CAPE COD COOPERATIVE EXTENSION
MARINE PROGRAM

County Commissioners Meeting 4-16-14

Diane Murphy, Fisheries & Aquaculture Specialist
Joshua Reitsma, Marine Program Specialist
Abigail Archer, Marine Resource Specialist

Cape Cod Cooperative Extension & Woods Hole Sea Grant

- Marine Program
  - Partnership with Woods Hole Sea Grant
    - Provides additional financial support
  - 3 extension agents (Diane Murphy, Joshua Reitsma, Abigail Archer)
    - (Greg Berman, Coastal Processes Specialist)
  - SEMAC (SouthEastern MA Aquaculture Center, MA DAR funded $50K/year)
- Purpose
  - Provide coastal communities & other stakeholders with scientific information and technical assistance
    - Informed decision making on management of coastal & marine resources
    - Promote ecological and economic sustainability
- Partnership Focus Areas
  - Healthy Coastal Ecosystems
    - Restoration of living marine resources
  - Sustainable Fisheries and Aquaculture
    - Shellfisheries management
    - Safe, sustainable seafood (particularly shellfish)

Recent & Ongoing Projects

- Nitrogen and shellfish
- Municipal Shellfish Propagation Program
- Marine water quality monitoring
- River Herring Network
- Research Farm Network (RFN)
- Shellfish Habitat Assessment (SHA, ShORE)
- Shellfish disease response (incl. Vibrio)
- Eelgrass restoration
- Outreach (courses, lectures, workshops)
- Grants

Focus Area:
Healthy Coastal Ecosystems

- **Shellfish and Nitrogen**
- **Marine water quality monitoring**
- Eelgrass restoration project
- Shellfish restoration



Focus Area: Sustainable Fisheries and Aquaculture

- Shellfisheries Management
  - **Municipal Shellfish Propagation Program**
  - RFN (Research Farm Network)
  - ShORE (Shellfish Officer Research & Education)
  - SHA (Shellfish Habitat Assessment)
- Fisheries Management
  - **Massachusetts River Herring Network**
- Safe, Sustainable Seafood
  - Vibrio monitoring
  - DRN (Disease Research Network)
  - Technical assistance to aquaculture industry

Nitrogen and Shellfish

Foundation

- Collaborative efforts between CCCE/WHSG and contractors
  - Directed studies and grant-funded projects
- *Remediation of eutrophication by oysters: Use of stable isotopes and empirical data from oysters grown in estuaries receiving different N loads*
  - 2003 study on Cape Cod
  - PI's William Walton, Ruth Carmichael and Heidi Clark
- *Mitigating the Effects of Excess Nutrients in Coastal Waters through Bivalve Aquaculture and Harvesting* (CICEET grant)
  - 2004 study in Waquoit Bay
  - PI's Hauke Kite-Powell, Dror Angel, Heidi Clark, Kevin Kroeger, Bill Walton, Di Jin, Porter Hoagland, and Megan Bela
- *Lonnie's Pond Shellfish Aquaculture Assessment:* Final Report 2007
  - CCCE/WHSG contractor: Heidi Clark, Woods Hole Group

Foundation

- Oyster remote-set
  - Nitrogen reduction
    - Improvements in water quality and clarity
  - Two coastal ponds in Orleans
  - 2004 - 2008

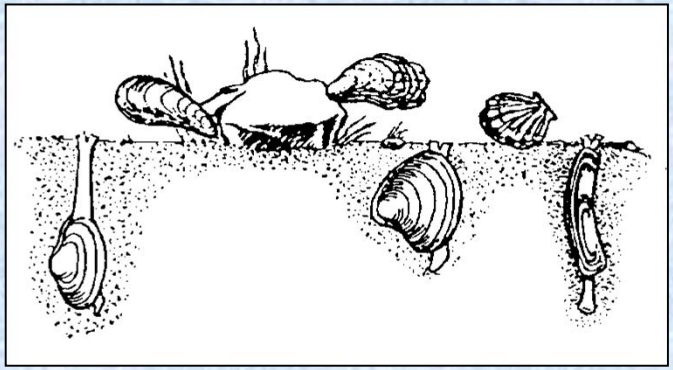
Nitrogen Content in Massachusetts Shellfish

Prepared By:
Josh Reitsma, Abigail Archer and Diane Murphy
Cape Cod Cooperative Extension
Woods Hole Sea Grant

The Mighty Bivalve
…to the N Problem Rescue?

- Lots of local interest in alternative nitrogen reduction strategies
- Still questions:
  - Where do shellfish fit in with nitrogen and potential removal of nitrogen?
  - How much nitrogen is associated our local shellfish?
  - How do we credit shellfish?

Shellfish and Nutrients



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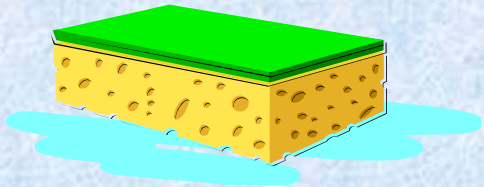

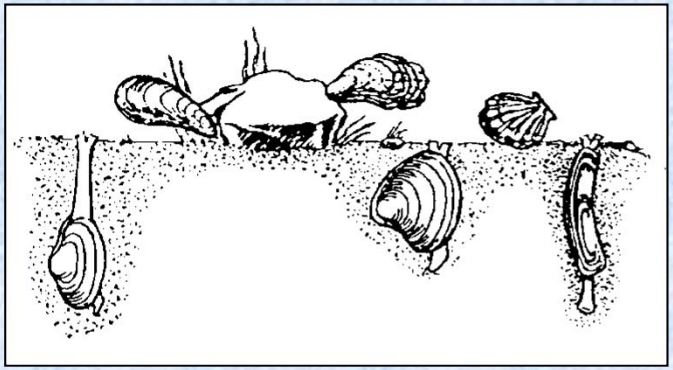

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Filtration – Effect on Water Quality

- Often difficult to measure in the field, but there has been some success locally
- 200 oysters in a pipe fed by a tidal creek were able to reduce Chlorophyll (algae) by 28% and Turbidity by about 22%

