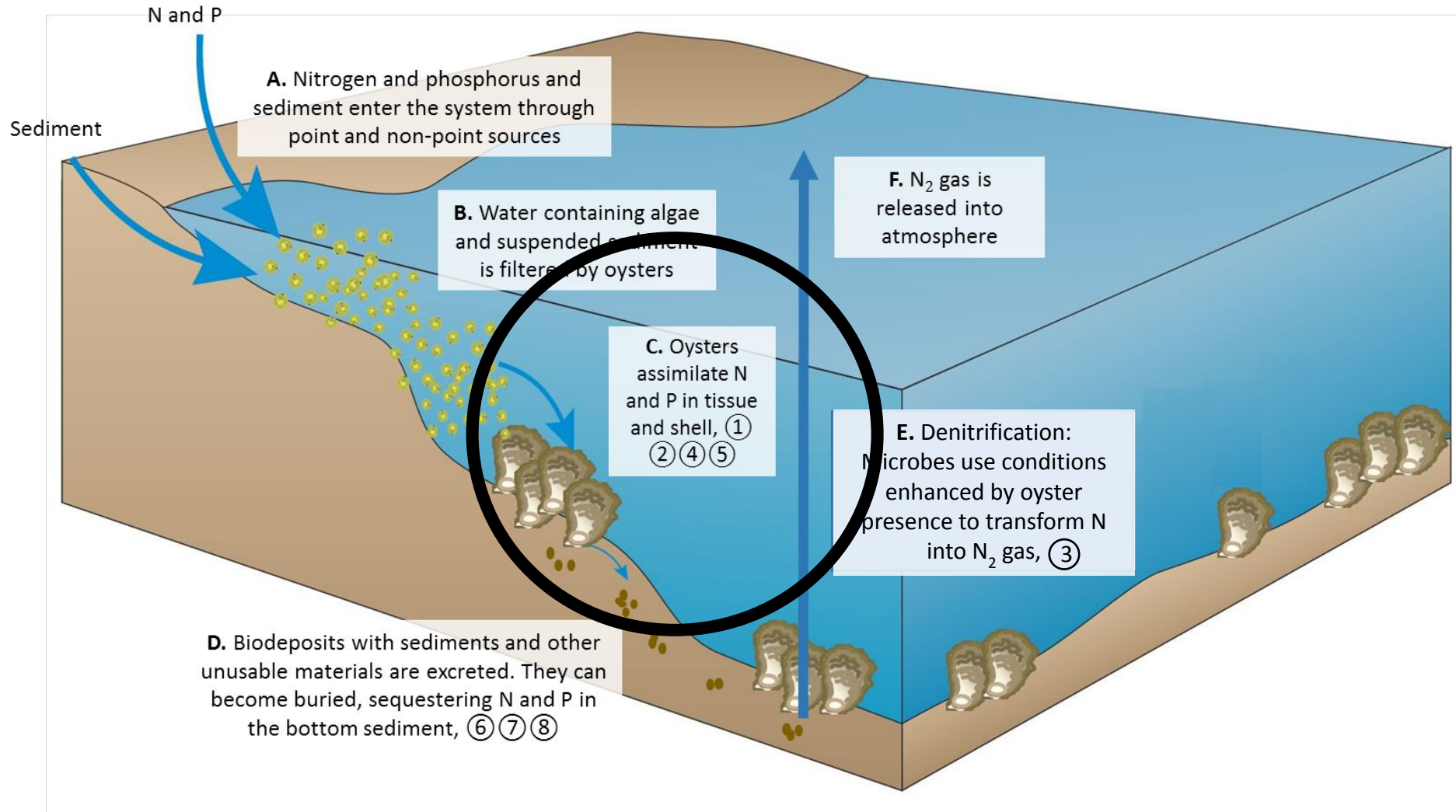
# Oyster BMP 2<sup>nd</sup> Report

- Harvest-Assimilation BMPs
- Restoration-Assimilation BMPs
- Restoration-Denitrification BMPs

