Scaling Ecosystem Services to Reef Development: Effects of Oyster Density on Nitrogen Removal and Biodiversity

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Evaluating Ecosystem Services Provided by Restored Reefs

- Water quality improvements
- Increased fish production
- Enhanced biodiversity
- Nutrient sequestration and removal

How do we evaluate this?

Report of the Oyster Metrics Group (2011)

"The quantity of an ecosystem service provided by a reef or a series of reefs in a tributary cannot be determined from sampling only on restored reefs, but requires comparisons to appropriate references areas in well-designed experiments."

Slide 2

LK4 Do you mean for this to be animated so that it comes up before the text at the left?
Lisa Kellogg, 6/8/2012

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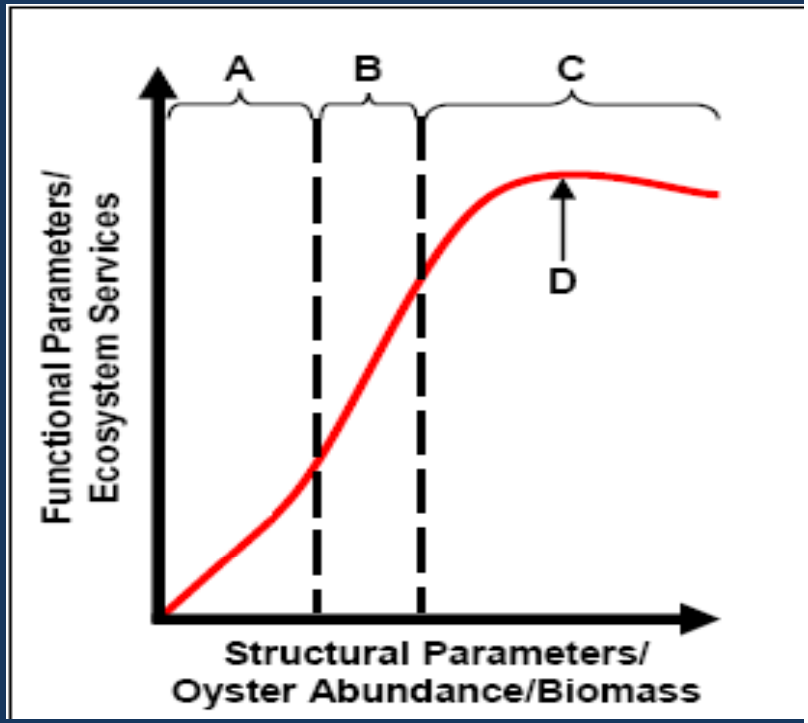


Report of the Oyster Metrics Group (2011)

The quantity of an ecosystem service provided by a reef or a series of reefs in a tributary cannot be determined from sampling only on restored reefs, but requires comparisons to appropriate references areas in well-designed experiments.

The report recommends developing experimentally-derived relationships between easily measurable quantities (e.g., oyster abundance or biomass) and the quantity of ecosystem services attained.

Slide 3

LK3 Do you plan to discuss the A,B,C and D aspects of this? If not, I shoudl be able to provide you with a copy without the labels. Regardless, the edging on this is weird and needs to be cropped or, if I can find it, replaced with a clearer copy.
Lisa Kellogg, 6/8/2012

Research Objectives

1. Construct replicated, experimental reefs with varying densities of oysters that can serve as a platform for developing relationships between ecosystem services and oyster reef characteristics (e.g., abundance, biomass, complexity)