Importance of Cycling Nutrients

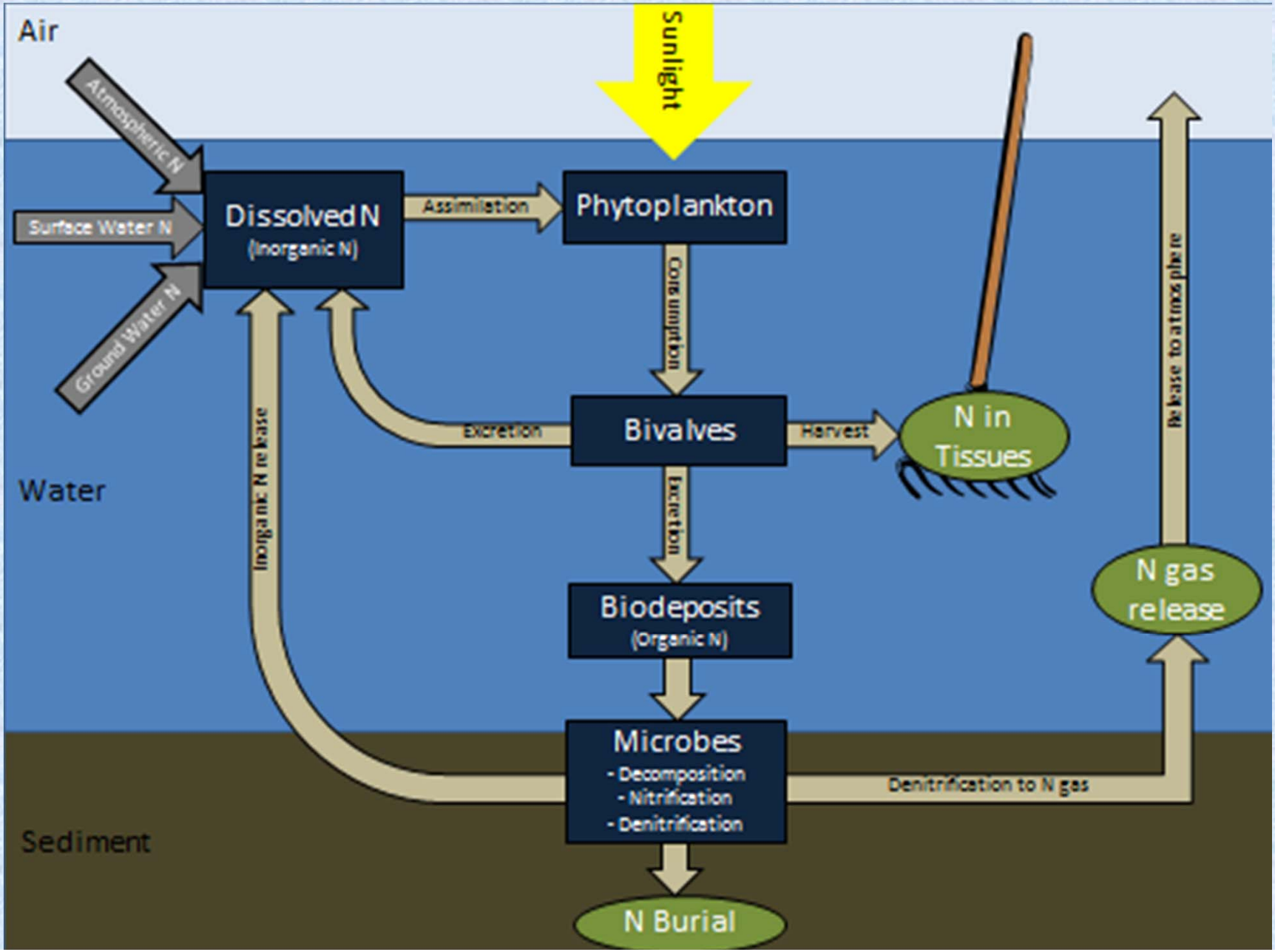
- Filtering bivalves graze down phytoplankton and a portion of those nutrients go back into the water column
- Phytoplankton bloom is regenerated
- Never more than what original N content was
  - Some assimilated or buried/removed

- If bloom left unchecked, could crash – cause anoxia and fish kills

http://www.nbcnews.com/id/40947831/ns/us_news-environment/t/millions-fish-wash-dead-chesapeake-bay/#.UbeBL5y1uHs

Areas for Potential Nutrient Removal (green ovals)

Adapted from: Newell et al. 2002 and http://oyster.agecon.vt.edu/Nutrient.htm

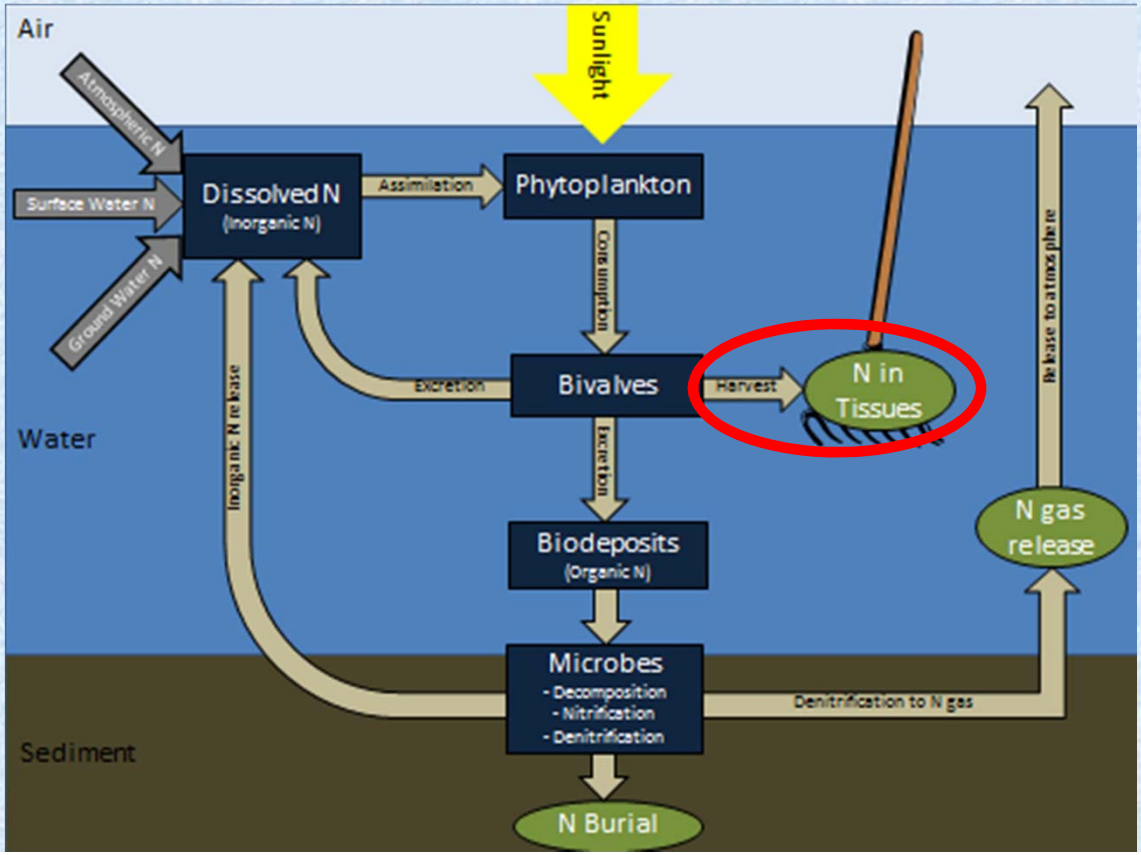


Nitrogen Removal by Denitrification or Burial

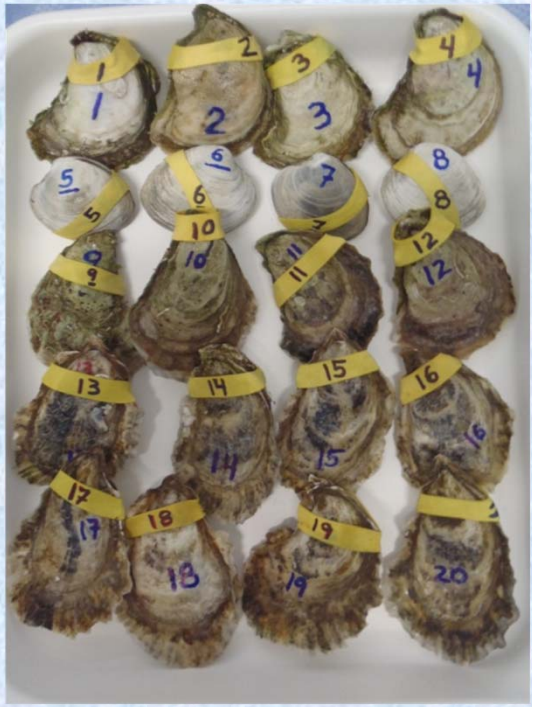
- Many questions remain about these processes:
  - What are the levels of removal through these processes?
  - Does species or density of bivalves make a large difference?
  - How do these processes apply to shellfish aquaculture?
  - How variable are rates in different marine environments?
  - How would we credit or quantify these forms of N removal?

