A study of the effects of cultured vs. wild oysters (*Crassostrea virginica*) on nitrogen removal and ecosystem enhancement in two similar eutrophic estuaries on Cape Cod, MA

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Woods Hole Group

February 25, 2014

The Study Team

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Diane Murphy (Woods Hole Sea Grant)
Josh Reitsma (Woods Hole Sea Grant)
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Part 1.

Little Pond
Shellfish Propagation Demonstration Project

Town of Falmouth

Massachusetts

Waquoit Bay
Little Pond
Woods Hole

Goals

Determine the effectiveness of shellfish culture on nitrogen removal

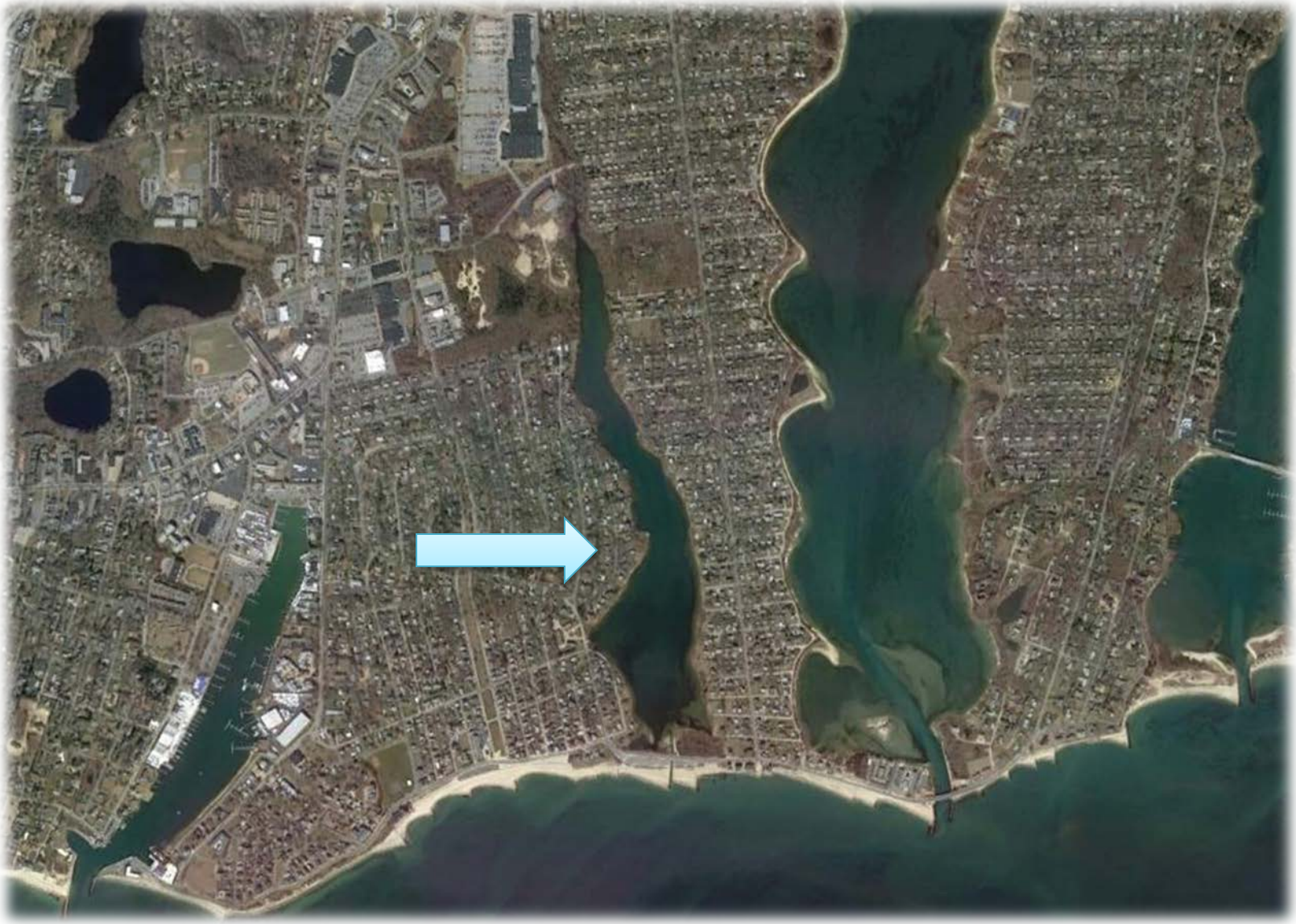
Demonstrate compliance with TMDL load reduction requirements

~ 70% Reduction in TN load to estuary based on conditions at sentinel station

Nitrogen Reduction and Removal Efforts

Shellfish Cultivation *
Inlet Widening
Denitrifying Septic Systems
Eco-toilets
Sewering
Permeable Reactive Barriers
Road Runoff Remediation

Little Pond (Falmouth, MA)



Division of Marine Fisheries (DMF)

Little Pond shellfish growing area classified as **Prohibited**

Municipalities can relay shellfish to/from

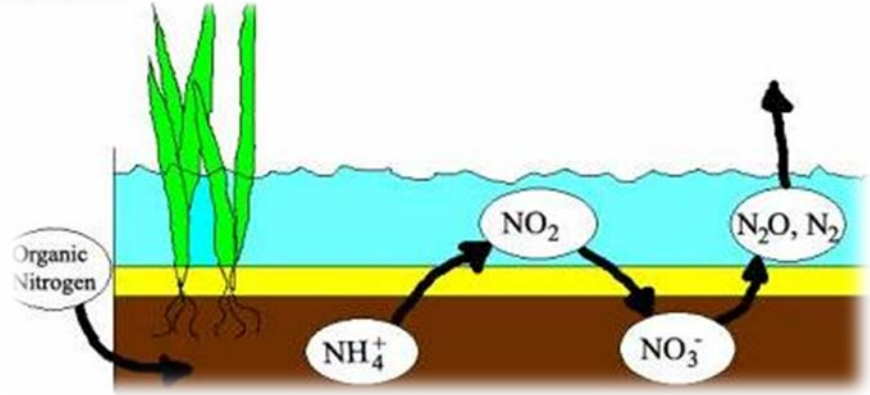
Shellfish must be relayed or destroyed prior to reaching market size (oysters = 3”)