2. Determine relationships between oyster reef characteristics and
   a. Abundance and diversity of the resident reef community

   b. Nitrogen sequestration

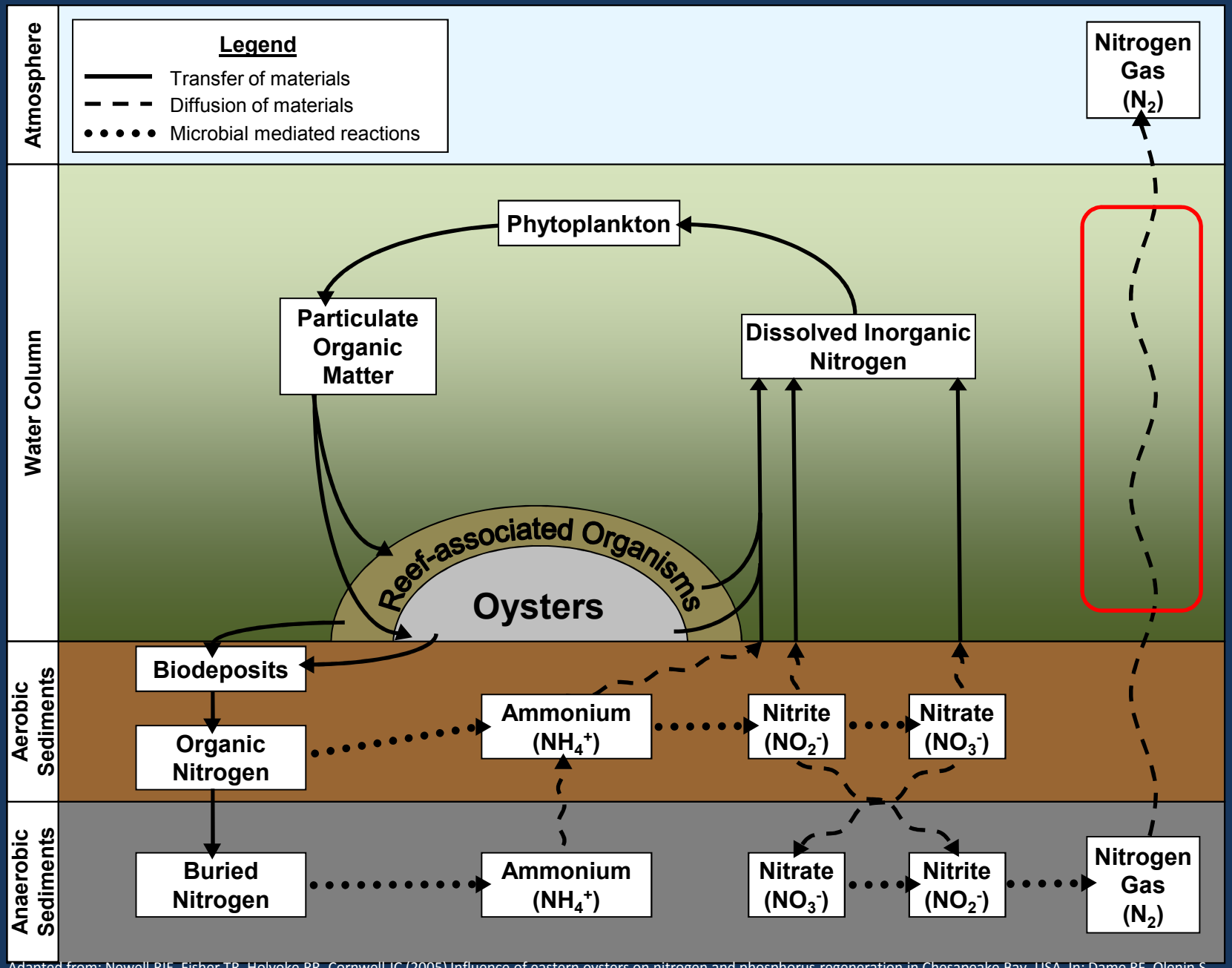
   c. Denitrification

   d. Alterations to sediment organic content

Research Objectives

1. Construct replicated, experimental reefs with varying densities of oysters that can serve as a platform for developing relationships between ecosystem services and oyster reef characteristics (e.g., abundance, biomass, complexity)