Where do we start?

- 3 areas of potential removal
- Most easily measured and likely more consistent – N in tissues
  - Also can provide economic activity and jobs



What's in our local shellfish?



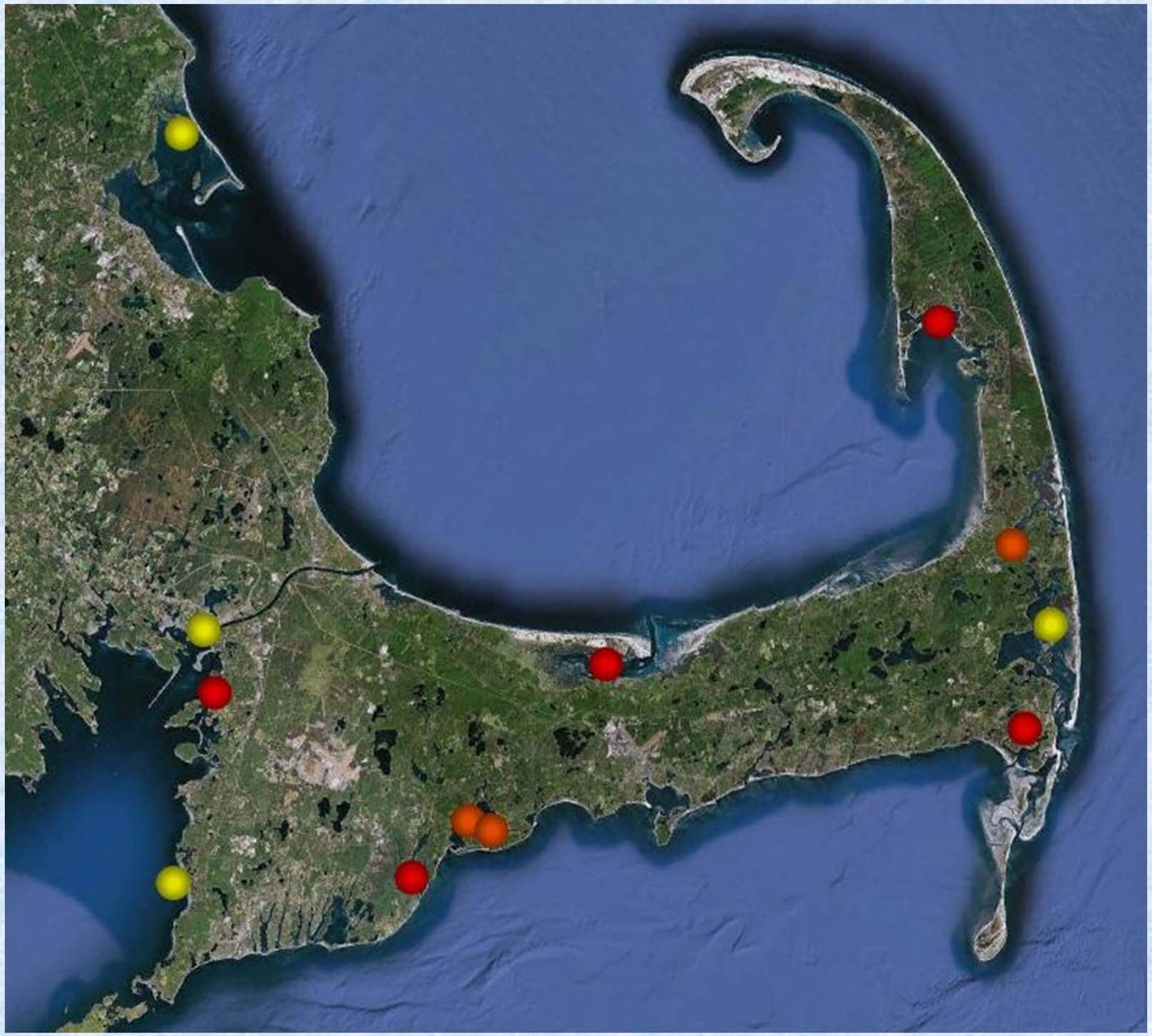
- Sampled June and Oct 2012
- Selected 4 per group, at typical harvest size
- Quahogs: 1-1.5" hinge width - littlenecks
  - Wild – 6 sites
  - Cultured – 5-6 sites
- Oysters: 3-3.5" if at all possible
  - Wild – 4 sites
  - Cultured, on-bottom – 6 sites
  - Cultured, off-bottom (any gear) – 8 sites
- Cooperation from a lot of folks to get samples
  - Town shellfish programs and private growers
- We collected and measured them, Boston University did the shell and tissue analyses (the hard part)

Sample Sites

Yellow: just oysters

Orange: just quahogs

Red: both



Differences???:

- Species?
- Water body?
- Growing Conditions?

Summary and Comparison

Cape Cod Oyster and Quahog Data Summary							
	Shell Length (mm)	Shell DW (g)	Tissue DW (g)	Tissue %N	Shell %N	Total N (g)	Total % N (DW)
Overall average from Cape Cod							
Oyster	83.8	40.9	2.43	8.01	0.24	0.28	0.69
Quahogs	56.1	31.2	2.22	7.69	0.18	0.22	0.67
Oysters from Cape Cod							
Wild	82.7	46	2.42	8.2	0.26	0.31	0.67
Cultured On	84.9	47.4	2.7	7.89	0.26	0.32	0.65
Cultured Off	83.1	35.7	2.36	7.95	0.21	0.26	0.7
Quahogs from Cape Cod							
Wild	57.1	32.6	2.43	7.5	0.18	0.24	0.67
Cultured	54.95	29.6	1.99	7.9	0.17	0.21	0.66
Wild oysters from reefs in Chesapeake (Newell 2004)							
	76	150	1	7	0.3	0.52	0.34
Cultured floating cage oysters - Chesapeake (Higgins et al. 2011)							
	85.5	37.6	1.58	7.28	0.17	0.18	0.45
Adapted from: Newell and Mann 2012							

- Comparison with Chesapeake oyster data

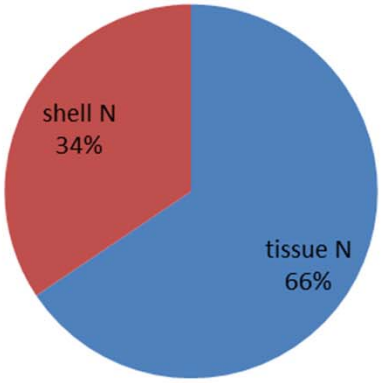
Quahogs & Oysters: Different Animals

Cape Cod Oyster and Quahog Data Summary							
	Whole Wt (g)	Shell DW (g)	Tissue DW (g)	Tissue %N	Shell %N	Total N (g)	Total % N (DW)
oysters	66.1	40.9	2.43	8.01	0.24	0.282	0.686
quahogs	51.7	31.2	2.22	7.69	0.18	0.221	0.665
Difference	*Yes	*Yes	No	*Yes	*Yes	*Yes	No

- Size is the biggest difference
- Oysters averaged higher %N in tissue and shell

