



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

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Oyster Recovery Partnership

CBP Sustainable Fisheries GIT Summer Meeting

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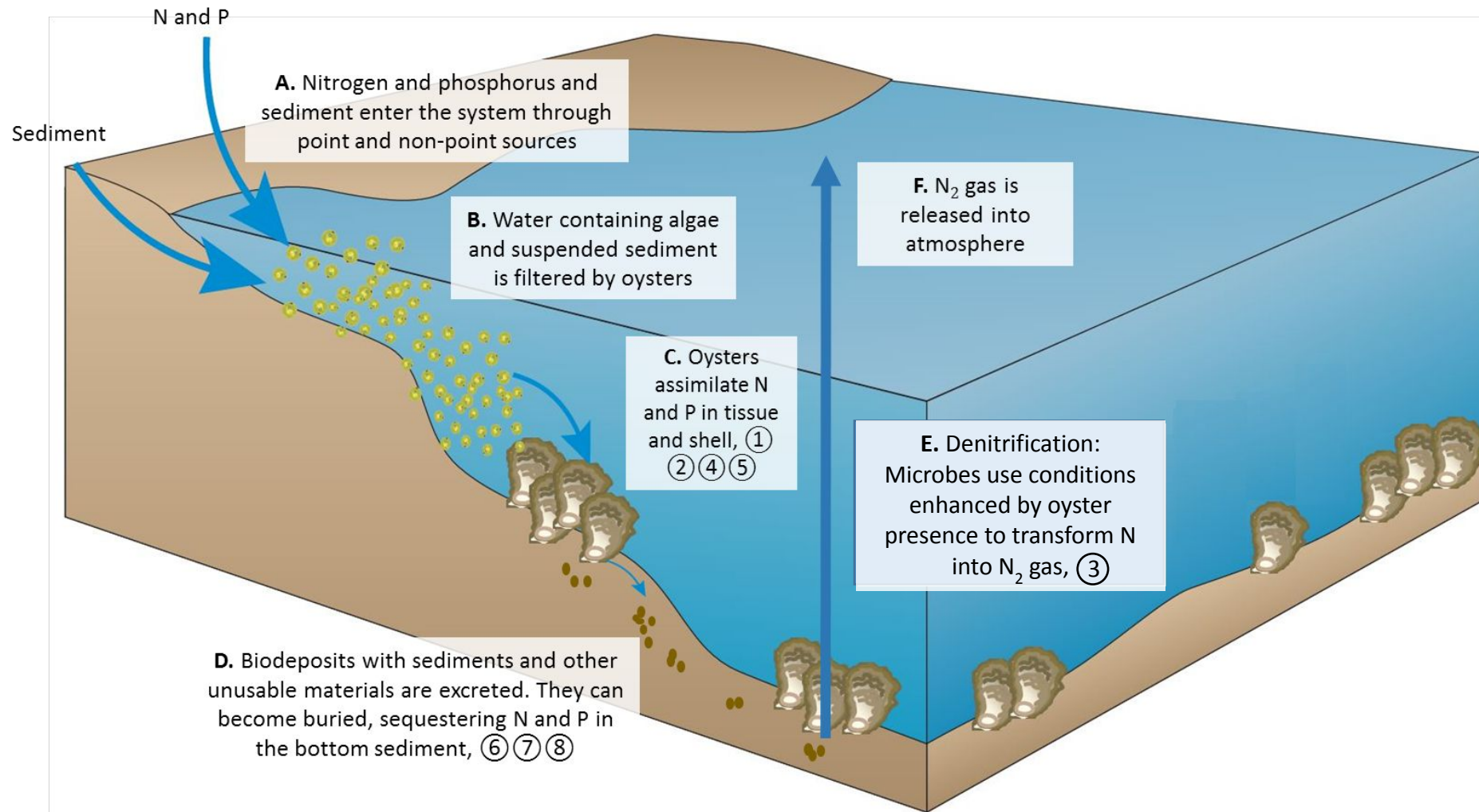
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# Oysters as a BMP

