## Measuring the impact of Oysters on Water Quality Town of Wellfleet







United States Department of Agriculture Natural Resources Conservation Service



Green Harbors Project



A partnership for engineering solutions.

Center for Coastal Studies

Provincetown

#### **Cape Cod Cooperative Extension**





Massachusetts Oyster Project www.massoyster.com

## Wellfleet Green Infrastructure Goals

- Protect and enhance the Wellfleet Harbor ecosystem now → think 1600's function
- Adaptive approach to nutrient management
- Identify low-cost, sustainable approaches
- Use best marine science focusing on
  - Integrated ecosystems
  - oyster reef restoration
  - salt marsh restoration

## Feasibility

- 30 years of science documents the nitrogen removal capacities of oysters and salt marshes
- Biodiversity of oyster reefs and salt marshes:
  - "habitat today  $\rightarrow$  fish tomorrow"
  - Buffers shoreline erosion and ocean acidification
- Similar projects have been on-going in TX, NC, FL, Chesapeake Bay for over 15 years

# **Shellfish and Nutrients**



# **Best Available Science**



**Oyster Nitrogen Removal** (gms/oyster/year)

other

organisms

0.75

oyster assimilation 0.375

oyster

0.35





### **Results in Maryland**

### MD: Governor O'Malley's Oyster Restoration

- **1**. Oyster sanctuaries increased from 9 percent to 24 percent;
- 2. Aquaculture leases increased land streamlined the permitting process;
- 3. \$2.2 million financial assistance program for aquaculture interests; and
- 4. 76 percent of the Bay's remains sustainable/managed public oyster fishery.
- Since implementation:
  - 28 new oyster farming leases have been approved on about 650 acres.
  - 52 lease applications covering 620 acres are currently being processed
  - MSX and Dermo have fallen to lowest levels ever recorded
  - Highest SPAT survival rates since 1985
  - Overall biomass up 44%
  - \$8 Million committed for 2014

http://www.oysterrecovery.org/Content/Content/1/Documents/2012\_October3 \_PressRelease\_2012 Oyster Planting Season Results.pdf



Proposed Oyster Propagation Sites (blue)

Commercial Cultch Area 2013 (red)

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## Wellfleet Results – Oyster Efforts

- Over 4 million new oysters in 2 acre study area
- 70% nitrogen reduction
- 50 million oysters from harbor-wide effort
- 2000 tons of shell (cultch) last 3 years
- 3 billion gallons of added water filtration per day
- Pilot projects show start-up costs are minimal and maintenance is low (under \$15/lb of N removed)
- Anecdotal:
  - Huge influx of shrimp, tunicates, quahogs, crabs, snails, invertebrates, small fish
  - Significant reduction in mud level
  - Return of menhaden
  - Paired diamond back turtles foraging, heavy turtle use

## Results – Oyster Efforts

### Awards:

Mass Recycle – Municipal Innovation

November 2012

 American Council of Engineering Companies – Engineering Excellence Award

March 2013

American Public Works Association – Project of the Year

April 2014

## **Increasing Interest in Oysters and WQ**

### Why?

- Population decline
  - < 1% historic levels
- Failure to meet WQ goals
- EPA-mandated WQ improvements (TMDLs) increasingly expensive
   MD and VA
  - Local governments will pay bulk of costs
- Enhancing oyster populations may cost less than other options
  - Additional benefits

Source: US EPA 2003. Economic analysis of nutrient and sediment reduction actions to restore Chesapeake Bay. Annapolis, MD



Exhibit 20: Estimated Distribution of Annual Costs (millions of 2001\$)





### Program Costs and Number of Human Nitrogen Equivalents Removed per Year \$/Ib Nitrogen Removed<sup>1,2,3</sup>

Commercial Harvest (Murphy/Reitsma) -\$812 -\$3,000,000 959 1. \$ 0.75 Town Sea Clam Cultching '10 '11 '12 (\$50,000) 2. 8,013 (\$100,000) \$ 1.78 Mayo Creek Salt Marsh Restoration 336 3. Oysterfest Shell Recycling '11&'12 \$ 2.01 (\$2,000) 119 4. \$ 5.67 (\$50,000) 5. **Oyster Propagation Zone** 1,055 Herring River Salt Marsh Restoration \$23.98 (\$60 million) 14,963 6. \$93.68 (\$324,000) **Baker Field Composting Toilets** 28 7. \$500-\$1,000 (\$60 million) 450 (CD) Sewering options (Giggey/Barnstable County) 8.

People Equivalents<sup>3</sup>

- 1. Costs only; economic benefits for 1-6 dwarf costs in most cases;
- 2. Merrill/Cornwell 2002 Role of Oligonaline Marshes in Estuarine Nutrient Cycling
- 3. M Rice "Environmental Impacts of Shellfish Aquaculture: Filter feeding to Control Eutrophication"



### Site visit on July 17, 2011: After cultching;





Deniz Bertuna (grad student)

Bi-weekly Monitoring of biological changes at the site

### 6-11 -2012; A. Frankic





http://www.flickr.com//photos/greenbostonha rbor/sets/72157631223836048/show/



Example of large number of baby oysters (spat) on a seaclam shell at site



414858.423	4642618.410	-0.763	wlhbr-01
414858.608	4642619.471	-0.750	wlhbr-02
414857.518	4642619.609	-0.757	wlhbr-03
414857.382	4642618.620	-0.748	wlhbr-04







Mark Borrelli, Jennifer Wilson Provincetown Center for Coastal Studies

Development of side-scan sonar tool to measure oyster population to monitor changes and track nitrogen reduction





- Uniqueness of Wellfleet Harbor
- Importance of Habitats Connectivity
- Challenges to restore & sustain keystone coastal habitats together and not separate

#### Facts:

- In Spring 1877, a Wellfleet schooner in 5 trips in one day landed 16,254 bushels of oysters (Ernest Ingersoll, 1881); 1 bushel ~ 100 oysters ~ 1.5 mill oysters
- Today: ~ 3 mill oysters/year





May 14 2011

Photos: A. Frankic



**Green** - compact sediment with cultch from the oyster festival; red – send and mud sediment with little cultch along the fringing salt marsh; purple - variable sediment texture with high cultch and young oysters and spats; blue - established oyster reef with adult oysters ~ 3y/o.

### Species biodiversity at the project site

#### 2013 species identified within quadrats:

- ribbed mussel (Geukensia demissa)
- mud crab (Neopanopeus sayi)
- amphipods (Gammarus)
- hard clams (Marcernaria m.)
- mud snails (Ilyanassa obsolete)
- oyster drills (Urosalpinx cinerea)
  ~58 individuals counted in September,
  7.25 individual oyster drills per m<sup>2</sup>
- mud warms (Polycheate)
- anemones (Ascidia)
- asian shore crab (*Hemigrapsus sanguineus*)
- barnacle
- mite
- whelk

Increased abundance and appearance of other species was observed throughout the project site:

- Terrapins (~40 at the site)
- Grey heron
- gulls
- juvenile fish
- Shrimps
- Oyster catcher



### Oyster population data 2012-13

2012 and 2013 oyster (including spat) comparisons per m<sup>2</sup>.





Fall 2013



#### Total Nitrogen 2012



## **Total Nitrogen**



### Chlorophyll 2012



Chlorophyll 2013



Comparison of Chlorophyll Levels at Cape Stations