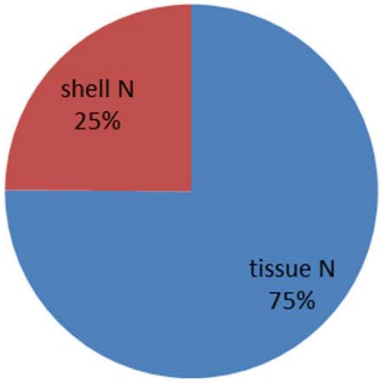
Oyster Nitrogen Contributions

0.282 g N Total



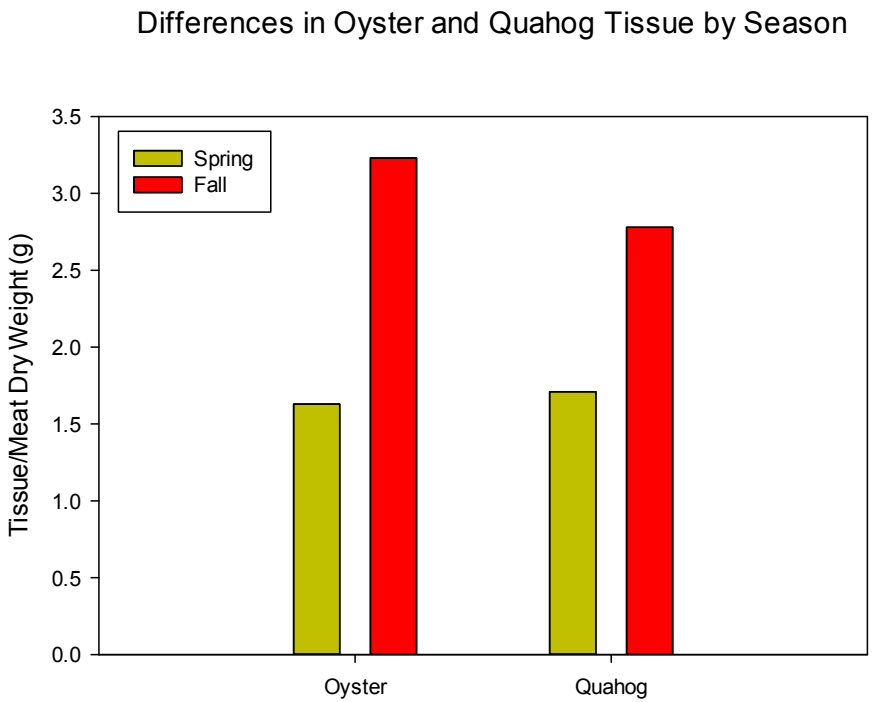
Quahog Nitrogen Contributions

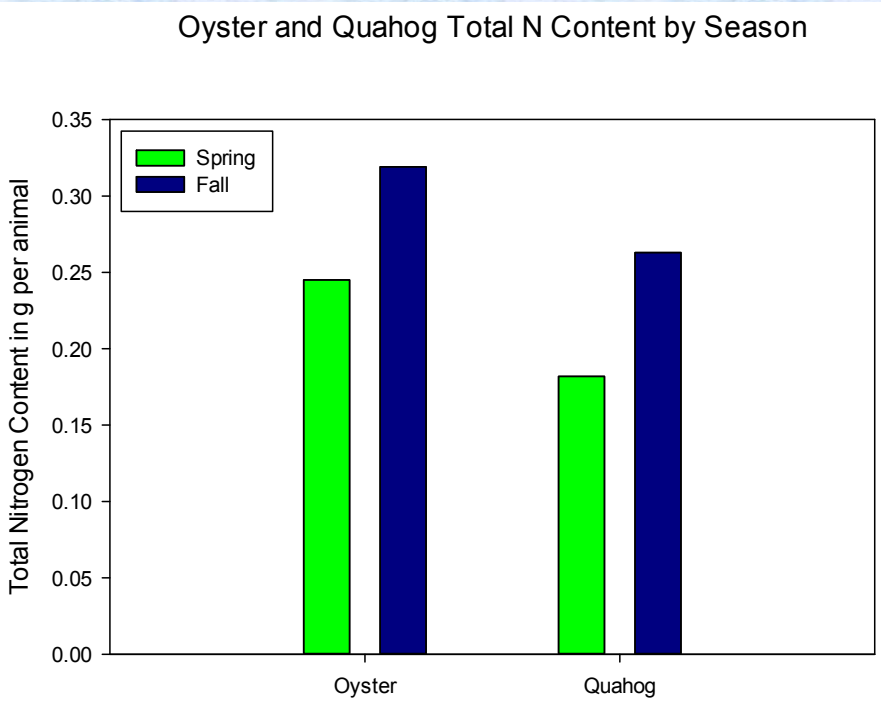
0.221 g N Total



Difference by Season

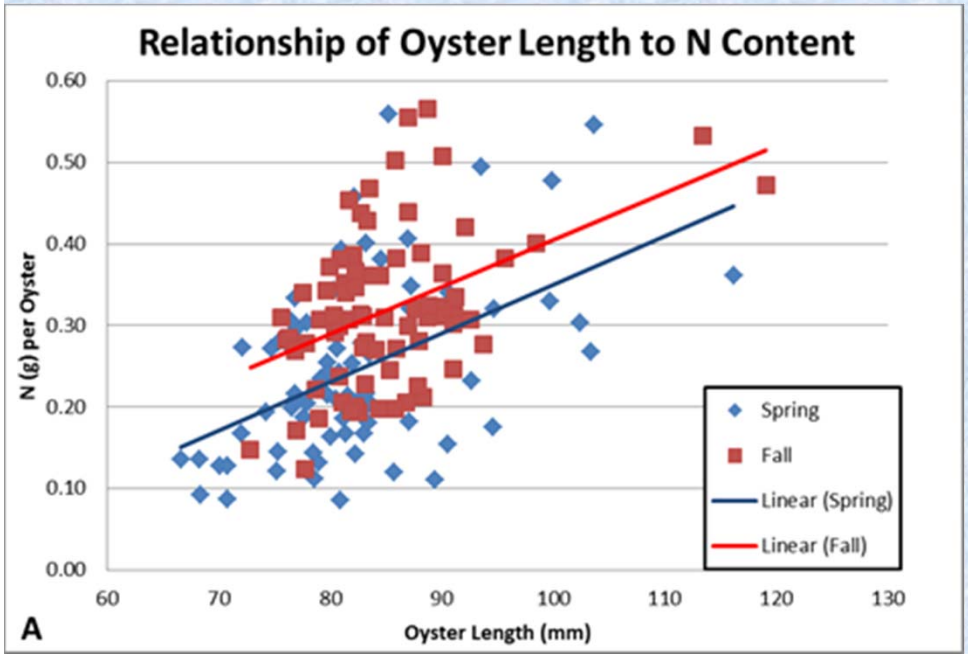
- Tissue or meat content was much higher in Fall
  - 98% and 63% more for oysters and quahogs respectively
- %N in the meat dropped a bit in fall
  - Tissues have more glycogen reserves, less % protein in fall
- Shell was similar, spring to fall