Evaluate and Estimate Nitrogen Removal Capacities of Oysters in Little Pond

Culture and Harvest

+

Denitrification and Burial

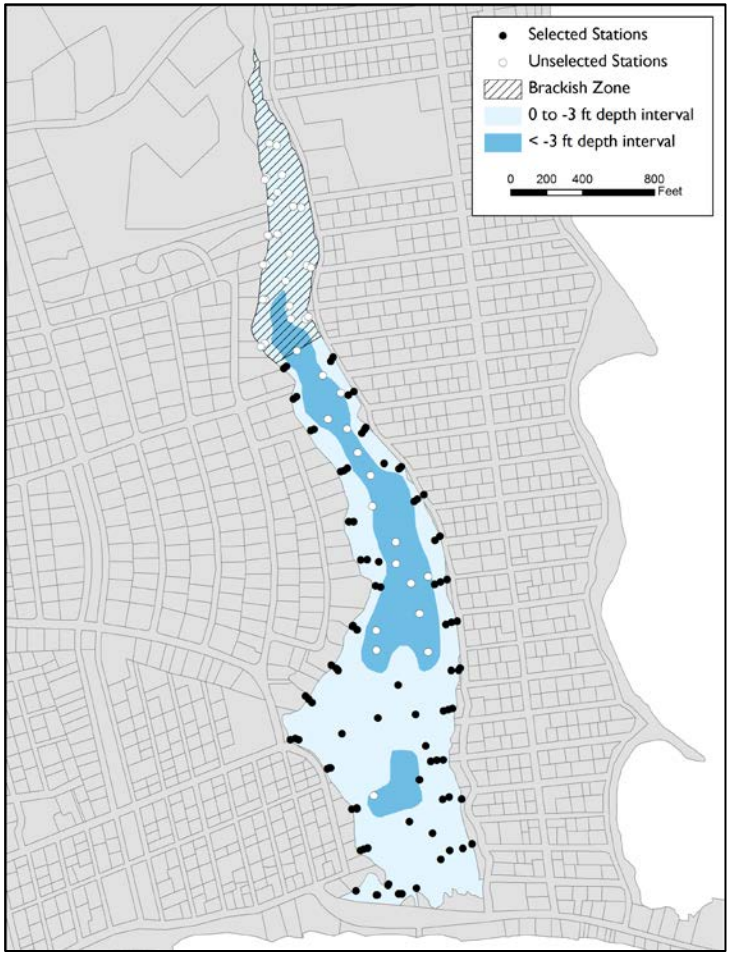


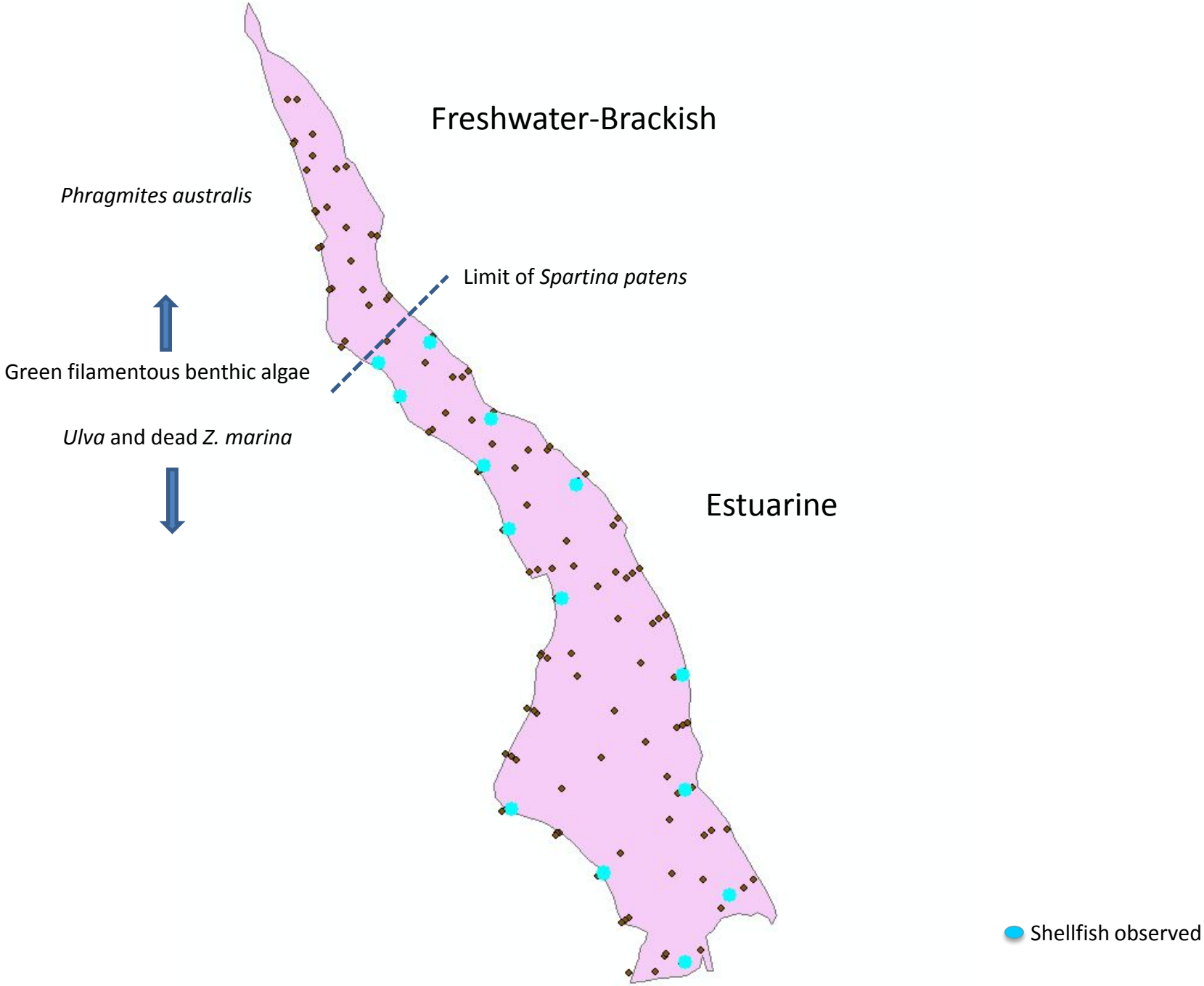
Standing Stock Assessment

Description	Samples (n)	Area (acres)	Density (#/ft^2)	Standing Stock
Little Pond (Total)	136	47.20	0.15	302,366
0.0 to -3.0 South of Transition	92	27.60	0.22	261,396

- Shellfish habitat is confined to -3.0 to 0.0 ft (MLW) elevations from the mouth of the estuary extending to the vicinity of Mayflower St.

- Estimated population size of *M. mercenaria* is 250,000 to 300,000.




Freshwater-Brackish
Phragmites australis
Limit of *Spartina patens*
Green filamentous benthic algae
Ulva and dead *Z. marina*
Estuarine
Shellfish observed

Other Activities

- DMF, ConCom, and USACE Permits
- Meetings, meetings, meetings
- Competing Uses

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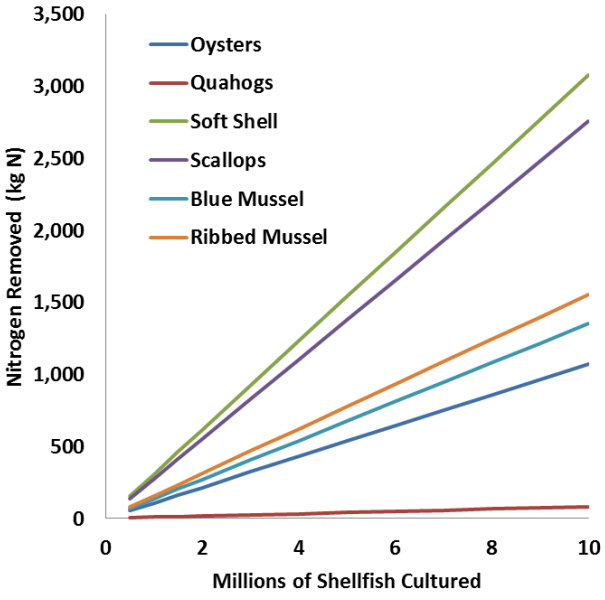
- DMF, ConCom, and USACE Permits
- Meetings, meetings, meetings
- Competing Uses

Estimating Nitrogen Removal Capacities

Harvest of Sub-Market Shellfish

- N in Tissue and Shell
- Growth Rates
- Assumptions on all rates, conversions, and other important factors.

