

Finding Solutions to our Coastal Challenges
Salem Sound Coastwatch 25th Anniversary Symposium

Eyes on The Coast

Barbara Warren

Salem Sound Coastwatch Executive Director
MassBays Lower North Shore Regional Coordinator

March 19, 2016

Report to the Community

- Bacterial Monitoring – *water quality*
- Invasive Species
- Winter Waterfowl
- Salt Marshes
- Turbidity in Salem Harbor – *water quality*

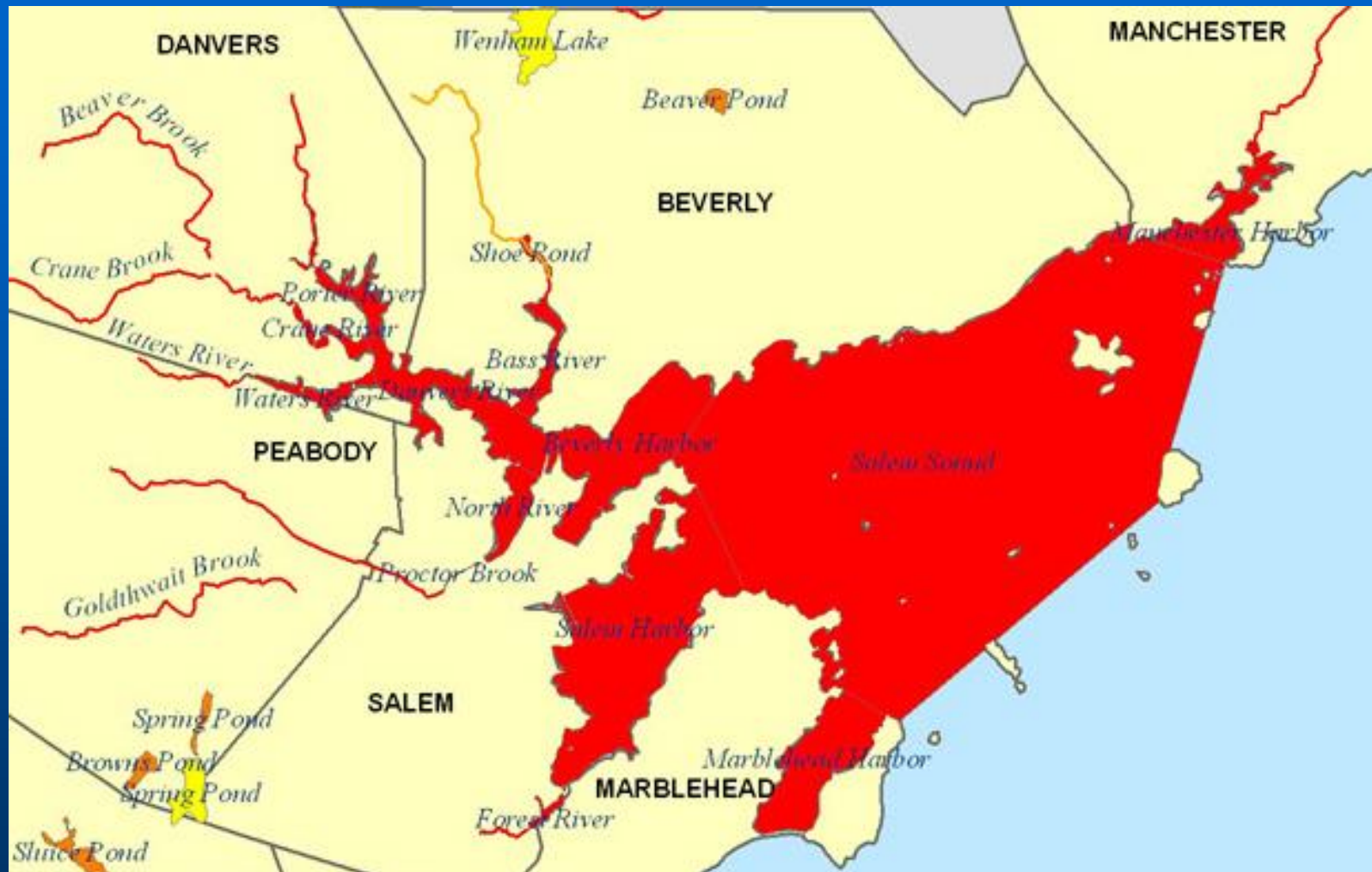
Efforts

Changes

Successes

*Citizen Scientists Become
The Local Stewardship Network.*

Water Quality Driver - Bacteria



North Coastal TMDL for Pathogens 2012

Water Quality Driver - Bacteria

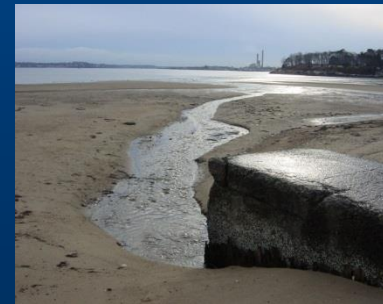


Rain Water = Storm Water



Shoreline Survey and Source Identification 1993

- 41-mile of shoreline surveyed by 100 trained volunteers
- Identified 166 potential pollution sources
- 100 sites monitored once a week for next two years
 - 25 Citizen Volunteers continued
- Salem 1994- 1998 - Many sewer repairs and at 115 units + 1 bar illicit connections removed = **51,060 gpd**
- Salem 1998 report
 - 165 houses on one street disconnected = **70,000 gpd**



Juniper Beach, Salem



CLEAN BEACHES & STREAMS PROGRAM – bacterial monitoring

Sharing the Results

Fatou Mandiang –
online visualizations

- The "wet conditions" are represented by the wavy pattern.
- CFU stands for Colony Forming Unit
- Weather ratings:
Dry - Less than 0.2" the day of sampling or less than 0.5" within three days preceding sampling
Wet - More than 0.2" the day of sampling or more than 0.5" within three days preceding sampling

- Data was collected by **Salem Sound Coastwatch**



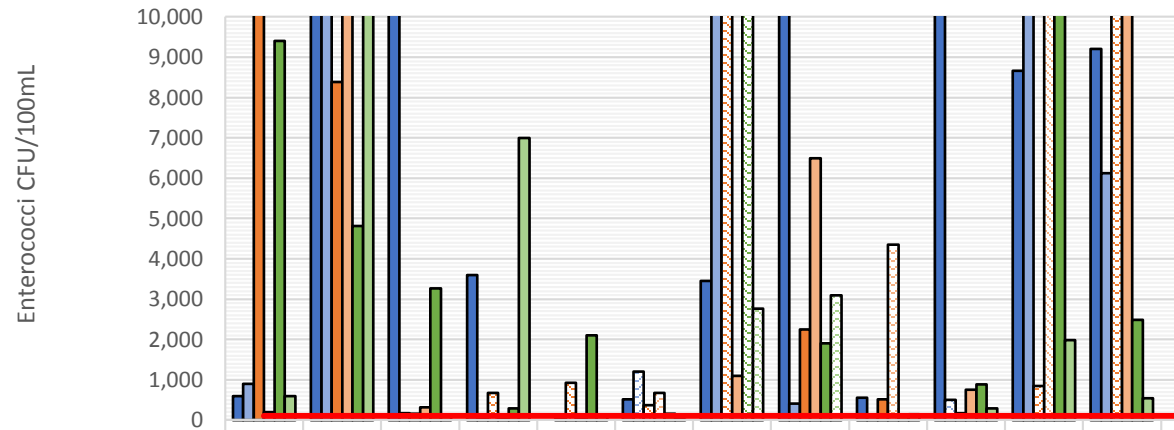
2006



2015



Juniper Beach, Salem (620)



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
June	600	198,630	16,740	3,600	0	520	3,450	24,200	554	24,000	8,660	9,210
June	900	81,640	173	20	30	1,200	24,200	410	97	504	24,000	6,130
July	17,000	8,390	156	680	920	370	24,000	2,250	520	173	842	11,200
July	200	30,760	316	40	70	680	1,100	6,490	4,350	754	11,200	13,000
Aug	9,400	4,814	3,266	290	2,100	160	24,200	1,900	110	880	24,200	2,480
Aug	600	14,210	124	7,000	120	10	2,760	3,090	144	295	1,990	539
Enterococci (104CFU/100mL)												