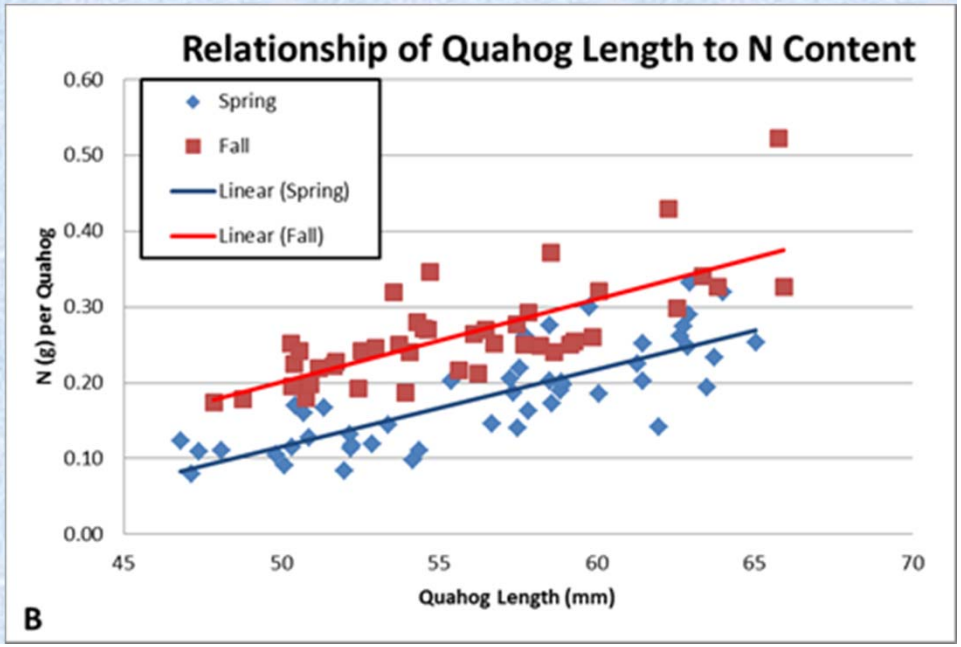




Relationship of Size and N Content

- Despite our best intentions to sample the exact same size everywhere
- Direct relationship to length (and weight)





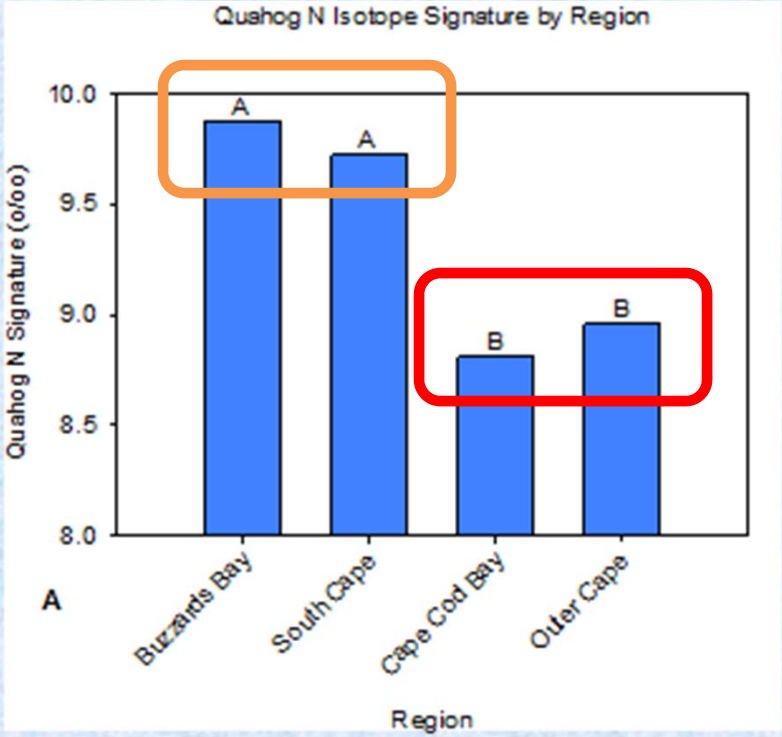
Other Notable Comparisons….

- Wild quahogs were not any different from cultured quahogs
- Wild oysters, and those grown on the bottom had heavier shells than oysters grown off the bottom (or grown in the water column)
- There were small differences between water bodies
  - Health of animals at point of sampling was a factor we did not account for

Isotope Signature Data

- Heavier N15 ratio with increased N from human sources – i.e. waste water
  - Signature 9-10 o/oo in quahogs indicates >50% N is wastewater (Carmichael et al. 2008)

- Differences by site
- Differ by water body
  - Cape Cod Bay
  - Buzz Bay/South Cape



Extraction Potential???

- Oyster harvest from town propagation program:
  - Harvest of 5000 peck baskets, or 250,000 oysters
    - 50 oysters/peck = 250,000 oysters
  - On-bottom culture method average = 0.32gN/oyster
    - At ~3.5 inch average
  - Harvest would include 176 lbs of N
- N equivalent:
  - Conventional septic inputs from 26 homes
    - 2 people per household
  - Sewage treatment of 196 people

    (N values from http://www.cbf.org)

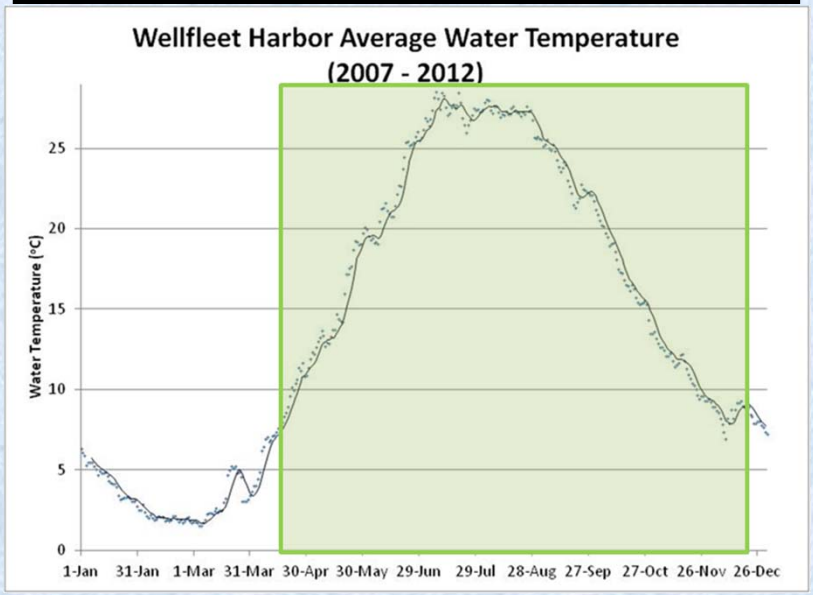
Extraction Potential???

- 90,000 lbs. of quahogs harvested from a particular water body, about 1200 bushels
  - 3906 lbs of meat tissue x 7.7%N = 301 lbs N
  - 54,360 lbs of shell x 0.18%N = 98 lbs N
- Total 399 lbs of N removed with harvest
- N equivalent:
  - Conventional septic inputs from 59 homes
    - 2 people per household
  - Sewage treatment of 443 people

(N values from http://www.cbf.org)

Challenges – Why don't they all survive?

Weather - Seasonality



Predators

Disease

Challenges…

Available Space

- State approved waters
- Not infringing on protected species
- Limited/no user conflicts
- Adjacent property owner approval - NIMBY
- Can be challenging to find a site

Accurate Numbers

- For accurate nitrogen removal estimates the harvest needs to be accurately quantified
  - By number
  - By weight
- May take some effort to get good numbers

Summary

- Oysters at 3-3.5” - 0.282g N (0.69% of DW)
  - Shell weight varied
- Quahogs (littlenecks) - 0.221g N (0.67% of DW)
  - Not much difference wild or cultured
- Size and time of year make the biggest difference in amount of N contained
  - Fall more than spring
  - Bigger means more N – more tissue
  - Most accurate N removal would be measured by weight of shellfish harvested not #
- Denitrification/burial of N????????