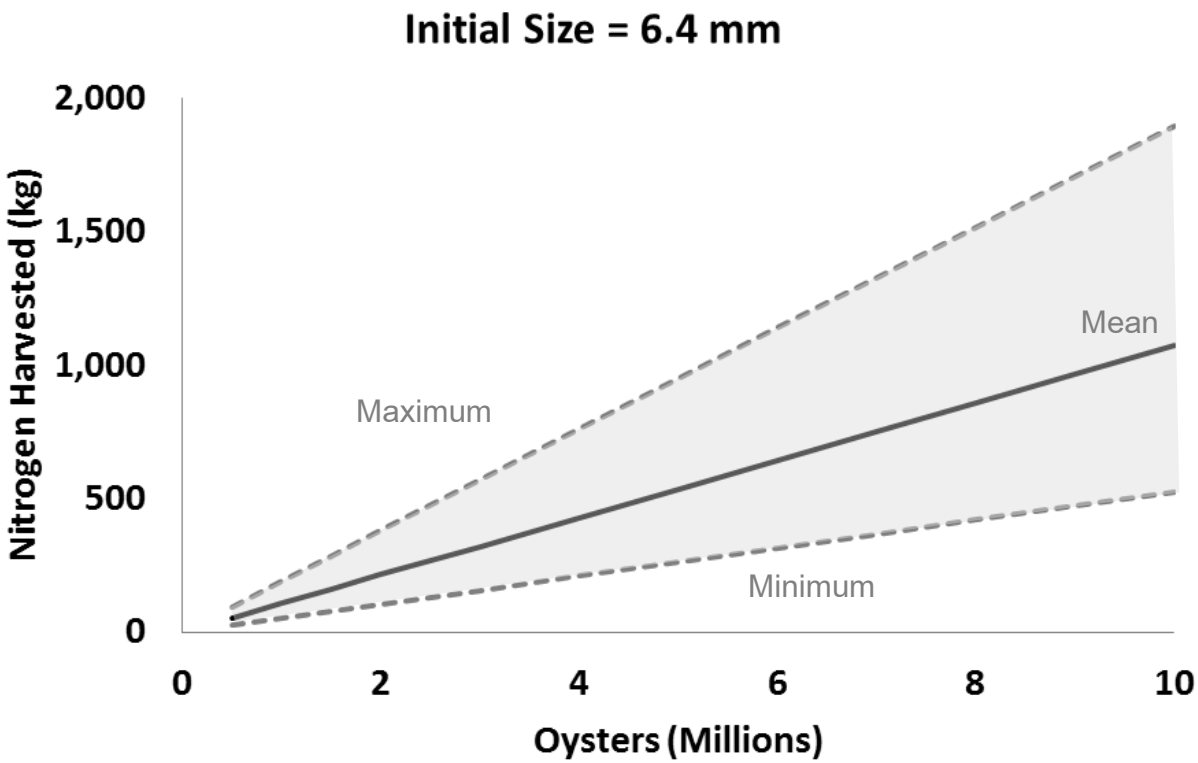


Nitrogen Removal Capacities

Harvest of Sub-Market Oysters

Minimum and maximum values used for % N in tissue and shell

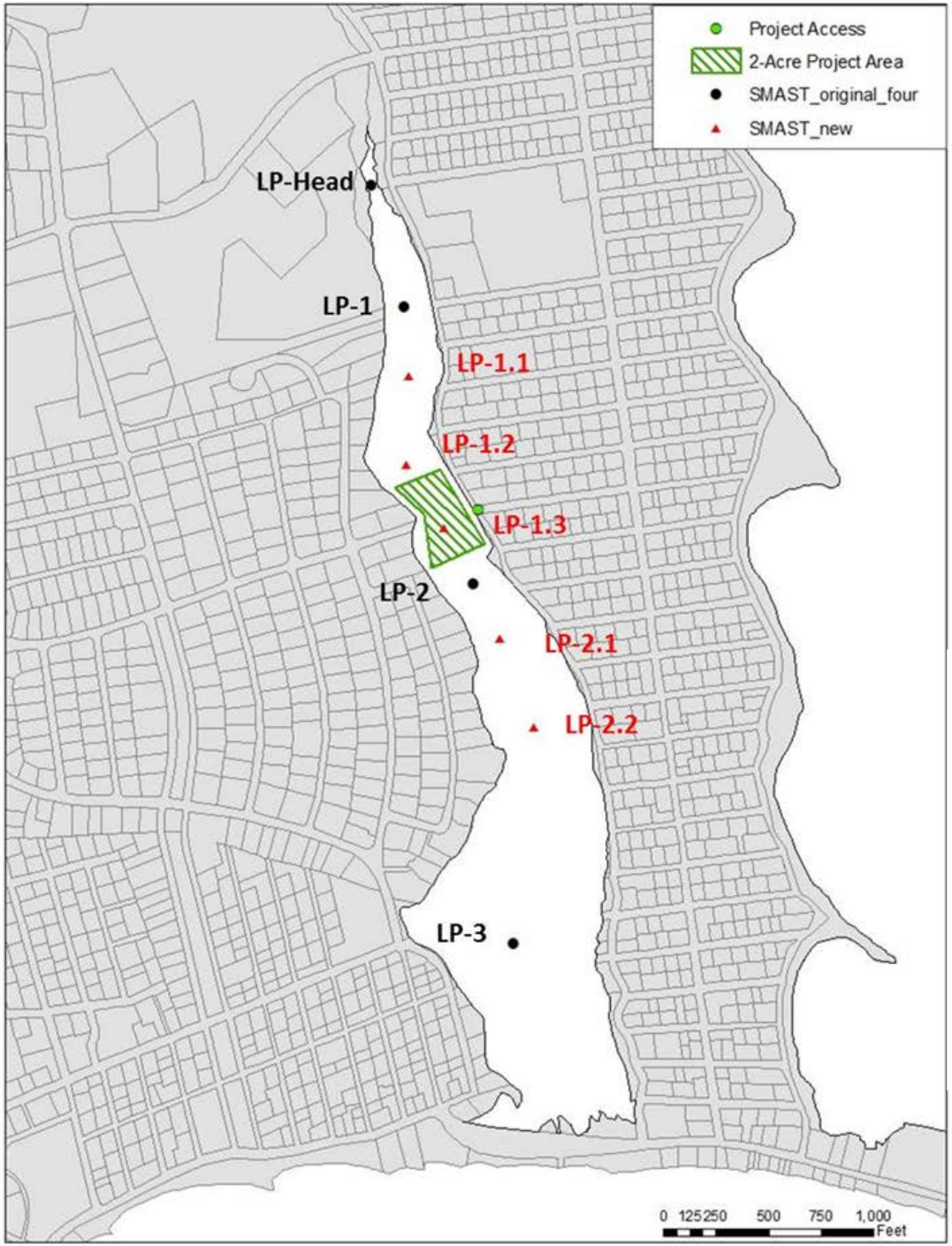
Some variability accounted for.