The diagram illustrates the nitrogen cycle in an oyster reef system, showing the flow of nitrogen and phosphorus through various stages:

- A.** Nitrogen and phosphorus and sediment enter the system through point and non-point sources.
- B.** Water containing algae and suspended sediment is filtered by oysters.
- C.** Oysters assimilate N and P in tissue and shell, (1) (2) (4) (5).
- D.** Biodeposits with sediments and other unusable materials are excreted. They can become buried, sequestering N and P in the bottom sediment, (6) (7) (8).
- E.** Denitrification: Microbes use conditions enhanced by oyster presence to transform N into  $N_2$  gas, (3).
- F.**  $N_2$  gas is released into atmosphere.

The diagram also shows the sediment layer and the oyster reef structure.



# Harvest-Assimilation: Practices & Protocols

1 Practices	<b>Practice F:</b> Licensed oyster harvest of hatchery-produced oysters
2 Protocols	<b>Protocol 1.</b> Nitrogen assimilation in <u>oyster tissue</u> <b>Protocol 4.</b> Phosphorous assimilation in <u>oyster tissue</u>
Implementation	<ul style="list-style-type: none"><li>• BMP site is open to harvest</li><li>• Oyster tissue only</li><li>• Panel recommendations impose limitations to avoid overcrediting</li></ul>

# Harvest-Assimilation: Recommendations

To ensure that harvested oysters are from the enhancement activity, apply:

- ***Default tissue nutrient content*** – based on diploid shell height-biomass regression (1<sup>st</sup> report)
- ***Default maximum harvest allowance*** – based on # hatchery produced oysters planted and survival rate (15%)
- ***Crediting time lag*** – account for time to grow to harvest size (2 years)
- ***Maximum crediting timeframe*** – credit can be applied up to 5 years after enhancement

Using recommended default estimates, up to 15% of planted oysters can be eligible for credit 2-5 years after enhancement