Marine Water Quality Monitoring

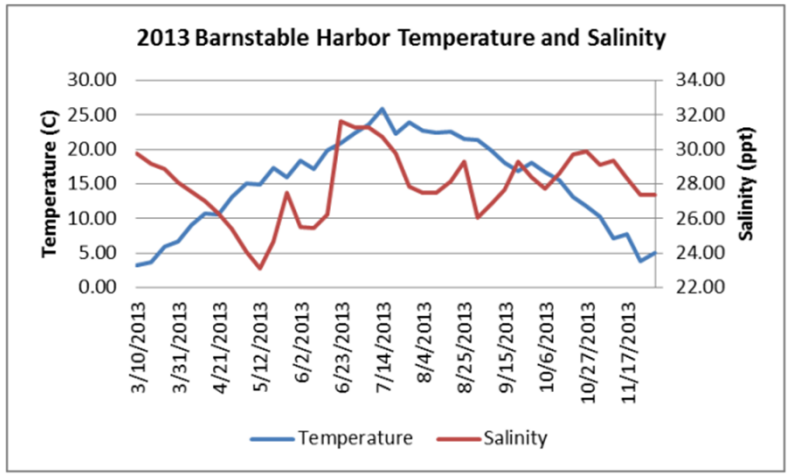
Why Monitor Water Quality?

Long Term Data Set

- Provides baseline to monitor change in WQ parameters
- Climate change concerns
  - Temperatures: warmer seasons/waters may create more favorable conditions for human pathogens (e.g. *Vibrio* spp.)
  - Species' range expansion
    - Includes shellfish pests/predators/diseases (e.g. Dermo)
    - Some formerly Gulf or mid-Atlantic now as far north as Maine & Canada
  - Ocean Acidification (OA)
    - monitor pH
  - Projections of sea level rise raise concerns over low-lying communities & infrastructure (septic & sewage treatment)
  - Projections of increases in rainfall and frequency & intensity of storm events
    - Create crop losses and additional harvest restrictions and closures (e.g. hurricanes Katrina & Sandy)

Water Quality Monitoring

- 5 WQ stations with YSI instruments
  - Wellfleet Harbor
    - L-Pier since 2004
    - Egg Island channel since 2010
  - Pleasant Bay
  - Barnstable Harbor
  - Cotuit Bay
  - Duxbury Bay (recent addition)
- 2 WQ stations relay real-time data
  - Wellfleet & Cotuit
- Up to 8 years of data being put up on website as weekly averages for now

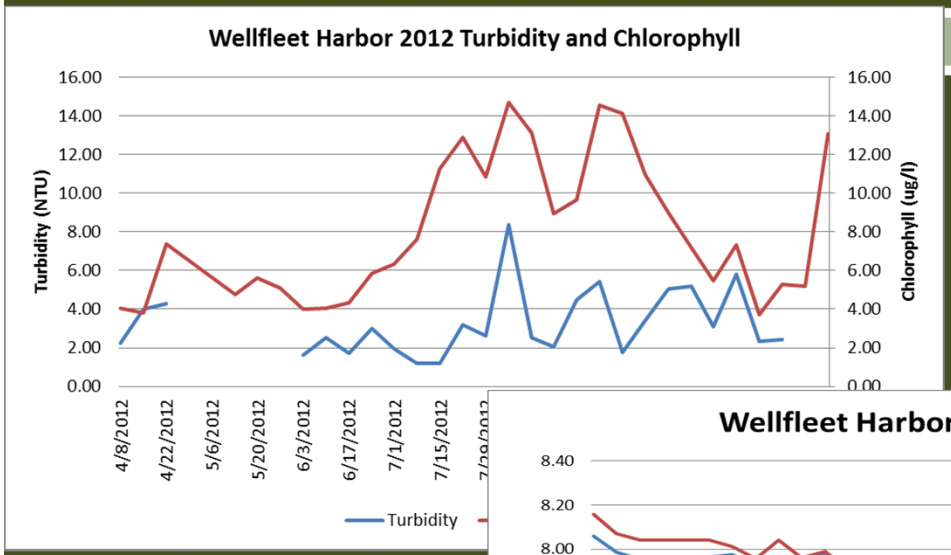


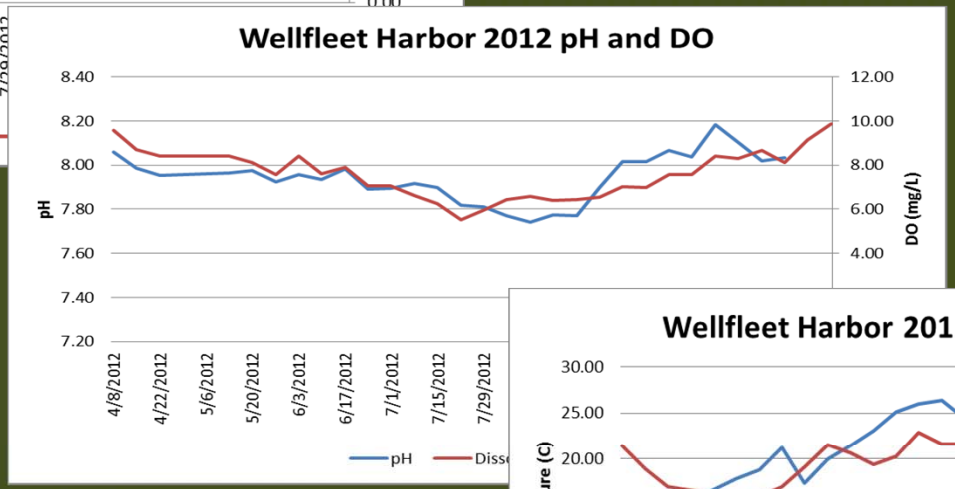
Weekly mean water temperature and salinity as measured at Scudders Landing in Barnstable Harbor during 2013.

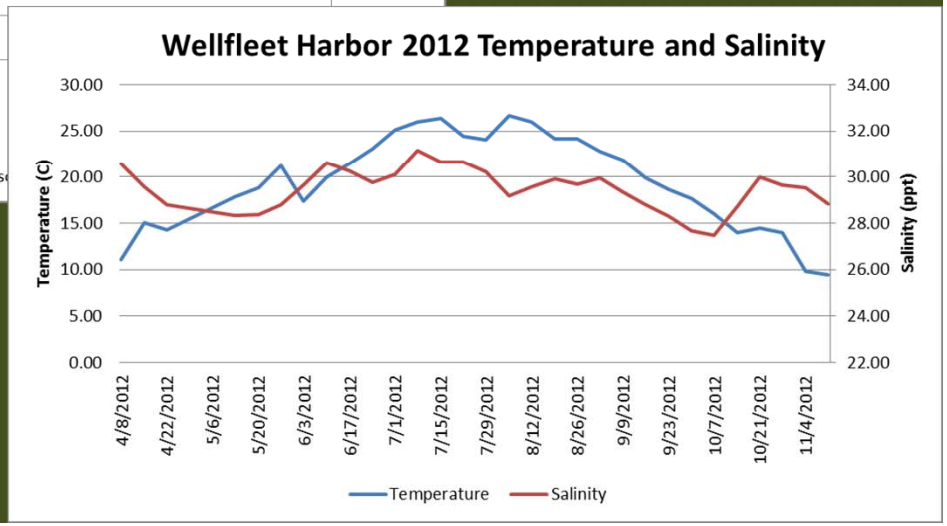
http://www.capecodextension.org/marine-programs/water-quality-monitoring-2/archived-data/

http://www.ysieconet.com/public/WebUI/Default.aspx?hidCustomerID=88

YSI Weekly Means







Monitoring Water Conditions In-Situ

Municipal Shellfish Propagation Program

Shellfish Seed Support

- Support municipal shellfish propagation programs through shellfish seed bid program
  - Help organize seed bid – obtain seed cheaper and more reliably
  - CCCE & WHSG help to fund
- To date seed bid program has helped purchase:
  - Over 160,000,000 seed quahogs (since 1999)
  - Approx. 27,000 bags of oyster remote-set, or about 27 million oysters since 2003
  - All 15 Barnstable County towns participate
  - Continue to work with local shellfish seed sources to ensure availability and test new species for commercial industry development