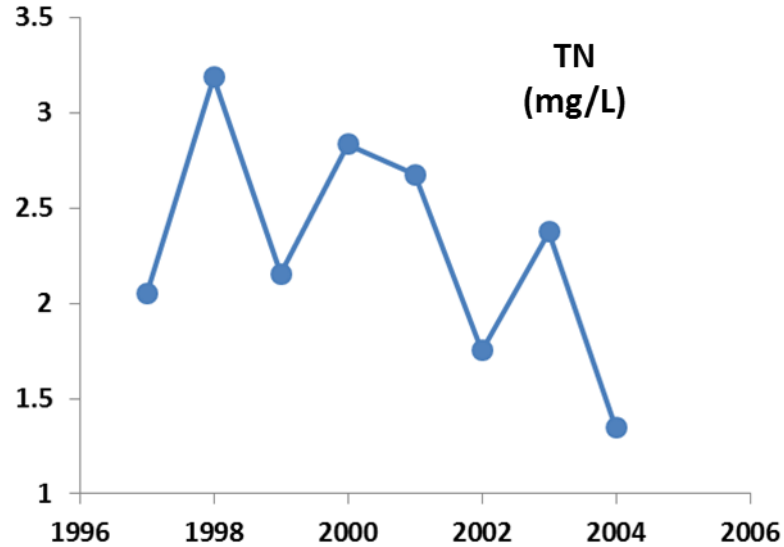


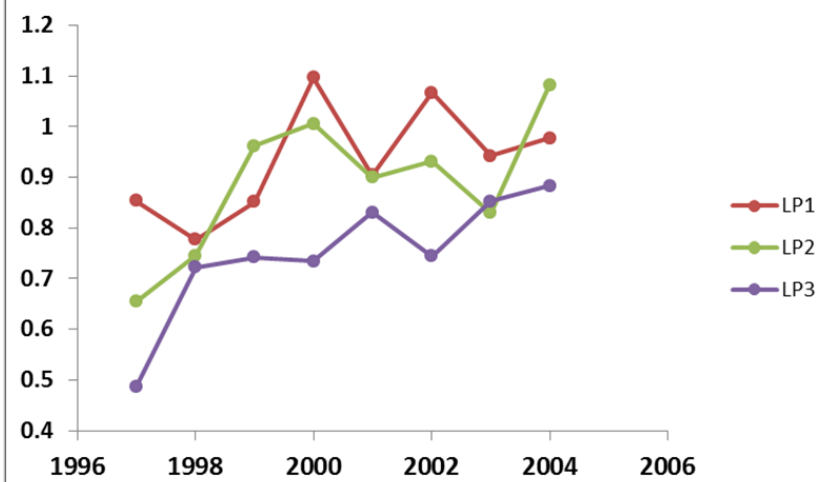
Question: How will the Town measure changes in water quality?

Because:

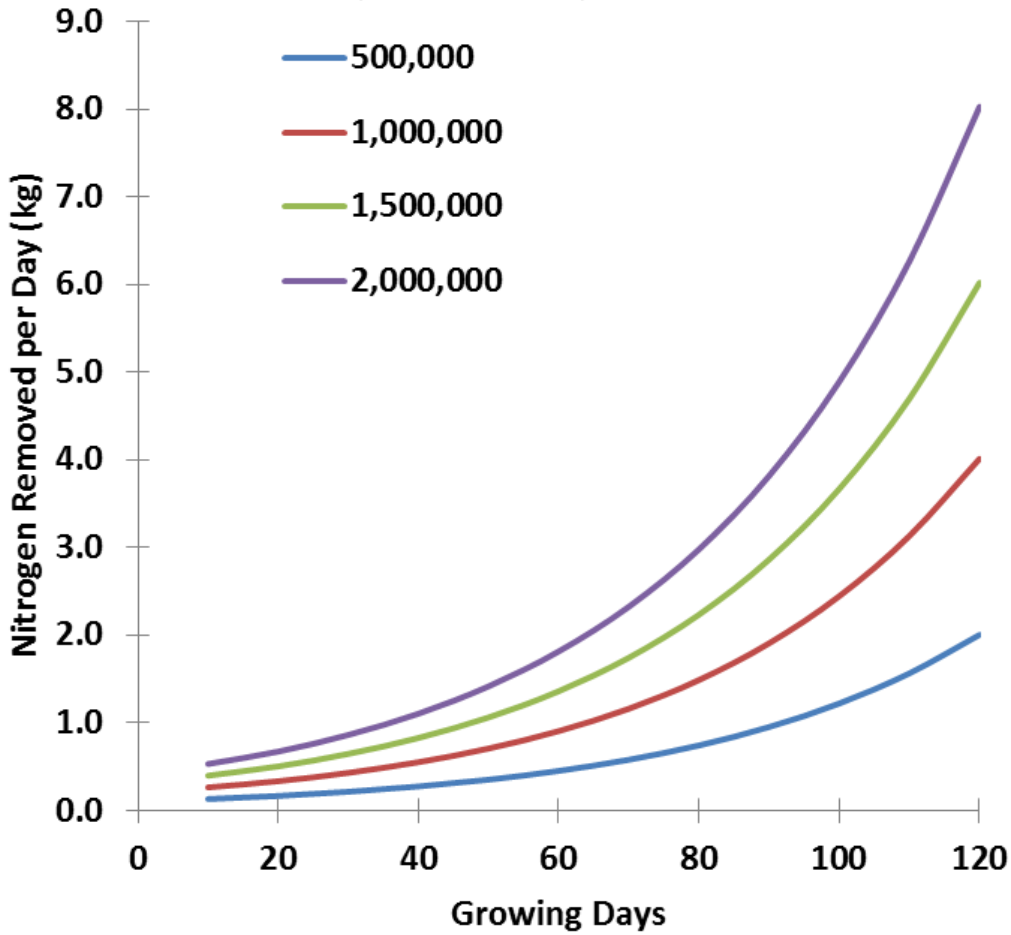
1. System variability may make it difficult to measure such small changes in TN;
2. N assimilation is a function of size and growth which is not uniform throughout the season.


Project Access
2-Acre Project Area
SMAST_original_four
SMAST_new
LP-Head
LP-1
LP-1.1
LP-1.2
LP-1.3
LP-2
LP-2.1
LP-2.2
LP-3
0 125 250 500 750 1,000
Feet


TN
(mg/L)
3.5
3
2.5
2
1.5
1
1996
1998
2000
2002
2004
2006


1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
1996
1998
2000
2002
2004
2006
LP1
LP2
LP3

Question: How will the Town measure changes (if any) in water quality?



Floating Bag Systems

Proposed Growing Approach

Combined Crops: Early and Late Seed

May 2013	*1.25 Million (2 mm)* ***UPWELLER***	*1.25 Million (2 mm)* ***UPWELLER***	July 2013
June 2013	*4 mm Bags* ***Density = 1,000/Bag***	*4 mm Bags* ***Density = 1,000/Bag***	September 2013
July 2013	*9 mm Bags* ***Density = 500/Bag***	*9 mm Bags* ***Density = 500/Bag***	October 2013
			Overwinter
October 2013	***Relay/Depurate Size ~ 50 – 60 mm***	***Relay/Depurate Size ~ 60 - 70 mm***	September 2014

Nitrogen Removal

Experimental Design: 1.25 M early and 1.25 M late seed
Hypothesis: Detectable change in nitrogen

	2013	2014
Early Seed (#)	1.25 million	1.25 million
Late Seed (#)	1.25 million	0
Nitrogen Removed (kg)	194	766
% Seasonal Load	6.6	26.0

Only from shell and tissue. Denitrification estimates not included.
From Woods Hole Group's Project Specifications and Cost Estimate, p 2 (submitted with NOI)