2. Determine relationships between oyster biomass and
   a. Abundance and diversity of the resident reef community (>99 million indiv. acre^{-1})
   b. Nitrogen sequestration (871 lbs N acre^{-1})
   c. Denitrification (Kellogg et al. Choptank 543 lbs N acre^{-1} yr^{-1})
   d. Alterations to sediment organic content



Adapted from: Newell RIE, Fisher TR, Holyoke RR, Cornwell JC (2005) Influence of eastern oysters on nitrogen and phosphorus regeneration in Chesapeake Bay, USA. In: Dame RF, Olenin S, (eds). The comparative roles of suspension feeders in ecosystems, NATO ASI Sci Ser 4 Earth Environ Sci, Springer-Verlag, Berlin, p 93–120.

Study Sites

1) Onancock Creek, VA
   - Shallow subtidal
   - Funded by NCBO
   - Partnering with CBF
   - 6 reef densities x 3 replicates = 18 reefs

2) Virginia Coast Reserve
   - Intertidal
   - Funded by TNC &NOAA Restoration Center
   - Partnering with TNC
   - 6 reef densities x 3 replicates = 18 reefs

3) Lynnhaven River, VA
   - Intertidal and shallow subtidal
   - Funded by ACOE and VA Beach
   - 8 existing reefs

Slide 7

LK10 I would mention the unmanipulated controls as well. Surely someone there will know what a BACI design is and want to know that there are controls.
Lisa Kellogg, 6/8/2012

Reef Construction

Reefs constructed in Nov. 2011

Each reef 16 m^2

Shell base constructed with 1 bushel of oyster shell m^{-2}

0, 10, 25, 50, 100 or 250 oysters m^{-2} added to reach the target density.

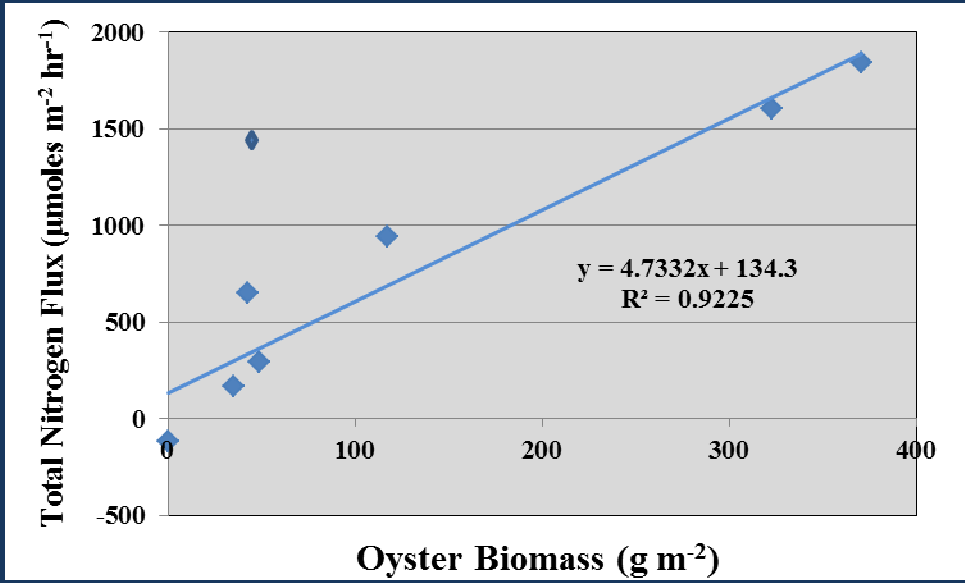
Slide 8

LK12 Change animation so that each picture diappears when a new one comes up.
Lisa Kellogg, 6/8/2012