Value of Program

- 160+ million quahog seed since 1999
  - If estimate 50% survival = 80 million seed
    - 80 million quahog seed X $.19 = **$7,600,000** potential wholesale value
- 27,000+ bags since 2003 represents >27 million oysters
  - If estimate 50% survival = 13.5 million seed
    - 13.5 million X $.50/oyster = **$6,750,000** potential wholesale value

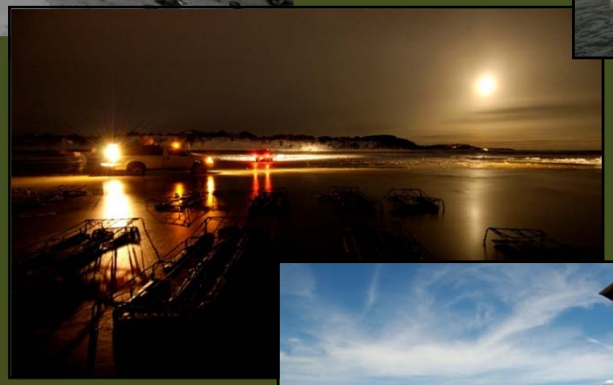
ARC Economic Development/Impact

- Commercial shellfishing
  - supports ~1,400 jobs
  - >1,200 comm permits (CC)
- Seed for shellfish growers
  - >350 lic grant holders (MA)
- Seed for County programs
- Recreational shellfishing
  - >17,000 rec permits (CC)
- **$20 million** wholesale value to Barnstable County in 2011
  (SAFIS – all shellfish harvest)
  - $60 million w/economic multiplier

Faces of Local Shellfish Farming

- Work closely with the state's shellfish farmers
  - Established, new and hopeful
- Education through classes and workshops
- Big emphasis on applied research

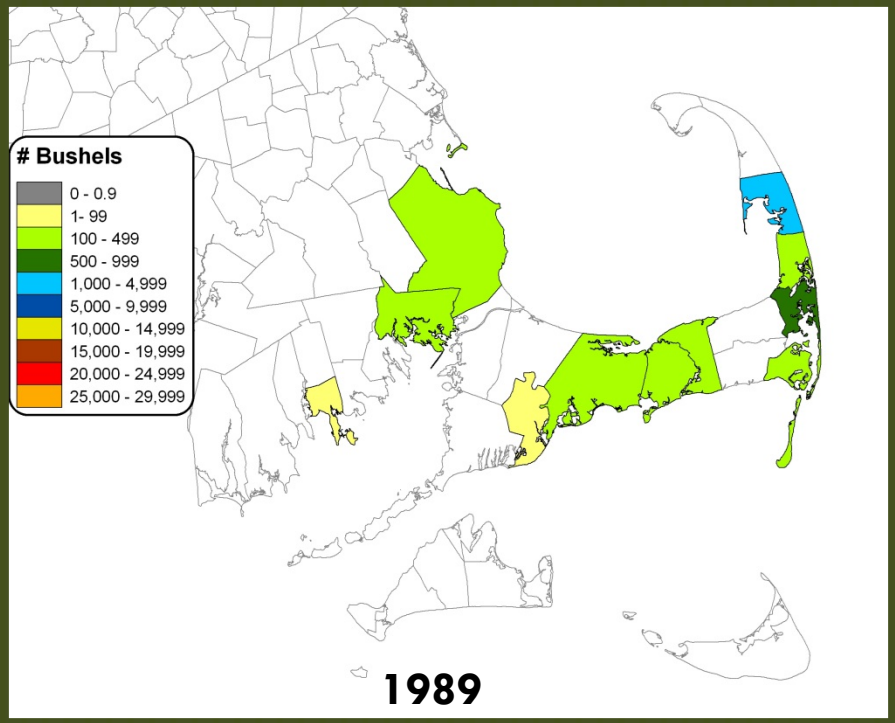


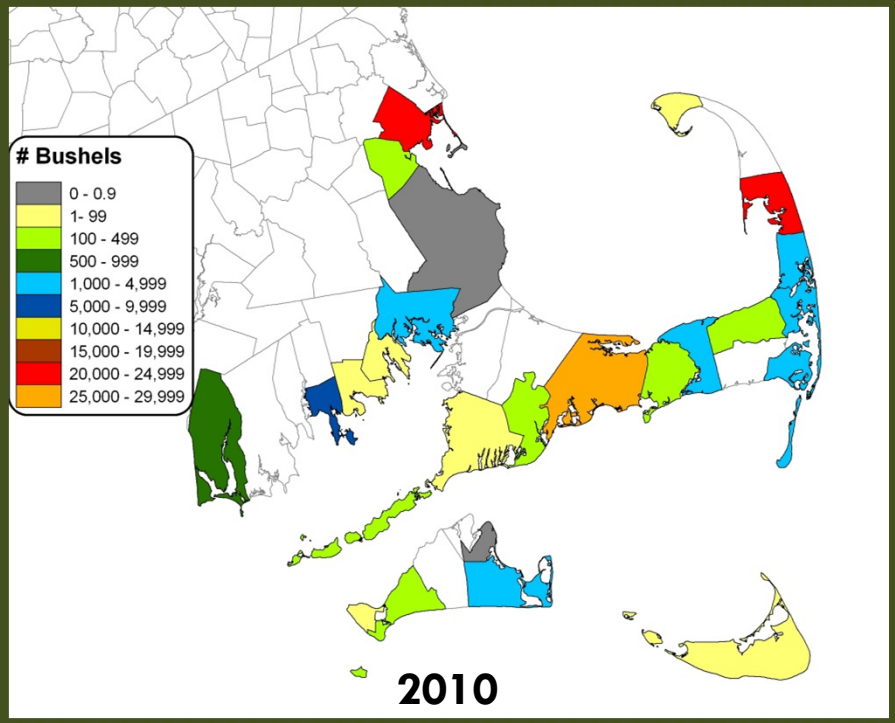






‘Growing’ Commercial Shellfish Harvest

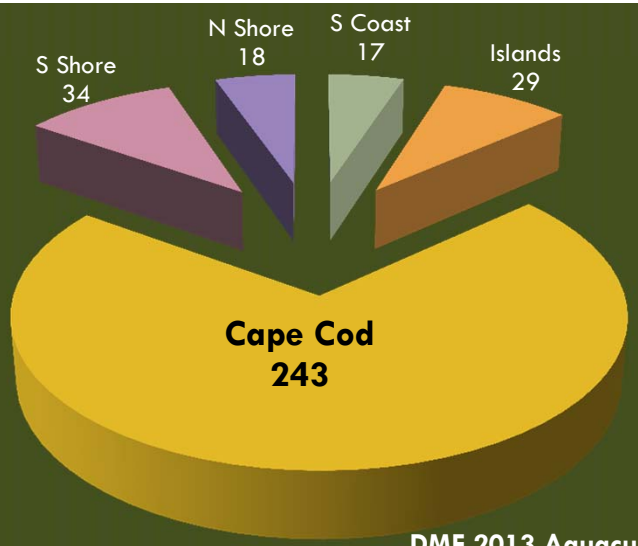
Reported harvest – all shellfish (bu) for reported years.