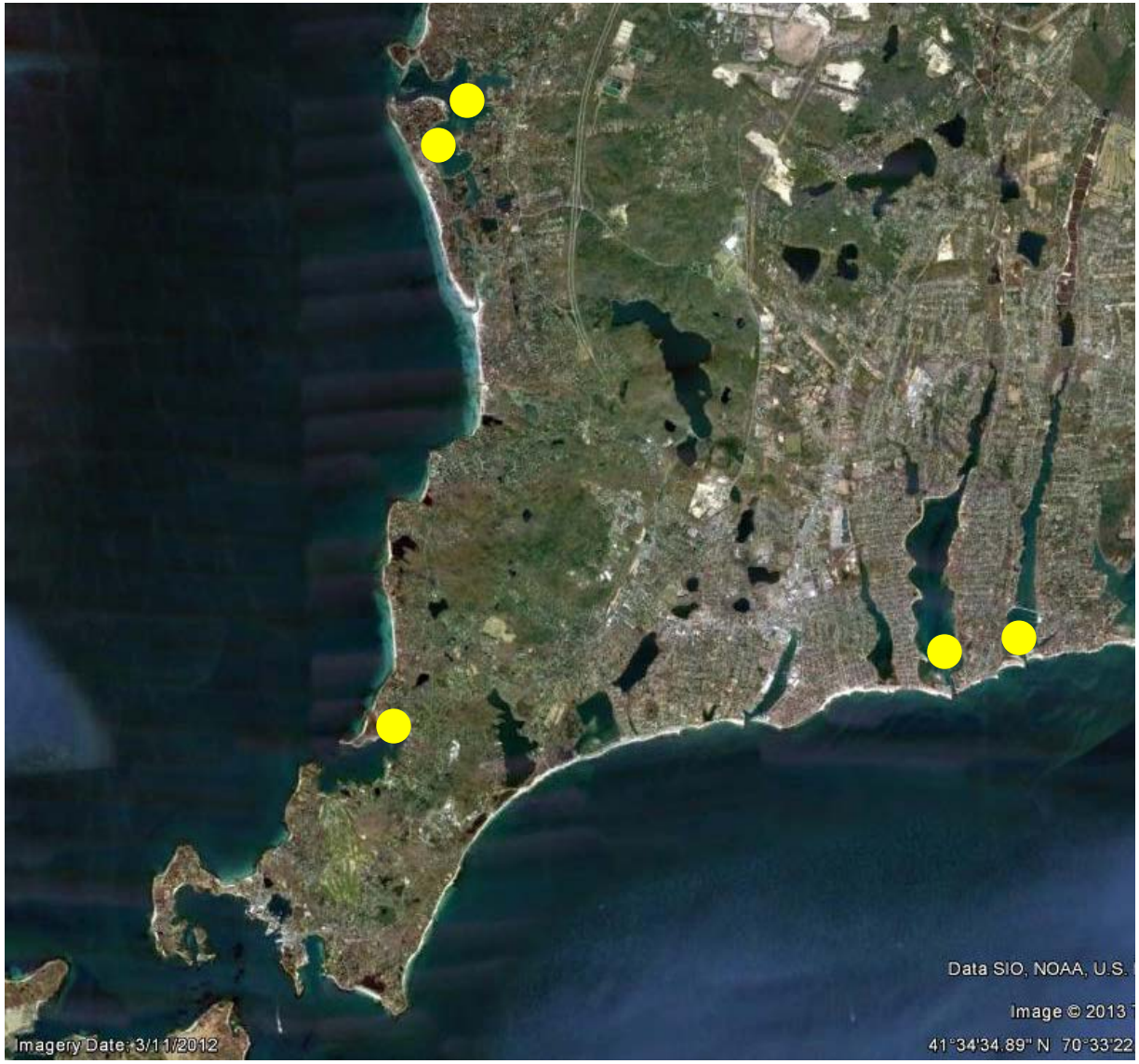
Range of Relay/Depuration Locations

West Falmouth Harbor

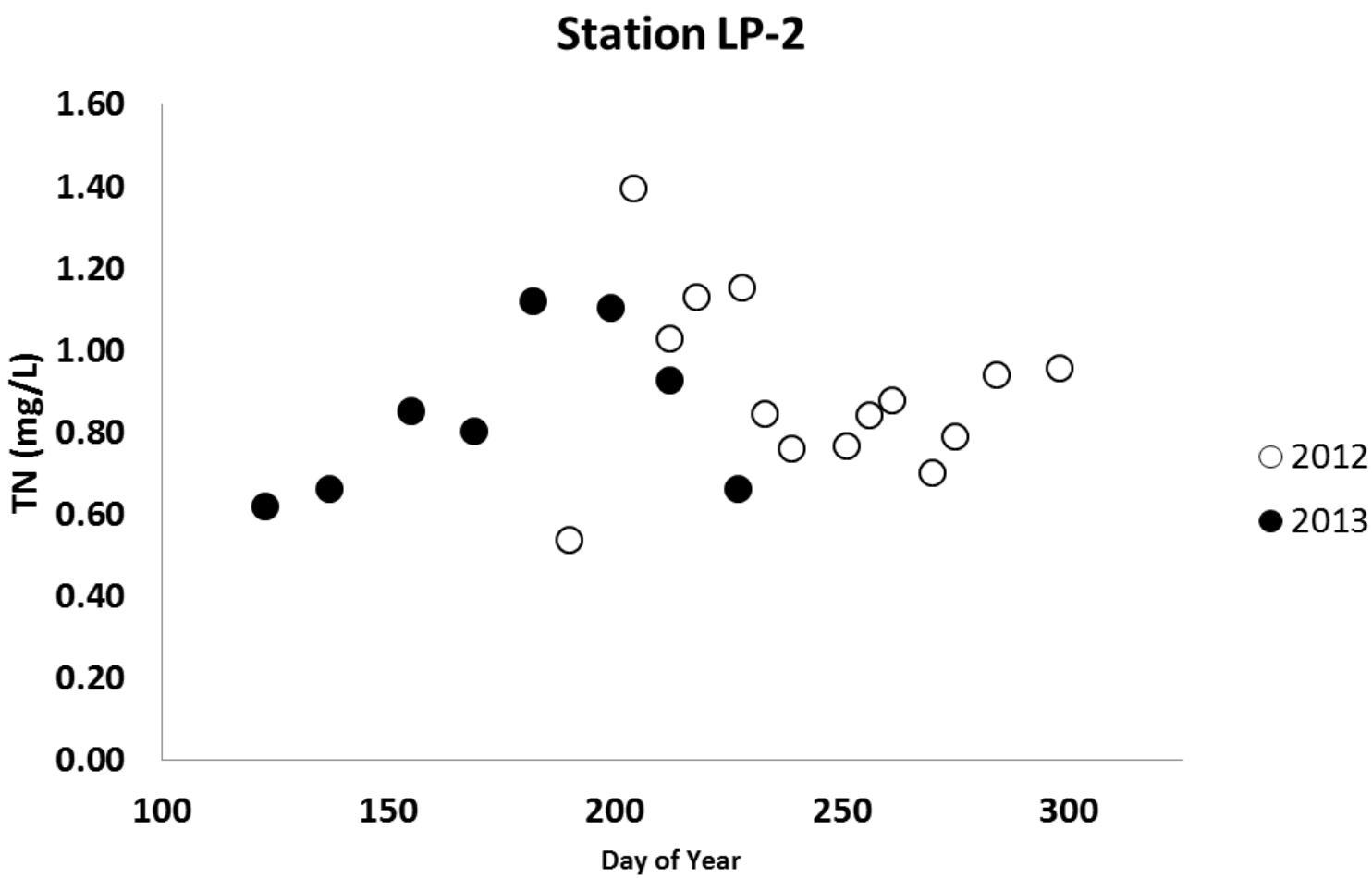
Quisset Harbor

Great Pond

Green Pond



Partial Results



The Future

- Continued monitoring (through 2015)
- Data analysis (this winter and subsequent years)
- Overwinter oysters and redeploy in March 2014
- At least one additional 1.25 million oysters in May 2014.

Part 2.