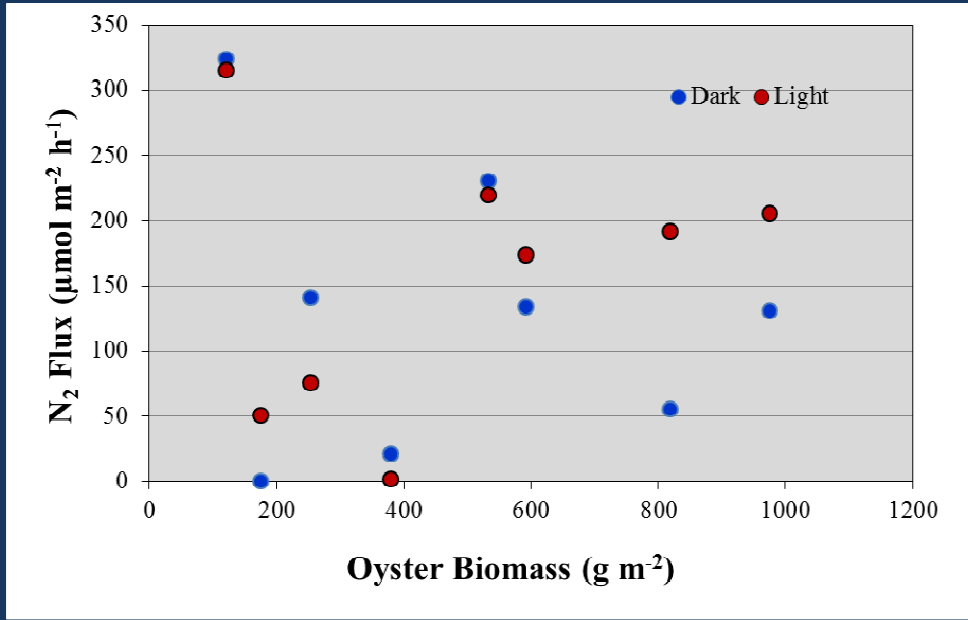
Research Timeline

	Site	2011	2012			
		Fall	Spring	Early Summer	Late Summer	Fall
Reef construction	OC	X				
	VCR	X				
Nutrient flux measurements	OC		X	X	X	X
	VCR				X	
	LR	X				
Biodiversity, sediment organics and nutrient sequestration	OC		X	X	X	X
	VCR		X	X	X	X
	LR	X				