# Harvest-Assimilation: Determination Steps

## Determination Steps:

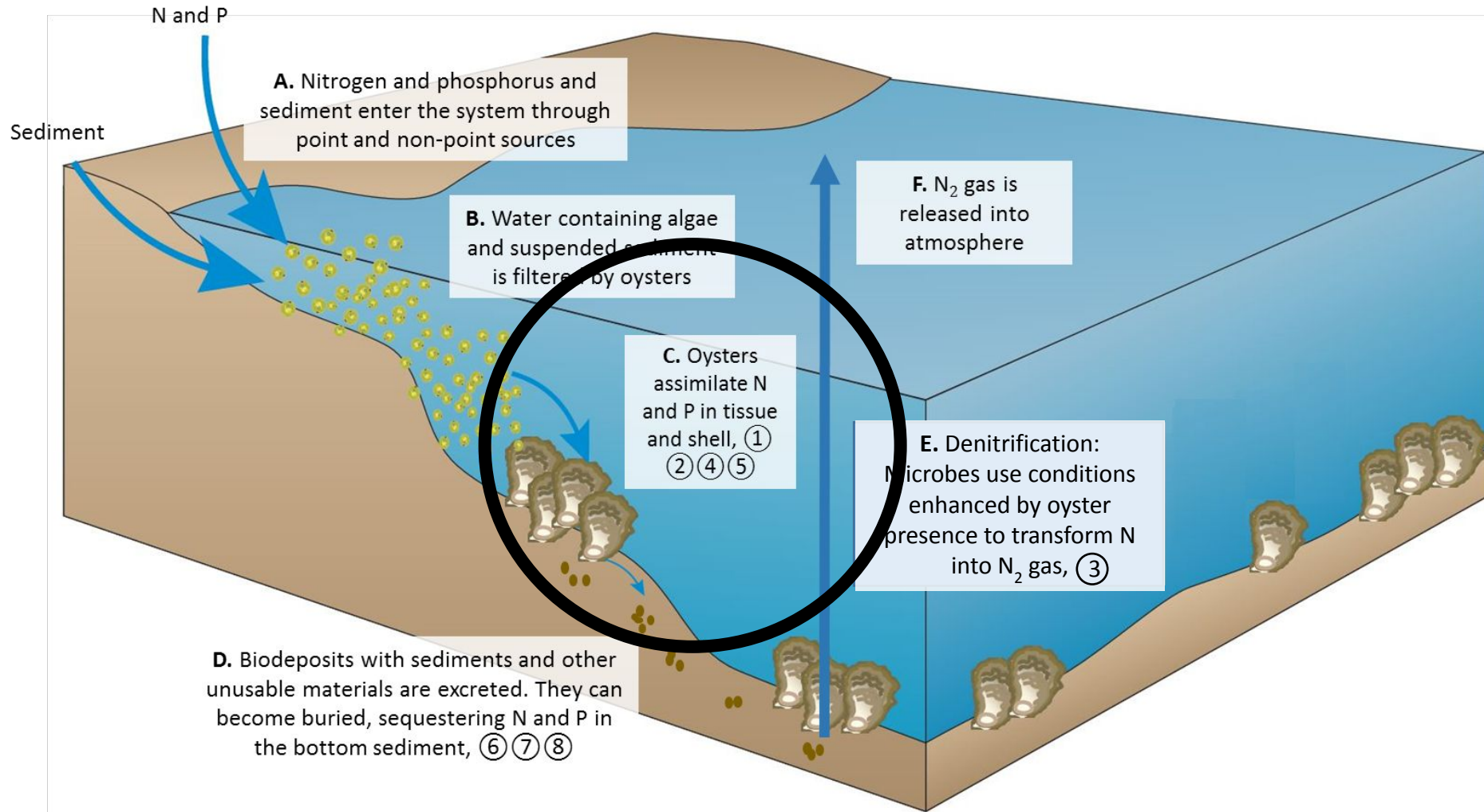
1. Determine the maximum harvest allowance (15%)
2. Determine the harvest crediting timeframe (2-5 years)
3. Determine total amount of N & P harvested
  - Verify the size and # oysters harvested

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
Diploid Licensed Oyster Harvest, Hatchery Produced 5.0 Inches	4.50-5.49	485	44
Diploid Licensed Oyster Harvest, Hatchery Produced >5.0 Inches	≥ 5.50**	683	66

\* Adjusted from 2.5-3.49. See text for details.

\*\* Based on midpoint of 6.0 inches

# Restoration-Assimilation



# Restoration-Assimilation: Practices & Protocols

## 2 Practices

**Practice J:** Restoration using hatchery-produced oysters

**Practice K:** Restoration using substrate addition

## 4 Protocols

**Protocol 1 & 2.** Nitrogen assimilation in oyster tissue and shell

**Protocol 4 & 5.** Phosphorous assimilation in oyster tissue and shell

## Implementation

- BMP site is protected from harvest
- Oyster tissue and shell are eligible
- Default approach for enhancement with small substrate only
- Only appreciated biomass can be credited

# Restoration BMPs: Small vs. Large Substrates

## Small substrates

- Suitable substrate characterized by
  - $\geq 90\%$  of material by volume  $\leq 12$  inches in diameter
  - A non-uniform or irregular structure
- Calculate oyster biomass per unit area
- Extrapolate to BMP site area

## Large substrates

- Suitable substrate characterized by
  - $< 90\%$  of material by volume  $\leq 12$  inches in diameter
  - A uniform, regular structure
- Calculate oyster biomass per structure
- Extrapolate to # structures at BMP site

**Default approaches are only recommended for reefs restored using *small substrate***



# Restoration-Assimilation: Recommendations

Panel conducted data review to:

- Generate default oyster shell height-biomass regressions
- Identify the N & P content (%) in oyster tissue and shell biomass

50 <sup>th</sup> Quantile	
Regression Equation	
Tissue	<b><math>y = 0.00037x^{1.83359}</math></b>
Shell	<b><math>y = 0.00147x^{2.3964}</math></b>

	N	P
Tissue	8.2%	0.9%
Shell	0.2%	0.04%

Credit can only be given for an increase in biomass that has not been credited previously

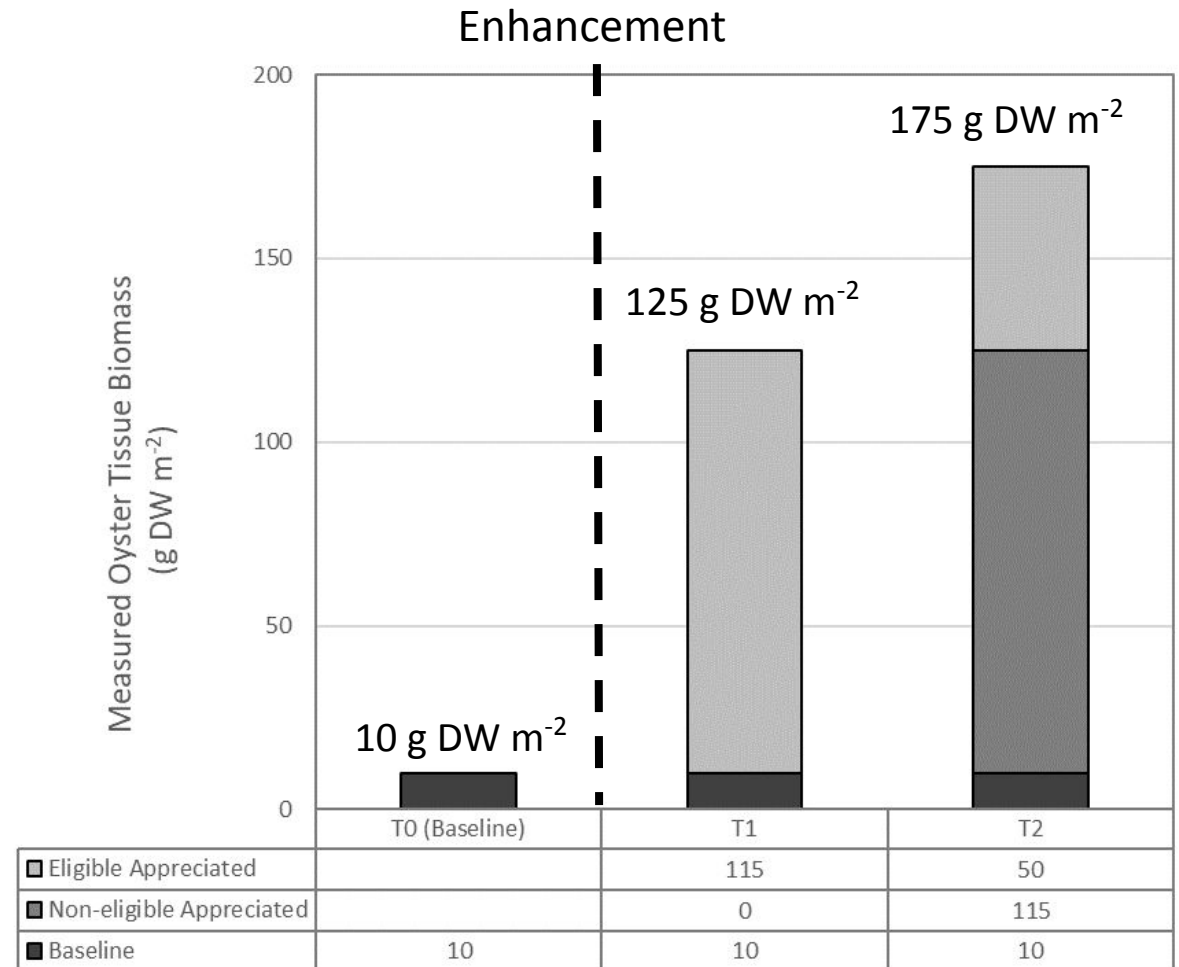
# Restoration-Assimilation: Determination Steps