Salt Pond

Waquoit Bay
Salt Pond
Woods Hole

Goals

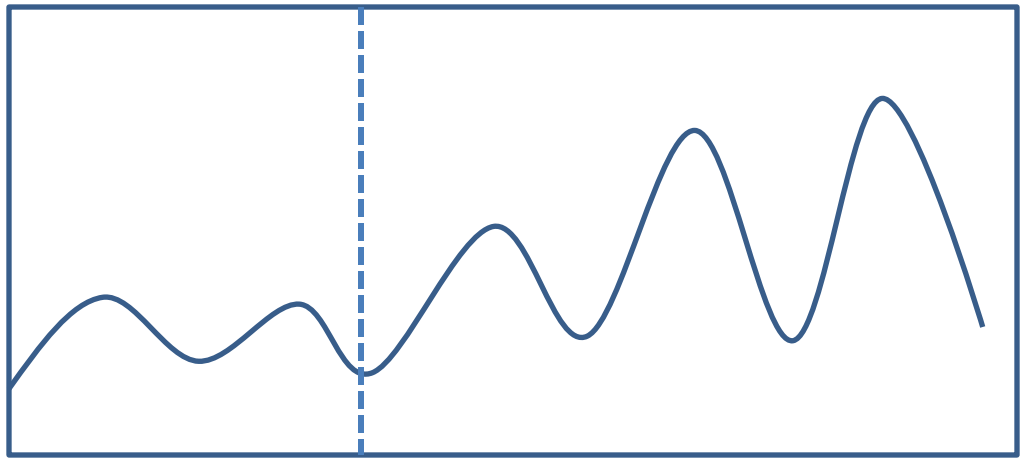
Determine the effect of a population of wild oysters on water quality

Compare this site to Little Pond and other Falmouth estuaries

Goals

Where did these oysters come from and how long will they be there?

For example:
Chl-a
Nutrients
Turbitity

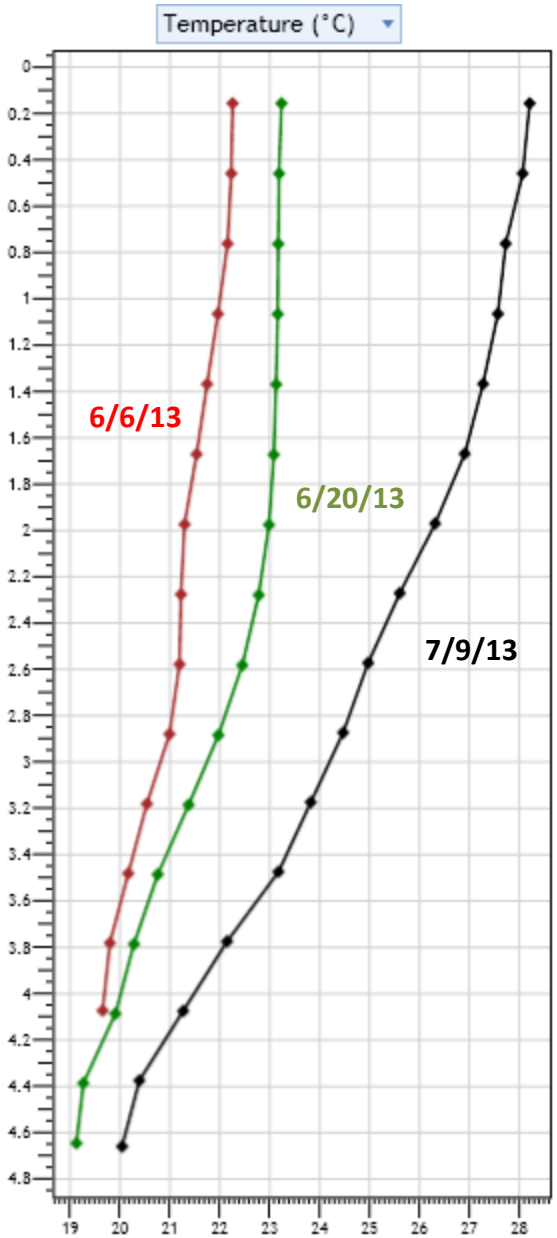


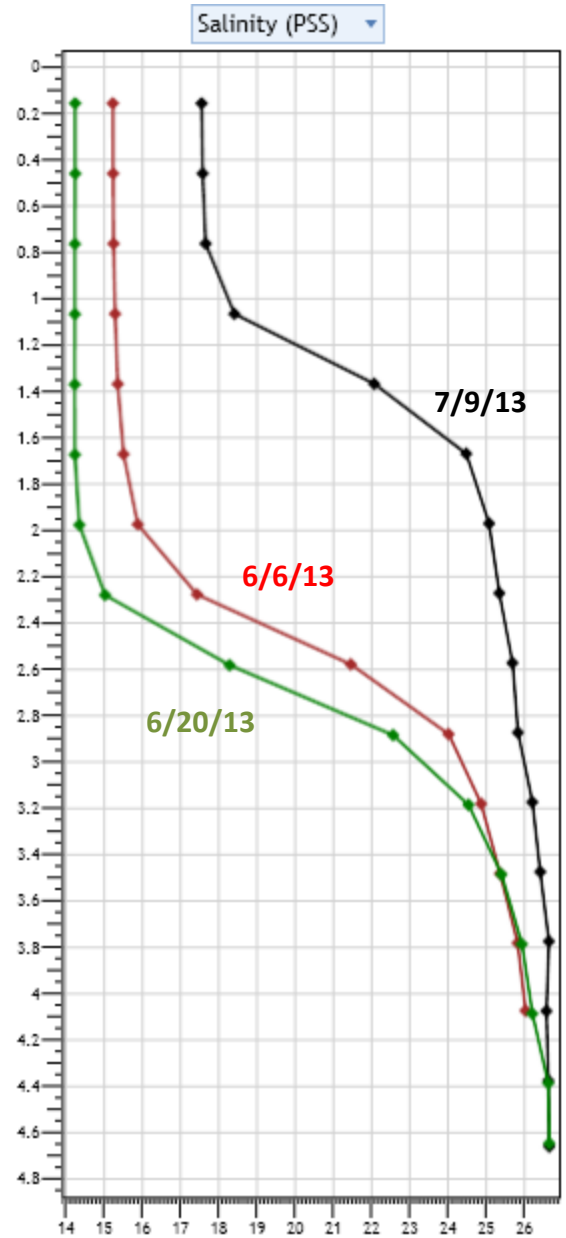
Salt Pond

- MEP ran monitoring in years previous to recent oyster set
- New baseline data
  - Population (2 to 4 million adults)
  - Water quality (nutrients, chl, light)
  - Genetic study (Cornell University)
  - Disease: 70% infected with Dermo