Outfall modification + periodic cleaning pre-2006 beach season

Manchester Coastal Stream Team

Wolf Trap Marsh, Black Beach, Kettle Cove, Manchester-by-the-Sea

77 Septic Systems
surround the marsh

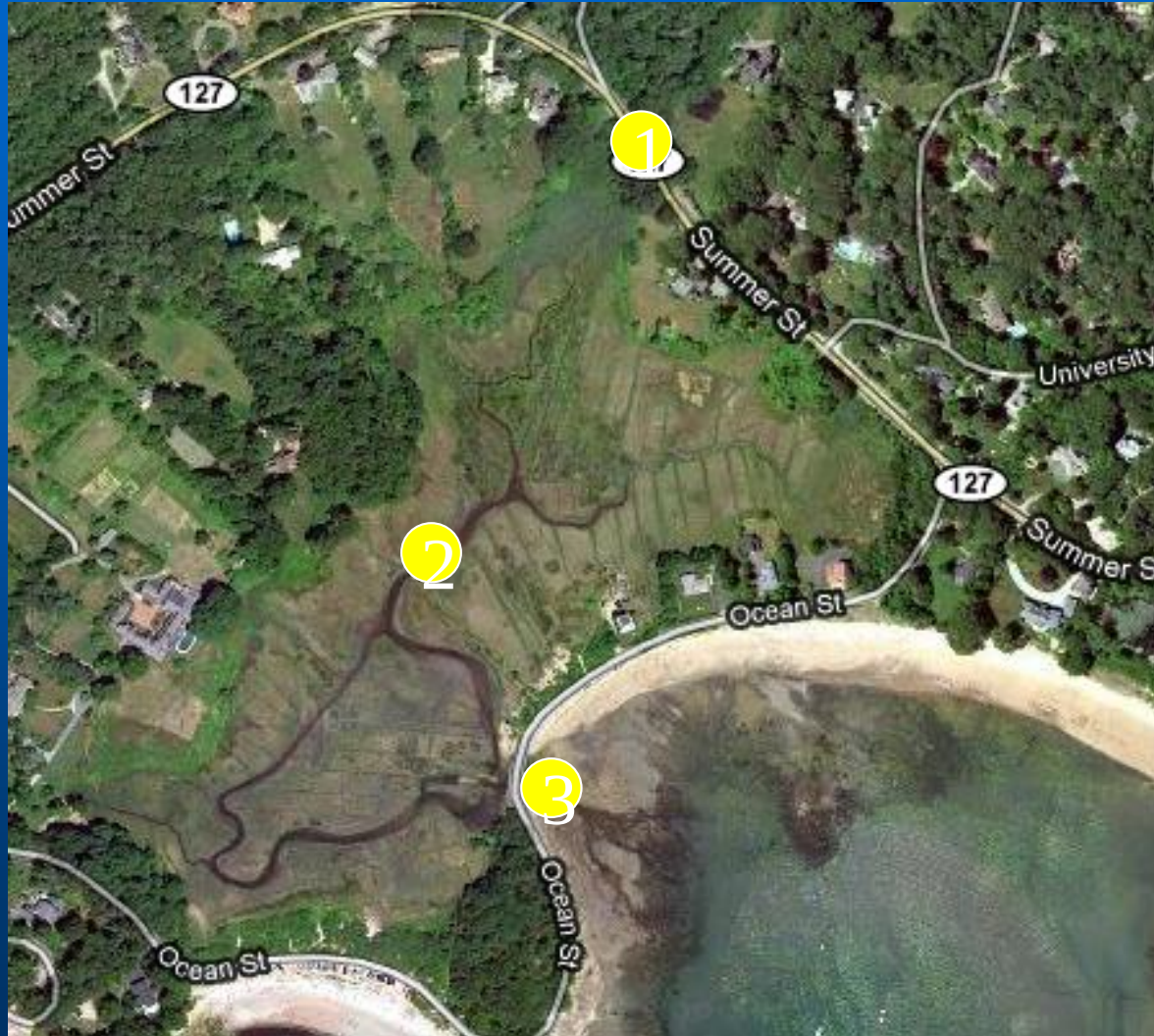
Passed Article at 2009

Manchester Town Meeting

To see if the Town will require the Board of Health to develop a plan of regular Title V testing of the Town's septic systems that are five years of age or older, with priority given to those systems in areas of environmental vulnerability.

2009-2015

52% Failed



23 passed - 38 replaced - 2 unoccupied by BOH order or tight tanks

Eyes on the Coast - Biodiversity

- Document what we see
 - Family or Species
 - General abundance
 - Distribution
 - Impacts?

Tide Pool to Marine Bioinvading Species

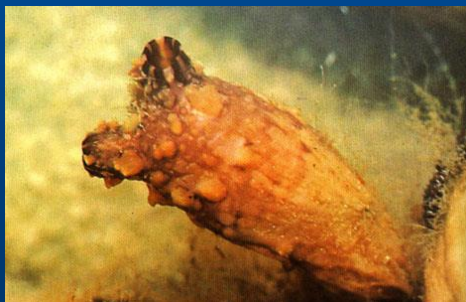


Dead man's fingers *Codium fragile*

Sea Vase (tunicate)



Asian Shore Crab



Club Tunicate



Orange Sheath Tunicate



European Green Crab

Monitoring Marine Non-Native and Native Species



Floating Docks
Rocky Intertidal
Tidepools



2016 Training: June 7 – Winter Island 6:30 – 8:00 pm

Need EYES on the water!

Questions and Memories

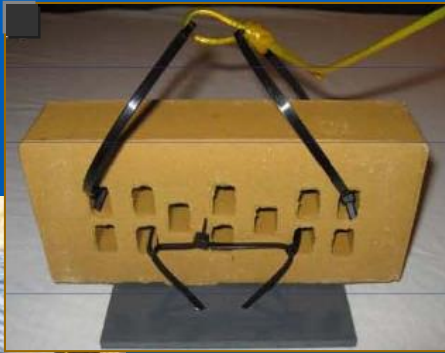
Where Have All the Mussels Gone?

What about the Sea Stars?

Why are we being invaded by Green Crabs?

Where Are You Looking?

Beverly Pier 2007 >
SETL plate in April 2010



Where Are You Looking?

SCRAPE SETL plates in April and June

From April to September 2010



What about the Sea Stars?

Go where the food is!

New dock at Beverly Pier in by 2010



2014 – Beverly Pier

Wasting Disease



2015 – July in Manchester

Nudibranchs at the SETL Plates

- Lay eggs in the spring
- BUT LAID EGGS in December 2011 and again December 2015



Eyes on our Beaches, but one has to listen

Heterosiphonia japonica

White Beach in Manchester in summer 2012!



Often there before you see it

Eyes on our Beaches, but one has to listen

Heterosiphonia japonica

White Beach in Manchester in summer 2012!



Often there before you see it

Marblehead Harbor - 2013

Colpomenia peregrina



Marblehead Harbor - 2013

Colpomenia peregrina



European Oyster (*Ostrea edulis*)

After warm winter of 2012, we saw expansion in numbers and distribution of European Oysters in the intertidal shoreline.

After cold 2014-2015 winter,
huge die-back along the shore



What is the European Oyster's Future?

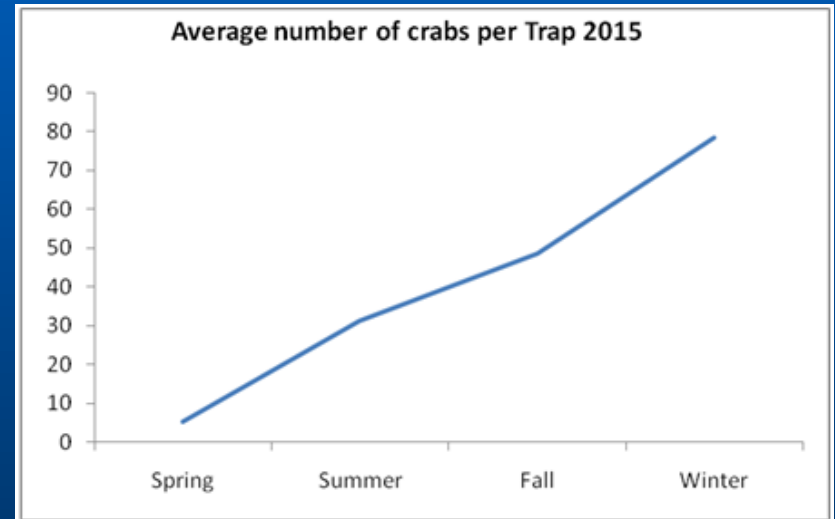
European Green Crab (*Carcinus maenas*)

After warm winter of 2012, we saw expansion in numbers and distribution of Green Crabs - intertidal and marshes.



destruction of softshell clam flats, eelgrass beds, and salt marshes since 2012

After cold 2014-2015 winter, saw die-back along the shore



Green crab populations began to recover through Summer 2015, reaching in a crab-per-trap average for December double that of the often more prolific season of late Summer/Fall.