Lynnhaven Results

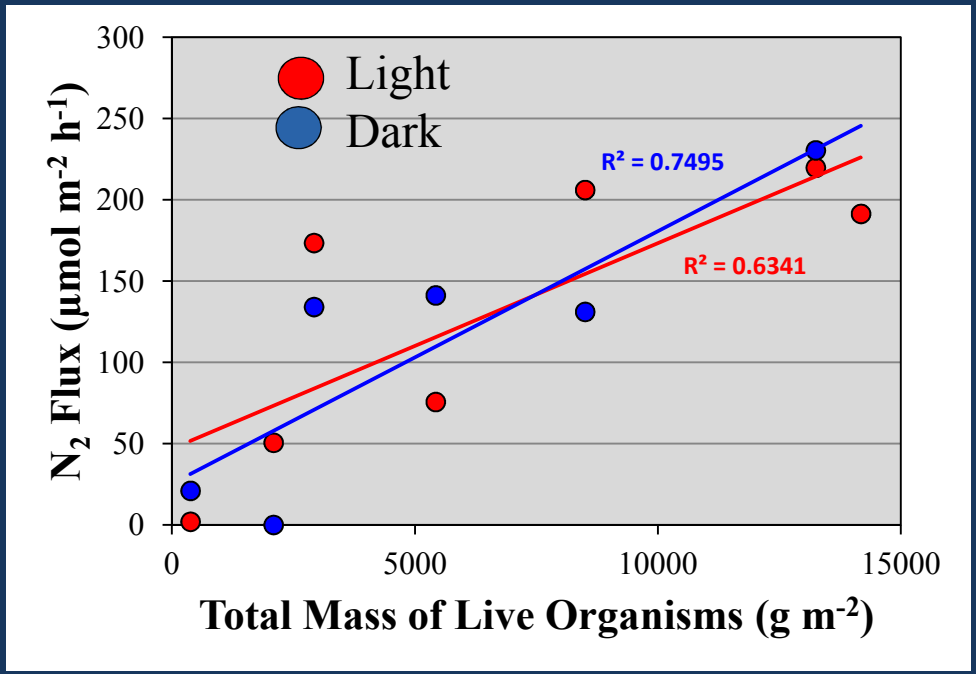


Strong positive relationship between oyster soft tissue biomass and total nitrogen flux



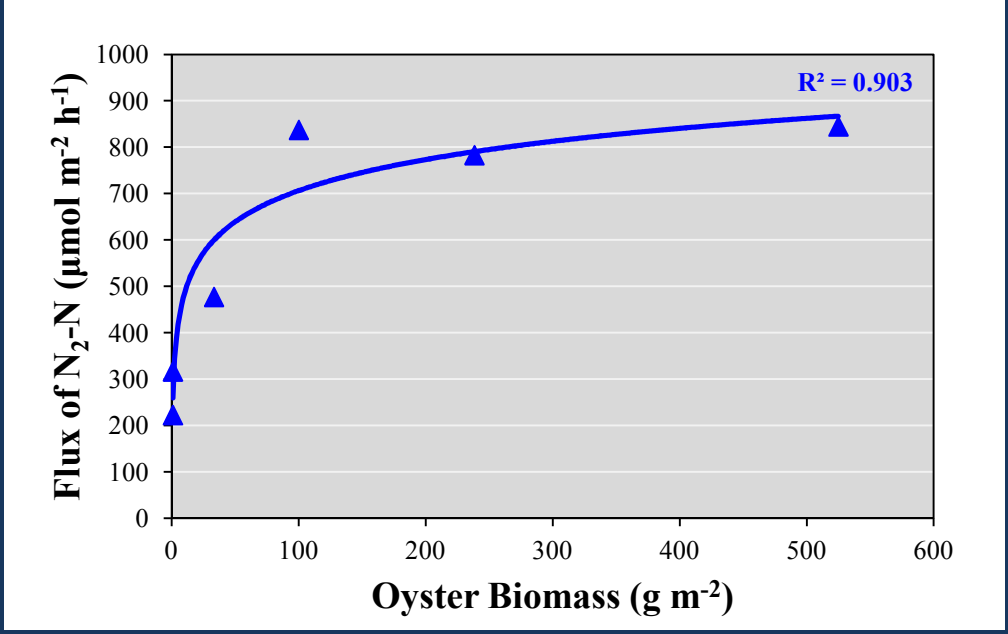
No relationship between oyster soft tissue biomass and denitrification.

Lynnhaven Results



A positive relationship between total mass of organisms (including shell) and denitrification rates.

Onancock Creek – Preliminary Results



A very strong positive relationship between oyster biomass and denitrification rate.

Denitrification rate asymptotes above ~100 g/m^2 (= 50 oysters/m^2)

These upper rates are roughly 60% greater those observed in the Choptank River by Kellogg et al.

They may reflect very high rates of organic input and decomposition or very high denitrification efficiency.

At this point we do not know which and the results should be treated as preliminary.

Summary

We have developed replicated, experimental oyster reefs in shallow subtidal and intertidal habitats that can serve as research platforms to investigate the relationships between oyster abundance (biomass) and some of ecological functions of oyster reefs.

Results to date suggest quantifiable relationships between easily measured reef characteristics (oyster density and biomass) and nitrogen dynamics, including denitrification.

We still need to:

1. Quantify seasonal rates;
2. Understand differences between intertidal and shallow- and deep-subtidal reefs;
3. Clarify which aspects reef structure (oyster abundance, oyster biomass [w/ & w/o shells] or total organism biomass) are most important in nitrogen dynamics.