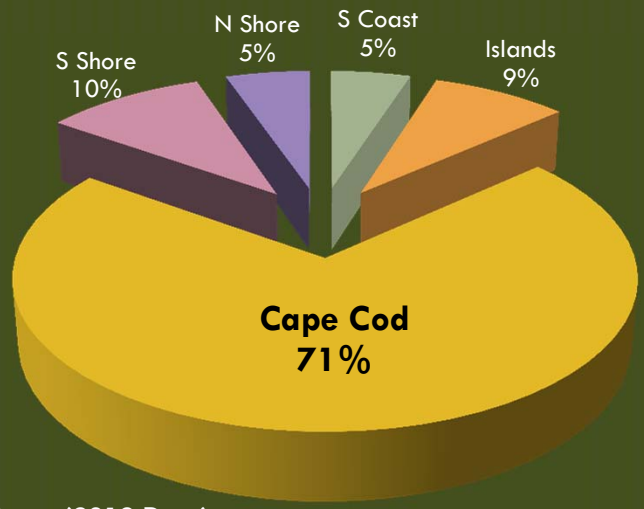


Cape Cod Shellfish Farming

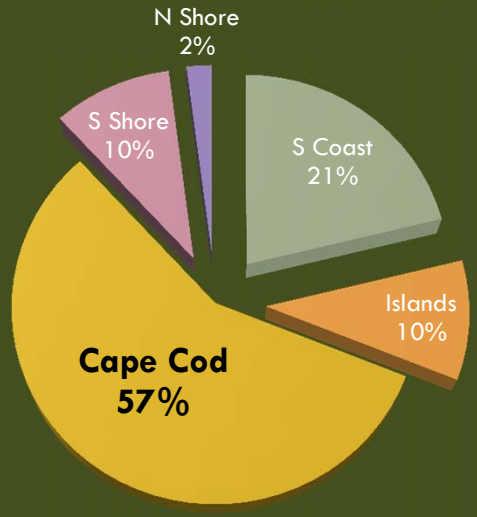
DMF 2013 Aquaculture Report - #Growers (2012 Data)



DMF 2013 Aquaculture Report - %Growers (2012 Data)



DMF 2013 Aquaculture Report %Total Acres (2012 Data)



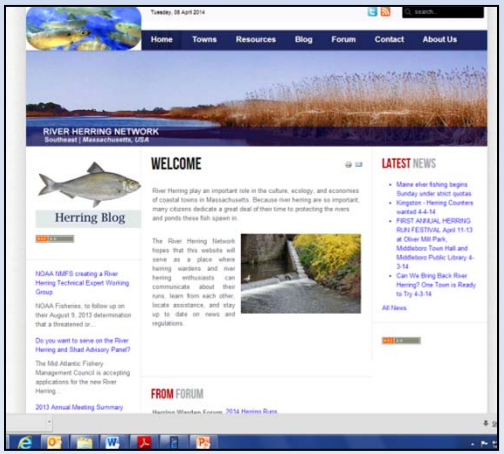
River Herring Network

Massachusetts River Herring Network

WEBSITE

www.riverherringnetwork.com

- Blog posts on timely management and scientific topics
- Latest news articles
- Reference material on grant opportunities and scientific studies
- Best Maintenance Practices template
- Discussion Forum



A professional society for river herring wardens & volunteers, and a clearinghouse of information for river herring enthusiasts

MISSION

Facilitate communication among herring wardens in MA

Support herring wardens in their role as active participants in local, state, and federal fisheries management processes

Gather and disseminate relevant information for wardens and volunteers

Document and communicate local management practices, and the natural and cultural history of herring runs

To sign up for the newsletter go to:
http://riverherringnetwork.com/about-us/join-us.html

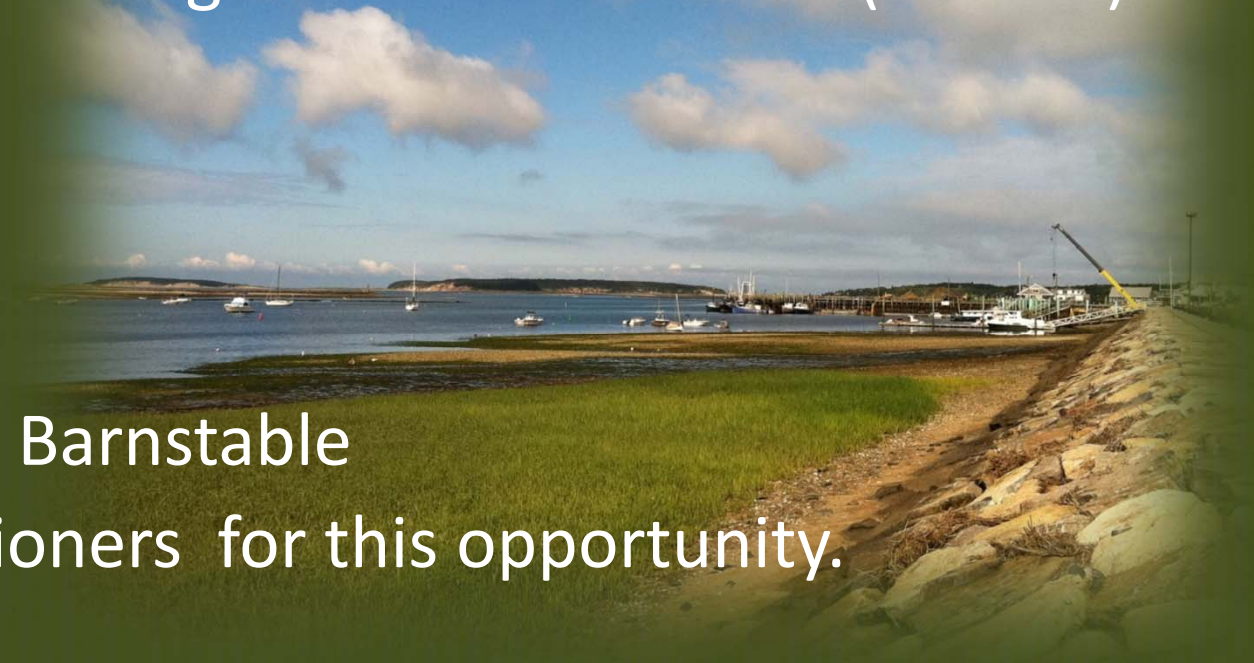
ANNUAL MEETING

October

- Provides an opportunity for herring wardens and volunteers to network with each other
- A forum to hear and discuss management and research updates from
  - -MA Division of Marine Fisheries
  - -Atlantic States Marine Fisheries Commission
  - - NOAA National Marine Fisheries Service
  - - Local Non Profit Organizations
  - - Academic Institutions

Acknowledgements

- Barnstable County
- Woods Hole Sea Grant
- MA Department of Agricultural Resources (SEMAC)



Thank-you to the Barnstable County Commissioners for this opportunity.