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

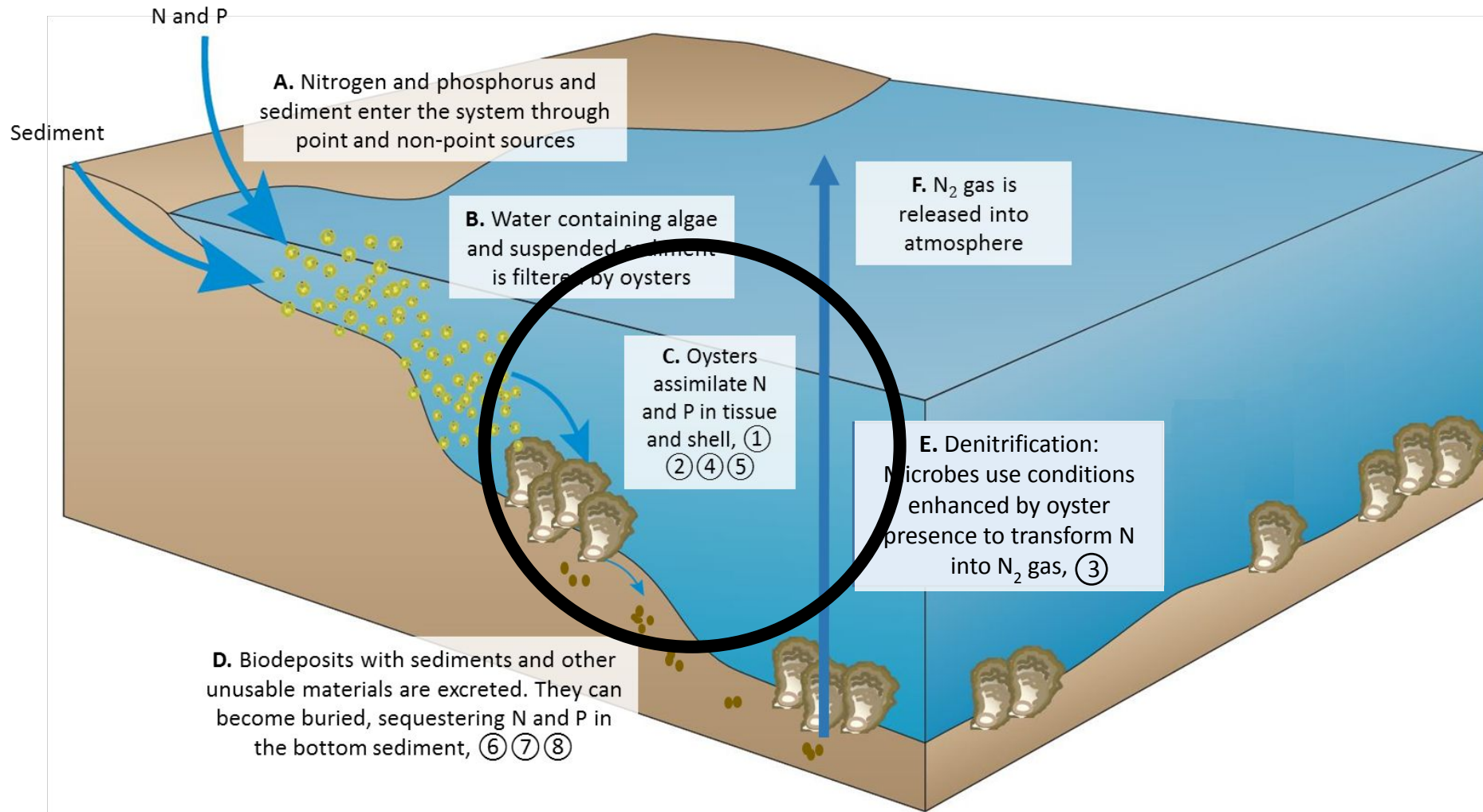
3 Practices	<b>Practice F:</b> Licensed oyster harvest using hatchery produced oysters <b>Practice J &amp; K:</b> Oyster reef restoration using hatchery produced oysters & substrate addition.
5 Protocols	<b>Protocol 1 &amp; 2.</b> Nitrogen assimilation in oyster tissue & shell <b>Protocol 4 &amp; 5.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