European Rock Shrimp !! 2010

Palaemon elegans

1st American sighting

Dock at
Hawthorne Cove Marina
and in
macroinvertebrate
salt marsh samples from
Gloucester & Salem

Physical Tolerance

NEW predator and food source



European Rock Shrimp !! 2010

Palaemon elegans

1st American sighting

Dock at
Hawthorne Cove Marina
and in
macroinvertebrate
salt marsh samples from
Gloucester & Salem

April 2015 – 100's of
frozen shrimp in the
bottom of a marsh panne

Summer 2015 – found ONE



Physical Tolerance



Climate Change Indicators

- Sea Temperature HUGE Factor
- 2011-2012 and again this past winter 2015-2016
- Indicators of Larger Changes

Think one is monitoring for one reason and turns out useful for another factor

Perennial Pepperweed

Since 2007 all around the Sound



Perennial Pepperweed

Under Control

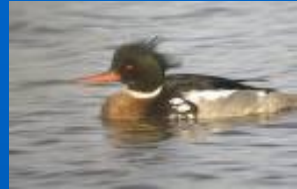
except along the Forest River



Need Concerted Effort – many volunteers in June 2016

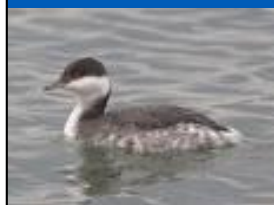
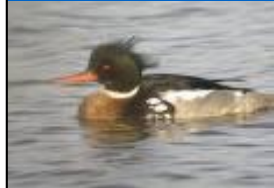
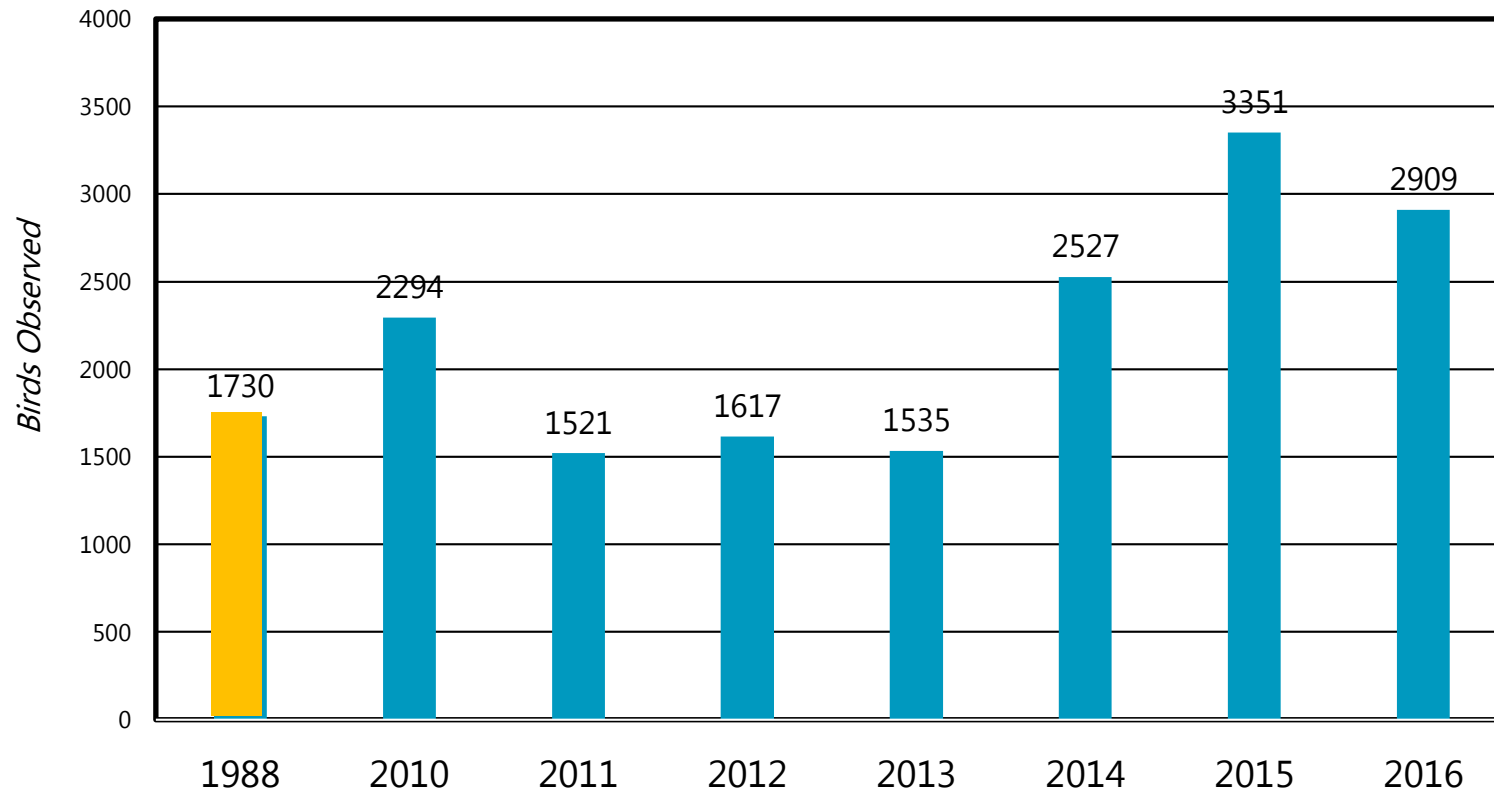
BioIndicator – Winter Waterfowl

- Migrate from the North for the Winter
- Food and shelter is why they are here
- Salem Sound area missed in Joppa Flats and Boston bird counts
- Robert Buchsbaum collected data in 1988

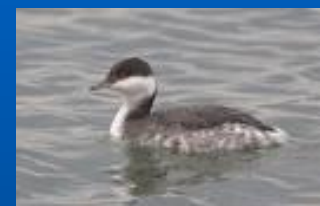
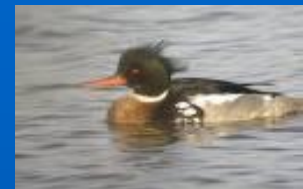
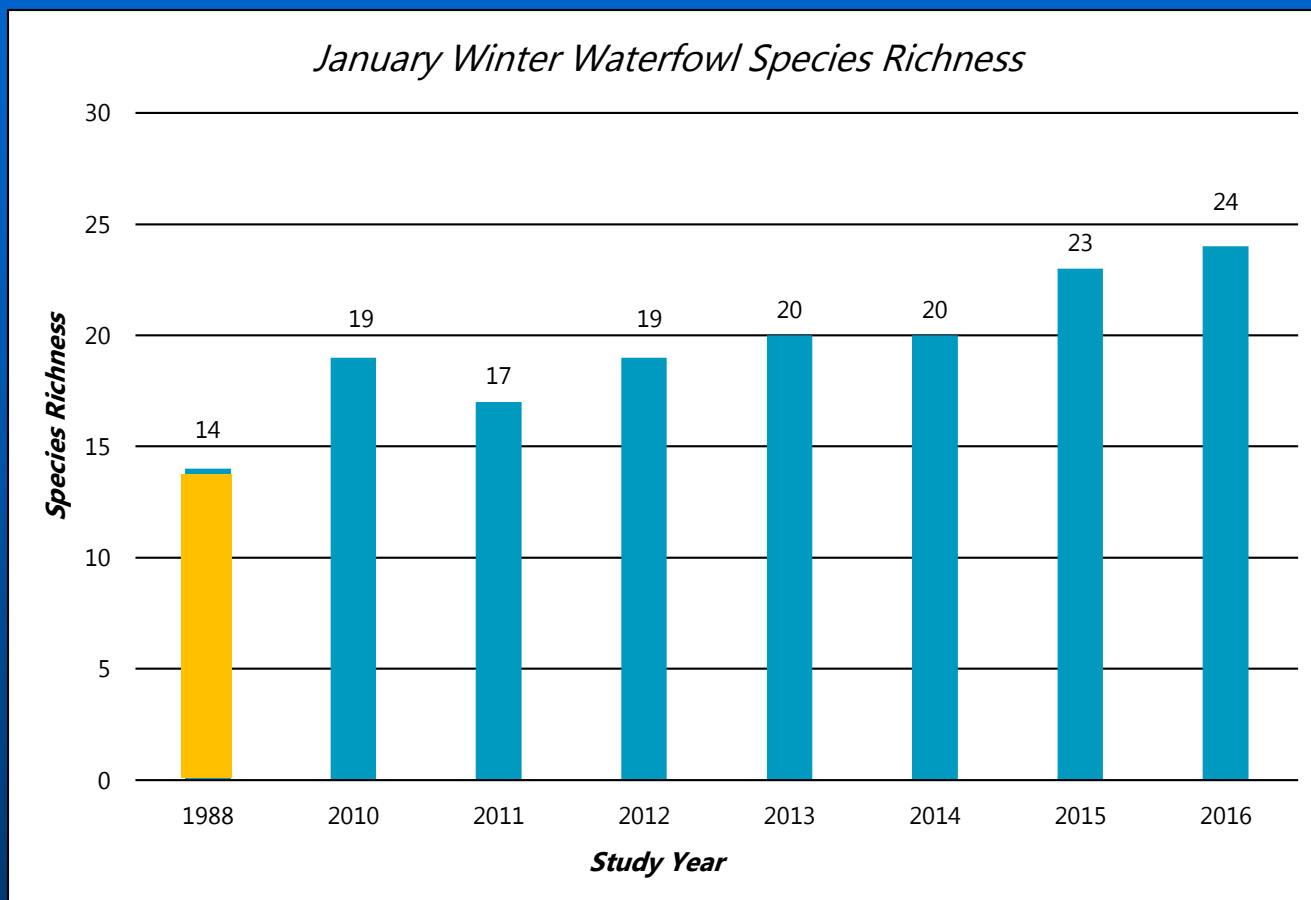