## Determination Steps:

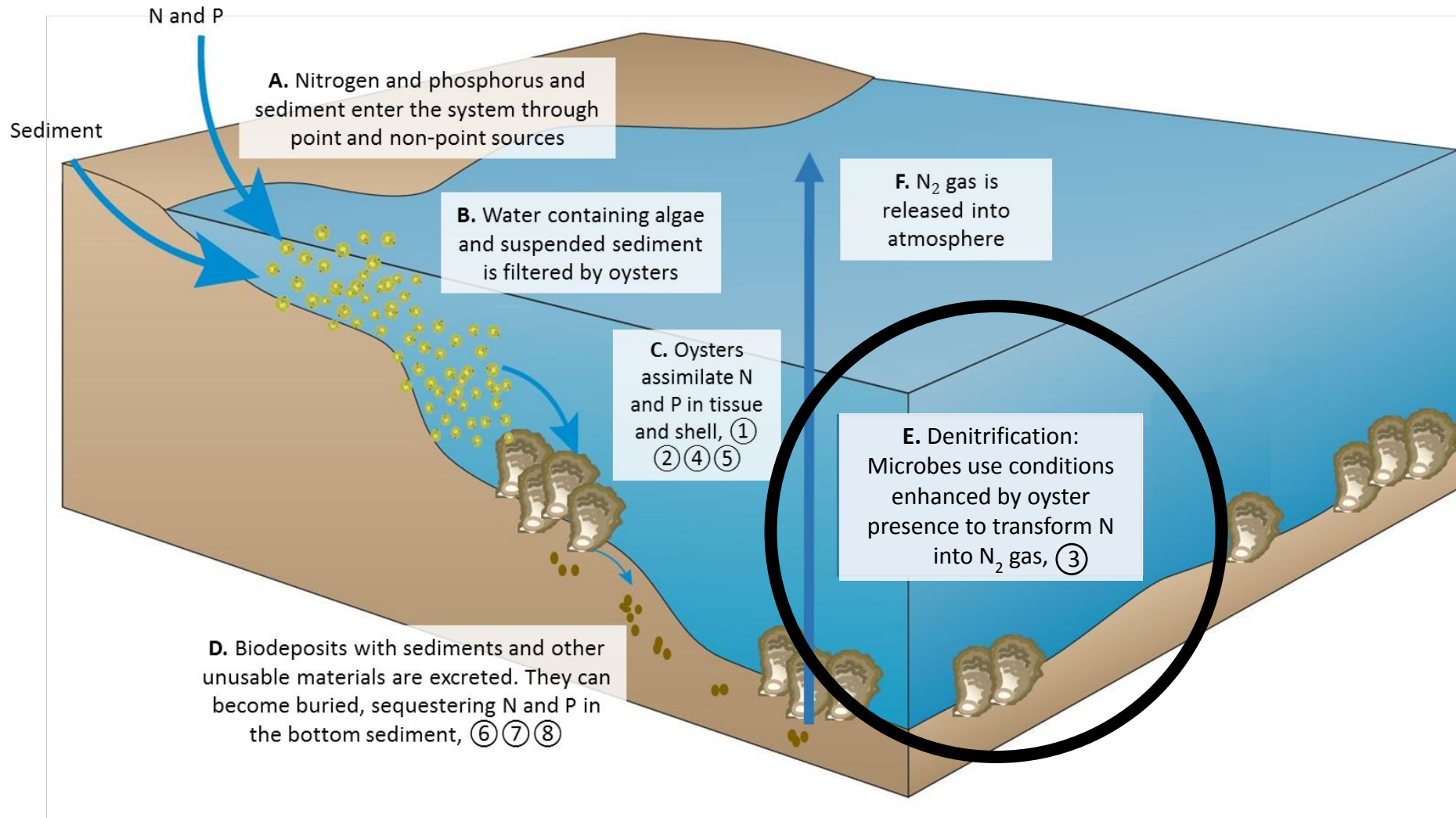
1. Measure baseline and post-restoration oyster biomass
2. Determine appreciated biomass
3. Estimate N & P assimilation
3. Extrapolate to BMP site area