# Harvest-Assimilation



# 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:

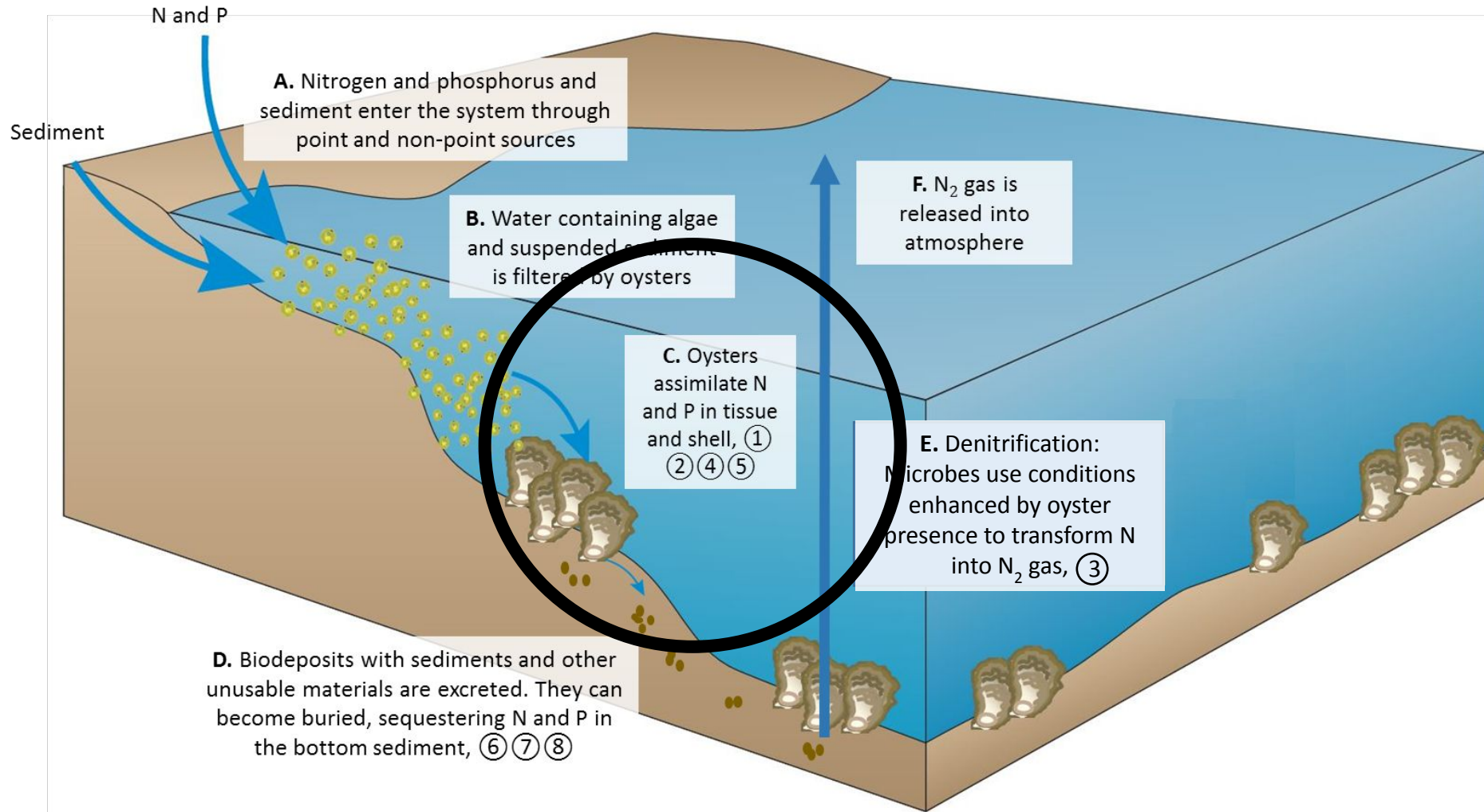
1. Determine the maximum harvest allowance (15%)
2. Determine the harvest crediting timeframe (2-5 years)
3. Determine total amount of N & P harvested
  - Verify the size and # oysters harvested