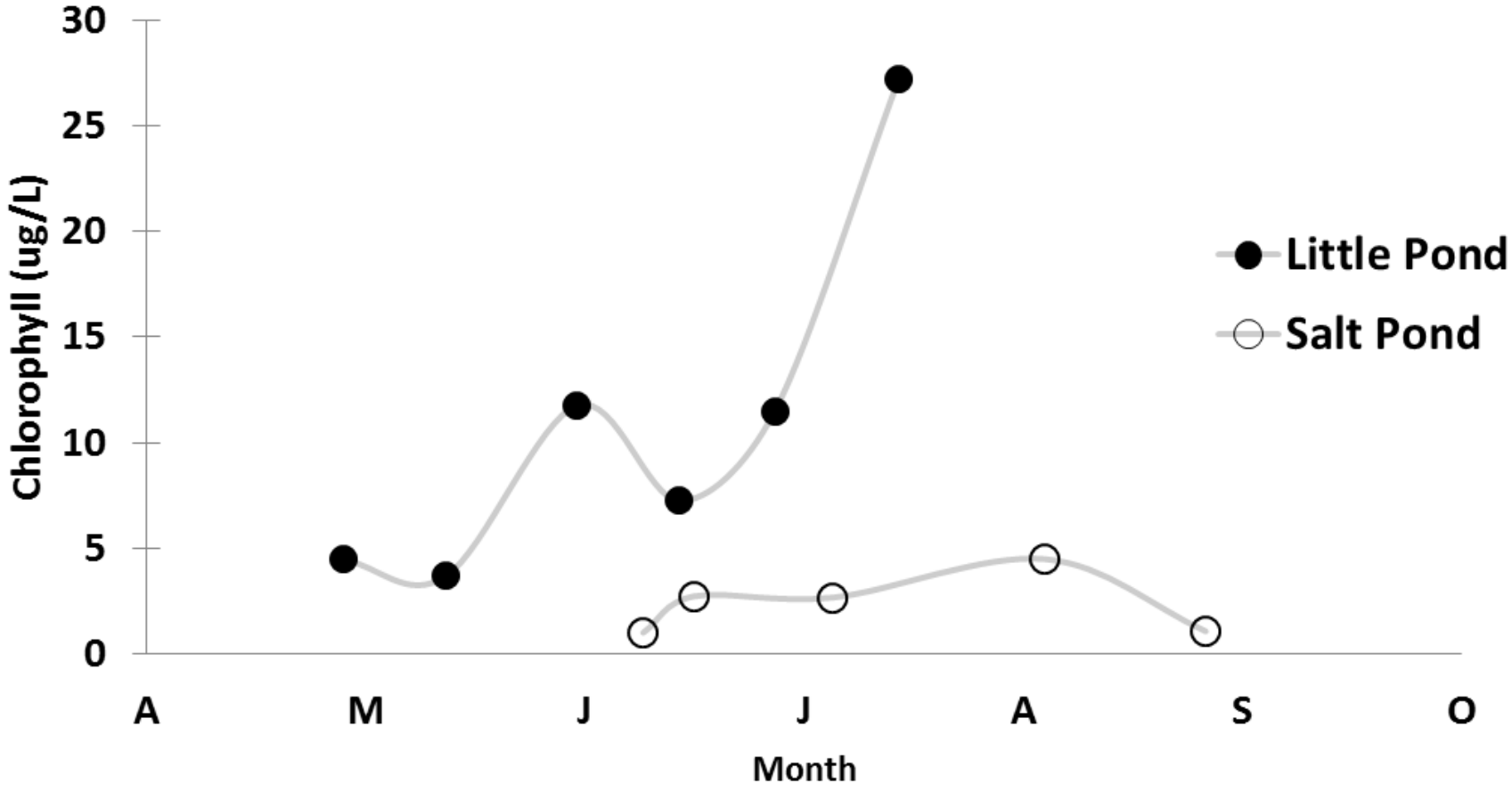
S5
S4
Salt Pond
S3
S2
S1
© 2013 Google

Station S4





2013 Chlorophyll



Additional Monitoring

Spat Collection (no spat set in 2013)

Genetic Studies (M. Hare, Cornell)

- Effective Population Size
- Relatedness of three age classes

Acknowledgements

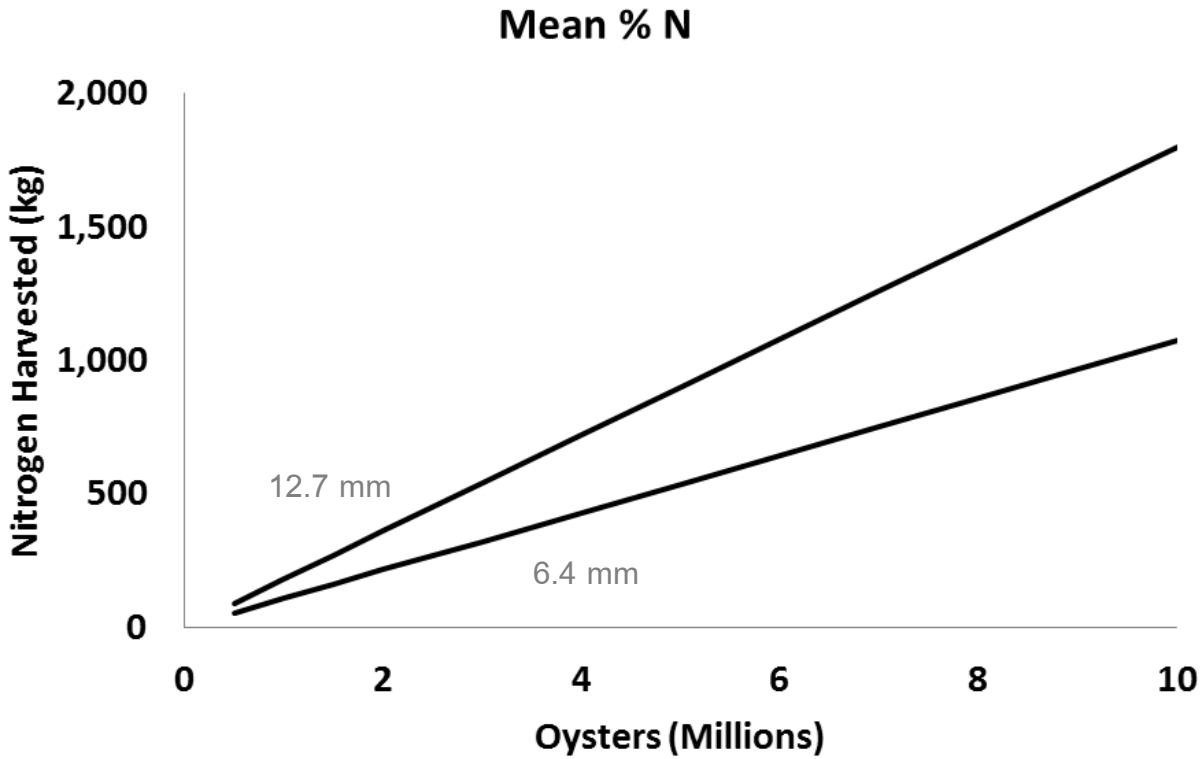
Town of Falmouth (Water Quality Management Committee & Sia Karplus)
Woods Hole Sea Grant (Diane Murphy, Josh Reitsma, and Judy McDowell)
Boston University (Wally Fulweiler, Robert Mitchner)
Cornell University (Matthew Hare)
Woods Hole Group (Heidi Clark, Chris Gallagher)
Ivan Valiela – for words of warning.

Nitrogen Removal Capacities

Harvest of Sub-Market Shellfish

Mean values used for % N in tissue and shell

6.4 mm and 12.7 mm initial seed sizes.



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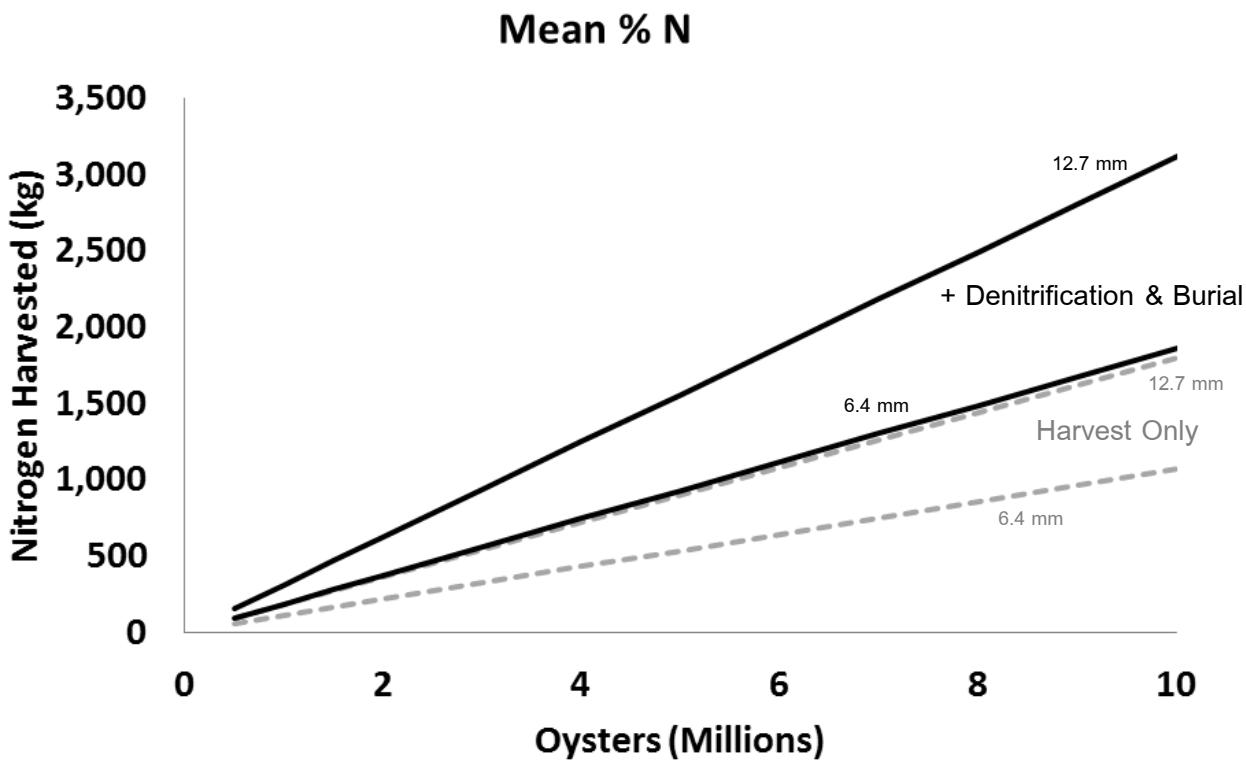