## Credit timeframe:

- Within 12 months of post-restoration monitoring



# Restoration-Denitrification



# Restoration-Denitrification: Practices & Protocols

## 2 Practices

**Practice J:** Restoration using hatchery-produced oysters

**Practice K:** Restoration using substrate addition

## 1 Protocol

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

## Implementation

- BMP site is protected from harvest
- Oyster tissue only
- Default approach for subtidal reefs restored with small substrate



# Restoration-Denitrification: Recommendations

Panel conducted meta-analysis to:

- Estimate annual DNF rates
- Quantify relationship between oyster tissue biomass and DNF rates

Constructed lookup table to estimate enhanced nitrogen removal using:

- Baseline oyster biomass
- Post-restoration oyster biomass

Enhanced Nitrogen Removal (lbs acre <sup>-1</sup> yr <sup>-1</sup> )		Post-restoration Oyster Biomass Range (g DW m <sup>-2</sup> )												
		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 <sup>-2</sup> )	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

Lookup table for default approach (subtidal, small substrate)

# Restoration-Denitrification: Determination Steps

## Determination Steps:

1. Measure baseline and post-restoration oyster tissue biomass
2. Estimate enhanced nitrogen removal using lookup table
3. Extrapolate to BMP site area

## Credit timeframe:

- Annually for up to 3 years

Enhanced Nitrogen Removal (lbs acre <sup>-1</sup> yr <sup>-1</sup> )		Post-restoration Oyster Biomass Range (g DW m <sup>-2</sup> )												
		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 <sup>-2</sup> )	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

Lookup table for default approach (subtidal, small substrate)

# Oyster BMP 2<sup>nd</sup> Report Summary

- Reviewed 45 practice-protocol combinations for ***licensed oyster harvest*** and ***oyster reef restoration practices***
- Provide recommendations for 12 combinations

3 Practices	<b>Practice F:</b> Licensed oyster harvest using hatchery produced oysters <b>Practice J &amp; K:</b> Oyster reef restoration using hatchery produced oysters & substrate addition.
5 Protocols	<b>Protocol 1 &amp; 2.</b> Nitrogen assimilation in oyster tissue & shell <b>Protocol 4 &amp; 5.</b> Phosphorous assimilation in oyster tissue & shell <b>Protocol 3.</b> Enhanced denitrification associated with oysters

# Oyster BMP 2<sup>nd</sup> Report Summary

BMP	Verification Step	Credit Timeframe
Harvest-Assimilation	Quantify size and # of oysters harvested	2-5 years after enhancement
Restoration-Assimilation	Measure baseline and post-restoration oyster biomass	Within 12 months of biomass assessment Lifetime of BMP
Restoration-Denitrification	Measure baseline and post-restoration oyster biomass	Annually for up to 3 years after biomass assessment Lifetime of BMP



# Oyster BMP 2<sup>nd</sup> Report Summary

The Panel concluded:

- Oyster biomass required to estimate reduction effectiveness
- Verification is required to determine whether enhancement improves oyster production
- Crediting approaches are intentionally conservative to minimize overcrediting
- Several research gaps and future work remain

# Upcoming BMP dates

- Submitted and available for review in August 2022
- Webinars will be hosted in late August-early September 2022