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

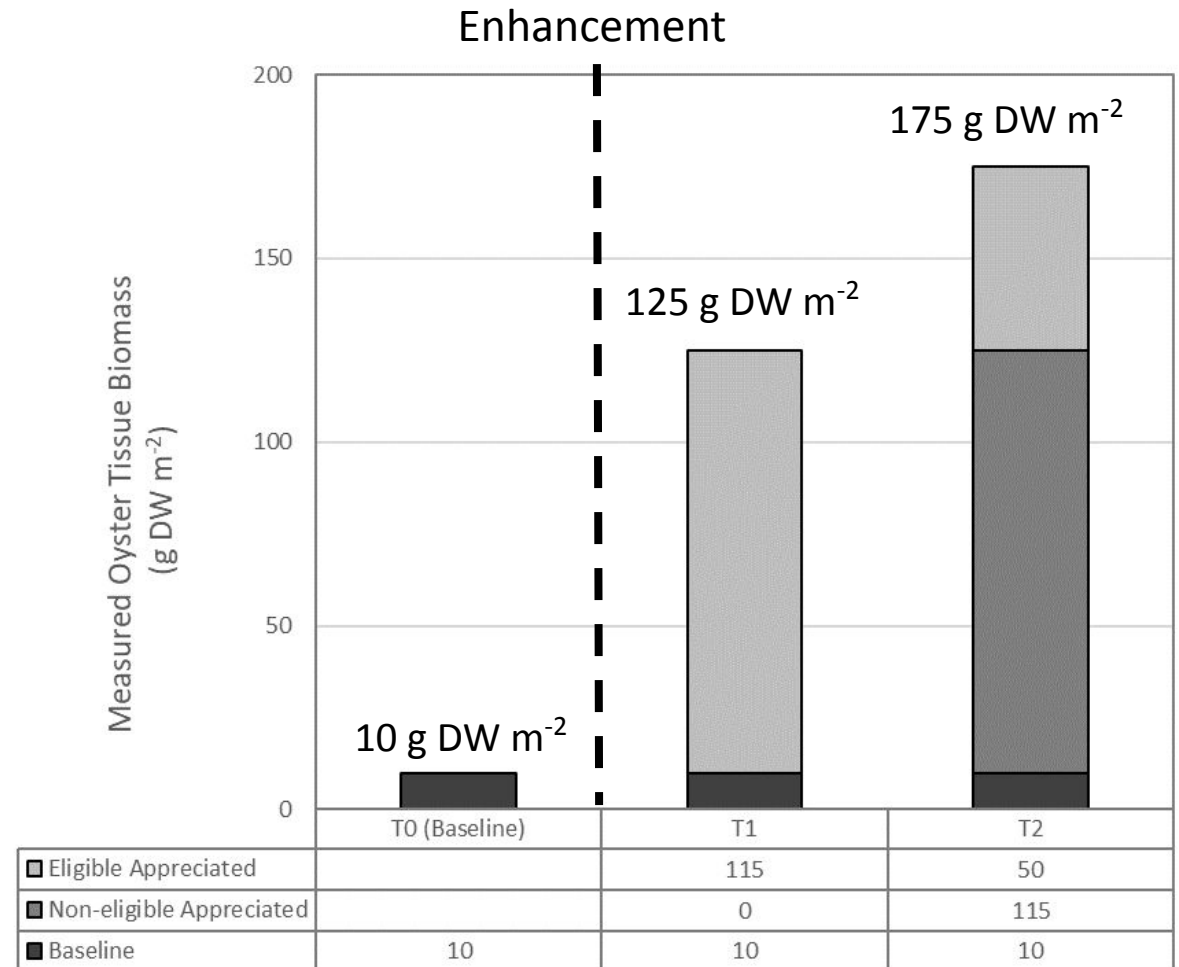
# Restoration-Assimilation: Determination Steps