Winter Waterfowl

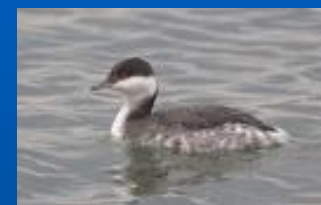
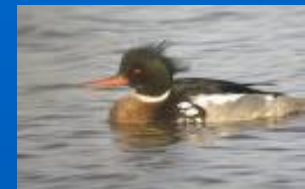
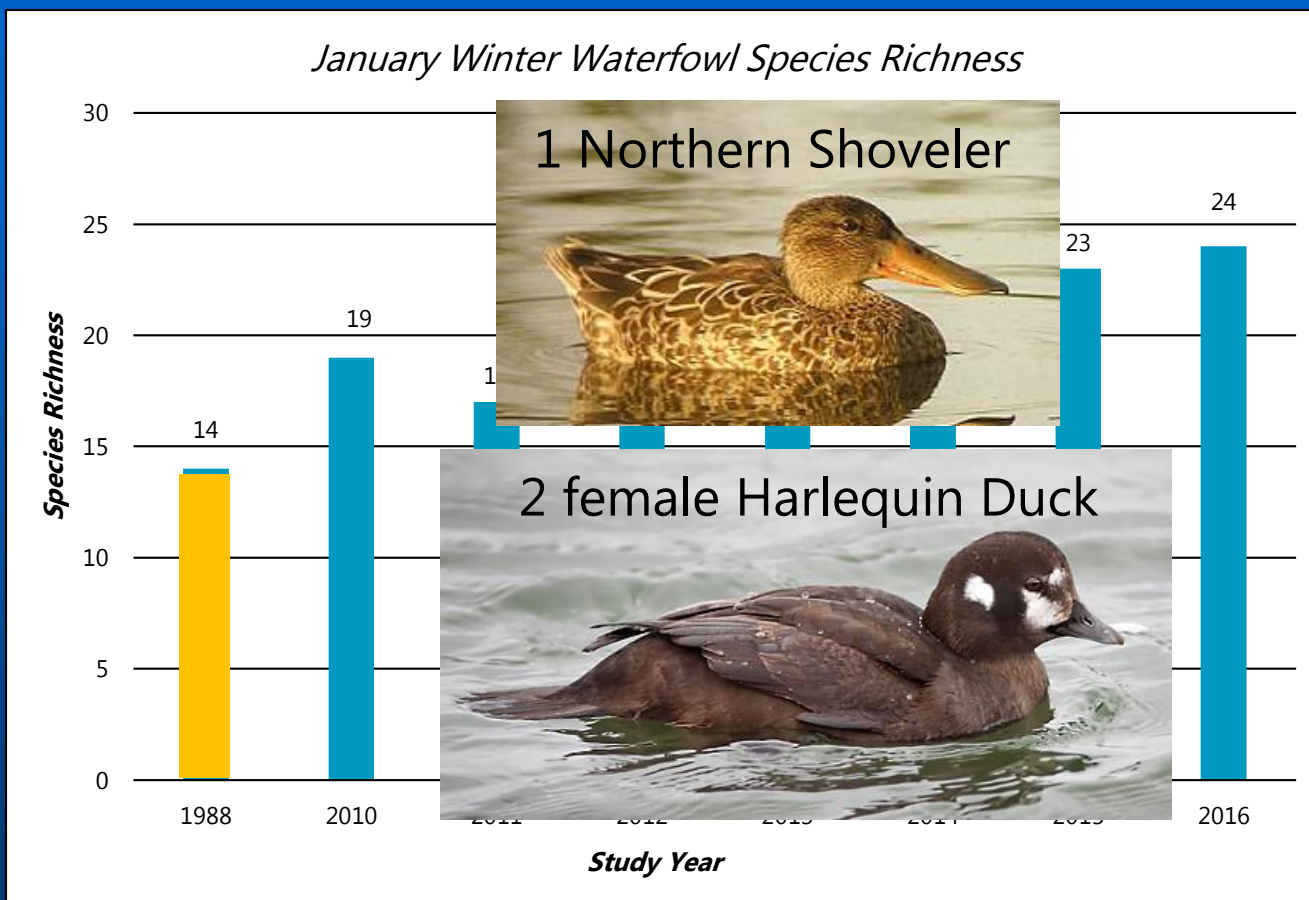
Number of Birds Observed January of 1988 & 2010-2016



Winter Waterfowl – *Snap Shoot in Time*



Winter Waterfowl – *Snap Shoot in Time*



Monitoring Salt Marshes

CZM – EPA – SSCW Protocol 1998

Affordable long-term data collection

Citizen-Scientists Volunteers



Pre and Post Restoration

Monitoring Good Harbor Marsh



August, 2005

Reference Site for Eastern Point Restoration

Sea Level Rise? Creek Bank Collapse?



Same Site 7 years later!

Sea Level Rise? Creek Bank Collapse?



August 2015

Same Site 10 years later!

Subtle Changes in Vegetation



August 2012

Loss of *Iva frutescens* (HIGH MARSH BUSH)

in the upper marsh at Good Harbor Marsh

Need to monitor for sea level rise

Subtle Changes in Vegetation

August 2005



August 2012

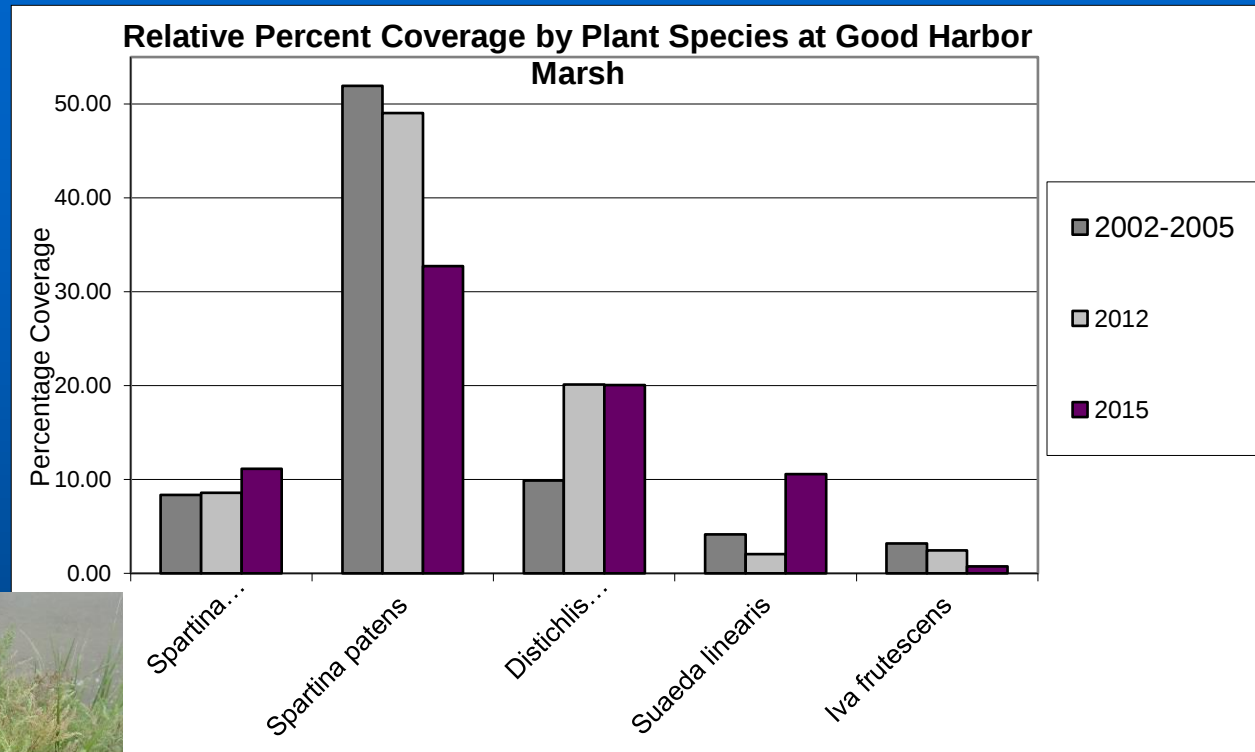


Loss of *Iva frutescens* (HIGH MARSH BUSH)