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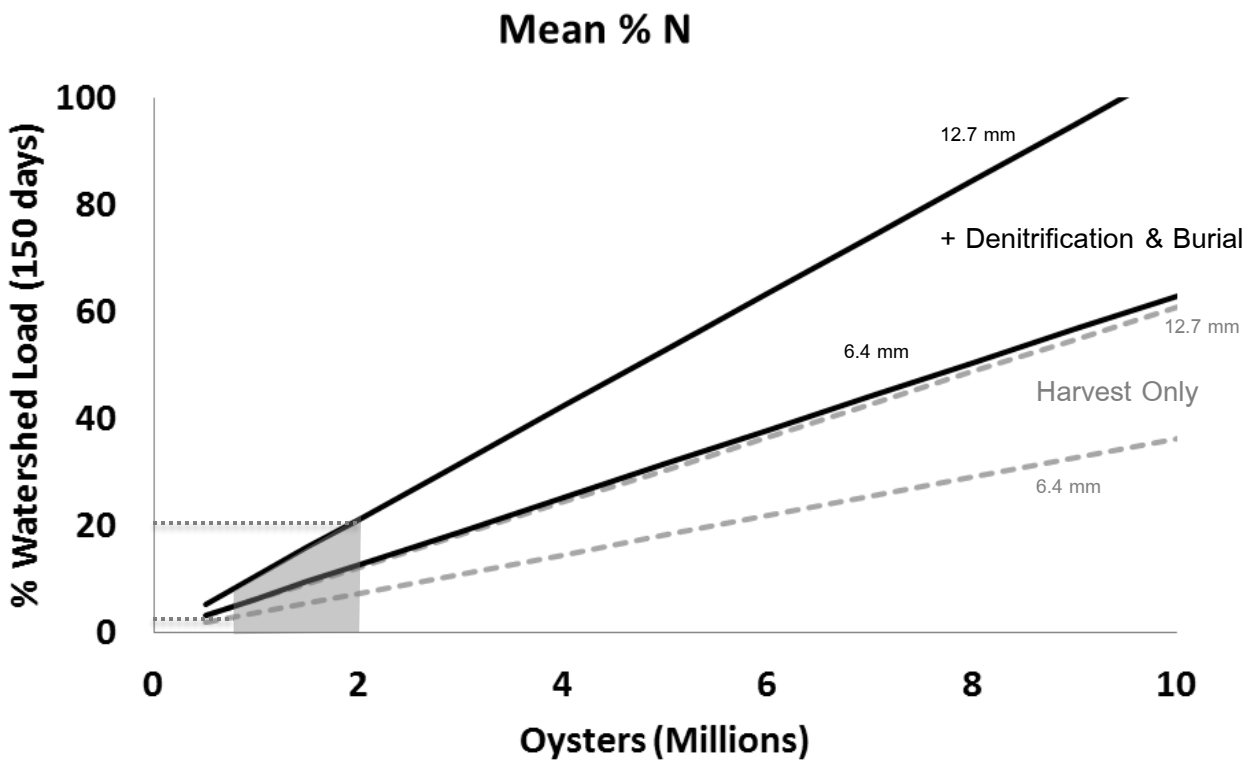
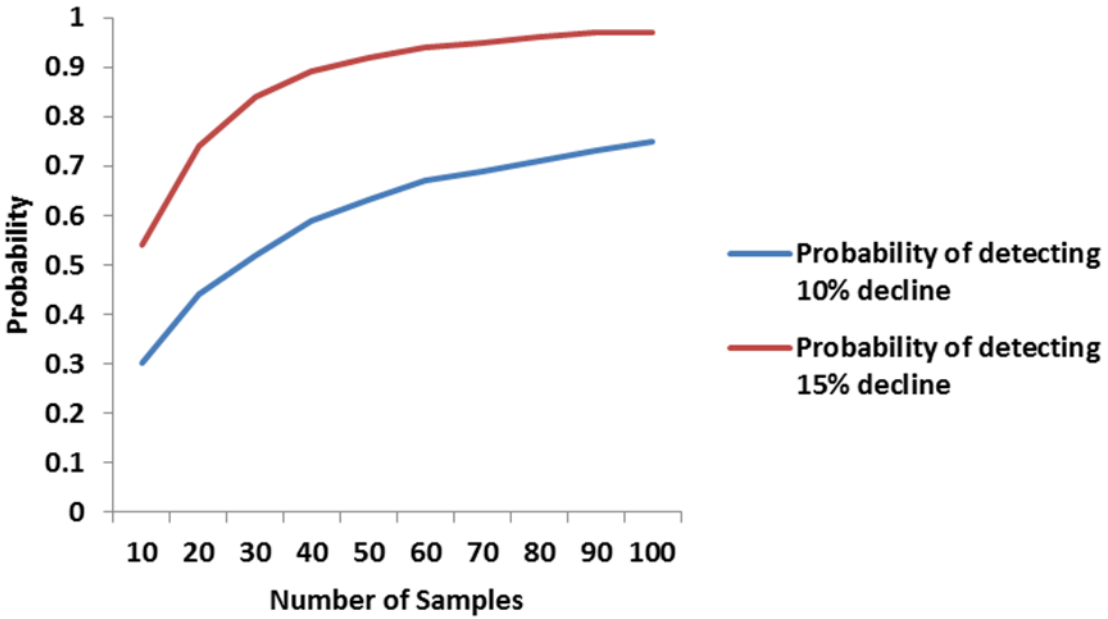


Monitoring

Number of samples	Probability of detecting 10% decline	Probability of detecting 15% decline
10	0.30	0.54
20	0.44	0.74
30	0.52	0.84
40	0.59	0.89
50	0.63	0.92
60	0.67	0.94
70	0.69	0.95
80	0.71	0.96
90	0.73	0.97
100	0.75	0.97



Total Nitrogen Concentration Summary

Little Pond Station LP-2 (Sentinel Station)

Nursery/Grow out Methods

(Bottom racks, long lines, floating gear, etc.)

What is appropriate for Little Pond?

Relatively Deep

Soft Bottom

Low Bottom Water DO

Oyster Growing Location

Approximately 2 acres is necessary to grow a crop of 2 million (with minimal spacing)