## 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:

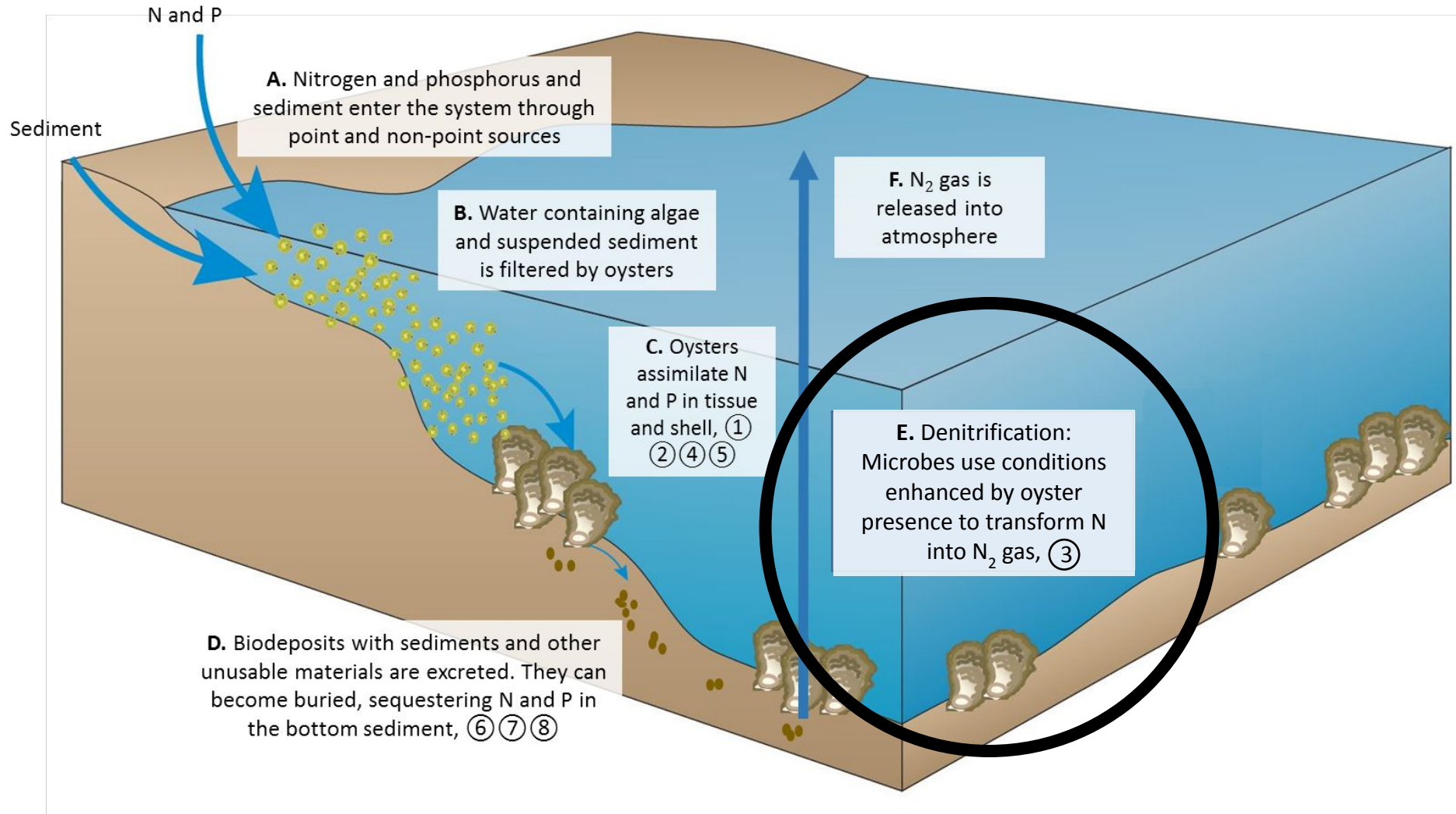
- Within 12 months of post-restoration monitoring



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.



# 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> )												
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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