in the upper marsh at Good Harbor Marsh

Need to monitor for sea level rise

Good Harbor Marsh, Gloucester

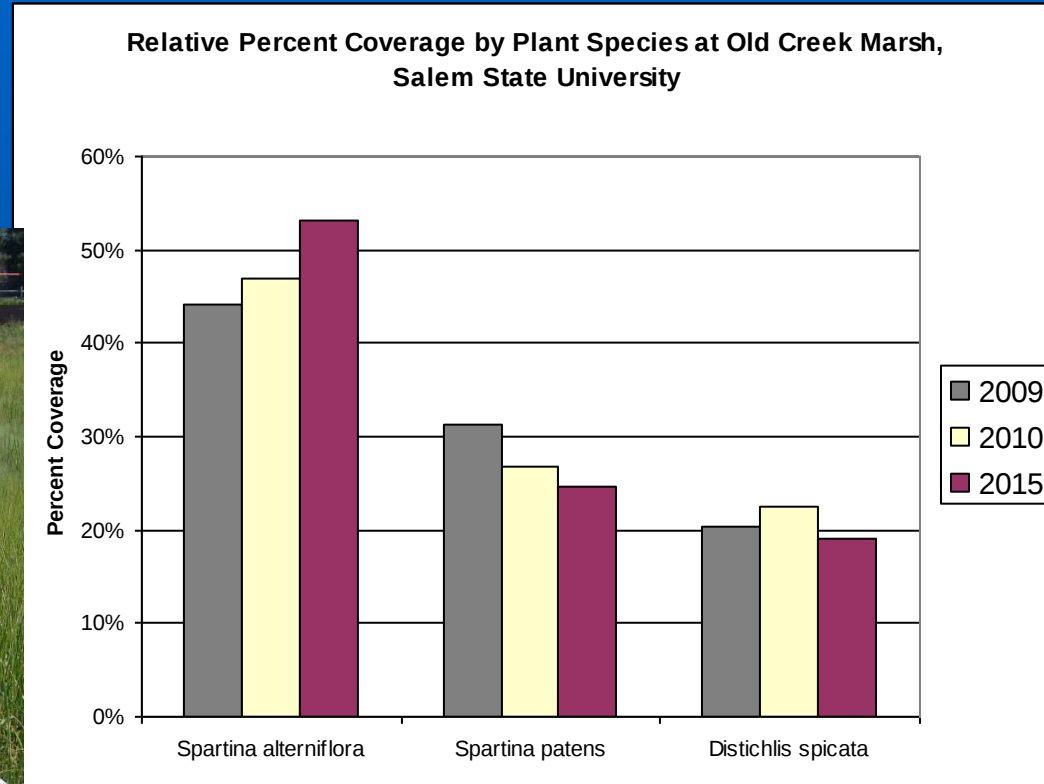


Seeing Changes in Vegetation
From 2002-2005; 2012; 2015

Increase in Spartina alterniflora & Suaeda linearis

Old Creek Marsh, Salem

Similar Changes in Vegetation in Salem from 2009 to 2015



Less High Marsh Grasses; More Low Marsh Grass

Future Citizen Science

Need to Work Together to come up with Standard Methods

1. Sea level rise

Document marsh elevation, Vertical accretion or subsidence

2. Bank erosion

Begin measuring creek and selected ditch widths, bank slumping

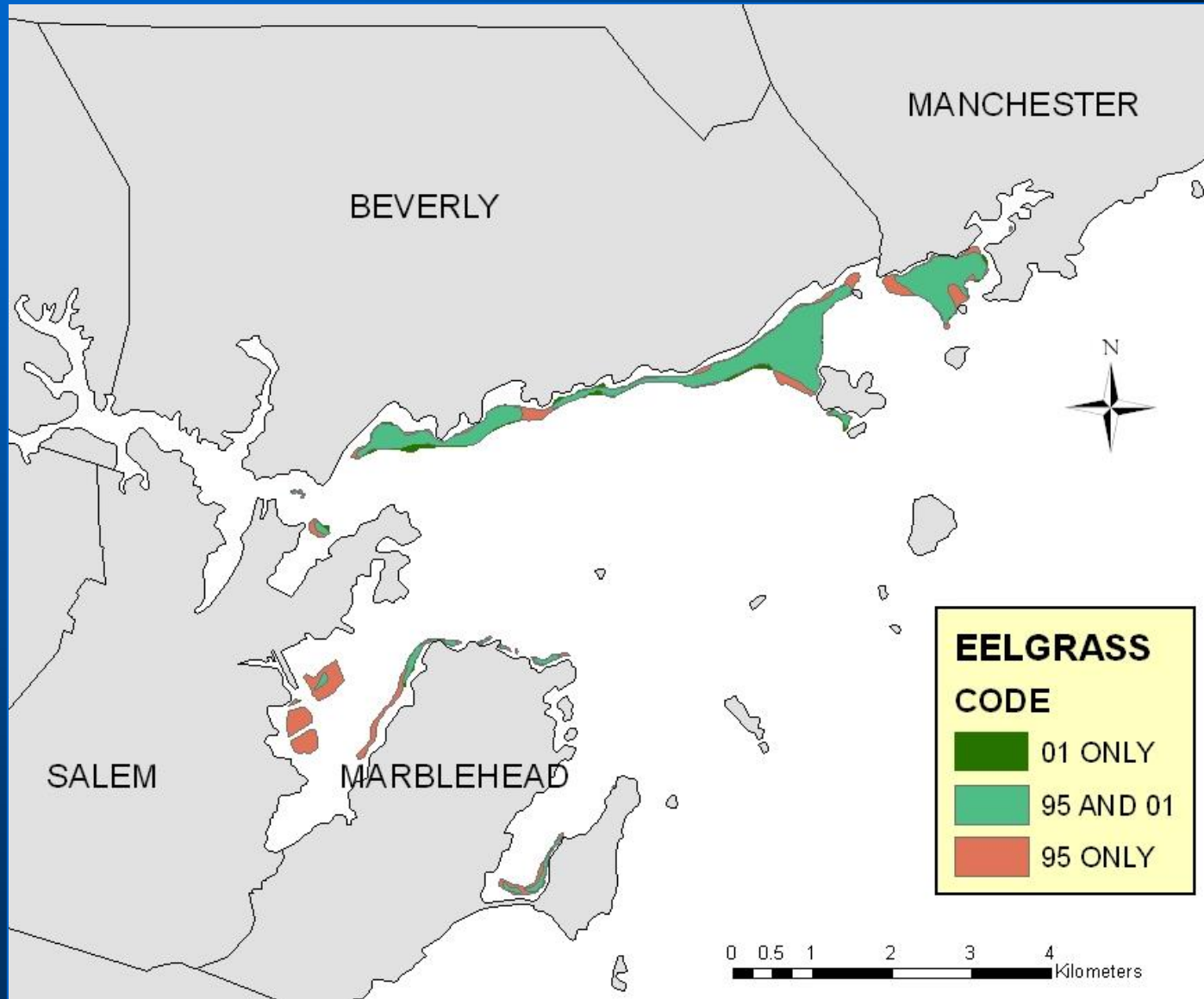
3. Invasive *Phragmites australis* assessment

Map for signs of retreat

4. Salt Pannes



Distribution of Eelgrass in Salem Sound



Salem Harbor: Elevated Turbidities?

- Decline in water clarity between 1997 and 2010-2011:

1997 DMF secchi depth of 3.5m at Winter Island, but 2010-2011 measurements by SSCW and SSU yielded mean of 3.2m at WI and 2.5m within the Harbor Proper:

- Concurrent eelgrass dieoffs were recorded:
 - Eelgrass (*Zostera marina*) is highly sensitive to light
 - Provides important habitat and substrate stabilization in the harbor

– Could there be a link?

Causes of elevated turbidity are worth investigating!

Salem Harbor Turbidity Study

Brad Hubeny - Associate Professor of Geological Sciences

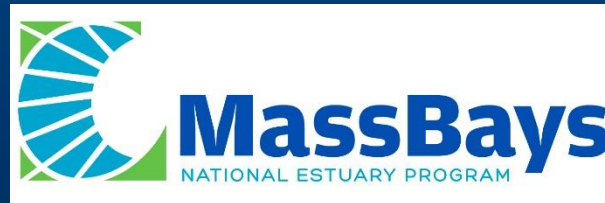


Barbara Warren



Melanie Kenney
- *Statistical Analysis & Report*

FUNDERS



Hypothesized Turbidity Elevated

1. Wind events resuspend harbor sediments
2. Precipitation events transport inland sediments to the harbor via runoff
3. Phytoplankton blooms increase organic particulate matter in the water

Salem Harbor Turbidity Study: 2012-2014

Data Collection

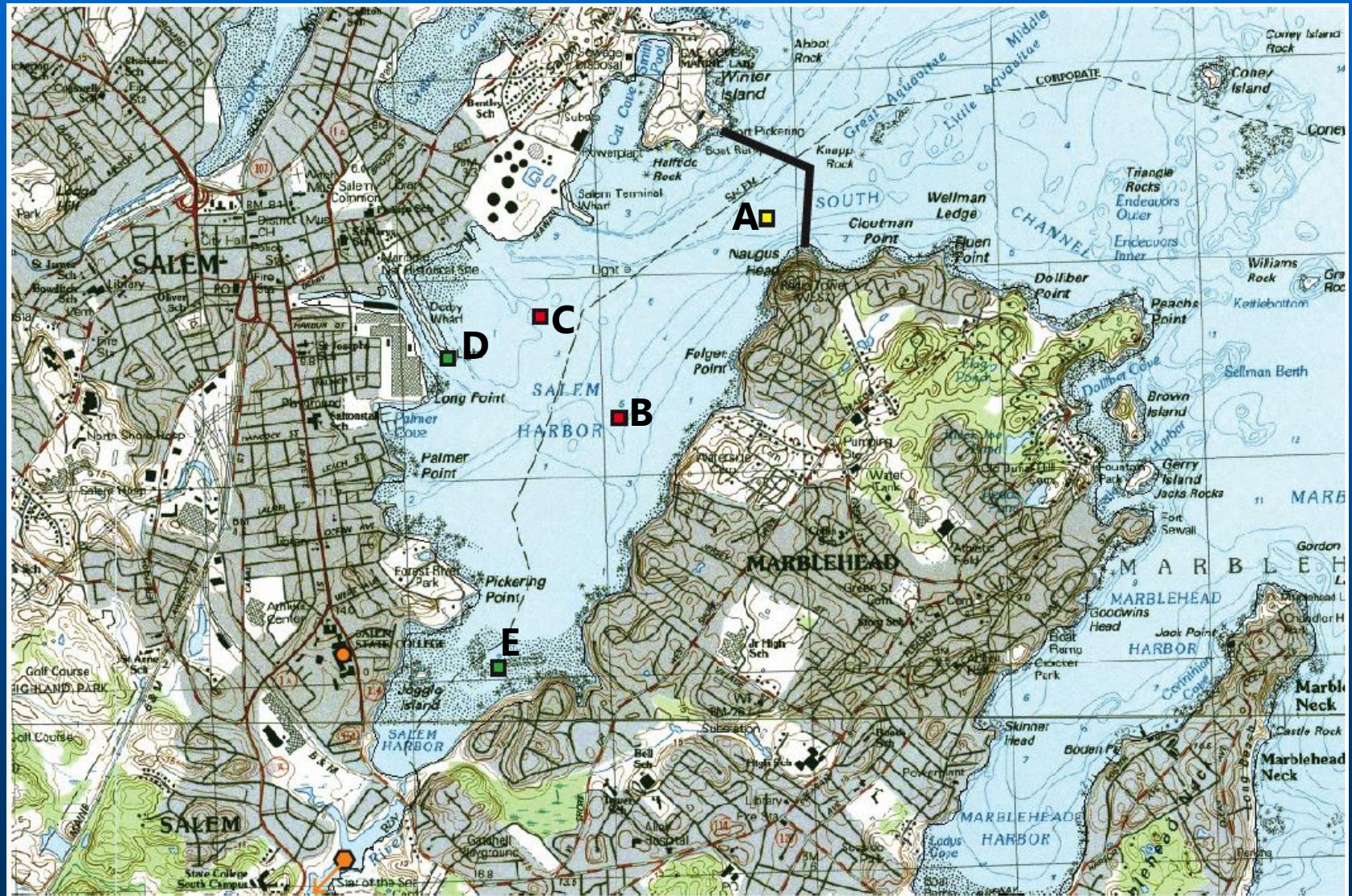
- Physical and Chemical Properties
- Meteorological Conditions



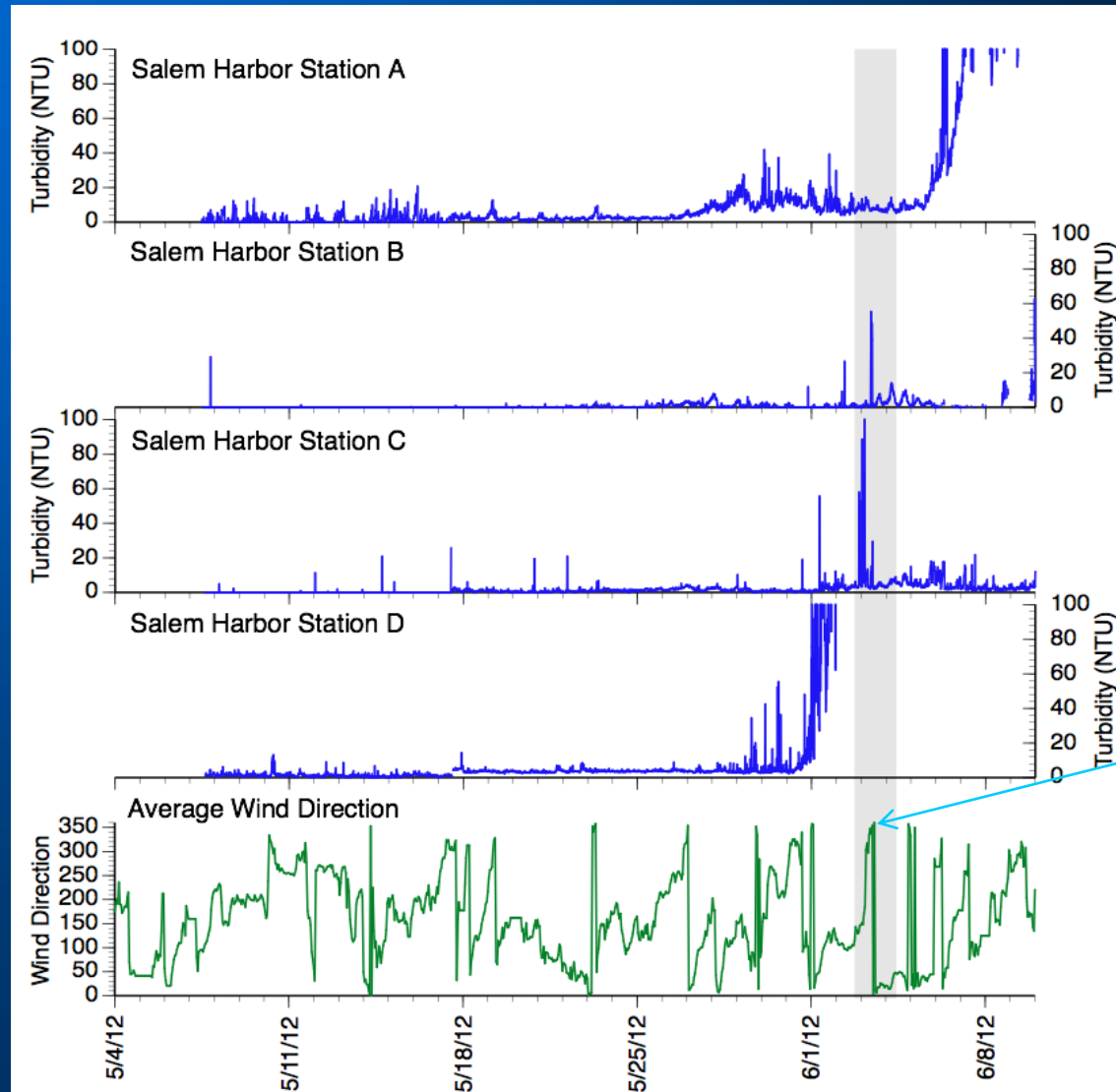
5 Eureka Manta2s temperature, conductivity
(which can be used to calculate specific conductance, salinity, and total
dissolved solids), and turbidity at 15 minute intervals

+ Sediment traps, water samples from Harbor, Rivers and Outfalls

Salem Harbor Turbidity Project



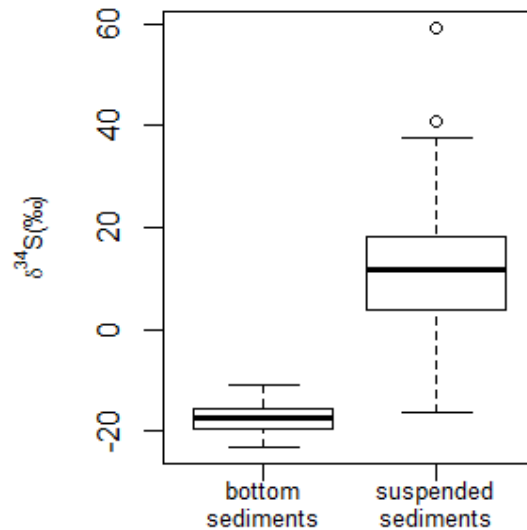
Wind: association with high turbidity when direction shifts.
Possible cause: boats shift on their moorings, resuspending bottom sediments?



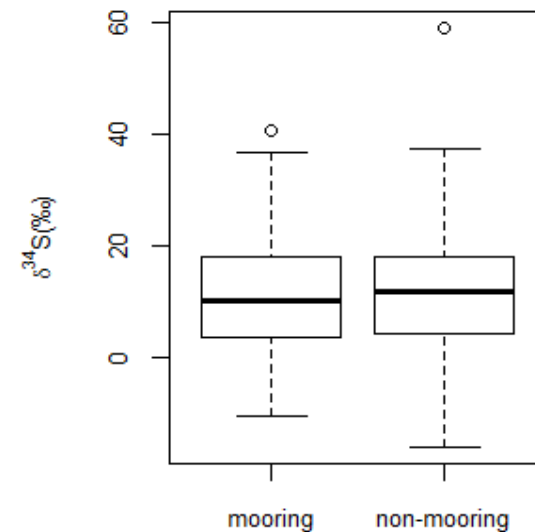
Veering Wind

...but resuspended bottom sediments don't predominate

Comparison of Harbor Bottom Sediments
to Suspended Sediments



Comparison of Suspended Sediments Within
and Outside of Mooring Fields



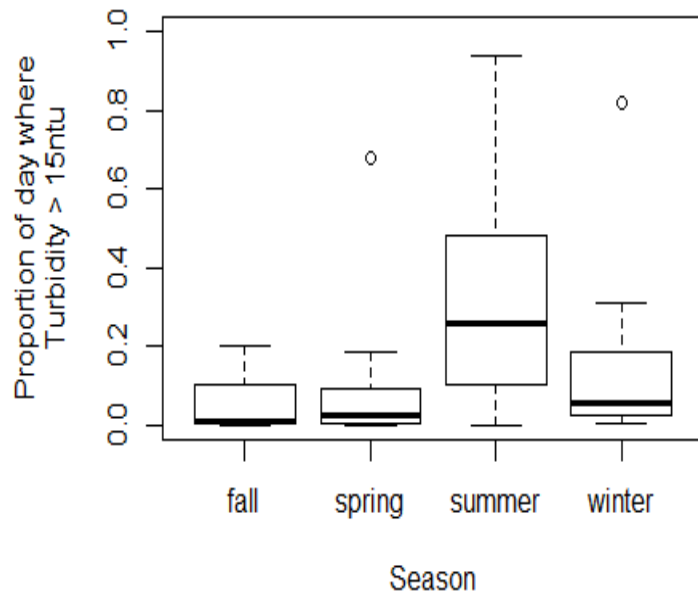
- $\delta^{34}\text{S}$ values are typically low in bottom sediments.
- Resuspension due to mooring shifts would yield comparably low values in suspended samples.
- Would also expect suspended samples from mooring fields to have substantially lower $\delta^{34}\text{S}$ values than suspended samples from elsewhere in the harbor.

Precipitation and Turbidity: No Apparent Correlation

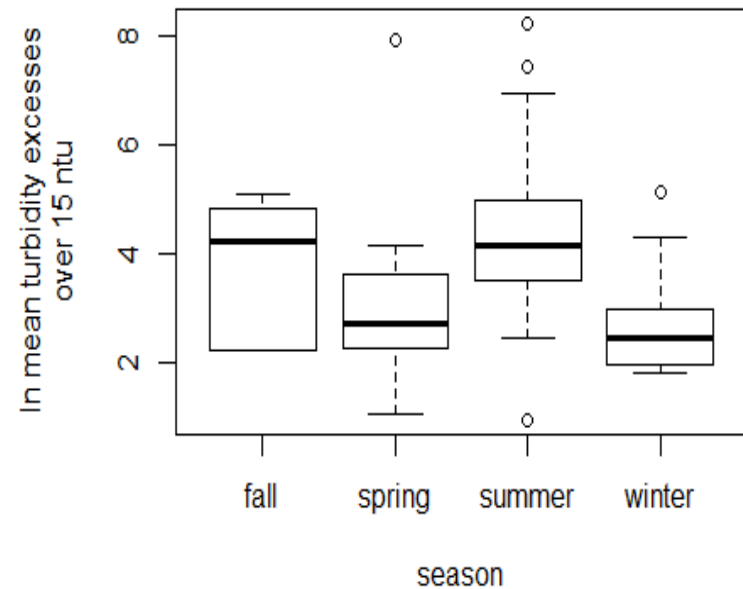
1. No linear correlation between mean daily turbidity and precipitation at any site or date.
2. Using salinity as a proxy for precipitation, we would expect high turbidity to associate with low salinity, but this wasn't the case!
3. Harbor samples had $\delta^{13}\text{C}$ and C:N ratio ranges typical of marine algae, not freshwater.

Turbidity Time-Series by Season implies Phytoplankton Blooms!

**Daily Duration of Elevated Turbidity
by Season, 2012-2014**

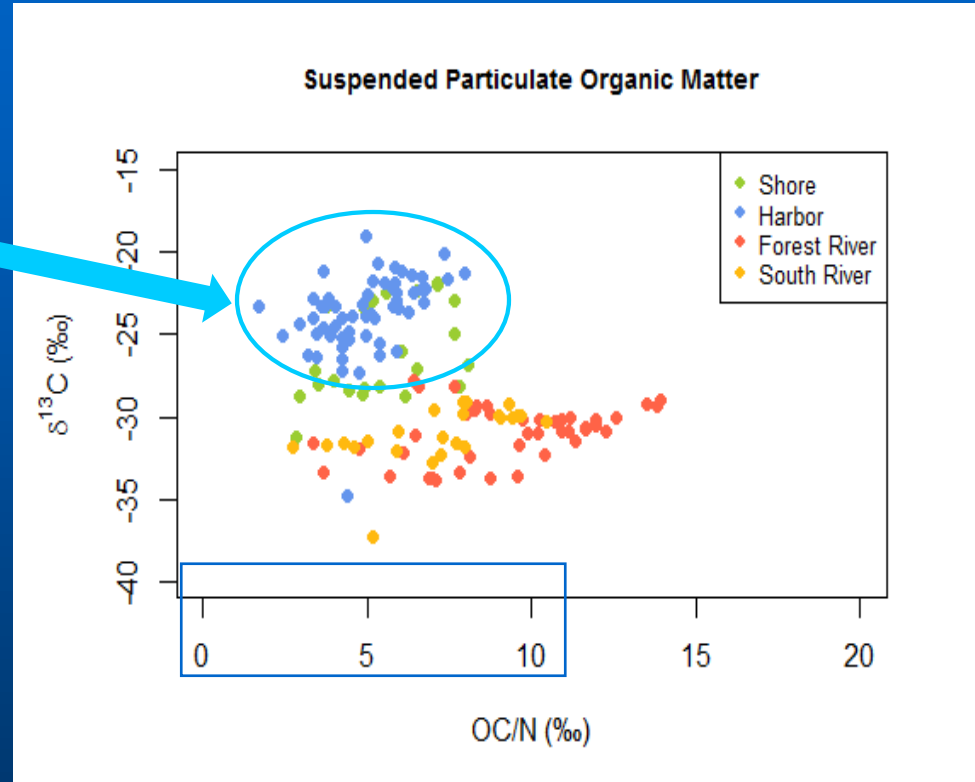
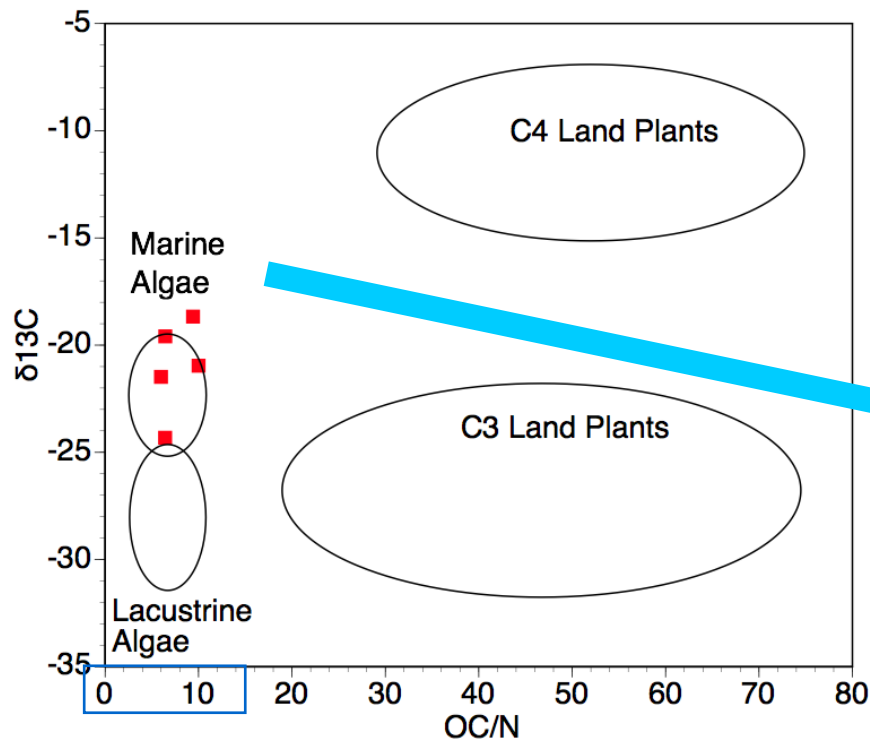


Turbidity Event Magnitude by Season, 2012-2014



Longest duration of high-turbidity events in summer and highest turbidities overall in summer and fall... suggests a light-dependent turbidity source.

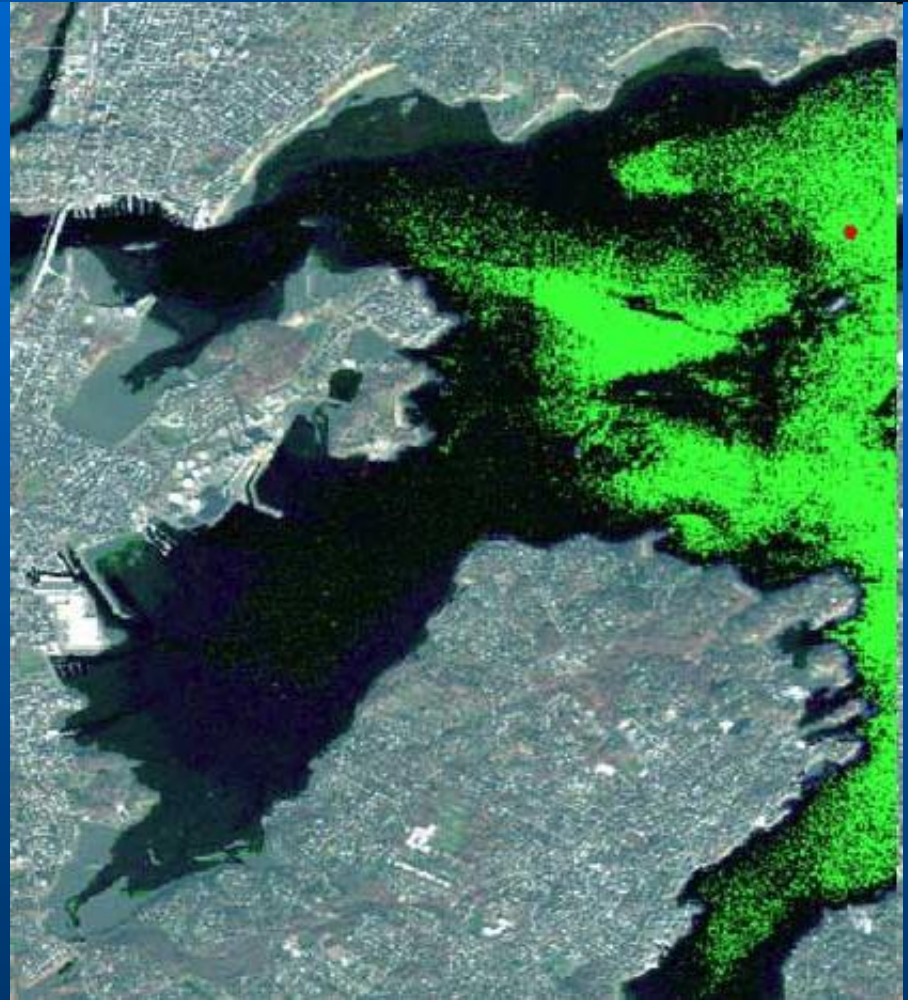
Phytoplankton seems to dominate particulate matter



Elemental analyzer/isotope ratio mass spectrometer quantified C/N concentrations as well as stable isotope ratios to constrain the source of the particulate matter in the water column.

Conclusions: Phytoplankton Supreme

- Turbidity stems mostly from phytoplankton blooms; this is consistent with the findings of several other studies (e.g. Kemp et al. 1983, Nixon 1995).
- Wind and precipitation play a role in *occasional, episodic* turbidity events; not the main cause of elevated turbidities in the Harbor overall



Chlorophyll-a plume – November 2010
processed satellite image (Applied Analysis Inc.)

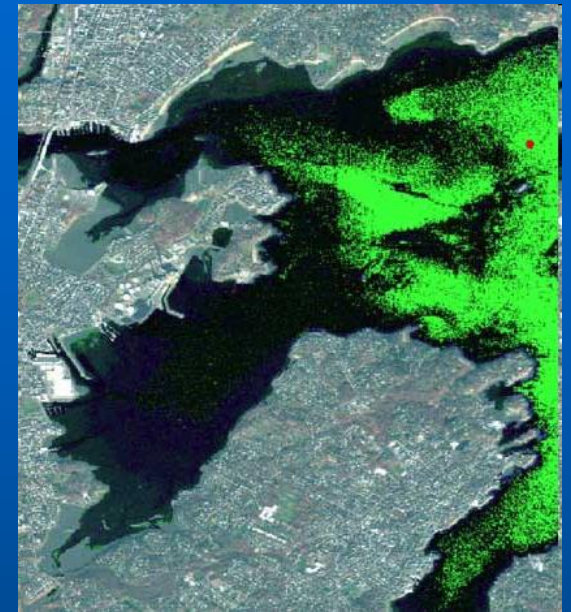
Next Steps: Nutrient Loading?

- Eutrophication accounts for phytoplankton blooms, but we must ID the source of nutrient loading (generally nitrogen).
- Next steps:
 - Continue monitoring efforts in the Harbor
 - Identify peak bloom times to inform future mitigation efforts
 - Measure discharge and nutrient concentrations from tributaries to the Sound
 - Identify and investigate non-point sources, e.g. leached raw sewage.

Here to Document Long Term Change



Migrating Beaches at Derby Wharf – Salem Maritime NPS



Plankton in the SOUND



Salt Marsh Pannes



Fiddler Crab



American oyster catcher

Report to the Community

- Bacterial Monitoring – *water quality* Efforts
- Invasive Species Changes
- Winter Waterfowl Successes
- Salt Marshes
- Turbidity in Salem Harbor – *water quality*

*Citizen Scientists Become
The Local Stewardship Network.*

Tracking Climate Change Impacts